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**BRENNER BASISTUNNEL**  
Detailplanung

*Potenziamento asse ferroviario Monaco - Verona*  
**GALLERIA DI BASE DEL BRENNERO**  
Progettazione di dettaglio

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<b>1</b>	<b>EINLEITUNG</b> .....	<b>6</b>
<b>1</b>	<b>INTRODUZIONE</b> .....	<b>6</b>
<b>2</b>	<b>GEGENSTAND UND ZIEL</b> .....	<b>7</b>
<b>2</b>	<b>OGGETTO E SCOPO</b> .....	<b>7</b>
<b>3</b>	<b>BESCHREIBUNG DER DEPONIE UND DER VORGESEHENEN BAUWERKE</b> .....	<b>8</b>
<b>3</b>	<b>DESCRIZIONE DEL DEPOSITO E DELLE OPERE PREVISTE</b> .....	<b>8</b>
3.1	BESCHREIBUNG DES SACHVERHALTS.....	8
3.1	DESCRIZIONE DELLO STATO DI FATTO.....	8
3.2	BESTEHENDE INFRASTRUKTUREN.....	8
3.2	INFRASTRUTTURE ESISTENTI.....	8
3.3	PROVISORISCHE UNTERKUNFT.....	9
3.3	SISTEMAZIONE PROVVISORIA.....	9
3.4	ENDGÜLTIGE ANORDNUNG.....	10
3.4	SISTEMAZIONE DEFINITIVA.....	10
<b>4</b>	<b>GEOLOGISCHER, HYDROGEOLOGISCHER UND GEOMORPHOLOGISCHER ÜBERBLICK</b> .....	<b>12</b>
<b>4</b>	<b>INQUADRAMENTO GEOLOGICO, IDROGEOLOGICO E GEOMORFOLOGICO</b> .....	<b>12</b>
<b>5</b>	<b>GEOTECHNISCHE CHARAKTERISIERUNG</b> .....	<b>13</b>
<b>5</b>	<b>CARATTERIZZAZIONE GEOTECNICA</b> .....	<b>13</b>
5.1	VERFÜGBARE UNTERSUCHUNGEN.....	13
5.1	INDAGINI DISPONIBILI.....	13
5.1.1	Umfragen.....	13
5.1.1	Sondaggi.....	13
5.1.2	Seismische Untersuchungen.....	14
5.1.2	Indagini sismiche.....	14
5.1.3	Labortests.....	15
5.1.3	Prove di laboratorio.....	15
5.1.4	Infiltrometrische Tests.....	17
5.1.4	Prove infiltrometriche.....	17
5.2	ORT DER UNTERSUCHUNGEN.....	18
5.2	UBICAZIONE DELLE INDAGINI.....	18
5.3	DEFINITION DER BEZUGSTRATIGRAPHIE.....	19
5.3	DEFINIZIONE DELLA STRATIGRAFIA DI RIFERIMENTO.....	19
5.4	GRUNDWASSERSPIEGEL.....	20
5.4	ANDAMENTO DELLA FALDA.....	20
5.5	MATERIAL GELAGERT IN DEN EHEMALIGEN GRUBEN.....	21
5.5	MATERIALI DI RIEMPIMENTO STOCCATI NELLE EX-CAVE.....	21
5.6	DEPONIEMATERIAL.....	23
5.6	MATERIALE DI DEPOSITO.....	23
5.6.1	BH1-Umfrageergebnisse.....	23
5.6.1	Risultati sondaggio BH1.....	23
5.6.2	BH2-Umfrageergebnisse.....	24
5.6.2	Risultati sondaggio BH2.....	24
5.7	BERECHNUNGSPARAMETER.....	27
5.7	PARAMETRI DI CALCOLO TERRENO DI FONDAZIONE.....	27
<b>6</b>	<b>PLANUNGSKRITERIEN NACH GRENZZUSTÄNDEN</b> .....	<b>28</b>
<b>6</b>	<b>CRITERI DI PROGETTAZIONE AGLI STATI LIMITE</b> .....	<b>28</b>
6.1	SICHERHEITSNACHWEISE IM STATISCHEN BEREICH.....	29

6.1	VERIFICHE DI SICUREZZA IN CAMPO STATICO .....	29
6.1.1	Grenzzustand der Gebrauchstauglichkeit (GZG) .....	29
6.1.1	Stati limite di esercizio (SLE) .....	29
6.1.2	Grenzzustand der Tragfähigkeit (GZT) .....	30
6.1.2	Stati limite ultimi (SLU) .....	30
6.2	SICHERHEITSNACHWEISE IM SEISMISCHEN BEREICH .....	32
6.2	VERIFICHE DI SICUREZZA IN CAMPO SISMICO .....	32
6.2.1	Bezugsgrenzzustände für Nachweise bei Erdbebeneinwirkung .....	32
6.2.1	Stati limite di riferimento per le verifiche sismiche .....	32
6.2.2	Grenzzustand der Gebrauchstauglichkeit (GZG) .....	35
6.2.2	Stati limite di esercizio (SLE) .....	35
6.2.3	Grenzzustand der Tragfähigkeit (GZT) .....	35
6.2.3	Stati limite ultimi (SLU) .....	35
6.3	BEMESSUNGSWERTE DER BEANSPRUCHUNG .....	36
6.3	AZIONI DI PROGETTO .....	36
<b>7</b>	<b>MODELLGEOMETRIE .....</b>	<b>37</b>
<b>7</b>	<b>GEOMETRIA DEI MODELLI .....</b>	<b>37</b>
7.1	MODEL SCHNITT 1 .....	38
7.1	MODELLO SEZIONE 1 .....	38
7.2	MODEL SCHNITT 2 .....	40
7.2	MODELLO SEZIONE 2 .....	40
7.3	MODEL SCHNITT 3 .....	42
7.3	MODELLO SEZIONE 3 .....	42
<b>8</b>	<b>NACHWEIS DER GRENZZUSTÄNDE DER TRAGFÄHIGKEIT UND GEBRAUCHS .....</b>	<b>44</b>
<b>8</b>	<b>VERIFICHE AGLI STATI LIMITE ULTIMI E DI ESERCIZIO .....</b>	<b>44</b>
8.1	ANALYSE DER ERGEBNISSE IN BEZUG AUF DIE EINSCHRÄNKUNGSZUSTÄNDE .....	45
8.1	ANALISI DEI RISULTATI RELATIVI AGLI STATI LIMITE DI ESERCIZIO .....	45
8.1.1	Ergebnisse des Schnitts 1 .....	45
8.1.1	Risultati sezione 1 .....	45
8.1.2	Ergebnisse des Schnitts 2 .....	47
8.1.2	Risultati sezione 2 .....	47
8.1.3	Ergebnisse des Schnitts 3 .....	49
8.1.3	Risultati sezione 3 .....	49
8.1.4	Analyse Auswirkungen auf die Vorfertigungsanlage der Segmente und relativen Quadrats .....	51
8.1.4	Analisi degli effetti indotti sull'impianto di prefabbricazione dei conci e relativo piazzale .....	51
8.1.5	Analyse der Auswirkungen auf bestehende Gebäude (Maso Sossai) .....	57
8.1.5	Analisi degli effetti indotti sugli edifici esistenti (Maso Sossai) .....	57
8.2	ANALYSE DER ERGEBNISSE FÜR DIE LETZTEN GRENZSTAATEN .....	64
8.2	ANALISI DEI RISULTATI RELATIVI AGLI STATI LIMITE ULTIMI .....	64
8.2.1	Ergebnisteil 1 .....	64
8.2.1	Risultati sezione 1 .....	64
8.2.2	Ergebnisteil 2 .....	68
8.2.2	Risultati sezione 2 .....	68
8.2.3	Ergebnisteil 3 .....	72
8.2.3	Risultati sezione 3 .....	72
8.3	BELASTUNGEN AUS EINEM HOCHWASSER MIT EINER WIEDERKEHRPERIODE VON .....	76
150 JAHREN .....		76
8.3	CONDIZIONI DI STABILITÀ DEL DEPOSITO IN CASO DI PIENA CON TEMPO DI RITORNO .....	76
150 ANNI .....		76

<b>9 BEWEISSICHERUNGSPLAN.....</b>	<b>78</b>
<b>9 PIANO DI MONITORAGGIO.....</b>	<b>78</b>
9.1 ALLGEMEINE KRITERIEN .....	78
9.1 CRITERI GENERALI.....	78
9.2 FESTLEGUNG ÜBERWACHUNGSSCHWELLEN.....	80
9.2 DEFINIZIONE SOGLIE DI MONITORAGGIO .....	80
9.3 EIGENSCHAFTEN DER INSTRUMENTE.....	81
9.3 CARATTERISTICHE STRUMENTAZIONE.....	81
9.3.1 Inklinometer.....	81
9.3.1 Inclinometri.....	81
9.4 REFERENZDOKUMENTE .....	83
9.4 DOCUMENTI DI RIFERIMENTO.....	83
Executive-Projekt.....	83
Progetto Esecutivo.....	83
Detailliertes Executive-Projekt .....	83
Progetto Esecutivo di Dettaglio.....	83
<b>10 LISTE DER ANHÄNGE.....</b>	<b>84</b>
<b>10 LISTA DELLE APPENDICI.....</b>	<b>84</b>
<b>ANHANG 1 - IN-SITU-TESTS.....</b>	<b>85</b>
<b>APPENDICE 1 – PROVE IN SITU.....</b>	<b>85</b>
<b>ANHANG 2 - LABORTESTS.....</b>	<b>117</b>
<b>APPENDICE 2 – PROVE DI LABORATORIO.....</b>	<b>117</b>
<b>ANHANG 3 – ERGEBNISSE DER PLAXIS SLE/SLD – ABSCHNITT 1.....</b>	<b>131</b>
<b>APPENDICE 3 – RISULTATI ANALISI PLAXIS SLE/SLD – SEZIONE 1.....</b>	<b>131</b>
<b>ANHANG 4 – ERGEBNISSE DER PLAXIS SLE/SLD – ABSCHNITT 2.....</b>	<b>223</b>
<b>APPENDICE 4 – RISULTATI ANALISI PLAXIS SLE/SLD – SEZIONE 2.....</b>	<b>223</b>
<b>ANHANG 5 – ERGEBNISSE DER PLAXIS SLE/SLD – ABSCHNITT 3.....</b>	<b>316</b>
<b>APPENDICE 5 – RISULTATI ANALISI PLAXIS SLE/SLD – SEZIONE 3.....</b>	<b>316</b>
<b>ANHANG 6 – ERGEBNISSE DER PLAXIS SLU/SLV – ABSCHNITT 1.....</b>	<b>409</b>
<b>APPENDICE 6 – RISULTATI ANALISI PLAXIS SLU/SLV – SEZIONE 1.....</b>	<b>409</b>
<b>ANHANG 7 – ERGEBNISSE DER SLIDE SLU – ABSCHNITT 1.....</b>	<b>523</b>
<b>APPENDICE 7 – RISULTATI ANALISI SLIDE SLU – SEZIONE 1.....</b>	<b>523</b>
<b>ANHANG 8 – ERGEBNISSE DER SLIDE SLV – ABSCHNITT 1.....</b>	<b>542</b>
<b>APPENDICE 8 – RISULTATI ANALISI SLIDE SLV – SEZIONE 1.....</b>	<b>542</b>
<b>ANHANG 9 – ERGEBNISSE DER PLAXIS SLU/SLV – ABSCHNITT 2.....</b>	<b>561</b>
<b>APPENDICE 9 – RISULTATI ANALISI PLAXIS SLU/SLV – SEZIONE 2.....</b>	<b>561</b>
<b>ANHANG 10 – ERGEBNISSE DER SLIDE SLU – ABSCHNITT 2.....</b>	<b>676</b>
<b>APPENDICE 10 – RISULTATI ANALISI SLIDE SLU – SEZIONE 2.....</b>	<b>676</b>
<b>ANHANG 11 – ERGEBNISSE DER SLIDE SLV – ABSCHNITT 2.....</b>	<b>697</b>
<b>APPENDICE 11 – RISULTATI ANALISI SLIDE SLV – SEZIONE 2.....</b>	<b>697</b>

<b>ANHANG 12 – ERGEBNISSE DER PLAXIS SLU/SLV – ABSCHNITT 3 .....</b>	<b>718</b>
<b>APPENDICE 12 – RISULTATI ANALISI PLAXIS SLU/SLV – SEZIONE 3.....</b>	<b>718</b>
<b>ANHANG 13 – ERGEBNISSE DER SLIDE SLU – ABSCHNITT 3 .....</b>	<b>832</b>
<b>APPENDICE 13 – RISULTATI ANALISI SLIDE SLU – SEZIONE 3 .....</b>	<b>832</b>
<b>ANHANG 14 – ERGEBNISSE DER SLIDE SLV – ABSCHNITT 3 .....</b>	<b>854</b>
<b>APPENDICE 14 – RISULTATI ANALISI SLIDE SLV – SEZIONE 3 .....</b>	<b>854</b>
<b>ANHANG 15 – ERGEBNISSE DER SLIDE SLU „PIENA“ – ABSCHNITT 3.....</b>	<b>876</b>
<b>APPENDICE 15 – RISULTATI ANALISI SLIDE SLU “PIENA” – SEZIONE 3.....</b>	<b>876</b>
<b>ANHANG 16 – ERGEBNISSE DER SLIDE SLU „SVASO RAPIDO“ – ABSCHNITT 3 .....</b>	<b>898</b>
<b>APPENDICE 16 – RISULTATI ANALISI SLIDE SLU “SVASO RAPIDO” – SEZIONE 3 .....</b>	<b>898</b>

## 1 EINLEITUNG

Für die Errichtung des Brennerbasistunnels sind auf italienischem Staatsgebiet zwei Deponien vorgesehen, um das Ausbruchsmaterial. Es handelt sich um die Materialdeponie Genauen 2 und um die Materialdeponie Hinterrigger, der Gegenstand des vorliegenden Berichts ist.

Mit Bezug zu den Planunterlagen der Deponien wurden unterschiedliche Gebrauchsklassen des Materials, das vom Ausbruch der Stollen und der beiden Haupttunnel des Brennerbasistunnels stammen, sowie aus den Verbindungstunnels und den Kavernen: (1) Klasse A, bestehend aus Material hochwertiger Qualität, geeignet für Zuschlagstoffe; (2) Klasse B, bestehend aus Material geeignet für Aufschüttungen oder Verfüllungen; (3) Klasse C bestehend aus Material, das somit definitiv gelagert wird.

Unter Berücksichtigung der filigranen Morphologie des Eisacktals und der Problematik, ausreichend voluminöse Speicherflächen zu schaffen, wurde besonderes Augenmerk darauf gelegt, die Lagerstätten selbst so zu dimensionieren und zu modellieren, dass sie sich bestmöglich in die bestehende Landschaft einfügen.

Dieser Bericht berichtet über die Ergebnisse der geotechnischen Studien, die für die ausführende Neugestaltung der teen Lagerstätte bei Hinterrigger durchgeführt Charaktedes Baugrundes und den dazu durchgeführten Untersuchungen wird auf das Dokument 02\_H61\_DB\_300\_KTB\_B0130\_51055 verwiesen.

Um das Lesen des Dokuments zu erleichtern, enthält es die folgenden 5 Anhänge verschiedenen Kapiteln des Berichts Bezug genommen wird:

- Anhang 1, der die Ergebnisse der Untersuchungen enthält, die die Lagerstätte besteht (Bohrungen und zugehörige Stratigraphie, seismische Refraktionsuntersuchung).
- Anhang 2, der die Ergebnisse der Laboruntersuchungen enthält, die an den Proben durchgeführt wurden, die bei den in Anhang 1 aufgeführten Erhebungen entnommen wurden;
- Anlagen 3, 4 und 5, die die Ergebnisse der mit der Finite-Elemente-Methode

Auch ein Sammel- und Entsorgungssystem für das Oberflächenwasser der Deponie ist vorgesehen, dessen Dimensionierung dem Regenwasserentsorgungsbericht 02\_H61\_DB\_300\_KTB\_B0130\_51054 zu entnehmen ist.

## 1 INTRODUZIONE

Per la realizzazione della Galleria di Base del Brennero, sul territorio italiano sono previsti due depositi per collocare, sia provvisoriamente sia definitivamente, lo smarino proveniente dagli scavi; si tratta del deposito di Genauen 2 e del deposito di Hinterrigger, questo oggetto della presente relazione.

Con riferimento agli elaborati grafici dei depositi, sono state distinte le seguenti classi di utilizzo del materiale proveniente dagli scavi del cunicolo di servizio e delle due canne principali della Galleria di Base del Brennero, comprese le interconnessioni e i cameroni: (1) classe A, costituita da materiale di alta qualità, idoneo per inerti; (2) classe B, costituita da materiale idoneo per riporti o riempimenti; (3) classe C costituita da materiale non riutilizzabile e destinato a deposito in via definitiva.

Tenendo conto della delicata morfologia presente in Val d'Isarco e della problematica di realizzare aree di deposito sufficientemente voluminose, si è posta particolare attenzione nel dimensionare e modellare i depositi stessi in modo tale da inserirli nel miglior modo possibile nel paesaggio esistente.

La presente relazione riporta le risultanze degli studi geotecnici effettuati per la riprogettazione esecutiva del deposito in fase provvisoria e definitiva di Hinterrigger. Per la caratterizzazione geotecnica del terreno di fondazione e le relative indagini effettuate si rimanda al documento 02\_H61\_DB\_300\_KTB\_B0130\_51055.

Per facilità di consultazione del documento, lo stesso comprende le appendici 1 e 2 gli output di calcolo (Appendice 3 – 14) sono riportati come allegati:

- Appendice 1 che contiene i risultati delle indagini effettuate per caratterizzare il materiale costituente il deposito (sondaggi e relative stratigrafie, indagine sismica a rifrazione).
- Appendice 2 che contiene i risultati delle prove di laboratorio effettuate sui campioni prelevati nei sondaggi riportati in Appendice 1;
- Appendici 3 - 14, riportano i dati di Input ed i risultati delle analisi numeriche agli elementi finiti e le analisi all'equilibrio limite effettuate per la verifica del deposito.

È inoltre previsto un sistema di raccolta e smaltimento delle acque superficiali del deposito, per il cui dimensionamento si rimanda alla relazione di smaltimento acque meteoriche 02\_H61\_DB\_300\_KTB\_B0130\_51054.

## **2 GEGENSTAND UND ZIEL**

Der vorliegende Bericht behandelt die Materialdeponie für Ausbruchmaterial Hinterrigger, die sich auf dem orographischen Rechten des Eisacks befindet und im Norden, Osten und Süden vom Fluss bogenförmig begrenzt ist. Im Westen erhebt sich eine einige Zehnermeter hohe Felswand bis zur Forch Terrasse. Vor allem im Süden, wo die Felswand fast senkrecht ist, besteht ein großes Steinschlagrisiko.

Ziel dieses Berichtes ist die Wiedergabe der Ergebnisse der Standsicherheitsnachweise und der Setzungsanalysen, die sich durch die Errichtung der Deponie zeigen können, und ihrer Auswirkungen auf die angrenzenden Strukturen und Infrastrukturen mit besonderem Hinblick auf die beiden Hochspannungslinien in der Nähe der Deponie. Dabei werden alle verfügbaren geotechnischen Untersuchungen überprüft, die Projektstratigraphie definiert und der Baugrund sowie das ganze Material, das deponiert wird, aus geotechnischer Sicht charakterisiert.

## **2 OGGETTO E SCOPO**

La presente relazione ha per oggetto il deposito dello smarino di Hinterrigger, situato sulla sponda orografica destra dell'Isarco e delimitato, a forma di arco, a nord, est e sud dal fiume. A ovest, una parete rocciosa alta decine di metri si staglia fino alla terrazza di Forch. Soprattutto a sud, dove la parete rocciosa è quasi verticale, c'è un elevato rischio di caduta massi.

Lo scopo della relazione è quello - dopo avere effettuato una revisione delle indagini geotecniche attualmente disponibili ed avere definito una stratigrafia di progetto ed una caratterizzazione geotecnica dei terreni di fondazione e dei materiali che costituiranno il deposito - di riportare i risultati delle verifiche di stabilità e delle analisi dei cedimenti indotti dalla realizzazione del deposito.



### 3 BESCHREIBUNG DER DEPONIE UND DER VORGESEHENEN BAUWERKE

#### 3.1 BESCHREIBUNG DES SACHVERHALTS

Das Areal der Materialdeponie Hinterrigger liegt im Riggertal auf der orographischen Rechten des Eisacks. Das Gelände befindet sich im Gemeindegebiet von Vahrn, circa auf Höhe der Autobahnausfahrt A22 "Brixen-Vahrn".

### 3 DESCRIZIONE DEL DEPOSITO E DELLE OPERE PREVISTE

#### 3.1 DESCRIZIONE DELLO STATO DI FATTO

L'area del deposito Hinterrigger è situata nella val di Riga sul lato orografico destro dell'Isarco. L'area è nel territorio comunale di Varna, circa all'altezza dell'uscita dell'autostrada A22 "Bressanone-Varna".



Abbildung 1: Lageplan Hinterrigger Zustand

Figura 1. Planimetria deposito Hinterrigger, stato di fatto

#### 3.2 BESTEHENDE INFRASTRUKTUREN

Anschließend führt man eine Zusammenfassung der bestehenden Interferenzen im Bereich der Materialdeponie:

- Grundwassermessstellen
- Sossai-Farm
- Wasserleitung [HR-V-1]
- RFI 132 kV Stromleitung

(das Spalier wird außerhalb der Grenzen der neu gestalteten Lagerstätte platziert, daher stört es den Stapel nicht)

#### 3.2 INFRASTRUTTURE ESISTENTI

Di seguito si dà un riepilogo delle interferenze esistenti nella zona del deposito:

- Piezometri di misura della falda
- Maso Sossai
- Tubazioni acquedotto non potabile [HR-V-1]
- Linea elettrica da 132kV della RFI

(il traliccio è posizionato al di fuori dei limiti del deposito riprogettato, pertanto non interferisce con il cumulo)

### 3.3 PROVVISORISCHE UNTERKUNFT

Als Vorbau ist in den Randbereichen eine Aufschüttung vorgesehen, innerhalb derer das Material dann sukzessive in max. 60 cm dick. Die Behelfsflächen sind mit einem solchen Gefälle herzustellen, dass Oberflächenwasser abfließen und in einem provisorischen Absetzbecken anlaufen kann. Der Damm wird unter anderem die Funktion eines Sicht- und Lärmschutzes haben.

#### Störung provisorische Unterkunft

Das Material wird vorübergehend in der Hinterigger platziert, unter Berücksichtigung der Anwesenheit des Implantats von Vorfertigung der Segmente, die für die gesamte Dauer der Arbeiten Teil der Fläche festgelegt ist.

### 3.3 SISTEMAZIONE PROVVISORIA

È stato realizzato preliminarmente nelle zone marginali un argine, all'interno del quale il materiale è stato sistemato in strati successivi di max. 60cm di spessore. Le superfici provvisorie dovranno essere realizzate con un'inclinazione tale da permettere lo scorrimento delle acque. Il terrapieno avrà tra l'altro la funzione di barriera paravista e antirumore.

#### Interferenze sistemazione provvisoria

Il materiale verrà sistemato provvisoriamente nell'area di Hinterigger, tenendo conto della presenza dell'impianto di prefabbricazione dei conci che occupa per l'intera durata dei lavori una parte significativa dell'area in oggetto.

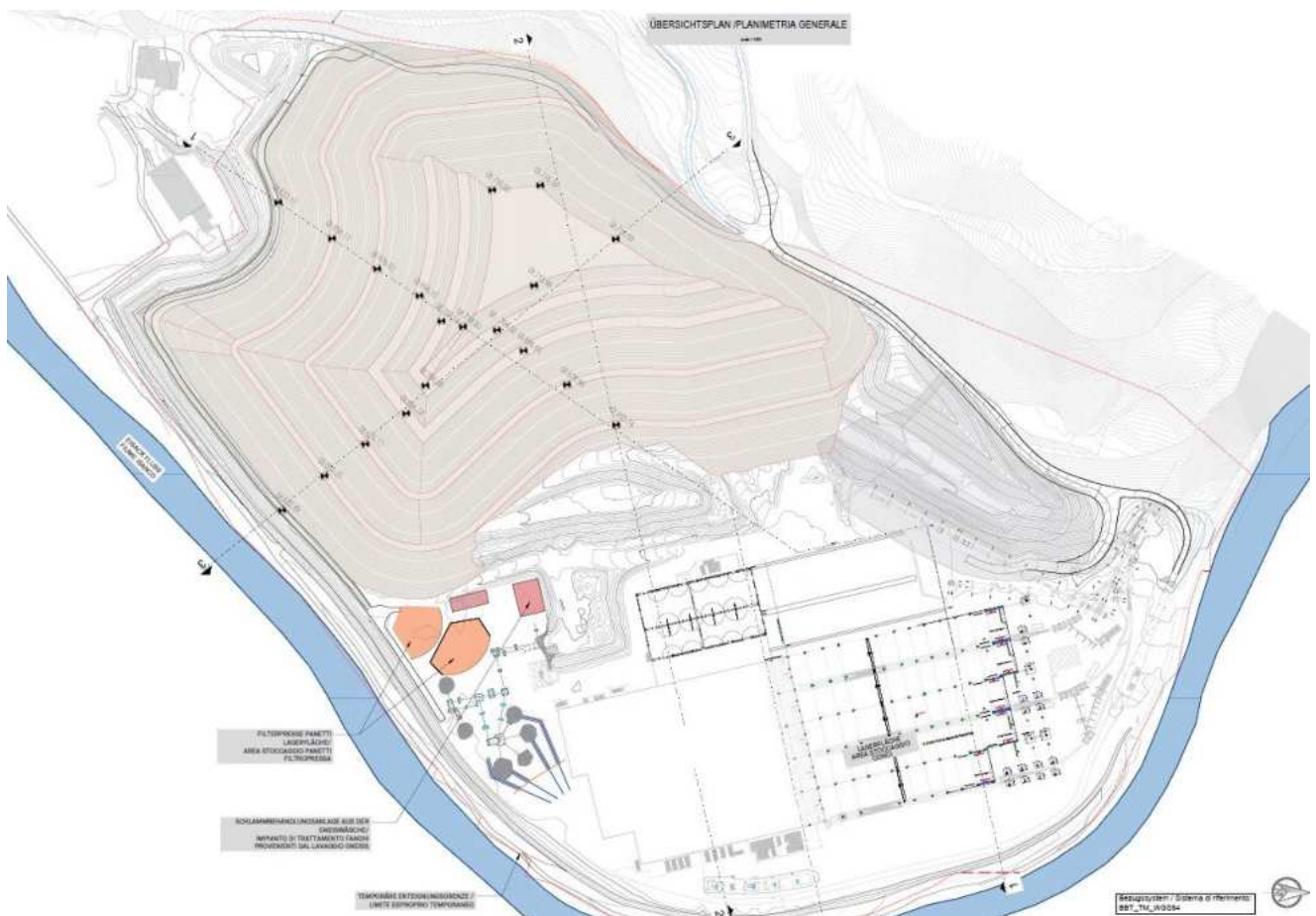


Abbildung 2: Lageplan Hinterrigger maximale Füllphase

Figura 2. Planimetria deposito Hinterrigger, fase provvisoria di massimo riempimento

### 3.4 ENDGÜLTIGE ANORDNUNG

Nach der Anordnung des Materials werden die Lagerfläche der Tübbinge und das Fertigteilwerk abgebaut.

Sobald die Halde während der Auffüllphase erreicht ist, wird sie von allen Unebenheiten im Boden angemessen eingeebnet, um das erforderliche Gefälle zu erhalten.

Die endgültige Geometrie des Modells in der vorläufigen Phase ist bis auf die hydraulische Anordnung zur Regulierung des Regenwassers identisch mit der endgültigen.

#### Endgeometrie der Lagerstätte

### 3.4 SISTEMAZIONE DEFINITIVA

Finita la sistemazione del materiale, l'area di stoccaggio dei conci e l'impianto di prefabbricazione saranno smantellati.

Il cumulo, una volta raggiunta la quota finale in fase di riempimento, verrà adeguatamente livellato da eventuali irregolarità del terreno per ottenere la pendenza necessaria.

La geometria finale del modello in fase provvisoria è identica a quella definitiva, a meno della sistemazione idraulica per la regimentazione delle acque piovane.

#### Geometria finale del deposito

Dati geometrici del cumulo di Progetto / Geometriche Daten der Projektakkumulation	
Area di deposito proiettato (m <sup>2</sup> ) / Voraussichtliche Lagerfläche (m <sup>2</sup> )	101.200
Volume di deposito (m <sup>3</sup> ) / Speichervolumen (m <sup>3</sup> )	4.884.862
Lunghezza max (m) / Maximale Länge (m)	456.48
Larghezza max (m) / Maximale Breite (m)	355.05
Altezza max (m) / Maximale Höhe (m)	716.71
Pendenza superficiale (long) / Oberflächenneigung (lang)	1V / 150H
Pendenza superficiale (trasv) / Oberflächenneigung (quer)	1V / 150H
Pendenza scarpata / Steilhang	1V / 1.33H

Das Material auf den Böschungen wird durch ein Oberflächenabflussnetz geschützt, das in der Endphase installiert wird und das den Abtransport des Wassers von der Halde durch Kanäle und Rohre bis zum Absetzbecken und schließlich in seinen endgültigen Vorfluter Eisack ermöglicht.

Änderungen am Pfahl und seiner Geometrie sind sicherheitshalber zu berücksichtigen, wenn sie auf eine geringere Materialmenge zurückzuführen sind. Jede Erhöhung der im Projekt vorgesehenen Endmenge muss im Hinblick auf die Überprüfung der globalen Stabilität der Akkumulation selbst bewertet werden.

Il materiale sulle scarpate sarà protetto da una rete di deflusso superficiale, messa in opera in fase finale, e che permetterà l'allontanamento delle acque dal cumulo attraverso canali e tubazioni, e di avviarle in una vasca di sedimentazione ed infine nel suo recettore finale Fiume Isarco.

Eventuali modifiche del cumulo e della sua geometria sono da considerarsi a favore di sicurezza nel momento in cui sono conseguenza di un minor quantitativo di materiale abbancato. Un eventuale aumento del quantitativo finale previsto in progetto, dovrà essere valutato nell'ottica di verificare la stabilità globale del cumulo stesso.

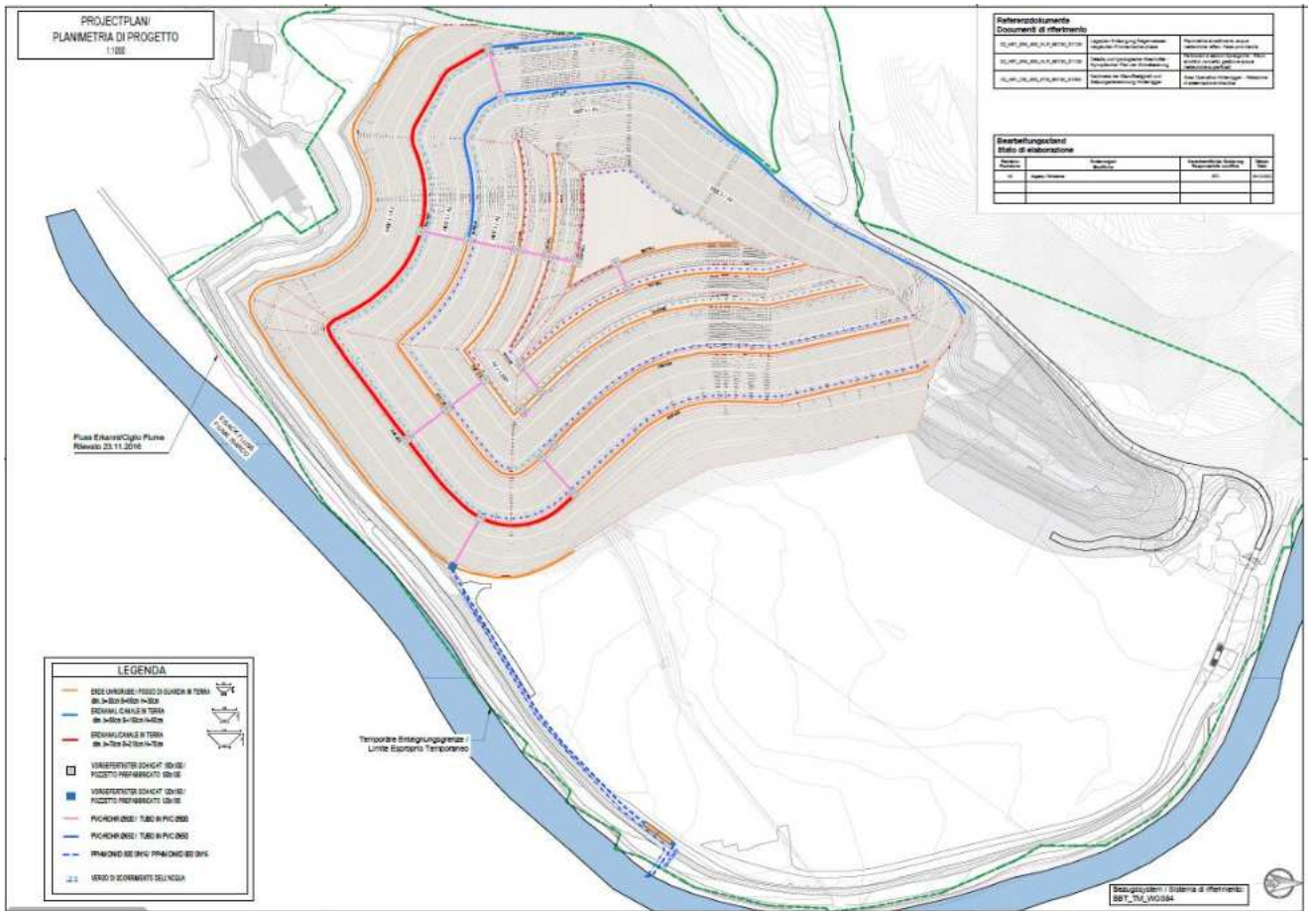


Abbildung 3: Lageplan Hinterrigger maximale Füllphase

Figura 3. Planimetria deposito Hinterrigger, fase finale di massimo riempimento

#### **4 GEOLOGISCHER, HYDROGEOLOGISCHER UND GEOMORPHOLOGISCHER ÜBERBLICK**

Die Materialdeponie Hinterrigger liegt im Riggertal im Bereich des Hofes Hinterrigger. Diese Studie betrifft neben dem Gelände der Materialdeponie des Stollens Unterplattner, der die Gebiete Unterplattner und Hinterrigger verbindet.

Die Studie erfolgte im Gebiet der Baustelle und der Materialdeponie Hinterrigger, die sich im Talboden und auf der Terrasse von Vahrn (Industriezone Vahrn) befinden und aus geologischer Sicht aus Lockermaterialablagerungen unterschiedlicher Herkunft bestehen.

Die Terrasse in der orographischen Rechten des Talbodens besteht vorwiegend aus fluvioglazialen und Seeablagerungen. Untergeordnet finden sich auch glaziale Moränenablagerungen. Im Talboden finden sich post-glaziale und fluviale Sedimente, am Terrassenrand finden sich auf eluviale und kolluviale Ablagerungen.

Nur an der nördlichen Grenze des Untersuchungsgebietes steht der felsige Untergrund an, der hier aus den Brixner Phylliten und Brixner Granit besteht.

Hier im Riggertal ist eine enge Schlucht ausgebildet, die durch den Eisack durch Erosion entstanden ist. Im Gebiet (SS49) der Brücke findet man den Übergang zwischen den Brixner Phylliten im Süden und dem Brixner Granit im Norden. Die Schieferung fällt mit 50° Richtung NO-SW ein. Die Trennflächenfamilien bestehen vorwiegend aus Klüften, wobei einige Störungsflächen auch Hinweise auf Bewegungsrichtungen findet drei Hauptklufsysteme.

Der Eisack, der das Gelände der Materialdeponie nach NO und N begrenzt, ist der Hauptsammler. Neben dem Eisack finden sich keine anderen Fließgewässer. Das Grundwasser befindet sich je nach Morphologie in ca. 2,5 m bis 15m Tiefe ab Geländeoberkante. Die Durchlässigkeit der Sedimente ist Funktion der Art der Ablagerungen. Im Talboden erwartet man sich hohe Durchlässigkeiten. Auf dem Gelände der Materialdeponie wird das Grundwasser nicht genutzt. Sei es der Tiefbrunnen "Sossai", der das Trinkwasser für den Hinterrigger Hof liefert, als auch die Tränke Baumgartner liegen südlich des Geländes der Materialdeponie Hinterrigger. Ein Einfluss auf das Wasser, was die Mengen betrifft, ist unwahrscheinlich. An der NW und W Grenze des Geländes Steinschlaggefahr, die nicht nur die Oberfläche der Materialdeponie betrifft, sondern auch dessen Zufahrtsstraße.

Es sind Arbeiten zum Schutz der Straßenrand- und Steinschlagnetze geplant, um den Hang vor PED zu schützen.

#### **4 INQUADRAMENTO GEOLOGICO, IDROGEOLOGICO E GEOMORFOLOGICO**

Il deposito Hinterrigger è situato nella Val Riga nella zona del podere Hinterrigger. Lo studio comprende, oltre all'area di deposito, anche la zona del cunicolo Unterplattner, che collega le aree Unterplattner e Hinterrigger.

Lo studio si è svolto nell'area di cantiere e del deposito Hinterrigger, situati sul fondovalle e sul terrazzo di Varna (zona industriale di Varna) che dal punto di vista geologico, sono formati principalmente da terreni sciolti d'origine diversa.

Il terrazzo in destra orografica del fondovalle è composto prevalentemente da sedimenti fluvioglaciali e lacustri. Subordinatamente si possono rinvenire depositi morenici conservati. Sul fondovalle si trovano sedimenti post-glaciali e fluviali, ai bordi del terrazzo vi sono anche depositi eluviali e colluviali.

Solo in corrispondenza del limite settentrionale della zona di studio affiora il substrato roccioso costituito da Fillade di Bressanone e Granito di Bressanone.

Qui la Val Riga si restringe in una gola stretta incisa dall'Isarco in seguito ad erosione. Nella zona (SS49) del ponte si trova il passaggio da Fillade di Bressanone a sud a Granito di Bressanone a nord. La scistosità della roccia ha direzione ca. NE-SW con inclinazione di 50° ca. Le famiglie dei giunti sono rappresentate prevalentemente da fratture e con alcuni piani di faglie con indicatori cinematici. Essenzialmente troviamo tre sistemi di frattura principali.

L'Isarco che delimita l'area di deposito verso NE e E, rappresenta il collettore principale. Oltre al fiume Isarco non sono presenti altre linee di deflusso. In relazione alla morfologia, la falda freatica si trova da ca. 2,5 m fino a 15m sotto il piano campagna. La permeabilità dei sedimenti varia in funzione della tipologia di deposito. Nel fondovalle ci si aspetta una permeabilità elevata. Nell'area di deposito non viene utilizzata l'acqua di falda. Sia il pozzo "Sossai" che fornisce acqua potabile al maso Hinterrigger che l'abbeveratoio Baumgartner sono situati a sud della superficie di deposito Hinterrigger. Un'interferenza quantitativa sulle acque risulta poco probabile. Lungo il limite NW e W dell'area persiste un notevole pericolo di caduta massi che è rilevante non solo per la superficie di deposito ma anche per la strada di accesso.

Sono previste opere a protezione del ciglio stradale e reti paramassi a protezione del versante da PED.

## 5 GEOTECHNISCHE CHARAKTERISIERUNG

Im Rahmen der Neugestaltung der temporären und definitiven Form der Lagerstätte wurden weitere Untersuchungen zur besseren Charakterisierung des Lagerstättenmaterials selbst durchgeführt (ohne Untersuchung der Gründungsschichten).

Die Baugrundcharakterisierungsparameter wurden auf Basis der vorliegenden Untersuchungen neu analysiert, resultierend konservativ im Vergleich zu Literaturwerten für analoge Materialien.

Es wird daher bestätigt, dass die in PE gewählten Werte ausreichend repräsentativ für das Material sind, das unterhalb der nachweispflichtigen Böschung vorhanden ist.

### 5.1 VERFÜGBARE UNTERSUCHUNGEN

Als Teil des ausführenden Projekts wurde eine Untersuchungskampagne durchgeführt, die aus 5 Bergungskernen (L = 15 m) und dynamischen penetrometrischen Tests (SPT) in den vorrückenden Kernbohrlöchern sowie Durchlässigkeitstests bestand, die beide im Bohrloch durchgeführt wurden als im Labor.

Die Ergebnisse dieser Untersuchungen und die getroffene geotechnische Charakterisierung sind im Bericht 02\_H61\_DB\_300\_KTB\_B0130\_51055 zur Überprüfung der Standsicherheit und Setzung von Hinterrigger beschrieben, auf den für weitere Informationen verwiesen werden sollte.

Die durchgeführten Untersuchungen bestehen aus:

- Kontinuierliches Kernbohren;
- Seismische Refraktionstomographie in P- und S-Wellen;
- Entnahme von Proben aus den Erhebungen mit Durchführung anschließender Laboruntersuchungen.
- Kontinuierliches Kernbohren;
- Infiltrometrische Tests;

Eine Untersuchung zu letzterem findet sich weiter unten.

#### 5.1.1 Umfragen

2 kontinuierliche Kernbohrungen namens BH1 und BH2 wurden von der Lagerstättenebene aus durchgeführt. Die Bohrung BH1 befindet sich in zentraler Lage der Lagerstätte, die Bohrung BH2 in Hangnähe. Die Bohrungen durchqueren den gesamten Lagerstättenkörper bis zum Baugrund. Bestimmtes:

- kontinuierliche Kernbohrung bis zu einer Tiefe von 80,00 m von b.c. genannt BH1 (Ausführungshöhe 705 m ü.M.);

## 5 CARATTERIZZAZIONE GEOTECNICA

Nell'ambito della riprogettazione della conformazione temporanea e definitiva del deposito, sono state eseguite ulteriori indagini per meglio caratterizzare il materiale costituente il deposito stesso (non indagando gli strati di fondazione).

I parametri di caratterizzazione del terreno di fondazione sono stati rianalizzati sulla base delle indagini disponibili, risultando cautelativi comparati a valori di letteratura per materiali analoghi.

Si conferma pertanto, che i valori scelti in PE sono sufficientemente rappresentativi del materiale presente al di sotto del rilevato oggetto di verifica.

### 5.1 INDAGINI DISPONIBILI

Nell'ambito del Progetto Esecutivo è stata eseguita una campagna di indagini costituita da 5 carotaggi a recupero (L=15 m) e da prove penetrometriche dinamiche (SPT) eseguite nei fori di carotaggio in avanzamento, nonché da prove di permeabilità e prove infiltrometriche realizzate sia in foro che in laboratorio.

I risultati di tali indagini e la caratterizzazione geotecnica adottata vengono descritti nella relazione 02\_H61\_DB\_300\_KTB\_B0130\_51055 di verifica di stabilità e assestamenti di Hinterrigger, alla quale si rimanda per ogni approfondimento.

Le indagini eseguite consistono in:

- Sondaggi a carotaggio continuo;
- Tomografia sismica a rifrazione in onde P e S;
- Prelievo di campioni dai sondaggi con esecuzione di successive prove di laboratorio.
- Sondaggi a carotaggio continuo;
- Prove infiltrometriche;

Nel seguito si riporta una disamina di quest'ultime.

#### 5.1.1 Sondaggi

Sono stati eseguiti n°2 sondaggi a carotaggio continuo denominati BH1 e BH2 eseguiti dalla quota del deposito. Il sondaggio BH1 ubicato in posizione centrale del deposito, il BH2 prossimo alla scarpata. I sondaggi attraversano l'intero corpo del deposito fino ad intestarsi nel terreno di fondazione. In particolare:

- sondaggio a carotaggio continuo spinto fino alla profondità di 80.00 m da p.c. denominato BH1 (quota di esecuzione 705 m s.l.m.);

- kontinuierliche Kernbohrung bis zu einer Tiefe von 62,00 m von b.c. genannt BH2 (Ausführungshöhe 686 m ü.M.).

Da es sich bei dem Material, aus dem die Lagerstätte besteht, hauptsächlich um grobkörnige Bestandteile handelt, wurden die Bohrungen „trocken“ durchgeführt, um eine Auswaschung zu vermeiden und somit eine maximale Repräsentativität der Kernbohrungen zu gewährleisten.

In Anhang 1 befinden sich die stratigraphische Beschreibung der erhaltenen Stämme und die Fotos der Kassetten. Weitere Informationen zu den angewandten sind dem Dokument zu entnehmen, das von der Firma wurde, die die Untersuchungen durchführt (Georicerche-Bericht – Geognostische, die in der Hinterrigger-Deponie mit in der Gemeinde Varna BZ durchgeführt wurde).

### 5.1.2 Seismische Untersuchungen

Es wurden zwei seismische Refraktionstomographie-Ausbreitungen in P- und S-Wellen durchgeführt. Die Länge der Ausbreitungen beträgt etwa 130 bzw. 150 m, wobei versucht wurde, die Breite, um eine tiefergehende innerhalb der Lagerstätte selbst zu ermöglichen.

Im Anhang 1 finden Sie das Ergebnis der seismischen Brechung mit den mit L1 und L2 bezeichneten Schichten.

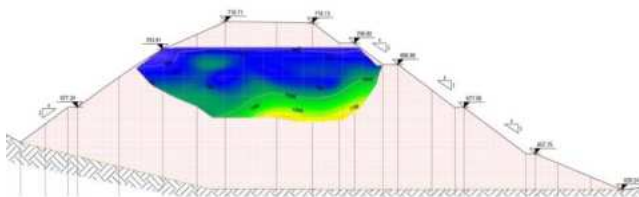


Abbildung 4: Seismisches Profil L1 und L2 mit Vp-Kompressions

Im L1-Profil finden sich Werte über 1000 m/s, typisch für eher verdichtete Ablagerungen, und erreichen ein Maximum von etwa 1800 m/s, was typisch für ein alteriertes Gesteinssubstrat wäre; Vor diesem Hintergrund deuten diese Werte eher auf kompaktes Lagerstättenmaterial hin.

Im Profil L2 betragen die Vp-Werte etwa 1100 m/s oder mehr, was auf den Bereich hinweist, in dem die Ablagerung relativ stärker verdichtet ist als der darüber liegende Teil.

Die beiden Verlegungen L1 und L2 wurden auf dem im Bau befindlichen Pfahl durchgeführt, in der Endphase wird die im Abschnitt angegebene maximale Höhe erreicht.

Weitere Informationen zu den verwendeten Ausführungsmethoden finden Sie im Dokument des Unternehmens, das die Untersuchungen durchführt (Akron-Tabelle – Seismische Brechung Vp und Vs).

- sondaggio a carotaggio continuo spinto fino alla profondità di 62.00 m da p.c. denominato BH2 (quota di esecuzione 686 m s.l.m.).

Dato che il materiale costituente il deposito è prevalentemente a componente grossolana, i sondaggi sono stati realizzati “a secco” per evitare dilavamenti e garantire quindi la massima rappresentatività del carotaggio.

In Appendice 1 è presente la descrizione stratigrafica dei logs ottenuti e le foto delle cassette. Per ulteriori informazioni sulle metodiche esecutive impiegate si rimanda al documento emesso dalla ditta esecutrice dei sondaggi (Report Georicerche - Campagna di indagini geognostiche eseguita nel deposito Hinterrigger ospitante materiale smarino nel comune di Varna BZ).

### 5.1.2 Indagini sismiche

Sono state eseguite n°2 stese di tomografia sismica a rifrazione in onde P e S. La lunghezza delle stese è rispettivamente di circa 130 e 150 m, cercando di sfruttare la massima ampiezza possibile per avere più profondità di indagine all'interno del deposito stesso.

In Appendice 1 è presente il risultato delle sismiche a rifrazione con le stese indicate come L1 e L2.

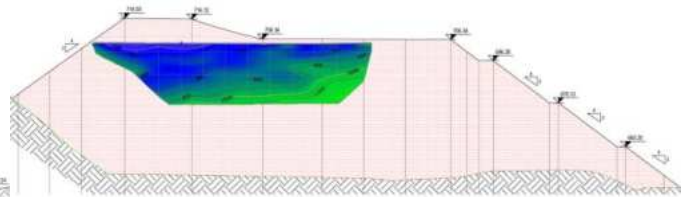


Figura 4. Profilo sismico, da sinistra L1 e L2 con onde Vp

Nel profilo L1 si trovano valori superiori a 1000m/s, tipici dei depositi piuttosto compattati, e raggiungono un massimo di circa 1800m/s, che sarebbero tipici di un substrato roccioso alterato; dato il contesto, tali valori indicano piuttosto materiale di deposito particolarmente compatto.

Nel profilo L2 i valori di Vp sono pari a circa 1100m/s o superiori, indicando la zona dove il deposito è relativamente più compattato rispetto alla parte sovrastante.

I due stendimenti L1 e L2 sono stati eseguiti sul cumulo in costruzione, nella fase finale si raggiunge la massima altezza indicata in sezione.

Per ulteriori informazioni sulle metodiche esecutive impiegate si rimanda al documento emesso dalla ditta esecutrice delle indagini (Tavola Akron - Sismica a rifrazione Vp e Vs).

### 5.1.3 Labortests

Bodenproben wurden aus 2 Bohrungen entnommen, die mit kontinuierlicher Kernbohrung durchgeführt wurden. Jede Probe wurde den folgenden Labortests unterzogen:

- Eröffnung und Beschreibung;
- Volumen Gewicht;
- Partikelgrößenanalyse;
- Atterberg-Grenzen;
- Großer Direktschnitttest.

Wir haben 7 Proben für die BH1-Umfrage und 6 Proben für die BH2-Umfrage getestet. In den Zertifikaten der Prüfstelle wurde BH1 mit BH2 vertauscht.

Die granulometrischen Analysen des Materials, die an den entnommenen Proben durchgeführt wurden, zeigten ein Material, das im Durchschnitt zu mehr als 40 % aus groben Körnungen bestand (in der Grafik sind die am Durchgang gesiebten Durchmesser 2 - 63 mm orange hervorgehoben).

### 5.1.3 Prove di laboratorio

Sono stati prelevati campioni di terreno dai n°2 sondaggi eseguiti a carotaggio continuo. Ciascun campione è stato sottoposto alle seguenti prove di laboratorio:

- Apertura e descrizione;
- Peso di volume;
- Analisi granulometrica;
- Limiti di Atterberg;
- Prova di taglio diretto di grandi dimensioni.

Si sono testati 7 campioni per il sondaggio BH1 e 6 campioni per il sondaggio BH2. Nei certificati emessi dal laboratorio incaricato delle prove è stato invertito il BH1 con il BH2.

Le analisi granulometriche del materiale, effettuate sui campioni prelevati hanno evidenziato un materiale composto mediamente per oltre il 40% da pezzature grossolane (nel grafico vengono evidenziate in arancio i diametri setacciati al passante 2 – 63 mm).

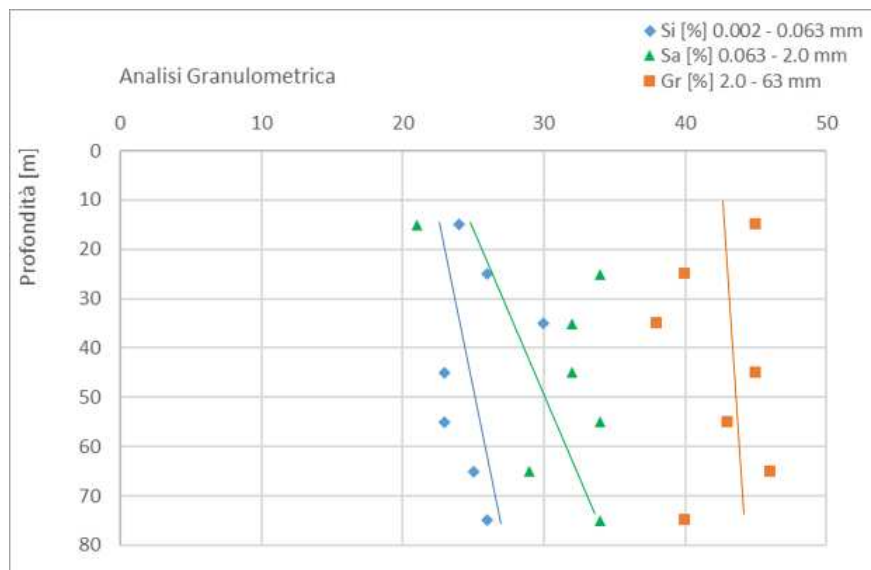


Abbildung 5. Granulometrische Analyse. Ergebnisse der Siebttests für BH1 und BH2

Figura 5. Analisi Granulometrica. Risultati delle prove al setaccio per BH1 e BH2

Insbesondere die direkten Scherversuche wurden aufgrund der Grobheit der untersuchten Böden in großen Zellen durchgeführt. Ziel war es, die Scherfestigkeitseigenschaften des Bodens bestmöglich zu untersuchen, da dies der Hauptparameter ist, der in den anschließenden Stabilitätsanalysen der Lagerstätte aufgrund der Empfindlichkeit derselben in Bezug auf die Bedingungen der Lagerstätte (Böschungen) verwendet werden muss der Böschungen und Höhen, die dadurch beträchtlich erreicht werden). Die herkömmliche Direktschneidausrüstung ist tatsächlich für begrenzte Korngrößen (typischerweise bis zu 1

In particolare, per le prove di taglio diretto, vista la natura grossolana dei terreni oggetto di indagine, sono state eseguite in cella di grandi dimensioni. Il fine era quello di indagare nel miglior modo possibile le caratteristiche di resistenza al taglio dei terreni, essendo questo il parametro principale da adottare nelle successive analisi di stabilità del deposito vista la delicatezza delle stesse in relazione alle condizioni del deposito (pendenze delle scarpate ed altezze ragguardevoli raggiunte dallo stesso). L'apparecchiatura di taglio diretto tradizionale è infatti adatta per granulometrie limitate (tipicamente fino a 1 mm di diametro) e pertanto è



mm Durchmesser) geeignet und daher nur teilweise repräsentativ für den zu testenden Boden. Bei größeren Partikelgrößen sieht der traditionelle Dosentest die Auswahl des feinen Teils des Bodens und die Rekonstitution der Proben nur mit dem so abgetrennten Teil vor.

In Anlage 2 befinden sich die Zertifikate der durchgeführten direkten Scherversuche und der granulometrischen Klassifizierung mit den Atterberg-Grenzen mit der AGI-Klassifizierung. Weitere Informationen zu Laboruntersuchungen entnehmen Sie bitte den Laborzertifikaten des mit der Untersuchung beauftragten Labors (Bericht Tiqu / ISB - Prüfberichte).

rappresentativa solo in parte del terreno sottoposto a prova. Nel caso di granulometrie maggiori la prova in scatola tradizionale prevede la selezione della parte fina del terreno e la ricostituzione dei provini solo con la porzione così separata.

In Appendice 2 sono presenti i certificati delle prove di taglio diretto eseguite e la classificazione granulometrica con i limiti di Atterberg con la classificazione AGI. Per ulteriori informazioni sulle prove di laboratorio si rimanda ai certificati di laboratorio emessi dal laboratorio incaricato delle prove (Report Tiqu/ISB – Rapporti di prova).

### 5.1.4 Infiltrimetrische Tests

Zur Diskretisierung des Permeabilitätskoeffizienten wurden 3 infiltrimetrische Tests durchgeführt.

Für jeden einzelnen Test wird der zurückgegebene Wert des Permeabilitätskoeffizienten als arithmetisches Mittel der während der Zeitdiskretisierung des Tests erhaltenen Einzelwerte bestimmt.

Anhang 1 enthält das Ergebnis der infiltrimetrischen Tests (Socotec).

Die erhaltenen Ergebnisse stimmen mit den Informationen überein, die aus der Fachliteratur und aus Experimenten stammen, die an durchlässigen Formationen durchgeführt wurden, die aus granulometrischer und lithologischer Sicht ähnlich sind und durch einen durchschnittlichen Durchlässigkeitsgrad von  $5 \times 10^{-4}$  [m/s] gekennzeichnet sind.

### 5.1.4 Prove infiltrometriche

Sono state eseguite n°3 prove infiltrometriche per discretizzare il coefficiente di permeabilità.

Per ogni singola prova, il valore del coefficiente di permeabilità restituito è determinato come media aritmetica dei singoli valori ottenuti durante la discretizzazione temporale della prova.

In Appendice 1 è presente il risultato delle prove infiltrometriche (Socotec).

I risultati ottenuti sono in linea con le informazioni deducibili dalla letteratura tecnica e da sperimentazioni eseguite su formazioni permeabili similare dal punto di vista granulometrico e litologico, caratterizzati da un grado di permeabilità medio pari  $5 \times 10^{-4}$  [m/s]

K (m/s)													
	$10^{-1}$	1	$10^{-1}$	$10^{-2}$	$10^{-3}$	$10^{-4}$	$10^{-5}$	$10^{-6}$	$10^{-7}$	$10^{-8}$	$10^{-9}$	$10^{-10}$	$10^{-11}$
Granulometria	omogenea	Ghiaia			Sabbia	Sabbia molto fine			Silt	Argilla			
	varia	Ghiaia grossa e media		Ghiaia e sabbia		Sabbia e argilla e limi							
Gradi di permeabilità		Elevata						Bassa				Nulla	
Tipi di formazioni		Permeabili						Semi-permeabili				Imper...	

Tabelle 5-1: infiltrimetrischer Test

Tabella 5-1: prova infiltrometrica

## 5.2 ORT DER UNTERSUCHUNGEN

Die folgenden Abbildungen zeigen den Ort der durchgeführten Untersuchungen zur Charakterisierung des Lagerstättenmaterials.

## 5.2 UBICAZIONE DELLE INDAGINI

Nelle figure seguenti si riporta l'ubicazione delle indagini eseguite per caratterizzare il materiale costituente il deposito.



Abbildung 6: Grundriss mit Standort der Erhebungen

Figura 6. Planimetria con ubicazione dei sondaggi

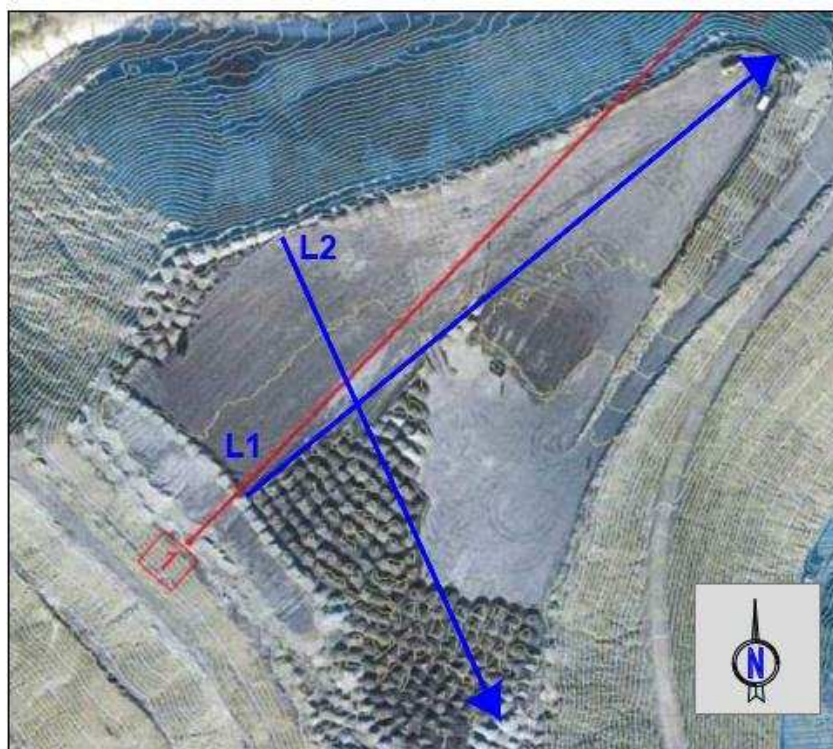


Abbildung 7: Planen Sie mit dem Standort der seismischen Untersuchungen

Figura 7. Planimetria con ubicazione delle indagini sismiche

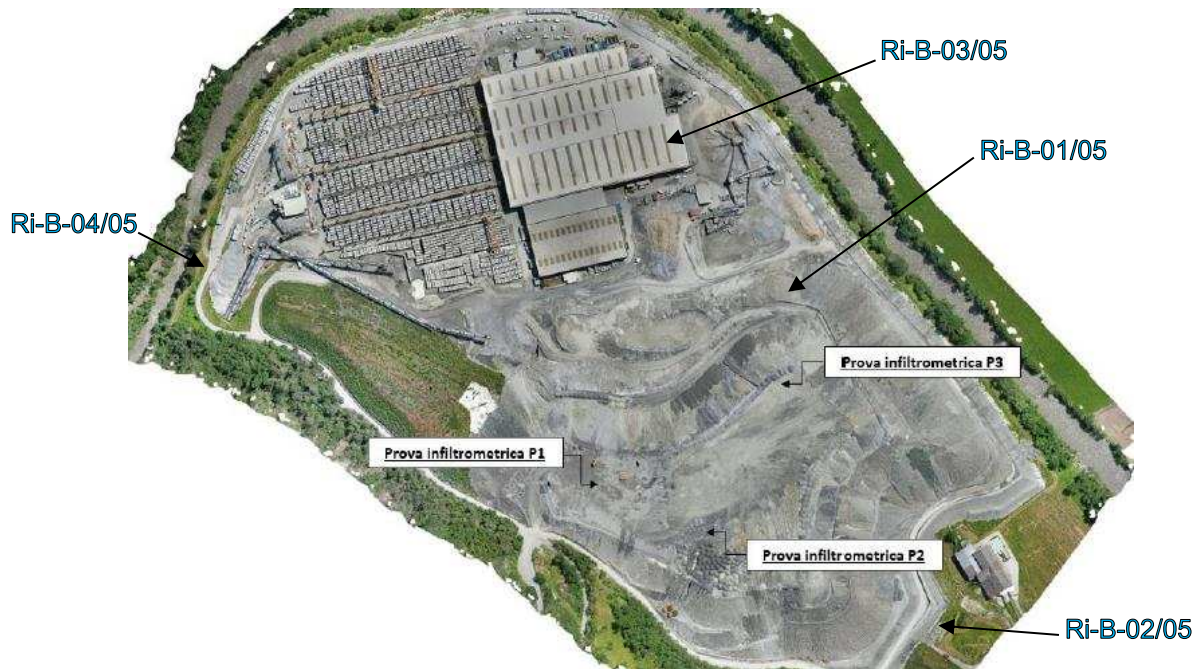


Abbildung 8: Lokalisierung von infiltrometrischen Tests

Figura 8. Localizzazione prove infiltrometriche

### 5.3 DEFINITION DER BEZUGSTRATIGRAPHIE

Basierend auf den in Anhang 1 enthaltenen Informationen zu den Erhebungskarten ist die Projektstratigraphie in der folgenden Tabelle dargestellt.

Strato n. Schicht Nr.	Profondità (m) Tiefe (m)		Descrizione Beschreibung
	Da	A	
BH1	0.00	80.00	Materiale di risulta costituito da detriti di varie litologie provenienti da lavori di scavo di galleria. Sandiger Kies mit Schluff
BH2	0.00	62.00	Materiale di risulta costituito da detriti di varie litologie provenienti da lavori di scavo di galleria. Feinsand mit Schluff, schluffiger Sand

Tabelle 2: Projektstratigraphie

### 5.3 DEFINIZIONE DELLA STRATIGRAFIA DI RIFERIMENTO

Sulla base delle informazioni contenute in Appendice 1 per le schede dei sondaggi si riporta nella tabella seguente la stratigrafia di progetto.

Tabella 2: Stratigrafia di progetto

#### 5.4 GRUNDWASSERSPIEGEL

Das Gelände für die vorgesehene Materialdeponie befindet sich im Gebiet des Riggertals und des Eisacks, der der Hauptsammler ist. Die Wasserführung des Eisacks wird durch reguliert durch den Fortezza-Staudamm. Neben dem Fluss Eisack gibt es im Rahmen der Lagerstätte keine weiteren Abflussleitungen.

Zur Messung des Grundwasserspiegels sind im Lagerbereich 4 Piezometer installiert. Der Grundwasserspiegel liegt bei Übergabe der Flächen auf ca. 630 Metern Seehöhe ca. 4 – 10 m unter dem bestehenden Geländeniveau. Es wird angenommen, dass es mit der Eisackebene verbunden ist. Diese Daten sind unverändert gegenüber den Annahmen im Projektdokument 02\_H61\_DB\_300\_KTB\_B0130\_51055, auf das für weitere Informationen bitte verwiesen wird.

Die in der Tabelle aufgeführten piezometrischen Messungen sind auch in ANHANG 1 im Bericht über die Testprotokolle der Bohrlöcher enthalten, die mit dem Detektor 02\_H61\_DB\_300\_KTB\_B0130\_51059 durchgeführt wurden.

#### 5.4 ANDAMENTO DELLA FALDA

La superficie di deposito prevista è situata nella zona della Val Riga e del fiume Isarco, che rappresenta il collettore principale. I deflussi dell'Isarco vengono regolati dalla diga di Fortezza. Accanto al fiume Isarco, nel contesto del deposito, non sono presenti altre linee di deflusso superficiale.

Nell'area di deposito sono installati 4 piezometri per la misura del livello di falda. Il livello della falda si trova a circa 4 – 10 m sotto il piano campagna esistente alla consegna delle aree alla quota 630 mslm circa. Si presume che sia collegato alla quota del fiume Isarco. Tali dati sono invariati rispetto alle assunzioni effettuate nel documento di progetto 02\_H61\_DB\_300\_KTB\_B0130\_51055, al quale si rimanda per ogni approfondimento.

Le misurazioni piezometriche, riportate in Tabella, sono presenti anche in ALLEGATO 1 nella relazione sulle minute di prova dei sondaggi eseguiti sul rilevato 02\_H61\_DB\_300\_KTB\_B0130\_51059.

Grundwasser messstelle / Piezometro	Versuchsteufe / profondità di prova [m]	GW-Stand/ livello falda [m]
Ri-B-01/05	12.00-13.50	9.4
Ri-B-02/05	12.00-13.50	9.2
Ri-B-03/05	12.00-13.50	3.2
Ri-B-04/05	12.00-13.50	10.1

Tabelle 3: Bei Untersuchungen festgestellter Grundwasserspiegel

Tabella 3: Livello di falda rilevato nei sondaggi

Nachfolgend finden Sie eine Grafik des Grundwassertrends, überwacht durch piezometrische Messungen.

Di seguito si mostra un grafico dell'andamento della falda, monitorato tramite misurazioni piezometriche.

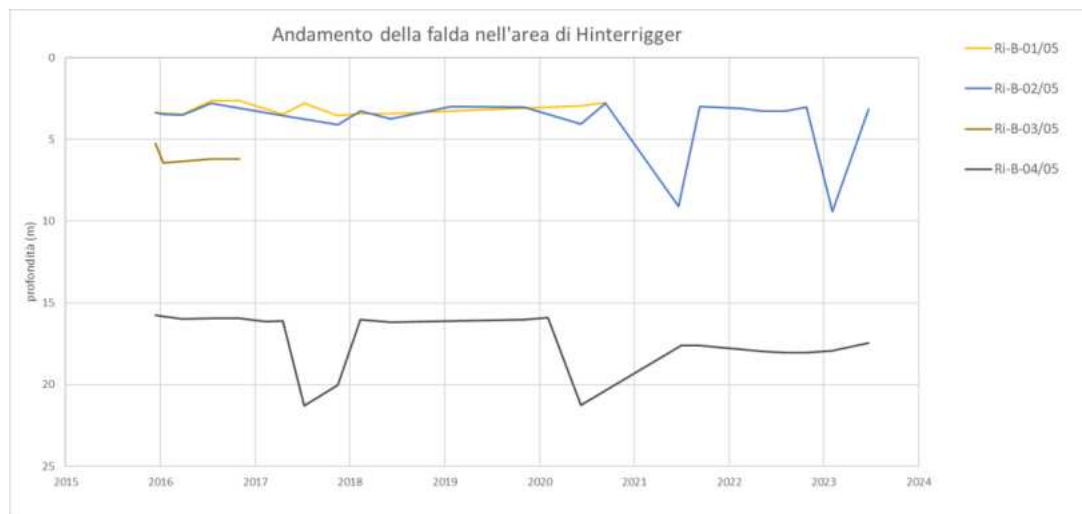


Abbildung 9: Planen Sie der seismischen Untersuchungen

Figura 9. Andamento della falda monitorato nei rilievi

## 5.5 MATERIAL GELAGERT IN DEN EHEMALIGEN GRUBEN

Im Bereich des Areals Hinterrigger, auf dem das aus dem Ausbruch der Baulose Mauls II und Mauls III resultierende Ausbruchmaterial gelagert wird, wurde Füllmaterial abgelagert, dessen wie folgt abgeschätzt werden.

Ausgehend von den um den Partialkoeffizienten reduzierten durchschnittlichen charakteristischen Parametern des „Falls F2“ ergäben sich charakteristische Werte oberhalb der in der Tabelle gezeigten Menge aus der „Fall F1“-Literatur.

Für die durchgeführten numerischen Analysen (Kap. 7) wurde daher unter Berücksichtigung des „Falls F1“ auf den kritischsten Fall in Bezug auf Widerstands- und dieser Lagerstätten Bezug genommen.

Der Wertesatz „Fall F1“ wurde als Satz geotechnischer, da er im Vergleich zum Satz der Mittelwerte F2, reduziert um den Koeffizienten  $\gamma_M$  der Gruppe M2, als abwertend und als gut repräsentativ angesehen wurde das Füllmaterial.

Es ist zu beachten, dass am Fuß des Hügels eine 60 cm dicke Schicht aus ausgewähltem und verdichtetem Aushubmaterial in grober Größe mit Kieseln mit einem Durchmesser von  $D = 100-200$  mm über die gesamte Oberfläche der Grundfläche des PED-Damms gelegt wurde.

Die Stratigraphie ist im Entwurfsdokument 02\_H61\_EW\_450\_KLP\_B0130\_51118 angegeben.

## 5.5 MATERIALI DI RIEMPIMENTO STOCCATI NELLE EX-CAVE

In corrispondenza dell'area di Hinterrigger, sono stati depositati dei materiali di riempimento ante-operam le cui caratteristiche vengono stimate come segue.

Partendo dai parametri caratteristici medi del “Caso F2” ridotti del coefficiente parziale, si otterrebbero valori caratteristici al di sopra del set più cautelativo riportato in tabella, da letteratura “Caso F1”.

Per le analisi numeriche effettuate (Cap. 7) si è fatto quindi riferimento al caso maggiormente critico in termini di parametri di resistenza e deformabilità di tali depositi, prendendo in esame il “Caso F1”.

Il set di valori “Caso F1” è stato assunto come Set di parametri geotecnici di progetto, in quanto ritenuto peggiorativo rispetto al set di valori medi F2 ridotti attraverso il coefficiente  $\gamma_M$  del gruppo M2 e sufficientemente rappresentativi del materiale di riempimento.

L'abbattimento dei parametri del “Caso F1” avrebbe comportato la restituzione di valori notevolmente bassi e poco indicativi dei terreni effettivamente presenti in situ

Si noti che alla base del cumulo è stato posizionato uno strato di 60cm di materiale da scavo selezionato e compattato, a pezzatura grossolana con ciottoli di diametro  $D=100-200$ mm, su tutta la superficie dell'impronta del rilevato da PED.

La stratigrafia viene riportata nell'elaborato progettuale 02\_H61\_EW\_450\_KLP\_B0130\_51118.

Fall/ Caso	$c_k'$ [kPa]	$\phi_k'$ [°]	$E_k$ [MPa]	Osservazioni
F1	0.00	20	5	Charakteristische Werte aus der Literatur für lehmig-tonige Böden Valori caratteristici ripresi da letteratura per terreni limo argillosi
F2	0.00	29	15	Mittelwerte zwischen Fall F1 und Fall F3 Valori medi tra il caso F1 e il caso F3
F3	0.00	38	25	Parameter, welche mit den Eigenschaften der ersten In-Situ-Bodenschicht übereinstimmen. Parametri coincidenti a quelli del primo strato di terreno in situ

Tabelle 4: Für die numerische Berechnung geotechnische Parameter

Tabella 4: Strati Parametri geotecnici ipotizzati per l'analisi numerica

Es ist zu beachten, dass die Scherfestigkeitseigenschaften in Form von effektiven Spannungen angenommen wurden, da diese Materialien im Laufe der Zeit über dem Boden abgelagert wurden und sich daher zu bestimmten Jahreszeiten in Bedingungen teilweiser Sättigung befinden, wenn nicht sogar , getrocknet.

Außerdem haben die Untersuchungen im Bereich der Gründungsschichten gezeigt, dass der Grundwasserspiegel sich auf einer variablen Tiefen zwischen 5 und 10 m befindet, weshalb ein Aufsteigen des Wassers durch Kapillarität auszuschließen ist.

Occorre evidenziare che le caratteristiche di resistenza al taglio sono state assunte in termini di tensioni efficaci in quanto tali materiali sono stati depositati nel tempo al di sopra del piano campagna e conseguentemente sono in condizioni di parziale saturazione se non addirittura, in certi periodi dell'anno, secchi.

Tra l'altro, le indagini condotte in corrispondenza dei terreni di fondazione hanno mostrato che la falda è situata ad una profondità variabile e compresa fra 5 e 10 m e quindi una risalita dell'acqua per capillarità è da escludere.

## 5.6 DEPONIEMATERIAL

In der von diesem Gutachten erfassten Lagerstätte wird Aushubmaterial der Gruppen B und C abgelagert, dh Material, das nicht für die Betonherstellung geeignet ist.

Da die von der Ablagerung vorgesehenen geometrischen Konfigurationen und Höhen ziemlich hoch sind und maximale Höhen von bis zu 80 m erreichen, wird es für die Stabilität des Damms wesentlich sein, dass er einen ausreichenden Verdichtungsgrad gewährleistet.

Die Bewertung der Scherfestigkeitseigenschaften des Lagerstättenmaterials für die in diesem Bericht berichteten Stabilitätsprüfungen basierten auf Labortests (Anhang 2), die an dem aus der Lagerstätte selbst stammenden Material durchgeführt wurden.

In den Zertifikaten der Prüfstelle wurde BH1 mit BH2 vertauscht.

### 5.6.1 BH1-Umfrageergebnisse

Die Tabelle zeigt die Durchschnittswerte der 6 Proben, an denen die Labortests durchgeführt wurden.

Die folgende Abbildung zeigt die Klassifizierung des Materials gemäß den Normen DIN 18196, UNI 11531-1 und USCS.

Es gibt auch die durchschnittliche granulometrische Kurve des Materials aus der BH1-Untersuchung an, aus der ersichtlich ist, dass das Material als Kies oder schluffiger oder toniger Sand mit einem schluffigen Anteil (0,006-0,06 mm) zwischen 22 und 33 % klassifiziert ist. ein Sandanteil (0,06-2 mm) zwischen 28 und 34 % und ein Kiesanteil (2-60 mm) etwa 36-46 %, das restliche Material hat einen Durchmesser größer als 63 mm (Kiesel).

Classificazione Terre	DIN 18196 / UNI 11531-1 / USCS					
	DIN	UNI	USCS	DIN	UNI	USCS
Coeff. di uniformità $C_u = D_{60}/D_{10}$	200	110	130	230	180	220
Coeff. di curvatura $C_c = D_{30}^2 / D_{60} * D_{10}$	0.3	0.3	0.2	0.3	0.4	0.5
Umidità naturale del terreno % W	ND	ND	ND	ND	ND	ND
Limite di liquidità WL	23.4	23.1	25.0	24.6	28.9	24.1
Indice di plasticità IP	1.2	1.6	5.4	2.3	2.8	2.4
DIN	GU*	SU*	SU*	GU*	GU*	SU*
UNI	A2 / A2-b	A2 / A2-4	A2 / A2-4	A2 / A2-4	A1 / A1-b	A2 / A2-4
USCS	GM	SM	GM-GC	GM	GM	SM

Abbildung 10. Ergebnisse der Bodenklassifizierung (durchgeführt am Material der BH1-Erhebung)

Im Folgenden beschreibt die Atterberg-Klassifikation den Boden als lehmige Anteile von weniger als 50 %, typisch für organische Böden mit geringer und leichter Plastizität.

## 5.6 MATERIALE DI DEPOSITO

Nel deposito oggetto della presente relazione sarà depositato materiale di scavo appartenente ai gruppi B e C, ovvero materiale non idoneo per il confezionamento dei calcestruzzi.

Poiché le configurazioni geometriche e le altezze previste dal deposito sono abbastanza elevate, raggiungendo altezze massime fino a 80 m, sarà indispensabile per garantirne la stabilità del rilevato la messa in opera che garantisca un sufficiente grado di compattazione.

La valutazione delle caratteristiche di resistenza al taglio del materiale del deposito per le verifiche di stabilità riportate nella presente relazione si sono basate su prove di laboratorio (Appendice 2) condotte sul materiale proveniente dal deposito stesso.

Nei certificati emessi dal laboratorio incaricato delle prove è stato invertito il BH1 con il BH2.

### 5.6.1 Risultati sondaggio BH1

Dal sondaggio sono stati prelevati 6 campioni su cui sono state effettuate le prove di laboratorio.

La Figura di seguito mostrata riporta la classificazione del materiale secondo le normative DIN 18196, UNI 11531-1 e USCS.

Riporta, inoltre la curva granulometrica media del materiale proveniente dal sondaggio BH1, dalla quale si può notare che il materiale è classificato come ghiaia con sabbia limosa che ha una frazione limosa (0.006-0.06 mm) compresa fra il 22 ed il 33% una frazione sabbiosa (0.06-2 mm) compresa fra il 28 ed il 34% ed una frazione di ghiaia (2-60 mm) intorno al 36-46%, il restante materiale ha un diametro superiore ai 63 mm (ciottoli).

Figura 10. Risultati classificazione terre (effettuata sul materiale prelevato dal sondaggio BH1)

La classificazione di Atterberg descrive il terreno come limoso con un limite di parte liquida inferiore al 50%, tipico dei terreni a bassa plasticità.



### 5.6.2 BH2-Umfrageergebnisse

Die Tabelle zeigt die Durchschnittswerte der 7 Proben, an denen die Labortests durchgeführt wurden.

Die folgende Abbildung zeigt die Klassifizierung des Materials gemäß den Normen DIN 18196, UNI 11531-1 und USCS.

Es berichtet auch die durchschnittliche granulometrische Kurve des Materials aus der BH1-Untersuchung, aus der ersichtlich ist, dass das Material als Kies oder schluffiger Sand klassifiziert ist, der einen schluffigen Anteil (0,006–0,06 mm) zwischen 23 und 30 % Sand aufweist (0,06-2 mm) zwischen 21 und 34 % und Kiesanteil (2-60 mm) etwa 38-45 %, das restliche Material hat einen Durchmesser größer als 63 mm (Kiesel).

### 5.6.2 Risultati sondaggio BH2

Dal sondaggio sono stati prelevati 7 campioni su cui sono state effettuate le prove di laboratorio.

La Figura di seguito mostrata riporta la classificazione del materiale secondo le normative DIN 18196, UNI 11531-1 e USCS.

Riporta, inoltre la curva granulometrica media del materiale proveniente dal sondaggio BH1, dalla quale si può notare che il materiale è classificato come ghiaia con sabbia limosa che ha una frazione limosa (0.006-0,06 mm) compresa fra il 23 ed il 30% una frazione sabbiosa (0.06-2 mm) compresa fra il 21 ed il 34% ed una frazione di ghiaia (2-60 mm) intorno al 38-45%, il restante materiale ha un diametro superiore ai 63 mm (ciottoli).

Classificazione Terre	DIN 18196 / UNI 11531-1 / USCS						
	DIN	UNI	USCS	DIN	UNI	USCS	DIN
Coeff. di uniformità $C_u = D_{60}/D_{10}$	200	110	130	180	210	350	180
Coeff. di curvatura $C_c = D_{30}^2 / (D_{60} \cdot D_{10})$	0.3	0.3	0.2	0.3	0.8	0.4	0.4
Umidità naturale del terreno % W	ND	ND	ND	ND	ND	ND	ND
Limite di liquidità WL	23.4	23.1	25.0	25.9	27.5	24.9	25.8
Indice di plasticità IP	1.2	1.6	5.4	5.7	6.3	6.8	6.0
DIN	GU*	SU*	SU*	GU*	GU*	GU*	GU*
UNI	A2 / A2-b	A2 / A2-4	A2 / A2-4	A1 / A1-b	A2 / A2-4	A2 / A2-4	A2 / A2-4
USCS	GM	SM	GM-GC	GM-GC	GM-GC	GM-GC	GM-GC

Abbildung 11. Ergebnisse der Bodenklassifizierung (durchgeführt am Material der BH2-Erhebung)

Figura 11. Risultati classificazione terre (effettuata sul materiale prelevato dal sondaggio BH2)

Im Folgenden beschreibt die Atterberg-Klassifikation den Boden als lehmig und tonig mit einer Grenze des flüssigen Anteils von weniger als 50%, typisch für organische Böden mit geringer und leichter Plastizität.

La classificazione di Atterberg descrive il terreno come limoso con un limite di parte liquida inferiore al 50%, tipico dei terreni a bassa plasticità.

Das berücksichtigte Volumengewicht wurde vorsichtig mit 21 kN / m<sup>3</sup> angenommen, wobei ein Durchschnitt der Volumengewichte aller durchgeführten Tests berücksichtigt wurde.

Il peso di volume considerato è stato preso come 21 kN/m<sup>3</sup> considerando una media dei pesi di volume di tutte le prove eseguite.

Die für das Material der Lagerstätte B + C angenommenen Parameter (in Übereinstimmung mit den durchgeführten Labortests) in den Berechnungsanalysen sind die folgenden:

I parametri caratteristici adottati per il materiale del deposito B+C, (in accordo con le prove di laboratorio eseguite) nelle analisi di calcolo sono i seguenti:

$$\gamma = 21 \text{ kN/m}^3;$$

$$c' = 45 \text{ kPa};$$

$$\phi' = 37^\circ;$$

$$E' = 30 \text{ MPa};$$

$$\nu' = 0.3.$$

Insbesondere wurde für den Reibungswinkel der sich aus Laborversuchen ergebende Mittelwert angenommen, für die Kohäsion vorsorglich ein Wert nahe dem Minimum.

Die folgenden Abbildungen zeigen die Ergebnisse der großformatigen direkten Scherversuche bezüglich Kohäsion und Reibungswinkel in Abhängigkeit von der Abzugstiefe.

In particolare, per l'angolo di attrito si è assunto il valore medio scaturito dalle prove di laboratorio mentre per la coesione, in via prudenziale, un valore prossimo al minimo.

Nelle figure successive sono riportati i risultati delle prove di taglio diretto di grandi dimensioni in termini di coesione e angolo d'attrito in funzione della profondità di prelievo.

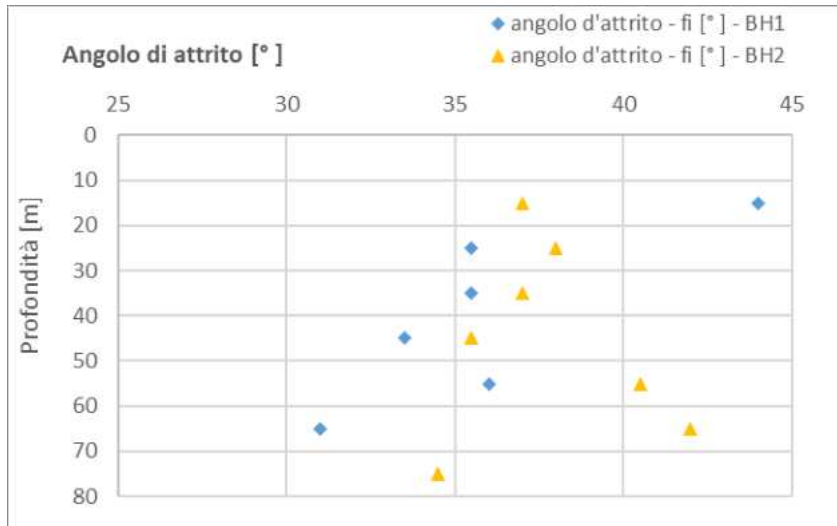


Abbildung 12. Charakteristische Werte des Scherwiderstandswinkels der Materialien in der Lagerstätte in Abhängigkeit von der Böschungshöhe. Ergebnisse des direkten Schertests mit großen Kästen für BH1 und BH2

Figura 12. Valori caratteristici dell'angolo di resistenza al taglio dei materiali del deposito in funzione dell'altezza del terrapieno. Risultati delle prove di taglio diretto in scatola di grandi dimensioni per BH1 e BH2

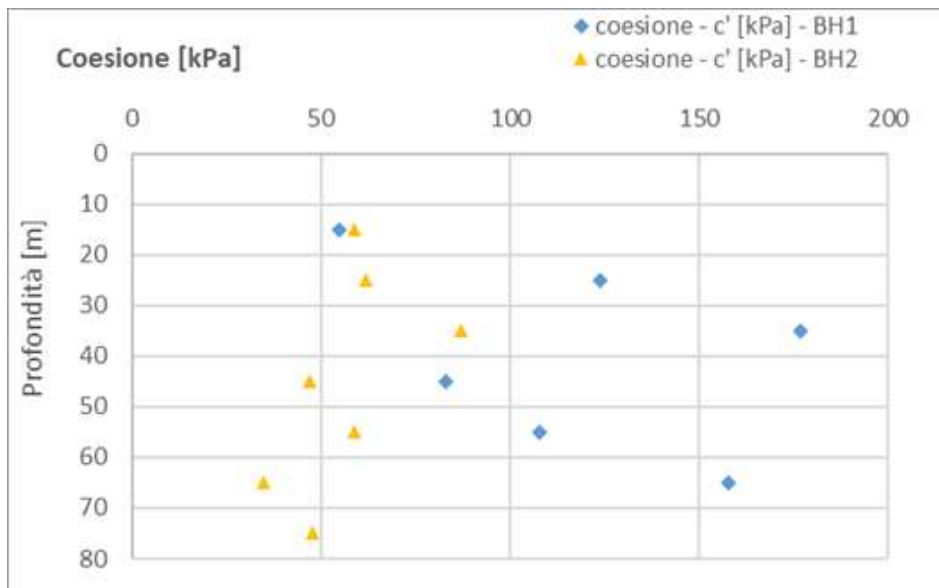


Abbildung 13. Charakteristische Kohäsionswerte der Lagerstättenmaterialien in Abhängigkeit von der Böschungshöhe. Ergebnisse des direkten Schertests mit großen Kästen für BH1 und BH2.

Figura 13. Valori caratteristici di coesione dei materiali del deposito in funzione dell'altezza del terrapieno. Risultati delle prove di taglio diretto in scatola di grandi dimensioni per BH1 e BH2.

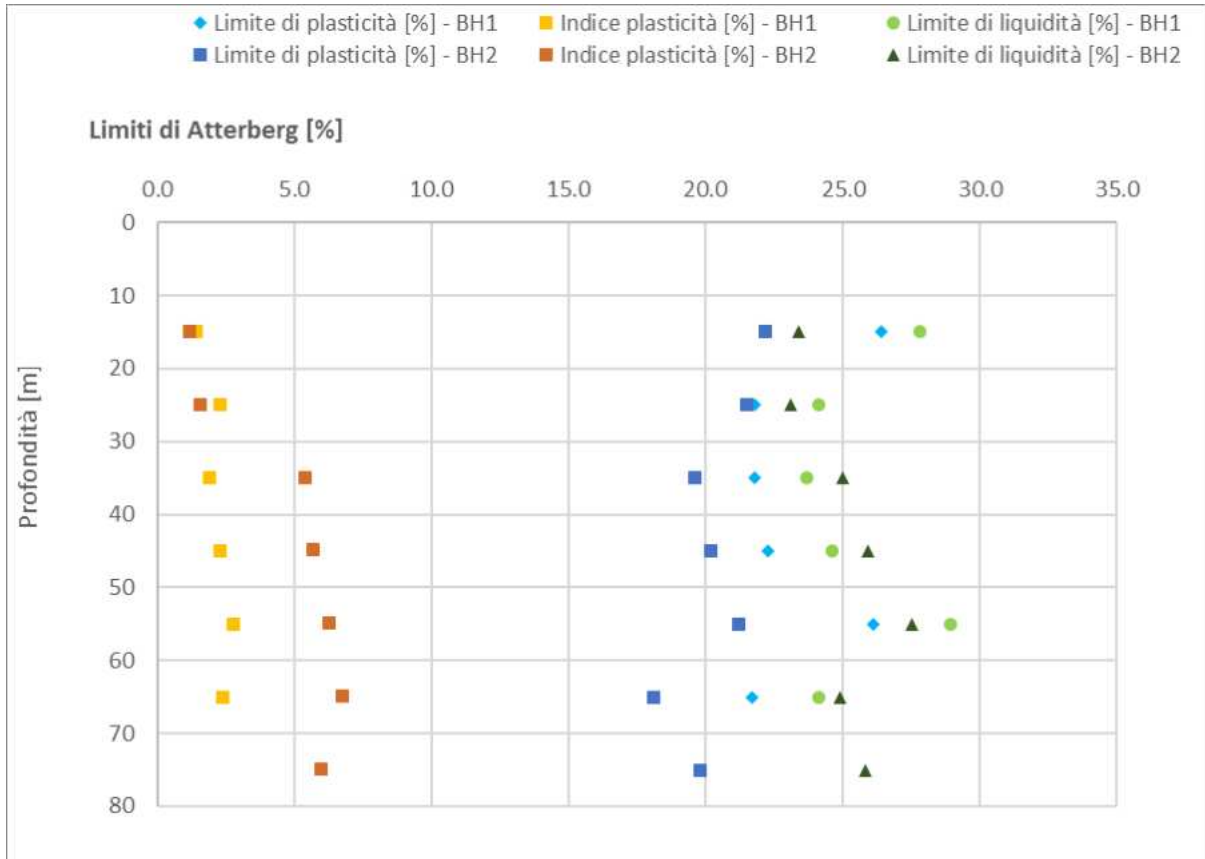


Abbildung 14. Werte der Atterberggrenzen der Lagerstättenmaterialien in Abhängigkeit von der Böschungshöhe, für BH1 und BH2.

Figura 14. Valori dei limiti di Atterberg dei materiali del deposito in funzione dell'altezza del terrapieno. Risultati delle prove per BH1 e BH2.

## 5.7 BERECHNUNGSPARAMETER

Die geotechnischen Parameter, die in den mit der Plaxis-Software implementierten numerischen Modellen mit Bezug auf den Baugrund verwendet wurden, sind unten aufgeführt. Weitere Informationen finden Sie im Bericht 02\_H61\_DB\_300\_KTB\_B0130\_51055.

Um das reale Verhalten der Böden möglichst genau zu berücksichtigen, insbesondere zum Zweck einer genaueren Analyse von induzierten Setzungen, wurde entschieden, das konstitutive Modell Hardening Soil zu verwenden.

Dieses Modell ermöglicht es, die Entwicklung der plastischen Verformung vor dem Bruch und die unterschiedliche Steifigkeit des Bodens unter Belastungs- und Entlastungs- / Wiederbelastungsbedingungen zu berücksichtigen.

Die Annahme für die Bestimmung der Parameter ist wie folgt:

- $E_{50} = E_{oed} = E_{MC}$
- $E_{ur} = 3 \times E_{50}$
- $K_0^{nc} = 1 - \sin(\varphi)$

Strato Schicht	Profundität (m) Tiefe (m)		Modello adottato	$\phi_k'$	$E_{Mc}$	$\frac{E_{50}^{ref}}{E_{oed}^{ref}}$	$E_{ur}^{ref}$	power (m)	$\nu$	$p_{ref}$	$K_0^{nc}$	$C_{ref}$	$\Psi$	$\gamma_s$
	Da	A												
1	0	3	HS	38		25	75	0	0.2	100	0.38	5	0	20
2	3	6	HS	40		40	120	0	0.2	100	0.36	0	0	20
3	6	13	HS	42		50	150	0	0.2	100	0.33	0	0	20
4	13	15	HS	36		30	90	0	0.2	100	0.41	0	0	20
5	15	25	HS	36		70	210	0.4	0.2	100	0.41	0	0	20
Riempimento ex-cave (F1)	Var. da 5 a 10m dal p.c.		MC	20	5				0.3			0	0	20

Tabelle 5: Geotechnische Berechnungsparameter

## 5.7 PARAMETRI DI CALCOLO TERRENO DI FONDAZIONE

Vengono di seguito riportati i parametri geotecnici utilizzati nei modelli numerici implementati tramite il software Plaxis con riferimento al terreno di fondazione. Per maggiori informazioni si rimanda alla relazione 02\_H61\_DB\_300\_KTB\_B0130\_51055.

Per tener conto in modo più accurato possibile del reale comportamento dei terreni, soprattutto ai fini di una più accurata analisi dei cedimenti indotti, si è deciso di utilizzare il modello costitutivo Hardening Soil.

Tale modello permette di tener conto dello sviluppo di deformazione plastiche pre-rottura e della differente rigidità del terreno in condizioni di carico e di scarico/ricarico.

L'assunzione per la determinazione dei parametri è la seguente:

- $E_{50} = E_{oed} = E_{MC}$
- $E_{ur} = 3 \times E_{50}$
- $K_0^{nc} = 1 - \sin(\varphi)$

Tabella 5: Parametri geotecnici di calcolo terreno di fondazione

Die Tiefen, auf die sich die verschiedenen Schichten beziehen, sind in Tabelle 3 gezeigt und sind in Bezug auf die Bestimmungen des ausführenden Projekts unverändert geblieben PED.

Le profondità alle quali sono riferiti i vari strati sono riportati nella Tabella 3 e sono rimasti invariati rispetto a quanto previsto nella relazione di PED

## 6 PLANUNGSKRITERIEN NACH GRENZZUSTÄNDEN

Für das geplante Bauwerk müssen die nachfolgenden Sicherheitsnachweise durchgeführt und Leistungen nachgewiesen werden (par. 6.2.3. der NTC2008):

- Nachweis des Grenzzustands der Gebrauchstauglichkeit (GZG).
- Nachweis des Grenzzustands der Tragfähigkeit (GZT);

Für jeden **Grenzzustand der Gebrauchstauglichkeit (GZG)** muss folgende Bedingung erfüllt sein:

$$E_d \leq C_d \quad (\text{Eq. 6.2.7 der NTC 2008})$$

wobei:

$E_d$  = Bemessungswert der Auswirkung der Einwirkungen;

$C_d$  = vorgeschriebener Grenzwert der Auswirkungen von Einwirkungen (vom Planer bestimmt).

Der Nachweis der Bedingung  $E_d \leq C_d$  muss unter der Anwendung der charakteristischen Werte der Einwirkungen und der geotechnischen Kenngrößen der Materialien erfolgen.

Für jeden **Grenzzustand der Tragfähigkeit (GZT)** muss folgende Bedingung erfüllt sein:

$$E_d \leq R_d \quad (\text{Eq. 6.2.1 der NTC 2008})$$

wobei:

$E_d$  = Bemessungswert Auswirkung der Einwirkungen;

$R_d$  = Bemessungswert Widerstand.

Der Nachweis der Bedingung  $E_d \leq R_d$  muss durch den Gebrauch verschiedener Kombinationen von Teilsicherheitsbeiwertgruppen erfolgen, die für die Einwirkungen ( $A1$  e  $A2$ ), für die geotechnischen Kenngrößen ( $M1$  e  $M2$ ) und für die Widerstände ( $R1$ ,  $R2$  e  $R3$ ) definiert sind. Die zu verwendenden Beiwerte bei den jeweiligen Kombinationen werden in Funktion des jeweiligen Nachweises definiert (siehe folgenden Kapitel). Es wird unterstrichen, dass für die Einwirkungen bestimmt werden können oder, die durch die charakteristischen Werte der Einwirkungen bestimmt werden (Kap. 6.2.3.1 der NTC 2008).

## 6 CRITERI DI PROGETTAZIONE AGLI STATI LIMITE

Per l'opera in esame devono essere svolte le seguenti verifiche di sicurezza e delle prestazioni attese (par. 6.2.3. delle NTC2008):

- verifiche agli Stati Limite d'Esercizio (SLE).
- verifiche agli Stati Limite Ultimi (SLU);

Per ogni **Stato Limite d'Esercizio (SLE)** deve essere rispettata la condizione:

$$E_d \leq C_d \quad (\text{Eq. 6.2.7 delle NTC 2008})$$

dove:

$E_d$  = valore di progetto dell'effetto dell'azione;

$C_d$  = valore limite prescritto dell'effetto delle azioni (definito dal Progettista).

La verifica della condizione  $E_d \leq C_d$  deve essere effettuata impiegando i valori caratteristici delle azioni e dei parametri geotecnici dei materiali.

Per ogni **Stato Limite Ultimo (SLU)** deve essere rispettata la condizione:

$$E_d \leq R_d \quad (\text{Eq. 6.2.1 delle NTC 2008})$$

dove:

$E_d$  = valore di progetto dell'azione o dell'effetto dell'azione;

$R_d$  = valore di progetto della resistenza.

La verifica della condizione  $E_d \leq R_d$  deve essere effettuata impiegando diverse combinazioni di gruppi di coefficienti parziali, rispettivamente definiti per le azioni ( $A1$  e  $A2$ ), per i parametri geotecnici ( $M1$  e  $M2$ ) e per le resistenze ( $R1$ ,  $R2$  e  $R3$ ). I coefficienti da adottarsi nelle diverse combinazioni sono definiti in funzione del tipo di verifica da effettuare (si vedano i paragrafi seguenti). Si sottolinea che per quanto concerne le azioni di progetto  $E_d$  tali forze possono essere determinate applicando i coefficienti parziali di cui sopra alle azioni caratteristiche, oppure, a posteriori, sulle sollecitazioni prodotte dalle azioni caratteristiche (Par. 6.2.3.1 delle NTC 2008).

## **6.1 SICHERHEITSNACHWEISE IM STATISCHEN BEREICH**

### **6.1.1 Grenzzustand der Gebrauchstauglichkeit (GZG)**

Es muss unter Verwendung der charakteristischen Werte der Einwirkungen und der geotechnischen Kenngrößen der Materialien (Kap. 6.5.3.2 der NTC 2008) nachgewiesen werden, dass die Verschiebungen des untersuchten Bauwerks und des umliegenden Bodens kompatibel mit der Funktionalität des Bauwerks selbst und mit der Sicherheit von angrenzenden Strukturen sind.

Im Projekt müssen demnach die Bestimmungen bzgl. der kompatiblen Verschiebungen für das Bauwerk und seiner erwarteten Funktionalität vorgeschrieben sein. Es ist Aufgabe des Projektanten die Werte der Verschiebungen/Rotationen festzulegen, die einem Grenzzustand der und der Strukturen werden müssen.

Man muss dabei beachten, dass die Nachweise des Grenzzustands der Gebrauchstauglichkeit restriktiver ausfallen können als jene des Grenzzustand der Tragfähigkeit.

## **6.1 VERIFICHE DI SICUREZZA IN CAMPO STATICO**

### **6.1.1 Stati limite di esercizio (SLE)**

Deve essere verificato, mediante analisi effettuate impiegando i valori caratteristici delle azioni e dei parametri geotecnici dei materiali (Par. 6.5.3.2 delle NTC 2008), che gli spostamenti dell'opera in esame e del terreno circostante siano compatibili con la funzionalità della struttura e con la sicurezza e la funzionalità di manufatti adiacenti.

All'interno del progetto devono pertanto essere definite le prescrizioni riguardanti gli spostamenti compatibili per l'opera e le prestazioni attese. È a carico del Progettista definire valori di spostamenti/rotazioni corrispondenti ad uno Stato Limite di Esercizio delle opere e strutture da confrontarsi con quelli calcolati.

Deve essere tenuto presente che le verifiche agli Stati Limite di Esercizio possono risultare più restrittive di quelle agli Stati Limite Ultimi.

### 6.1.2 Grenzzustand der Tragfähigkeit (GZT)

Die Nachweise der Standsicherheit im statischen Bereich für Bauwerke aus Lockermaterial, wie Aufschüttungen und Dämme, müssen nachfolgenden Ansatz erfolgen (Kap. 6.8.2 der NTC 2008).

#### **Ansatz 1:**

#### **Kombination 2:**

$$A2 + M2 + R2$$

unter Berücksichtigung der Teilsicherheitsbeiwerte aus den Tabelle 7.1, 7.2 und 7.3.

Der Gesamtstandsicherheitsnachweis gilt erfüllt, wenn:

$$\frac{R_d}{E_d} \geq 1 \Rightarrow \frac{1}{\gamma_R} \cdot R \geq 1 \Rightarrow \frac{R}{E_d} \geq \gamma_R$$

R, der Gesamtwiderstand des Systems (siehe Kap. C.6.8.6.2 der Circolare 2 febbraio 2009, n. 617 - Istruzioni per l'applicazione delle "Nuove norme tecniche per le costruzioni" di cui al D.M. 14 gennaio 2008) aufgrund der Bemessungswerte der Einwirkungen, der Projektparameter und der Projektgeometrie berechnet wird ( $R = R \left[ \gamma_F \cdot F_k; \frac{X_k}{\gamma_m}; a_d \right]$ ).

Die Gesamtstandsicherheit der Einheit Bauwerk-Baugrund muss unter den unterschiedlichen Bedingungen untersucht werden, die den verschiedenen Bauphasen und dem Endzustand des Bauwerks entsprechen.

### 6.1.2 Stati limite ultimi (SLU)

Le verifiche di stabilità in campo statico di opere in materiali sciolti, quali rilevati e terrapieni, devono essere eseguite secondo il seguente approccio (Par. 6.8.2 delle NTC 2008).

#### **Approccio 1:**

#### **Combinazione 2:**

tenendo conto dei coefficienti parziali riportati nelle tabelle 7.1, 7.2 e 7.3.

La verifica di stabilità globale si ritiene soddisfatta se:

essendo R resistenza globale del sistema (vedasi Par. C.6.8.6.2 della Circolare 2 febbraio 2009, n. 617 - Istruzioni per l'applicazione delle "Nuove norme tecniche per le costruzioni" di cui al D.M. 14 gennaio 2008), calcolata sulla base delle azioni di progetto, dei parametri di progetto e della geometria di progetto ( $R = R \left[ \gamma_F \cdot F_k; \frac{X_k}{\gamma_m}; a_d \right]$ ).

La stabilità globale dell'insieme manufatto-terreno di fondazione deve essere studiata nelle condizioni corrispondenti alle diverse fasi costruttive ed al termine della costruzione.

CARICHI LASTEN	EFFETTO EINWIRKUNG	Coefficiente parziale Teilsicherheitsbei wert $\gamma_F$ (o $\gamma_E$ )	EQU	(A1)	(A2)
Permanenti Ständige	Favorevole Günstig	$\gamma_{G1}$	0.9	1.0	1.0
	Sfavorevole Ungünstig		1.1	1.3	1.0
Permanenti non strutturali <sup>(1)</sup> Ständige, nicht statische <sup>(1)</sup>	Favorevole Günstig	$\gamma_{G2}$	0.0	0.0	0.0
	Sfavorevole Ungünstig		1.5	1.5	1.3
Variabili Veränderliche	Favorevole Günstig	$\gamma_{Qi}$	0.0	0.0	0.0
	Sfavorevole Ungünstig		1.5	1.5	1.3

<sup>(1)</sup> Nel caso in cui i carichi permanenti non strutturali (ad es. i carichi permanenti portati) siano completamente definiti, si potranno adottare gli stessi coefficienti validi per le azioni permanenti

<sup>(1)</sup> Im Falle, dass die ständigen nicht statischen Lasten (z. B. die getragenen ständigen Lasten) vollständig definiert sind, kann man dieselben Beiwerte anwenden, die für ständige Einwirkungen gelten

Tabelle 6: Teilsicherheitsbeiwert der Einwirkungen (Tab. 6.2.I der NTC 2008)

Tabella 6: Coefficienti parziali sulle azioni (Tab. 6.2.1 delle NTC 2008)

PARAMETRO KENNWERT	Coefficiente parziale Teilsicherheits beiwerte	(M1)	(M2)
Tangente dell'angolo di resistenza al taglio Tangente des Reibungswinkels	$\gamma_{\phi'}$	1.0	1.25
Coesione efficace effektive Kohäsion	$\gamma_{c'}$	1.0	1.25
Resistenza non drenata Festigkeit des undrännierten Bodens	$\gamma_{Cu}$	1.0	1.4
Peso dell'unità di volume Wichte	$\gamma_{\gamma}$	1.0	1.0

Tabelle 7: Teilsicherheitsbeiwerte der Böden (M1 und M2) (Tab. 6.2.II der NTC 2008)

Tabella 7: Coefficienti parziali sui terreni (M1 ed M2) (Tab. 6.2.II delle NTC 2008)

Coefficiente parziale Teilsicherheits beiwert	(R2)
$\gamma_R$	1.1

Tabelle 8: Teilsicherheitsbeiwert der Widerstände (R2) für den Gesamtstandsicherheitsnachweis (Tab. 6.8.1 der NTC 2008)

Tabella 8: Coefficiente parziale sulle resistenze (R2) per le verifiche di stabilità globale (Tab. 6.8.1 delle NTC 2008)



## 6.2 SICHERHEITSNACHWEISE IM SEISMISCHEN BEREICH

### 6.2.1 Bezugsgrenzzustände für Nachweise bei Erdbebeneinwirkung

Die NTC 2008 definieren verschiedene Grenzzustände (sei es der Gebrauchstauglichkeit als auch der Tragfähigkeit) je nach Wichtigkeit des Bauwerks (Definition der Gebrauchsklasse) und dann in Funktion des Schadens, der Folge eines gewissen Grenzzustands ist.

Im Besonderen werden folgende Grenzzustände der Gebrauchstauglichkeit und der Tragfähigkeit definiert (laut Kap. 3.2.1 der NTC 2008):

- **Grenzzustand der Gebrauchstauglichkeit (GZG)**
  - Grenzzustand der unmittelbaren Arbeitsfähigkeit **SLO** für das Bauwerk und die Maschinen, die nach einem Erdbeben arbeitsfähig bleiben müssen. Dieser Grenzzustand wird nicht auf das vorliegende Bauwerk angewandt.
  - Grenzzustand des Schadens **SLD**, als jener Grenzzustand definiert, der eine grundlegende Vollständigkeit des Bauwerks und seines unmittelbaren Gebrauchs garantiert.
- **Grenzzustand der Tragfähigkeit (GZT):**
  - Grenzzustand der Wahrung des menschlichen Lebens, **SLV**, definiert als jener Grenzzustand, bei dem das Bauwerk einen bedeutenden Verlust der Starrheit in Bezug auf horizontale Lasten, aber nicht auf vertikale Lasten erfährt. Es besteht ein Sicherheitsspielraum für den Kollaps aufgrund von horizontalen Erdbebeneinwirkungen.
  - Grenzzustand der Vorbeugung des Kollapses, **SLC**, Grenzzustand bei dem das Bauwerk schwere statische Schäden erfährt, aber trotzdem ein Sicherheitsspielraum für vertikale Einwirkungen und einen geringen Sicherheitsspielraum für horizontale Lasten beibehält.

Die Tabelle 9 gibt in Funktion der Gebrauchsklasse des Bauwerks den zu berücksichtigenden Grenzzustand in Funktion des geeigneten Sicherheitsnachweises für das Bauwerk an (Tabelle C7.1.1 der Circolare del 2 febbraio 2009, n. 617).

Mit Bezug zum geplanten Bauwerk und unter Berücksichtigung des Punktes C7.1 der Circolare del 2

## 6.2 VERIFICHE DI SICUREZZA IN CAMPO SISMICO

### 6.2.1 Stati limite di riferimento per le verifiche sismiche

Le NTC 2008 stabiliscono differenti Stati Limite (sia d'Esercizio che Ultimi) in funzione, in primo luogo, dell'importanza dell'opera mediante l'identificazione della Classe d'Uso e poi in funzione del danno conseguente ad un certo Stato Limite.

In particolare si definiscono i seguenti Stati Limite di Esercizio e Ultimi, come riportato al par. 3.2.1 delle NTC 2008:

- **Stati Limite di Esercizio (SLE):**
  - Stato Limite di immediata Operatività **SLO** per le strutture ed apparecchiature che debbono restare operative a seguito dell'evento sismico. Tale stato limite non si applica per l'opera in oggetto.
  - Stato Limite di Danno **SLD** definito come lo stato limite da rispettare per garantire la sostanziale integrità dell'opera ed il suo immediato utilizzo.
- **Stati Limite Ultimi (SLU):**
  - Stato Limite di Salvaguardia della Vita umana, **SLV**, definito come lo stato limite in cui la struttura subisce una significativa perdita della rigidità nei confronti dei carichi orizzontali ma non nei confronti dei carichi verticali. Permane un margine di sicurezza nei confronti del collasso per azioni sismiche orizzontali.
  - Stato Limite di Prevenzione del Collasso, **SLC**, stato limite nel quale la struttura subisce gravi danni strutturali, mantenendo comunque un margine di sicurezza per azioni verticali ed un esiguo margine di sicurezza a collasso per carichi orizzontali.

La Tabella 9 riporta, in funzione della classe d'uso della struttura, lo stato limite da considerare in funzione della verifica di sicurezza appropriata per l'opera (Tabella C7.1.1 della Circolare del 2 febbraio 2009, n. 617).

Con riferimento all'opera in oggetto, e considerando quanto riportato al punto C7.1 della Circolare del 2 febbraio 2009, n.

febbraio 2009, n. 617, müssen die geotechnischen Nachweise im Falle von Erdbeben folgende Grenzzustände nachweisen:

- Grenzzustand der Tragfähigkeit: **SLV** - Grenzzustand der Wahrung des Lebens (dem eine Übertretungswahrscheinlichkeit von  $P_{vr} = 10\%$  während eines Zeitraums von  $V_r$  entspricht);
- Grenzzustand der Gebrauchstauglichkeit: **SLD** - Grenzzustand des Schadens (dem eine Übertretungswahrscheinlichkeit von  $P_{vr} = 63\%$  während eines Zeitraums von  $V_r$  entspricht):

Die obengenannten Wahrscheinlichkeiten wurden für den Bezugszeitraum  $V_r$  für die Erdbebeneinwirkung bewertet und erlauben es, für jeden Grenzzustand die Wiederkehrzeit des entsprechenden Bemessungserdbebens zu bestimmen.

617, le verifiche geotecniche in presenza di un evento sismico richiedono la verifica ai seguenti stati limite:

- Stato Limite Ultimo: **SLV** – Stato Limite di Salvaguardia della Vita (cui corrisponde una probabilità di superamento  $P_{vr} = 10\%$  nel periodo  $V_r$ );
- Stato Limite Esercizio: **SLD** – Stato Limite di Danno (cui corrisponde una probabilità di superamento  $P_{vr} = 63\%$  nel periodo  $V_r$ ).

Le suddette probabilità, valutate nel periodo di riferimento  $V_r$  per l'azione sismica, consentono di determinare, per ciascuno stato limite, il tempo di ritorno del terremoto di progetto corrispondente.

Stato Limite Grenzzustand	Prestazione da verificare Nachzuweisende Leistungen	Classe d'uso Gebrauchsklasse			
		I	II	III	IV
SLO	Contenimento del danno degli elementi non strutturali Eindämmung von Schäden an nicht statischen Elementen			X	X
	Funzionalità degli impianti Funktionalität der Anlagen			X	X
SLD	Resistenza degli elementi strutturali Widerstand der statischen Elemente			X	X
	Contenimento del danno degli elementi non strutturali Eindämmung von Schäden an nicht statischen Elementen	X	X		
	Contenimento delle deformazioni del sistema fondazione-terreno Eindämmung der Verformungen des Systems Baugrund-Boden	X	X	X	X
	Contenimento degli spostamenti permanenti dei muri di sostegno Eindämmung der ständigen Verschiebungen der Stützmauer	X	X	X	X
SLV	Assenza di martellamento tra strutture contigue Abwesenheit von Schwingungswirkungen zwischen angrenzenden Bauwerken	X	X	X	X
	Resistenza delle strutture Widerstand der Bauwerke	X	X	X	X
	Duttilità delle strutture Flexibilität der Bauwerke	X	X	X	X
	Assenza di collasso fragile ed espulsione di elementi non strutturali Fehlen der fragile Kollaps und Auswurf von nicht statischen Elementen	X	X	X	X
	Resistenza dei sostegni e collegamenti degli impianti Widerstand der Stützen und Verbindungen der Anlagen	X	X	X	X
	Stabilità del sito Standsicherheit des Ortes	X	X	X	X
	Stabilità dei fronti di scavo e dei rilevati Standsicherheit der Aushubfronten und der Aufschüttungen	X	X	X	X
	Resistenza del sistema terreno-fondazione Widerstand des Systems Baugrund-Gründung	X	X	X	X
	Stabilità del muro di sostegno Standsicherheit der Stützmauern	X	X	X	X
	Stabilità delle paratie Standsicherheit der Baugrubenwände	X	X	X	X
	Resistenza e stabilità dei sistemi di contrasto e degli ancoraggi Widerstand und Standsicherheit der Kontrast -Systeme und der Verankerungen	X	X	X	X
SLC	Resistenza dei dispositivi di vincolo temporaneo tra costruzioni isolate Widerstand der temporären Verbindungen temporäre Bindung zwischen isolierten Bauwerken	X	X	X	X
	Capacità di spostamento degli isolatori Fähigkeit zur Verschiebung der Isolatoren	X	X	X	X

Tabelle 9: Sicherheitsnachweise in Funktion der Gebrauchsklasse (Tab. C7.1.1 der Circolare del 2 febbraio 2009, n. 617)

Tabella 9: Verifiche di sicurezza in funzione della Classe d'uso (Tab. C7.1.1 della Circolare del 2 febbraio 2009, n. 617)

### 6.2.2 Grenzzustand der Gebrauchstauglichkeit (GZG)

Es muss nachgewiesen werden unter Verwendung der charakteristischen Werte der Einwirkungen und der geotechnischen Kenngrößen der Materialien, dass die vom Erdbeben verursachten ständigen Verschiebungen den Widerstand der Gründungen nicht grundlegend verändern und mit der Funktionstüchtigkeit des Bauwerks kompatibel sind. Tabelle 9). Für das vorliegende Bauwerk, wie im Kap. 6.2.1 definiert, werden die Nachweise des Grenzzustands der Gebrauchstauglichkeit mit Bezug zum Grenzzustand des Schadens (**SLD**) durchgeführt.

### 6.2.3 Grenzzustand der Tragfähigkeit (GZT)

Bei allen Nachweisen muss der Bemessungswert der Erdbebeneinwirkung aufgrund der Grenzzustände des nachzuweisenden Bauwerks ermittelt werden (siehe Tabelle 9). Für das vorliegende Bauwerk, wie im Kap. 6.2.1 definiert, werden die Nachweise des Grenzzustands der Tragfähigkeit mit Bezug zum Grenzzustand der Wahrung des Lebens (**SLV**) durchgeführt.

Die Sicherheitsweise der Tragfähigkeit müssen im seismischen Bereich mindestens denen entsprechen, die im statischen Bereich erfolgen. Im Besonderen muss die Gesamtstandsicherheit unter seismischen Bedingungen von Bauwerken aus Lockermaterial nach dem *Ansatz 1 - Kombination 2* durchgeführt werden:

$$A2 + M2 + R2$$

unter Berücksichtigung der Teilsicherheitsbeiwerte Tabelle 4 und mit den Teilsicherheitsbeiwerten der Einwirkungen gleich 1 (siehe Kap.7.11.1 der NTC 2008).

Die Standsicherheitsbedingungen des Damms bzw. der Aufschüttung müssen darauf nachgewiesen werden, dass vor, während und nach einem Erdbeben die Widerstände des Systems größer sind als die Einwirkungen. D. h. die ständigen Verschiebungen durch das Erdbeben dürfen nicht so groß sein, dass sie die Sicherheit oder die Funktionstüchtigkeit der Bauwerke oder der Infrastrukturen beeinträchtigen.

Wie im Kap. 7.11.6.3.11 der NTC 2008 angegeben, können die Nachweise durch quasi-statische Methoden, Methoden der Verschiebungen und der dynamischen Analyse durchgeführt werden.

### 6.2.2 Stati limite di esercizio (SLE)

Deve essere verificato, mediante analisi effettuate impiegando i valori caratteristici delle azioni e dei parametri geotecnici dei materiali, che gli spostamenti permanenti indotti dal sisma non alterino significativamente la resistenza della fondazione e devono essere compatibili con la funzionalità dell'opera. L'azione sismica di progetto deve essere valutata sulla base degli Stati Limite relativi all'opera da verificare (vedasi Tabella 9). Per l'opera in oggetto, come definito al paragrafo 6.2.1, le verifiche agli Stati Limite di Esercizio verranno condotte con riferimento allo Stato Limite di Danno (**SLD**).

### 6.2.3 Stati limite ultimi (SLU)

Per tutte le verifiche l'azione sismica di progetto deve essere valutata sulla base degli Stati Limite relativi all'opera da verificare (vedasi Tabella 9). Per l'opera in oggetto, come definito al paragrafo 6.2.1, le verifiche agli Stati Limite Ultimi verranno condotte con riferimento allo Stato Limite di Salvaguardia della Vita (**SLV**).

Le verifiche di sicurezza agli SLU in campo sismico devono contemplare almeno le medesime verifiche definite in campo statico. In particolare la stabilità globale in condizioni sismiche delle opere in materiali sciolti, quali rilevati, deve essere svolta secondo l'*Approccio 1 - Combinazione 2*:

tenendo conto dei coefficienti parziali riportati in Tabella 4 ponendo i coefficienti parziali sulle azioni tutti pari ad uno (vedasi Par.7.11.1 delle NTC 2008).

Le condizioni di stabilità del rilevato-terrapieno devono essere verificate affinché prima, durante e dopo il sisma la resistenza del sistema sia superiore alle azioni, ovvero gli spostamenti permanenti indotti dal sisma siano di entità tale da non pregiudicare le condizioni di sicurezza o di funzionalità delle strutture o infrastrutture medesime.

Come riportato al Par. 7.11.6.3.11 delle NTC 2008, le verifiche possono essere condotte mediante metodi pseudo statici, metodi degli spostamenti e metodi di analisi dinamica.

### 6.3 BEMESSUNGSWERTE DER BEANSPRUCHUNG

Auf den Materialdeponien wirken folgenden Lasten:

- Eigengewicht.
- Filtrationskräfte: Dank eines Entwässerungspakets am Boden des Ablagerungskörpers und der durch Tests vor Ort festgestellten Durchlässigkeit (angegeben im Bericht über die hydraulische Anordnung 2) können diese Kräfte vernachlässigt werden.
- Beanspruchungen im Falle von Erdbeben: die Studie zum Gesetzgebung sehen für Bereich eine zwischen 0.025 e 0.050 g vor. Die Stabilitätsanalysen wurden unter Berücksichtigung geführt, um die folgenden seismischen Koeffizienten:  $k_h=0.005$  und  $k_v=0.003$  (SLD),  $k_h=0.013$  und  $k_v=0.006$  (SLV).
- Belastungen aus einem Hochwasser mit einer Wiederkehrperiode von 150 Jahren
- Lasten aus Steinschlag: Dank der Steinschlagnetze, die oberhalb der Materialdeponie angebracht werden, können die Lasten durch Steinschlag ausgeschlossen werden.

### 6.3 AZIONI DI PROGETTO

Sui depositi agiscono i seguenti carichi:

- Peso proprio.
- Forze di filtrazione: in funzione della granulometria riscontrata dai sondaggi e dell'elevata permeabilità rilevata dalle prove in sito, il comportamento del materiale del rilevato può essere considerato drenato. Pertanto tali forze risultano essere trascurabili.
- Sollecitazioni in caso di terremoto: lo studio di rischio sismico e l'attuale normativa indicano per il sito in oggetto un'accelerazione massima compresa fra 0.025 e 0.050 g. Le verifiche di stabilità sono state eseguite tenendo conto dei seguenti coefficienti sismici:  $k_h=0.005$  e  $k_v=0.003$  nel caso di SLD,  $k_h=0.013$  e  $k_v=0.006$  nel caso di SLV.
- Carichi derivanti da una piena con periodo di ritorno di 150 anni
- Carichi da caduta massi: grazie alle reti di protezione che sono state posizionate sopra il deposito, il caso di carichi da caduta massi per la stessa può essere escluso.

## 7 MODELLGEOMETRIE

Die Spannungs-Dehnungs-Analyse wurde unter Verwendung des zweidimensionalen Finite-Elemente-Plaxis-Programms durchgeführt, um die durch das Vorhandensein der Lagerstätte induzierten Setzungen zu untersuchen und die Stabilität der Lagerstätte zu überprüfen.

Die Vorteile der FEM-Analyse gegenüber bestehen hauptsächlich darin, dass:

- 1) es ist nicht erforderlich, eine Bruchfläche anzugeben;
- 2) sowohl elastisches als auch plastisches Verhalten können in die Analyse einbezogen werden.

In den Modellen wurde eine Höhe des felsigen Untergrunds von 100 Metern über dem Boden berücksichtigt. In den Bereichen, in denen die Verfüllmaterialien vorhanden sind, wurde, wie oben angegeben, eine Mächtigkeit von 8 Metern unter der Geländeoberfläche berücksichtigt.

Die in der Modellierung analysierten Schnitte stellen die endgültige Konfiguration des Abraumphaufens mit maximalem Füllvolumen dar. Es sind insgesamt 3 und sie sind entsprechend der Abbildung positioniert.

## 7 GEOMETRIA DEI MODELLI

L'analisi sforzi-deformazioni è stata eseguita mediante il programma di calcolo bidimensionale agli elementi finiti Plaxis al fine di indagare i cedimenti indotti dalla presenza del deposito e verificare la stabilità del deposito.

I vantaggi nell'impiegare l'analisi FEM rispetto ai modelli all'equilibrio limite consistono principalmente nel fatto che:

- 1) non è necessario specificare alcuna superficie di rottura;
- 2) si possono includere nell'analisi sia il comportamento elastico che quello plastico.

Nei modelli è stata considerata una quota del substrato roccioso pari a 100 metri dal piano campagna. Nelle aree in cui sono presenti i materiali di riempimento, come indicato in precedenza, è stato considerato uno spessore di 8 metri al di sotto del piano campagna.

Le sezioni analizzate nella modellazione sono rappresentative della configurazione finale del cumulo di materiale di smarino, con il massimo volume di riempimento., in totale sono 3 e sono posizionate in accordo con quanto riportato nella figura.

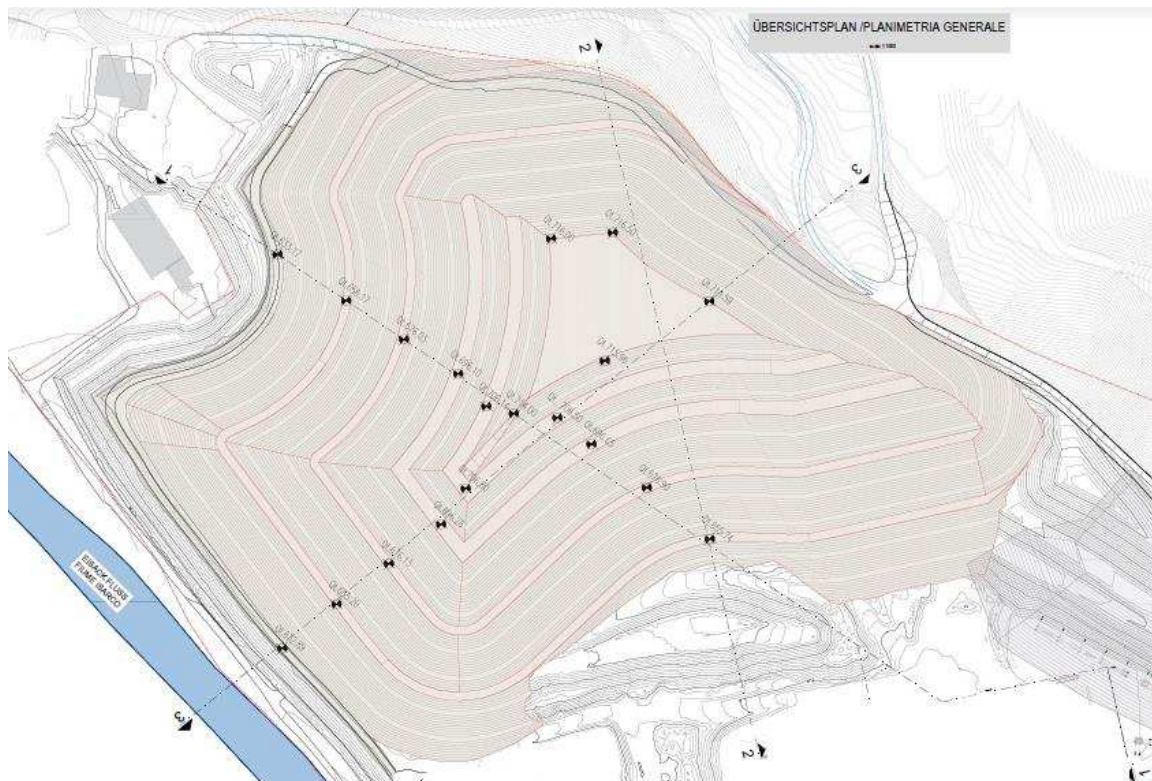


Abbildung 15. Schematischer Lageplan mit Angabe der untersuchten Schnitte für die Analyse der Spannungszustände

Figura 15. Planimetria schematica con indicazione delle sezioni di studio per l'analisi sforzi-deformazioni

## 7.1 MODEL SCHNITT 1

Die geometrischen und geotechnischen Eigenschaften der verschiedenen Materialien für den betrachteten **Abschnitt 1** sind unten aufgeführt.

### Modellgeometrie

SCHNITT 1 / ABSCHNITT 1

Maximale Höhe auf der Anlagenseite (m) 714,0

Tageslichtsteilheit 1V / 1,33H

Der in der Modellierung berücksichtigte Berechnungsteil zum Nachweis des SLS und des ULS/SLV ist in der ausführlichen 02\_H61\_BE\_450\_KQP\_B0130\_54607 detailliert.

## 7.1 MODELLO SEZIONE 1

Le caratteristiche geometriche e geotecniche dei vari materiali per la **sezione 1** considerata sono riportate di seguito.

### Geometria del Modello

SCHNITT 1 / SEZIONE 1

Altezza massima lato impianto (m) 714.0

Pendenza scarpata 1V / 1.33H

La sezione di calcolo considerata nella modellazione al fine di verificare gli SLE e gli SLU/SLV, viene dettagliata nell'elaborato 02\_H61\_BE\_450\_KQP\_B0130\_54607.

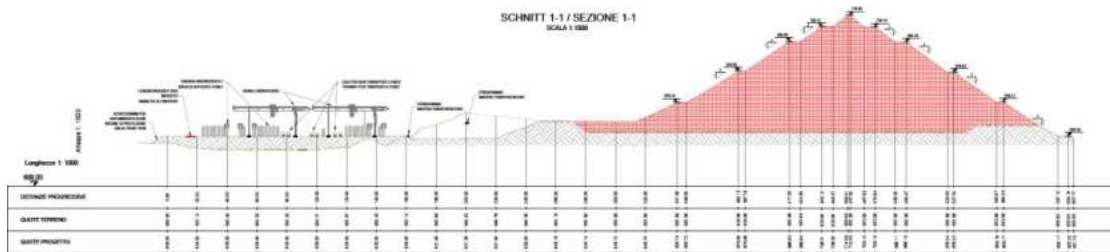


Abbildung 16. Schnitt 1 PHASE 19

Figura 16. Sezione 1 PHASE 19

Die Hauptmerkmale des geotechnischen Modells werden im Folgenden beschrieben. Die Nachweise der finiten Elemente, der Stratigraphie und der Angaben zu den zugeordneten Materialien sind in Anhang 3 aufgeführt.

Sono di seguito descritte le principali caratteristiche del modello geotecnico. Le verifiche agli elementi finiti, la stratigrafia ed il dettaglio dei materiali assegnati sono riportati in [Appendice 3](#).

### Eigenschaften des Modellmaterials

Die in der Modellierung angenommenen reduzierten geotechnischen Bemessungsparameter sind in der Tabelle dargestellt.

### Caratteristiche del Materiale del Modello

Sono riportati in Tabella i parametri geotecnici ridotti di progetto adottati nella modellazione.

Profondità	m	Var. 0 - 8 m	Var. 0 - 8 m	0 - 3 m	3 - 6 m	6 - 13 m	13 - 15 m	15 - 25 m
Colour		<span style="color: orange;">■</span> B+C	<span style="color: red;">■</span> Strato F1	<span style="color: cyan;">■</span> Strato 1	<span style="color: green;">■</span> Strato 2	<span style="color: yellow;">■</span> Strato 3	<span style="color: lightblue;">■</span> Strato 4	<span style="color: lightgreen;">■</span> Strato 5
$\gamma_{\text{unsat}}$	kN/m <sup>3</sup>	21,00	20,00	20,00	20,00	20,00	20,00	20,00
$c'$	kPa	36,00	0,00	4,00	0,00	0,00	0,00	0,00
$\phi$ (phi)	°	31,08	20,00	32,01	33,87	35,77	30,17	30,17
$E_{50 \text{ ref}}$	kN/m <sup>2</sup>	30,00E3	5,00E3	25,00E3	40,00E3	50,00E3	30,00E3	70,00E3

Tabelle 7-10: Gestaltungswerte von Modelliermaterialien

Tabella 7-10: valori di progetto dei materiali di modellazione

### Modellrechnungsphasen

Beschreibung der in die Modellierung übernommenen Berechnungsschritte

1. SLE Geostatischer Zustand;
2. SLE Erster Einzahlungsschritt  
(ca. +20 m vom Bodenniveau; 643,12 m ü.M.);
3. SLE Zweiter Einzahlungsschritt  
(ca. +40 m vom Boden; 643,12 m ü.M.);
4. SLE Dritter Einzahlungsschritt  
(ca. +60 m vom Boden; 643,12 m ü.M.);
5. SLE Vierter Einzahlungsschritt  
(ca. +75 m vom Boden; 643,12 m ü.M.);
6. SLE / SLU Fünfter Einzahlungsschritt (statisch)  
(ca. +80 m vom Boden; 643,12 m ü.M.);
7. SLE / ULS Fünfter Ablagerungsschritt (seismisch)  
(ca. +80 m vom Boden; 643,12 m ü.M.);

Die letzte Phase des Modells ist unten mit maximaler Füllung dargestellt.

### Fasi di Calcolo del Modello

Descrizione degli step di calcolo adottati nella modellazione

1. SLE Condizione geostatica;
2. SLE Primo step di deposito  
(circa +20m dal piano campagna; 643,12 m.s.l.m);
3. SLE Secondo step di deposito  
(circa +40m dal piano campagna; 643,12 m.s.l.m);
4. SLE Terzo step di deposito  
(circa +60m dal piano campagna; 643,12 m.s.l.m);
5. SLE Quarto step di deposito  
(circa +75m dal piano campagna; 643,12 m.s.l.m);
6. SLE / SLU Quinto step di deposito (statica)  
(circa +80m dal piano campagna; 643,12 m.s.l.m);
7. SLE / SLU Quinto step di deposito (sismica)  
(circa +80m dal piano campagna; 643,12 m.s.l.m);

Di seguito si mostra la fase finale il modello, con massimo riempimento.

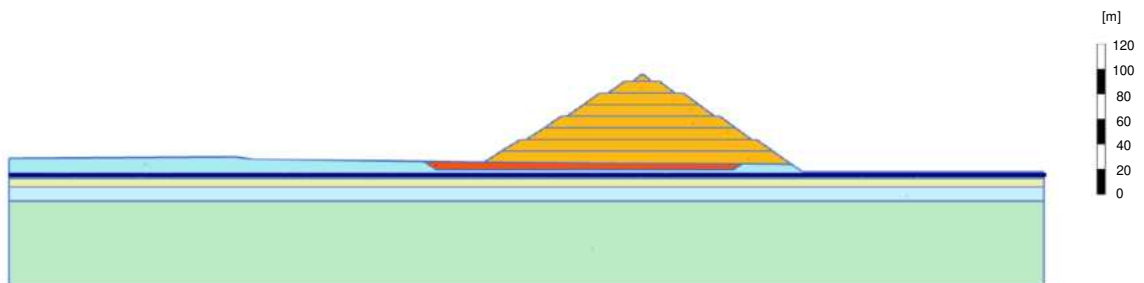


Abbildung 17. Model 1 PHASE 19

Figura 17. Modello 1 PHASE 19



## 7.2 MODEL SCHNITT 2

Die geometrischen und geotechnischen Eigenschaften der verschiedenen Materialien für den betrachteten **Abschnitt 2** sind unten aufgeführt.

### Modellgeometrie

#### SCHNITT 1 / ABSCHNITT 1

Maximale Höhe auf der Anlagenseite (m) 716,13

Tageslichtsteilheit 1V / 1,33H

Der in der Modellierung berücksichtigte Berechnungsteil zum Nachweis des SLS und des ULS/SLV ist in der ausführlichen 02\_H61\_BE\_450\_KQP\_B0130\_54607 detailliert.

## 7.2 MODELLO SEZIONE 2

Le caratteristiche geometriche e geotecniche dei vari materiali per la **sezione 2** considerata sono riportate di seguito.

### Geometria del Modello

#### SCHNITT 2 / SEZIONE 2

Altezza massima lato impianto (m) 716.13

Pendenza scarpata 1V / 1.33H

Le sezioni di calcolo considerate nella modellazione al fine di verificare gli SLE e gli SLU/SLV, sono meglio dettagliate nell'elaborato 02\_H61\_BE\_450\_KQP\_B0130\_54607.

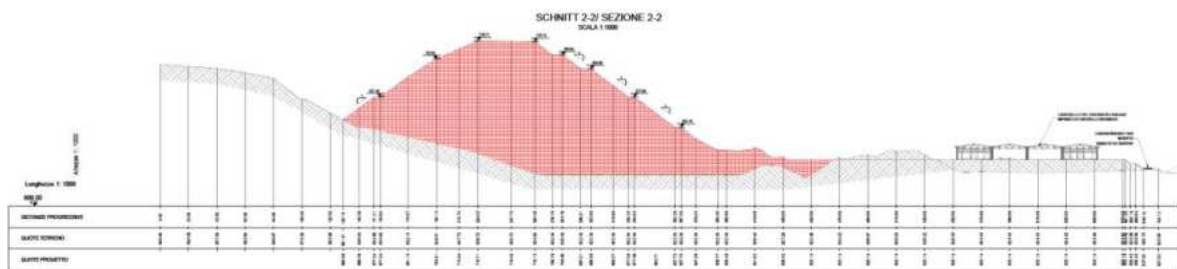


Abbildung 18: Schnitt 2 PHASE 19

Figura 18. Sezione 2 PHASE 19

Die Hauptmerkmale des geotechnischen Modells werden im Folgenden beschrieben. Die Nachweise der finiten Elemente, der Stratigraphie und der Angaben zu den zugeordneten Materialien sind in Anhang 4 aufgeführt.

Sono di seguito descritte le principali caratteristiche del modello geotecnico. Le verifiche agli elemnti finiti, la stratigrafia ed il dettaglio dei materiali assegnati sono riportati in Appendice 4.

### Eigenschaften des Modellmaterials

Die in der Modellierung angenommenen reduzierten geotechnischen Bemessungsparameter sind in der Tabelle dargestellt.

### Caratteristiche del Materiale del Modello

Sono riportati in Tabella i parametri geotecnici ridotti di progetto adottati nella modellazione.

Profondità	m	Var. 0 - 8 m	Var. 0 - 8 m	0 - 3 m	3 - 6 m	6 - 13 m	13 - 15 m	15 - 25 m
Colour		B+C	Strato F1	Strato 1	Strato 2	Strato 3	Strato 4	Strato 5
$\gamma_{\text{unsat}}$	kN/m <sup>3</sup>	21,00	20,00	20,00	20,00	20,00	20,00	20,00
$c'$	kPa	36,00	0,00	4,00	0,00	0,00	0,00	0,00
$\phi$ (phi)	°	31,08	20,00	32,01	33,87	35,77	30,17	30,17
$E_{50 \text{ ref}}$	kN/m <sup>2</sup>	30,00E3	5,00E3	25,00E3	40,00E3	50,00E3	30,00E3	70,00E3

Tabelle 7-11: Gestaltungswerte von Modelliermaterialien

Tabella 7-11:valori di progetto dei materiali di modellazione

### Modellrechnungsphasen

Beschreibung der in die Modellierung übernommenen Berechnungsschritte

1. SLE Geostatischer Zustand;
2. SLE Erster Einzahlungsschritt  
(ca. +20 m vom Bodenniveau; 639,24 m ü.M.);
3. SLE Zweiter Einzahlungsschritt  
(ca. +40 m vom Boden; 639,24 m ü.M.);
4. SLE Dritter Einzahlungsschritt  
(ca. +60 m vom Boden; 639,24 m ü.M.);
5. SLE Vierter Einzahlungsschritt  
(ca. +70 m vom Boden; 639,24 m ü.M.);
6. SLE / SLU Fünfter Einzahlungsschritt (statisch)  
(ca. +80 m vom Boden; 639,24 m ü.M.);
7. SLE / ULS Fünfter Ablagerungsschritt (seismisch)  
(ca. +80 m vom Boden; 639,24 m ü.M.);

Die letzte Phase des Modells ist unten mit maximaler Füllung dargestellt.

### Fasi di Calcolo del Modello

Descrizione degli step di calcolo adottati nella modellazione

1. SLE Condizione geostatica;
2. SLE Primo step di deposito  
(circa +20m dal piano campagna; 639,24 m.s.l.m);
3. SLE Secondo step di deposito  
(circa +40m dal piano campagna; 639,24 m.s.l.m);
4. SLE Terzo step di deposito  
(circa +60m dal piano campagna; 639,24 m.s.l.m);
5. SLE Quarto step di deposito  
(circa +70m dal piano campagna; 639,24 m.s.l.m);
6. SLE / SLU Quinto step di deposito (statica)  
(circa +80m dal piano campagna; 639,24 m.s.l.m);
7. SLE / SLU Quinto step di deposito (sismica)  
(circa +80m dal piano campagna; 639,24 m.s.l.m);

Di seguito si mostra la fase finale il modello, con massimo riempimento.

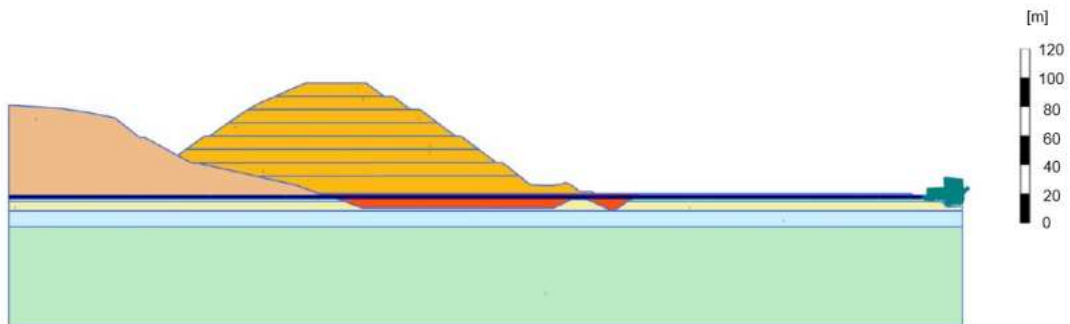


Abbildung 19: Model 2 PHASE 19

Figura 19. Modello 2 PHASE 19

### 7.3 MODEL SCHNITT 3

Die geometrischen und geotechnischen Eigenschaften der verschiedenen Materialien für den betrachteten **Abschnitt 3** sind unten aufgeführt.

#### Modellgeometrie

##### SCHNITT 1 / ABSCHNITT 1

Maximale Höhe auf der Anlagenseite (m) 716,12

Tageslichtsteilheit 1V / 1,33H

Der in der Modellierung berücksichtigte Berechnungsteil zum Nachweis des SLS und des ULS/SLV ist in der ausführlichen 02\_H61\_BE\_450\_KQP\_B0130\_54607 detailliert.

### 7.3 MODELLO SEZIONE 3

Le caratteristiche geometriche e geotecniche dei vari materiali per la **sezione 3** considerata sono riportate di seguito.

#### Geometria del Modello

##### SCHNITT 3 / SEZIONE 3

Altezza massima lato fiume (m) 716.12

Pendenza scarpata 1V / 1.33H

Le sezioni di calcolo considerate nella modellazione al fine di verificare gli SLE e gli SLU/SLV, sono meglio dettagliate nell'elaborato 02\_H61\_BE\_450\_KQP\_B0130\_54607.

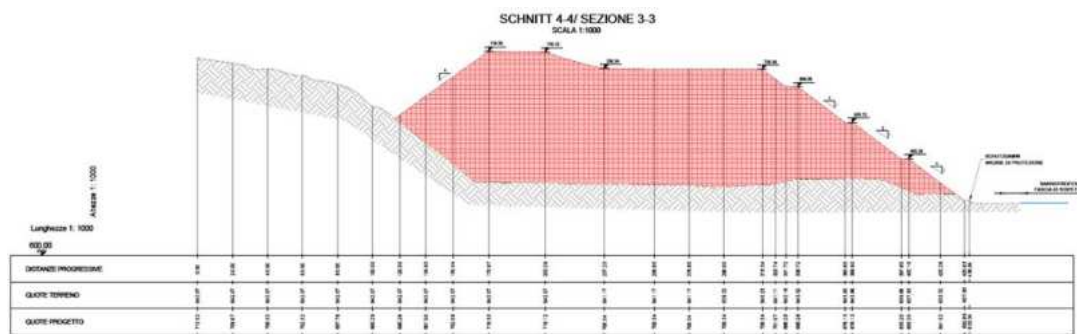


Abbildung 20: Schnitt 3 PHASE 19

Figura 20. Sezione 3 PHASE 19

Die Hauptmerkmale des geotechnischen Modells werden im Folgenden beschrieben. Die Nachweise der finiten Elemente, der Stratigraphie und der Angaben zu den zugeordneten Materialien sind in Anhang 5 aufgeführt.

Sono di seguito descritte le principali caratteristiche del modello geotecnico. Le verifiche agli elementi finiti, la stratigrafia ed i materiali assegnati sono riportati anche in [Appendice 5](#).

#### Eigenschaften des Modellmaterials

Die in der Modellierung angenommenen reduzierten geotechnischen Bemessungsparameter sind in der Tabelle dargestellt.

#### Eigenschaften des Modellmaterials

Die in der Modellierung angenommenen reduzierten geotechnischen Bemessungsparameter sind in der Tabelle dargestellt.

Profondità	m	Var. 0 - 8 m	Var. 0 - 8 m	0 - 3 m	3 - 6 m	6 - 13 m	13 - 15 m	15 - 25 m
Colour		<span style="background-color: orange;">■</span> B+C	<span style="background-color: red;">■</span> Strato F1	<span style="background-color: cyan;">■</span> Strato 1	<span style="background-color: green;">■</span> Strato 2	<span style="background-color: yellow;">■</span> Strato 3	<span style="background-color: lightblue;">■</span> Strato 4	<span style="background-color: lightgreen;">■</span> Strato 5
$\gamma_{\text{unsat}}$	kN/m <sup>3</sup>	21,00	20,00	20,00	20,00	20,00	20,00	20,00
$c'$	kPa	36,00	0,00	4,00	0,00	0,00	0,00	0,00
$\phi$ (phi)	°	31,08	20,00	32,01	33,87	35,77	30,17	30,17
$E_{50 \text{ ref}}$	kN/m <sup>2</sup>	30,00E3	5,00E3	25,00E3	40,00E3	50,00E3	30,00E3	70,00E3

Tabelle 7-12: Gestaltungswerte von Modelliermaterialien

Tabella 7-12: valori di progetto dei materiali di modellazione

### Modellrechnungsphasen

Beschreibung der in die Modellierung übernommenen Berechnungsschritte

1. SLE Geostatischer Zustand;
2. SLE Erster Einzahlungsschritt  
(ca. +20 m vom Bodenniveau 631,55 m ü.M.);
3. SLE Zweiter Einzahlungsschritt  
(ca. +40 m vom Boden; 631,55 m ü.M.);
4. SLE Dritter Einzahlungsschritt  
(ca. +60 m vom Boden; 631,55 m ü.M.);
5. SLE Vierter Einzahlungsschritt  
(ca. +70 m vom Boden; 631,55 m ü.M.);
6. SLE / SLU Fünfter Einzahlungsschritt (statisch)  
(ca. +80 m vom Boden; 631,55 m ü.M.);
7. SLE / ULS Fünfter Ablagerungsschritt (seismisch)  
(ca. +80 m vom Boden; 631,55 m ü.M.);

Die letzte Phase des Modells ist unten mit maximaler Füllung dargestellt.

### Fasi di Calcolo del Modello

Descrizione degli step di calcolo adottati nella modellazione

8. SLE Condizione geostatica;
9. SLE Primo step di deposito  
(circa +20m dal piano campagna; 631,55 m.s.l.m);
10. SLE Secondo step di deposito  
(circa +40m dal piano campagna; 631,55 m.s.l.m);
11. SLE Terzo step di deposito  
(circa +60m dal piano campagna; 631,55 m.s.l.m);
12. SLE Quarto step di deposito  
(circa +70m dal piano campagna; 631,55 m.s.l.m);
13. SLE / SLU Quinto step di deposito (statica)  
(circa +80m dal piano campagna; 631,55 m.s.l.m);
14. SLE / SLU Quinto step di deposito (sismica)  
(circa +80m dal piano campagna; 631,55 m.s.l.m);

Di seguito si mostra la fase finale il modello, con massimo riempimento.

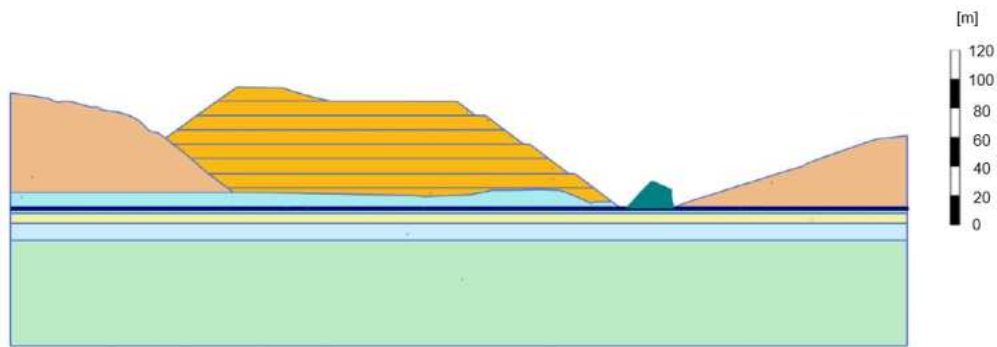


Abbildung 21: Model 3 PHASE 19

Figura 21. Modello 3 PHASE 19

## 8 NACHWEIS DER GRENZZUSTÄNDE DER TRAGFÄHIGKEIT UND GEBRAUCHS

Zur Bewertung der Böschungstabilität wurde die SSR-Methode (Shear Strength Reduction) angewendet, die in der automatischen Reduzierung der Scherfestigkeit (SSR) der Materialien besteht.

Der kritische Reduktionsfaktor, bei dem die numerische Nichtkonvergenz aufzutreten beginnt, wird als gleich dem Sicherheitsfaktor angesehen. Bei diesem Wert, bei dem die Spannungszustände nicht gleichzeitig das Versagenskriterium und das globale Gleichgewicht erfüllen, wird die Steigung also brechen.

Der Zustand in den betrieblichen Grenzzuständen wird dann in Bezug auf die Werft, auf der das Vorfertigungssystem der Segmente vorhanden ist, und in Bezug auf das bestehende Gebäude (Maso Sossai), das sich im südwestlichen Teil des Baufelds befindet, nachgewiesen.

Die Stabilität der Halde wird auch durch Analyse des Abschnitts mit der maximalen Höhe überprüft.

Die Abschnitte 1, 2 und 3 wurden unter Bedingungen im Grenzzustand der Gebrauchstauglichkeit (SLE) analysiert, da sie als repräsentativ für die Analyse der Auswirkungen auf den Platz vor den Halden gelten, auf denen verschiedene Strukturen, wie z. B. Kräne, Gleise usw.; und am Bestandsgebäude südwestlich der Baustelle.

Es ist vernünftig zu erwarten, dass die Isozedanzkurven um den Pfahl herum einen Trend aufweisen, der die Form desselben weitgehend nachzeichnet, und die Analyse der zwei identifizierten Abschnitte beschreibt zuverlässig das tatsächliche Verhalten.

Stattdessen wurden die Berechnungsabschnitte 2 und 3 mit dem Ziel analysiert, die Standsicherheit der Halden bei den Grenzzuständen der Tragfähigkeit (ULS) zu bewerten, die sich durch eine größere Höhe auszeichnen.

Die Bemessungsneigung der Pfähle ist für alle Phasen konstant und beträgt 3:4 (vertikal: horizontal), für Material vom Typ B + C.

## 8 VERIFICHE AGLI STATI LIMITE ULTIMI E DI ESERCIZIO

Per la valutazione della stabilità del versante si è adottato il metodo SSR (shear strength reduction) che consiste nella riduzione automatica delle resistenze al taglio (SSR) dei materiali.

Il fattore di riduzione critico in corrispondenza del quale inizia ad aver luogo la non convergenza numerica viene considerato pari al fattore di sicurezza. Per questo valore, per il quale gli stati di stress non soddisfano contemporaneamente il criterio di rottura e l'equilibrio globale, avverrà, quindi, la rottura del versante.

Si andrà quindi a verificare la condizione agli stati limite di esercizio relativamente al piazzale dove è presente l'impianto di prefabbricazione dei conci e relativamente all'edificio esistente (maso Sossai) localizzato nella parte sud-ovest dell'area di cantiere.

Verrà inoltre verificata la stabilità del cumulo analizzando la sezione con la massima altezza.

Le sezioni 1, 2 e 3 sono state analizzate in condizioni di stati limite di esercizio (SLE) in quanto sono quelle considerate rappresentative per l'analisi degli effetti indotti sul piazzale antistante i cumuli che ospita varie strutture, quali impianto di prefabbricazione dei conci, carriponte, binari, ecc; e sull'edificio esistente a sud-ovest dell'area di cantiere.

È ragionevole attendersi che le curve di isocedimento intorno al cumulo abbiano un andamento che ricalchi in linea di massima la forma dello stesso e l'analisi delle 2 sezioni individuate descrivano in maniera attendibile il reale comportamento.

Le sezioni di calcolo 1, 2 e 3 sono state invece analizzate con il fine di valutare la stabilità dei cumuli agli stati limite ultimi (SLU)

La pendenza di progetto dei cumuli è costante per tutte le fasi, pari a 3:4 (verticale: orizzontale), per il materiale di tipo B+C.

## 8.1 ANALYSE DER ERGEBNISSE IN BEZUG AUF DIE EINSCHRÄNKUNGSZUSTÄNDE

Nachfolgend sind die Ergebnisse der am GZG durchgeführten Analysen aufgeführt. Es ist zu beachten, dass in Bezug auf die Art des Fundamentbodens (grobkörnig) die Ablagerungen unmittelbar und nicht zeitverzögert erfolgen.

### 8.1.1 Ergebnisse des Schnitts 1

Abschnitt 1 ist der nördlichste der analysierten Abschnitte. Der Platz, der für die Lagerung der verwendet wird, befindet sich etwa 30 Meter vom Fuß der Halde entfernt, während sich die Achse des nächsten Gleises etwa 100 Meter entfernt befindet. Die Analysen gingen von einer Höhe des in einer Tiefe von etwa 2,7 m über aus. Die Zahlenwerte der eingegebenen Parameter sind in Anlage 3 dargestellt.

Mit Verweis auf Anhang 3 für eine detaillierte Auflistung der und der Ergebnisse, variiert die maximale Setzung bei maximaler Höhe der zwischen einem Wert von ca. 400 cm.

## 8.1 ANALISI DEI RISULTATI RELATIVI AGLI STATI LIMITE DI ESERCIZIO

Di seguito sono riportati i risultati relativi alle analisi condotte allo SLE. Si evidenzia che in relazione alla tipologia di terreno di fondazione (a grana grossa) i cedimenti saranno di tipo immediato e non differiti nel tempo e avverranno quindi durante la costruzione del deposito stesso.

### 8.1.1 Risultati sezione 1

La sezione 1 è la sezione più a nord tra quelle analizzate. Il piazzale che sarà utilizzato per lo stoccaggio dei conci si trova a circa 30 metri dal piede del cumulo mentre l'asse del binario più vicino si trova a circa 100 metri. Nelle analisi si è assunta una quota della falda ad una profondità di circa 2,7 m da piano campagna. I valori numerici dei parametri geotecnici di input sono riportati in Appendice 3.

Rimandando all'Appendice 3 per il dettaglio dei dati di input e dei risultati, il cedimento massimo con configurazione con la massima altezza del deposito è di circa 400 cm.

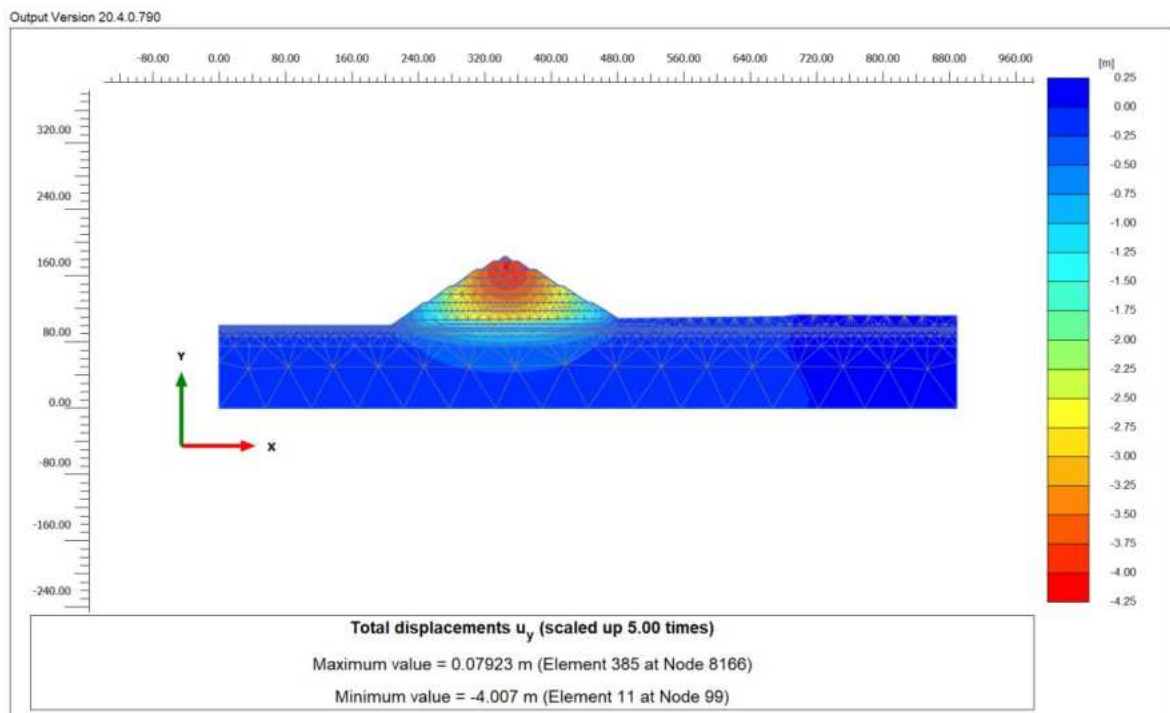


Abbildung 22. Bewertung der Setzungen für den Schnitt 1

Figura 22. Valutazione dei cedimenti per la sezione 1

Betreffend die Plastifizierung wird im Fall F1 darauf hingewiesen, dass der gesamte Bereich der ehemaligen Gruben plastifiziert und die zentrale Plastifizierung der Materialdeponie sich bedeutsam ausbreitet.

Per quanto riguarda le plasticizzazioni si evidenzia che per il caso F1, il settore delle ex-cave risulta interamente plasticizzato e la plasticizzazione nel deposito si estende in modo significativo nell'intero deposito.

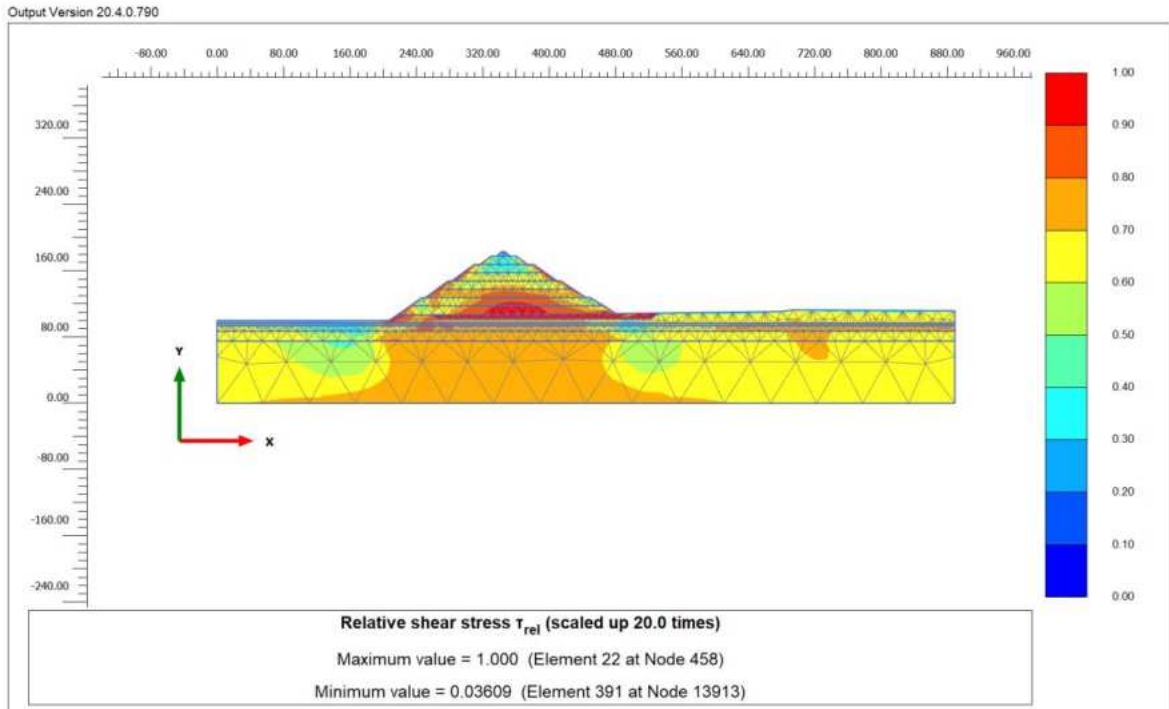


Abbildung 23. Plastifizierung Schnitt 1

Figura 23. Plasticizzazione sezione 1

Die folgende Abbildung zeigt den Trend der vertikalen Besiedlung auf Höhe des aktuellen Bodenniveaus.

Nella figura seguente viene riportato l'andamento del cedimento verticale a livello di fondazione del rilevato.

Hervorzuheben ist, dass sich die größten vertikalen Setzungen auf der Pflanzenseite entwickeln und etwa 100 m vom Pfahlfuß entfernt vollständig enden.

Si mette in evidenza che i cedimenti verticali maggiori si sviluppano lato impianto, andando ad esaurirsi completamente a circa 100m dal piede del cumulo.

In einer Entfernung von 35 m kommt es weniger als 5 cm.

A distanza di 35m si hanno cedimenti inferiori a 5cm.

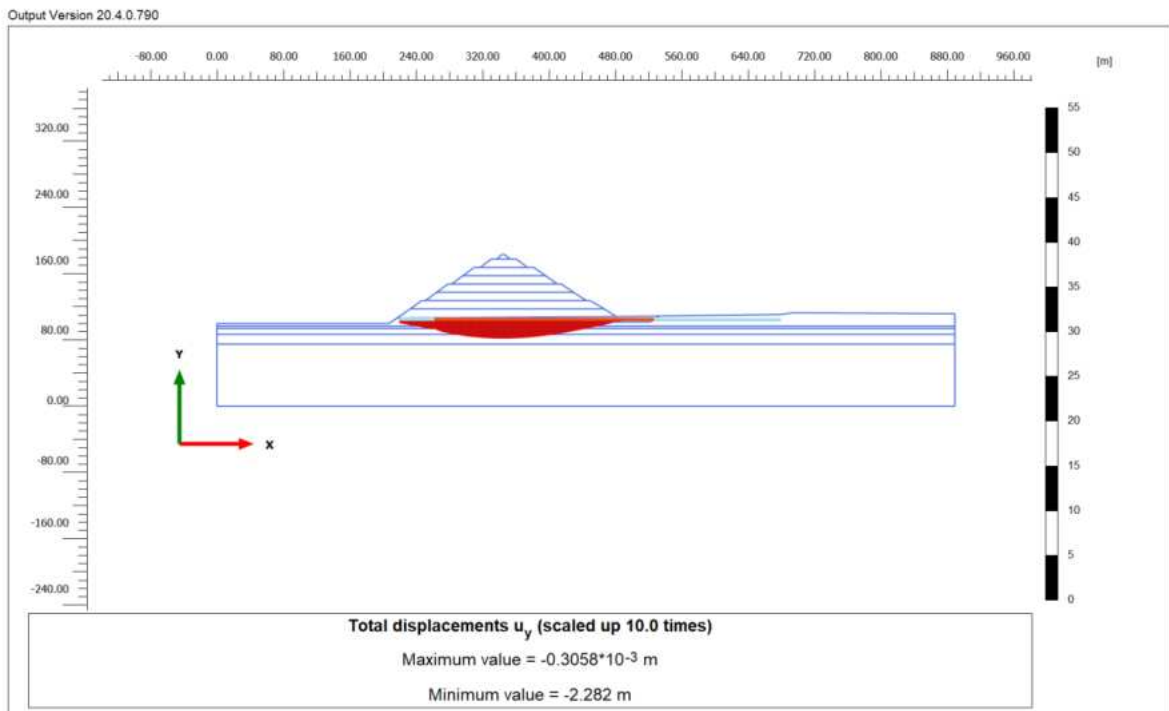


Abbildung 24. Setzungen für den Schnitt 1

Figura 24. Cedimenti sezione 1

### 8.1.2 Ergebnisse des Schnitts 2

Abschnitt 2 ist der zentrale Abschnitt unter den analysierten. Die Segment-Vorfertigungsanlage befindet sich etwa 160 Meter vom Pfahlfuß entfernt. Die Analysen gingen von einer Höhe des Grundwasserspiegels in einer Tiefe von etwa 2,7 m über aus. Die Zahlenwerte der eingegebenen geotechnischen Parameter sind in Anlage 4 dargestellt.

Mit Verweis auf Anhang 4 für eine detaillierte Auflistung der und der Ergebnisse, variiert die maximale Setzung bei maximaler Höhe der zwischen einem Wert von ca. 492 cm.

### 8.1.2 Risultati sezione 2

La sezione 2 è la sezione centrale tra quelle analizzate. L'impianto di prefabbricazione dei conci si trova a circa 160 metri dal piede del cumulo. Nelle analisi si è assunta una quota della falda ad una profondità di circa 2,7 m da piano campagna. I valori numerici dei parametri geotecnici di input sono riportati in Appendice 4.

Rimandando all'Appendice 4 per il dettaglio dei dati di input e dei risultati, il cedimento massimo con configurazione con la massima altezza del deposito è di circa 492 cm.

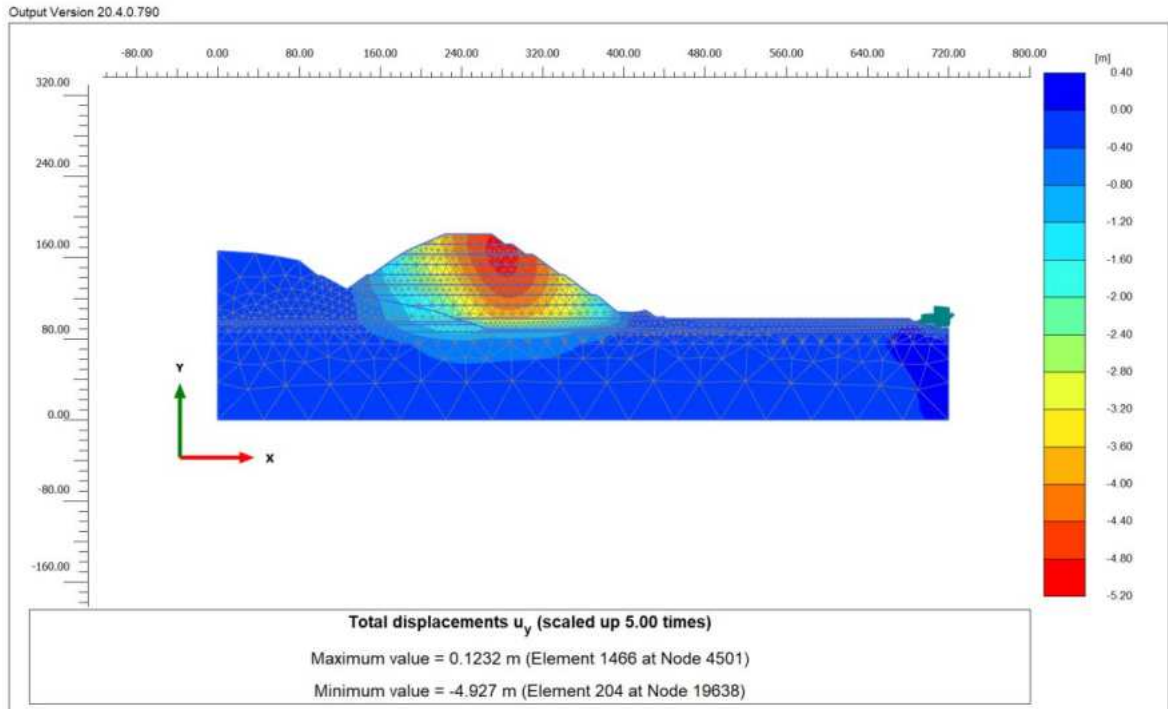


Abbildung 25. Bewertung der Setzungen für den Schnitt 2

Figura 25. Valutazione dei cedimenti per la sezione 2

Betreffend die Plastifizierung wird im Fall F1 darauf hingewiesen, dass der gesamte Bereich der ehemaligen Gruben plastifiziert und die zentrale Plastifizierung der Materialdeponie sich bedeutsam ausbreitet.

Per quanto riguarda le plasticizzazioni si evidenzia che per il caso F1, il settore delle ex-cave risulta interamente plasticizzato e la plasticizzazione nel deposito si estende in modo significativo nell'intero deposito.



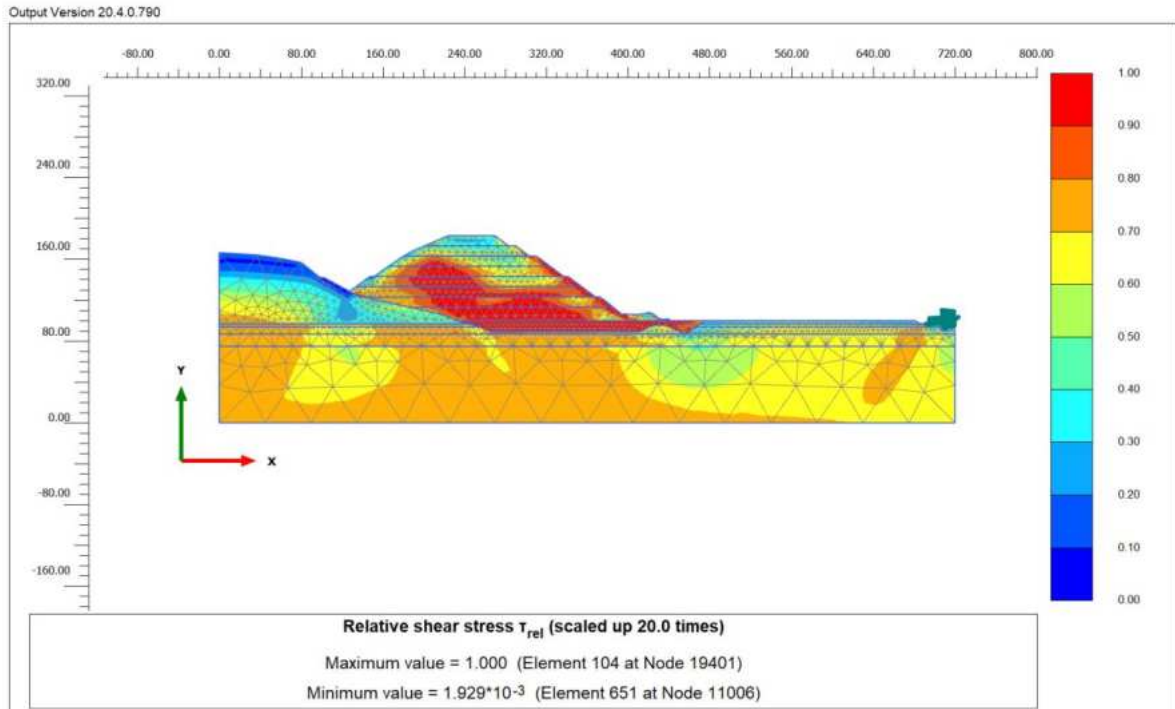


Abbildung 26. Plastifizierung Schnitt 2

Figura 26. Plasticizzazione sezione 2

Die folgende Abbildung zeigt den Trend der vertikalen Besiedlung auf Höhe des aktuellen Bodenniveaus.

Nella figura seguente viene riportato l'andamento del cedimento verticale a livello di fondazione del rilevato.

Hervorzuheben ist, dass sich die größten vertikalen Setzungen auf der Pflanzenseite entwickeln und etwa 50 m vom Pfahlfuß entfernt vollständig enden.

Si mette in evidenza che i cedimenti verticali maggiori si sviluppano lato impianto, andando ad esaurirsi completamente a circa 50m dal piede del cumulo.

In einer Entfernung von 15 m kommt es weniger als 5 cm.

A distanza di 15m si hanno cedimenti inferiori a 5cm.

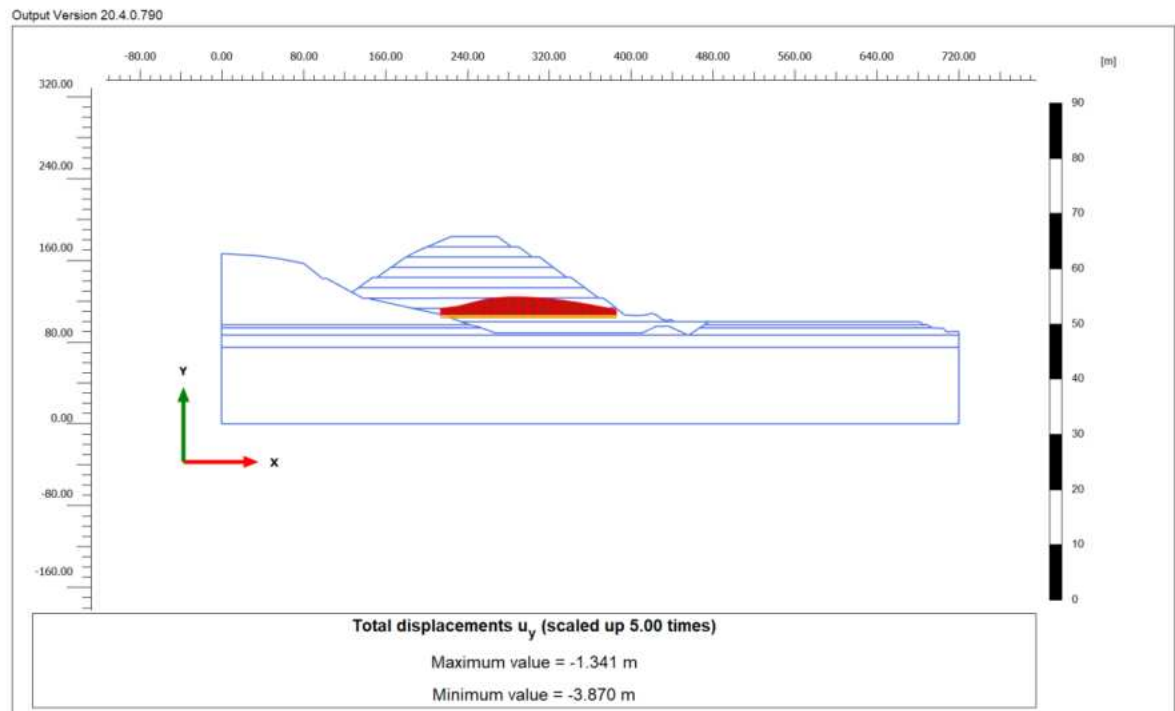


Abbildung 27. Setzungen für den Schnitt 2

Figura 27. Cedimenti sezione 2

Die Siedlungen unterhalb der Halde sind sowohl aufgrund ihrer hohen Höhe als auch aufgrund der sehr vorsichtigen Eigenschaften, mit denen die Befüllung der vorhandenen Steinbrüche modelliert wird, von großer Bedeutung.

Diese Ausfälle sind kein Hinweis auf ein Problem mit der Stabilität der Halden und beeinträchtigen nicht die Funktionalität der Vorfertigungsanlage, die in Kapitel 8.1.4 ausführlich analysiert wird.

### 8.1.3 Ergebnisse des Schnitts 3

Abschnitt 3 ist der südlichste der untersuchten Abschnitte. Die Berechnungen gingen von einer Höhe des Grundwasserspiegels gleich der Geländeoberkante am Fuß der Böschung aus. Die Zahlenwerte der eingegebenen geotechnischen Parameter sind in Anlage 5 dargestellt.

Mit Verweis auf Anhang 5 für eine detaillierte Auflistung der Eingabedaten und der, variiert die maximale Setzung bei maximaler Höhe der zwischen einem Wert von ca. 324 cm.

I cedimenti al di sotto del cumulo risultano essere molto rilevanti sia a causa dell'elevata altezza dello stesso che delle proprietà molto cautelative con le quali viene modellato il riempimento delle cave esistenti.

Tali cedimenti non sono comunque indice di un problema della stabilità dei cumuli e non compromettono la funzionalità dell'impianto di prefabbricazione che verrà analizzata in dettaglio nel capitolo 8.1.4.

### 8.1.3 Risultati sezione 3

La sezione 3 è la sezione più a sud tra quelle analizzate. Nelle analisi si è assunta una quota della falda pari a quella del piano campagna in corrispondenza del piede del rilevato. I valori numerici dei parametri geotecnici di input sono riportati in Appendice 5.

Rimandando all'Appendice 5 per il dettaglio dei dati di input e dei risultati, il cedimento massimo con configurazione con la massima altezza del deposito è di circa 324 cm.

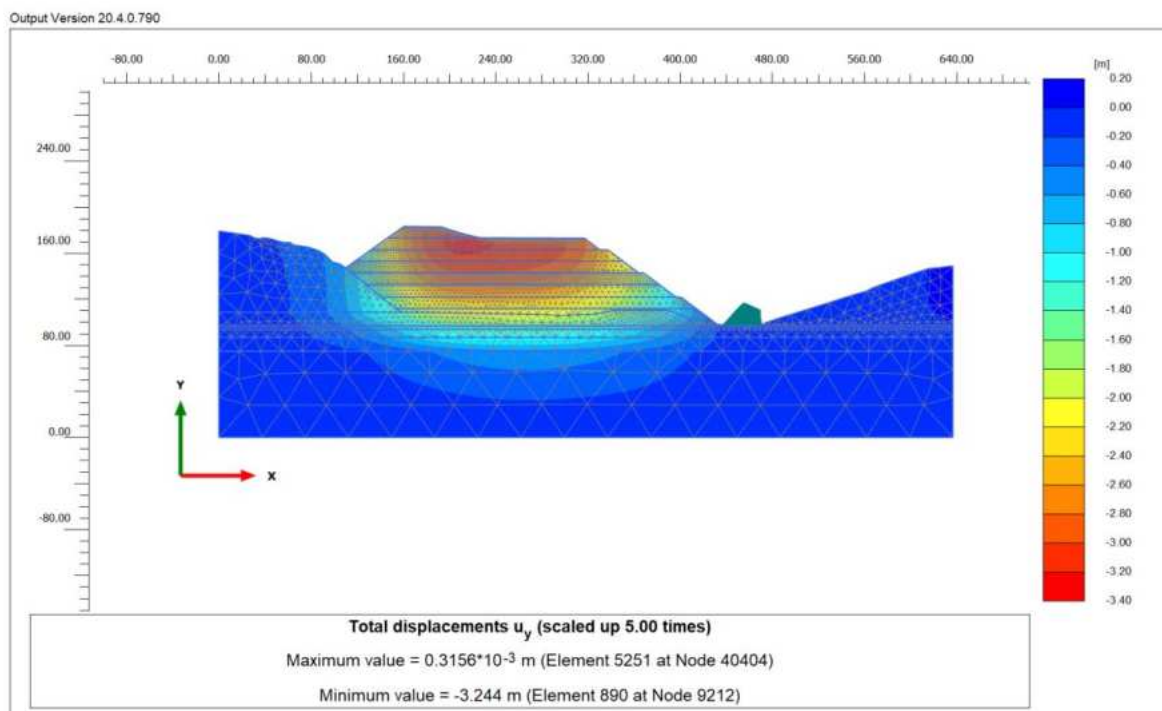


Abbildung 28. Bewertung der Setzungen für den Schnitt 3

Figura 28. Valutazione dei cedimenti per la sezione 3

Betreffend die Plastifizierung wird im Fall F1 darauf hingewiesen, dass der gesamte Bereich der ehemaligen Gruben plastifiziert und die zentrale Plastifizierung der Materialdeponie sich bedeutsam ausbreitet.

Per quanto riguarda le plasticizzazioni si evidenzia che per il caso F1, il settore delle ex-cave risulta interamente plasticizzato e la plasticizzazione nel deposito si estende in modo significativo nell'intero deposito.

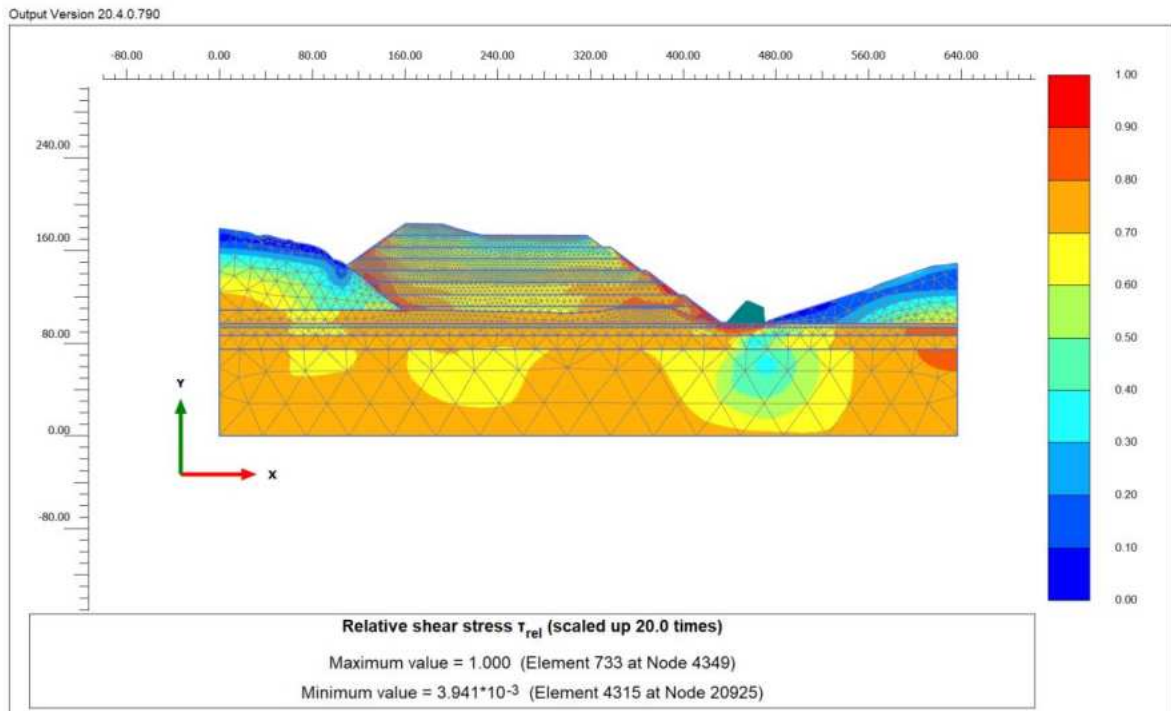


Abbildung 29. Plastifizierung Schnitt 3

Figura 29. Plasticizzazione sezione 3

Die folgende Abbildung zeigt den Trend der vertikalen Besiedlung auf Höhe des aktuellen Bodenniveaus.

Nella figura seguente viene riportato l'andamento del cedimento verticale a livello di fondazione del rilevato.

Es wird hervorgehoben, dass die größten vertikalen Setzungen an der Seite der Baustelle entstehen und etwa 100 m vom Fuß des Pfahls entfernt vollständig enden.

Si mette in evidenza che i cedimenti verticali maggiori si sviluppano lato pista di cantiere, andando ad esaurirsi completamente a circa 100m dal piede del cumulo.

Auf der Eisackseite enden die Siedlungen etwa 60 m vom Pfahl entfernt, in 25 m Entfernung unter 5 cm auf.

Lato fiume Isarco i cedimenti si esauriscono a circa 60 m dal cumulo, a distanza di 25m mostrano valori inferiori a 5cm.

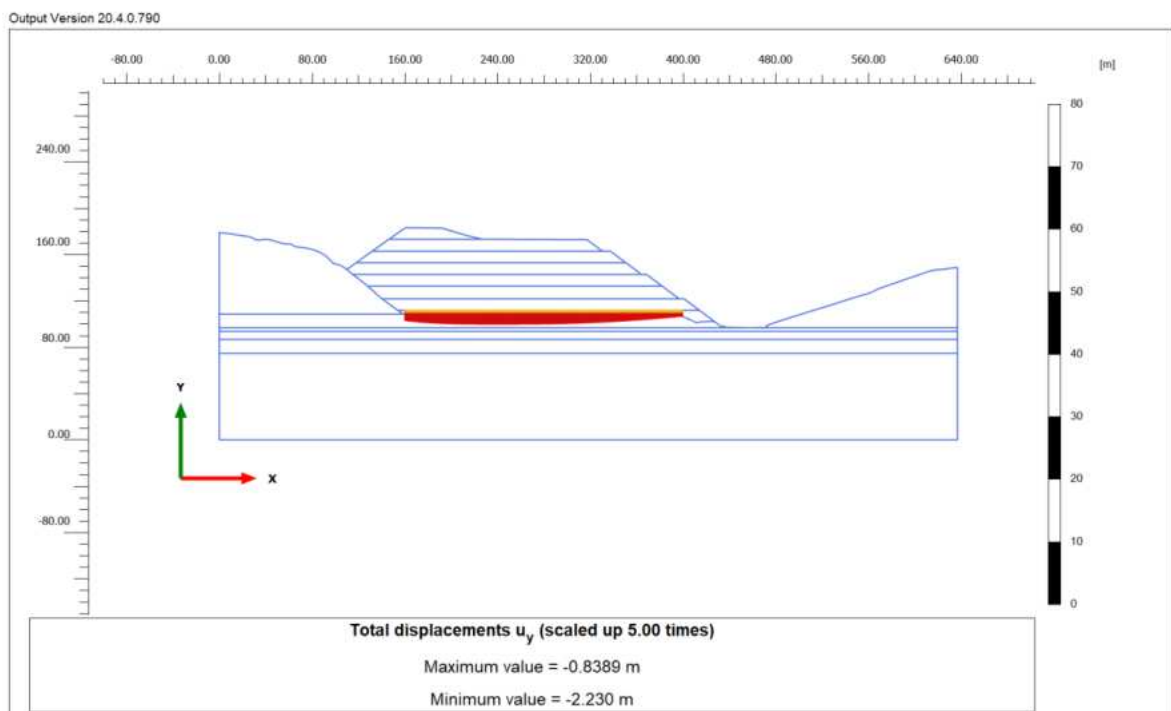


Abbildung 30. Setzungen für den Schnitt 3

Figura 30. Cedimenti sezione 3

Die Siedlungen unterhalb der Halde sind sowohl aufgrund ihrer hohen Höhe als auch aufgrund der sehr vorsichtigen Eigenschaften, mit denen die Befüllung der vorhandenen Steinbrüche modelliert wird, von großer Bedeutung.

#### **8.1.4 Analyse Auswirkungen auf die Vorfertigungsanlage der Segmente und relativen Quadrats**

Die nunmehr konsolidierte Methodik zur Bestimmung des Ausmaßes potenzieller Schäden an Gebäuden erfordert die Definition einer Reihe repräsentativer Größen durch numerische Bewertungen oder basierend auf empirischen Formulierungen, die mit Grenzwerten verglichen werden, die das Ausmaß der Schäden definieren.

Die Analyse zielt daher darauf ab, durch die Wechselwirkung zwischen dem Bauwerk und dem Boden die Elemente bereitzustellen, die für die Bewertung der Auswirkungen der Ausgrabung auf die Artefakte in Bezug auf Verschiebungen, Verformungen und möglicherweise Spannungen auf die Bauwerkselemente erforderlich sind.

In diesem Fall wurde die Analyse unter Freifeldbedingungen durchgeführt, ohne das Vorhandensein der zu bauenden Strukturen.

Auf diese Weise sind die erhaltenen Verschiebungen und Verzerrungen größer als in dem Fall, in dem auch die Strukturen modelliert werden, die aufgrund ihrer Steifigkeit die Siedlungen reduzieren und umverteilen.

Die Analyse der Folgemaßnahmen bezog sich auf die vorläufigen Schätzungen zu den Auswirkungen der Ansammlung von Ablagerungen auf die Vorfeldstrukturen.

In der Analysemethode für die Grenzzustände des Betriebs schlagen die Normen zulässige Werte für die häufigsten Parameter zur Ermittlung des Verformungszustands vor, um festzustellen, welchen möglichen Schäden ein Gebäude ausgesetzt ist. Darüber hinaus gibt es eine aussagekräftige bibliografische Dokumentation zu diesem Thema, anhand derer wir anhand von experimentellen Beobachtungen und Feldversuchen die Schadenskategorien bestimmen können, die durch charakteristische Werte der Identifikationsparameter des induzierten Verformungszustands abgegrenzt sind, wie im folgenden Diagramm dargestellt.

I cedimenti al di sotto del cumulo risultano essere molto rilevanti sia a causa dell'elevata altezza dello stesso che delle proprietà molto cautelative con le quali viene modellato il riempimento delle cave esistenti.

#### **8.1.4 Analisi degli effetti indotti sull'impianto di prefabbricazione dei conci e relativo piazzale**

La metodologia oramai consolidata per la definizione del livello di danneggiamento potenziale di edifici prevede la definizione, attraverso valutazioni numeriche o basate su formulazioni empiriche, di una serie di grandezze rappresentative che vengono confrontate con valori limiti che ne definiscono il livello di danneggiamento.

L'analisi, attraverso l'interazione fra struttura e terreno, ha dunque lo scopo di fornire gli elementi necessari alla valutazione degli effetti dello scavo sui manufatti, in termini di spostamenti, deformazioni ed eventualmente di sollecitazioni sugli elementi strutturali.

In questo caso l'analisi è stata effettuata in condizioni free field, senza tener conto della presenza delle strutture che saranno realizzate.

Procedendo in questo modo gli spostamenti e le distorsioni che si ottengono sono maggiori rispetto al caso in cui vengano modellate anche le strutture che grazie alla loro rigidità vanno a ridurre e ridistribuire i cedimenti.

Le analisi di danno di seguito riportate forniscono delle valutazioni in merito agli effetti prodotti dai cumuli di deposito sulle strutture del piazzale.

Nella metodologia di analisi agli stati limite di esercizio, al fine di stabilire il potenziale danneggiamento cui è sottoposto un fabbricato, le norme propongono dei valori ammissibili relativi ai più comuni parametri d'identificazione dello stato deformativo. Risulta inoltre presente una significativa documentazione bibliografica sull'argomento che permette di determinare, sulla base di osservazioni sperimentali ed esperienze condotte sul campo, delle categorie di danno delimitate da valori caratteristici dei parametri identificativi dello stato deformativo indotto, come riportato nello schema seguente.

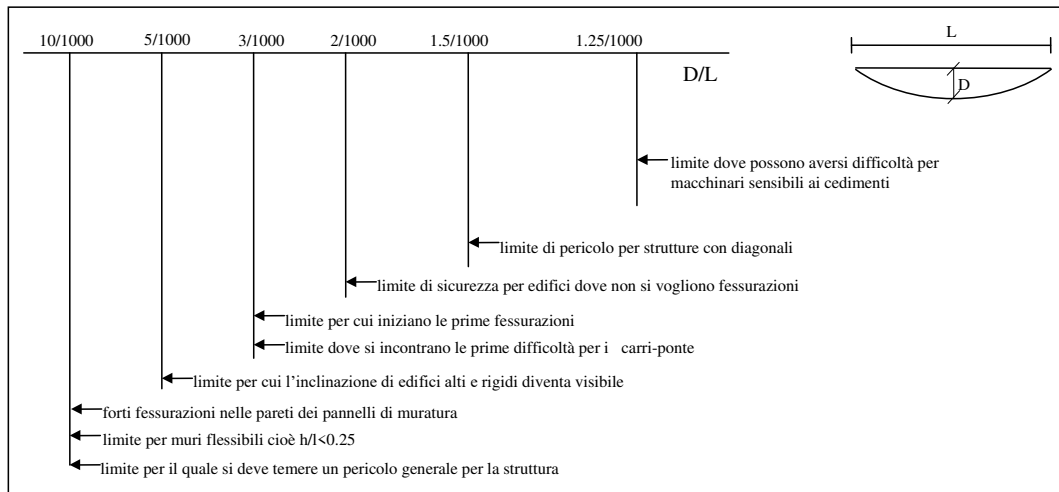


Abbildung 31. Zulässige Durchbiegungsgrenzen für verschiedene Strukturen

Figura 31. Limiti ammissibili della inflessione per varie strutture

Es muss hervorgehoben werden, dass das Versagen an sich keine Ursache für Schäden an den Bauwerken ist und daher nicht als wirksames Maß für den potenziellen Schaden angesehen werden kann. Es müssen jedoch auch Beurteilungen in Bezug auf eine Reihe anderer Parameter durchgeführt werden.

È necessario evidenziare come il cedimento in sé non è causa di danno alle strutture, e pertanto non può essere considerato una misura efficace del potenziale danneggiamento, ma sarà necessario effettuare altresì valutazioni relative ad una serie di altri parametri.

Bei gerahmten Strukturen sind die wichtigsten Parameter die Winkelverformung der Siedlungskurve  $\beta$ . Bei Werten von  $1 / < 1/300$  treten keine Risse in den Füllstrukturen auf, bei  $> 1/150$  können die tragenden Betonstrukturen beschädigt werden.

Per strutture intelaiate i più importanti parametri risultano essere la deformazione angolare della curva  $\beta$  dei cedimenti. Per valori di  $\beta < 1/300$  non si ha comparsa di fessure nelle strutture di tamponamento mentre per  $\beta > 1/150$  si possono riscontrare danni alle strutture portanti in calcestruzzo.

In dieser Hinsicht zeigen Skempton und MacDonald (1956), die auf der Beobachtung von 98 Gebäuden und unter Bezugnahme auf die Studie von Ricceri und Sorazo (1985) über 25 in Italien gebaute Bauwerke beruhen, dass dies nicht der Fall ist es treten Risse an den Füllungsstrukturen bis zu  $1 / < 1/300$  auf, und um Schäden an den tragenden Betonstrukturen zu erkennen, müssen  $\beta$ -Werte von  $1/150$  erreicht werden.

Al riguardo, facendo riferimento alla bibliografia esistente sull'argomento, Skempton e MacDonald (1956), basandosi sull'osservazione di 98 edifici e con riferimento anche allo studio di Ricceri e Sorazo (1985) su 25 strutture realizzate in Italia, evidenziano che non si ha comparsa di fessure sulle strutture di tamponamento fino a valori di  $\beta < 1/300$  e per vedere danni sulle strutture portanti in calcestruzzo è necessario arrivare a valori di  $\beta$  pari a  $1/150$ .

Eurocode 7 für geotechnische Arbeiten gibt die zulässigen Werte der vorsorglichen Winkelverformung an, die  $1/500$  für Stahlbetonrahmenkonstruktionen mit Verkleidung und  $1/200$  für offene Rahmen entsprechen.

L'Eurocodice 7 per le opere di ingegneria geotecnica indica valori ammissibili della deformazione angolare maggiormente cautelativi, pari a  $1/500$  per strutture a telaio in calcestruzzo armato con tamponature e  $1/200$  per i telai aperti.

Bjerrum (1963) hob hervor, wie die Variable, die das Verformungsphänomen steuert, zur Winkelverzerrung führt, und hat die Art der Beschädigung mit den Werten dieses Parameters in Verbindung gebracht.

Bjerrum (1963) ha evidenziato come la variabile che governa il fenomeno deformativo risulti la distorsione angolare, ed ha associato la tipologia di danneggiamento ai valori di tale parametro.

Angular distortion	Damage assessment
1/100	Limit where structural damage is to be feared. Safe limit for flexible brick walls with $h/L < 0.25$ . Considerable cracking in panel walls and brick walls
1/250	Limit where tilting of high rigid buildings may become visible
1/300	Limit where difficulties with overhead cranes can be expected
1/500	Safe limits for buildings where cracking are not permissible
1/600	Danger limit for frame with diagonals
1/750	Lower limit for sensitive machinery

Abbildung 32. Typische Werte von Winkelverzerrungen in Bezug auf den Grad der möglichen Beschädigung eines Gebäudes (Bjerrum, 1963)

Figura 32. Valori tipici delle distorsioni angolari in relazione al grado di potenziale danneggiamento di un edificio (Bjerrum, 1963)

Nachfolgend sind die Fehler aufgeführt, die in den drei Analysen festgestellt wurden, die zur Beurteilung des Betriebsgrenzzustands der Vorfertigungsanlage für Quader und Vorplatz durchgeführt wurden.

Vengono di seguito riportati gli spostamenti ed i cedimenti ottenuti dalle analisi numeriche svolte con il fine di valutare lo stato limite di esercizio dell'impianto di prefabbricazione dei conci e del piazzale antistante.

Der maximale Fehler, der in einer Entfernung von 10 m vom Fuß des Haufens erwartet wird, liegt in der von 5,4 cm.

Il cedimento massimo atteso ad una distanza di 10 m dal piede del cumulo è nell'ordine di 5,4 cm.

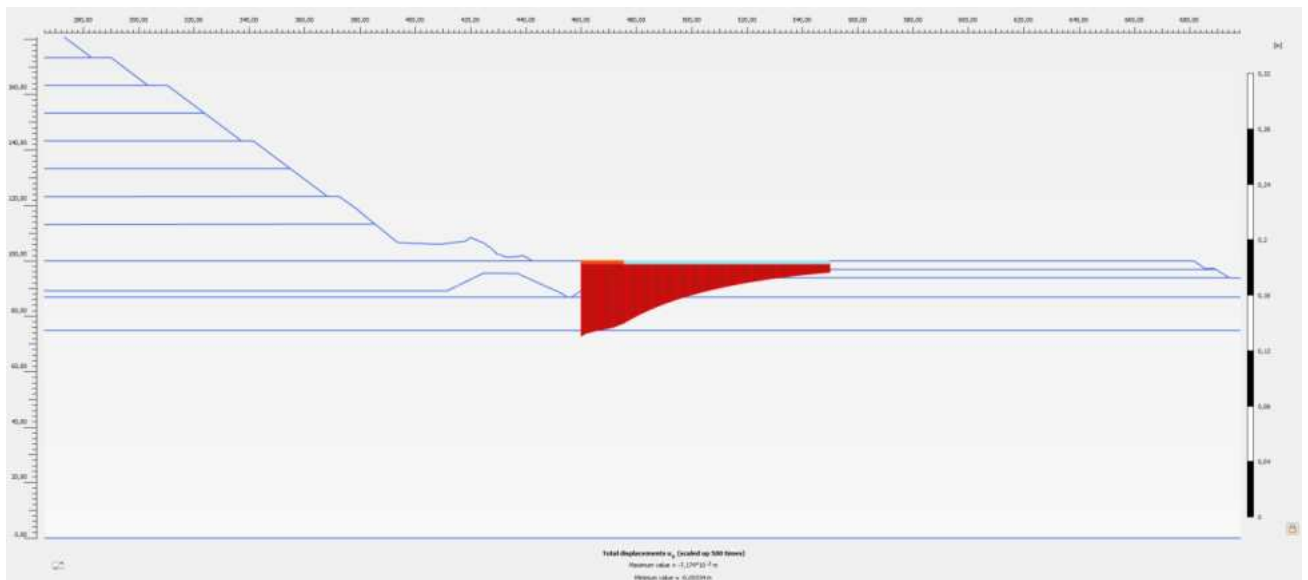


Abbildung 33. Induzierte Siedlungen auf dem Vorfeld (sektion 1-1)

Figura 33. Spostamenti verticali al temine della costruzione del rilevato (sezione 1-1)

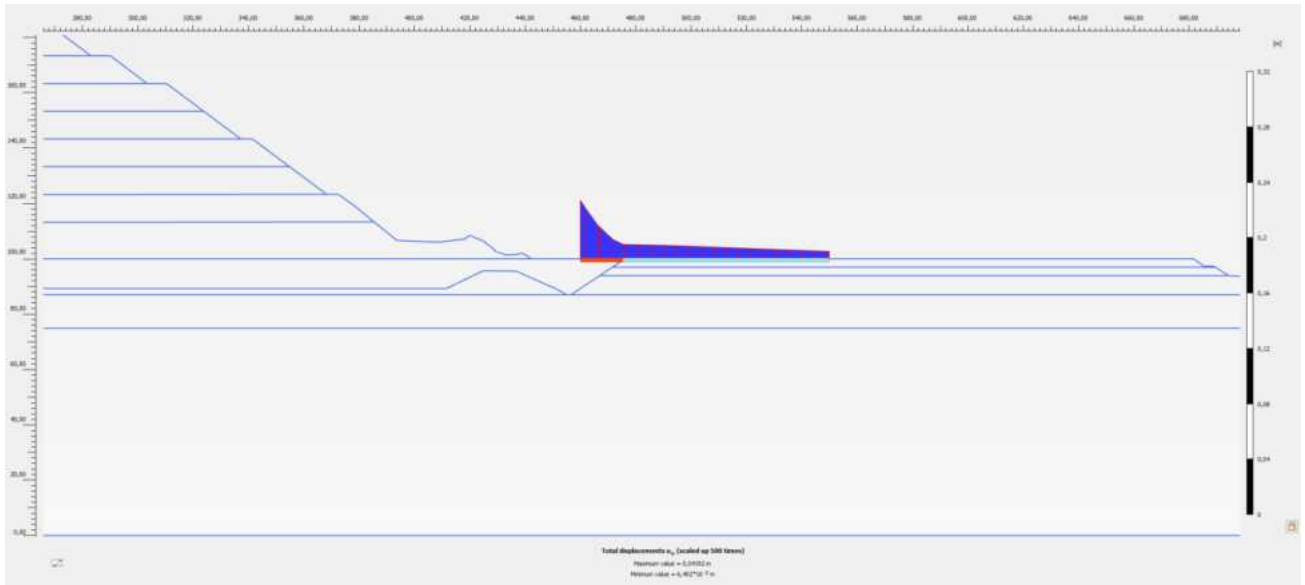


Abbildung 34. Induzierte Siedlungen auf dem Vorfeld (sektion 1-1)

Figura 34. Spostamenti orizzontali al termine della costruzione del riavato (sezione 1-1)

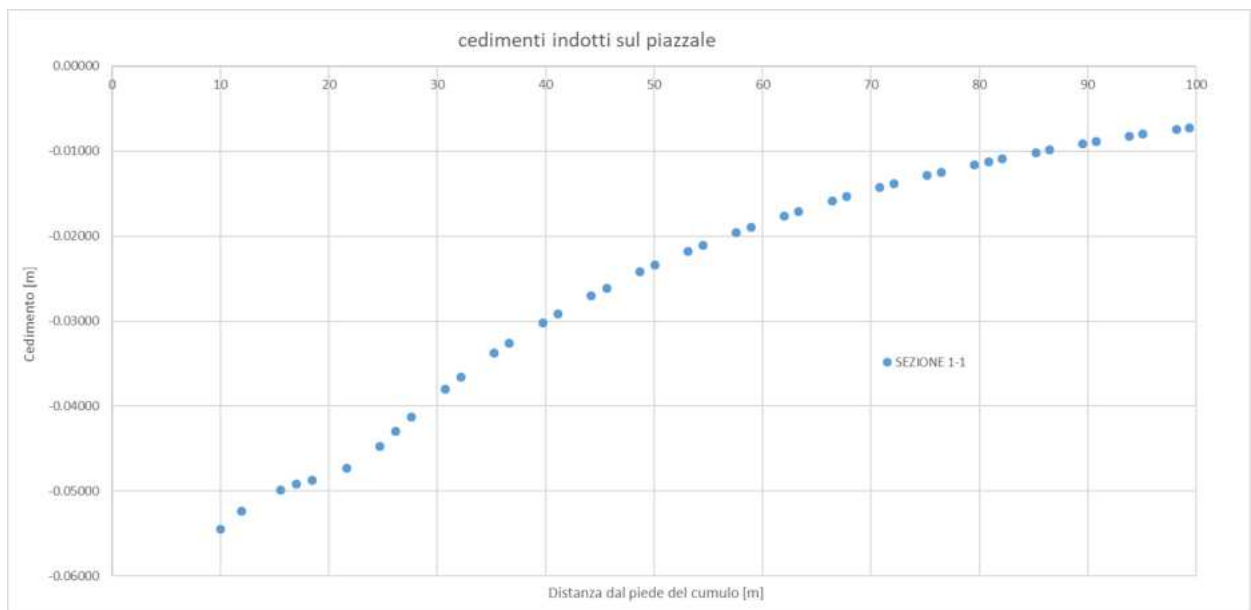


Abbildung 35. Induzierte Siedlungen auf dem Vorfeld (sektion 1-1)

Figura 35. Cedimenti indotti sul piazzale (sezione 1-1)

Die horizontalen Verschiebungen, die durch die Konstruktion der Haufen verursacht werden, sind in der folgenden Grafik dargestellt.

Gli spostamenti orizzontali indotti dalla costruzione dei cumuli sono riportati nel grafico seguente.

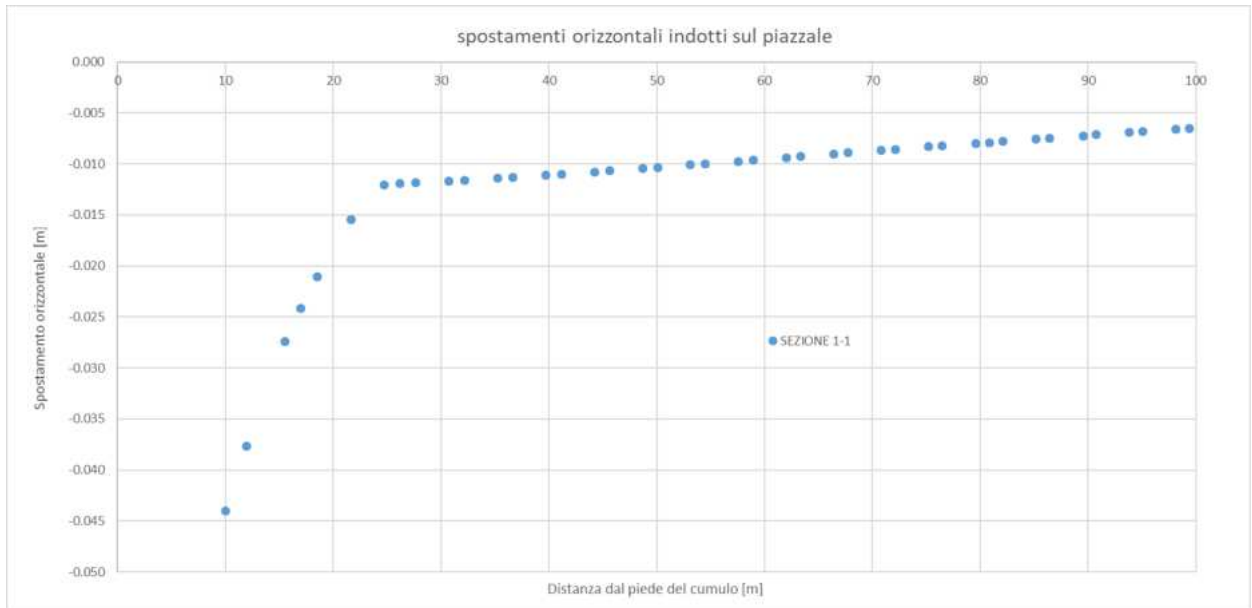


Abbildung 36. Induzierte horizontale Verschiebungen auf dem Vorfeld (sektion 1-1)

Figura 36. Spostamenti orizzontali indotti sul piazzale (sezione 1-1)

Die folgende Grafik zeigt die Winkelverzerrung auf Bodenniveau unter Freifeldbedingungen.

Il grafico seguente riporta invece la distorsione angolare a livello del piano campagna in condizioni free field.

Zusätzlich zu den erzielten Ergebnissen werden 2 Schwellenwerte definiert, die (in Übereinstimmung mit Bjerrum) 2 Grenzwerte definieren, über die hinaus:

Oltre ai risultati ottenuti sono riportati 2 livelli di soglia che definiscono 2 limiti (in accordo con Bjerrum) oltre i quali:

- Es besteht die Möglichkeit von Problemen mit den Brückenkranen ( $\beta > 1/300$ ).
- In den Füllelementen können sich Risse bilden ( $\beta > 1/500$ ).
- Si ha la possibilità di avere delle problematiche con i carriponte ( $\beta > 1/300$ ).
- Si ha la possibilità di formazione di fessure negli elementi di tamponatura ( $\beta > 1/500$ ).

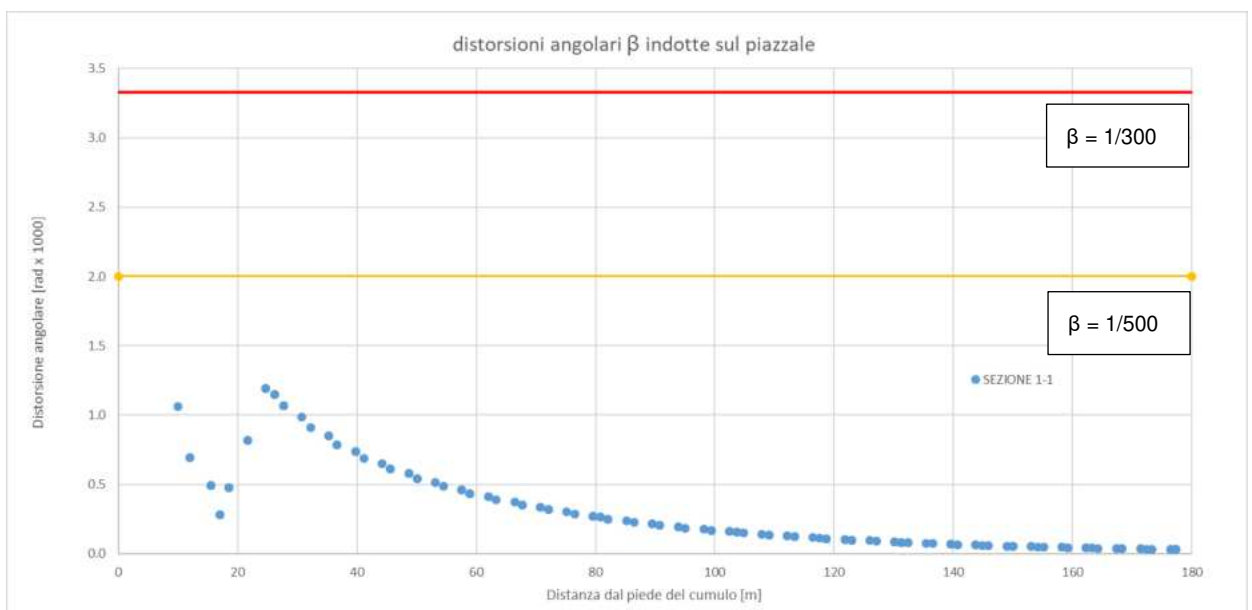




Abbildung 37. Induzierte Verzerrungen

Aus der oben gezeigten Grafik ist ersichtlich, dass keine besonderen Probleme an den Bauwerken zu erwarten sind, die aufgrund der durch die Pfähle verursachten Ansiedlungen entstehen.

Aus einer Entfernung von 20 m zum Haufenfuß können Schäden jeglicher Art ausgeschlossen werden, auch an zu installierenden Füllelementen.

Die folgende Abbildung zeigt detailliert die Situation der erwarteten Ausfälle an der dem Pfahl an der nächsten gelegenen Strecke.

Figura 37. Distorsioni indotte sul piazzale

Dal grafico riportato sopra si può vedere come non si attendano particolari problematiche sulle strutture realizzate dovute ai cedimenti indotti dai cumuli.

E' inoltre possibile escludere qualsiasi tipo di danno anche sugli eventuali elementi di tamponatura che verranno installati.

Nella figura seguente viene riportata in dettaglio la situazione dei cedimenti attesi in corrispondenza del binario più vicino al cumulo.

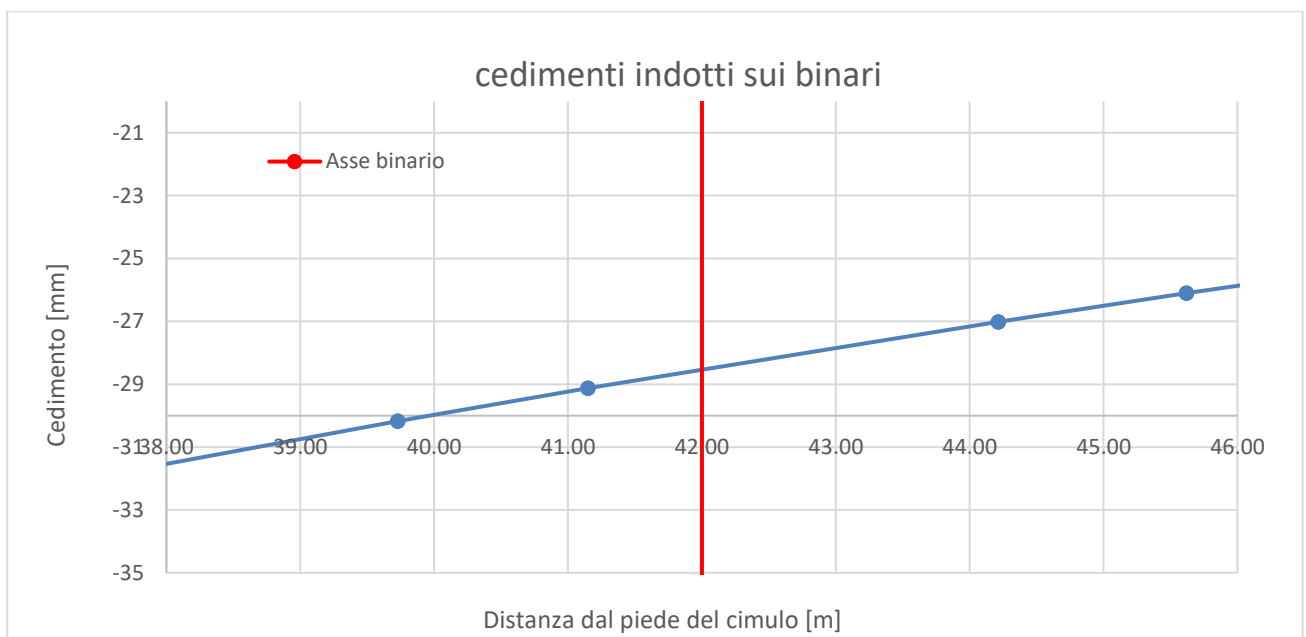


Abbildung 38. Induzierte Siedlungen auf den Gleisen

Die klassischen Prüfungen der Gleisqualitätsparameter sind in diesem Fall nicht anwendbar und umfassen Prüfungen des Überhöhungsfehlers, des Überhöhungsfehlers und des Längsfehlers.

Im Untersuchungsgebiet werden die für die Materialversorgung eingesetzten Züge eine sehr begrenzte Geschwindigkeit haben: Die Haufen befinden sich am Ende der Eisenbahnlinien.

Es ist jedoch sofort ersichtlich, dass die zu erwartenden Ausfälle besonders eingeschränkte Werte haben.

Der Überhöhungsfehler, der bei induzierten Ausfällen zwischen den beiden Schienen des Gleises entsteht, als der 90-cm-Achsabstand betrachtet, beträgt weniger als 1 mm.

Figura 38. Cedimenti indotti sui binari

Non sono applicabili a questo caso le classiche verifiche sui parametri di qualità del binario che prevedono dei controlli sul difetto di sopraelevazione, sullo sghembo e sul livello longitudinale.

Nell'area in esame i treni adibiti all'approvvigionamento del materiale hanno infatti una velocità molto limitata: i cumuli sono in corrispondenza del capolinea delle linee ferroviarie.

Risulta comunque immediatamente evidente che i cedimenti attesi hanno dei valori particolarmente limitati.

Il difetto di sopraelevazione che si viene a creare tra le due rotaie del binario per i cedimenti indotti, considerato l'interasse di 90 cm, è minore di 1 mm.

Auf den Gleisen ist keine instrumentelle Überwachung vorgesehen.

Sie müssen in jedem Fall visuell überprüft werden und müssen möglicherweise lokal verstaüt werden, um die induzierten Verformungen zu korrigieren.

Non viene previsto alcun monitoraggio strumentale sui binari.

Essi devono comunque essere controllati visivamente e eventualmente dovranno essere localmente rincalzati al fine di correggere le deformazioni indotte.

#### 8.1.5 Analyse der Auswirkungen auf bestehende Gebäude (Maso Sossai)

Die vorliegende Analyse bezieht sich speziell auf die Bewertung möglicher Auswirkungen, die im Stall und in der Obstlagerstätte südlich des Baugebiets verursacht werden.

Diese Überlegungen betreffen nicht das Haus und die Kirche in der Gegend, da sie aufgrund der größeren Entfernung von den Haufen vernachlässigbaren Auswirkungen unterliegen.

Die folgende Abbildung zeigt die analysierten Gebäude im Detail.

#### 8.1.5 Analisi degli effetti indotti sugli edifici esistenti (Maso Sossai)

La presente analisi è riferita nello specifico alla valutazione di possibili effetti indotti al fienile e al deposito frutta posti a sud dell'area di cantiere.

Tali considerazioni non riguardano invece l'abitazione e la chiesa che si trovano nella zona in quanto, vista la distanza maggiore a circa 60m dal piede dei cumuli, essi subiscono degli effetti del tutto trascurabili.

Nella figura seguente sono evidenziati in dettaglio gli edifici oggetto dell'analisi.

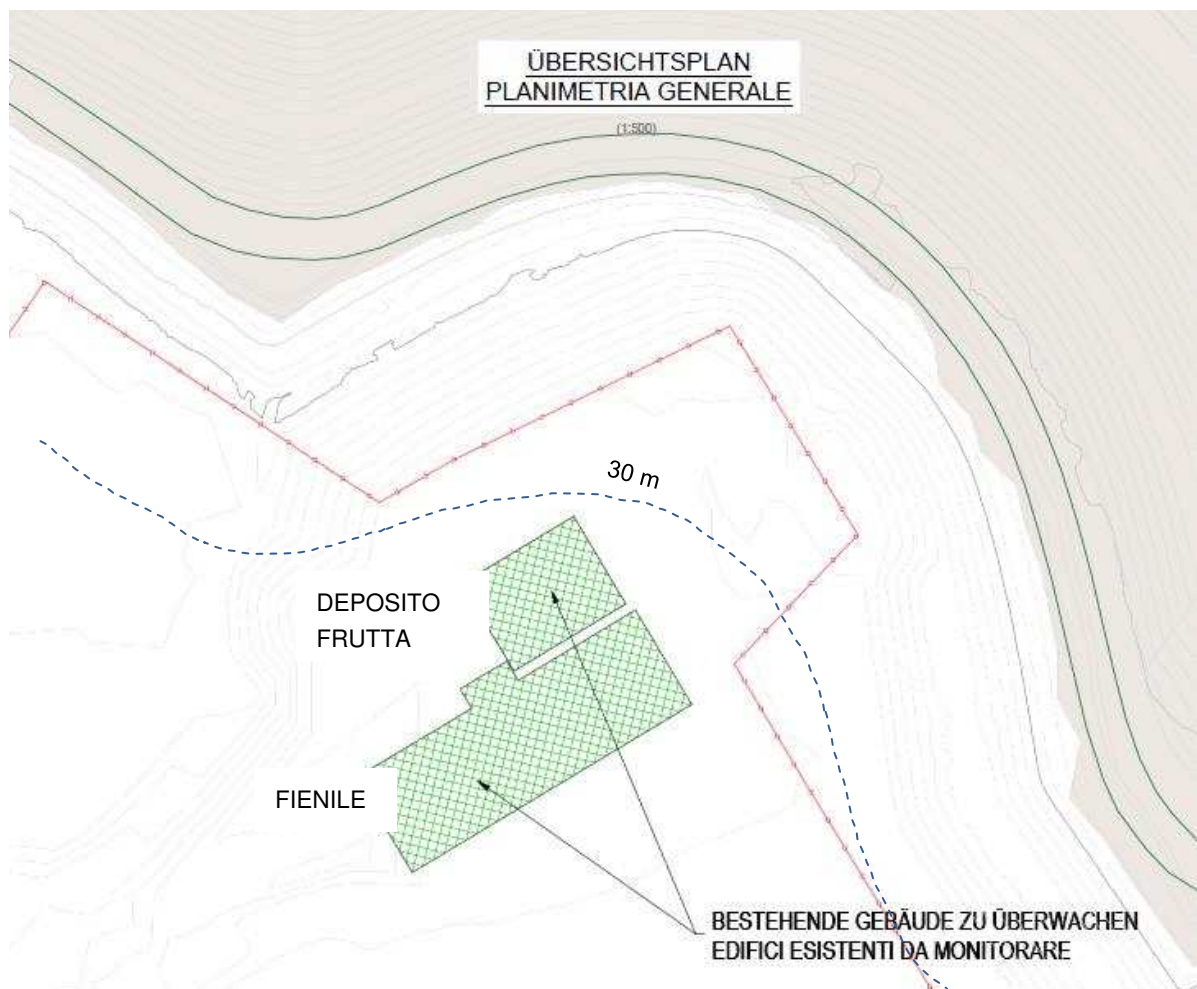


Abbildung 39. Detailplan der vorhandenen Gebäudefläche (Scheune und Lagerung)

Figura 39. Planimetria di dettaglio dell'area degli edifici esistenti (fienile e deposito)

Nachfolgend sind die Fehler aufgeführt, die bei der Analyse 1 mit dem Ziel der Beurteilung des Betriebsgrenzzustands des vorhandenen Gebäudes festgestellt wurden.

Auch in diesem Fall wird der wahrscheinlichste Zustand in der Konfiguration der Haufen in Phase mit der maximalen eingelagerten Materialmenge ist.

Das Gebäude befindet sich etwa 30 m vom Fuß des Hügels entfernt. Bei den Analysen wird von einer Gebäudeausdehnung von 37 m ausgegangen.

Vengono di seguito riportati i cedimenti che sono stati ottenuti nell'analisi sezione 1 svolta con il fine di valutare lo stato limite di esercizio dell'edificio esistente.

Anche per questo caso la condizione più probante è identificata nella configurazione con il quantitativo massimo di materiale in deposito.

L'edificio si trova a circa 30 m dal piede del cumulo. Nelle analisi si assume che il fabbricato abbia una estensione pari a 37 m.

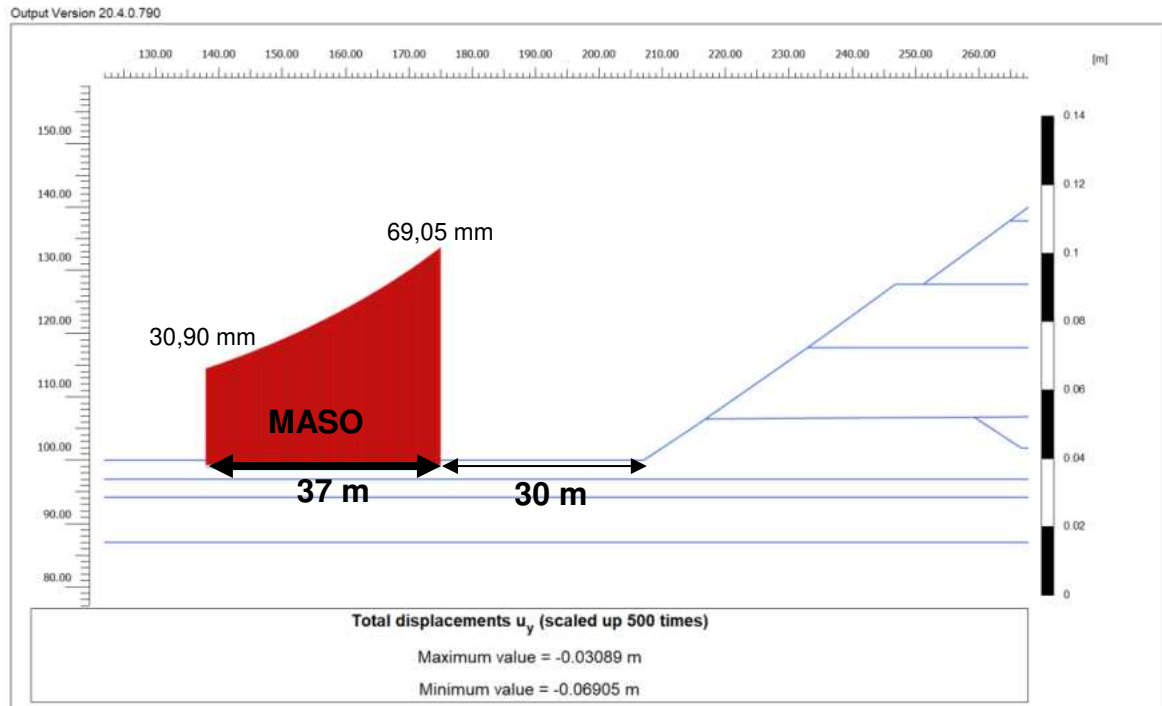


Abbildung 40. Induzierte Besiedlung bestehender Gebäude

Figura 40. Cedimenti indotti edificio esistente

Generell zeigt sich, dass die Ausfälle besonders begrenzt sind.

Das Folgende sind Winkelverzerrungen und horizontale Verformungen.

In generale si può notare come i cedimenti siano particolarmente limitati.

Di seguito si riportano gli spostamenti orizzontali.

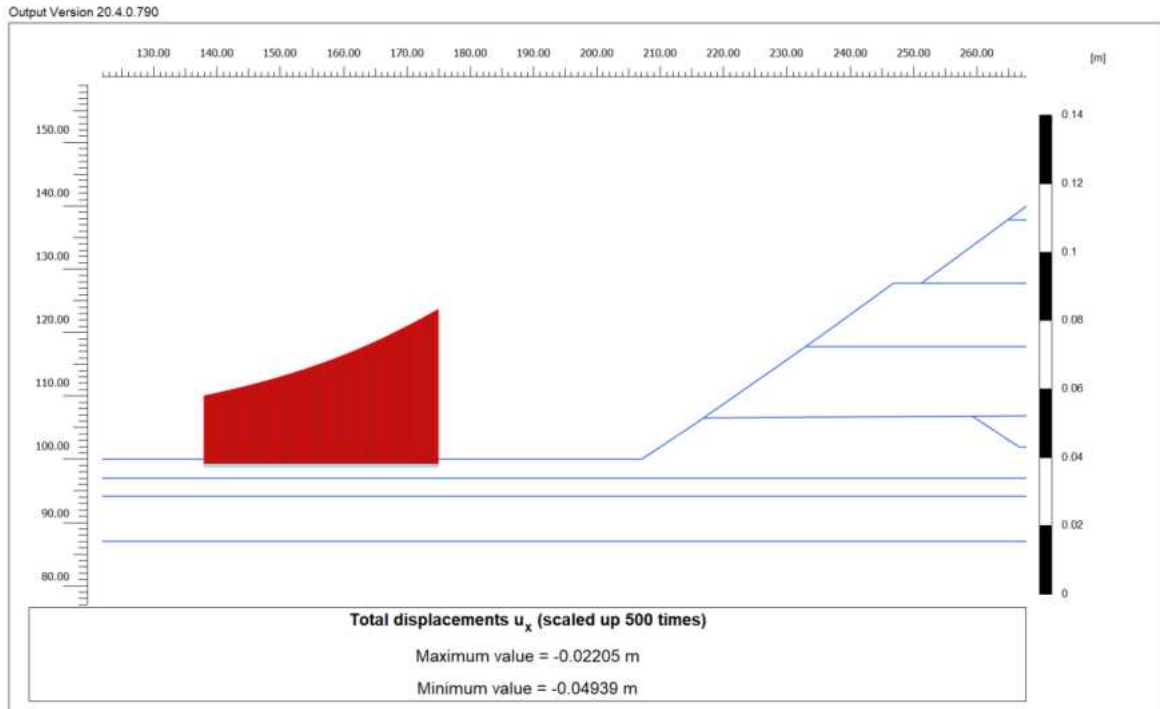


Abbildung 41. Induzierte horizontale Verschiebung des vorhandenen Gebäudes

Figura 41. Spostamenti orizzontali indotti edificio esistente

Im Allgemeinen ist zu sehen, wie stark die Winkelverzerrung in jedem Fall ist, und die horizontale Verformung, die durch die Konstruktion des Haufens verursacht wird, bewirkt eine Kompression auf dem Niveau der Landschaft, auf der sich das Gebäude befindet. Dieses Verhalten des Baugrundes ist sicherheitsfördernd, so dass horizontale Verschiebungen bei der Abschätzung der Gesamtverformungen vernachlässigt werden.

In generale si può notare come il livello di distorsione angolare sia comunque contenuto e la deformazione orizzontale causata dalla costruzione del cumulo causi una compressione a livello del piano campagna dove si trova l'edificio.

Questo comportamento del terreno risulta a favore di sicurezza, per cui nella stima delle deformazioni totali gli spostamenti orizzontali verranno trascurati.

Das Folgende ist eine Schätzung der unterschiedlichen vertikalen Verschiebungen, die den Hof am Ende der letzten Bauphase des Damms betreffen. Der Hof hat einen Mindestabstand von ca. 30m am Fuße der Böschung. Die Siedlung wurde entlang Abschnitt 1-1 bewertet, der die Farm auf einer Länge von 37 m schneidet.

Di seguito si riporta la stima degli spostamenti verticali differenziali che interessano il maso al termine della fase finale costruttiva del rilevato di abbancamento. Il maso ha una distanza minima al piede del rilevato di circa 30m. il cedimento è stato valutato lungo la sezione 1-1 la quale taglia il maso per una lunghezza pari a 37m.

Differenzialausgleich ist:

Il cedimento differenziale è:

$$\Delta = 69,09 - 30,90 = 38,15 \text{ mm}$$

$$\Delta = 69,09 - 30,90 = 38,15 \text{ mm}$$

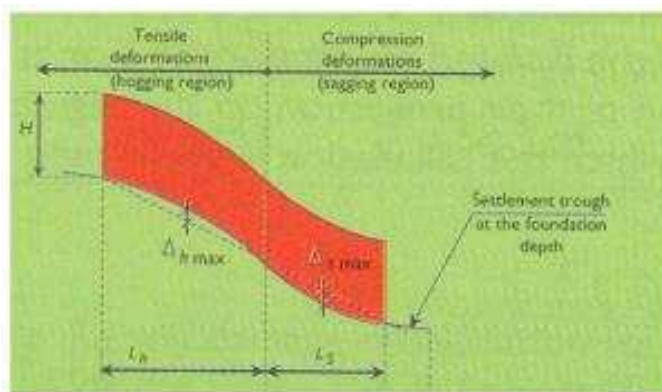


Abbildung 42. Analyse des Schadenspotentials in Übereinstimmung mit Boscardin und Cording (1989)



Figura 42. Analisi del potenziale di danno in accordo con le zone di Hogging e Sagging

Die Schadensanalyse wurde unter Berücksichtigung der kombinierten Wirkungen durch vertikale und horizontale Setzungen durchgeführt. Die Analysen werden mit dem Schema des Ersatzträgers durchgeführt. Das Gebäude ist tatsächlich als einfacher elastischer und gewichtsloser Balken mit einer Höhe H und einer Länge L gleich denen des analysierten Gebäudes schematisiert (Burland, 1997).

L'analisi di danno è stata condotta considerando gli effetti combinati dovuti ai cedimenti verticali ed orizzontali. Le analisi sono svolte con lo schema della trave equivalente. Il fabbricato viene schematizzato infatti come semplice trave elastica e priva di peso avente altezza H e lunghezza L pari a quella dell'edificio analizzato (Burland, 1997).

Es wird davon ausgegangen, dass die Definition der induzierten Verformungen dem Träger, der dem Gebäude entspricht, das gleiche verformte "grüne Feld" verleiht. Wir befinden uns daher im vorliegenden Fall in der Konfiguration der Konkavität nach unten, für den "Hogging-Bereich", Strukturen, die auf Zug beansprucht werden.

Per la definizione delle deformazioni indotte si considera di imprimere alla trave equivalente all'edificio la stessa deformata "green field". Siamo quindi nel caso in oggetto nella configurazione di concavità verso il basso per cui "hogging region", strutture sottoposte a trazione.

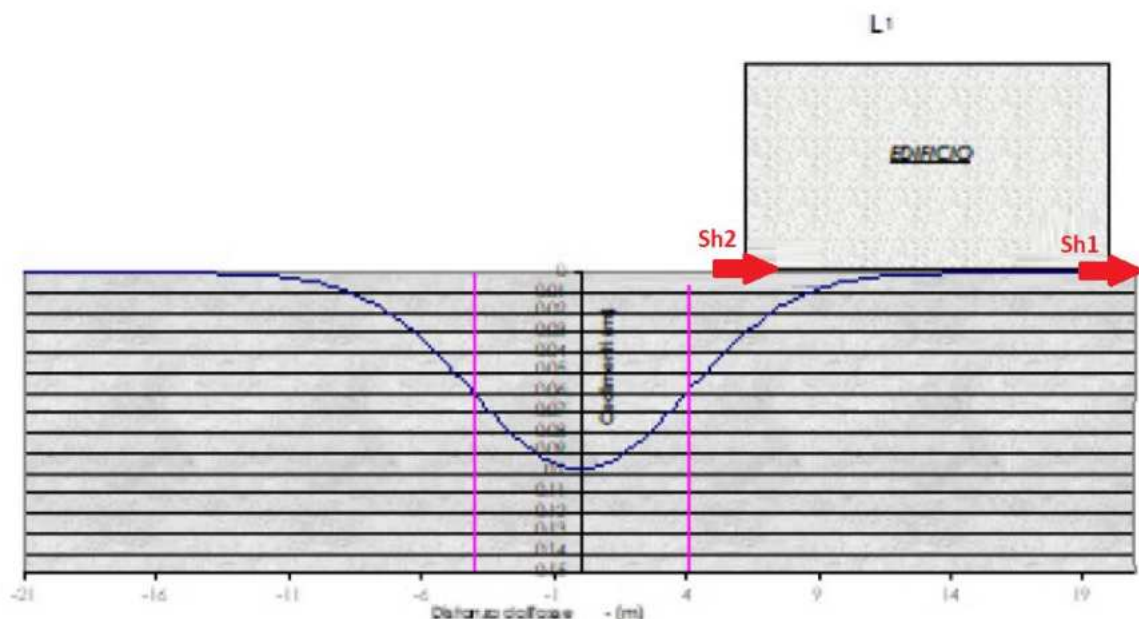


Abbildung 43. Grenzbereich der Farm "Hogging region"

Figura 43. Zona limite del maso "Hogging region"

Die Biege- und Schubdehnungen können nach folgenden Beziehungen bestimmt werden:

Le deformazioni flessionale e di taglio possono essere determinate secondo le seguenti relazioni:

$$\varepsilon_f = \frac{\Delta/L_i}{\left[ \frac{L_i}{12t} + \frac{3I}{2tL_iH} * \frac{E}{G} \right]}$$

$$\varepsilon_t = \frac{\Delta/L_i}{\left[ 1 + \frac{HL_i^2}{18I} * \frac{G}{E} \right]}$$

Wo ist es:

Dove:

Gebäuelänge  $L_i = 37,00$  m

Lunghezza edificio

$L_i = 37.00$  m

Durchbiegungsverhältnis  $\Delta / L_i = 0,00010$  m

Rapporto di inflessione

$\Delta/L_i = 0.00010$  m

Gebäudehöhe  $H = 6,00$  m

Altezza edificio

$H = 6.00$  m

Trägheitsmodul  $I = H^3 / 12$  (Durchhängen) =  $18$  m<sup>3</sup>

Modulo di inerzia

$I = H^3/12$  (sagging) =  $18$  m<sup>3</sup>

$I = H^3 / 3$  (Zerspanung) =  $72$  m<sup>3</sup>

$I = H^3/3$  (hogging) =  $72$  m<sup>3</sup>

Längs- / Tangentialmodul  $E / G$ :

Modulo longitudinale / tangenziale  $E/G$ :

2.6 Mauerwerk

2.6 muratura

12,5 Beton

12.5 calcestruzzo

Neutraler Achsabstand  $t = H / 2$  (Durchhängen) =  $3$  m

Distanza asse neutro

$t = H/2$  (sagging) =  $3$  m

$t = H$  (Zerspanung) =  $6$  m

$t = H$  (hogging) =  $6$  m

Aus der Analyse der Fließkurve haben wir die Hogging-Zone, für die die berechneten Verformungen gleich sind:

Dall'analisi della curva dei cedimenti si ha la zona di Hogging, per cui le deformazioni calcolate sono pari a:

Biegeverformungen  $\varepsilon_f = 0,00013556$

Deformazioni flessionali

$\varepsilon_f = 0.00013556$

Querverformungen  $\varepsilon_t = 0,00002858$

Deformazioni trasversali

$\varepsilon_t = 0.00002858$

Zusätzlich zu diesen Verformungen müssen die Auswirkungen der horizontalen Verformungen des Bodens berücksichtigt werden, die sich aus der folgenden Gleichung ergeben:

Oltre a queste deformazioni, si deve tener conto degli effetti delle deformazioni orizzontali del terreno, ricavabili dalla seguente equazione:

$$\varepsilon_y = \frac{\Delta S_h}{L_i}$$

Wo ist es:

Dove:

Differentialverschiebung horiz.  $dSch = 0,02813$  m

Differenziale spost. orizz.  $\Delta S_h = 0,02813$  m

Gebäuelänge  $L_i = 37,00$  m

Lunghezza edificio

$L_i = 37.00$  m

Betrachtet man die Setzung in einem bestimmten Abstand von der y-Achse, so ist die horizontale Verformung gleich:

Considerando il cedimento posto ad una certa distanza dall'asse y, la deformazione orizzontale è pari a:

Horizontale Verformungen  $\varepsilon_y = 0,00076016$

Deformazioni orizzontali

$\varepsilon_y = 0.00076016$

Die horizontalen Verformungen  $\Delta y$  werden vorsichtshalber vernachlässigt, da sie zugunsten der Sicherheit wirken. Das Modell zeigt, dass die horizontalen Verschiebungsvektoren,

In via cautelativa le deformazioni orizzontali  $\varepsilon_y$  vengono trascurate, in quanto il loro effetto è a favore di sicurezza. Dal modello si evince come i vettori di spostamento

die das Gebäude schneiden, die gleiche Richtung, aber abnehmende Intensität haben, aus diesem Grund würde jede Verschiebung des Gebäudes das Fundament verdichten.

orizzontale che intercettano il fabbricato, hanno stessa direzione ma intensità decrescente, per questo motivo un eventuale spostamento del fabbricato andrebbe a compattare la fondazione.

Die Verformungsfelder setzen sich daher nach folgenden Gleichungen zusammen:

I campi di deformazione vengono pertanto composti secondo le seguenti equazioni:

$$\varepsilon_{totale} = \varepsilon_y + \varepsilon_f = \varepsilon_f$$

$$\varepsilon_{totale} = 0.35 * \varepsilon_y + \left[ (0.65 * \varepsilon_f)^2 + \varepsilon_t^2 \right]^{0.5} = \left[ (0.65 * \varepsilon_f)^2 + \varepsilon_t^2 \right]^{0.5}$$

Def. Gesamt eps tot = 0,014 % Biegung

Def. Totali

eps tot = 0.014%

a flessione

Def. Ingesamt eps tot = 0,003 % pro Schnitt

Def. Totali

eps tot = 0.003%

a taglio

Mit diesen beiden Parametern können wir die Schadenskategorien von Gebäuden definieren.

Con questi due parametri possiamo definire le categorie di danno degli edifici.

Das an den Bauwerken induzierte Schadensklassifizierungssystem basiert auf der „Reparaturfreundlichkeit“ unter Berücksichtigung einiger Aspekte wie Rissöffnung, Neigung, Leitungsschäden.

Il sistema di classificazione del danno indotto sulle strutture è basato sulla “facilità di riparazione”, prendendo in considerazione alcuni aspetti quali l’apertura delle fessure, l’inclinazione, i danni ai servizi.

Diesem Klassifikationssystem, bestehend aus sechs Schadensklassen (von 0 bis 5), entsprechen Boscardin und Cording (1989) die in den folgenden Tabellen angegebenen und beschriebenen Zugdehnungsgrenzwerte.

A tale sistema di classificazione, composto da sei classi di danno (da 0 a 5), Boscardin e Cording (1989) fanno corrispondere dei valori limite di deformazione a trazione, riportati e descritti nelle seguenti tabelle.

Categoria di danno	Intensità di danno	Deformazione limite (%)	Descrizione
0	Trascurabile	0.00 – 0.05	Fessure capillari con apertura < 0.1 mm
1	Molto Lieve	0.05 – 0.075	Fessure sottili cui si rimedia facilmente con lavori di tinteggiatura. Il danno in genere è limitato agli intonaci delle pareti interne. Fessure alle pareti esterne rilevabili con attento esame. Tipica apertura delle lesioni < 1 mm
2	Lieve	0.075 – 0.15	Fessure facilmente stuccabili, tinteggiatura necessaria. Le fessure ricorrenti possono essere mascherate con opportuni rivestimenti. Fessure visibili anche all'esterno: può essere necessaria qualche ripresa della stillatura per garantire l'impermeabilità. Possibili difficoltà nell'apertura di porte e finestre. Tipica apertura delle lesioni < 5 mm
3	Moderata	0.15 – 0.30	Le fessure richiedono cucì e scuci della muratura. Anche all'esterno sono necessari interventi sulla muratura. Possibile blocco di porte e finestre. Rottura di tubazioni. Spesso l'impermeabilità non è garantita. Tipica apertura delle lesioni 5 - 15 mm oppure numero elevato di lesioni con apertura < 3 mm
4	Severa	> 0.3	Necessarie importanti riparazioni, compresa demolizione e ricostruzione di parti di muri, specie al di sopra di porte e di finestre. I telai di porte e di finestre si distorcono: percepibile pendenza dei pavimenti. Muri inclinati o spanciati; qualche perdita d'appoggio di

			travi. Tubazioni distrutte. Tipica apertura delle lesioni 15 - 25 mm, dipendente anche dal numero delle lesioni
5	Molto Severa	> 0.5	Richiesti importanti lavori con parziale o totale demolizione e ricostruzione. Le travi perdono l'appoggio, i muri si inclinano fortemente e richiedono puntellatura. Pericolo di instabilità. Tipica apertura delle lesioni < 25 mm, dipendente anche dal numero delle lesioni

Abbildung 44. Beschreibung des Schadens und der damit verbundenen Auswirkungen

Figura 44. Categorie di danno e corrispondenti deformazioni limite (Boscardin e Cording, 1989) a cui sono associati descrizione dei danni e degli effetti associati

Wie oben festgestellt, können wir sagen, dass wir in die Schadenskategorie 0 – Vernachlässigbar fallen, da die berechnete maximale Gesamtverformung 0,014 % beträgt und im Bereich von 0,00–0,05 % der Schadenskategorie 0 liegt.

Es wird betont, dass die durchgeführten Analysen sehr vorsorglich sind und die ungünstigste Schadenskonfiguration darstellen, da das Vorhandensein von Fundamenten, die einen aussteifenden Beitrag zum Verformungsverhalten des Gebäudes liefern, nicht berücksichtigt wurde und dass die induzierten Verschiebungen und Verformungen die sind entsprechende auf die "grüne Wiese"-Bedingung.

Horizontale Verformungen wurden bei der Abschätzung der Gesamtverformungen ebenfalls vernachlässigt, da sie dazu neigen, das darüber liegende Gebäude zu verdichten und damit den Fundamenten ein sicherheitsrelevantes Druckverhalten zu verleihen.

Per quanto sopra determinato possiamo affermare di rientrare nella categoria di danno 0 – Trascurabile in quanto la deformazione totale massima calcolata è pari a 0.014% e compresa nell'intervallo 0.00-0.05% della categoria di danno 0.

Si sottolinea come le analisi effettuate sono molto cautelative e rappresentano la peggiore configurazione di danno possibile in quanto non è stato tenuto conto della presenza delle fondazioni che forniscono un contributo irrigidente al comportamento deformativo dell'edificio e che gli spostamenti e le deformazioni indotte sono quelle corrispondenti alla condizione "green field".

Sono state inoltre trascurate le deformazioni orizzontali nella stima delle deformazioni totali in quanto hanno una tendenza a compattare l'edificio soprastante e quindi imprimono un comportamento a compressione nelle fondazioni che risulterebbe a favore di sicurezza.



## 8.2 ANALYSE DER ERGEBNISSE FÜR DIE LETZTEN GRENZSTAATEN

Die Ergebnisse zu den Berechnungsabschnitten 2 und 3, die aus Sicht der globalen Stabilität als die kritischsten angesehen werden, sind nachstehend aufgeführt.

### 8.2.1 Ergebnisteil 1

Bei den Analysen des Abschnitts 1 wurde eine Höhe des Grundwasserspiegels in einer Tiefe von etwa 2,7 m über Geländeoberkante angenommen. Die numerischen Werte der eingegebenen geotechnischen Parameter sind in Anhang 6 (Plaxis) und in Anhang 7 und 8 (Folie) angegeben.

Die Analyse wurde durchgeführt, wobei die Bodenbeständigkeitswerte mit den M2-Parametern verringert wurden.

Die maximale Höhe der Böschung beträgt ca. 80 m und besteht aus Material des Typs B + C.

Die seismische Einwirkung in Plaxis wurde mit dem Verfahren "Pseudostatische Analyse" eingefügt, indem äquivalente statische Kräfte auf das gesamte Modell angewendet wurden. Die Erdbebenbeiwerte wurden gemäß den Bestimmungen der Technischen Regelwerke „Arbeiten in Schüttgütern und Baugrubenfronten“ ermittelt. Die Werte der in den Analysen angenommenen seismischen Koeffizienten sind unten zusammengefasst.

$$k_h = a_{\max} * \beta = 0.034 * 0.38 = 0.013 \text{ g};$$

$$k_v = k_h * 0.5 = 0.013 * 0.5 = 0.006 \text{ g}.$$

Für die globale Stabilität des Abschnitts 1 beträgt der Mindestsicherheitsfaktor bei Erdbeben 1,16, was über dem gesetzlich festgelegten Mindestwert liegt. Anschließend wird die Gesamtstabilität der Lagerstätte überprüft.

## 8.2 ANALISI DEI RISULTATI RELATIVI AGLI STATI LIMITE ULTIMI

Vengono di seguito riportati i risultati relativi alle sezioni di calcolo 1, 2 e 3 considerate le più critiche dal punto di vista della stabilità globale.

### 8.2.1 Risultati sezione 1

Nelle analisi della sezione 1 si è assunta una quota della falda ad una profondità di circa 2,7 m da piano campagna. I valori numerici dei paratri geotecnici di input sono riportati in Appendice 6 (Plaxis) e in Appendice 7 e 8 (Slide).

L'analisi agli elementi finiti (Plaxis) è stata effettuata con i valori di resistenza del terreno ridotti con i parametri M2.

L'altezza massima del rilevato è pari a circa 80 m ed è costituita da materiale di tipo B+C.

L'azione sismica in plaxis è stata inserita mediante la procedura "Pseudostatic analysis" applicando all'intero modello forze statiche equivalenti. I coefficienti sismici sono stati valutati in accordo con quanto prescritto dalla normativa tecnica per le "Opere in materiali sciolti e fronti di scavo". I valori dei coefficienti sismici adottati nelle analisi sono riassunti a seguire.

$$k_h = a_{\max} * \beta = 0.034 * 0.38 = 0.013 \text{ g};$$

$$k_v = k_h * 0.5 = 0.013 * 0.5 = 0.006 \text{ g}.$$

Per la stabilità globale della sezione 1, il fattore di sicurezza minimo in presenza di sisma, è pari a 1.16 che è superiore al valore minimo imposto da normativa. La stabilità globale del deposito è quindi verificata.

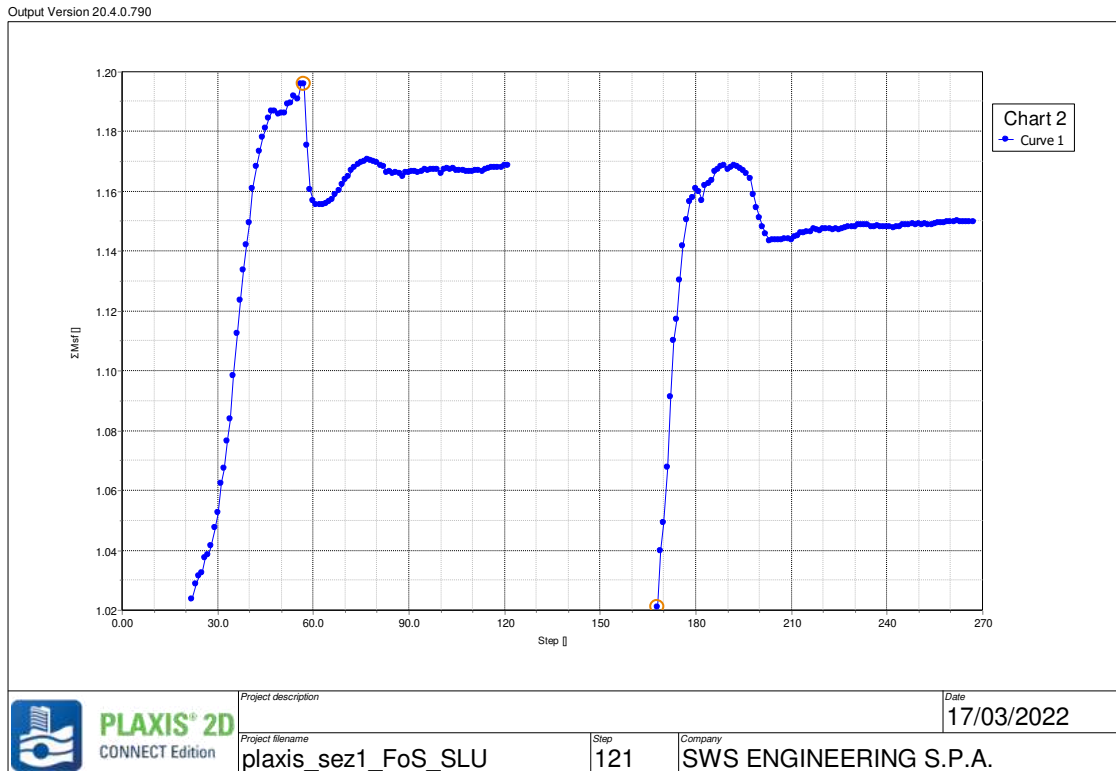


Abbildung 45. Bewertung der Gesamtstandsicherheit für den Schnitt 3 (SRFmin = 1.16)

Figura 45. Fattore di riduzione dei parametri ottenuto tramite l'analisi SSR in condizioni statiche e in condizioni sismiche: sezione 1 (SRFmin = 1.16)

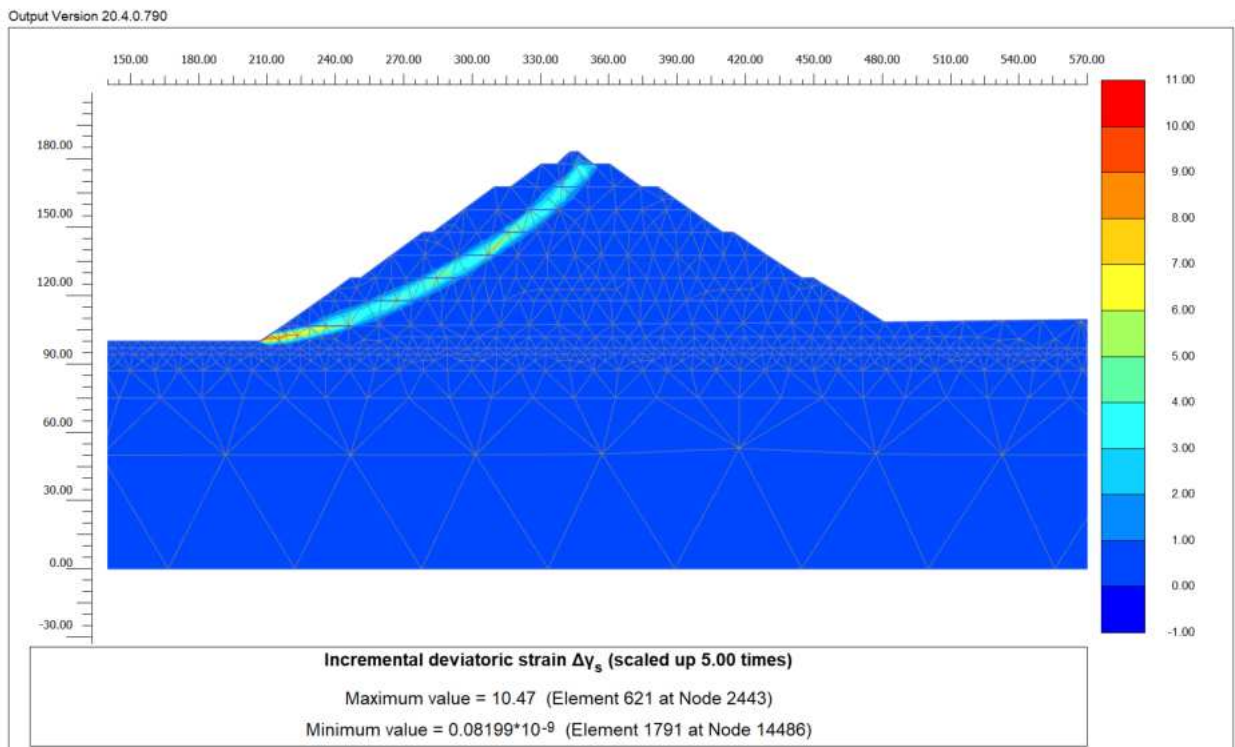


Abbildung 46. Bewertung der Gesamtstandsicherheit für den Schnitt 3 (SRFmin = 1.16)

Figura 46. Deformazioni deviatoriche al termine dell'analisi SSR in condizioni sismiche per la sezione 1 (SRFmin = 1.16)

Der Brechmechanismus ist an die Stabilität der künstlichen Vermessung gekoppelt und beeinflusst den Baugrund nicht.

Il meccanismo di rottura è connesso alla stabilità del rilevato artificiale a progetto e non interessa i terreni di fondazione.

Unter Bruchbedingungen wird der größte Teil des die Böschung bildenden Materials plastifiziert.

In condizioni di rottura gran parte del materiale costituente il rilevato risulta plasticizzato.

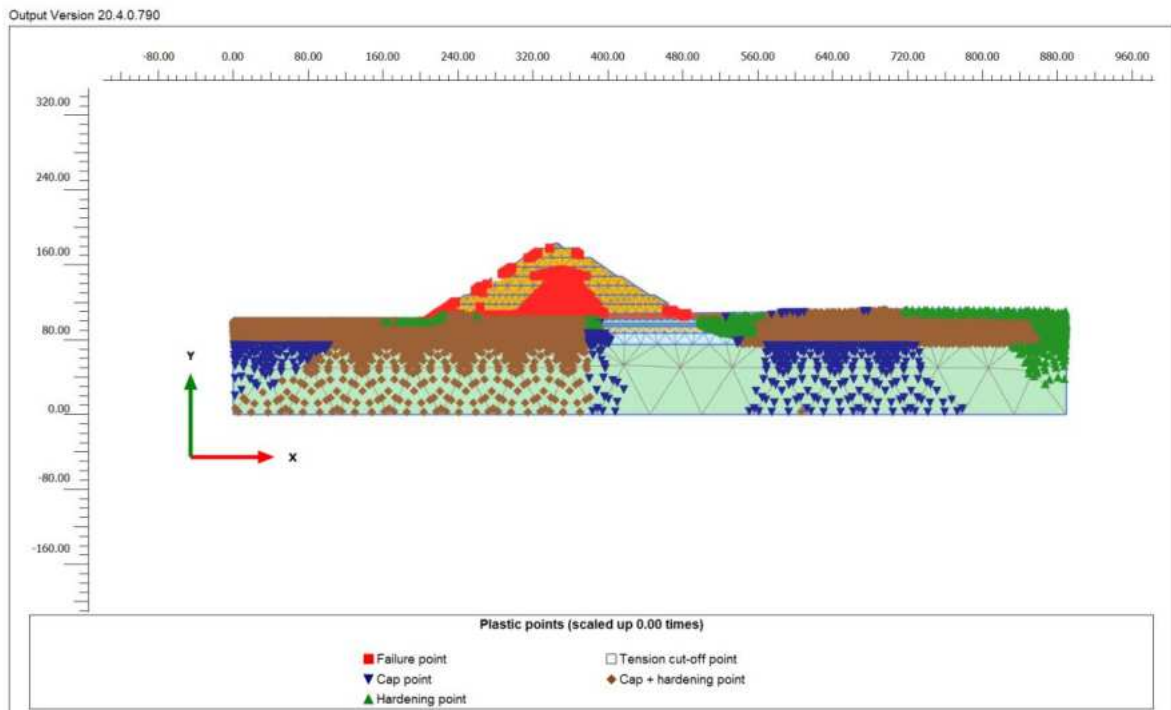


Abbildung 47. Plastifizierung Schnitt B – Fall F1

Figura 47. Plasticizzazione sezione 3

Um die zuvor erhaltenen Werte für die Stabilität der Böschung mit der endgültigen Konfiguration der Lagerstätte zu bestätigen, wurde eine Stabilitätsanalyse mit der ULS-Grenzgleichgewichtsmethode unter Verwendung der Software SLIDE (Rocscience) durchgeführt.

Al fine di confermare i valori precedentemente ottenuti per la stabilità del pendio avente la configurazione definitiva del deposito, è stata condotta una analisi di stabilità con il metodo all'equilibrio limite allo SLU mediante il software SLIDE (Rocscience).

Die Analyse wurde mit den Designparametern (M2) durchgeführt, wobei nach einem Reduktionskoeffizienten desselben gleich  $SRF_{min} = 1,1$  gesucht wurde.

L'analisi è stata effettuata con i parametri di progetto (M2) ricercando un coefficiente di riduzione degli stessi pari a  $SRF_{min} = 1.1$ .

Analog zur Finite-Elemente-Analyse wurde die seismische Einwirkung mit dem pseudostatischen Ansatz berücksichtigt. Die angenommenen seismischen Koeffizienten sind die zuvor berichteten.

In analogia con quanto fatto nell'analisi agli elementi finiti l'azione sismica è stata considerata mediante l'approccio pseudo-statico. I coefficienti sismici adottati sono quelli riportati precedentemente.

Die folgenden Abbildungen zeigen die kritischen Gleitflächen für den ULS und für den SLV.

Nelle figure a seguire si riportano rispettivamente per lo SLU e per lo SLV le superfici di scorrimento critiche.

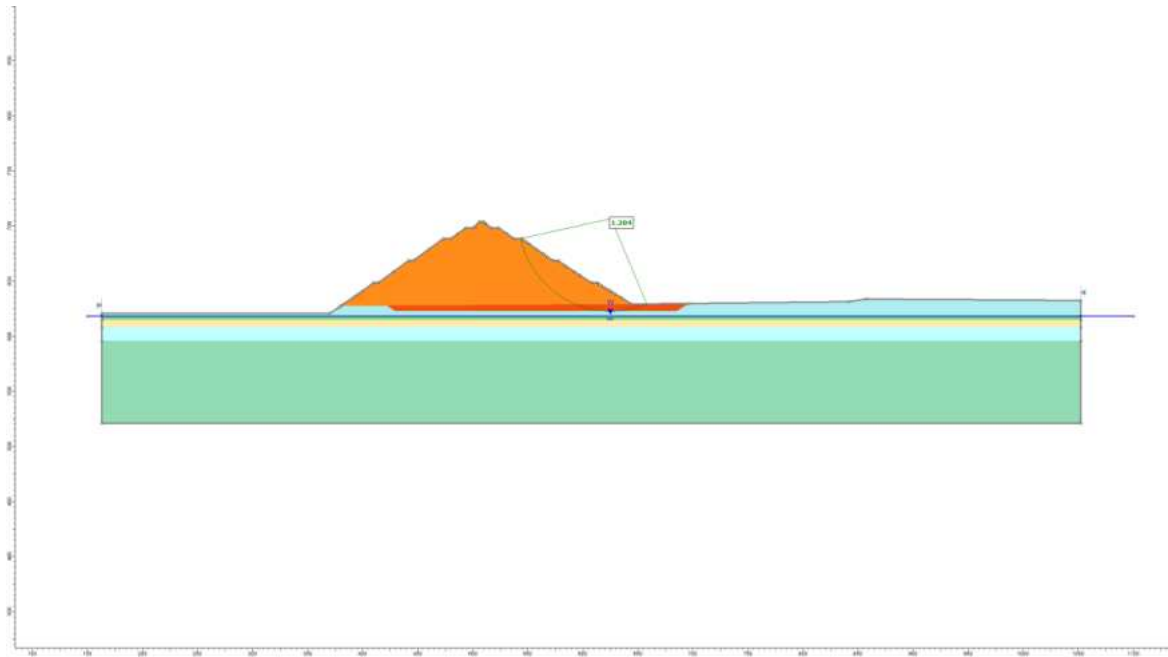


Abbildung 48. Bewertung der Gesamtstabilität unter statischen Bedingungen (ULS) für Abschnitt 1 (SRFmin = 1,204)

Figura 48. Valutazione della stabilità globale in condizioni statiche (SLU) per la sezione 1 (SRFmin = 1.204)

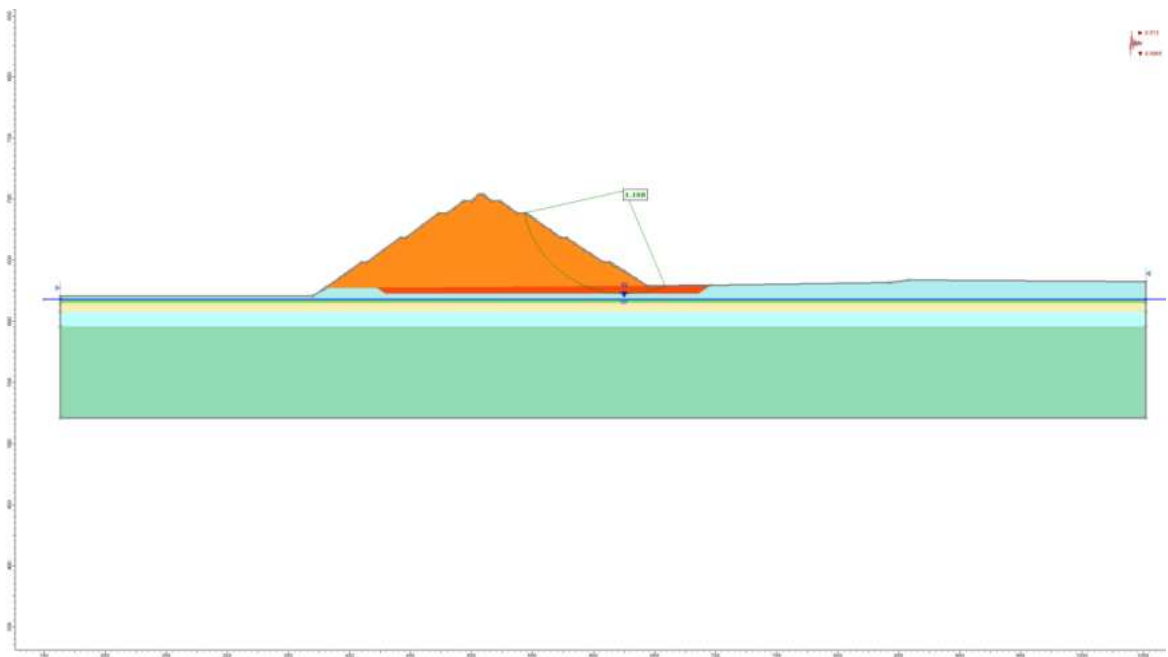


Abbildung 49. Bewertung der globalen Stabilität unter seismischen Bedingungen (SLV) für Abschnitt 1 (SRFmin = 1,168)

Figura 49. Bewertung der globalen Stabilität unter seismischen Bedingungen (SLV) für Abschnitt 1 (SRFmin = 1,168)

### 8.2.2 Ergebnisteil 2

Bei den Analysen des Abschnitts 2 wurde eine Höhe des Grundwasserspiegels in einer Tiefe von etwa 2,7 m über Geländeoberkante angenommen. Die numerischen Werte der eingegebenen geotechnischen Parameter sind in Anlage 9 (Plaxis) und in Anlage 10 und 11 (Folie) angegeben.

Die seismische Einwirkung in Plaxis wurde mit dem Verfahren "Pseudostatische Analyse" eingefügt, indem äquivalente statische Kräfte auf das gesamte Modell angewendet wurden. Die Erdbebenbeiwerte wurden gemäß den Bestimmungen der Technischen Regelwerke „Arbeiten in Schüttgütern und Baugrubenfronten“ ermittelt. Die Werte der in den Analysen angenommenen seismischen Koeffizienten sind unten zusammengefasst.

$$k_h = a_{\max} * \beta = 0.034 * 0.38 = 0.013 \text{ g};$$

$$k_v = k_h * 0.5 = 0.013 * 0.5 = 0.006 \text{ g}.$$

Für die Gesamtstabilität von Abschnitt 2 beträgt der Mindestsicherheitsfaktor unter statischen Bedingungen 1,104, was über dem von den Vorschriften festgelegten Mindestwert liegt. Anschließend wird die Gesamtstabilität der Lagerstätte überprüft.

### 8.2.2 Risultati sezione 2

Nelle analisi della sezione 2 si è assunta una quota della falda ad una profondità di circa 2,7 m da piano campagna. I valori numerici dei parametri geotecnici di input sono riportati in Appendice 9 (Plaxis) e in Appendice 10 e 11 (Slide).

L'analisi agli elementi finiti (Plaxis) è stata effettuata con i valori di resistenza del terreno ridotti con i parametri M2

L'azione sismica in plaxis è stata inserita mediante la procedura "Pseudostatic analysis" applicando all'intero modello forze statiche equivalenti. I coefficienti sismici sono stati valutati in accordo con quanto prescritto dalla normativa tecnica per le "Opere in materiali sciolti e fronti di scavo". I valori dei coefficienti sismici adottati nelle analisi sono riassunti a seguire.

$$k_h = a_{\max} * \beta = 0.034 * 0.38 = 0.013 \text{ g};$$

$$k_v = k_h * 0.5 = 0.013 * 0.5 = 0.006 \text{ g}.$$

Per la stabilità globale della sezione 2, il fattore di sicurezza minimo in condizioni statiche, è pari a 1.104 che è superiore al valore minimo imposto da normativa. La stabilità globale del deposito è quindi verificata.

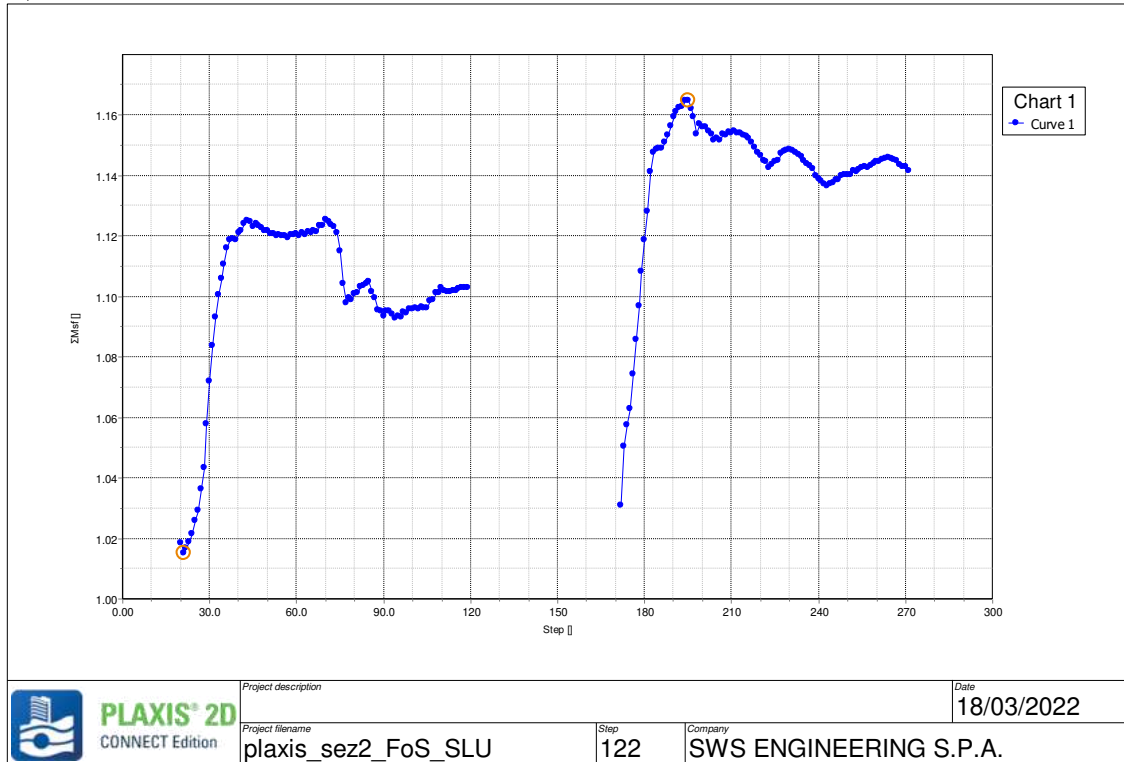


Abbildung 50. Parameterreduktionsfaktor, erhalten durch SSR-Analyse unter statischen Bedingungen und unter seismischen Bedingungen: Abschnitt 2 (SRFmin = 1,104)

Figura 50. Fattore di riduzione dei parametri ottenuto tramite l'analisi SSR in condizioni statiche e in condizioni sismiche: sezione 2 (SRFmin = 1.104)

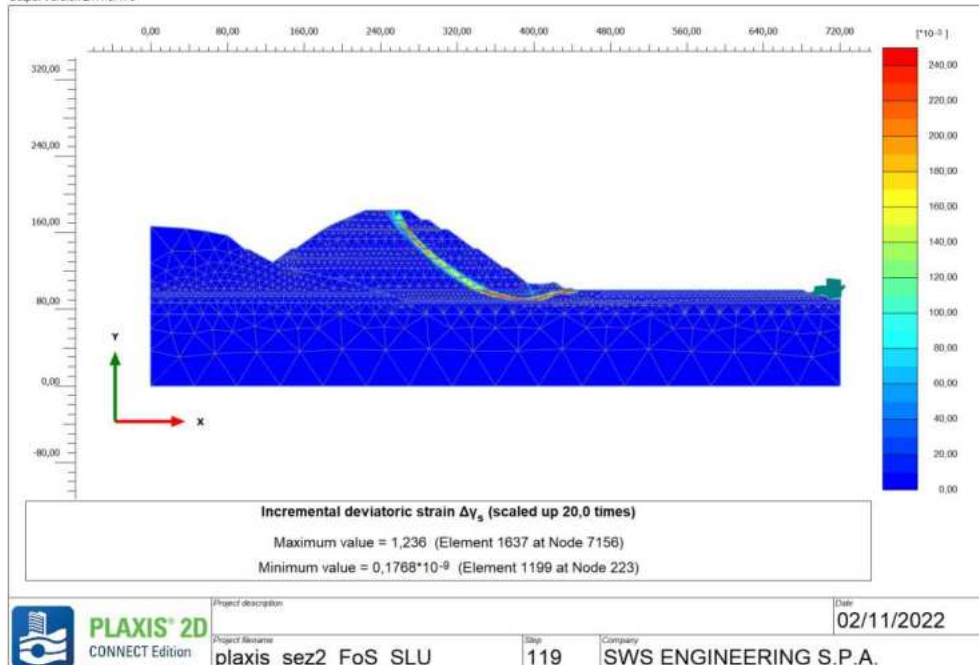


Abbildung 51. Deviatorische Verformungen am Ende der SSR-Analyse unter seismischen Bedingungen für Abschnitt 2 (SRFmin = 1,104)

Figura 51. Deformazioni deviatoriche al termine dell'analisi SSR in condizioni sismiche per la sezione 2 (SRFmin = 1.104)

Der Brechmechanismus ist an die Stabilität der künstlichen Vermessung gekoppelt und beeinflusst den Baugrund nicht.

Il meccanismo di rottura è connesso alla stabilità del rilevato artificiale a progetto e non interessa i terreni di fondazione.

Unter Bruchbedingungen wird der größte Teil des die Böschung bildenden Materials plastifiziert.

In condizioni di rottura gran parte del materiale costituente il rilevato risulta plasticizzato.

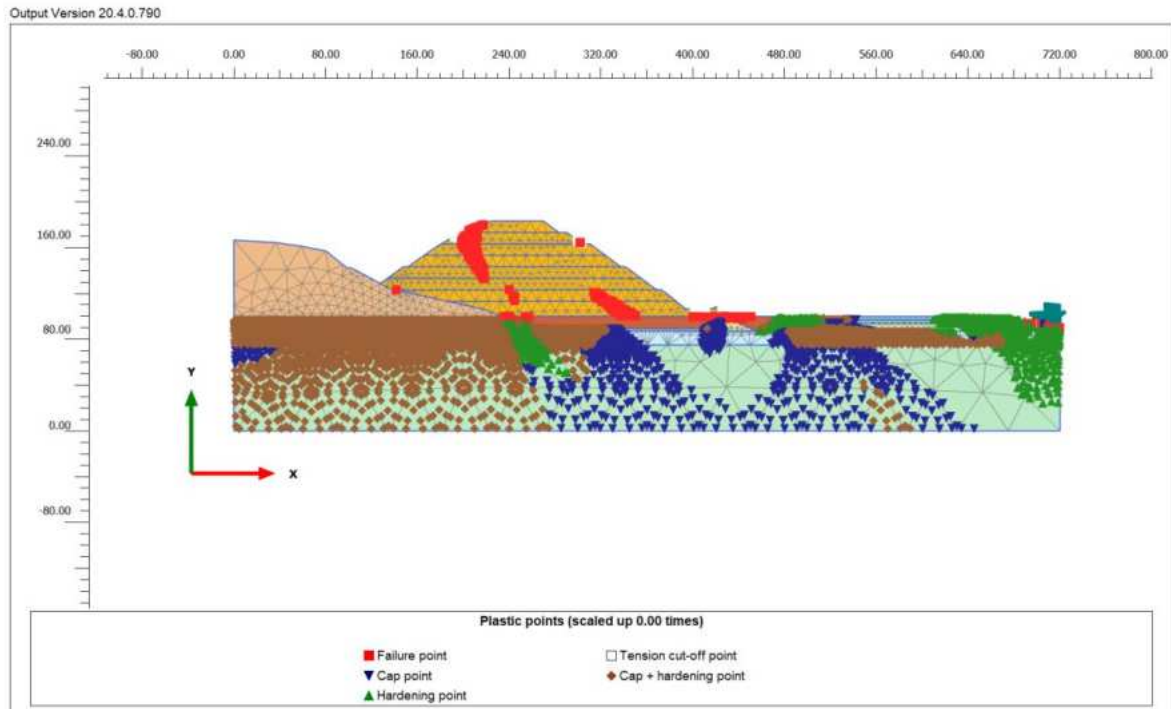


Abbildung 52. Plastifizierung Schnitt 2

Figura 52. Plasticizzazione sezione 2

Um die zuvor erhaltenen Werte für die Stabilität der Böschung mit der endgültigen Konfiguration der Lagerstätte zu bestätigen, wurde eine Stabilitätsanalyse mit der ULS-Grenzgleichgewichtsmethode unter Verwendung der Software SLIDE (Rocscience) durchgeführt.

Al fine di confermare i valori precedentemente ottenuti per la stabilità del pendio avente la configurazione definitiva del deposito, è stata condotta una analisi di stabilità con il metodo all'equilibrio limite allo SLU mediante il software SLIDE (Rocscience).

Die Analyse wurde mit den Designparametern (M2) durchgeführt, wobei nach einem Reduktionskoeffizienten desselben gleich  $SRF_{min} = 1,1$  gesucht wurde.

L'analisi è stata effettuata con i parametri di progetto (M2) ricercando un coefficiente di riduzione degli stessi pari a  $SRF_{min} = 1.1$ .

Analog zur Finite-Elemente-Analyse wurde die seismische Einwirkung mit dem pseudostatischen Ansatz berücksichtigt. Die angenommenen seismischen Koeffizienten sind die zuvor berichteten.

In analogia con quanto fatto nell'analisi agli elementi finiti l'azione sismica è stata considerata mediante l'approccio pseudo-statico. I coefficienti sismici adottati sono quelli riportati precedentemente.

Die folgenden Abbildungen zeigen die kritischen Gleitflächen für den ULS und für den SLV.

Nelle figure a seguire si riportano rispettivamente per lo SLU e per lo SLV le superfici di scorrimento critiche.

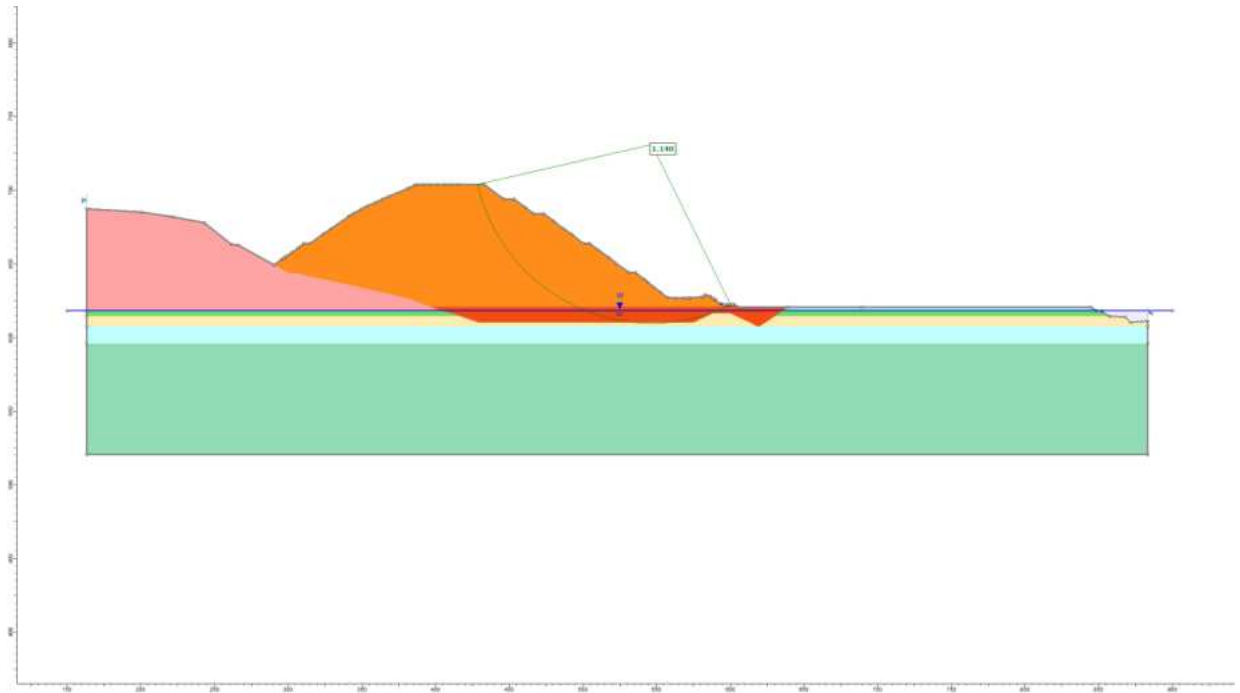


Abbildung 53. Bewertung der Gesamtstabilität unter statischen Bedingungen (ULS) für Abschnitt 2 (SRFmin = 1,14)

Figura 53. Valutazione della stabilità globale in condizioni statiche (SLU) per la sezione 2 (SRFmin = 1.14)

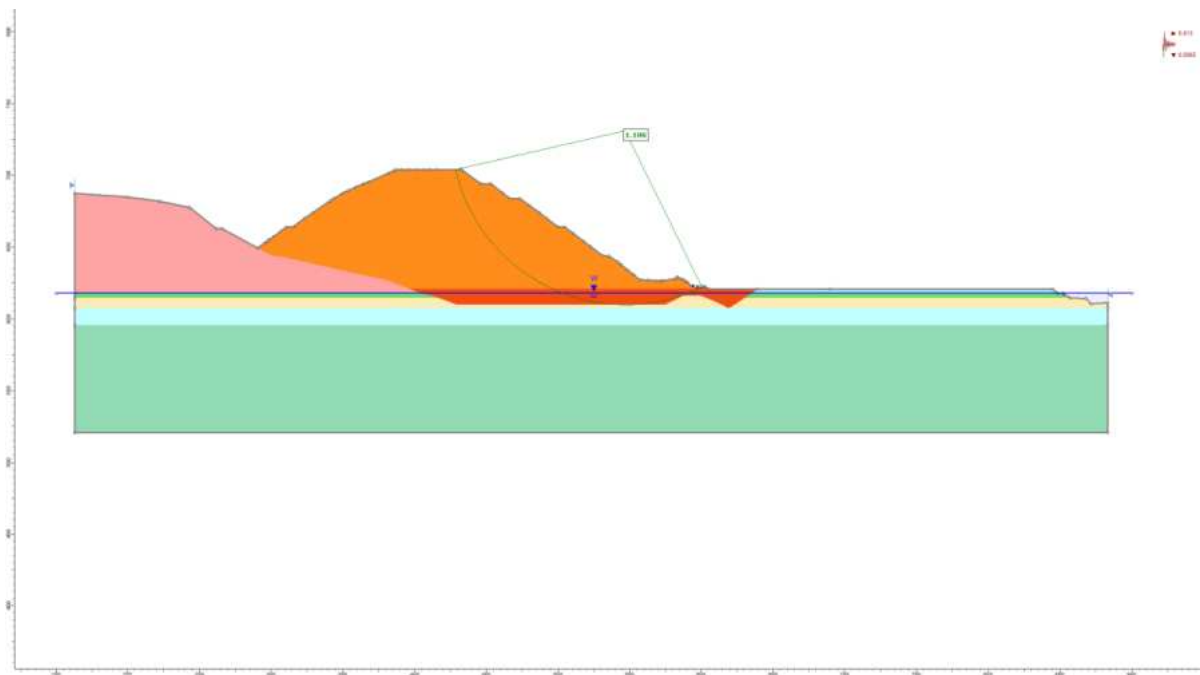


Abbildung 54. Bewertung der globalen Stabilität unter seismischen Bedingungen (SLV) für Abschnitt 2 (SRFmin = 1,106)

Figura 54. Valutazione della stabilità globale in condizioni sismiche (SLV) per la sezione 2 (SRFmin=1.106)



### 8.2.3 Ergebnisteil 3

Bei den Analysen des Abschnitts 3 wurde eine Höhe des Grundwasserspiegels gleich der Geländeoberkante am Böschungsfuß angenommen. Die Zahlenwerte der geotechnischen Eingangsparameter sind in Anlage 12 (Plaxis) und in Anlage 13 und 14 (Folie) angegeben.

Die Finite-Elemente-Analyse (Plaxis) wurde mit Bodenwiderstandswerten durchgeführt, die mit M2-Parametern reduziert wurden.

Die seismische Einwirkung in Plaxis wurde mit dem Verfahren "Pseudostatische Analyse" eingefügt, indem äquivalente statische Kräfte auf das gesamte Modell angewendet wurden. Die Erdbebenbeiwerte wurden gemäß den Bestimmungen der Technischen Regelwerke „Arbeiten in Schüttgütern und Baugrubenfronten“ ermittelt. Die Werte der in den Analysen angenommenen seismischen Koeffizienten sind unten zusammengefasst.

$$k_h = a_{\max} * \beta = 0.034 * 0.38 = 0.013 \text{ g};$$

$$k_v = k_h * 0.5 = 0.013 * 0.5 = 0.006 \text{ g}.$$

Für die Gesamtstabilität von Abschnitt 2 beträgt der Mindestsicherheitsfaktor unter statischen Bedingungen 1,107, was über dem von den Vorschriften festgelegten Mindestwert liegt. Anschließend wird die Gesamtstabilität der Lagerstätte überprüft.

### 8.2.3 Risultati sezione 3

Nelle analisi della sezione 3 si è assunta una quota della falda pari a quella del piano campagna in corrispondenza del piede del rilevato. I valori numerici dei parametri geotecnici di input sono riportati in Appendice 12 (Plaxis) e in Appendice 13 e 14 (Slide).

L'analisi agli elementi finiti (Plaxis) è stata effettuata con i valori di resistenza del terreno ridotti con i parametri M2.

L'azione sismica in plaxis è stata inserita mediante la procedura "Pseudostatic analysis" applicando all'intero modello forze statiche equivalenti. I coefficienti sismici sono stati valutati in accordo con quanto prescritto dalla normativa tecnica per le "Opere in materiali sciolti e fronti si scavo". I valori dei coefficienti sismici adottati nelle analisi sono riassunti a seguire.

$$k_h = a_{\max} * \beta = 0.034 * 0.38 = 0.013 \text{ g};$$

$$k_v = k_h * 0.5 = 0.013 * 0.5 = 0.006 \text{ g}.$$

Per la stabilità globale della sezione 2, il fattore di sicurezza minimo in condizioni statiche, è pari a 1.107 che è superiore al valore minimo imposto da normativa. La stabilità globale del deposito è quindi verificata.

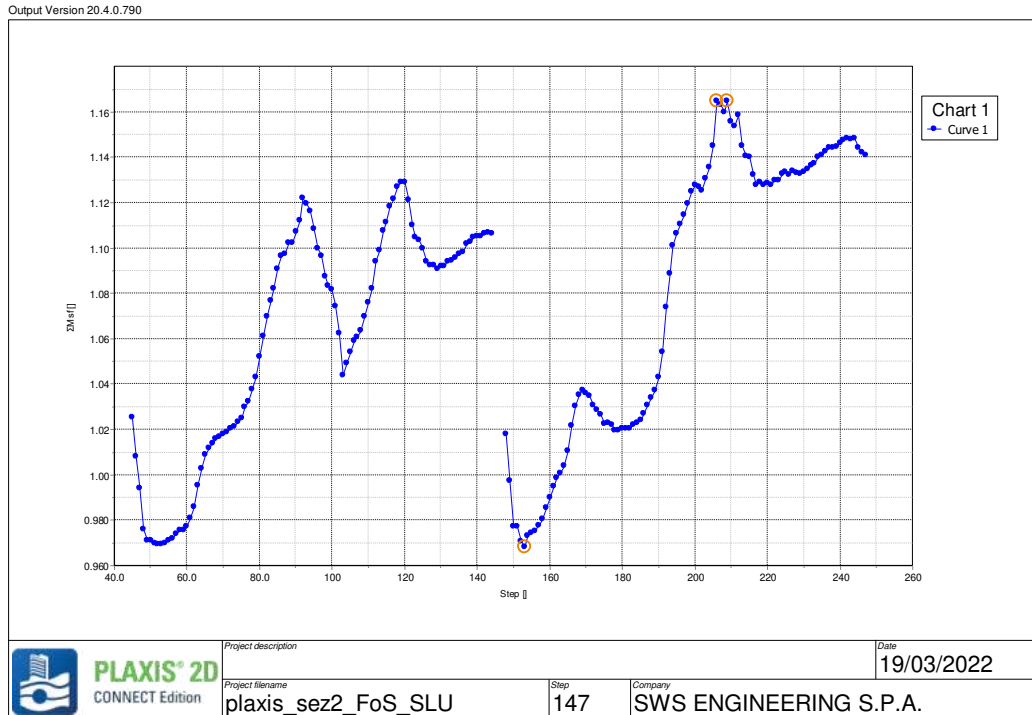


Abbildung 55. Parameterreduktionsfaktor, erhalten durch SSR-Analyse unter statischen und seismischen Bedingungen: Abschnitt 3 (SRFmin = 1,107)

Figura 55. Fattore di riduzione dei parametri ottenuto tramite l'analisi SSR in condizioni statiche e in condizioni sismiche: sezione 3 (SRFmin = 1.107)

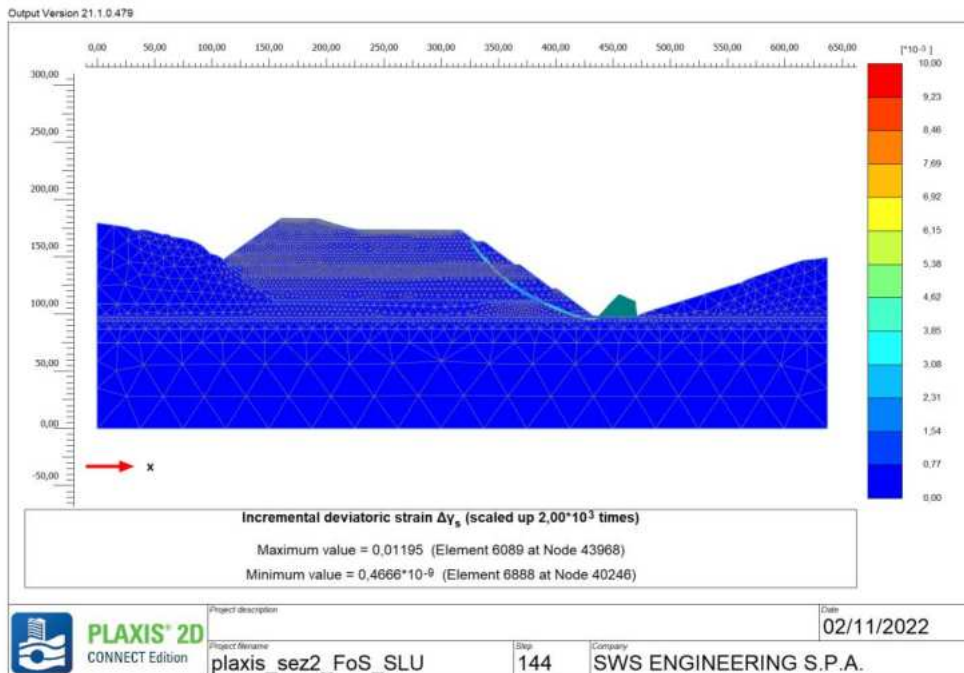


Abbildung 56. Deviatorische Verformungen am Ende der SSR-Analyse unter seismischen Bedingungen für Abschnitt 3 (SRFmin = 1,107)

Figura 56. Deformazioni deviatoriche al termine dell'analisi SSR in condizioni sismiche per la sezione 3 (SRFmin = 1.107)

Der Brechmechanismus ist an die Stabilität der künstlichen Vermessung gekoppelt und beeinflusst den Baugrund nicht.

Il meccanismo di rottura è connesso alla stabilità del rilevato artificiale a progetto e non interessa i terreni di fondazione.

Unter Bruchbedingungen wird der größte Teil des die Böschung bildenden Materials plastifiziert.

In condizioni di rottura gran parte del materiale costituente il rilevato risulta plasticizzato.

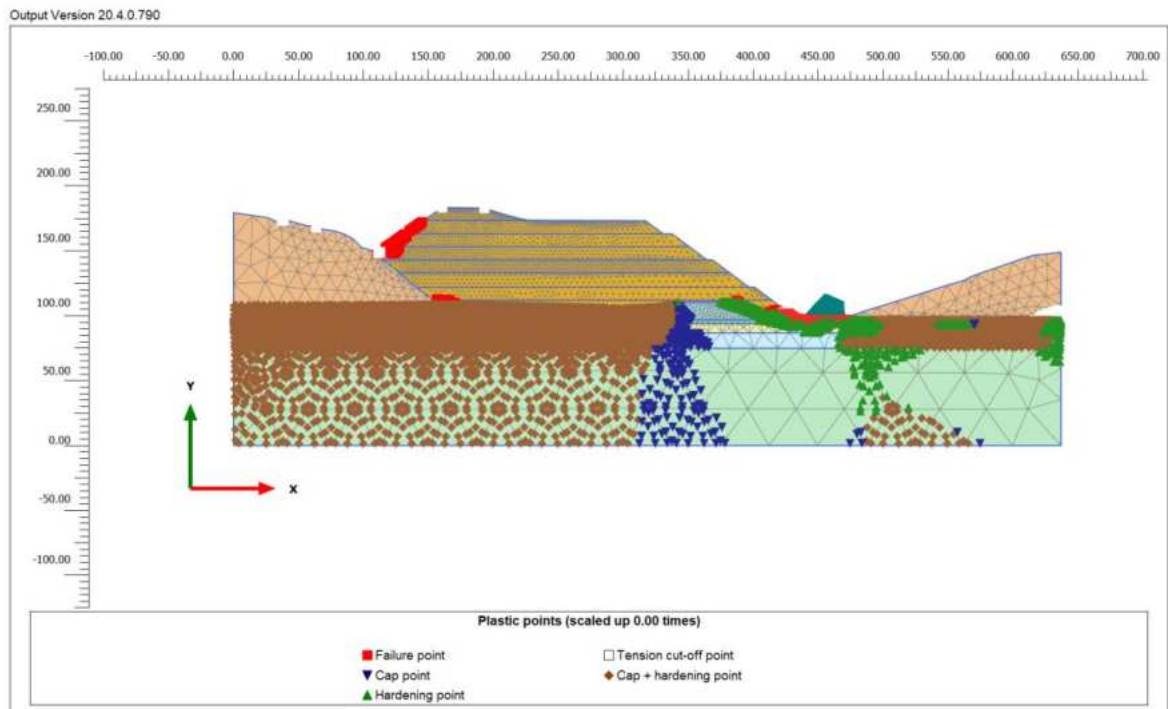


Abbildung 57. Plastifizierung Schnitt B – Fall F1

Figura 57. Plasticizzazione sezione 3

Um die zuvor erhaltenen Werte für die Stabilität der Böschung mit der endgültigen Konfiguration der Lagerstätte zu bestätigen, wurde eine Stabilitätsanalyse mit der ULS-Grenzgleichgewichtsmethode unter Verwendung der Software SLIDE (Rocscience) durchgeführt.

Al fine di confermare i valori precedentemente ottenuti per la stabilità del pendio avente la configurazione definitiva del deposito, è stata condotta una analisi di stabilità con il metodo all'equilibrio limite allo SLU mediante il software SLIDE (Rocscience).

Die Analyse wurde mit den Designparametern (M2) durchgeführt, wobei nach einem Reduktionskoeffizienten desselben gleich  $SRF_{min} = 1,1$  gesucht wurde.

L'analisi è stata effettuata con i parametri di progetto (M2) ricercando un coefficiente di riduzione degli stessi pari a  $SRF_{min} = 1.1$ .

Analog zur Finite-Elemente-Analyse wurde die seismische Einwirkung mit dem pseudostatischen Ansatz berücksichtigt. Die angenommenen seismischen Koeffizienten sind die zuvor berichteten.

In analogia con quanto fatto nell'analisi agli elementi finiti l'azione sismica è stata considerata mediante l'approccio pseudo-statico. I coefficienti sismici adottati sono quelli riportati precedentemente.

Die folgenden Abbildungen zeigen die kritischen Gleitflächen für den ULS und für den SLV.

Nelle figure a seguire si riportano rispettivamente per lo SLU e per lo SLV le superfici di scorrimento critiche.

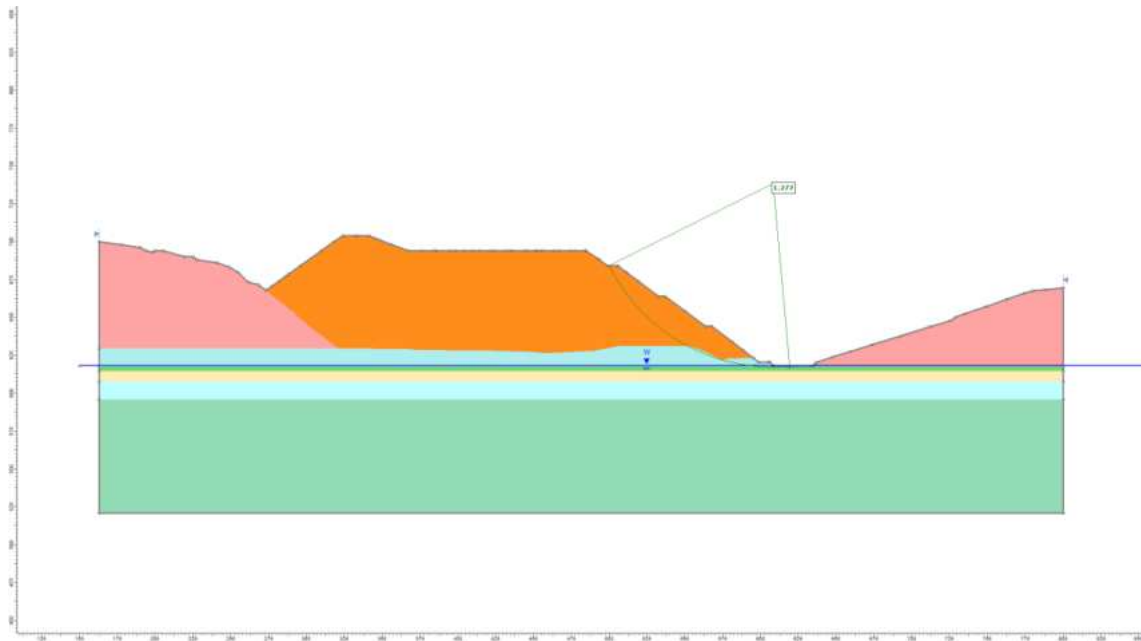


Abbildung 58. Bewertung der Gesamtstabilität unter statischen Bedingungen (ULS) für Abschnitt 3 (SRFmin = 1,277)

Figura 58. Valutazione della stabilità globale in condizioni statiche (SLU) per la sezione 3 (SRFmin = 1.277)

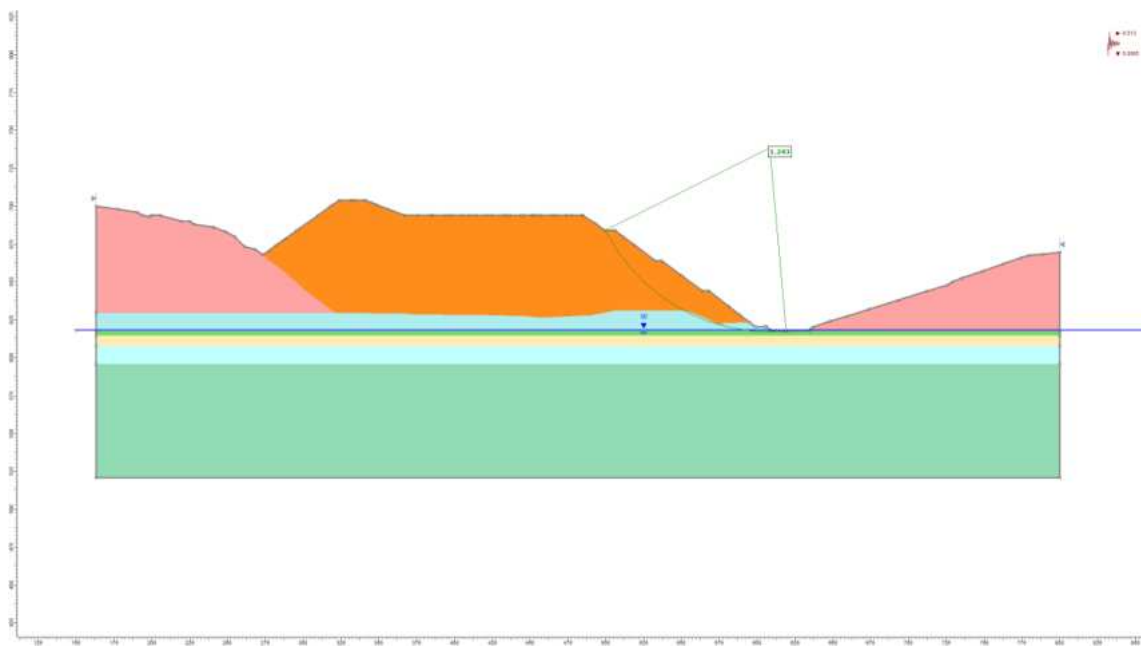


Abbildung 59. Bewertung der globalen Stabilität unter seismischen Bedingungen (SLV) für Abschnitt 3 (SRFmin = 1,243)

Figura 59. Valutazione della stabilità globale in condizioni sismiche (SLV) per la sezione 3 (SRFmin = 1.243)

Die erhaltenen Werte der Sicherheitskoeffizienten sind immer höher als die von der Norm geforderten Werte der Sicherheitskoeffizienten.

I valori dei coefficienti di sicurezza ottenuti sono sempre superiori ai valori dei coefficienti di sicurezza previsti dalla norma.

### 8.3 BELASTUNGEN AUS EINEM HOCHWASSER MIT EINER WIEDERKEHRPERIODE VON 150 JAHREN

Bei einem Hochwasser mit einer Wiederkehrzeit von 150 erreicht der Wasserspiegel des Eisacks den Fuß der Lagerstätte.

Beim Zurückgehen des Hochwassers fließt das Wasser aus der Lagerstätte und verursacht durch das schnelle Absenken des Flussspiegels eine destabilisierende Sickerkraft (Rapid Flow Condition).

Stabilitätsprüfungen werden mit der Slide-Software im „vollen“ Zustand mit piezometrischer Oberfläche (Anlage 15) und mit Filtrationsbewegung im „schnellen Aufweitungszustand“ (Anlage 16) durchgeführt.

Für die Berechnung wurde konservativ angenommen, dass der maximale Hochwasserstand der maximalen Höhe des Schutzwalls (Steigung von etwa 5 Metern gegenüber der Höhe des Flussbettes) entspricht und sich anschließend eine vorsorgliche Abnahme von 4 Metern (Höhe 1 Meter über dem Niveau des Flussbettes). Für die Baugründe wurde der Mittelwert des Durchlässigkeitsbeiwertes auf Basis der in situ durchgeführten Versuche berücksichtigt ( $k_s = 3,91 \cdot 10^{-5}$ ).

Unter Bezugnahme auf Anlage 15 und 16 wird nachgewiesen, dass bei maximaler Überschwemmung (HQ 150) eine minimale Abnahme der Standsicherheit im Vergleich zur Dimensionierung ohne Überschwemmung auftritt.

$FS_{minHQ150} (S3-ULS) = 1,247$  – „voll“

$FS_{minHQ150} (S3-SLU) = 1,268$  – „Schnellsenker“

$FS_{min} (S3-ULS) = 1,276$  – „ohne Hochwasser“

Die folgenden Abbildungen zeigen die Ergebnisse, die in den beiden analysierten Konfigurationen erzielt wurden. Die Sicherheitsfaktoren sind gleich 1,248 bzw. 1,273 für den "vollen" Zustand und für den "schnellen Abfackel"-Zustand.

Beide Koeffizienten sind höher als das gesetzlich vorgeschriebene Minimum. Damit ist die globale Stabilität der Lagerstätte verifiziert.

### 8.3 CONDIZIONI DI STABILITÀ DEL DEPOSITO IN CASO DI PIENA CON TEMPO DI RITORNO 150 ANNI

Nel caso di una piena con tempo di ritorno di 150, il livello delle acque dell'Isarco raggiunge i piedi del deposito.

Al ritirarsi della piena, l'acqua fluisce dal deposito e determina una forza di filtrazione destabilizzante per effetto del rapido abbassamento del livello del fiume (Condizione di Svaso Rapido).

Le verifiche di stabilità vengono eseguite con il software Slide, nella condizione di "piena" con superficie piezometrica (Appendice 15) e con moto di filtrazione nella condizione di "svaso rapido" (Appendice 16).

Per il calcolo, si è ipotizzato cautelativamente che il livello di massima piena corrisponda alla massima quota dall'argine di protezione (innalzamento di circa 5 metri rispetto alla quota di fondo alveo) e che si abbia una successiva diminuzione cautelativa di 4 metri (altezza di 1 metro dalla quota di fondo alveo). Per i terreni di fondazione è stato considerato il valore medio del coefficiente di permeabilità sulla base delle prove effettuate in situ ( $k_s = 3,91 \cdot 10^{-5}$ ).

Rimandando all'Appendice 15 e 16, si verifica che nel caso di massima piena (HQ 150) si ha una minima diminuzione della stabilità in confronto al caso di dimensionamento senza piena.

$FS_{minHQ150} (S3-SLU) = 1,247$  – "piena"

$FS_{minHQ150} (S3-SLU) = 1,268$  – "svaso rapido"

$FS_{min} (S3-SLU) = 1,276$  – "senza piena"

Nelle figure che seguono si riportano i risultati ottenuti nelle due configurazioni analizzate. I fattori di sicurezza sono pari a 1.248 e 1.273 rispettivamente per la condizione di "piena" e per la condizione di "svaso rapido".

Entrambi i coefficienti sono superiori al minimo imposto da normativa. La stabilità globale del deposito è quindi verificata.

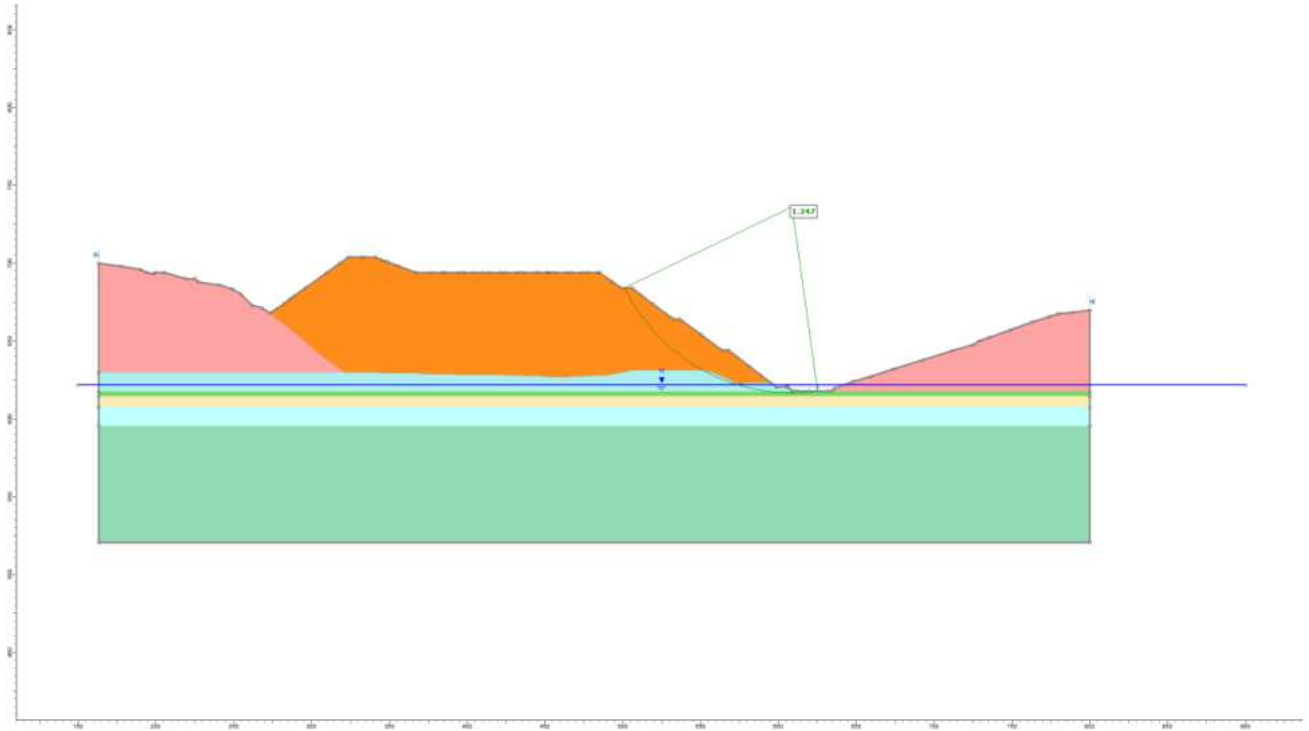


Abbildung 60. Bewertung der Gesamtstabilität unter statischen Bedingungen für Abschnitt 3 (SRFmin = 1,247)

Figura 60. Valutazione della stabilità globale nella condizione di PIENA per la sezione 3 (SRFmin = 1.247)

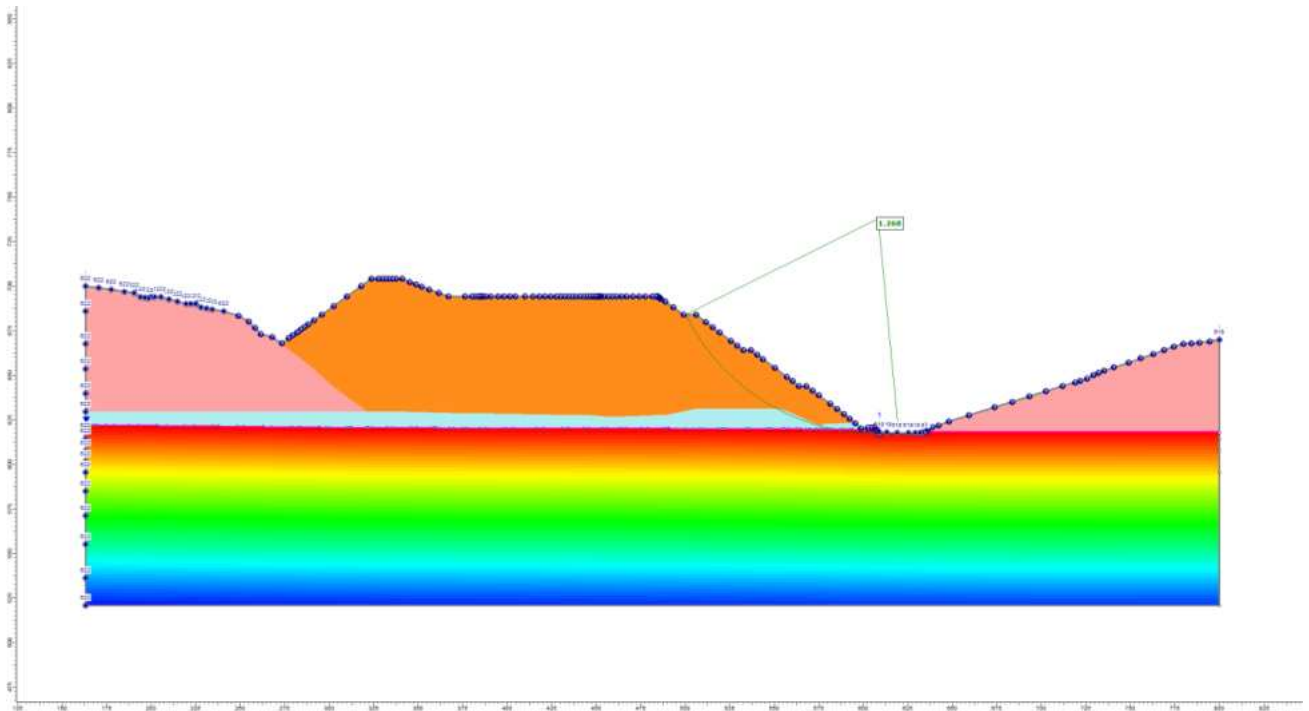


Abbildung 61. Bewertung der globalen Stabilität unter seismischen Bedingungen für Abschnitt 3 (SRFmin = 1,268)

Figura 61. Valutazione della stabilità globale nella condizione di SVASO RAPIDO per la sezione 3 (SRFmin = 1.268)

## 9 BEWEISSICHERUNGSPLAN

### 9.1 ALLGEMEINE KRITERIEN

Die Materialdeponie Hinterrigger befindet sich auf dem orographischen Rechten des Eisacks und im Norden, Osten und Süden vom Fluß bogenförmig begrenzt ist. Im Westen erhebt sich eine einige Zehnermeter hohe Felswand bis zur Forch Terrasse. Vor allem im Süden, wo die Felswand fast senkrecht ist, besteht ein großes Steinschlagrisiko. Die Materialdeponie wird ca. 5.000.000 m<sup>3</sup> Ausbruchmaterial der Gebrauchsklassen B+C (Material für Verfüllungen oder Aufschüttungen, nicht wiederverwendbares Material und daher Endlagerung). Die maximale Bemessung der Materialdeponie ist wie folgt:

- (1) maximale Länge Materialdeponie im Endzustand= 470 m;
- (2) maximale Breite Materialdeponie im Endzustand = 350 m;
- (3) maximale Höhe des Zwischenlagers = 80 m.

Die 5 im Areal der Materialdeponie durchgeführten Erkundungsbohrungen wurden in eine Tiefe von bis zu 15 m abgeteuft. Es fanden sich grobkörnige Böden, bestehend vorwiegend aus Kiesen mit Sanden und Sanden mit Schluff mit einem Verdichtungsgrad zwischen mittel bis dicht (Lagerungsdichte zwischen 45 und 80%). Daher werden die Setzungen im Baugrund unter dränierten Bedingungen stattfinden und werden sich im Laufe der Aufschüttung der Deponie verändern.

Im vorhergehenden Kapitel 7 wurden die Nachweise der Deponie mit seinen größten Ausmaßen durchgeführt, d. h. unter Berücksichtigung der maximalen Höhe, sei es für den Grenzzustand der Tragfähigkeit, um die Standsicherheit des Bauwerks zu überprüfen, als auch für den Grenzzustand der Gebrauchstauglichkeit, um den Wert der in den umliegenden Bereichen induzierten Setzungen zu bestimmen, mit besonderer Berücksichtigung der Eisenbahn, der Hochspannungsleitungen und der vorhandenen Gebäude in der Nähe der Materialdeponie.

Im vorliegenden Kapitel werden die Kontrollinstrumente beschrieben, um während der Arbeiten den Sicherheitsgrad und die Korrektheit der Projektannahmen und der im vorhergehenden Kapitel 7 angeführten Nachweise zu überprüfen.

Das Beweissicherungsprogramm ermöglicht es, die Bewegungen innerhalb der Materialdeponie sowie die Wasserstände zu beobachten. Das zu installierende Überwachungssystem wird aus Pegelmessern, Inklinometern,

## 9 PIANO DI MONITORAGGIO

### 9.1 CRITERI GENERALI

Il deposito di Hinterrigger è situato sulla sponda orografica dell'Isarco e viene delimitato, a forma di arco, a nord, est e sud dal fiume. A ovest, una parete rocciosa alta decine di metri si staglia fino alla terrazza di Forch. Soprattutto a sud, dove la parete rocciosa è quasi verticale c'è un elevato rischio di caduta massi. Il deposito prevede per un volume di circa 5.000.000 m<sup>3</sup> nella sua massima capienza, con smarino di classe di utilizzo B+C (materiale idoneo per riporti o riempimenti si tratta di un deposito con smarino). Le dimensioni massime del deposito sono le seguenti:

- (1) lunghezza massima del deposito finale = 470 m;
- (2) larghezza massima del deposito finale = 350 m;
- (3) altezza massima del deposito finale = 80 m.

I 5 sondaggi eseguiti in PE in corrispondenza del deposito, spinti fino ad una profondità di 15 m, hanno evidenziato la presenza di terreni a grana grossa costituiti prevalentemente da ghiaie con sabbia e sabbie con limo con grado di addensamento da medio a denso (valori della densità relativa compresi fra il 45 e l'80%). Conseguentemente, i cedimenti nei terreni di fondazione avverranno in condizioni drenate ed evolveranno durante lo stesso innalzamento del terrapieno del deposito.

Nel precedente capitolo 7 sono riportate le verifiche del deposito, nelle sue massime configurazioni geometriche, ovverosia considerando le massime altezze, sia agli stati limite ultimi, al fine di verificare il grado di stabilità dell'opera, sia agli stati limite di esercizio, per valutare l'entità dei cedimenti del deposito e, soprattutto, i valori dei cedimenti indotti nel terreno circostante, con particolare riferimento alla presenza della linea ferroviaria e dei fabbricati presenti in prossimità del deposito.

Nel presente capitolo è illustrata la strumentazione di controllo prevista per verificare, in corso d'opera, il grado di sicurezza del deposito e la correttezza delle assunzioni progettuali e delle verifiche riportate nel precedente capitolo 7.

Il sistema di monitoraggio previsto permetterà di monitorare i movimenti del deposito. Il sistema di monitoraggio da installare sarà costituito da strumentazione comprendente inclinometri, e mire topografiche.

Setzungsmesser mit Inkrementalmessung und topographischen Fixpunkten bestehen.

Was die technischen Eigenschaften der Instrumente und ihre Installation betrifft, müssen diese den dafür bestimmten Spezifikationen des Ausführungsprojektes entsprechen.

Das Ziel der vorgeschlagenen Instrumentierung besteht darin, etwaige Formänderungen vor der endgültigen Begrünung zu beobachten. Daher wird es als ausreichend angesehen, das Verhalten des Pfahls zu analysieren.

Die Lesefrequenz und die Installationszeiten sind für die verschiedenen Instrumente in den jeweiligen Überwachungstabellen definiert. Die ausführlichen Referenzdiagramme sind die folgenden:

- 02\_H61\_DB\_300\_KLP\_B0130\_51242;

Das Überwachungssystem zusammen mit dem Leseprogramm und der Datenanalyse könnte möglicherweise in der Zahl erhöht und in der Lesefrequenz intensiviert werden, um jede kleinste Bewegung, auch oberflächliche, des Cumulus zu erkennen.

Im Detail besteht das geotechnische Beweissicherungssystem aus:

- **Inklinometer:** man sieht 8 Inklinometer (I1-I8) vor, um die vorläufigen und definitiven Böschungen der Aufschüttung zu überwachen. Die Instrumente werden am Ende der Arbeiten im jeweiligen Zuständigkeitsgebiet jedes Instrument angebracht. Sie müssen in eine Tiefe von mindestens 20 m ab aktueller GOK reichen.  
Die Häufigkeit der Ablesungen erfolgt während des Baus der Lagerstätte und in den ersten 3 Monaten nach Abschluss der Arbeiten wöchentlich, danach bis zur Stabilisierung der Maßnahmen selbst vierteljährlich.
- **Topographische Fixpunkte:** unmittelbar nach dem Ende der Aufschüttungsarbeiten müssen auf der fertigen Oberfläche topographische Fixpunkte installiert werden. Es ist vorgesehen 41 Festpunkte auf der gesamten Oberfläche, die die Aufschüttung bedeckt, anzubringen, um die Setzungen und Verschiebungen nach Ende der Aufschüttungsarbeiten zu messen.  
Die der Benchmarks wöchentlich, in den folgenden 3 Monaten monatlich und danach vierteljährlich.

Nel presente capitolo vengono descritti gli strumenti e le quantità previste.

Per quanto concerne le caratteristiche tecniche delle strumentazioni previste e le modalità di installazione dovranno essere conformi alle apposite specifiche tecniche predisposte per il Progetto Esecutivo.

La strumentazione proposta ha come obiettivo quello di osservare eventuali cambiamenti di forma, prima del rinverdimento finale, pertanto si ritiene sufficiente ad analizzare il comportamento del cumulo.

La frequenza di lettura e le tempistiche di installazione sono definite per i diversi strumenti nelle relative tavole di monitoraggio. Gli elaborati grafici di riferimento sono i seguenti:

- 02\_H61\_DB\_300\_KLP\_B0130\_51242;

Il sistema di monitoraggio, insieme al programma delle letture e l'analisi dei dati, potranno essere eventualmente potenziati in numero e intensificati in frequenza di lettura, al fine di rilevare ogni minimo movimento anche superficiale del cumulo.

Nel dettaglio il sistema di monitoraggio geotecnico sarà costituito da:

- **Inclinometri:** si prevede di installare 6 inclinometri (A, B, C, D, E, F), per il monitoraggio delle scarpate del riempimento. Gli inclinometri dovranno essere spinti fino ad una profondità di almeno 10 m all'interno del terreno di fondazione del deposito.  
La frequenza delle letture sarà settimanale durante la costruzione del deposito e per i primi 3 mesi dopo la fine dei lavori, successivamente le letture saranno trimestrali fino alla stabilizzazione delle misure stesse.
- **Caposaldi topografici:** si prevede di realizzarne 38 per il monitoraggio dei cedimenti e degli spostamenti superficiali del deposito stesso. Sono costituiti da una barra in acciaio  $\phi 22$  che viene cementata in foro e sulla quale viene montato un manicotto per il rilievo topografico degli spostamenti.  
La frequenza delle letture sarà settimanale nei primi 3 mesi dall'installazione dei caposaldi, mensile nei 3 mesi successivi, successivamente letture trimestrali.



## 9.2 FESTLEGUNG ÜBERWACHUNGSSCHWELLEN

Das vorgeschlagene Überwachungssystem wurde in Bezug auf die neue geometrische Konfiguration der Halde als am besten geeignet identifiziert.

Die bereitgestellte Instrumentierung ermöglicht die Überwachung von oberflächliche und tiefe Verschiebungen der Ablagerung und damit das Verhalten der Ablagerung (Stabilität) über die Zeit zu überwachen.

Im jetzigen Stand der Böschung gilt nur noch die Überwachung der Standsicherheit der Böschungen, da alle Arten von Setzungs- und Verformungserscheinungen am Dammfuß als erschöpft gelten, ebenso wie etwaige Eingriffe in das darunter liegende Grundwasser.

Die folgende Tabelle zeigt die SLE-Verschiebungswerte, die mit den oben dargestellten Berechnungsmodellen ermittelt wurden, für die Punkte übernommen wurden, die den installierten optischen Visieren am nächsten liegen.

Auf diese Weise ist es möglich, eine begrenzte und signifikante Anzahl. Es wurde beschlossen, durchschnittlich 80 % des absoluten Verschiebungswerts als Referenz für die Aufmerksamkeitsschwellen und 100 % für die Alarmschwellen zu verwenden.

Die Synthese dieser Schwellenwerte gilt sowohl für die optischen Ziele als auch für die direkt auf der Bank installierten gleiche Verschiebung haben müssen wie die entsprechenden optischen Ziele auf der Oberfläche.

## 9.2 DEFINIZIONE SOGLIE DI MONITORAGGIO

Il sistema di monitoraggio proposto è stato individuato come il più idoneo in rapporto alla nuova configurazione geometrica del cumulo.

La strumentazione prevista consente il monitoraggio degli spostamenti superficiali e profondi del deposito e quindi di monitorare il comportamento del deposito (stabilità) nel tempo.

Allo stadio attuale del rilevato si reputa valido il solo monitoraggio della stabilità delle scarpate, in quanto si ritengono esauriti ogni tipo di fenomeni di assestamento e deformazione alla base del rilevato, oltre che l'eventuale interferenza con la falda sottostante.

Nella seguente tabella vengono riportati i valori di spostamento agli SLE, ottenuti nei modelli di calcolo sopra illustrati, adottando i parametri caratteristici del materiale di deposito abbattuti del 10%, per i punti più prossimi alle mire ottiche installate.

In questo modo è possibile definire un numero limite e significativo delle soglie. Si è deciso di utilizzare mediamente l'80% del valore assoluto di spostamento come riferimento per le soglie di attenzione ed il 100% per le soglie di allarme. La sintesi di tali soglie è valida sia per le mire ottiche che per gli inclinometri, installati direttamente sulla ribanca, i quali devono avere lo stesso spostamento, in testa, delle mire ottiche corrispondenti sulla superficie.

Soglia di Attenzione / Aufmerksamkeitsschwelle	Soglia di Allarme / Alarmschwelle
10 cm	15 cm

Abbildung 62. Verschiebungsgrenzwerte in der Nähe der installierten optischen Visiere

Figura 62. valori limite di spostamento in prossimità delle mire ottiche installate

### 9.3 EIGENSCHAFTEN DER INSTRUMENTE

Nachfolgend werden die Eigenschaften der wichtigsten Instrumente angegeben.

#### 9.3.1 Inklinometer

Die Inklinometermessungen ermitteln die Abweichung von der Senkrechten ausgewählter Referenzpunkte entlang der Vertikalen. Aus den Messungen kann man durch numerische Integration die Verschiebungen erkennen und somit die Bewegungszonen im Untergrund. Die Messungen erfolgen normalerweise händisch mit mobilen Geräten mit Führungsrädern (Inklinometersonde), die in eigens dafür bestimmten Nutrohre hinuntergelassen werden. Die Nutrohre werden ein Bohrloch zementiert (Abbildung 63). Eine Erhebung besteht normalerweise aus vier Messungen, wobei die Sonde im Bohrloch um 90° gedreht wird, um die systematischen Fehler zu annullieren. Die Messungen können nach unten oder nach oben erfolgen und werden normalerweise im Abstand von 0.5 oder 1 m durchgeführt.

Jede Erhebung wird mit der ersten Messung (Nullmessung) verglichen. Die Verschiebungen entlang der Senkrechten können sich auf den Rohrkopf des Inklinometerrohrs beziehen (diese Position muss mittels optischer Messungen bestimmt werden) oder auf das Bohrende (als fix betrachtet). Die Verformungskurve wird durch den Rotationswinkel der Sonde zur Senkrechten auf zwei vertikalen, normal zueinanderstehenden Ebenen bestimmt und normalerweise in einem polaren Koordinatensystem (Modul und Azimut) dargestellt. Man kann auch andere Bezugssysteme verwenden, wie z. B. ein kartesisches Koordinatensystem x-y.

Die Genauigkeit der Inklinometermessungen hängt von der Qualität der Messgeräte und von der Ausführung der Messungen ab. Systematische Fehler beruhen auf:

1. Die Empfindlichkeitsvariationen des Messgeräts (Temperaturänderungen, Alterung der Sensoren);
2. Die Variation der Nullwerte des Sensors;
3. Die Variation der Ausrichtung der Sensoren aufgrund der Mechanik des Gerätes;
4. Fehler durch die Nutrohre.

Den ersten drei Fehlerquellen kann man durch häufige Eichung des Gerätes entgegenwirken. Zufällige Fehler sind hingegen die Änderung der Anordnung der Sonden (Variationen der mechanischen Toleranz zwischen Räder und Führung durch Verschmutzungen, Krusten, Fugen, usw.) und die Fehler bei der Bestimmung der Höhe der Sonde. Diese können durch eine Wiederholung der Messungen vermieden werden.

### 9.3 CARATTERISTICHE STRUMENTAZIONE

Di seguito si riportano le caratteristiche dei principali strumenti.

#### 9.3.1 Inclinatori

I rilievi inclinometrici consistono nelle misure di deviazione dalla verticalità di punti significativi disposti lungo una verticale. Dalle misure, mediante integrazione numerica, si risale agli spostamenti evidenziando così le zone in movimento nel sottosuolo. I rilievi sono generalmente effettuati in modo manuale con attrezzature removibili munite di guide (sonde inclinometriche) che vengono calate in appositi tubi scanalati, cementati in un foro di sondaggio (Figura 63). Un rilievo comporta di solito l'esecuzione di quattro cicli di misura, ruotando la sonda di 90° nel foro per annullare gli errori sistematici. Le misure possono essere effettuate sia in discesa che in risalita, con passo di solito pari a 0.5 o 1 m.

Ogni elaborazione di rilievi inclinometrici è confrontata con la deformata della lettura iniziale (di zero). Gli spostamenti lungo la verticale possono essere riferiti alla testa della tubazione inclinometrica (la cui posizione deve essere determinata con misure ottiche) oppure al fondo foro (considerato fisso). La deformata, determinata dagli angoli di rotazione della sonda rispetto alla verticale in due piani verticali normali, viene di solito descritta con riferimento a un sistema di coordinate polari (modulo ed azimut). E' anche possibile utilizzare altri sistemi di riferimento, per esempio un sistema di coordinate cartesiane x-y.

L'accuratezza delle misure inclinometriche dipende dalla qualità della strumentazione e dall'esecuzione delle misure. Sono causa di errori sistematici:

1. la variazione della sensibilità delle apparecchiature di misura (derive di temperatura e invecchiamento dei sensori);
2. la variazione dei valori di zero degli stessi sensori;
3. la variazione di assetto dei sensori inclinometrici, dovuta alla meccanica dello strumento;
4. gli errori dovuti alla spiratura delle tubazioni.

Ai primi tre si pone parziale rimedio con una frequente taratura dello strumento. Sono invece causa di errori accidentali la variazione dell'assetto della sonda (dovuta a variazioni di tolleranza meccanica tra ruote e guide, a causa di impurità, incrostazioni, giunti, ecc.) e gli errori nella determinazione della quota della sonda. Essi si possono ridurre con la ripetizione delle misure.

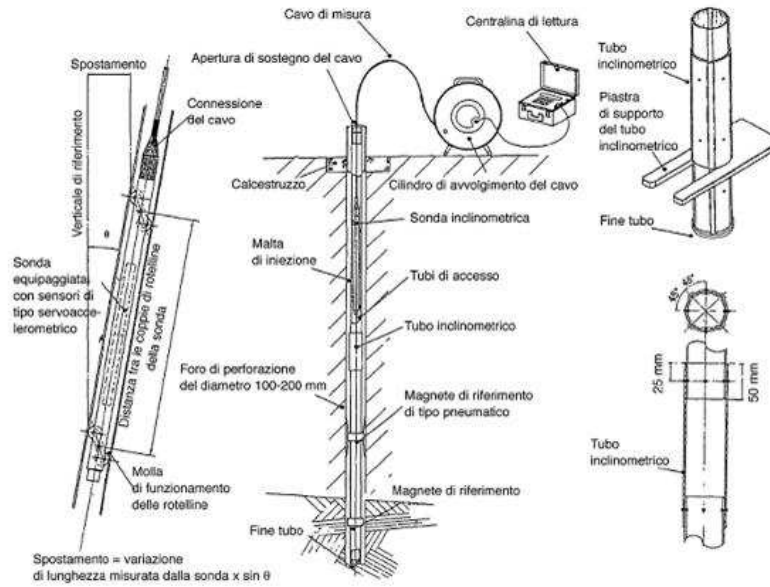


Abbildung 63. Bestandteile eines Inclinometermesssystems mit mobiler Sonde.

Figura 63. Componenti di un sistema per misure inclinometriche con sonda removibile.

## 9.4 REFERENZDOKUMENTE

### Executive-Projekt

- [1] Technischer Bericht Materialdeponie Hinterrigger Geologie des Deponieareals D0150-TB-00667-01
- [2] Technischer Bericht Materialdeponie Hinterrigger Geotechnik des Deponieareals D0150-TB-00944-01
- [3] Lageplan Materialdeponie Hinterrigger-Geologie/Geomorphologie D0150-LP-00232-01
- [4] Lageplan Materialdeponie Hinterrigger-Hydrogeologie D0150-LP-00233-01
- [5] Längsschnitt Materialdeponie Hinterrigger-Geologie/Geomorphologie D0150-LP-00241-01
- [6] Längsschnitt Materialdeponie Hinterrigger-Hydrogeologie D0150-LP-00241-01
- [7] Fotodokumentation Bohrungen Hinterrigger Ri-B-01-05, Ri-B-02-05, Ri-B-03-05, Ri-B-04-05, Ri-B-05-05

### Detailliertes Executive-Projekt

- [8] Bericht Hydraulische Anordnung - Vorläufige Phase 02\_H61\_DB\_300\_KTB\_B0130\_51054
- [9] Regen- und Abwasserentsorgungsplan - Vorläufige Phase 02\_H61\_EW\_450\_KLP\_B0130\_51128
- [10] Abschnitte Abwasserbeseitigung - Vorläufige Phase 02\_H61\_EW\_450\_KLP\_B0130\_51129
- [11] Übersichtsplan Betriebshof Hinterrigger-02\_H61\_BE\_450\_KBE\_B0130\_54586
- [12] Längsschnitt Lagerstätte Hinterrigger-02\_H61\_BE\_450\_KQP\_B0130\_54607
- [13] Überwachung Lagerstätte Hinterrigger - Provisorische Phase - Plan und Schnitte 02\_H61\_DB\_300\_KLP\_B0130\_5124

## 9.4 DOCUMENTI DI RIFERIMENTO

### Progetto Esecutivo

- [1] Relazione tecnica Deposito Hinterrigger Geologia area di deposito D0150-TB-00667-01
- [2] Relazione tecnica Deposito Hinterrigger Geotecnica area di deposito D0150-TB-00944-01
- [3] Planimetria deposito Hinterrigger-Geologia/geomorfologia D0150-LP-00232-01
- [4] Planimetria deposito Hinterrigger- Idrogeologia D0150-LP-00233-01
- [5] Sezione longitudinale deposito Hinterrigger-Geologia/geomorfologia D0150-LP-00a241-01
- [6] Sezione longitudinale deposito Hinterrigger-Idrogeologia D0150-LP-00242-01
- [7] Documentazione fotografica sondaggi Hinterrigger Ri-B-01-05, Ri-B-02-05, Ri-B-03-05, Ri-B-04-05, Ri-B-05-05

### Progetto Esecutivo di Dettaglio

- [8] Relazione di sistemazione idraulica – Fase provvisoria 02\_H61\_DB\_300\_KTB\_B0130\_51054
- [9] Planimetria smaltimento acque meteoriche e reflue – Fase provvisoria 02\_H61\_EW\_450\_KLP\_B0130\_51128
- [10] Sezioni smaltimento acque meteoriche reflue – Fase provvisoria 02\_H61\_EW\_450\_KLP\_B0130\_51129
- [11] Planimetria generale deposito Hinterrigger-02\_H61\_BE\_450\_KBE\_B0130\_54586
- [12] Sezione longitudinale deposito Hinterrigger-02\_H61\_BE\_450\_KQP\_B0130\_54607
- [13] Monitoraggio del deposito Hinterrigger – Fase provvisoria – Planimetria e Sezioni 02\_H61\_DB\_300\_KLP\_B0130\_5124

## 10 LISTE DER ANHÄNGE

- **ANHANG 1:** IN-SITU-TESTS (pag.75)
- **ANHANG 2:** LABORTTESTS (pag.107)
- **ANHANG 3:** PLAXIS-ANALYSE beer SLS / SLD von ABSCHNITT 1 (pag.121)
  - o Statische Bedingungen: Phase\_1 - Phase\_5
  - o Seismische Bedingungen: Phase\_8
- **ANHANG 4:** PLAXIS-ANALYSE bei SLE / SLD – ABSCHNITT 2 (pag.213)
  - o Statische Bedingungen: Phase\_1 - Phase\_5
  - o Seismische Bedingungen: Phase\_8
- **ANHANG 5:** PLAXIS-ANALYSE bei SLS / SLD – ABSCHNITT 3 (pag.306)
  - o Statische Bedingungen: Phase\_1 - Phase\_5
  - o Seismische Bedingungen: Phase\_8
- **ANHANG 6:** ULS-/LLS-PLAXIS-ANALYSE – ABSCHNITT 1 (pag.399)
  - o Statische Bedingungen: Phase\_1 – Phase\_5 und Phase\_7
  - o Seismische Bedingungen: Phase 6 und Phase\_8
- **ANHANG 7:** OBJEKTIVANALYSE bei ULS – ABSCHNITT 1 (pag.513)
- **ANHANG 8:** OBJEKTIVANALYSE bei SLV – ABSCHNITT 1 (pag.532)
- **ANHANG 9:** ULS-/LLS-PLAXIS-ANALYSE – ABSCHNITT 2 (pag.551)
  - o Statische Bedingungen: Phase\_1 – Phase\_5 und Phase\_7
  - o Seismische Bedingungen: Phase 6 und Phase\_8
- **ANHANG 10:** OBJEKTIVANALYSE bei ULS – ABSCHNITT 2 (pag.666)
- **ANHANG 11:** OBJEKTIVANALYSE bei SLV – ABSCHNITT 2 (pag.687)
- **ANHANG 12:** ULS-/LLS-PLAXIS-ANALYSE – ABSCHNITT 3 (pag.708)
  - o Statische Bedingungen: Phase\_1 - Phase\_6
  - o Seismische Bedingungen: Phase 7 - Phase\_8
- **ANHANG 13:** OBJEKTIVANALYSE bei ULS – ABSCHNITT 3 (pag.822)
- **ANHANG 14:** OBJEKTIVANALYSE bei SLV – ABSCHNITT 3 (pag.843)

## 10 LISTA DELLE APPENDICI

- **APPENDICE 1:** PROVE IN SITU (pag.75)
- **APPENDICE 2:** PROVE DI LABORATORIO (pag.107)
- **APPENDICE 3:** ANALISI PLAXIS allo SLE/SLD - SEZ 1 (pag.121)
  - Condizioni statiche: Phase\_1 – Phase\_5
  - Condizioni sismiche: Phase\_8
- **APPENDICE 4:** ANALISI PLAXIS allo SLE/SLD - SEZ 2 (pag.213)
  - Condizioni statiche: Phase\_1 – Phase\_5
  - Condizioni sismiche: Phase\_8
- **APPENDICE 5:** ANALISI PLAXIS allo SLE/SLD - SEZ 3 (pag.306)
  - Condizioni statiche: Phase\_1 – Phase\_5
  - Condizioni sismiche: Phase\_8
- **APPENDICE 6:** ANALISI PLAXIS allo SLU/SLV - SEZ 1 (pag.399)
  - Condizioni statiche: Phase\_1/\_5 e Phase\_7
  - Condizioni sismiche: Phase 6 e Phase\_8
- **APPENDICE 7:** ANALISI SLIDE allo SLU - SEZ 1 (pag.513)
- **APPENDICE 8:** ANALISI SLIDE allo SLV - SEZ 1 (pag.532)
- **APPENDICE 9:** ANALISI PLAXIS allo SLU/SLV - SEZ 2 (pag.551)
  - Condizioni statiche: Phase\_1/\_5 e Phase\_7
  - Condizioni sismiche: Phase 6 e Phase\_8
- **APPENDICE 10:** ANALISI SLIDE allo SLU - SEZ 2 (pag.666)
- **APPENDICE 11:** ANALISI SLIDE allo SLV - SEZ 2 (pag.687)
- **APPENDICE 12:** ANALISI PLAXIS allo SLU/SLV - SEZ 3 (pag.708)
  - Condizioni statiche: Phase\_1 – Phase\_6
  - Condizioni sismiche: Phase 7 - Phase\_8
- **APPENDICE 13:** ANALISI SLIDE allo SLU - SEZ 3 (pag.822)
- **APPENDICE 14:** ANALISI SLIDE allo SLV - SEZ 3 (pag.843)

ANHANG 1 - IN-SITU-TESTS

APPENDICE 1 – PROVE IN SITU

UMFRAGE NEU GESTALTEN

SONDAGGI DI RIPROGETTAZIONE

Certificato n° 2020/027-06 del 24/01/2022	
Committente: BRENNERO TUNNEL CONSTRUCTION S.c.a.r.l.	Sondaggio: BH1
Riferimento: Varna (BZ) - Deposito Hinterrigger	Data: 03-16/12/2021
Coordinate: 46.760929 - 11.646371	Quota:
Perforazione: Perforazione a carotaggio continuo	

SCALA 1:205	<b><u>STRATIGRAFIA</u></b>	Pagina 1/2
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Ø mm	R. m	metri base	LITOLOGIA	Prel. % 0-100	Cass. prof. m	DESCRIZIONE
		1.			1	Smarino: Materiale di risulta costituito da detriti di varie litologie provenienti da lavori di scavo di galleria.
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		3.				
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		41.				

Committente: BRENNERO TUNNEL CONSTRUCTION S.c.a.r.l.	Sondaggio: BH1
Riferimento: Varna (BZ) - Deposito Hinterrigger	Data: 03-16/12/2021
Coordinate: 46.760929 - 11.646371	Quota:
Perforazione: Perforazione a carotaggio continuo	

SCALA 1:205

## STRATIGRAFIA

Pagina 2/2

o mm	R. v	metri bat.	LITOLOGIA	Prel. % 0 --- 100	Cass.	prof. m	DESCRIZIONE	
		42				14	Smarino: Materiale di risulta costituito da detriti di varie litologie provenienti da lavori di scavo di galleria.	
		43					15	
		44					16	
		45					17	
		46					18	
		47					19	
		48					20	
		48					21	
		50					22	
		51					23	
		52					24	
		53					25	
		54					26	
		56					27	
		78				78,0		
		78				80,0	Limo argilloso molto addensato, marron chiaro nocciola.	
152		80						
131								

Una volta terminato il carotaggio, il foro di sondaggio è stato chiuso con una miscela di cemento e bentonite.

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Sondaggio: BH1

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Data: 03-16/12/2021

Fotografie - Pagina 2/14

Pagina 2



Cassetta n° 1 - profondità da m 0,00 a m 3,00



Cassetta n° 2 - profondità da m 3,00 a m 6,00



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Sondaggio: BH1

Riferimento: Vama (BZ) - Deposito Hinterrigger

Data: 03-16/12/2021

Fotografie - Pagina 3/14

Pagina 3



Cassetta n° 3 - profondità da m 6,00 a m 9,00



Cassetta n° 4 - profondità da m 9,00 a m 12,00

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Committente: BRENNERO TUNNEL CONSTRUCTION S.c.a.r.l.

Sondaggio: BH1

Riferimento: Varna (BZ) - Deposito Hinterrigger

Data: 03-16/12/2021

Fotografie - Pagina 4/14

Pagina 4



Cassetta n° 5 - profondità da m 12,00 a m 15,00



Cassetta n° 6 - profondità da m 15,00 a m 18,00

Certificato n° 2020/027-06 del 24/01/2022

Committente: BRENNERO TUNNEL CONSTRUCTION S.c.a.r.l.

Sondaggio: BH1

Riferimento: Varna (BZ) - Deposito Hinterrigger

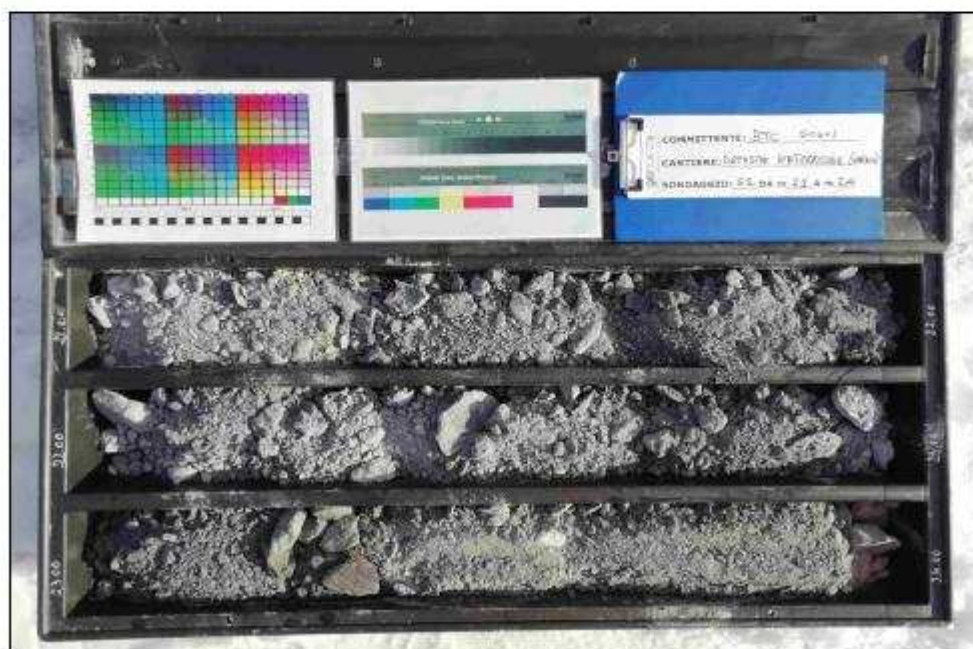
Data: 03-16/12/2021

Fotografie - Pagina 5/14

Pagina 5



Cassetta n° 7 - profondità da m 18,00 a m 21,00



Cassetta n° 8 - profondità da m 21,00 a m 24,00

Certificato n° 2020/027-06 del 24/01/2022

Committente: BRENNERO TUNNEL COSTRUCTION S.c.a.r.l.

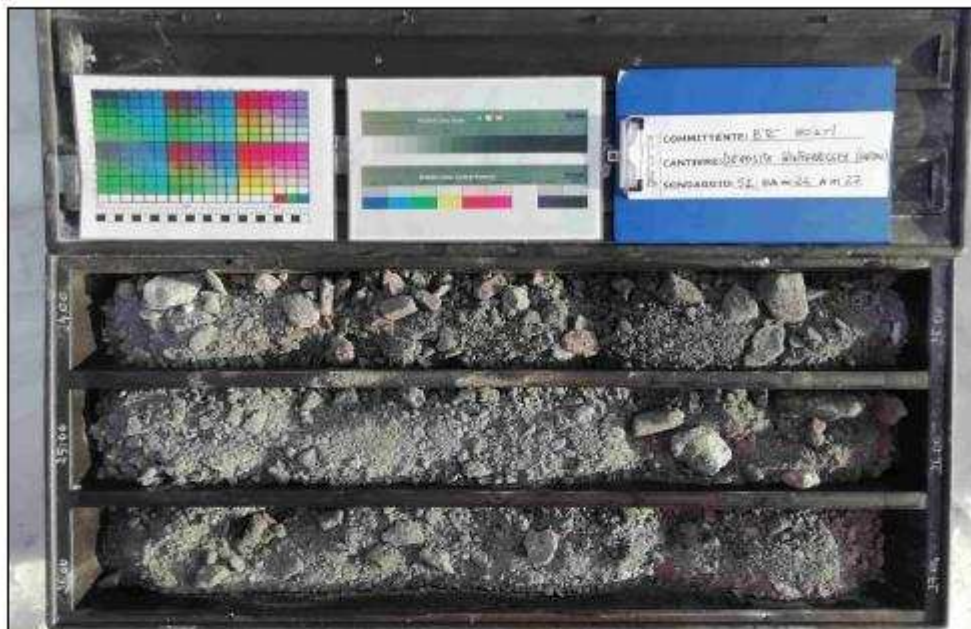
Sondaggio: BH1

Riferimento: Varna (BZ) - Deposito Hinterrigger

Data: 03-16/12/2021

Fotografie - Pagina 6/14

Pagina 6



Cassetta n° 9 - profondità da m 24,00 a m 27,00



Cassetta n° 10 - profondità da m 27,00 a m 30,00

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Committente: BRENNERO TUNNEL COSTRUCTION S.c.a.r.l.

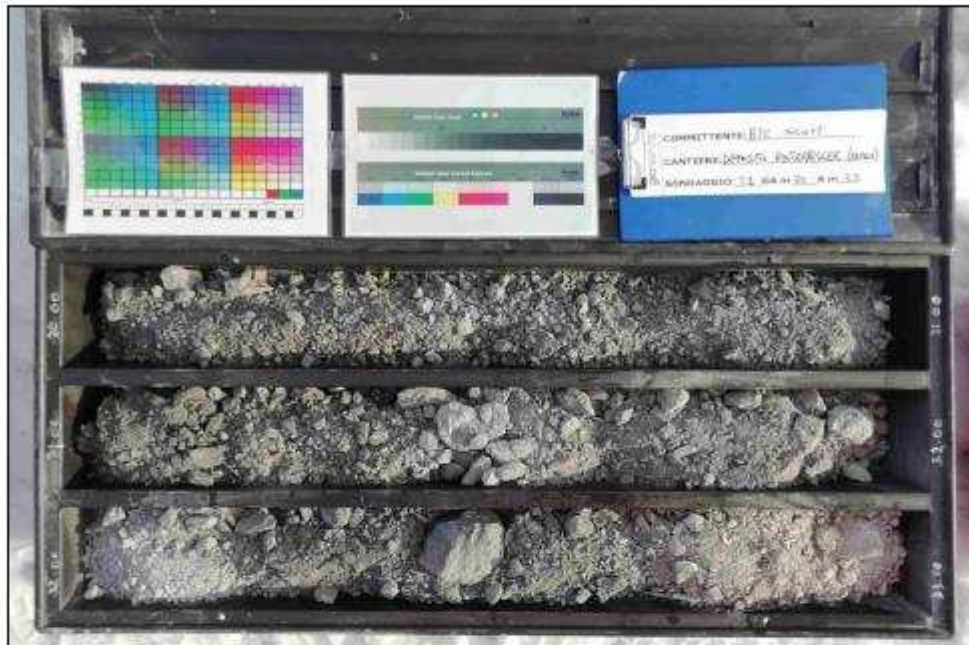
Sondaggio: BH1

Riferimento: Varna (BZ) - Deposito Hinterrigger

Data: 03-16/12/2021

Fotografie - Pagina 7/14

Pagina 7



Cassetta n° 11 - profondità da m 30,00 a m 33,00



Cassetta n° 12 - profondità da m 33,00 a m 36,00

Certificato n° 2020/027-06 del 24/01/2022

Committente: BRENNERO TUNNEL COSTRUCTION S.c.a.r.l.

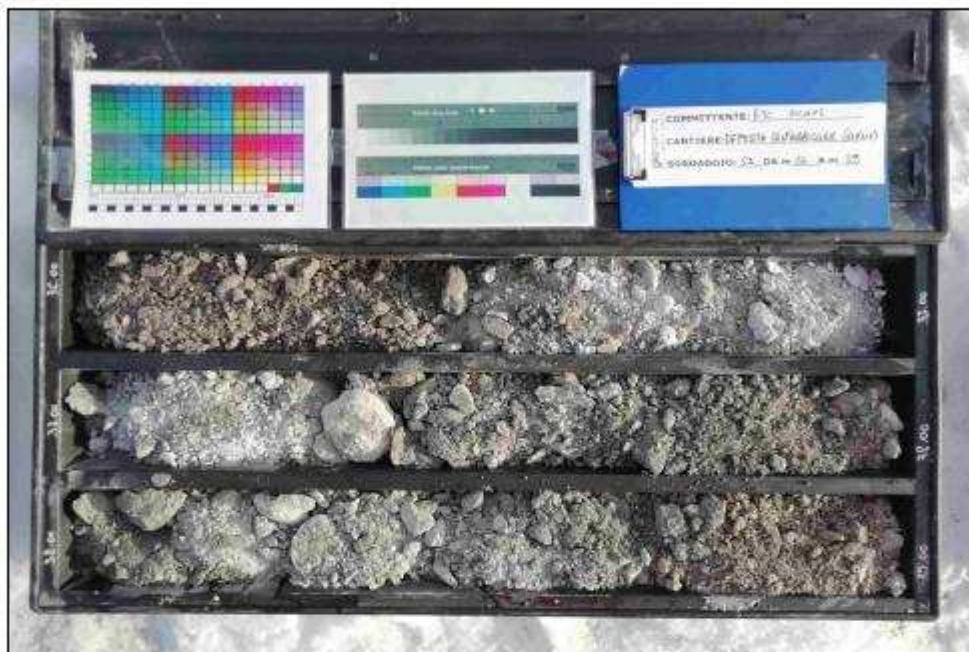
Sondaggio: BH1

Riferimento: Varna (BZ) - Deposito Hinterrigger

Data: 03-16/12/2021

Fotografie - Pagina 8/14

Pagina 8



Cassetta n° 13 - profondità da m 36,00 a m 39,00



Cassetta n° 14 - profondità da m 39,00 a m 42,00

Certificato n° 2020/027-06 del 24/01/2022

Committente: BRENNERO TUNNEL COSTRUCTION S.c.a.r.l.

Sondaggio: BH1

Riferimento: Varna (BZ) - Deposito Hinterrigger

Data: 03-16/12/2021

Fotografie - Pagina 9/14

Pagina 9



Cassetta n° 15 - profondità da m 42,00 a m 45,00



Cassetta n° 16 - profondità da m 45,00 a m 48,00

Certificato n° 2020/027-06 del 24/01/2022

Committente: BRENNERO TUNNEL CONSTRUCTION S.c.a.r.l.

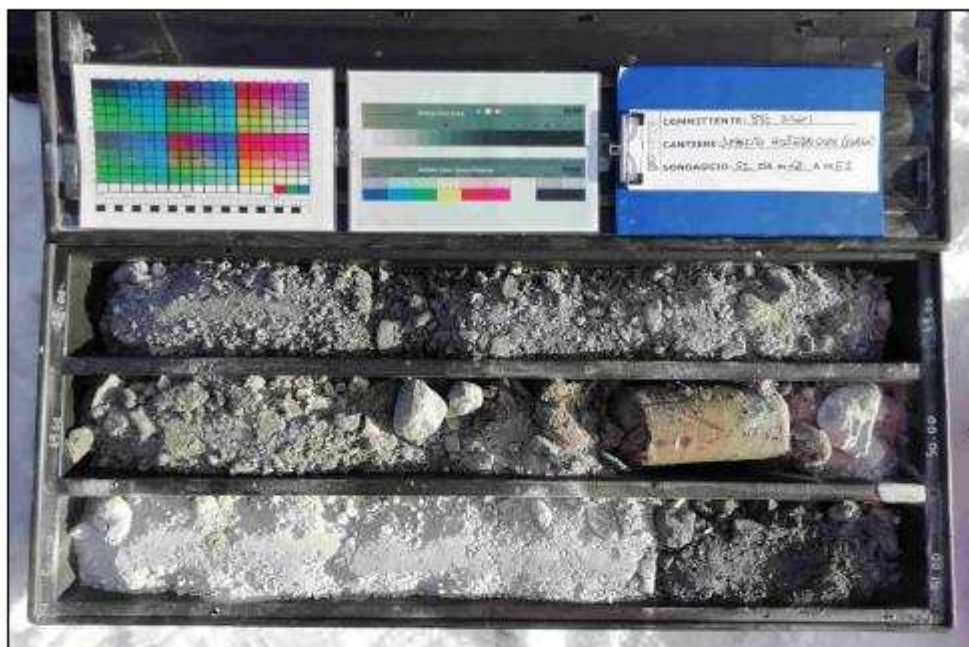
Sondaggio: BH1

Riferimento: Varna (BZ) - Deposito Hinterrigger

Data: 03-16/12/2021

Fotografie - Pagina 10/14

Pagina 10



Cassetta n° 17 - profondità da m 51,00 a m 54,00



Cassetta n° 18 - profondità da m 51,00 a m 54,00



Certificato n° 2020/027-06 del 24/01/2022

Committente: BRENNERO TUNNEL CONSTRUCTION S.c.a.r.l.

Sondaggio: BH1

Riferimento: Varna (BZ) - Deposito Hinterrigger

Data: 03-16/12/2021

Fotografie - Pagina 11/14

Pagina 11



Cassetta n° 19 - profondità da m 54,00 a m 57,00



Cassetta n° 20 - profondità da m 57,00 a m 60,00

Certificato n° 2020/027-06 del 24/01/2022

Committente: BRENNERO TUNNEL CONSTRUCTION S.c.a.r.l.

Sondaggio: BH1

Riferimento: Varna (BZ) - Deposito Hinterrigger

Data: 03-16/12/2021

Fotografie - Pagina 12/14

Pagina 12



Cassetta n° 21 - profondità da m 60,00 a m 63,00



Cassetta n° 22 - profondità da m 66,00 a m 69,00

Certificato n° 2020/027-06 del 24/01/2022

Committente: BRENNERO TUNNEL COSTRUCTION S.c.a.r.l.

Sondaggio: BH1

Riferimento: Varna (BZ) - Deposito Hinterrigger

Data: 03-16/12/2021

Fotografie - Pagina 13/14

Pagina 13



Cassetta n° 23 - profondità da m 69,00 a m 72,00



Cassetta n° 24 - profondità da m 75,00 a m 78,00

Certificato n° 2020/027-06 del 24/01/2022

Committente: BRENNERO TUNNEL COSTRUCTION S.c.a.r.l.

Sondaggio: BH1

Riferimento: Varna (BZ) - Deposito Hinterrigger

Data: 03-16/12/2021

Fotografie - Pagina 14/14

Pagina 14



Cassetta n° 25 - profondità da m 78,00 a m 80,00

Certificato n° 2020/027-06 del 24/01/2022

Committente: BRENNERO TUNNEL COSTRUCTION S.c.a.r.l.

Sondaggio: BH2

Riferimento: Varna (BZ) - Deposito Hinterrigger

Data: 16/12/2021-12/01/2022

Coordinate: 46.763409 - 11.648881

Quota:

Perforazione: Perforazione a carotaggio continuo

SCALA 1:200

## STRATIGRAFIA

Pagina 1/2

Prof. (m)	Prof. (m)	LITOLOGIA	Pre. % 0 --- 100	Class.	DESCRIZIONE
1	1			1	Smarino: Materiale di risulta costituito da detriti di varie litologie provenienti da lavori di scavo di galleria.
2	2				
3	3				
4	4				
5	5				
6	6				
7	7				
8	8				
9	9				
10	10				
11	11				
12	12				
13	13				
14	14				
15	15				
16	16				
17	17				
18	18				
19	19				
20	20				
21	21				
22	22				
23	23				
24	24				
25	25				
26	26				
27	27				
28	28				
29	29				
30	30				
31	31				
32	32				
33	33				
34	34				
35	35				
36	36				
37	37				
38	38				
39	39				
40	40				

Certificato n° 2020/027-06 del 24/01/2022

Committente: BRENNERO TUNNEL CONSTRUCTION S.c.a.r.l.

Sondaggio: BH2

Riferimento: Varna (BZ) - Deposito Hinterrigger

Data: 16/12/2021-12/01/2022

Coordinate: 46.763409 - 11.648881

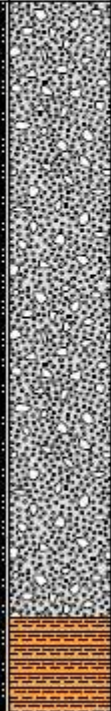
Quota:

Perforazione: Perforazione a carotaggio continuo

SCALA 1:200

## STRATIGRAFIA

Pagina 2/2

o mm	R m	metri m	LITOLOGIA	Prel. % 0 --- 100	Cass. m	DESCRIZIONE	
41					14	Smarino: Materiale di risulta costituito da detriti di varie litologie provenienti da lavori di scavo di galleria.	
42						15	
43						16	
44						17	
45						18	
46						19	
47						20	
48						20	
49						20	
50						20	
51						20	
52						20	
53						20	
54						20	
55						20	
56						20	
57						20	
58						20	
59						20	
60					20	Limo argilloso molto addensato, marron chiaro nocciola.	
61					21		
152					21		
131					21		

Una volta terminato il carotaggio, il foro di sondaggio è stato chiuso con una miscela di cemento e bentonite.

Certificato n° 2020/027-06 del 24/01/2022

Committente: BRENNERO TUNNEL COSTRUCTION S.c.a.r.l.

Sondaggio: BH2

Riferimento: Varna (BZ) - Deposito Hinterrigger

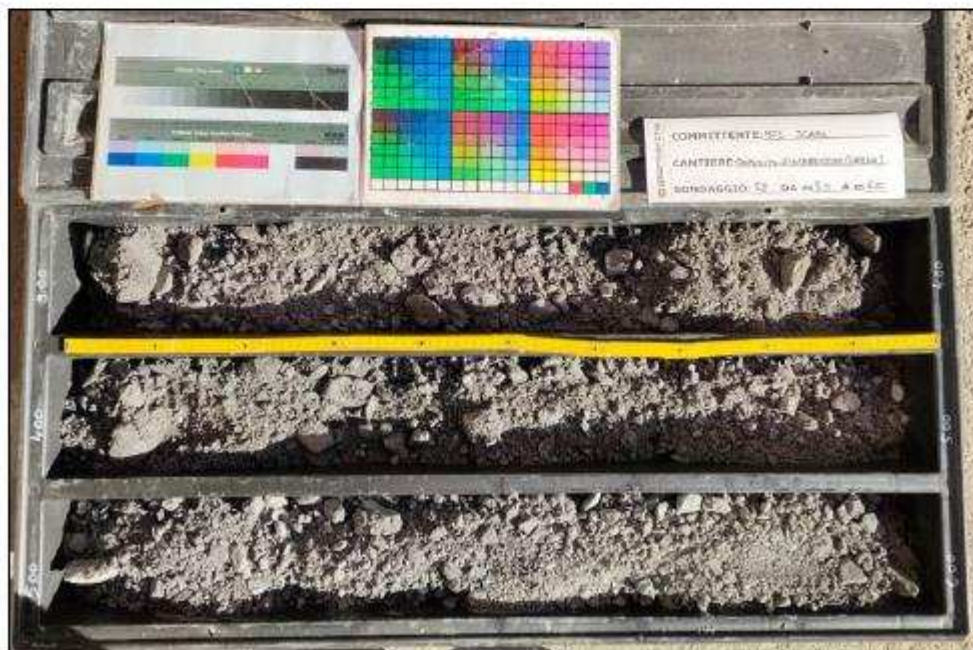
Data: 16/12/2021-12/01/2022

Fotografie - Pagina 3/13

Pagina 3



Cassetta n° 1 - profondità da m 0,00 a m 3,00



Cassetta n° 2 - profondità da m 3,00 a m 6,00

Certificato n° 2020/027-06 del 24/01/2022

Committente: BRENNERO TUNNEL COSTRUCTION S.c.a.r.l.

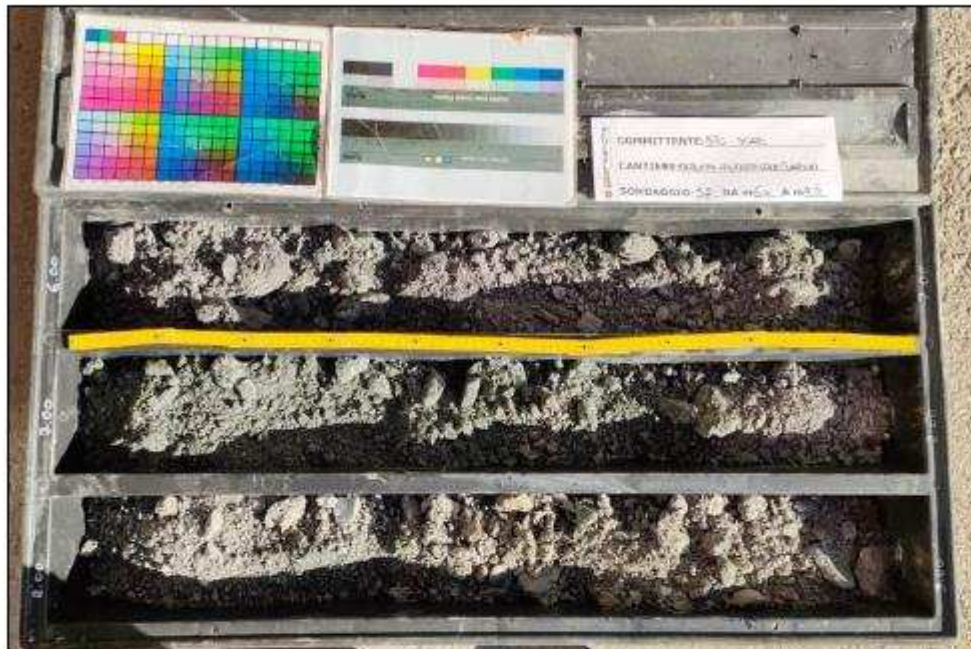
Sondaggio: BH2

Riferimento: Varna (BZ) - Deposito Hinterrigger

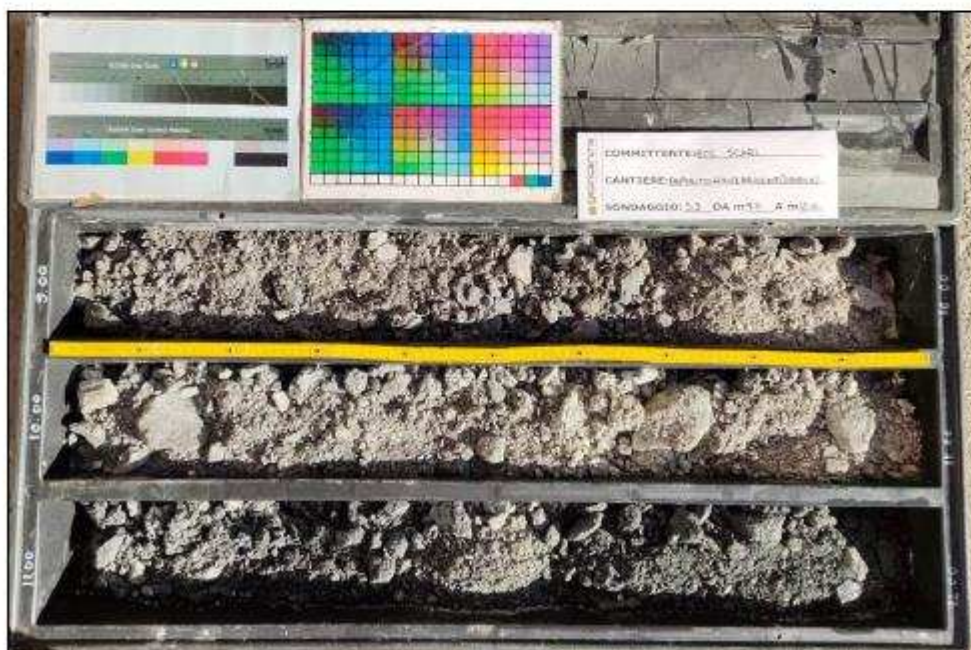
Data: 16/12/2021-12/01/2022

Fotografie - Pagina 4/13

Pagina 4



Cassetta n° 3 - profondità da m 6,00 a m 9,00



Cassetta n° 4 - profondità da m 9,00 a m 12,00



Certificato n° 2020/027-06 del 24/01/2022

Committente: BRENNERO TUNNEL COSTRUCTION S.c.a.r.l.

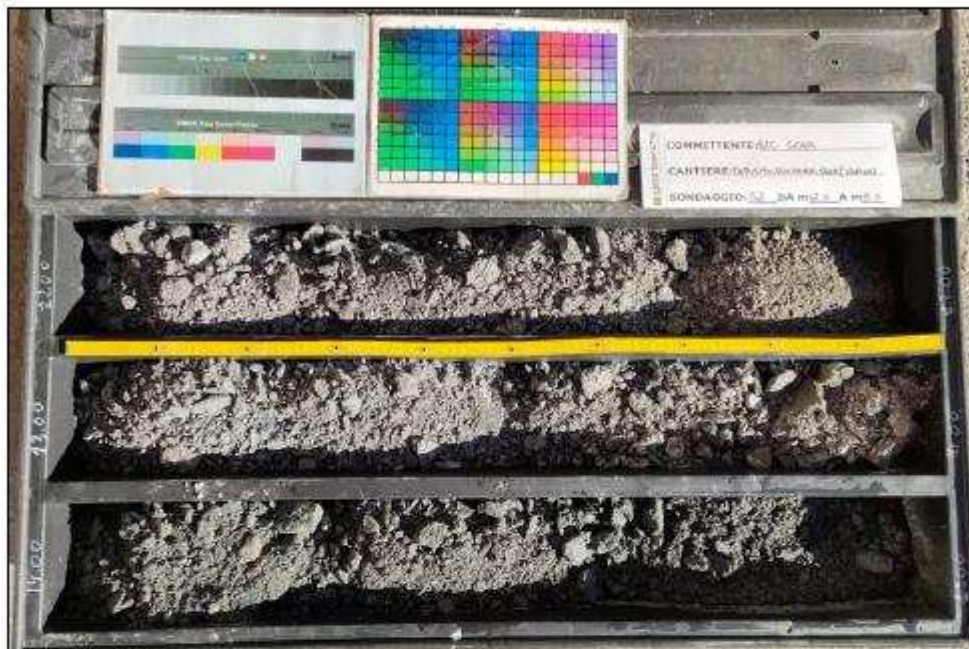
Sondaggio: BH2

Riferimento: Varna (BZ) - Deposito Hinterrigger

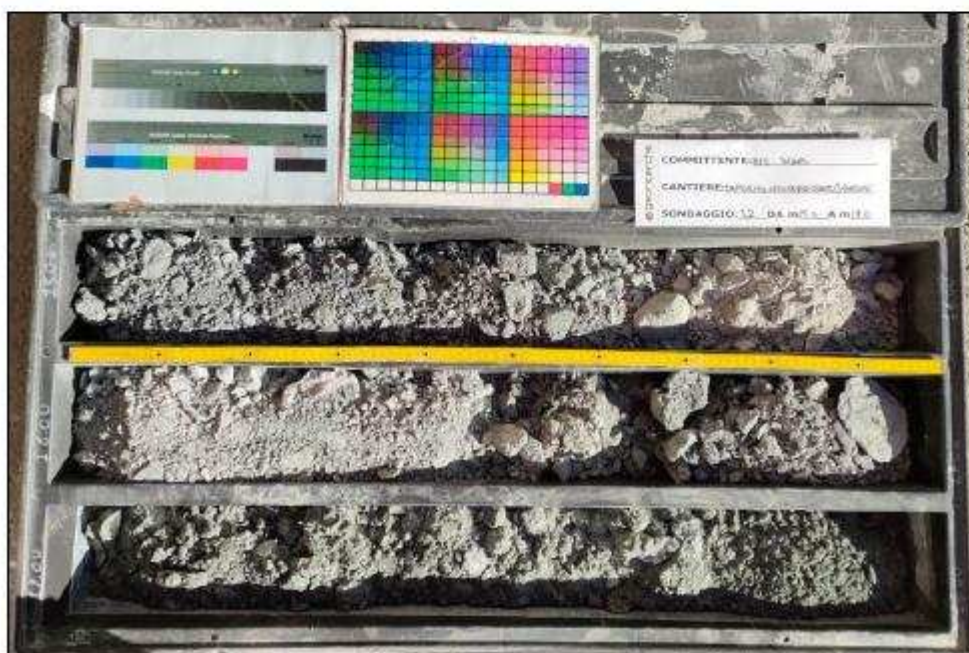
Data: 16/12/2021-12/01/2022

Fotografie - Pagina 5/13

Pagina 5



Cassetta n° 5 - profondità da m 12,00 a m 15,00



Cassetta n° 6 - profondità da m 15,00 a m 18,00

Certificato n° 2020/027-06 del 24/01/2022

Committente: BRENNERO TUNNEL COSTRUCTION S.c.a.r.l.

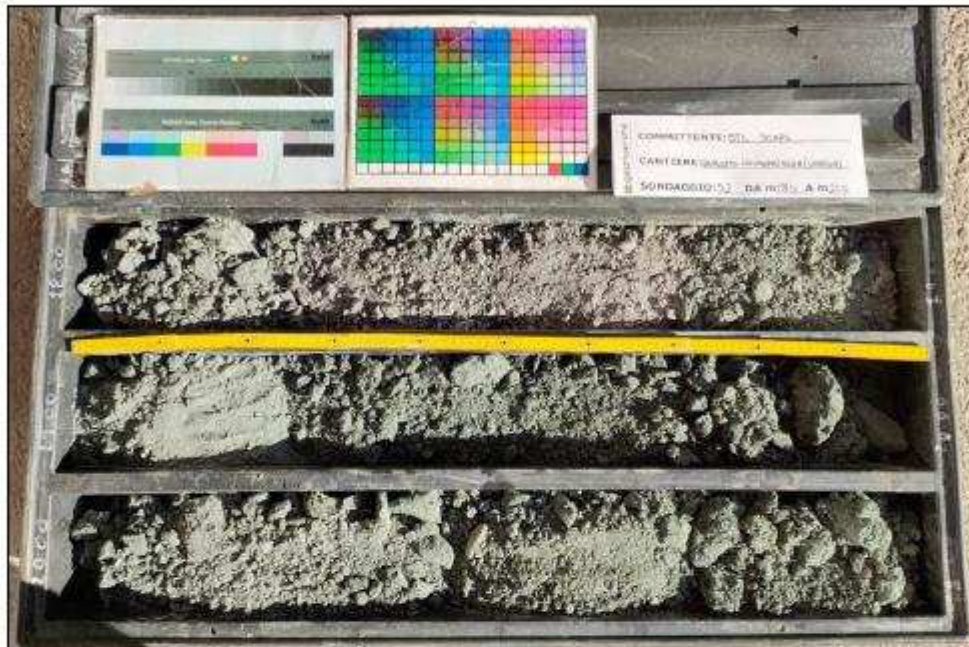
Sondaggio: BH2

Riferimento: Varna (BZ) - Deposito Hinterrigger

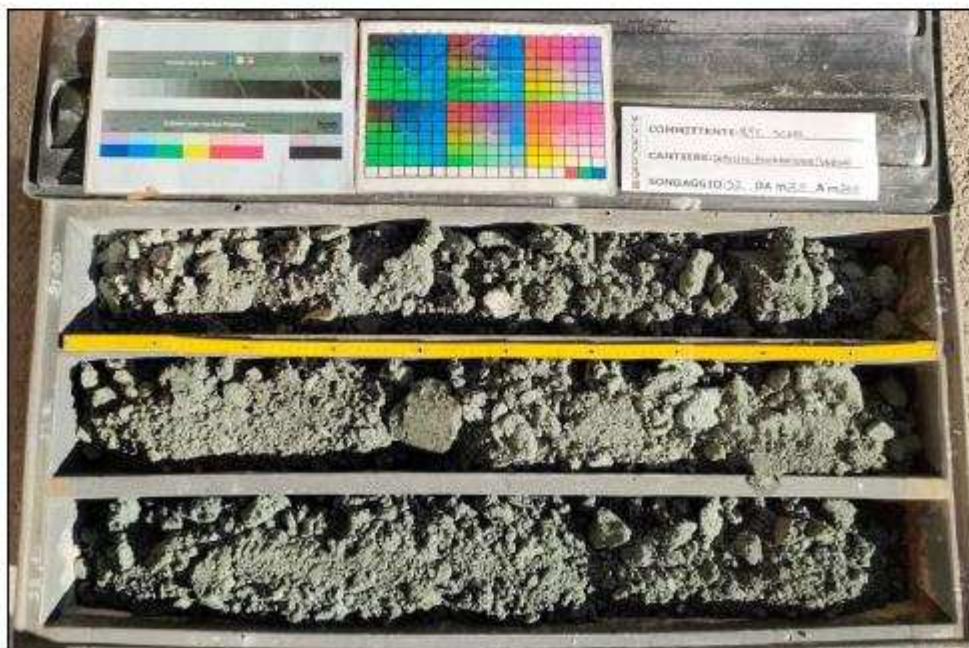
Data: 16/12/2021-12/01/2022

Fotografie - Pagina 6/13

Pagina 6



Cassetta n° 7 - profondità da m 18,00 a m 21,00



Cassetta n° 8 - profondità da m 21,00 a m 24,00

Certificato n° 2020/027-06 del 24/01/2022

Committente: BRENNERO TUNNEL COSTRUCTION S.c.a.r.l.

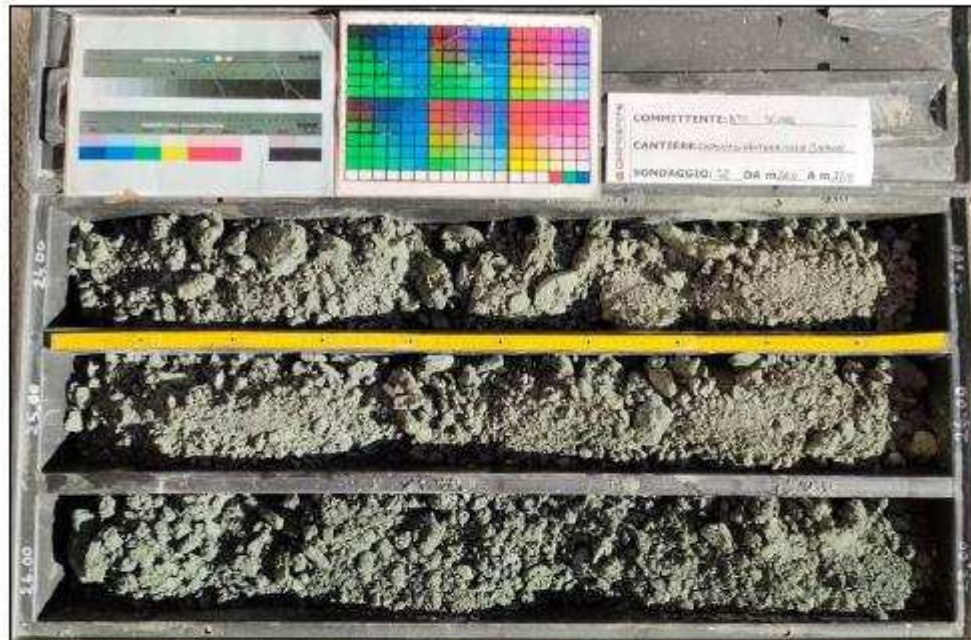
Sondaggio: BH2

Riferimento: Varna (BZ) - Deposito Hinterrigger

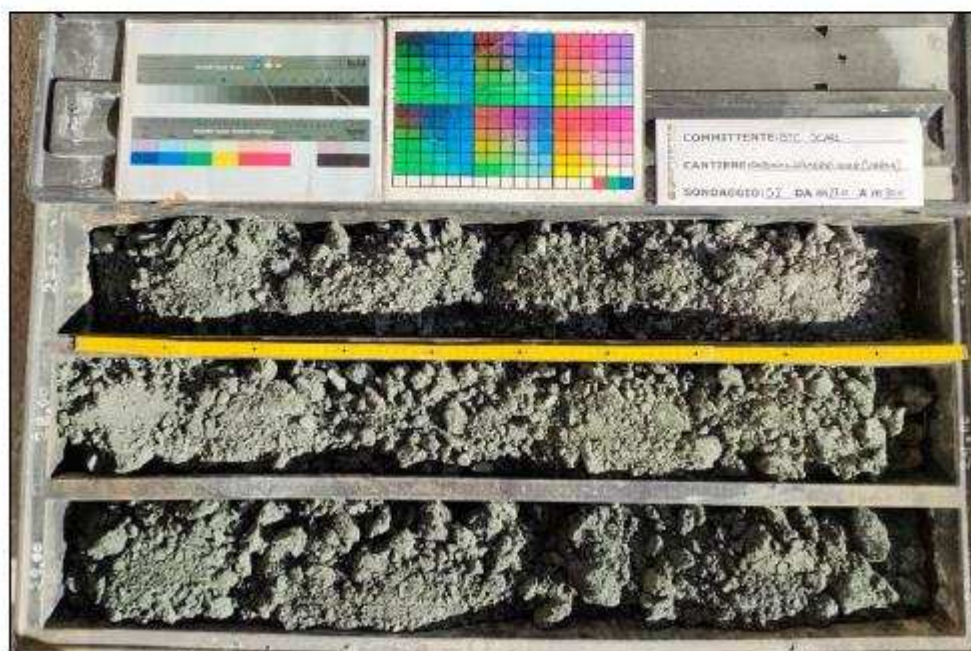
Data: 16/12/2021-12/01/2022

Fotografie - Pagina 7/13

Pagina 7



Cassetta n° 9 - profondità da m 24,00 a m 27,00



Cassetta n° 10 - profondità da m 27,00 a m 30,00

Certificato n° 2020/027-06 del 24/01/2022

Committente: BRENNERO TUNNEL COSTRUCTION S.c.a.r.l.

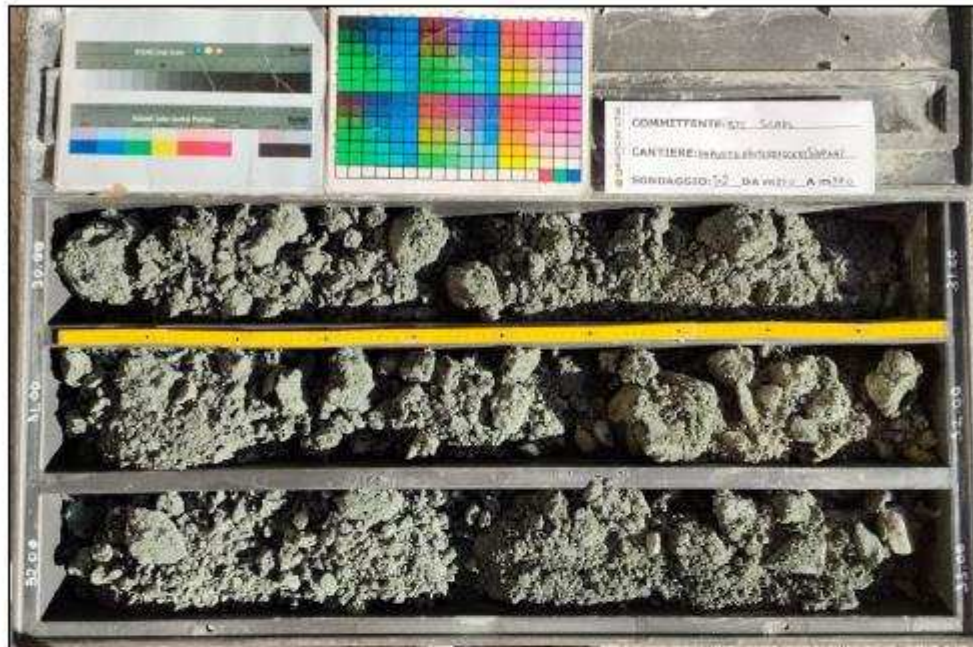
Sondaggio: BH2

Riferimento: Varna (BZ) - Deposito Hinterrigger

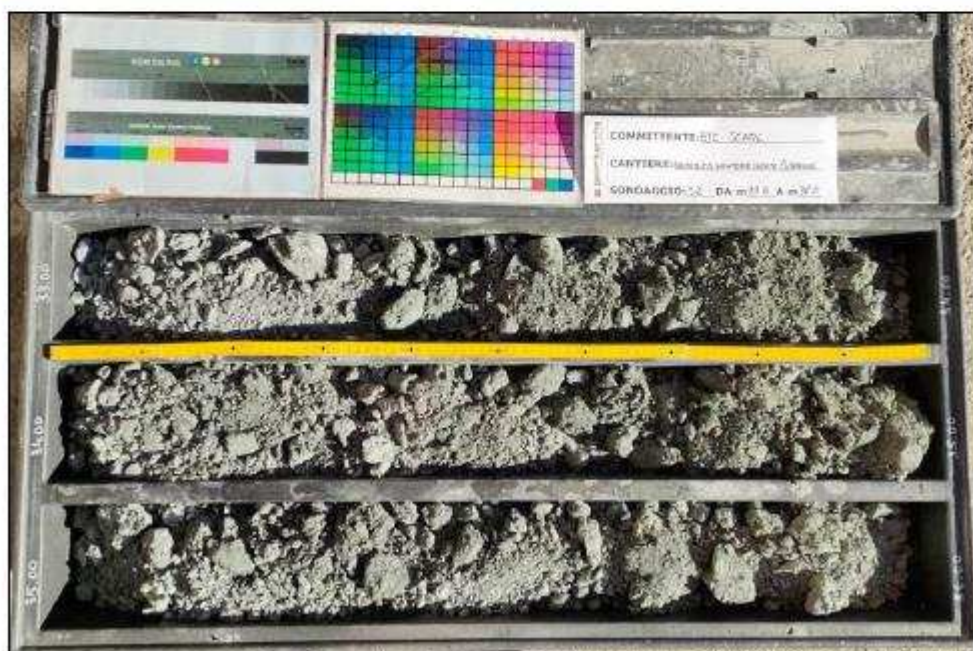
Data: 16/12/2021-12/01/2022

Fotografie - Pagina 8/13

Pagina 8



Cassetta n° 11 - profondità da m 30,00 a m 33,00



Cassetta n° 12 - profondità da m 33,00 a m 36,00

Certificato n° 2020/027-06 del 24/01/2022

Committente: BRENNERO TUNNEL COSTRUCTION S.c.a.r.l.

Sondaggio: BH2

Riferimento: Varna (BZ) - Deposito Hinterrigger

Data: 16/12/2021-12/01/2022

Fotografie - Pagina 9/13

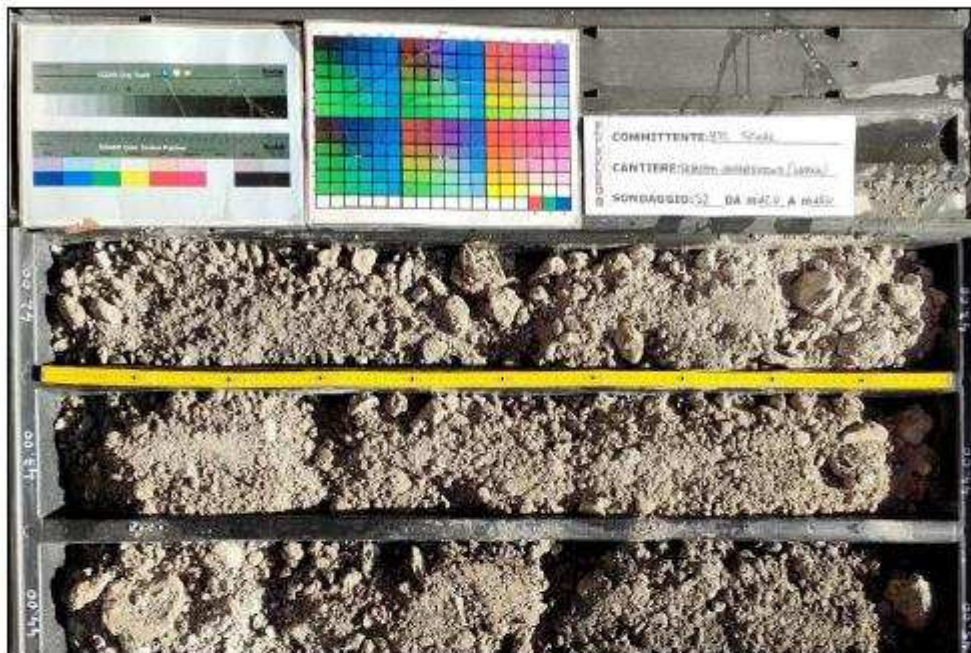
Pagina 9



Cassetta n° 13 - profondità da m 36,00 a m 39,00



Cassetta n° 14 - profondità da m 39,00 a m 42,00



Cassetta n° 15 - profondità da m 42,00 a m 45,00



Cassetta n° 16 - profondità da m 45,00 a m 48,00

Certificato n° 2020/027-06 del 24/01/2022

Committente: BRENNERO TUNNEL COSTRUCTION S.c.a.r.l.

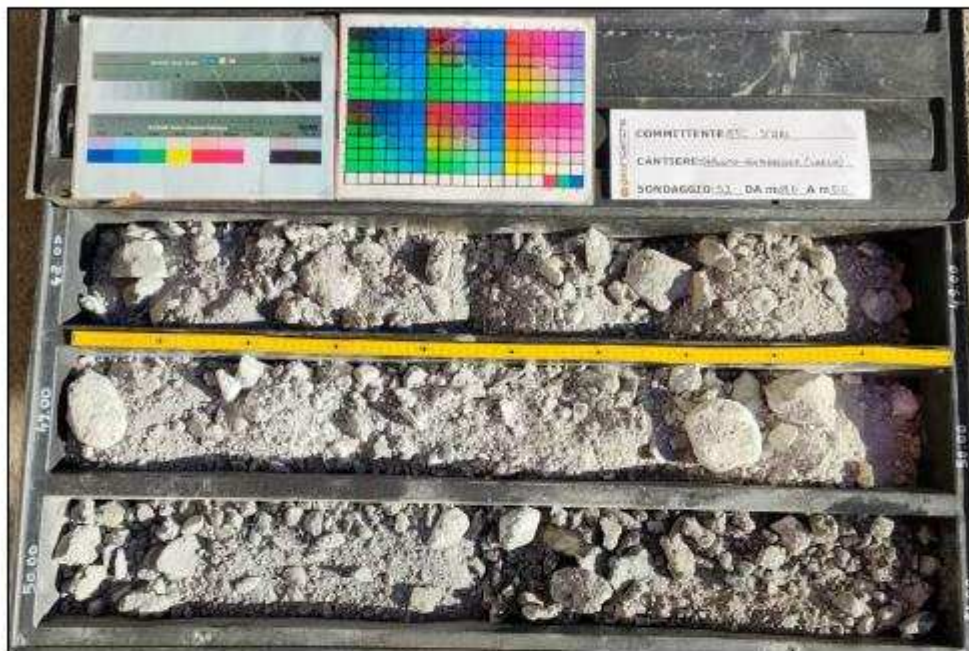
Sondaggio: BH2

Riferimento: Varna (BZ) - Deposito Hinterrigger

Data: 16/12/2021-12/01/2022

Fotografie - Pagina 11/13

Pagina 11



Cassetta n° 17 - profondità da m 48,00 a m 51,00



Cassetta n° 18 - profondità da m 51,00 a m 54,00

Certificato n° 2020/027-06 del 24/01/2022

Committente: BRENNERO TUNNEL COSTRUCTION S.c.a.r.l.

Sondaggio: BH2

Riferimento: Varna (BZ) - Deposito Hinterrigger

Data: 16/12/2021-12/01/2022

Fotografie - Pagina 12/13

Pagina 12



Cassetta n° 19 - profondità da m 54,00 a m 57,00



Cassetta n° 20 - profondità da m 57,00 a m 60,00



Certificato n° 2020/027-06 del 24/01/2022

Committente: BRENNERO TUNNEL COSTRUCTION S.c.a.r.l.

Sondaggio: BH2

Riferimento: Varna (BZ) - Deposito Hinterrigger

Data: 16/12/2021-12/01/2022

Fotografie - Pagina 13/13

Pagina 13

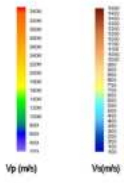


Cassetta n° 21 - profondità da m 60,00 a m 62,00

SEISMISCHE UNTERSUCHUNG DER REFRAKTIONSTOMOGRAPHIE

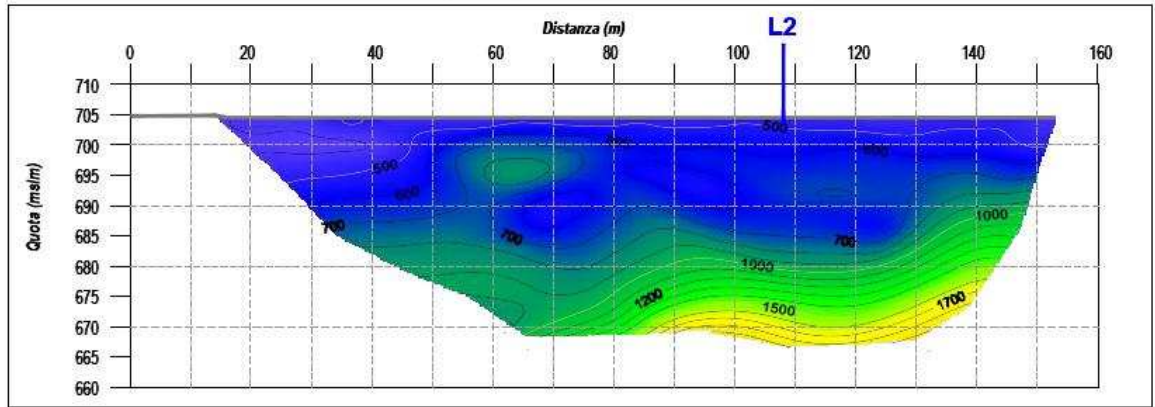
INDAGINE SISMICA DI TOMOGRAFIA A RIFRAZIONE

LEGENDA



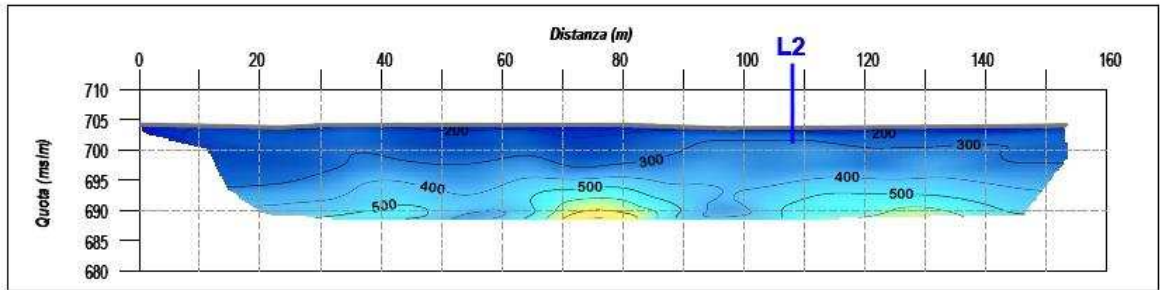
PROFILO L1

SISMICA A RIFRAZIONE Vp



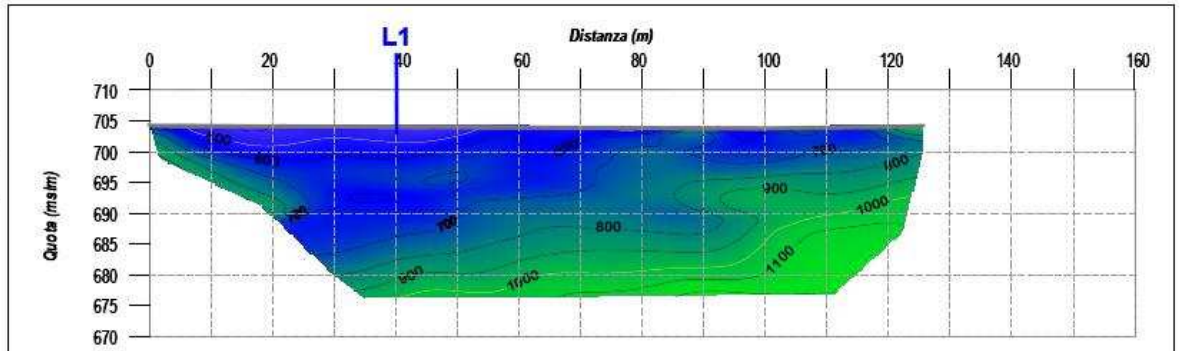
SISMICA A RIFRAZIONE Vs

PROFILO L1



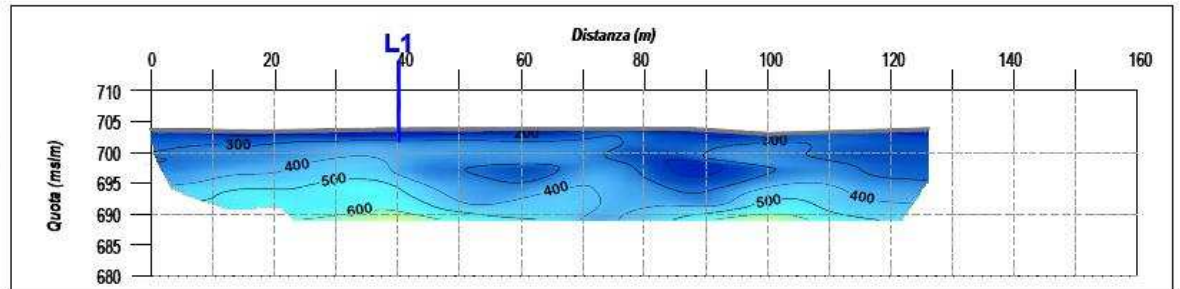
SISMICA A RIFRAZIONE Vp

PROFILO L2



SISMICA A RIFRAZIONE Vs

PROFILO L2



## INFILTROMETRISCHE TESTS

## PROVE INFILTROMETRICHE

### 5.1 PROVA INFILTROMETRICA P1

Di seguito sono riportate tutte le registrazioni eseguite per l'esecuzione della prova P1.

Prova 1: Dati terreno			
N. lettura	Tempo (s)	Livello acqua (cm)	Abbassamento (cm)
1	0	25	-
2	30	18.4	6.6
3	60	13.2	5.2
4	90	9.1	1.1
5	120	7	2.1
6	150	5.5	1.5
7	180	5	0.5
8	210	3.5	1.5
9	240	3	0.5
10	300	2	1

Tabella 1 – Dati di campagna per la prova 1.

Prova 1: Rielaborazione dei dati								
N. lettura	Tempo (s)	Livello acqua (cm)	Abbassamento acqua (cm)	Intervallo tempo (s)	Velocità infiltrazione	Livello idrico su P.C.	Gradiente idraulico (-)	Permeabilità (cm/s)
1	0	25	-	-	-	17	-	-
2	30	18.4	6.6	30	0.22	10.4	2.30	0.095
3	60	13.2	5.2	30	0.17	5.2	1.65	0.105
4	90	9.1	1.1	30	0.13	1.1	1.14	0,120
5	120	7	2.1	30	0.07	-1	0.88	0,080
6	150	5.5	1.5	30	0.05	-2.5	0.69	0,072
7	180	5	0.5	30	0,01	-3	0.63	0,026
8	210	3.5	1.5	30	0.05	-4.5	0.44	0,114
9	240	7.4	0.5	30	0.01	-5	0.38	0,044
10	300	6.7	1	60	0.01	-6	0.25	0,066

Tabella 2 – Elaborazione dati per la prova 1.

Alla luce dei risultati ottenuti per la prova P1, è possibile stimare un coefficiente di permeabilità media pari a  $7.20 \times 10^{-4}$  [m/s].

## 5.2 PROVA INFILTROMETRICA P2

Di seguito sono riportate tutte le registrazioni eseguite per l'esecuzione della prova P2, realizzata in sommità del cumulo realizzato in corrispondenza dell'area di coltivazione presente lungo il tatto vallivo del cantiere:

Prova 2: Dati terreno			
N. lettura	Tempo (s)	Livello acqua (cm)	Abbassamento (cm)
1	0	25	-
2	30	23	2
3	60	20.4	2.6
4	90	18.5	2
5	120	17.8	0.6
6	150	15.8	2
7	240	14	1.8
8	270	13.2	0.8
9	360	8.7	4.5
10	480	6.4	2.3
11	600	4.3	2.1
12	720	2.7	1.6
13	900	1.5	1.2

Tabella 3 – Dati di campagna per la prova 2.

Prova 2: Rielaborazione dei dati								
N. lettura	Tempo (s)	Livello acqua (cm)	Abbassamento acqua (cm)	Intervallo tempo (s)	Velocità infiltrazione	Livello idrico su P.C.	Gradiente idraulico (-)	Permeabilità (cm/s)
1	0	25	-	-	-	-	-	-
2	30	23	2	30	0,0667	19	5.75	0,0116
3	60	20.4	2.6	30	0,0867	16.4	5.10	0,0170
4	90	18.5	2	30	0,0667	14.4	4.60	0,0145
5	120	17.8	0.6	30	0,02	13.8	4.45	0,0045
6	150	15.8	2	30	0,0667	11.8	3.95	0,0169
7	240	14	1.8	90	0,02	10	3.50	0,0057
8	270	13.2	0.8	30	0,0267	9.2	3.30	0,0081
9	360	8.7	4.5	90	0,05	4.7	2.18	0,0230
10	480	6.4	2.3	120	0,0191	2.4	1.6	0,0120
11	600	4.3	2.1	120	0,0175	0.3	1.08	0,0163
12	720	2.7	1.6	120	0,0133	-1.3	0.68	0,0198
13	900	1.5	1.2	180	0,0066	-2.5	0.38	0,0178

Tabella 4 – Dati di campagna per la prova 2.

Alla luce dei risultati ottenuti per la prova P2, è possibile stimare un coefficiente di permeabilità media pari a  $1.40 \times 10^{-4}$  [m/s].

### 5.3 PROVA INFILTROMETRICA P3

Di seguito sono riportate tutte le registrazioni eseguite per l'esecuzione della prova P3.

Prova3: Dati terreno			
N. lettura	Tempo (s)	Livello acqua (cm)	Abbassamento (cm)
1	0	23	-
2	30	18.7	4.3
3	60	11.2	7.5
4	90	7.4	3.8
5	120	6.2	1.2
6	150	3.8	2.4
7	180	2.1	1.7

Tabella 5 – Dati di campagna per la prova 3.

Prova 3: Rielaborazione dei dati								
N. lettura	Tempo (s)	Livello acqua (cm)	Abbassamento acqua (cm)	Intervallo tempo (s)	Velocità infiltrazione	Livello idrico su P.C.	Gradiente idraulico (-)	Permeabilità (cm/s)
1	0	23	-	-	-	16	3.29	-
2	30	18.7	4.3	30	0.14	11.7	2.67	0.05
3	60	11.2	7.5	30	0,25	4.2	1.60	0.015
4	90	7.4	3.8	30	0,12	0.4	1.06	0.012
5	120	6.2	1.2	30	0,04	-0.8	0.89	0.04
6	150	3.8	2.4	30	0,08	-3.2	0.54	0.14
7	180	2.1	1.7	30	0,05	-4.9	0.30	0.18

Tabella 6 – Dati di campagna per la prova 2.

Alla luce dei risultati ottenuti per la prova P3, è possibile stimare un coefficiente di permeabilità media pari a  $8.00 \times 10^{-4}$  [m/s].

GRENZEN VON ATTERBERG

LIMITI DI ATTERBERG

Risultati di prova

Numero di laboratorio: 210542/008

Denominazione campione:

BH1 52,0-59,0 m

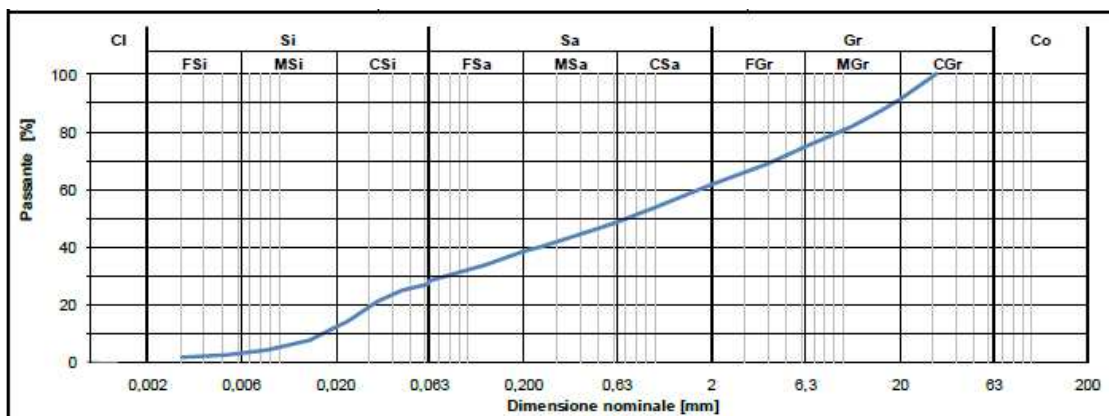
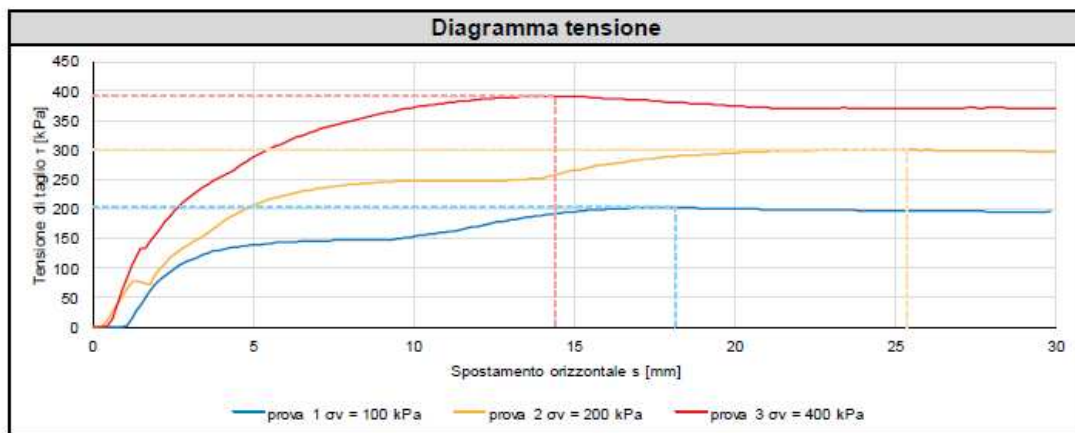
Data di campionatura: Non determinata.

Campionatura eseguita da:

cliente

Nota: -

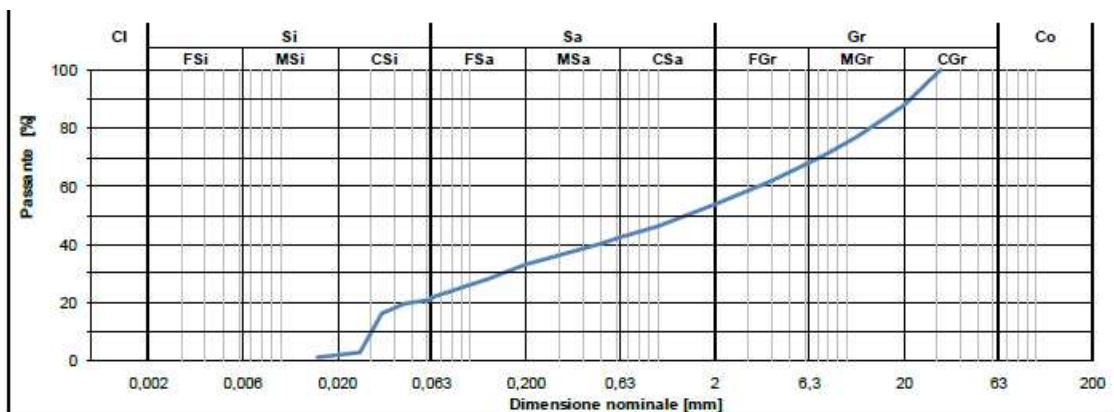
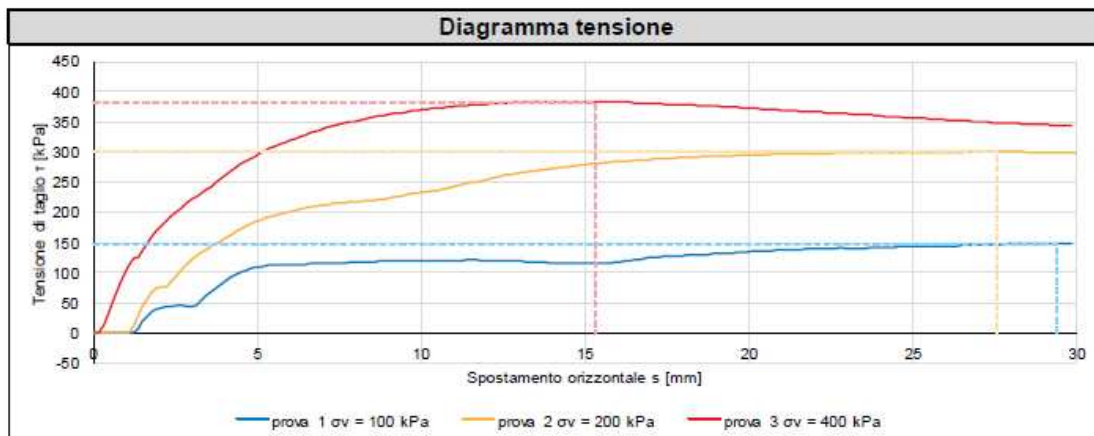
Prova di taglio diretto			
Prova secondo		EN ISO 17892-10	
Prova	n°1	n°2	n°3
<b>Caratteristiche iniziali dei provini</b>			
Area di base del provino	900 cm <sup>2</sup> (30 cm x 30 cm)		
Altezza iniziale del provino [mm]	155	155	155
Contenuto di umidità iniziale [%]	5,4	5,4	5,4
Massa volumica [Mg/m <sup>3</sup> ]	2,17	2,15	2,17
Massa volumica a secco [Mg/m <sup>3</sup> ]	2,06	2,04	2,06
Velocità di spostamento del taglio [mm/min]	0,10	0,10	0,10
<b>Condizioni di taglio</b>			
Tensione verticale $\sigma$ [kPa]	100	200	400
Tensione di taglio $\tau$ [kPa]	204	301	391
Spostamento orizzontale s [mm]	18	25	14
<b>Parametri derivate</b>			
Angolo di attrito $\phi$ [°]	31,0	Coesione c' [kPa]	
			158



Numero di laboratorio: 210542/009  
 Data di campionatura: Non determinata.  
 Nota: -

Denominazione campione: BH1 42,0-48,0 m  
 Campionatura eseguita da: cliente

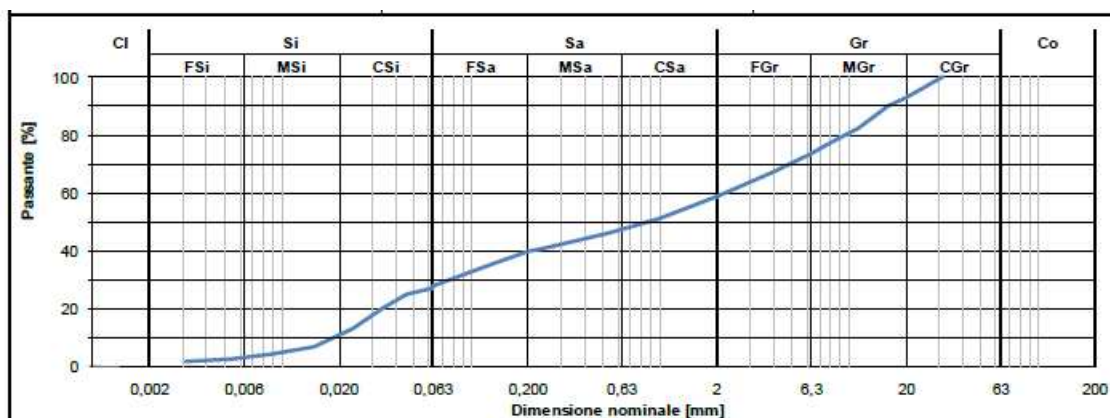
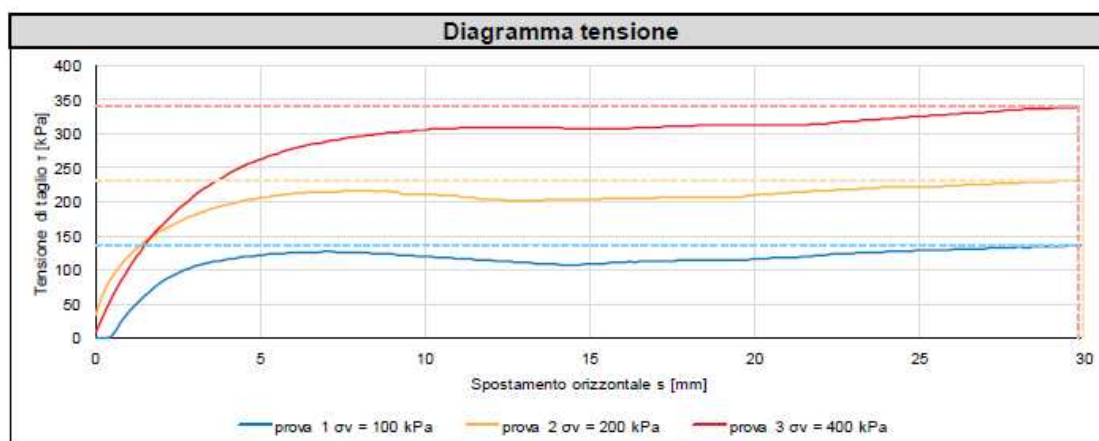
Prova di taglio diretto			
Prova secondo		EN ISO 17892-10	
Prova	n°1	n°2	n°3
<b>Caratteristiche iniziali dei provini</b>			
Area di base del provino	900 cm <sup>2</sup> (30 cm x 30 cm)		
Altezza iniziale del provino [mm]	165	155	160
Contenuto di umidità iniziale [%]	5,3	5,3	5,3
Massa volumica [Mg/m <sup>3</sup> ]	2,15	2,18	2,15
Massa volumica a secco [Mg/m <sup>3</sup> ]	2,05	2,07	2,04
Velocità di spostamento del taglio [mm/min]	0,10	0,10	0,10
<b>Condizioni di taglio</b>			
Tensione verticale $\sigma$ [kPa]	100	200	400
Tensione di taglio $\tau$ [kPa]	149	301	384
Spostamento orizzontale s [mm]	29	28	15
<b>Parametri derivate</b>			
Angolo di attrito $\phi$ [°]	36,0	Coesione c' [kPa]	108



Numero di laboratorio: 210542/0010  
 Data di campionatura: Non determinata.  
 Nota: -

Denominazione campione: BH1 33,0-40,0 m  
 Campionatura eseguita da: cliente

Prova di taglio diretto			
		EN ISO 17892-10	
Prova	n°1	n°2	n°3
<b>Caratteristiche iniziali dei provini</b>			
Area di base del provino	900 cm <sup>2</sup> (30 cm x 30 cm)		
Altezza iniziale del provino [mm]	155	160	160
Contenuto di umidità iniziale [%]	5,2	5,2	5,2
Massa volumica [Mg/m <sup>3</sup> ]	2,24	2,21	2,22
Massa volumica a secco [Mg/m <sup>3</sup> ]	2,13	2,10	2,11
Velocità di spostamento del taglio [mm/min]	0,10	0,10	0,10
<b>Condizioni di taglio</b>			
Tensione verticale $\sigma$ [kPa]	100	200	400
Tensione di taglio $\tau$ [kPa]	137	232	340
Spostamento orizzontale s [mm]	30	30	30
<b>Parametri derivate</b>			
Angolo di attrito $\phi$ [°]	33,5	Coesione $c'$ [kPa]	83

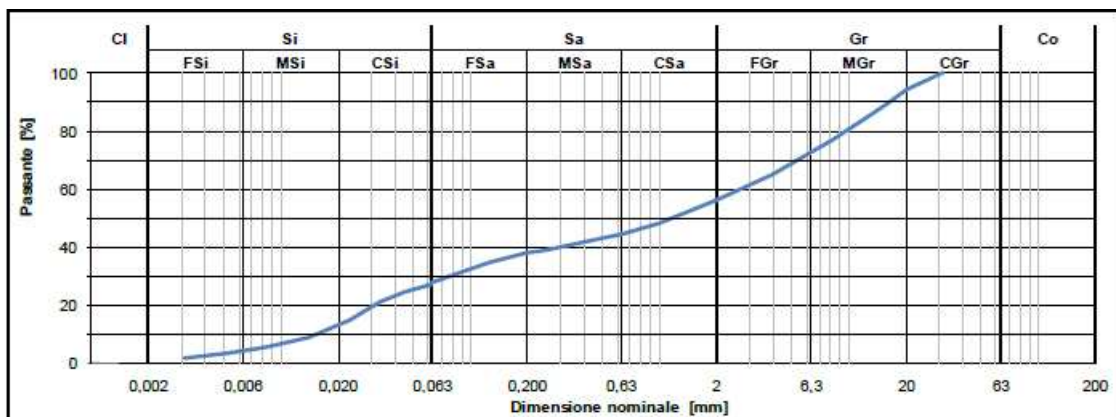
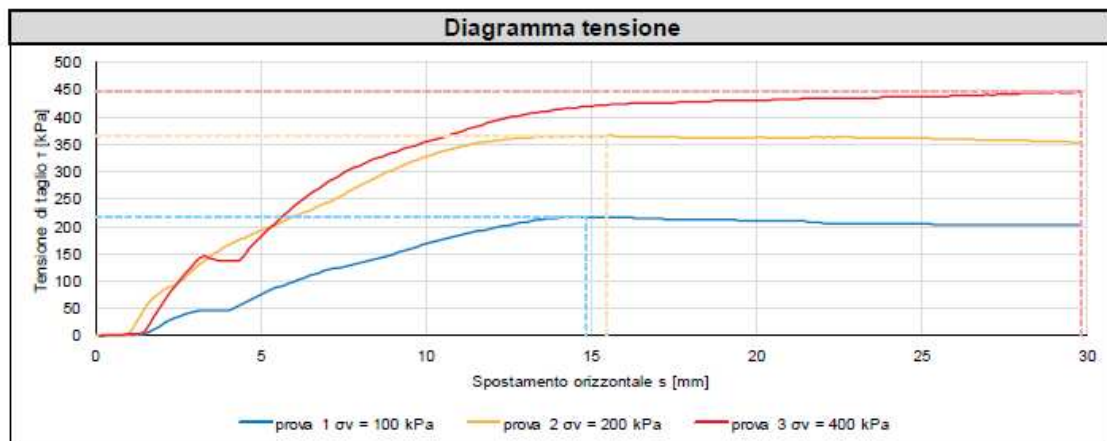




Numero di laboratorio: 210542/0011  
 Data di campionatura: Non determinata.  
 Nota: -

Denominazione campione: BH1 24,0-31,0 m  
 Campionatura eseguita da: cliente

Prova di taglio diretto			
Prova secondo		EN ISO 17892-10	
Prova	n°1	n°2	n°3
<b>Caratteristiche iniziali dei provini</b>			
Area di base del provino	900 cm <sup>2</sup> (30 cm x 30 cm)		
Altezza iniziale del provino [mm]	155	160	160
Contenuto di umidità iniziale [%]	6,2	6,2	6,2
Massa volumica [Mg/m <sup>3</sup> ]	2,44	2,43	2,43
Massa volumica a secco [Mg/m <sup>3</sup> ]	2,29	2,29	2,29
Velocità di spostamento del taglio [mm/min]	0,10	0,10	0,10
<b>Condizioni di taglio</b>			
Tensione verticale $\sigma$ [kPa]	100	200	400
Tensione di taglio $\tau$ [kPa]	217	366	446
Spostamento orizzontale s [mm]	15	15	30
<b>Parametri derivate</b>			
Angolo di attrito $\phi$ [°]	35,5	Coesione $c'$ [kPa]	
		177	



Numero di laboratorio: 210542/012

Denominazione  
campione:

BH1 17,0-23,0 m

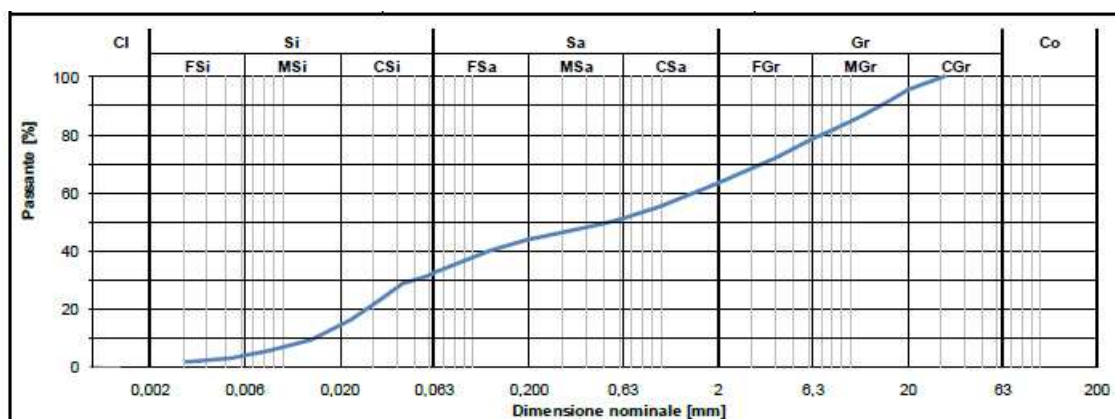
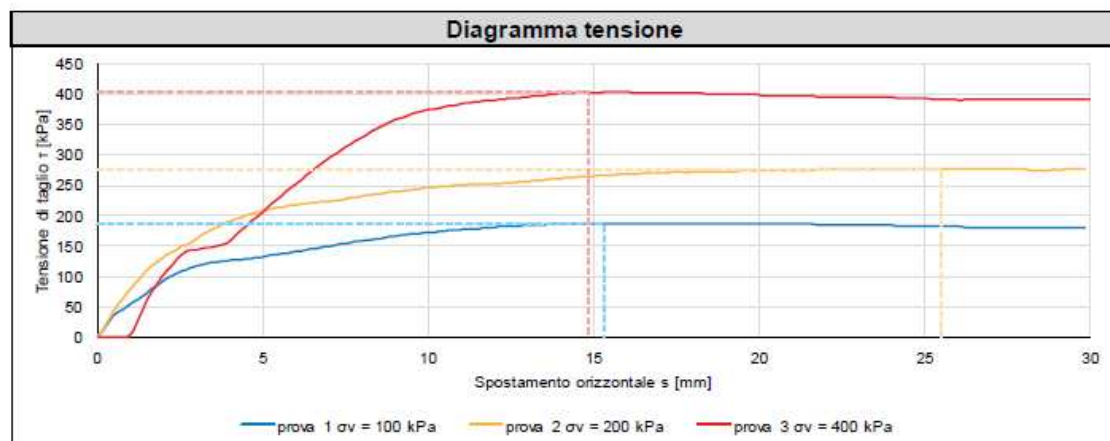
Data di campionatura: Non determinata.

Campionatura  
eseguita da:

cliente

Nota:

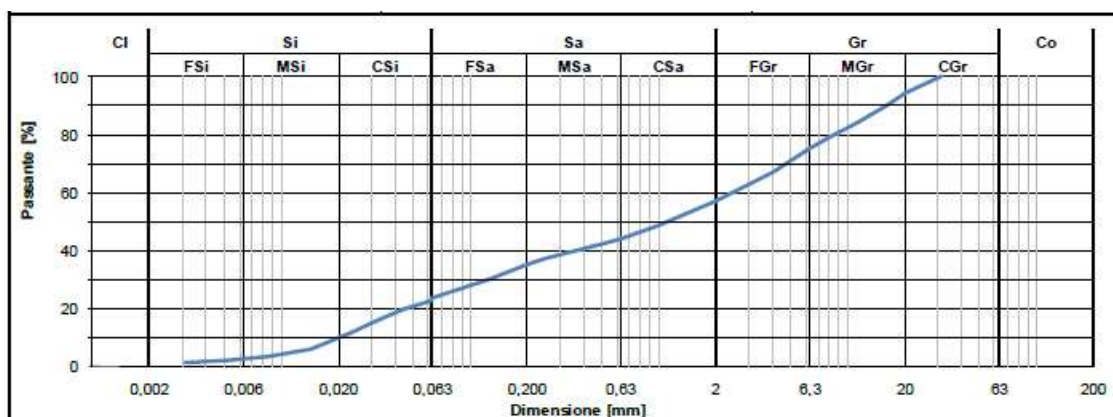
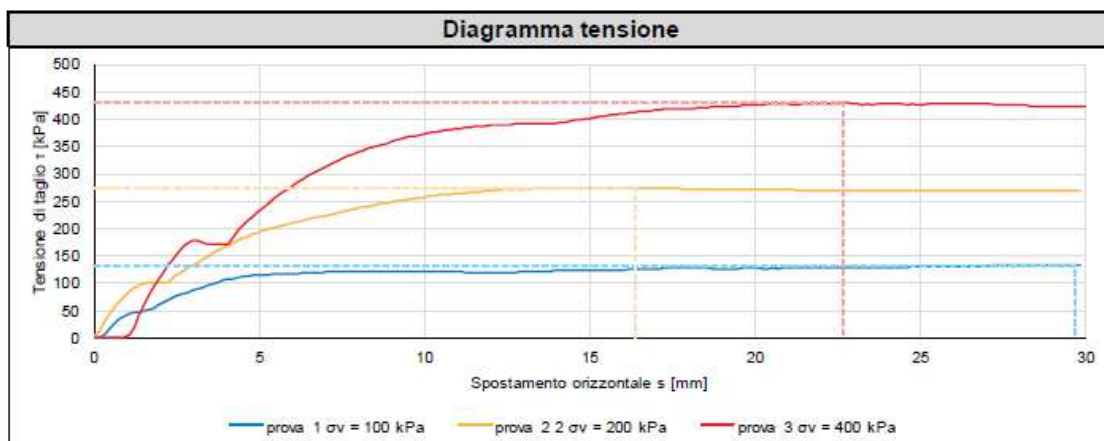
Prova di taglio diretto			
Prova secondo		EN ISO 17892-10	
Prova	n°1	n°2	n°3
<b>Caratteristiche iniziali dei provini</b>			
Area di base del provino	900 cm <sup>2</sup> (30 cm x 30 cm)		
Altezza iniziale del provino [mm]	160	160	160
Contenuto di umidità iniziale [%]	5,2	5,2	5,2
Massa volumica [Mg/m <sup>3</sup> ]	2,26	2,29	2,26
Massa volumica a secco [Mg/m <sup>3</sup> ]	2,14	2,17	2,15
Velocità di spostamento del taglio [mm/min]	0,10	0,10	0,10
<b>Condizioni di taglio</b>			
Tensione verticale $\sigma$ [kPa]	100	200	400
Tensione di taglio $\tau$ [kPa]	187	277	403
Spostamento orizzontale s [mm]	15	26	15
<b>Parametri derivate</b>			
Angolo di attrito $\phi$ [°]	35,5	Coesione c' [kPa]	
			124



Numero di laboratorio: 210542/013  
 Data di campionatura: Non determinata.  
 Nota: -

Denominazione campione: BH1 6,0-15,0 m  
 Campionatura eseguita da: cliente

Prova di taglio diretto			
Prova secondo		EN ISO 17892-10	
Prova	n°1	n°2	n°3
<b>Caratteristiche iniziali dei provini</b>			
Area di base del provino	900 cm <sup>2</sup> (30 cm x 30 cm)		
Altezza iniziale del provino [mm]	155	155	155
Contenuto di umidità iniziale [%]	6,2	6,2	6,2
Massa volumica [Mg/m <sup>3</sup> ]	2,25	2,26	2,24
Massa volumica a secco [Mg/m <sup>3</sup> ]	2,12	2,13	2,11
Velocità di spostamento del taglio [mm/min]	0,10	0,10	0,10
<b>Condizioni di taglio</b>			
Tensione verticale $\sigma$ [kPa]	100	200	400
Tensione di taglio $\tau$ [kPa]	133	274	429
Spostamento orizzontale s [mm]	30	16	23
<b>Parametri derivate</b>			
Angolo di attrito $\phi$ [°]	44,0	Coesione $c'$ [kPa]	55



## Risultati di prova

Numero di laboratorio: 210542/001

Data di campionatura: Non determinata.

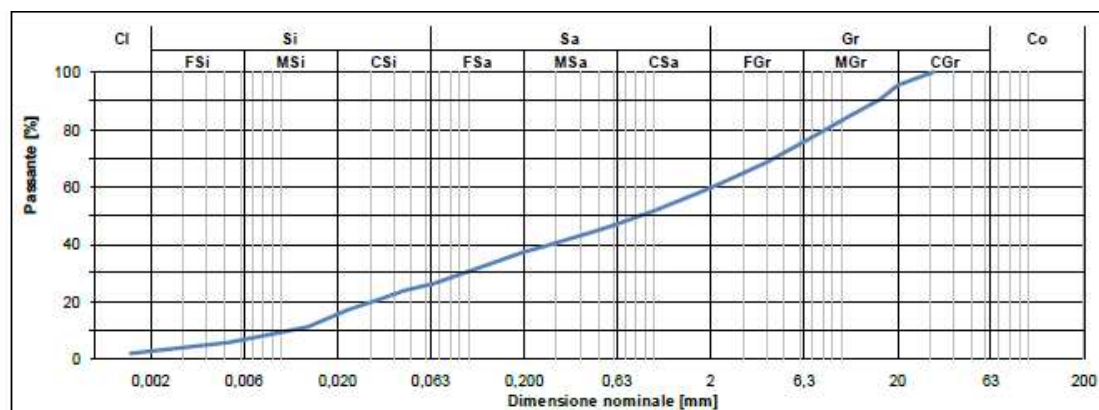
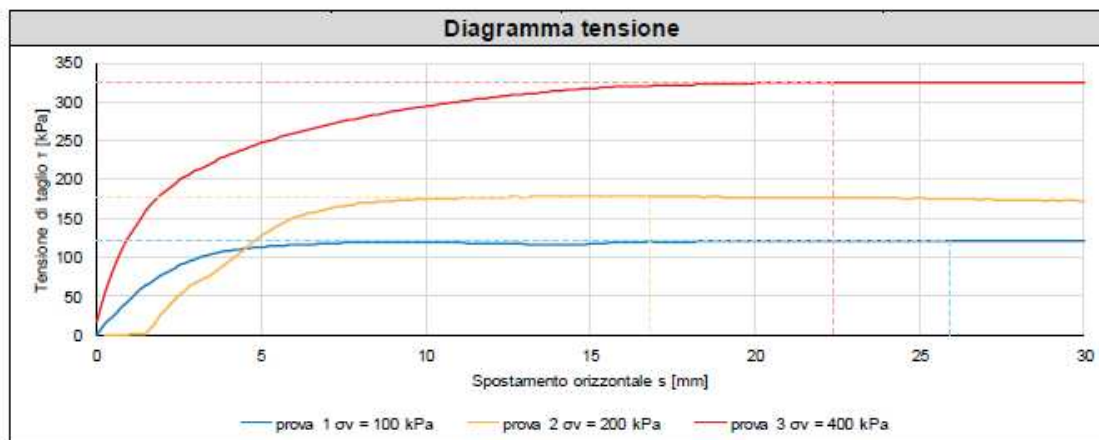
Nota:

Denominazione  
campione:  
Campionatura  
eseguita da:

BH2 69,00 - 77,00 m

cliente

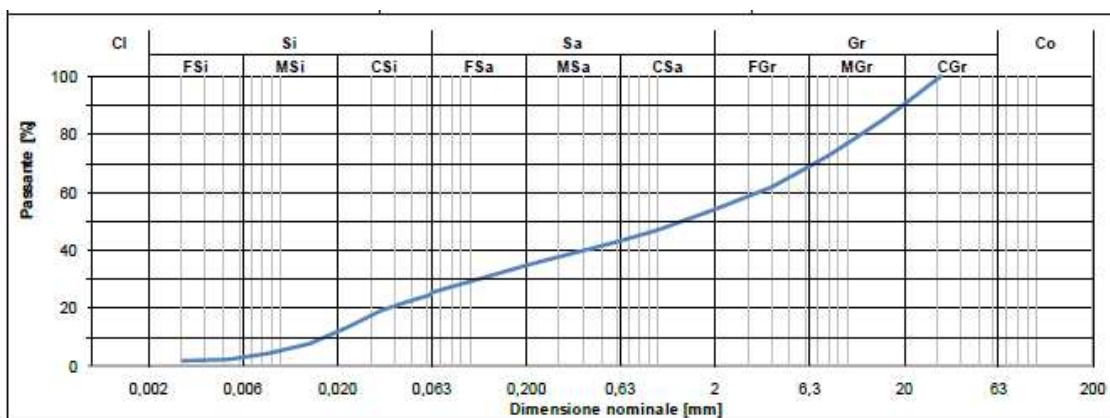
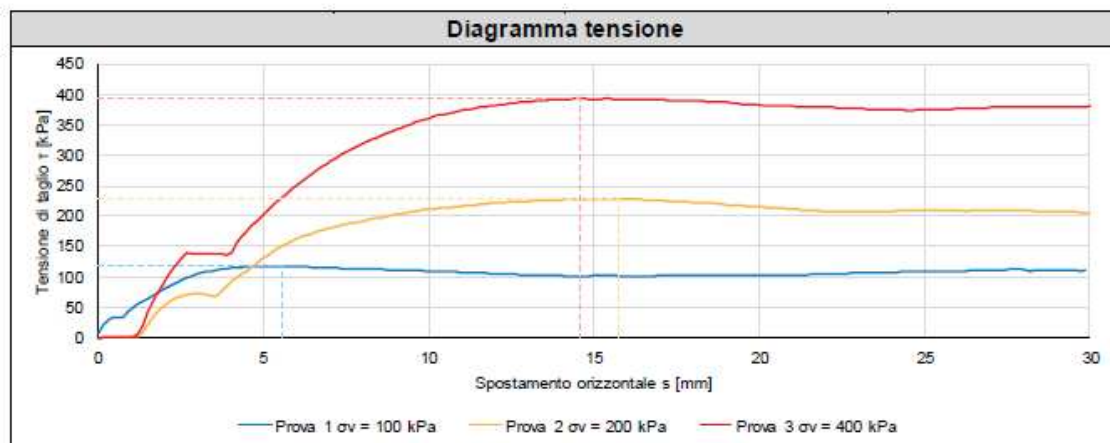
Prova di taglio diretto			
Prova secondo		EN ISO 17892-10	
Prova	n°1	n°2	n°3
<b>Caratteristiche iniziali dei provini</b>			
Area di base del provino	900 cm <sup>2</sup> (30 cm x 30 cm)		
Altezza iniziale del provino [mm]	165	170	175
Contenuto di umidità iniziale [%]	4,2	4,2	4,2
Massa volumica [Mg/m <sup>3</sup> ]	2,19	2,12	2,14
Massa volumica a secco [Mg/m <sup>3</sup> ]	2,10	2,04	2,05
Velocità di spostamento del taglio [mm/min]	0,10	0,10	0,10
<b>Condizioni di taglio</b>			
Tensione verticale $\sigma$ [kPa]	100	200	400
Tensione di taglio $\tau$ [kPa]	122	179	326
Spostamento orizzontale s [mm]	26	17	22
<b>Parametri derivate</b>			
Angolo di attrito $\phi$ [°]	34,5	Coesione c' [kPa]	48



Numero di laboratorio: 210542/002  
 Data di campionatura: Non determinata  
 Nota: -

Denominazione campione: BH2 60,00 - 68,00 m  
 Campionatura eseguita da: cliente

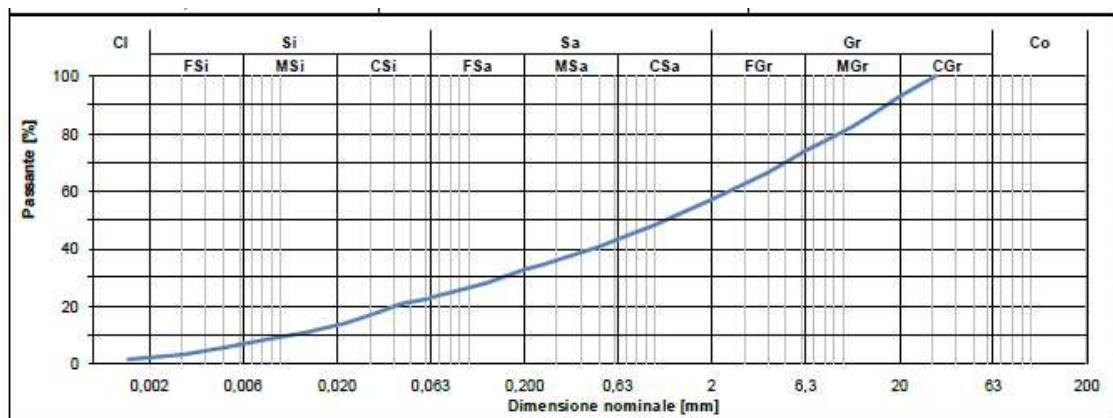
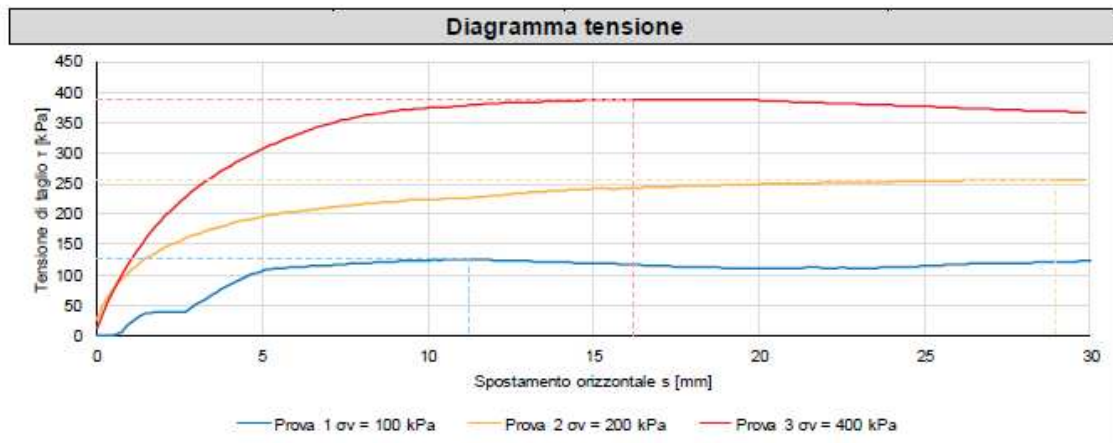
Prova di taglio diretto			
Prova secondo		EN ISO 17892-10	
Prova	n°1	n°2	n°3
<b>Caratteristiche iniziali dei provini</b>			
Area di base del provino	900 cm <sup>2</sup> (30 cm x 30 cm)		
Altezza iniziale del provino [mm]	160	160	150
Contenuto di umidità iniziale [%]	3,1	3,1	3,1
Massa volumica [Mg/m <sup>3</sup> ]	2,12	2,11	2,15
Massa volumica a secco [Mg/m <sup>3</sup> ]	2,06	2,05	2,09
Velocità di spostamento del taglio [mm/min]	0,10	0,10	0,10
<b>Condizioni di taglio</b>			
Tensione verticale $\sigma$ [kPa]	100	200	400
Tensione di taglio $\tau$ [kPa]	118	228	393
Spostamento orizzontale s [mm]	6	16	15
<b>Parametri derivate</b>			
Angolo di attrito $\phi$ [°]	42,0	Coesione c' [kPa]	35



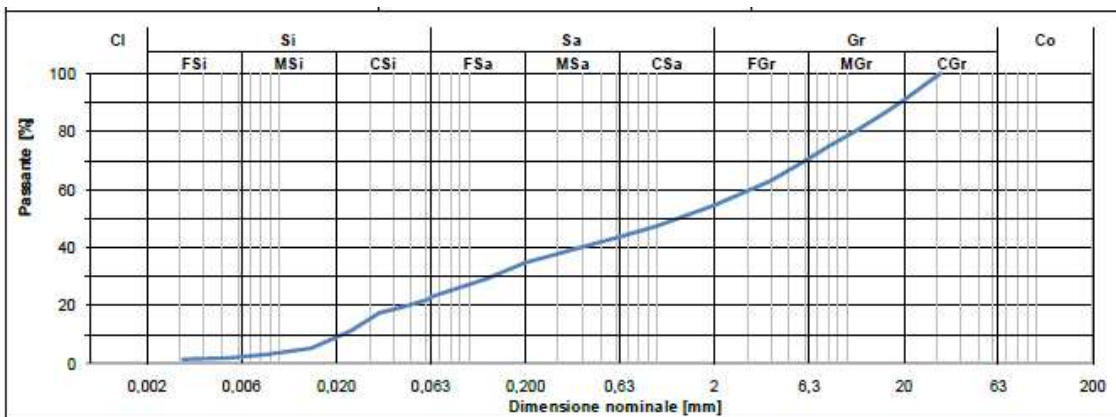
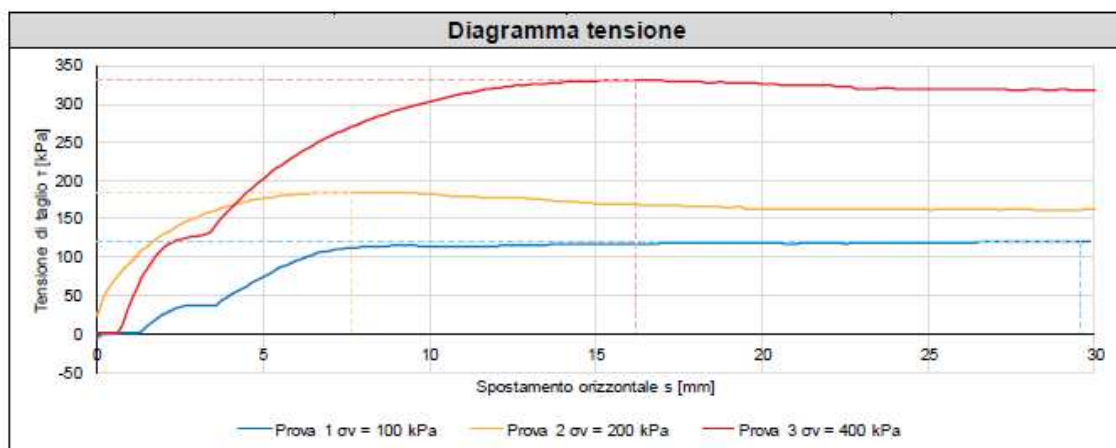
Numero di laboratorio: 210542/003  
 Data di campionatura: Non determinata.  
 Nota: -

Denominazione campione: BH2 41,00 - 48,00 m  
 Campionatura eseguita da: cliente

Prova di taglio diretto			
Prova secondo		EN ISO 17892-10	
Prova	n°1	n°2	n°3
<b>Caratteristiche iniziali dei provini</b>			
Area di base del provino	900 cm <sup>2</sup> (30 cm x 30 cm)		
Altezza iniziale del provino [mm]	165	155	155
Contenuto di umidità iniziale [%]	4,4	4,4	4,4
Massa volumica [Mg/m <sup>3</sup> ]	2,13	2,18	2,19
Massa volumica a secco [Mg/m <sup>3</sup> ]	2,04	2,09	2,10
Velocità di spostamento del taglio [mm/min]	0,10	0,10	0,10
<b>Condizioni di taglio</b>			
Tensione verticale $\sigma$ [kPa]	100	200	400
Tensione di taglio $\tau$ [kPa]	124	256	388
Spostamento orizzontale s [mm]	11	29	16
<b>Parametri derivate</b>			
Angolo di attrito $\phi$ [°]	40,5	Coesione c' [kPa]	59



Prova di taglio diretto			
Prova secondo		EN ISO 17892-10	
Prova	n°1	n°2	n°3
<b>Caratteristiche iniziali dei provini</b>			
Area di base del provino	900 cm <sup>2</sup> (30 cm x 30 cm)		
Altezza iniziale del provino [mm]	155	160	160
Contenuto di umidità iniziale [%]	3,5	3,5	3,5
Massa volumica [Mg/m <sup>3</sup> ]	2,12	2,06	2,07
Massa volumica a secco [Mg/m <sup>3</sup> ]	2,05	1,99	2,00
Velocità di spostamento del taglio [mm/min]	0,10	0,10	0,10
<b>Condizioni di taglio</b>			
Tensione verticale $\sigma$ [kPa]	100	200	400
Tensione di taglio $\tau$ [kPa]	121	185	332
Spostamento orizzontale s [mm]	30	8	16
<b>Parametri derivate</b>			
Angolo di attrito $\varphi$ [°]	35,5	Coesione $c'$ [kPa]	47



Numero di laboratorio: 210542/005

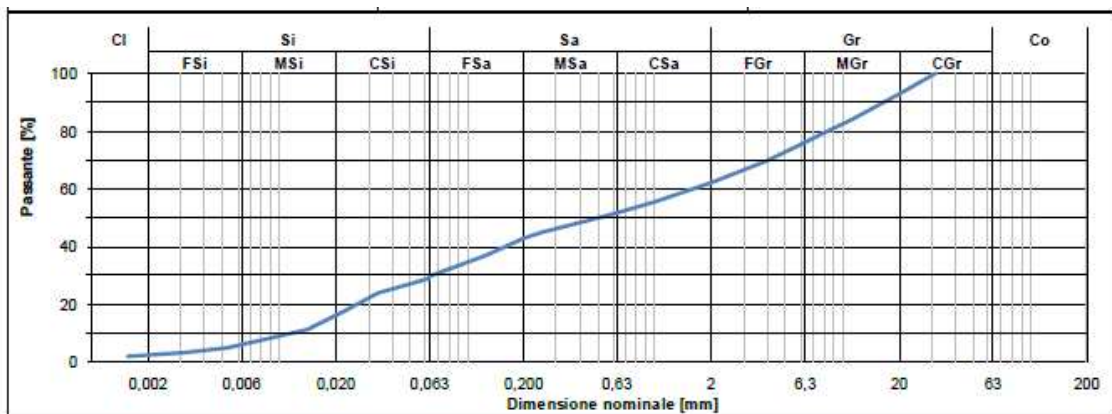
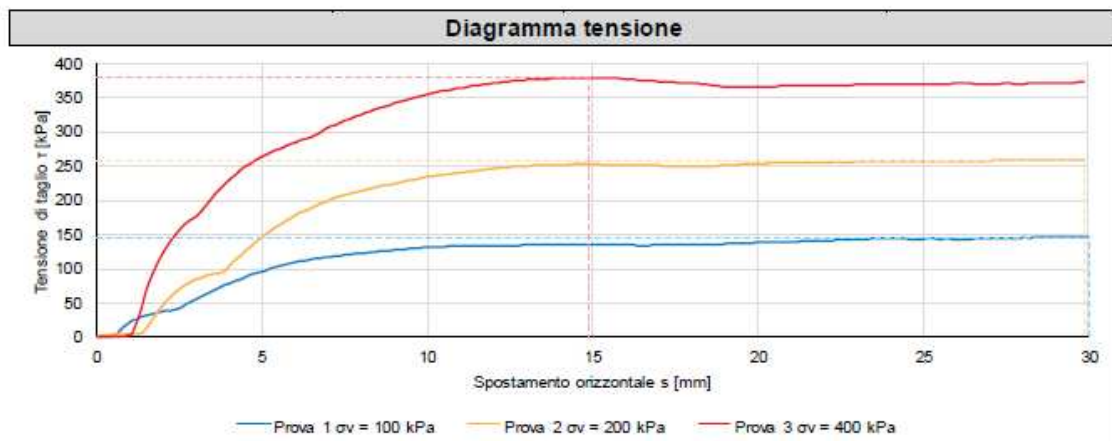
Denominazione campione: BH2 30,00 - 37,00 m

Data di campionatura: Non determinata.

Campionatura eseguita da: cliente

Nota: -

Prova di taglio diretto			
Prova secondo		EN ISO 17892-10	
Prova	n°1	n°2	n°3
<b>Caratteristiche iniziali dei provini</b>			
Area di base del provino	900 cm <sup>2</sup> (30 cm x 30 cm)		
Altezza iniziale del provino [mm]	155	160	155
Contenuto di umidità iniziale [%]	4,1	4,1	4,1
Massa volumica [Mg/m <sup>3</sup> ]	2,10	2,07	2,14
Massa volumica a secco [Mg/m <sup>3</sup> ]	2,02	1,99	2,05
Velocità di spostamento del taglio [mm/min]	0,10	0,10	0,10
<b>Condizioni di taglio</b>			
Tensione verticale $\sigma$ [kPa]	100	200	400
Tensione di taglio $\tau$ [kPa]	146	260	379
Spostamento orizzontale s [mm]	30	30	15
<b>Parametri derivate</b>			
Angolo di attrito $\phi$ [°]	37,0	Coesione c' [kPa]	87

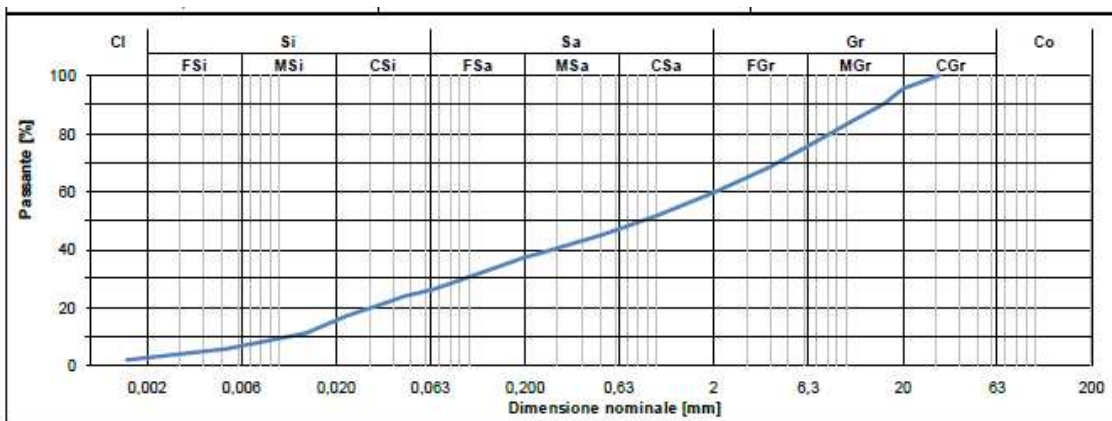
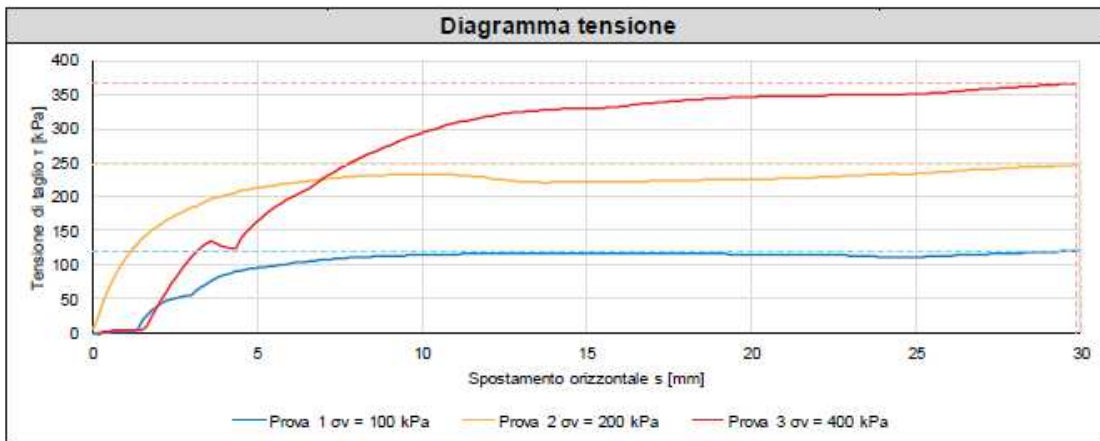




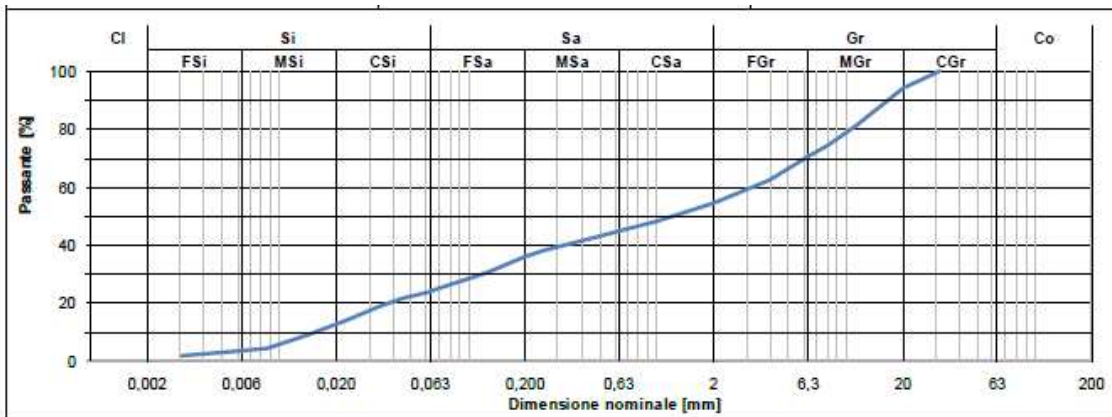
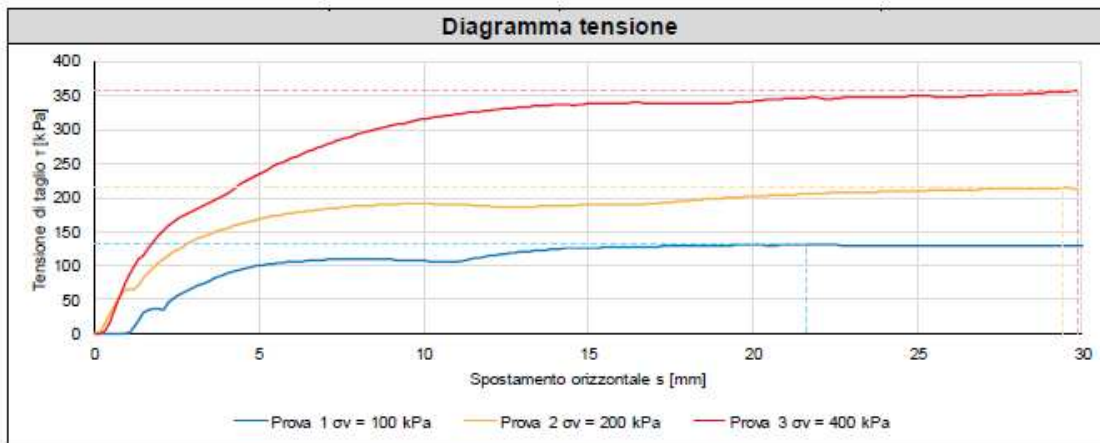
Numero di laboratorio: 210542/006  
 Data di campionatura: Non determinata.  
 Nota:

Denominazione campione: BH2 21,00 - 28,00 m  
 Campionatura eseguita da: cliente

Prova di taglio diretto			
Prova secondo		EN ISO 17892-10	
Prova	n°1	n°2	n°3
<b>Caratteristiche iniziali dei provini</b>			
Area di base del provino	900 cm <sup>2</sup> (30 cm x 30 cm)		
Altezza iniziale del provino [mm]	155	165	160
Contenuto di umidità iniziale [%]	2,7	2,7	2,7
Massa volumica [Mg/m <sup>3</sup> ]	2,19	2,02	2,14
Massa volumica a secco [Mg/m <sup>3</sup> ]	2,13	1,97	2,09
Velocità di spostamento del taglio [mm/min]	0,10	0,10	0,10
<b>Condizioni di taglio</b>			
Tensione verticale $\sigma$ [kPa]	100	200	400
Tensione di taglio $\tau$ [kPa]	121	247	367
Spostamento orizzontale s [mm]	30	30	30
<b>Parametri derivate</b>			
Angolo di attrito $\phi$ [°]	38,0	Coesione c' [kPa]	62



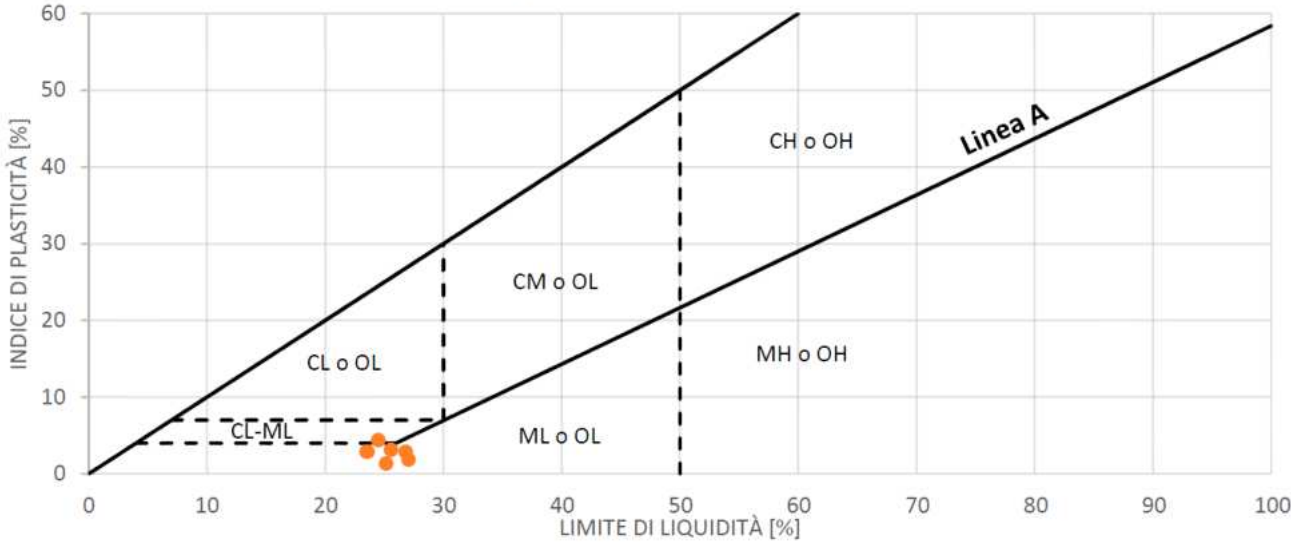
Prova di taglio diretto			
Prova secondo		EN ISO 17892-10	
Prova	n°1	n°2	n°3
<b>Caratteristiche iniziali dei provini</b>			
Area di base del provino	900 cm <sup>2</sup> (30 cm x 30 cm)		
Altezza iniziale del provino [mm]	165	160	155
Contenuto di umidità iniziale [%]	3,0	3,0	3,0
Massa volumica [Mg/m <sup>3</sup> ]	2,08	2,13	2,17
Massa volumica a secco [Mg/m <sup>3</sup> ]	2,02	2,07	2,10
Velocità di spostamento del taglio [mm/min]	0,10	0,10	0,10
<b>Condizioni di taglio</b>			
Tensione verticale $\sigma$ [kPa]	100	200	400
Tensione di taglio $\tau$ [kPa]	131	214	357
Spostamento orizzontale s [mm]	22	29	30
<b>Parametri derivate</b>			
Angolo di attrito $\phi$ [°]	37,0	Coesione c' [kPa]	59



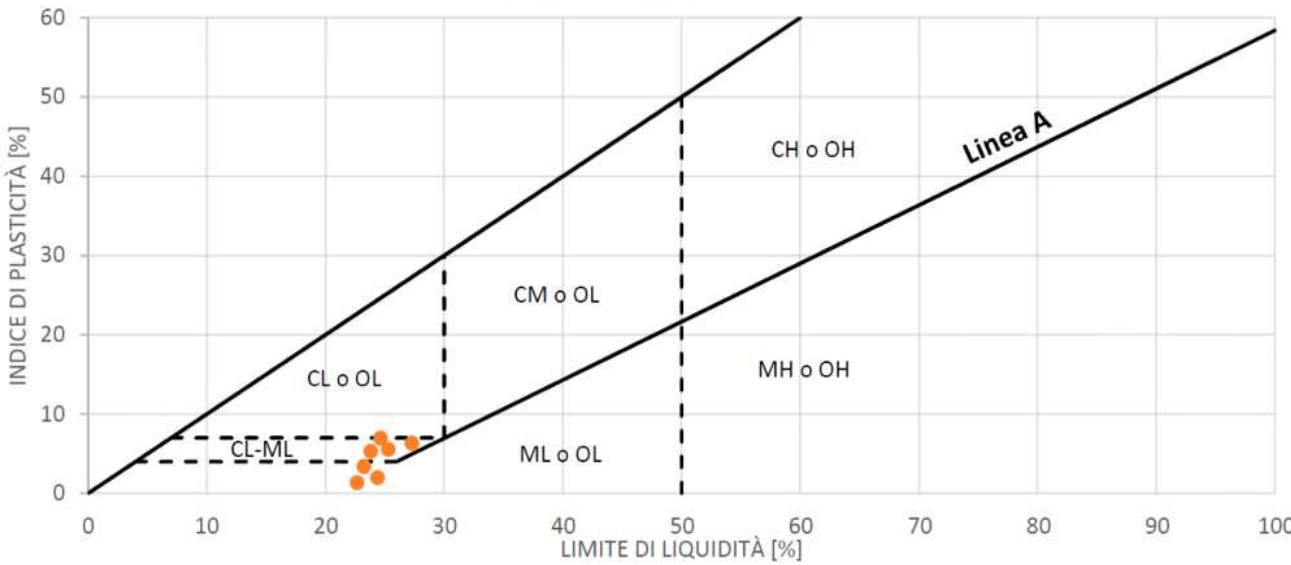
**GRENZEN VON ATTERBERG**

**LIMITI DI ATTERBERG**

**Diagramma di plasticità BH1**



**Diagramma di plasticità BH2**

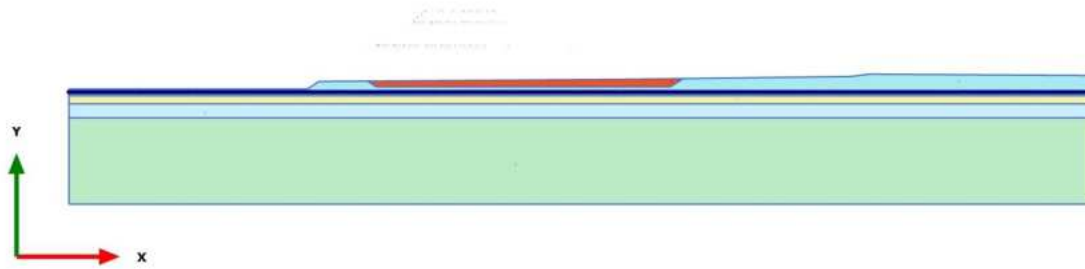


**ANHANG 3 – ERGEBNISSE DER PLAXIS SLE/SLD – ABSCHNITT 1**

**APPENDICE 3 – RISULTATI ANALISI PLAXIS SLE/SLD – SEZIONE 1**

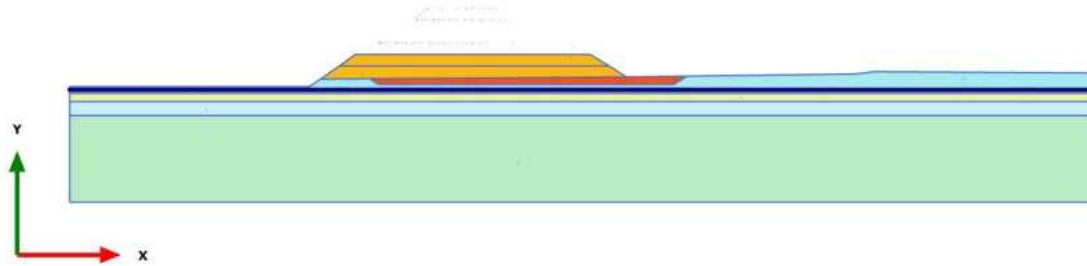
# PLAXIS Report

1.1.1.1 Calculation results, Initial phase [InitialPhase] (0/13), Materials plot



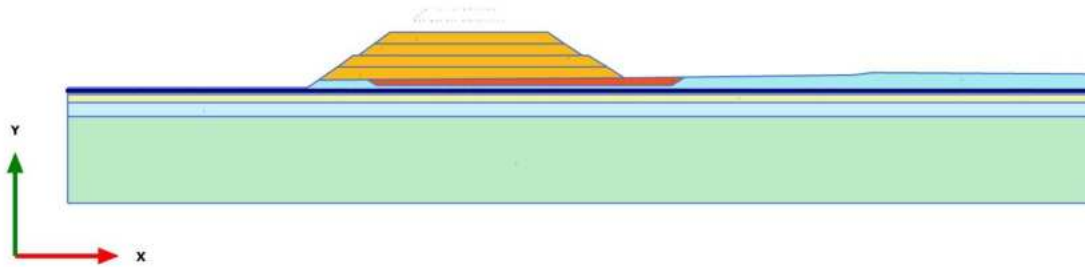
**Materials plot**

1.1.1.2 Calculation results, Phase\_1 [Phase\_1] (8/18), Materials plot



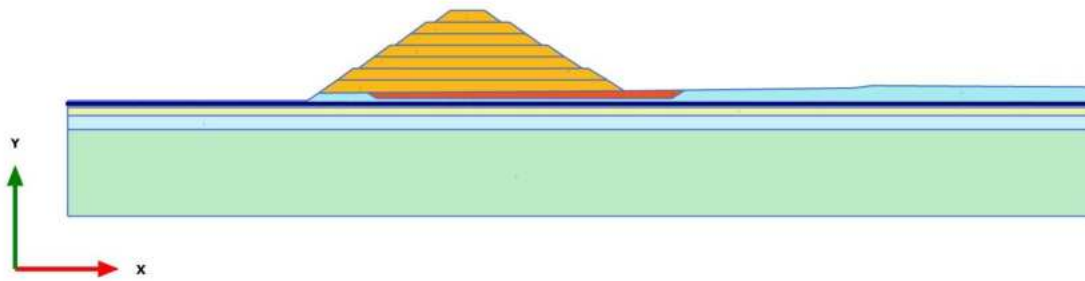
**Materials plot**

1.1.1.3 Calculation results, Phase\_2 [Phase\_2] (9/22), Materials plot



**Materials plot**

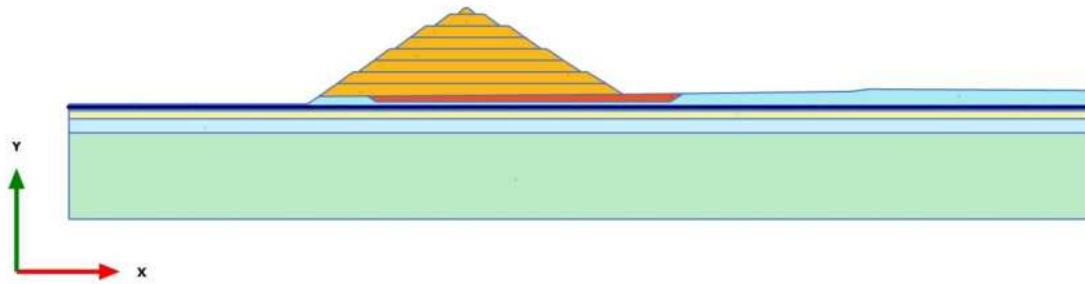
1.1.1.4 Calculation results, Phase\_4 [Phase\_4] (11/25), Materials plot



**Materials plot**

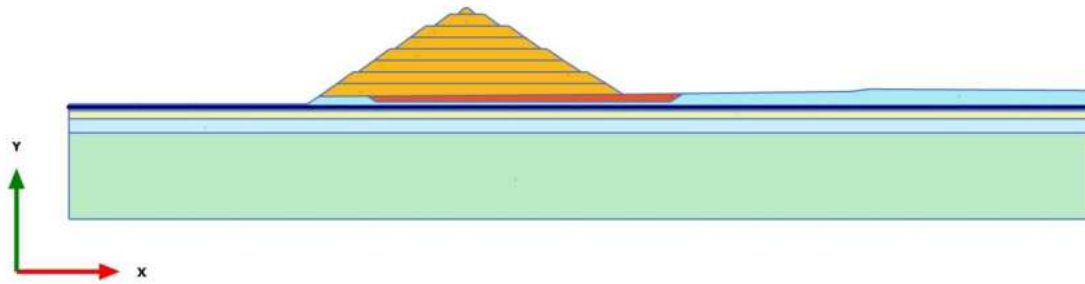


1.1.1.5 Calculation results, Phase\_5\_static [Phase\_5] (12/28), Materials plot



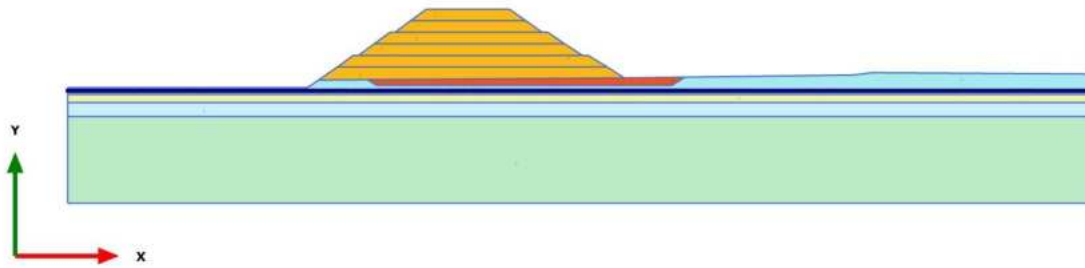
**Materials plot**

1.1.1.6 Calculation results, Phase\_8 \_seismic [Phase\_8] (2/32), Materials plot








**Materials plot**

1.1.1.7 Calculation results, Phase\_3 [Phase\_3] (10/39), Materials plot



**Materials plot**

1.1.2.1.1 Materials - Soil and interfaces - Hardening soil





Identification		Strato 1	Strato 2	Strato 3	Strato 4	Strato 5
Identification number		1	2	3	4	5
Drainage type		Drained	Drained	Drained	Drained	Drained
Colour						
Comments						
$\gamma_{unsat}$	kN/m <sup>3</sup>	20,00	20,00	20,00	20,00	20,00
$\gamma_{sat}$	kN/m <sup>3</sup>	20,00	20,00	20,00	20,00	20,00
Dilatancy cut-off		No	No	No	No	No
$e_{init}$		0,5000	0,5000	0,5000	0,5000	0,5000
$e_{min}$		0,000	0,000	0,000	0,000	0,000
$e_{max}$		999,0	999,0	999,0	999,0	999,0
Rayleigh $\alpha$		0,000	0,000	0,000	0,000	0,000
Rayleigh $\beta$		0,000	0,000	0,000	0,000	0,000
$E_{50\ ref}$	kN/m <sup>2</sup>	25,00E3	40,00E3	50,00E3	30,00E3	70,00E3
$E_{oed\ ref}$	kN/m <sup>2</sup>	23,55E3	36,94E3	45,27E3	28,84E3	66,76E3
$E_{ur\ ref}$	kN/m <sup>2</sup>	75,00E3	120,0E3	150,0E3	90,00E3	210,0E3
power (m)		0,000	0,000	0,000	0,000	0,4000
Use alternatives		No	No	No	No	No
$C_c$		0,01465	9,339E-3	7,621E-3	0,01196	5,167E-3
Identification		Strato 1	Strato 2	Strato 3	Strato 4	Strato 5

$C_s$		4,140E-3	2,587E-3	2,070E-3	3,450E-3	1,479E-3
$e_{init}$		0,5000	0,5000	0,5000	0,5000	0,5000
$c_{ref}$	kN/m <sup>2</sup>	5,000	0,000	0,000	0,000	0,000
$\phi$ (phi)	°	38,00	40,00	42,00	36,00	36,00
$\psi$ (psi)	°	0,000	0,000	0,000	0,000	0,000
Set to default values		No	No	No	No	No
$v_{ur}$		0,2000	0,2000	0,2000	0,2000	0,2000
$p_{ref}$	kN/m <sup>2</sup>	100,0	100,0	100,0	100,0	100,0
$K_{0nc}$		0,3943	0,3695	0,3449	0,4194	0,4217
$c_{inc}$	kN/m <sup>2</sup> /m	0,000	0,000	0,000	0,000	0,000
$y_{ref}$	m	0,000	0,000	0,000	0,000	608,0
$R_f$		0,9000	0,9000	0,9000	0,9000	0,9000
Tension cut-off		Yes	Yes	Yes	Yes	Yes
Tensile strength	kN/m <sup>2</sup>	0,000	0,000	0,000	0,000	0,000
Undrained behaviour		Standard	Standard	Standard	Standard	Standard
Skempton-B		0,9866	0,9866	0,9866	0,9866	0,9866
$v_u$		0,4950	0,4950	0,4950	0,4950	0,4950
$K_{w,ref} / n$	kN/m <sup>2</sup>	3,073E6	4,917E6	6,146E6	3,687E6	8,604E6
Stiffness		Standard	Standard	Standard	Standard	Standard
Strength		Rigid	Rigid	Rigid	Rigid	Rigid
$R_{inter}$		1,000	1,000	1,000	1,000	1,000
Consider gap closure		Yes	Yes	Yes	Yes	Yes

Identification		Strato 1	Strato 2	Strato 3	Strato 4	Strato 5
$\delta_{inter}$		0,000	0,000	0,000	0,000	0,000
Cross permeability		Impermeable	Impermeable	Impermeable	Impermeable	Impermeable
Drainage conductivity, dk	m <sup>3</sup> /day/m	0,000	0,000	0,000	0,000	0,000
R	m <sup>2</sup> K/kW	0,000	0,000	0,000	0,000	0,000
K <sub>0</sub> determination		Automatic	Automatic	Automatic	Automatic	Automatic
K <sub>0,x</sub> = K <sub>0,z</sub>		Yes	Yes	Yes	Yes	Yes
K <sub>0,x</sub>		0,3943	0,3695	0,3449	0,4194	0,4217
K <sub>0,z</sub>		0,3943	0,3695	0,3449	0,4194	0,4217
OCR		1,000	1,000	1,000	1,000	1,000
POP	kN/m <sup>2</sup>	0,000	0,000	0,000	0,000	0,000
Data set		Standard	Standard	Standard	Standard	Standard
Type		Coarse	Coarse	Coarse	Coarse	Coarse
< 2 μm	%	10,00	10,00	10,00	10,00	10,00
2 μm - 50 μm	%	13,00	13,00	13,00	13,00	13,00
50 μm - 2 mm	%	77,00	77,00	77,00	77,00	77,00
Use defaults		None	None	None	None	None
k <sub>x</sub>	m/day	0,000	0,000	0,000	0,000	0,000
k <sub>y</sub>	m/day	0,000	0,000	0,000	0,000	0,000
-ψ <sub>unsat</sub>	m	10,00E3	10,00E3	10,00E3	10,00E3	10,00E3
e <sub>init</sub>		0,5000	0,5000	0,5000	0,5000	0,5000
S <sub>s</sub>	1/m	0,000	0,000	0,000	0,000	0,000
c <sub>k</sub>		1000E12	1000E12	1000E12	1000E12	1000E12

Identification		Strato 1	Strato 2	Strato 3	Strato 4	Strato 5
$c_s$	$\text{kJ/t/K}$	0,000	0,000	0,000	0,000	0,000
$\lambda_s$	$\text{kW/m/K}$	0,000	0,000	0,000	0,000	0,000
$\rho_s$	$\text{t/m}^3$	0,000	0,000	0,000	0,000	0,000
Solid thermal expansion		Volumetric	Volumetric	Volumetric	Volumetric	Volumetric
$\alpha_s$	$1/\text{K}$	0,000	0,000	0,000	0,000	0,000
$D_v$	$\text{m}^2/\text{day}$	0,000	0,000	0,000	0,000	0,000
$f_{Tv}$		0,000	0,000	0,000	0,000	0,000
Unfrozen water content		None	None	None	None	None

1.1.2.1.2 Materials - Soil and interfaces - Mohr-Coulomb

Identification		Rock	A	F1	GNEISS
Identification number		6	7	8	9
Drainage type		Drained	Drained	Drained	Drained
Colour					
Comments					
$\gamma_{\text{unsat}}$	kN/m <sup>3</sup>	20,00	21,00	20,00	20,00
$\gamma_{\text{sat}}$	kN/m <sup>3</sup>	20,00	21,00	20,00	20,00
Dilatancy cut-off		No	No	No	No
$e_{\text{init}}$		0,5000	0,5000	0,5000	0,5000
$e_{\text{min}}$		0,000	0,000	0,000	0,000
$e_{\text{max}}$		999,0	999,0	999,0	999,0
Rayleigh $\alpha$		0,000	0,000	0,000	0,000
Rayleigh $\beta$		0,000	0,000	0,000	0,000
E	kN/m <sup>2</sup>	100,0E3	60,00E3	5000	30,00E3
$\nu$ (nu)		0,3000	0,3000	0,3000	0,3000
G	kN/m <sup>2</sup>	38,46E3	23,08E3	1923	11,54E3
$E_{\text{oed}}$	kN/m <sup>2</sup>	134,6E3	80,77E3	6731	40,38E3
Identification		Rock	A	F1	GNEISS
$c_{\text{ref}}$	kN/m <sup>2</sup>	500,0	45,00	0,000	40,00



$\phi$ (phi)	°	35,00	37,00	20,00	36,00
$\psi$ (psi)	°	0,000	3,000	0,000	3,000
$V_s$	m/s	137,4	103,8	30,71	75,23
$V_p$	m/s	257,0	194,2	57,46	140,7
Set to default values		Yes	Yes	Yes	Yes
$E_{inc}$	kN/m <sup>2</sup> /m	0,000	0,000	0,000	0,000
$y_{ref}$	m	0,000	0,000	0,000	0,000
$C_{inc}$	kN/m <sup>2</sup> /m	0,000	0,000	0,000	0,000
$y_{ref}$	m	0,000	0,000	0,000	0,000
Tension cut-off		Yes	Yes	Yes	Yes
Tensile strength	kN/m <sup>2</sup>	0,000	0,000	0,000	0,000
Undrained behaviour		Standard	Standard	Standard	Standard
Skempton-B		0,9783	0,9783	0,9783	0,9783
$v_u$		0,4950	0,4950	0,4950	0,4950
$K_{w,ref} / n$	kN/m <sup>2</sup>	3,750E6	2,250E6	187,5E3	1,125E6
Stiffness		Standard	Standard	Standard	Standard
Strength		Rigid	Rigid	Rigid	Rigid
$R_{inter}$		1,000	1,000	1,000	1,000
Identification		Rock	A	F1	GNEISS
Consider gap closure		Yes	Yes	Yes	Yes

$\delta_{inter}$		0,000	0,000	0,000	0,000
Cross permeability		Impermeable	Impermeable	Impermeable	Impermeable
Drainage conductivity, dk	m <sup>3</sup> /day/m	0,000	0,000	0,000	0,000
R	m <sup>2</sup> K/kW	0,000	0,000	0,000	0,000
K <sub>0</sub> determination		Automatic	Automatic	Automatic	Automatic
K <sub>0,x</sub> = K <sub>0,z</sub>		Yes	Yes	Yes	Yes
K <sub>0,x</sub>		0,4264	0,3982	0,6580	0,4122
K <sub>0,z</sub>		0,4264	0,3982	0,6580	0,4122
Data set		Standard	USDA	Standard	USDA
Model		Van Genuchten	Van Genuchten	Van Genuchten	Van Genuchten
Type		Coarse	Coarse	Coarse	Coarse
Type		Sand	Sand	Sand	Sand
< 2 μm	%	10,00	4,000	10,00	4,000
2 μm - 50 μm	%	13,00	4,000	13,00	4,000
50 μm - 2 mm	%	77,00	92,00	77,00	92,00
Use defaults		None	None	None	None
k <sub>x</sub>	m/day	0,000	0,000	0,000	0,000
k <sub>y</sub>	m/day	0,000	0,000	0,000	0,000
Identification		Rock	A	F1	GNEISS
-ψ <sub>unsat</sub>	m	10,00E3	10,00E3	10,00E3	10,00E3

$e_{init}$		0,5000	0,5000	0,5000	0,5000
$S_s$	1/m	0,000	0,000	0,000	0,000
$C_k$		1000E12	1000E12	1000E12	1000E12
$c_s$	kJ/t/K	0,000	0,000	0,000	0,000
$\lambda_s$	kW/m/K	0,000	0,000	0,000	0,000
$\rho_s$	t/m <sup>3</sup>	0,000	0,000	0,000	0,000
Solid thermal expansion		Volumetric	Volumetric	Volumetric	Volumetric
$\alpha_s$	1/K	0,000	0,000	0,000	0,000
$D_v$	m <sup>2</sup> /day	0,000	0,000	0,000	0,000
$f_{TV}$		0,000	0,000	0,000	0,000
Unfrozen water content		None	None	None	None

#### 1.1.3.1 Calculation information

Calculation information	
Step info	
Phase	Initial phase [InitialPhase]
Step	Initial
Calculation mode	Classical mode
Step type	Gravity loading
Solver type	Picos
Kernel type	64 bit
Extrapolation factor	1,025

Relative stiffness 0,3786

Multipliers

Soil weight  $\Sigma M_{\text{Weight}}$  1,000

Strength reduction factor  $M_{\text{sf}}$  0,000  $\Sigma M_{\text{sf}}$  1,000

Time Increment 0,000 End time 0,000

Staged construction

Active proportion total area  $M_{\text{Area}}$  0,3026  $\Sigma M_{\text{Area}}$  0,9007

Active proportion of stage  $M_{\text{Stage}}$  0,3360  $\Sigma M_{\text{Stage}}$  1,000

Calculation information

Forces

$F_x$  0,000 kN/m

$F_y$  0,000 kN/m

Consolidation

Realised  $P_{\text{Excess,Max}}$  0,000 kN/m<sup>2</sup>

### 1.1.3.2 Calculation information

Calculation information				
Step info				
Phase	Phase_1 [Phase_1]			
Step	Initial			
Calculation mode	Classical mode			
Step type	Plastic			
Updated mesh	False			
Solver type	Picos			
Kernel type	64 bit			
Extrapolation factor	0,9878			
Relative stiffness	0,4068			
Multipliers				
Soil weight			$\Sigma M_{\text{Weight}}$	1,000
Strength reduction factor	$M_{\text{sf}}$	0,000	$\Sigma M_{\text{sf}}$	1,000
Time	Increment	0,000	End time	0,000
Staged construction				
Active proportion total area	$M_{\text{Area}}$	0,02217	$\Sigma M_{\text{Area}}$	0,9455
Calculation information				
Active proportion of stage	$M_{\text{Stage}}$	0,3082	$\Sigma M_{\text{Stage}}$	1,000

Forces

$F_x$  0,000 kN/m

$F_y$  0,000 kN/m

Consolidation

Realised  $P_{\text{Excess,Max}}$  0,000 kN/m<sup>2</sup>

### 1.1.3.3 Calculation information

Calculation information				
Step info				
Phase	Phase_2 [Phase_2]			
Step	Initial			
Calculation mode	Classical mode			
Step type	Plastic			
Updated mesh	False			
Solver type	Picos			
Kernel type	64 bit			
Extrapolation factor	0,7471			
Relative stiffness	0,4281			
Multipliers				
Soil weight			$\Sigma M_{\text{Weight}}$	1,000
Strength reduction factor	$M_{\text{sf}}$	0,000	$\Sigma M_{\text{sf}}$	1,000
Time	Increment	0,000	End time	0,000
Staged construction				
Active proportion total area	$M_{\text{Area}}$	0,01162	$\Sigma M_{\text{Area}}$	0,9766
Calculation information				
Active proportion of stage	$M_{\text{Stage}}$	0,2389	$\Sigma M_{\text{Stage}}$	1,000

Forces

$F_x$  0,000 kN/m

$F_y$  0,000 kN/m

Consolidation

Realised  $P_{Excess,Max}$  0,000 kN/m<sup>2</sup>



#### 1.1.3.4 Calculation information

Calculation information				
Step info				
Phase	Phase_4 [Phase_4]			
Step	Initial			
Calculation mode	Classical mode			
Step type	Plastic			
Updated mesh	False			
Solver type	Picos			
Kernel type	64 bit			
Extrapolation factor	0,9997			
Relative stiffness	0,3475			
Multipliers				
Soil weight			$\Sigma M_{\text{Weight}}$	1,000
Strength reduction factor	$M_{\text{sf}}$	0,000	$\Sigma M_{\text{sf}}$	1,000
Time	Increment	0,000	End time	0,000
Staged construction				
Active proportion total area	$M_{\text{Area}}$	2,056E-3	$\Sigma M_{\text{Area}}$	0,9995
Calculation information				
Active proportion of stage	$M_{\text{Stage}}$	0,2821	$\Sigma M_{\text{Stage}}$	1,000

Forces

$F_x$  0,000 kN/m

$F_y$  0,000 kN/m

Consolidation

Realised  $P_{\text{Excess,Max}}$  0,000 kN/m<sup>2</sup>

1.1.3.5 Calculation information

Calculation information				
Step info				
Phase	Phase_5_static [Phase_5]			
Step	Initial			
Calculation mode	Classical mode			
Step type	Plastic			
Updated mesh	False			
Solver type	Picos			
Kernel type	64 bit			
Extrapolation factor	1,060			
Relative stiffness	0,1980			
Multipliers				
Soil weight			$\Sigma M_{\text{Weight}}$	1,000
Strength reduction factor	$M_{\text{sf}}$	0,000	$\Sigma M_{\text{sf}}$	1,000
Time	Increment	0,000	End time	0,000
Staged construction				
Active proportion total area	$M_{\text{Area}}$	0,2629E-3	$\Sigma M_{\text{Area}}$	1,000
Calculation information				
Active proportion of stage	$M_{\text{Stage}}$	0,2386	$\Sigma M_{\text{Stage}}$	1,000

Forces

$F_x$  0,000 kN/m

$F_y$  0,000 kN/m

Consolidation

Realised  $P_{\text{Excess,Max}}$  0,000 kN/m<sup>2</sup>

1.1.3.6 Calculation information

Calculation information				
Step info				
Phase	Phase_8 _seismic [Phase_8]			
Step	Initial			
Calculation mode	Classical mode			
Step type	Plastic			
Updated mesh	False			
Solver type	Picos			
Kernel type	64 bit			
Extrapolation factor	0,4567			
Relative stiffness	0,1528			
Multipliers				
Soil weight			$\Sigma M_{\text{Weight}}$	1,000
Strength reduction factor	$M_{\text{sf}}$	0,000	$\Sigma M_{\text{sf}}$	1,000
Time	Increment	0,000	End time	0,000
Staged construction				
Active proportion total area	$M_{\text{Area}}$	0,000	$\Sigma M_{\text{Area}}$	1,000
Calculation information				
Active proportion of stage	$M_{\text{Stage}}$	0,07614	$\Sigma M_{\text{Stage}}$	1,000

Forces	
$F_x$	0,000 kN/m
$F_y$	0,000 kN/m
Consolidation	
Realised $P_{\text{Excess,Max}}$	0,000 kN/m <sup>2</sup>
Pseudo-static acceleration	
X	5,000E-3 g
Y	3,000E-3 g

1.1.3.7 Calculation information

Calculation information				
Step info				
Phase	Phase_3 [Phase_3]			
Step	Initial			
Calculation mode	Classical mode			
Step type	Plastic			
Updated mesh	False			
Solver type	Picos			
Kernel type	64 bit			
Extrapolation factor	0,03150			
Relative stiffness	0,3463			
Multipliers				
Soil weight			$\Sigma M_{Weight}$	1,000
Strength reduction factor	$M_{sf}$	0,000	$\Sigma M_{sf}$	1,000
Time	Increment	0,000	End time	0,000
Staged construction				
Active proportion total area	$M_{Area}$	0,2953E-3	$\Sigma M_{Area}$	0,9954
Calculation information				
Active proportion of stage	$M_{Stage}$	9,330E-3	$\Sigma M_{Stage}$	1,000

Forces

$F_x$  0,000 kN/m

$F_y$  0,000 kN/m

Consolidation

Realised  $P_{\text{Excess,Max}}$  0,000 kN/m<sup>2</sup>



#### 1.1.4 Calculation information per phase

Identification	Phase	Start from Calculation type	Loading input	Pore pressure	Time step [day]	First step	Last step
Initial phase [InitialPhase]	0	N/A Gravity loading	N/A	Phreatic	0,000	0	13
Phase_1 [Phase_1]	8	0 Plastic	Staged construction	Phreatic	0,000	14	18
Phase_2 [Phase_2]	9	8 Plastic	Staged construction	Phreatic	0,000	19	22
Phase_3 [Phase_3]	10	9 Plastic	Staged construction	Phreatic	0,000	36	39
Phase_4 [Phase_4]	11	10 Plastic	Staged construction	Phreatic	0,000	23	25
Phase_5_static [Phase_5]	12	11 Plastic	Staged construction	Phreatic	0,000	26	28
Phase_8 _seismic [Phase_8]	2	12 Plastic	Staged construction	Phreatic	0,000	29	32

1.1.5.1 Step info

Step	Phase Step type	Extrapolation factor	Relative stiffness [ $10^{-3}$ ]
13	0 Gravity loading	1,025	378,643
18	8 Plastic	0,988	406,838
22	9 Plastic	0,747	428,115
39	10 Plastic	0,031	346,261
25	11 Plastic	1,000	347,466
28	12 Plastic	1,060	198,030
32	2 Plastic	0,457	152,754

1.1.5.2 Multipliers

Step	Phase $\Sigma M_{DispX}$	$\Sigma M_{DispY}$	$\Sigma M_{Weight}$	$M_{sf}$	$\Sigma M_{sf}$
13	0 0,000	0,000	1,000	0,000	1,000
18	8 0,000	0,000	1,000	0,000	1,000
22	9 0,000	0,000	1,000	0,000	1,000
39	10 0,000	0,000	1,000	0,000	1,000
25	11 0,000	0,000	1,000	0,000	1,000
28	12 0,000	0,000	1,000	0,000	1,000
32	2 0,000	0,000	1,000	0,000	1,000

### 1.1.5.3 Time

Step	Phase Time step [day]	End time [day]
13	0 0,000	0,000
18	8 0,000	0,000
22	9 0,000	0,000
39	10 0,000	0,000
25	11 0,000	0,000
28	12 0,000	0,000
32	2 0,000	0,000

1.1.5.4 Staged construction

Step	Phase M <sub>Area</sub>	ΣM <sub>Area</sub>	M <sub>Stage</sub> [10 <sup>-3</sup> ]	ΣM <sub>Stage</sub>
13	0 1,000	0,901	335,955	1,000
18	8 0,624	0,946	308,229	1,000
22	9 0,639	0,977	238,869	1,000
39	10 0,592	0,995	9,330	1,000
25	11 0,564	1,000	282,118	1,000
28	12 0,450	1,000	238,620	1,000
32	2 0,333	1,000	76,139	1,000

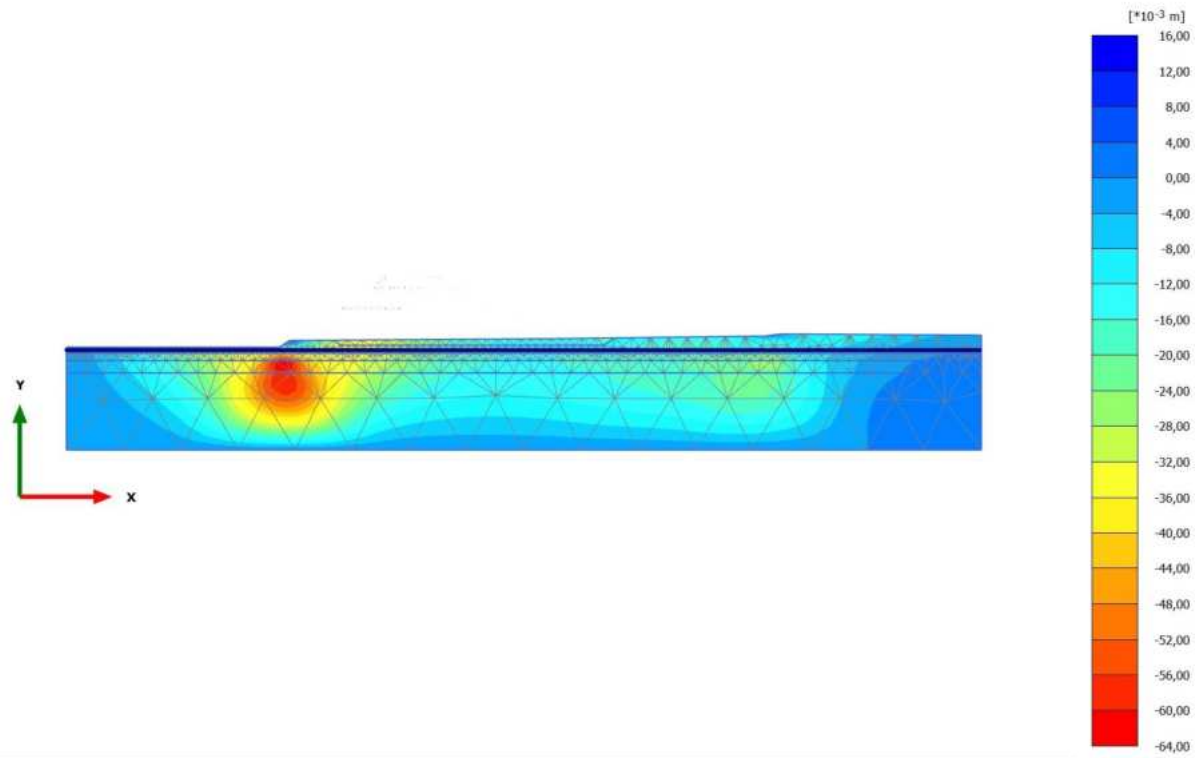
### 1.1.5.5 Forces

Step	Phase $F_x$ [kN/m]	$F_y$ [kN/m]
13	0 0,000	0,000
18	8 0,000	0,000
22	9 0,000	0,000
39	10 0,000	0,000
25	11 0,000	0,000
28	12 0,000	0,000
32	2 0,000	0,000

### 1.1.5.6 Consolidation

Step	Phase Rel. P <sub>Max</sub> [kN/m <sup>2</sup> ]
13	0 0,000
18	8 0,000
22	9 0,000
39	10 0,000
25	11 0,000
28	12 0,000
32	2 0,000

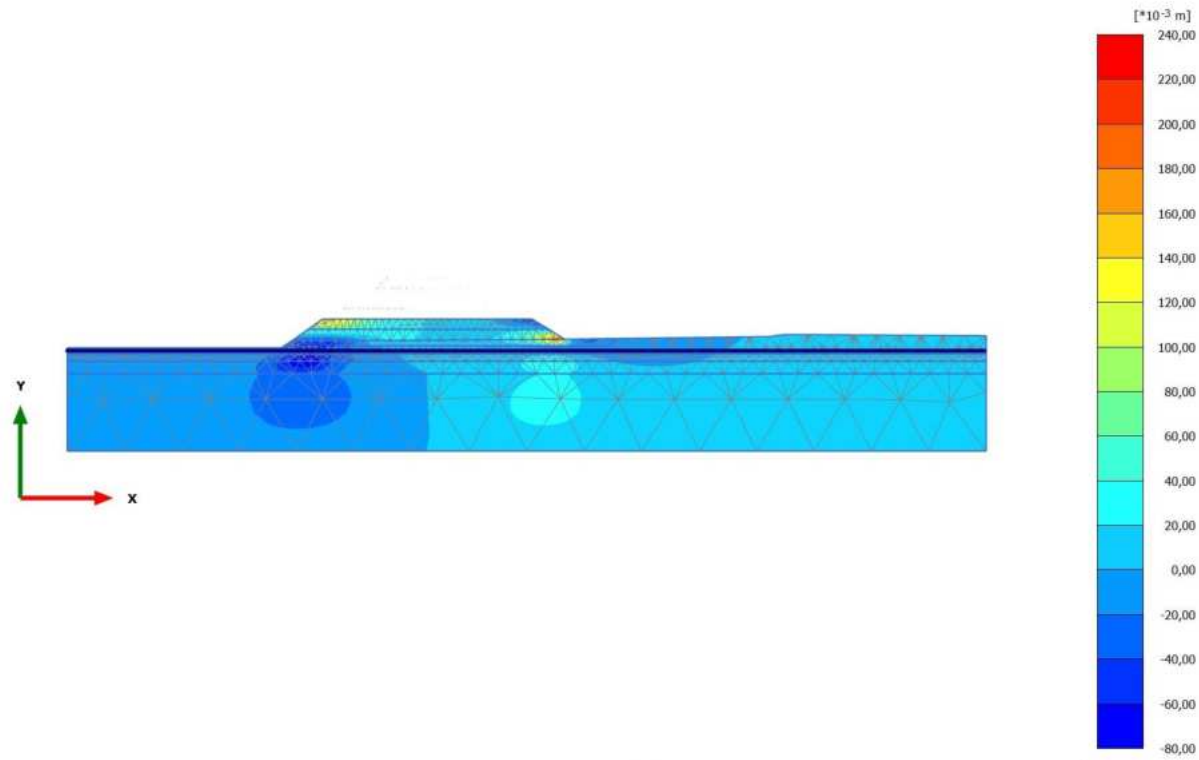
2.1.1.1.1 Calculation results, Initial phase [InitialPhase] (0/13), Total displacements  $u_x$



**Total displacements  $u_x$  (scaled up 500 times)**  
Maximum value = 0,01548 m (Element 731 at Node 1549)  
Minimum value = -0,06374 m (Element 1773 at Node 7688)

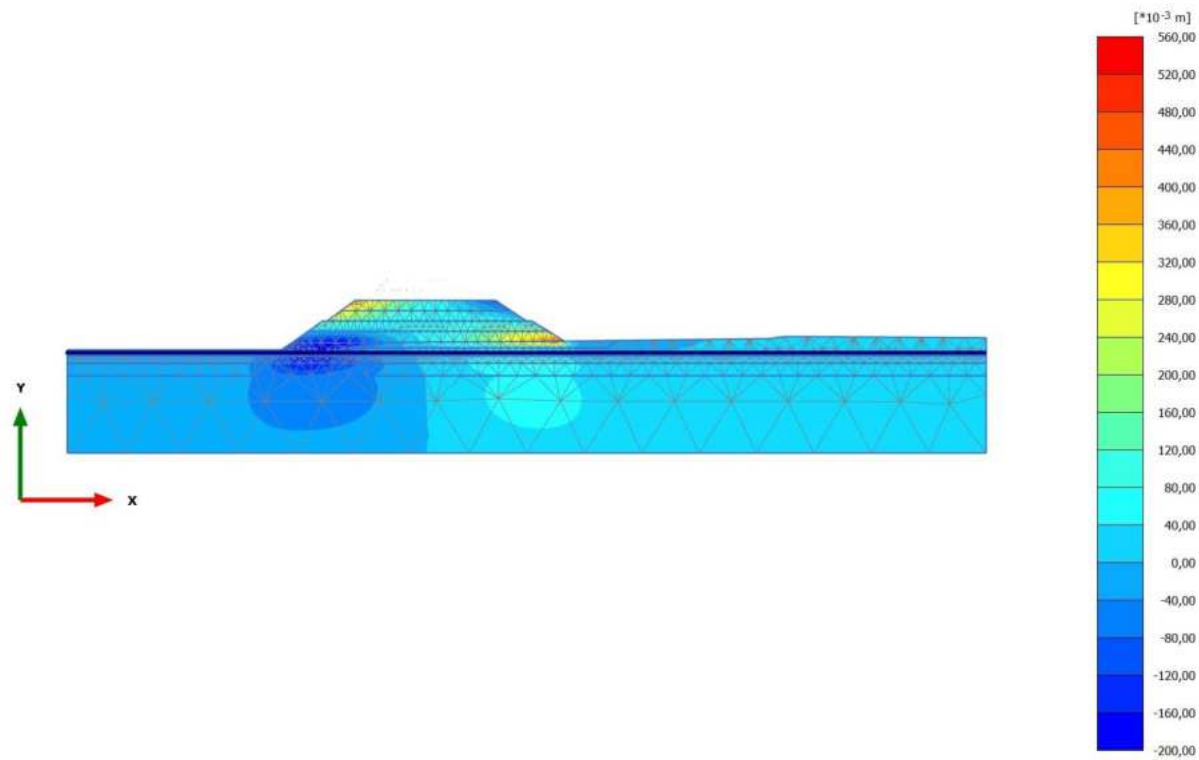


2.1.1.1.2 Calculation results, Phase\_1 [Phase\_1] (8/18), Total displacements  $u_x$



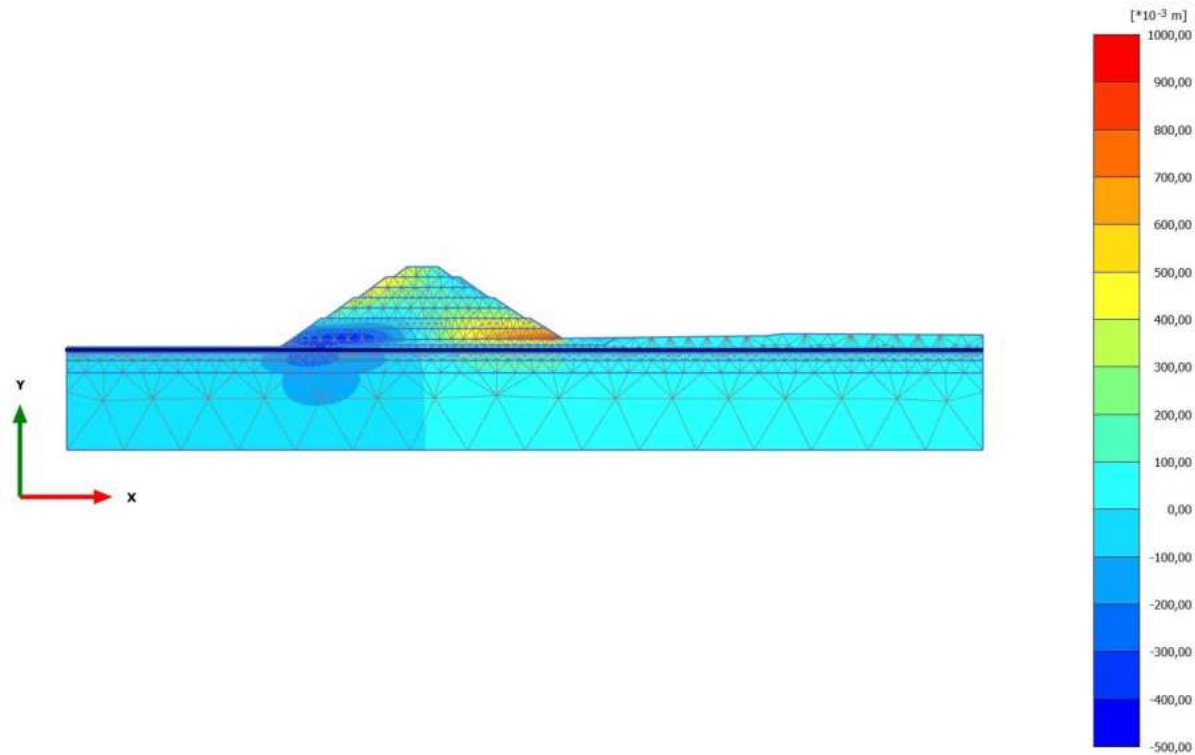
**Total displacements  $u_x$  (scaled up 50,0 times)**  
Maximum value = 0,2339 m (Element 287 at Node 8163)  
Minimum value = -0,07324 m (Element 1228 at Node 7667)

2.1.1.1.3 Calculation results, Phase\_2 [Phase\_2] (9/22), Total displacements  $u_x$



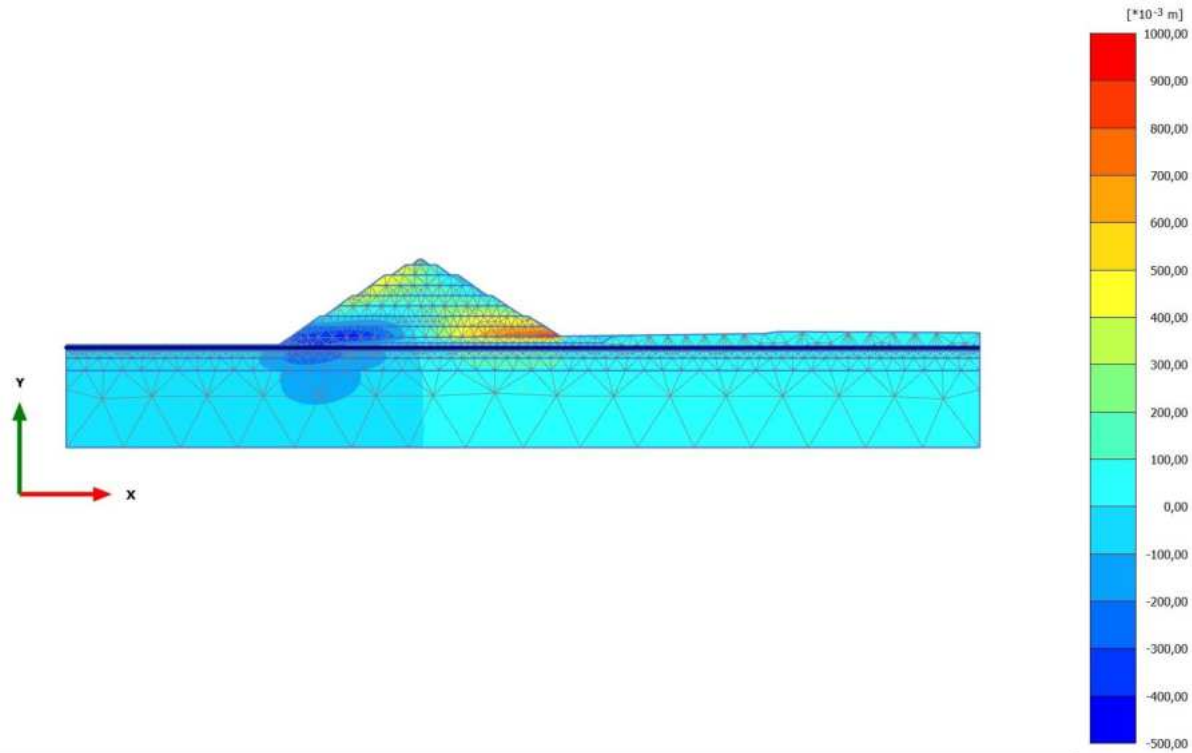
**Total displacements  $u_x$  (scaled up 50,0 times)**  
Maximum value = 0,5203 m (Element 287 at Node 8163)  
Minimum value = -0,1969 m (Element 268 at Node 2229)

2.1.1.1.4 Calculation results, Phase\_4 [Phase\_4] (11/25), Total displacements  $u_x$



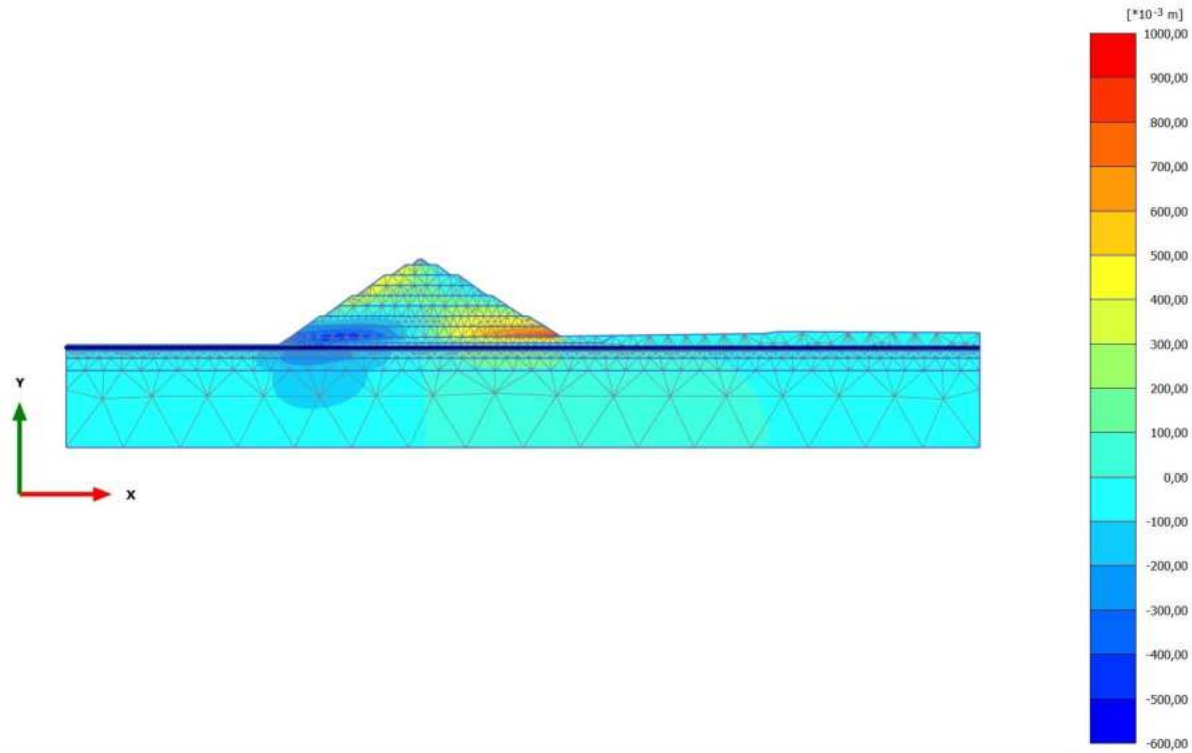
**Total displacements  $u_x$  (scaled up 20,0 times)**  
Maximum value = 0,9602 m (Element 287 at Node 8163)  
Minimum value = -0,4546 m (Element 268 at Node 2497)

2.1.1.1.5 Calculation results, Phase\_5\_static [Phase\_5] (12/28), Total displacements  $u_x$



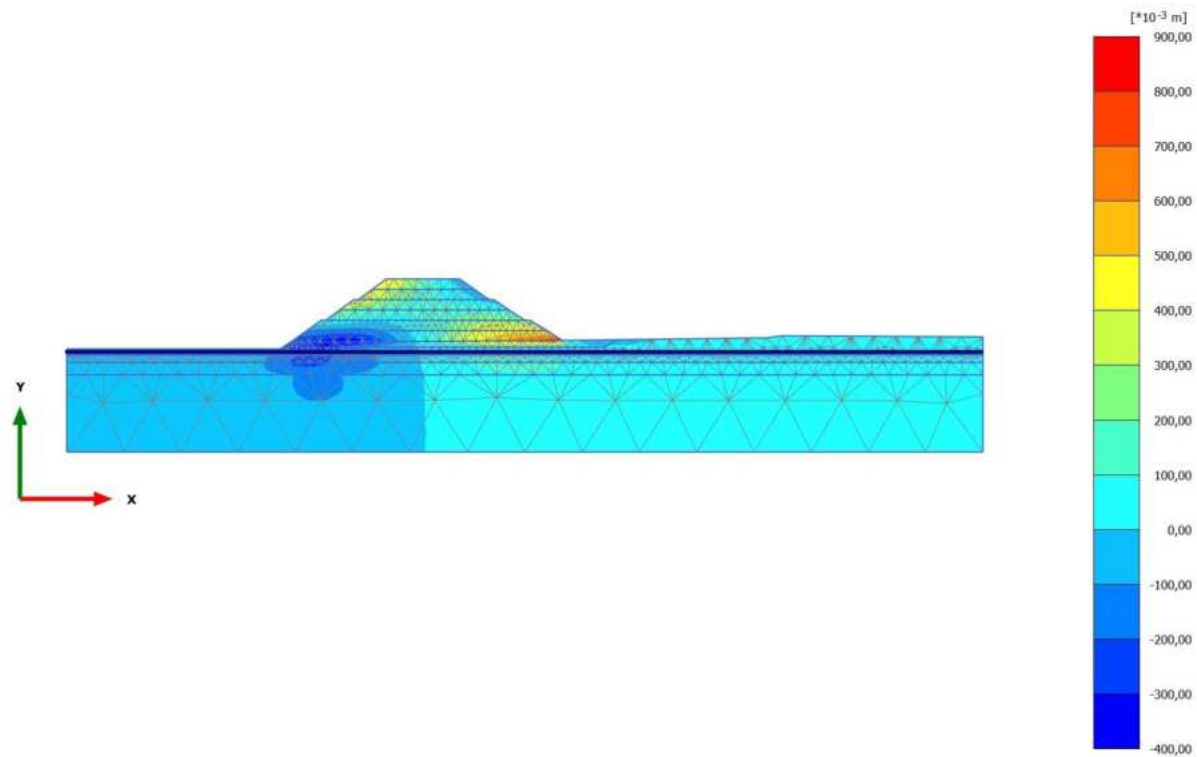
**Total displacements  $u_x$  (scaled up 20,0 times)**  
Maximum value = 0,9979 m (Element 287 at Node 8163)  
Minimum value = -0,4707 m (Element 268 at Node 2497)

2.1.1.1.6 Calculation results, Phase\_8\_seismic [Phase\_8] (2/32), Total displacements  $u_x$



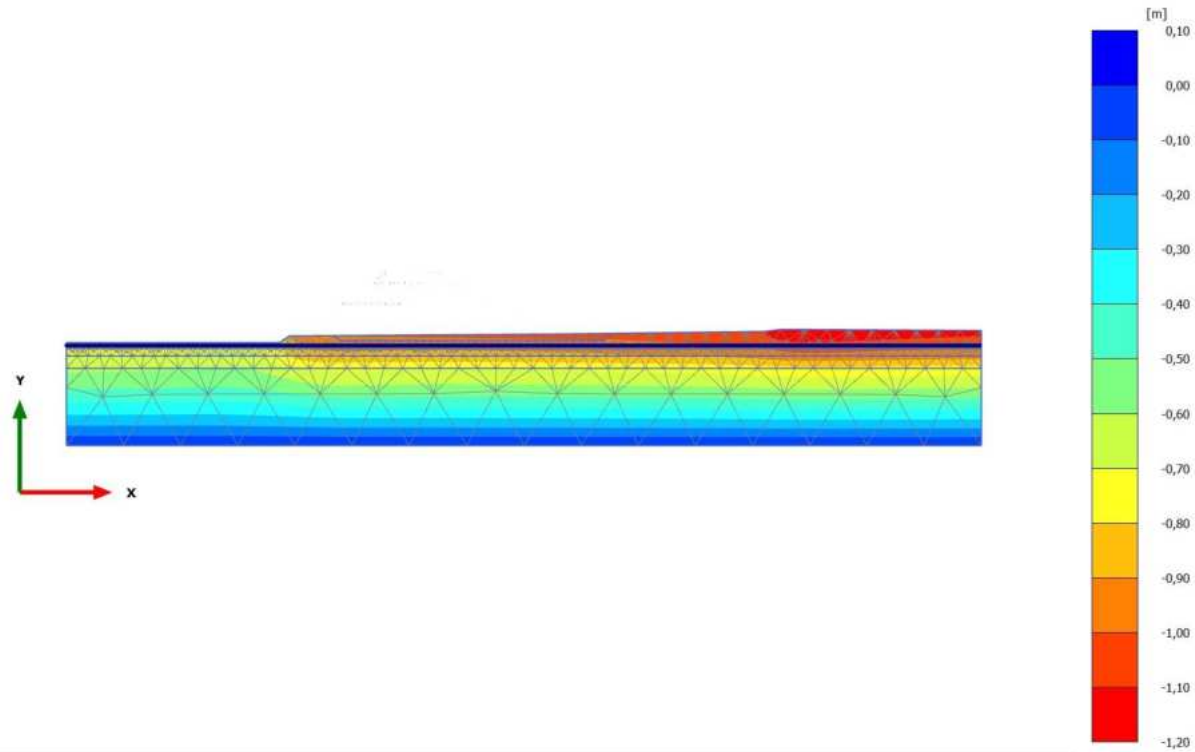
**Total displacements  $u_x$  (scaled up 20,0 times)**  
Maximum value = 0,9914 m (Element 287 at Node 8163)  
Minimum value = -0,5053 m (Element 268 at Node 2497)

2.1.1.1.7 Calculation results, Phase\_3 [Phase\_3] (10/39), Total displacements  $u_x$



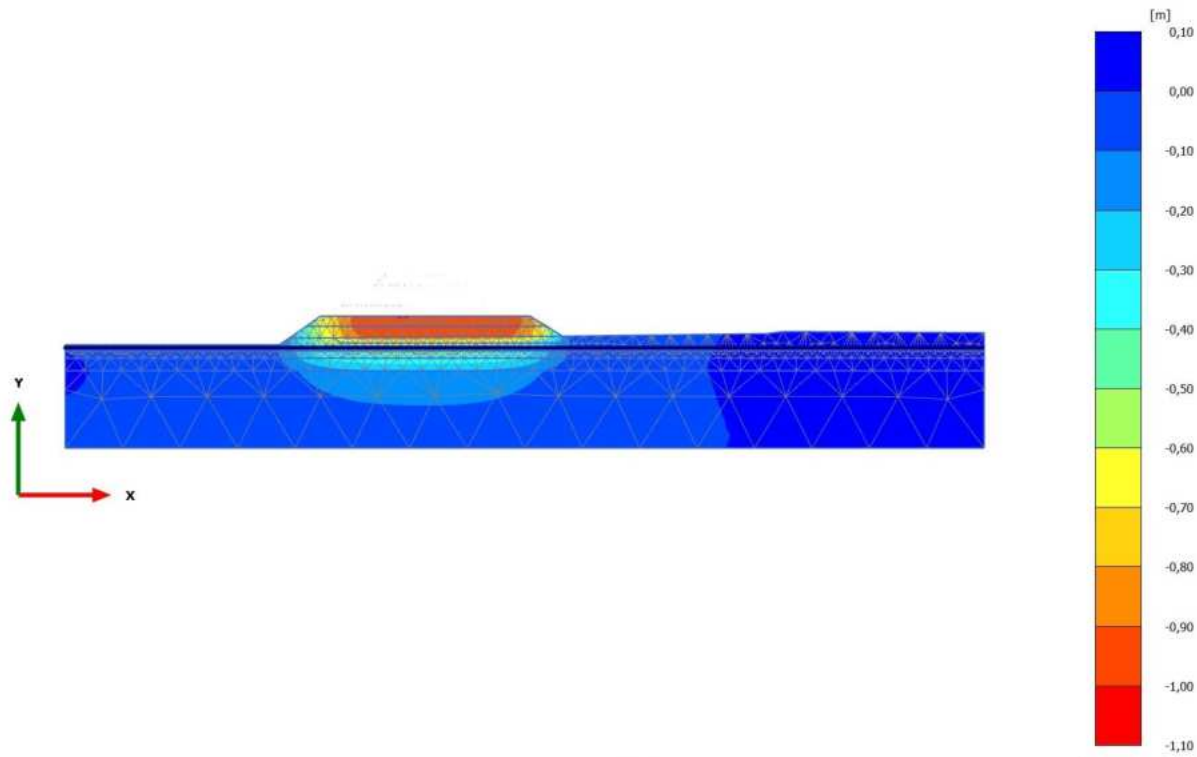
**Total displacements  $u_x$  (scaled up 20,0 times)**  
Maximum value = 0,8357 m (Element 287 at Node 8163)  
Minimum value = -0,3866 m (Element 268 at Node 2231)

2.1.1.2.1 Calculation results, Initial phase [InitialPhase] (0/13), Total displacements  $u_y$



**Total displacements  $u_y$  (scaled up 20,0 times)**  
Maximum value = 0,000 m (Element 1790 at Node 5189)  
Minimum value = -1,163 m (Element 391 at Node 13563)

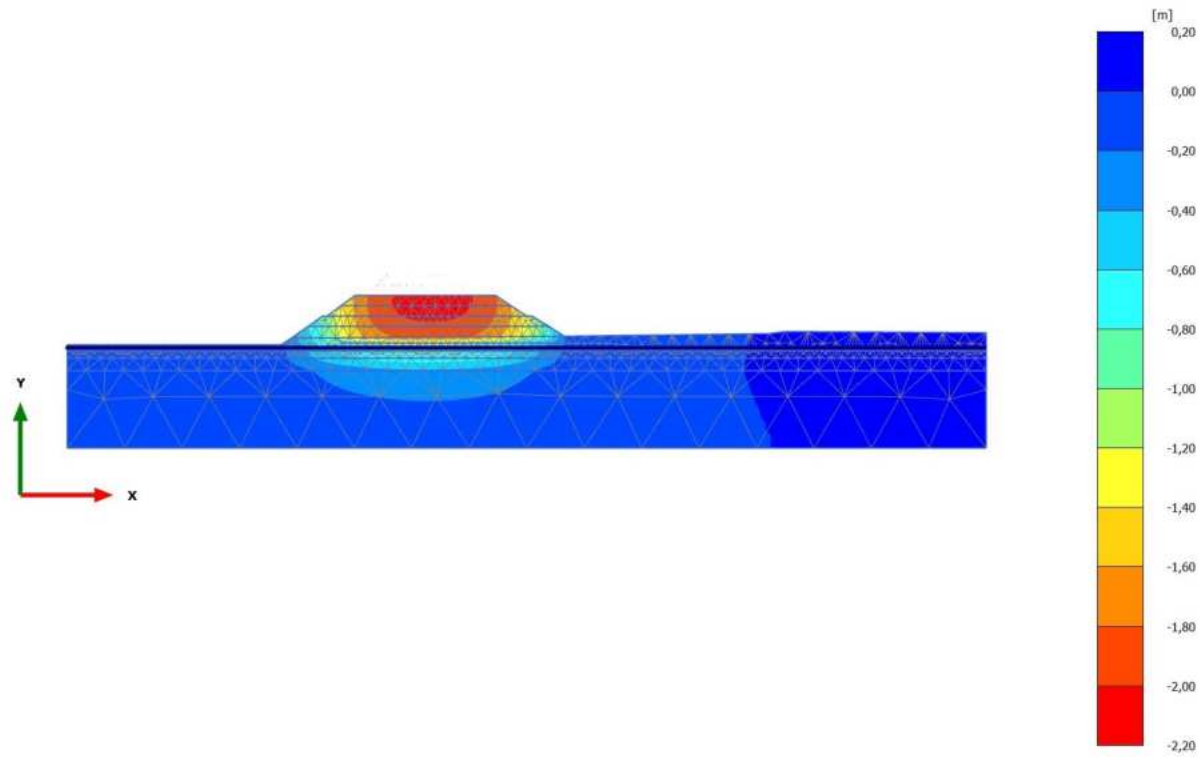
2.1.1.2.2 Calculation results, Phase\_1 [Phase\_1] (8/18), Total displacements  $u_y$



**Total displacements  $u_y$  (scaled up 20,0 times)**  
Maximum value =  $0,8020 \cdot 10^{-3}$  m (Element 420 at Node 13276)  
Minimum value = -1,000 m (Element 190 at Node 1296)

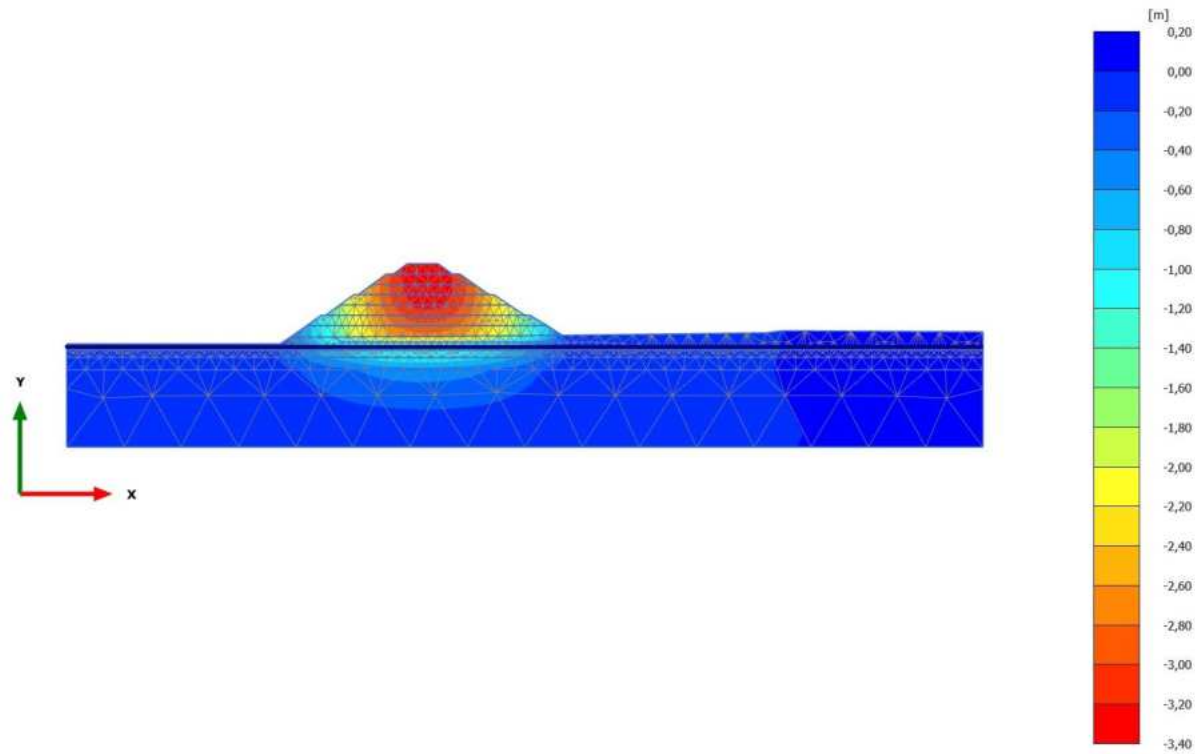


2.1.1.2.3 Calculation results, Phase\_2 [Phase\_2] (9/22), Total displacements  $u_y$



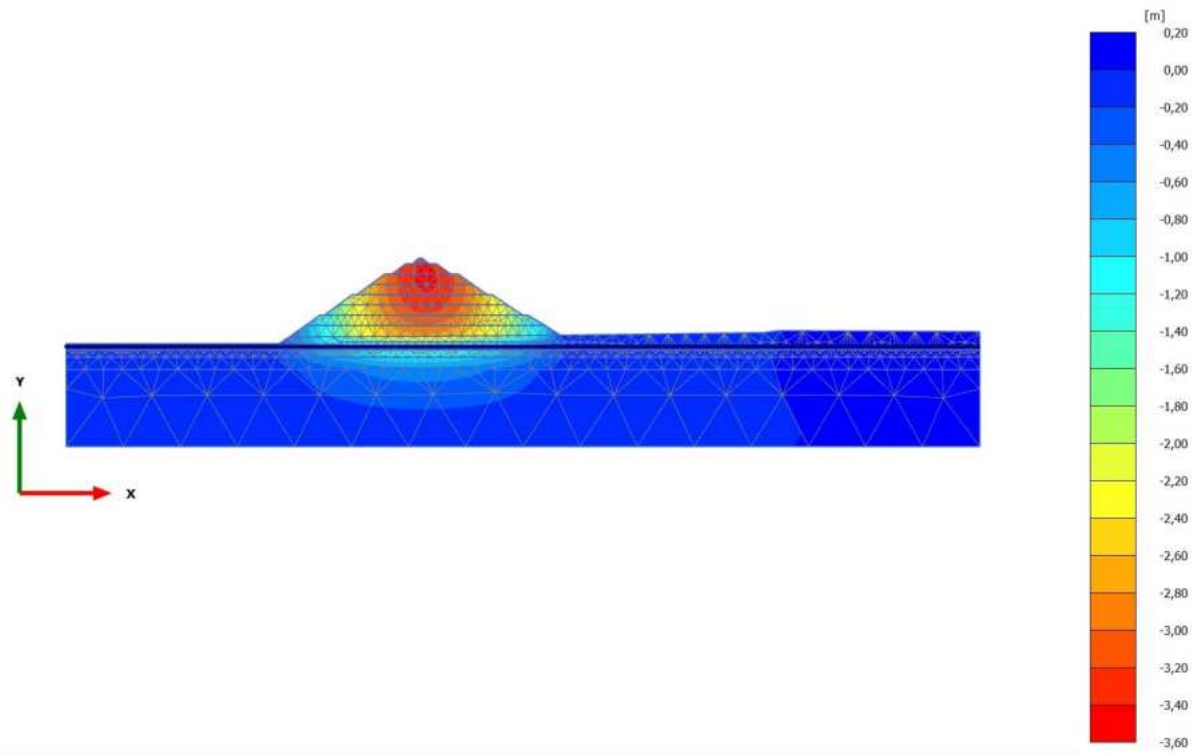
**Total displacements  $u_y$  (scaled up 10,0 times)**  
Maximum value =  $0,7482 \cdot 10^{-3}$  m (Element 1215 at Node 13130)  
Minimum value = -2,082 m (Element 107 at Node 673)

2.1.1.2.4 Calculation results, Phase\_4 [Phase\_4] (11/25), Total displacements  $u_y$



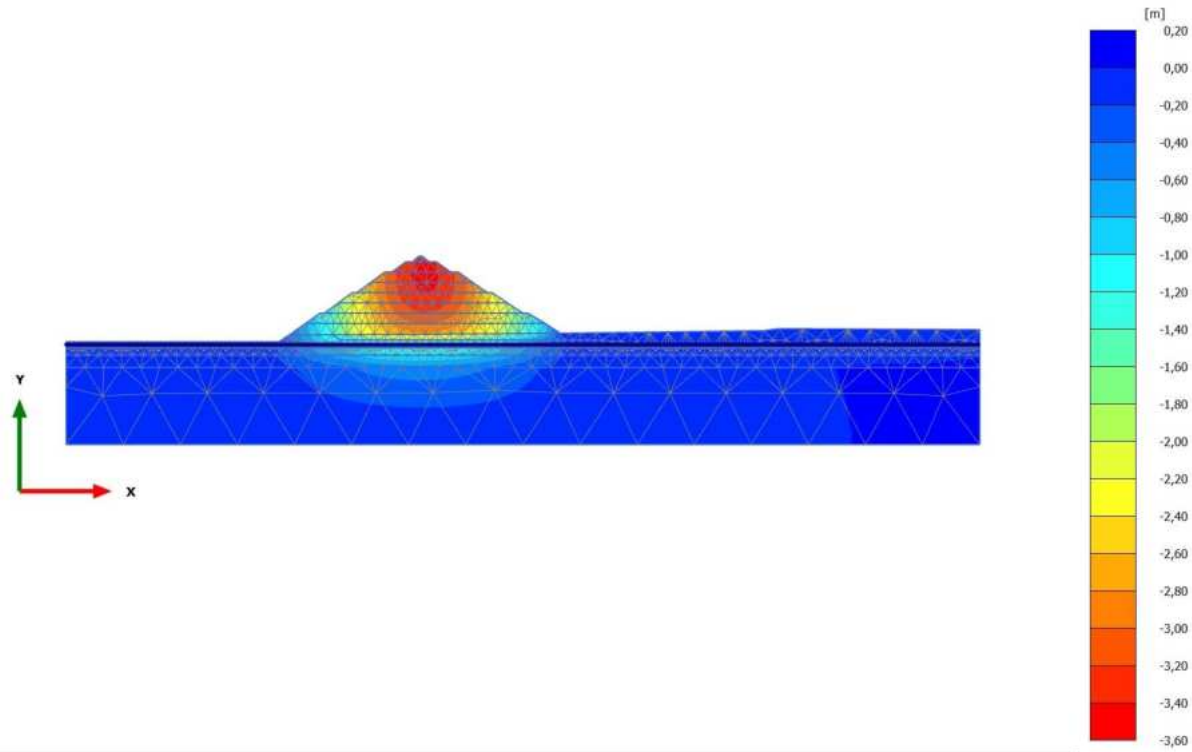
**Total displacements  $u_y$  (scaled up 5,00 times)**  
Maximum value = 0,09866 m (Element 385 at Node 8166)  
Minimum value = -3,383 m (Element 30 at Node 179)

2.1.1.2.5 Calculation results, Phase\_5\_static [Phase\_5] (12/28), Total displacements  $u_y$



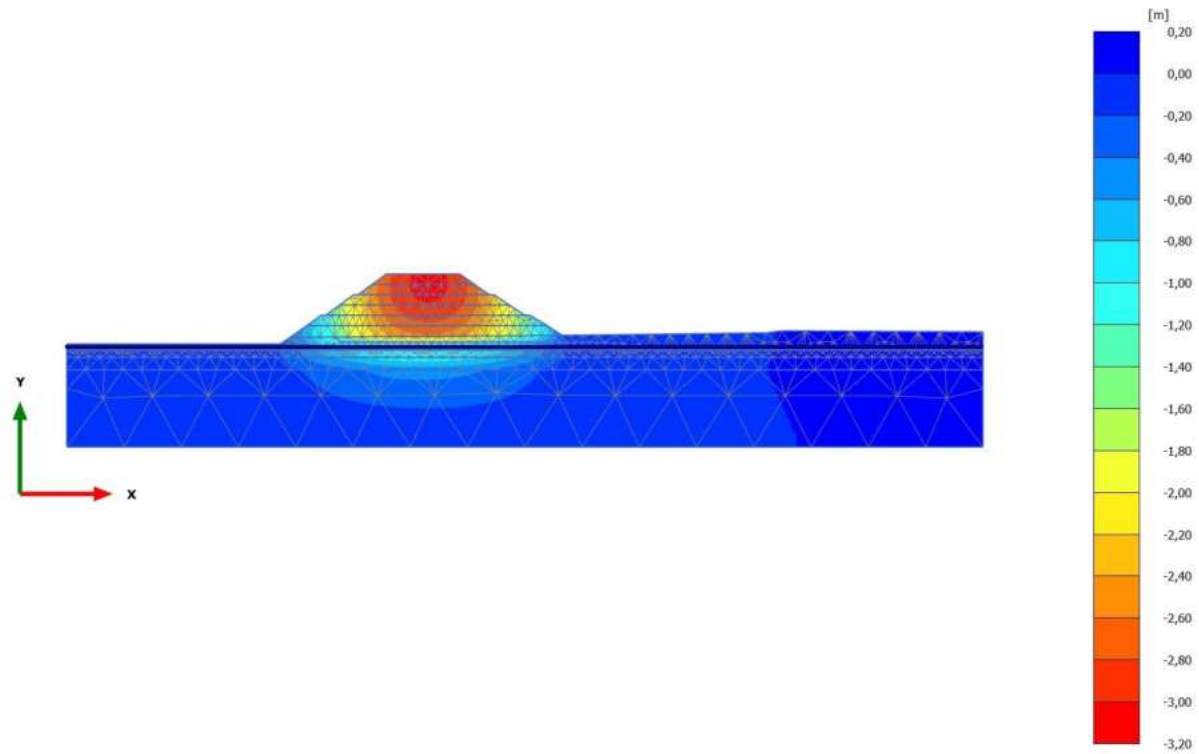
**Total displacements  $u_y$  (scaled up 5,00 times)**  
Maximum value = 0,1212 m (Element 385 at Node 8166)  
Minimum value = -3,439 m (Element 31 at Node 157)

2.1.1.2.6 Calculation results, Phase\_8\_seismic [Phase\_8] (2/32), Total displacements  $u_y$



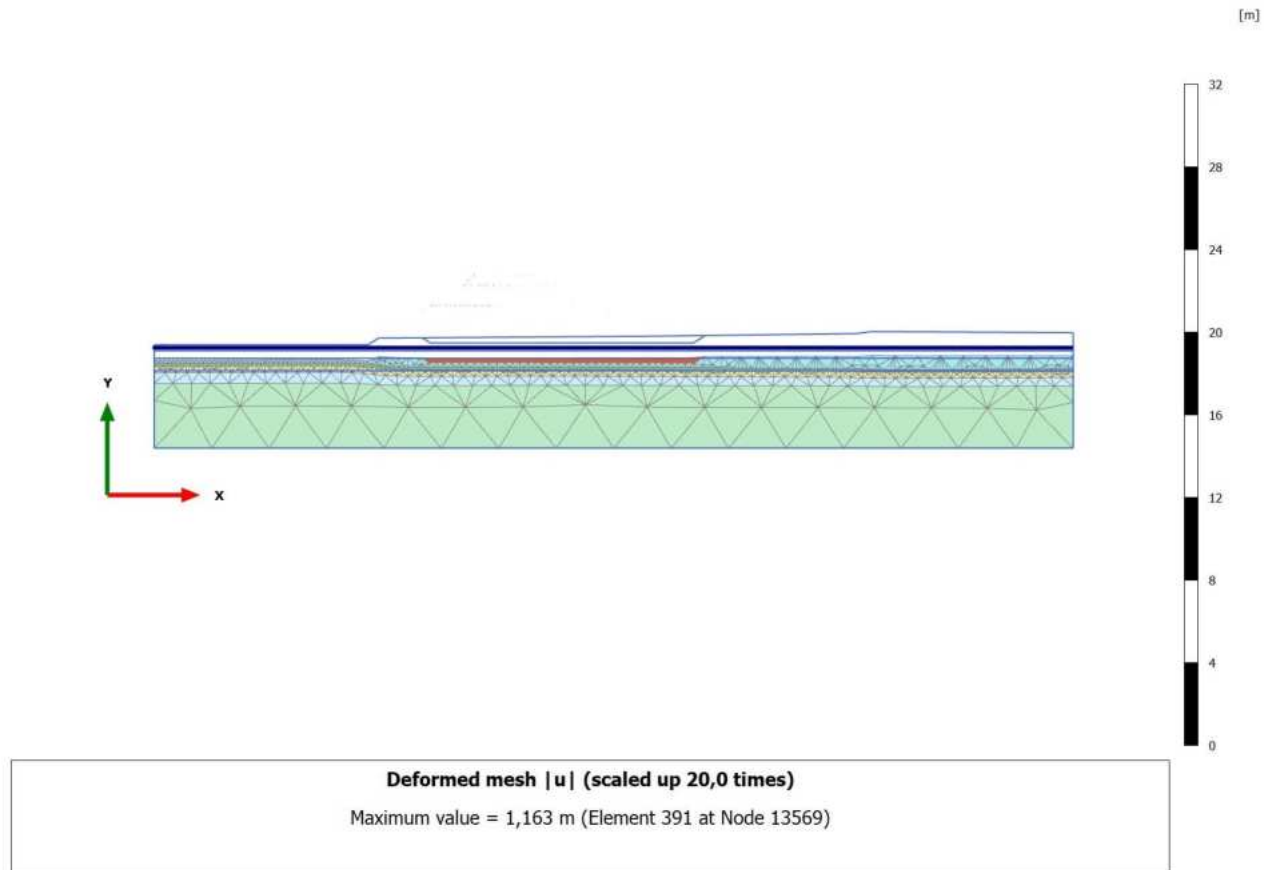
**Total displacements  $u_y$  (scaled up 5,00 times)**  
Maximum value = 0,1270 m (Element 385 at Node 8166)  
Minimum value = -3,460 m (Element 31 at Node 157)

2.1.1.2.7 Calculation results, Phase\_3 [Phase\_3] (10/39), Total displacements  $u_y$

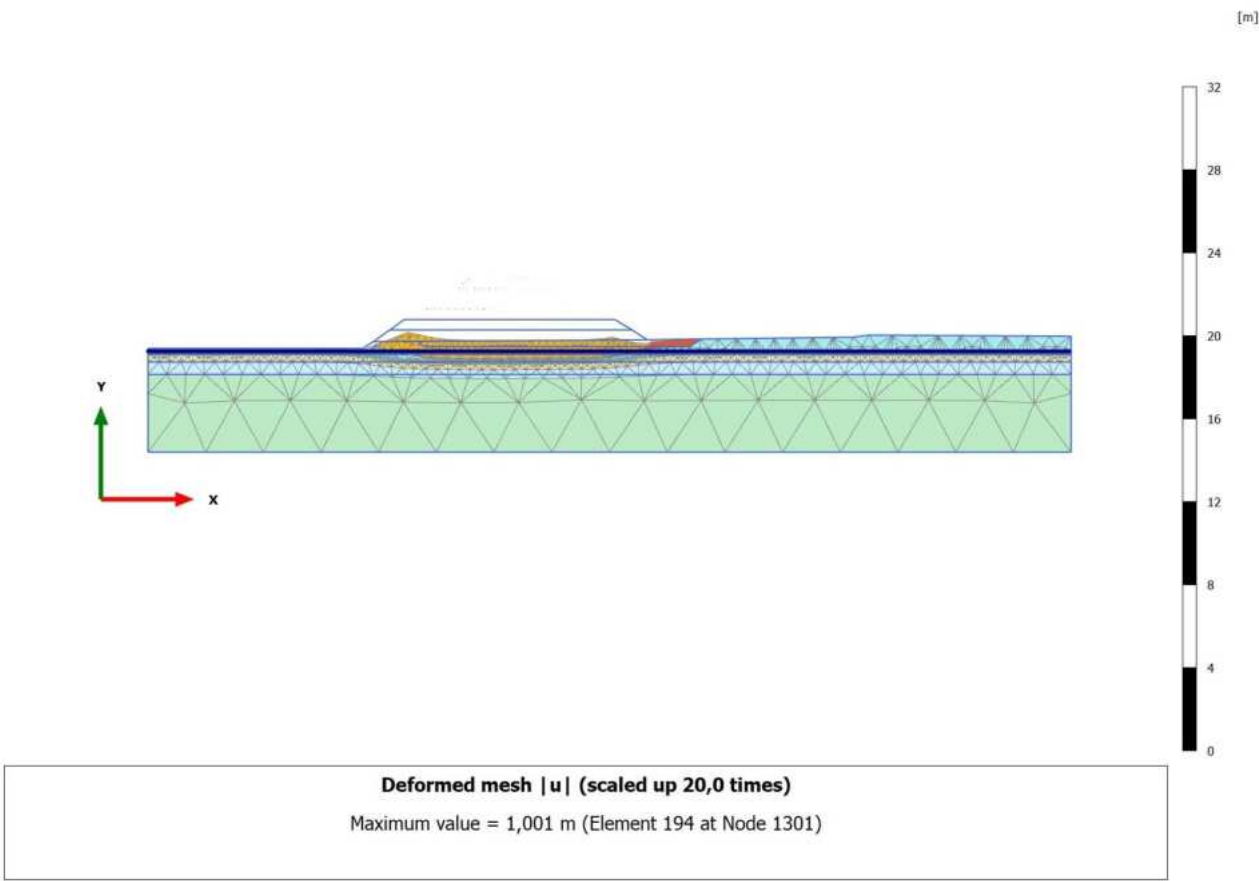


**Total displacements  $u_y$  (scaled up 5,00 times)**  
Maximum value = 0,05768 m (Element 385 at Node 8166)  
Minimum value = -3,062 m (Element 26 at Node 367)

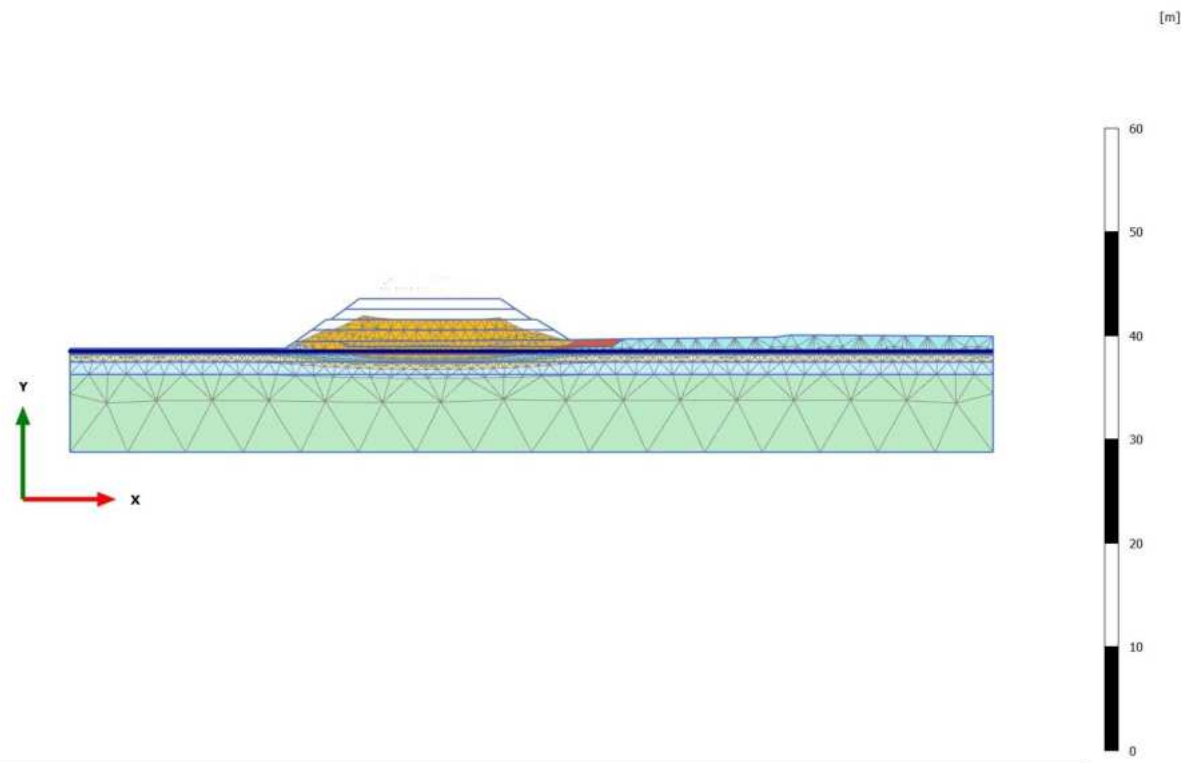
2.1.2.1 Calculation results, Initial phase [InitialPhase] (0/13), Deformed mesh |u|



2.1.2.2 Calculation results, Phase\_1 [Phase\_1] (8/18), Deformed mesh |u|



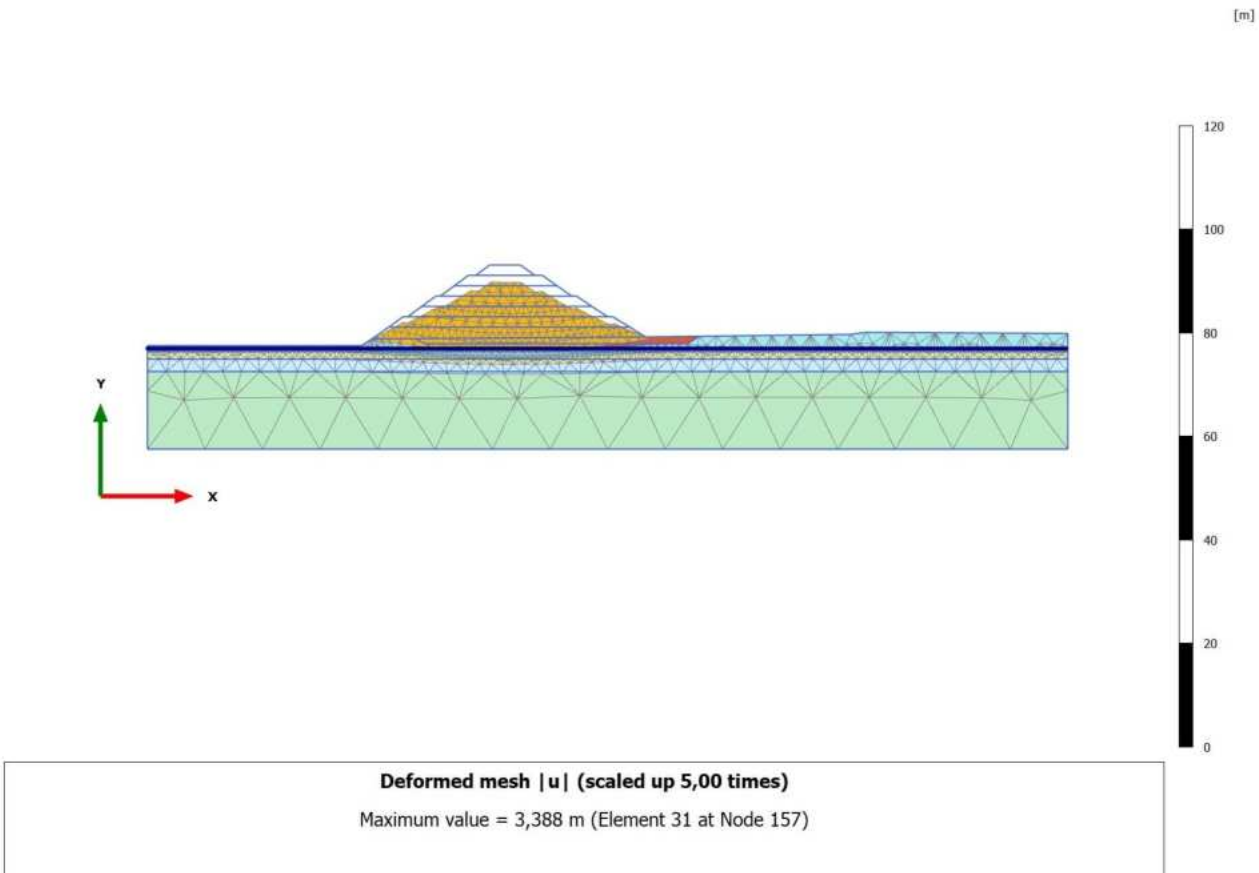
2.1.2.3 Calculation results, Phase\_2 [Phase\_2] (9/22), Deformed mesh |u|



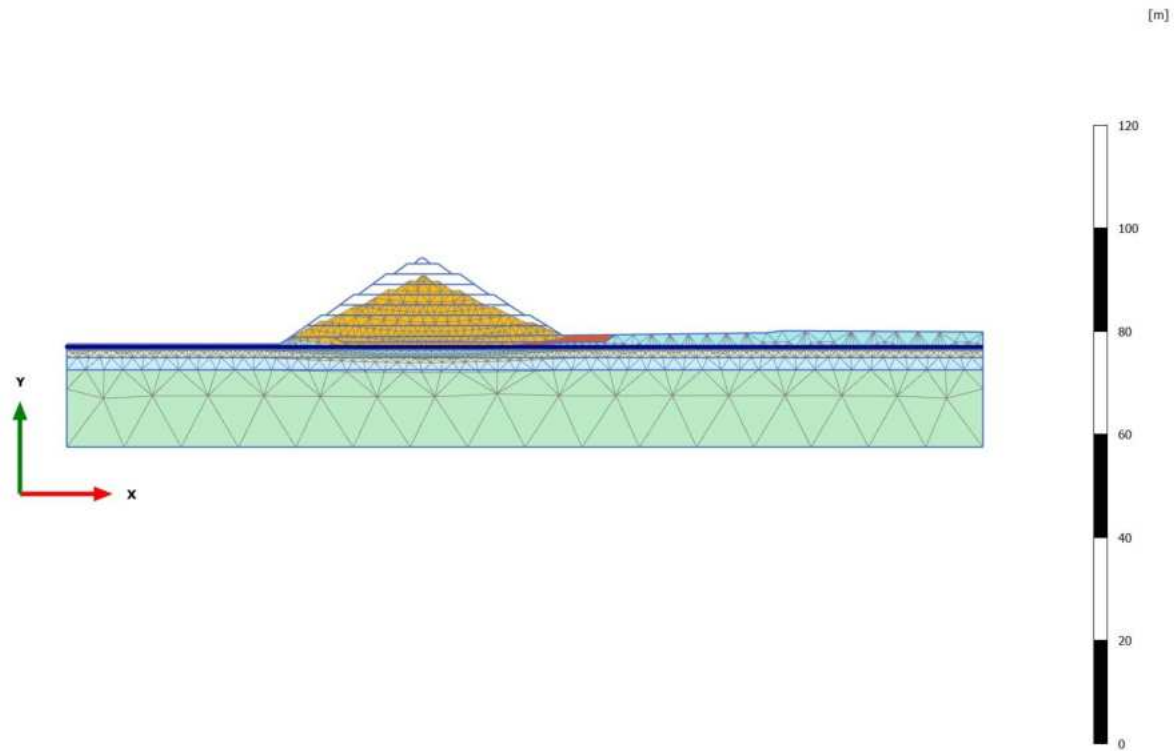
**Deformed mesh |u| (scaled up 10,0 times)**  
Maximum value = 2,083 m (Element 107 at Node 674)



2.1.2.4 Calculation results, Phase\_4 [Phase\_4] (11/25), Deformed mesh |u|

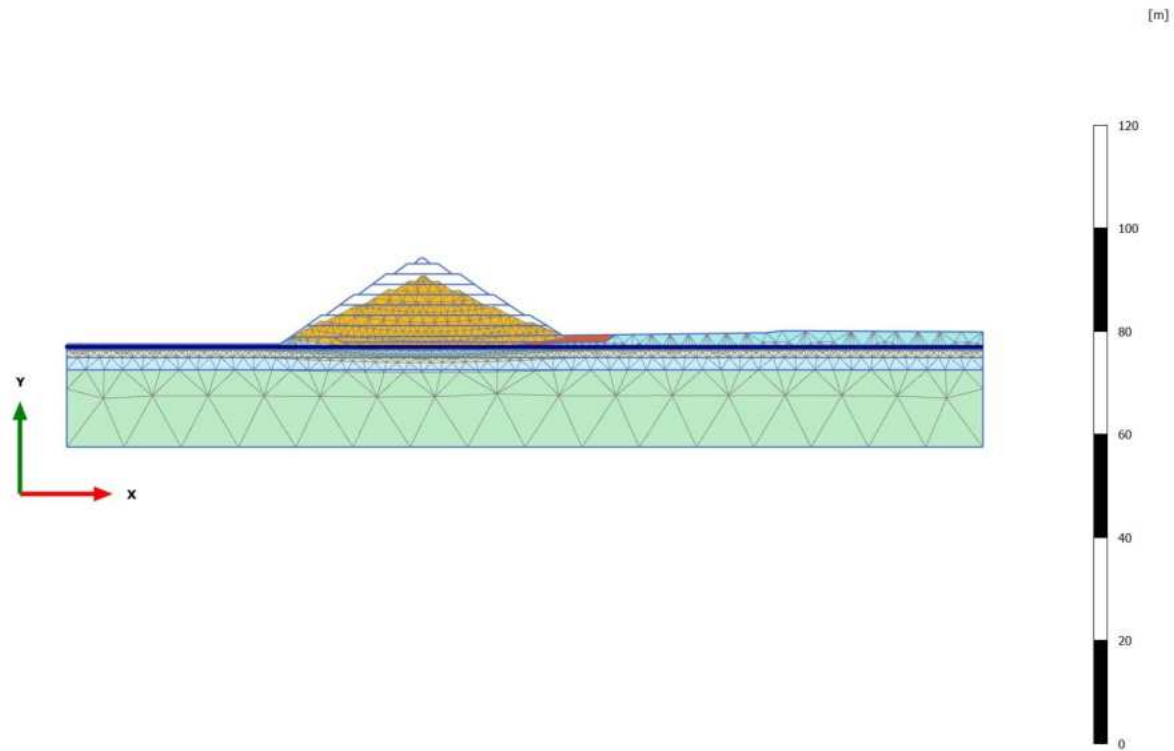


2.1.2.5 Calculation results, Phase\_5\_static [Phase\_5] (12/28), Deformed mesh |u|



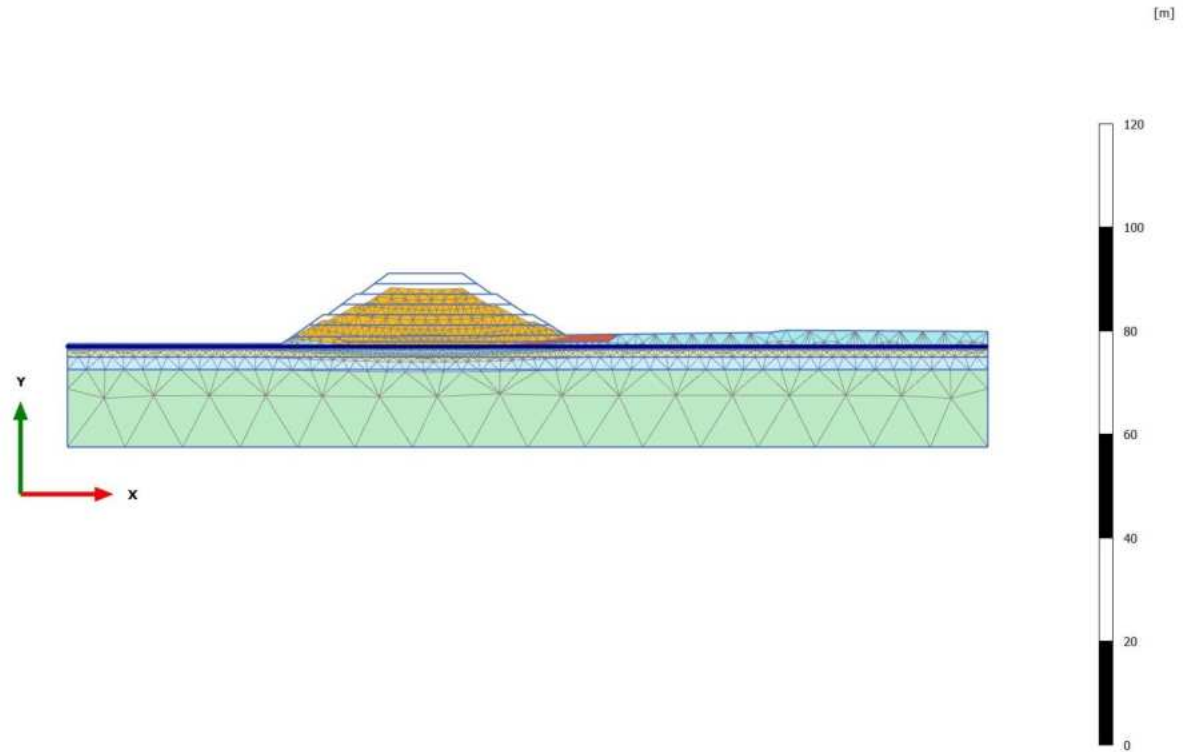
**Deformed mesh |u| (scaled up 5,00 times)**  
Maximum value = 3,445 m (Element 31 at Node 157)

2.1.2.6 Calculation results, Phase\_8 \_seismic [Phase\_8] (2/32), Deformed mesh |u|



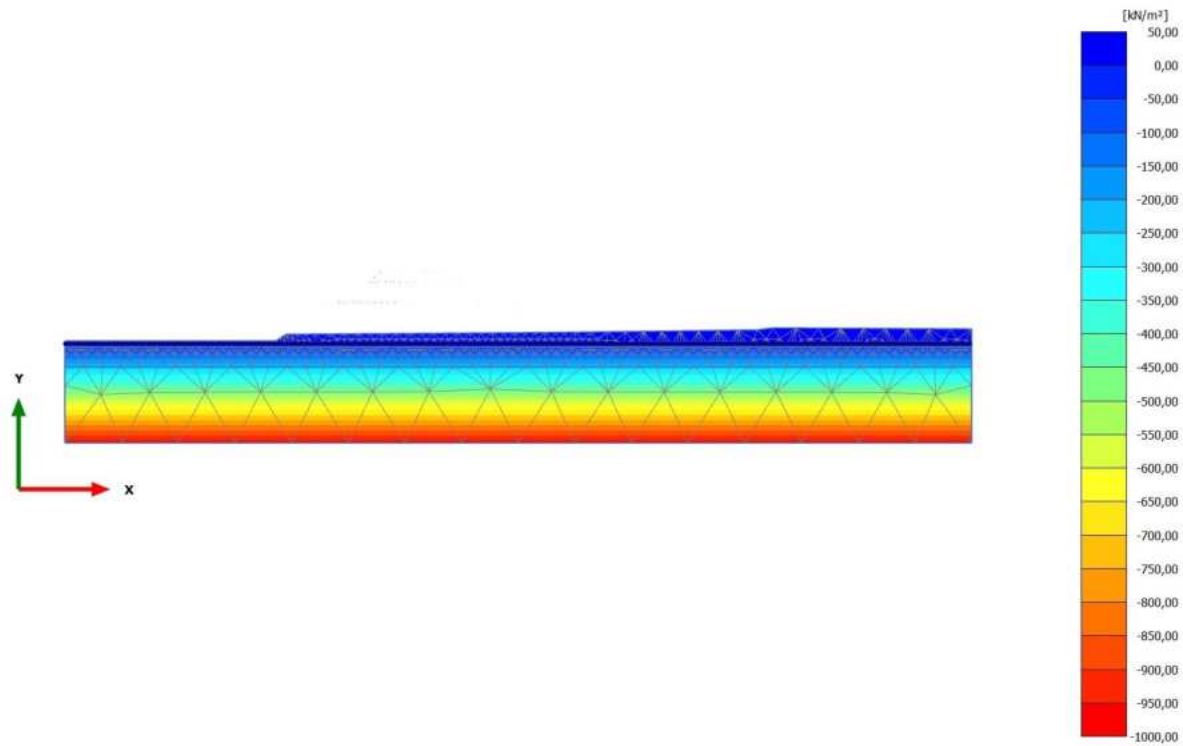
**Deformed mesh |u| (scaled up 5,00 times)**  
Maximum value = 3,464 m (Element 31 at Node 157)

2.1.2.7 Calculation results, Phase\_3 [Phase\_3] (10/39), Deformed mesh |u|



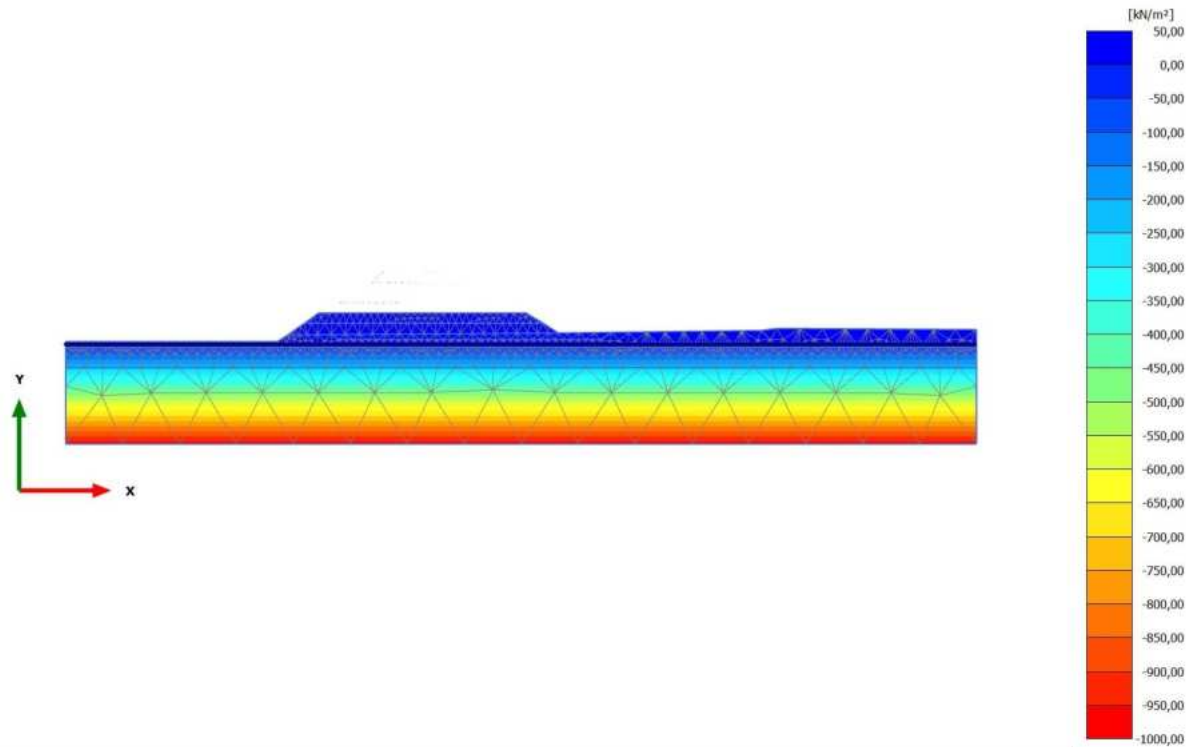
**Deformed mesh |u| (scaled up 5,00 times)**  
Maximum value = 3,065 m (Element 26 at Node 367)

2.2.1.1.1 Calculation results, Initial phase [InitialPhase] (0/13), Steady state pore pressures  $p_{steady}$



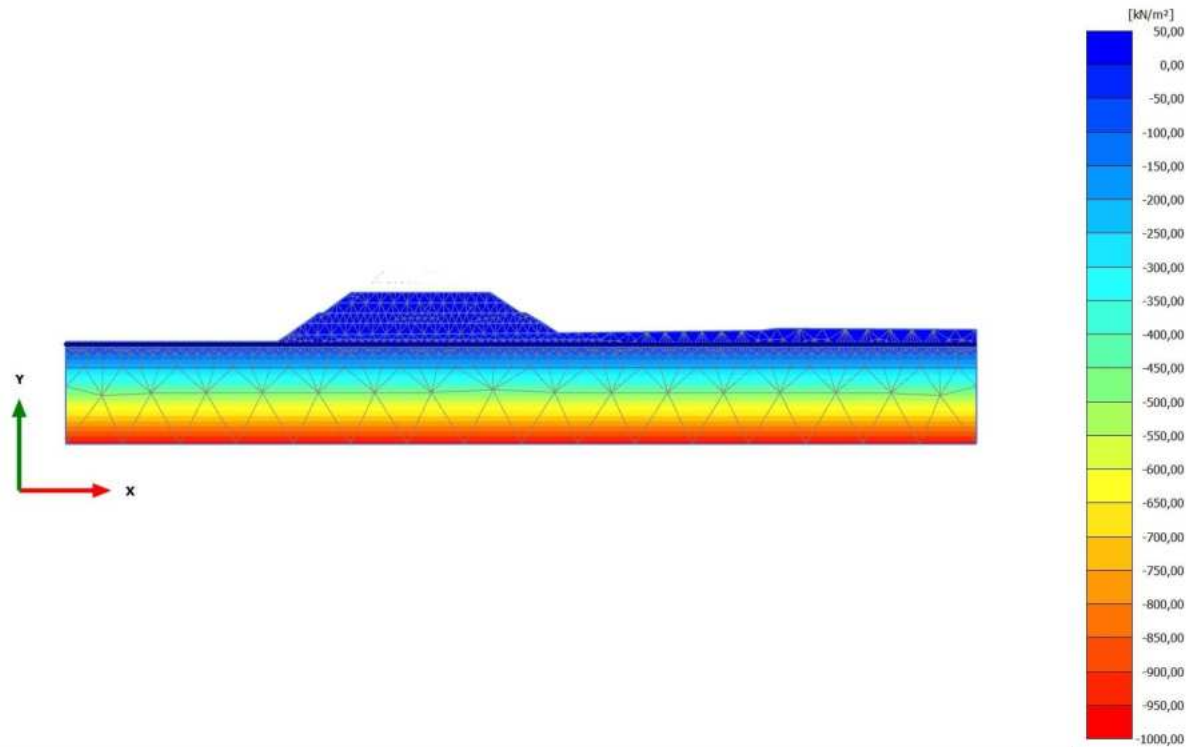
**Steady state pore pressures  $p_{steady}$  (scaled up 0,0200 times) (Pressure = negative)**  
Maximum value = 0,000  $\text{kN/m}^2$  (Element 333 at Node 9763)  
Minimum value = -972,7  $\text{kN/m}^2$  (Element 1791 at Node 14485)

2.2.1.1.2 Calculation results, Phase\_1 [Phase\_1] (8/18), Steady state pore pressures  $p_{steady}$



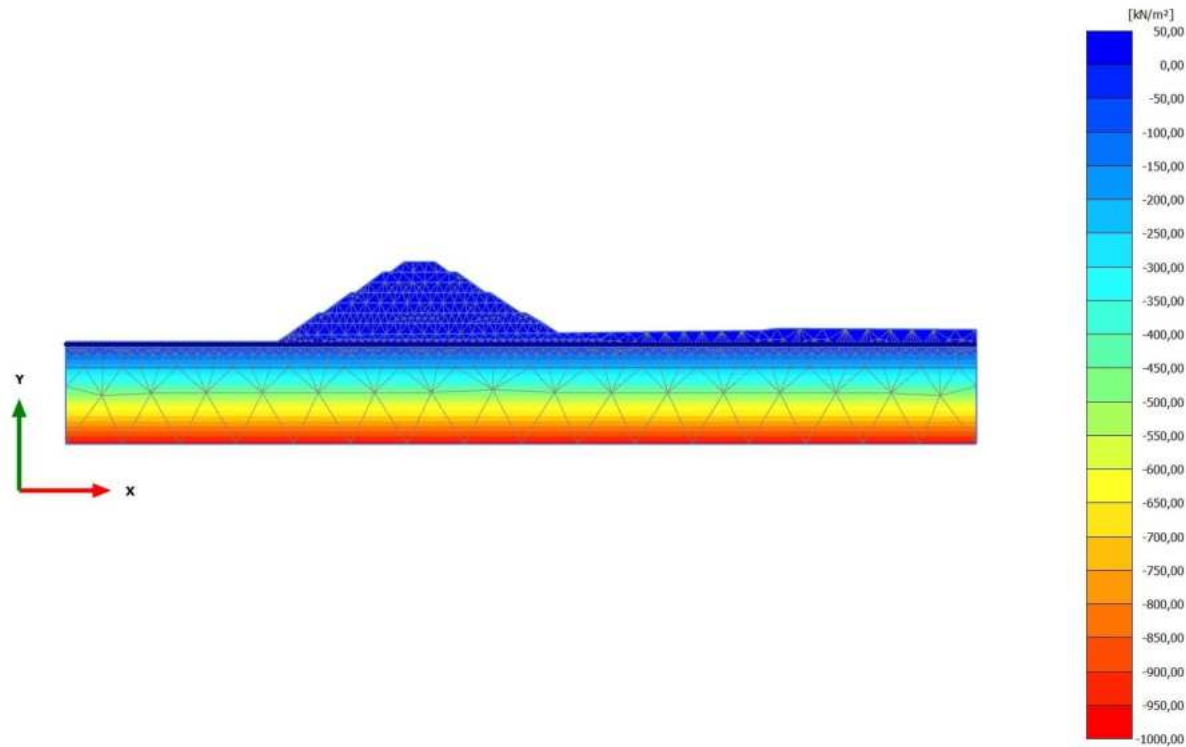
**Steady state pore pressures  $p_{steady}$  (scaled up 0,0200 times) (Pressure = negative)**  
Maximum value = 0,000 kN/m<sup>2</sup> (Element 169 at Node 5713)  
Minimum value = -972,7 kN/m<sup>2</sup> (Element 1791 at Node 14485)

2.2.1.1.3 Calculation results, Phase\_2 [Phase\_2] (9/22), Steady state pore pressures  $p_{steady}$



**Steady state pore pressures  $p_{steady}$  (scaled up 0,0200 times) (Pressure = negative)**  
Maximum value = 0,000 kN/m<sup>2</sup> (Element 81 at Node 895)  
Minimum value = -972,7 kN/m<sup>2</sup> (Element 1791 at Node 14485)

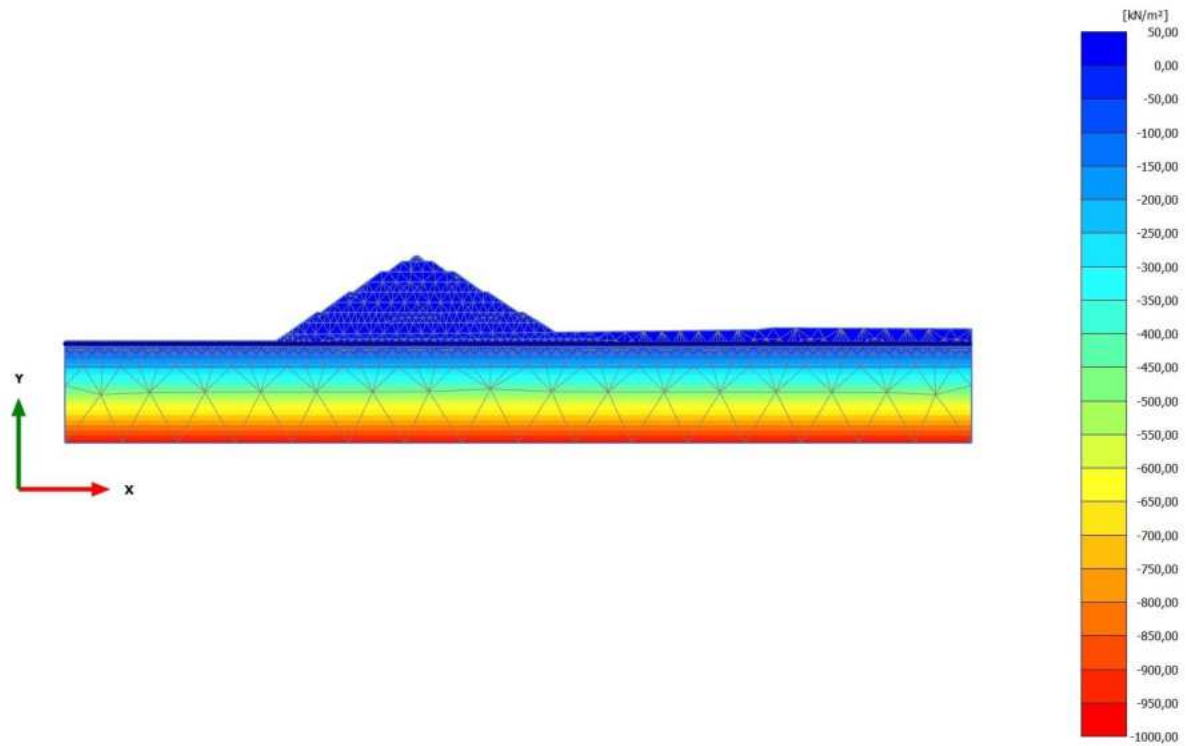
2.2.1.1.4 Calculation results, Phase\_4 [Phase\_4] (11/25), Steady state pore pressures  $p_{steady}$



**Steady state pore pressures  $p_{steady}$  (scaled up 0,0200 times) (Pressure = negative)**  
Maximum value = 0,000 kN/m<sup>2</sup> (Element 10 at Node 175)  
Minimum value = -972,7 kN/m<sup>2</sup> (Element 1791 at Node 14485)

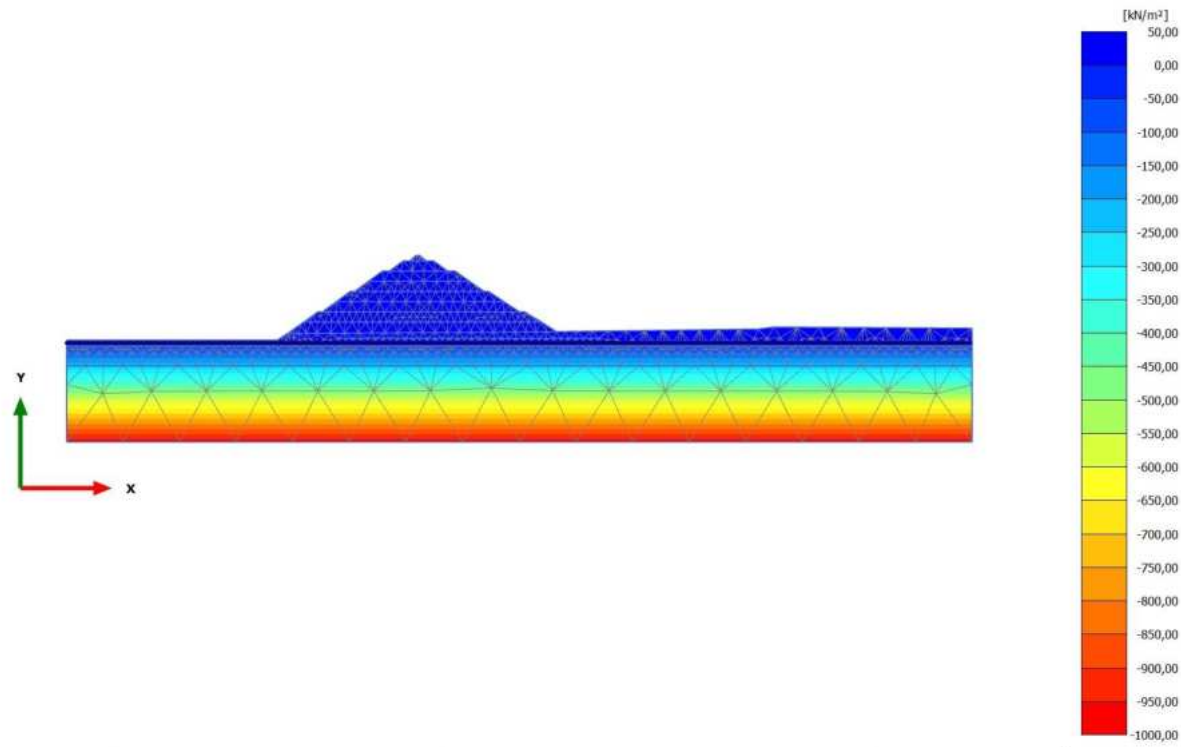


2.2.1.1.5 Calculation results, Phase\_5\_static [Phase\_5] (12/28), Steady state pore pressures  $p_{steady}$



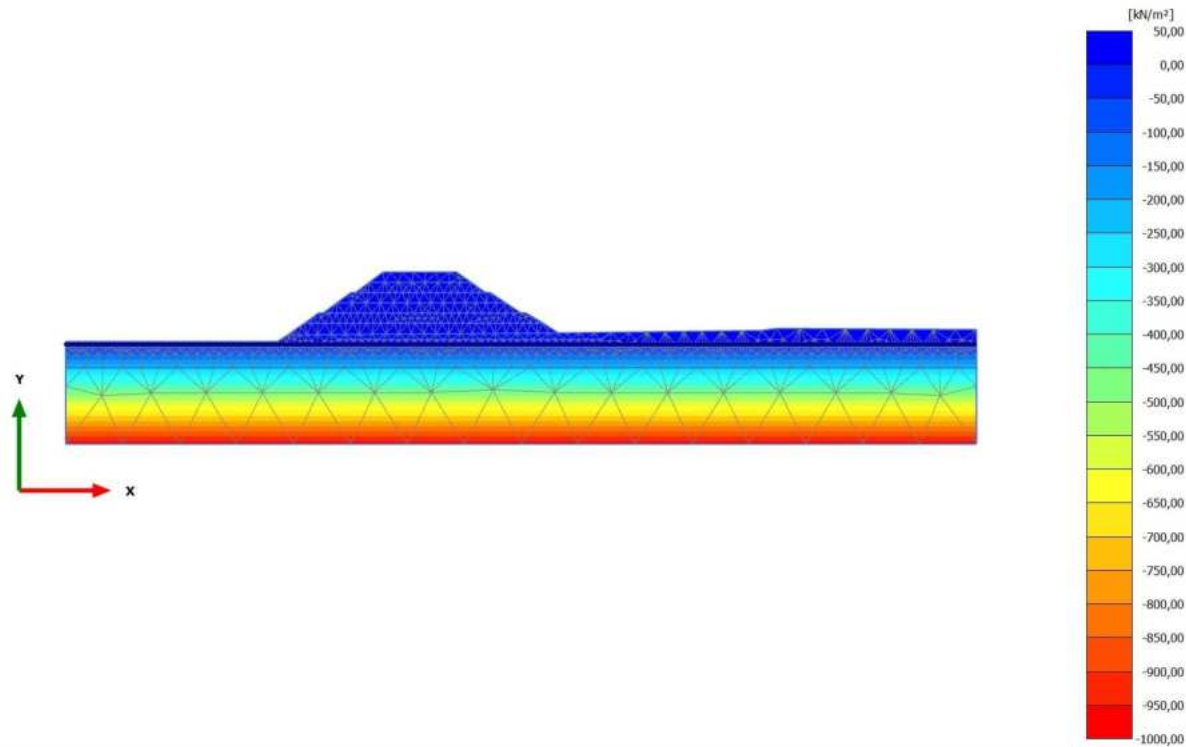
**Steady state pore pressures  $p_{steady}$  (scaled up 0,0200 times) (Pressure = negative)**  
Maximum value = 0,000  $\text{kN/m}^2$  (Element 1 at Node 13)  
Minimum value = -972,7  $\text{kN/m}^2$  (Element 1791 at Node 14485)

2.2.1.1.6 Calculation results, Phase\_8 \_seismic [Phase\_8] (2/32), Steady state pore pressures  $p_{steady}$



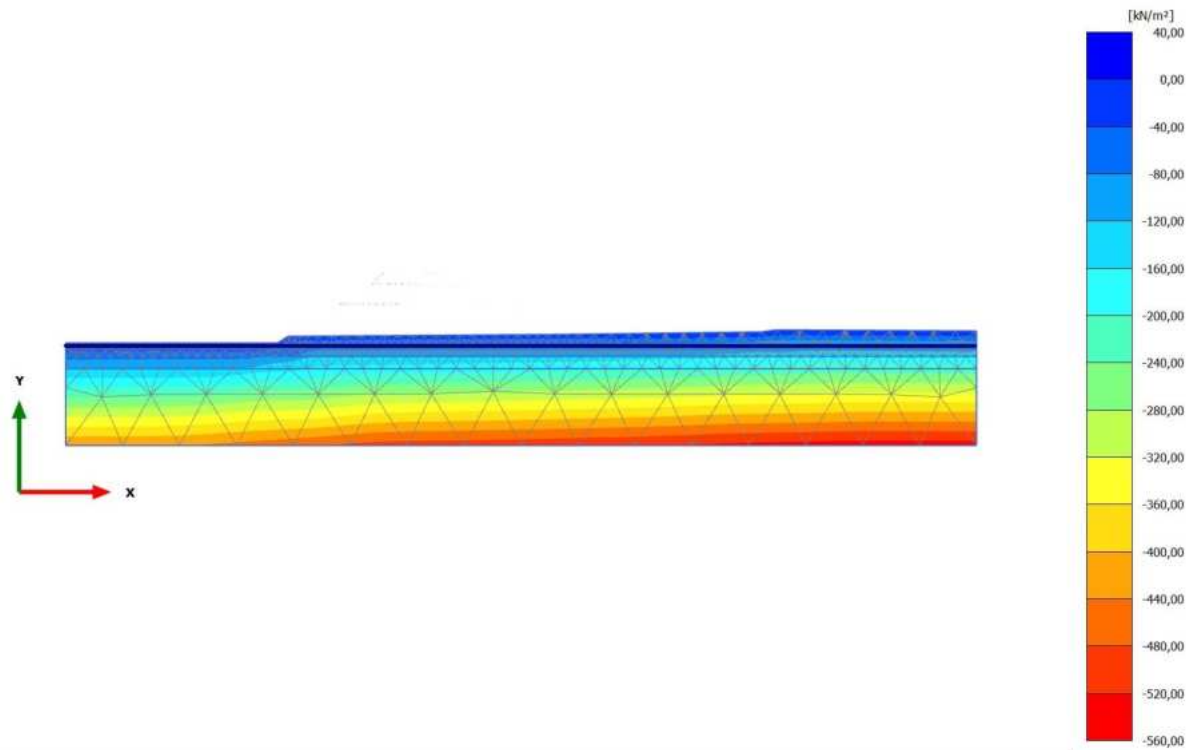
**Steady state pore pressures  $p_{steady}$  (scaled up 0,0200 times) (Pressure = negative)**  
Maximum value = 0,000 kN/m<sup>2</sup> (Element 1 at Node 13)  
Minimum value = -975,7 kN/m<sup>2</sup> (Element 1791 at Node 14485)

2.2.1.1.7 Calculation results, Phase\_3 [Phase\_3] (10/39), Steady state pore pressures  $p_{steady}$



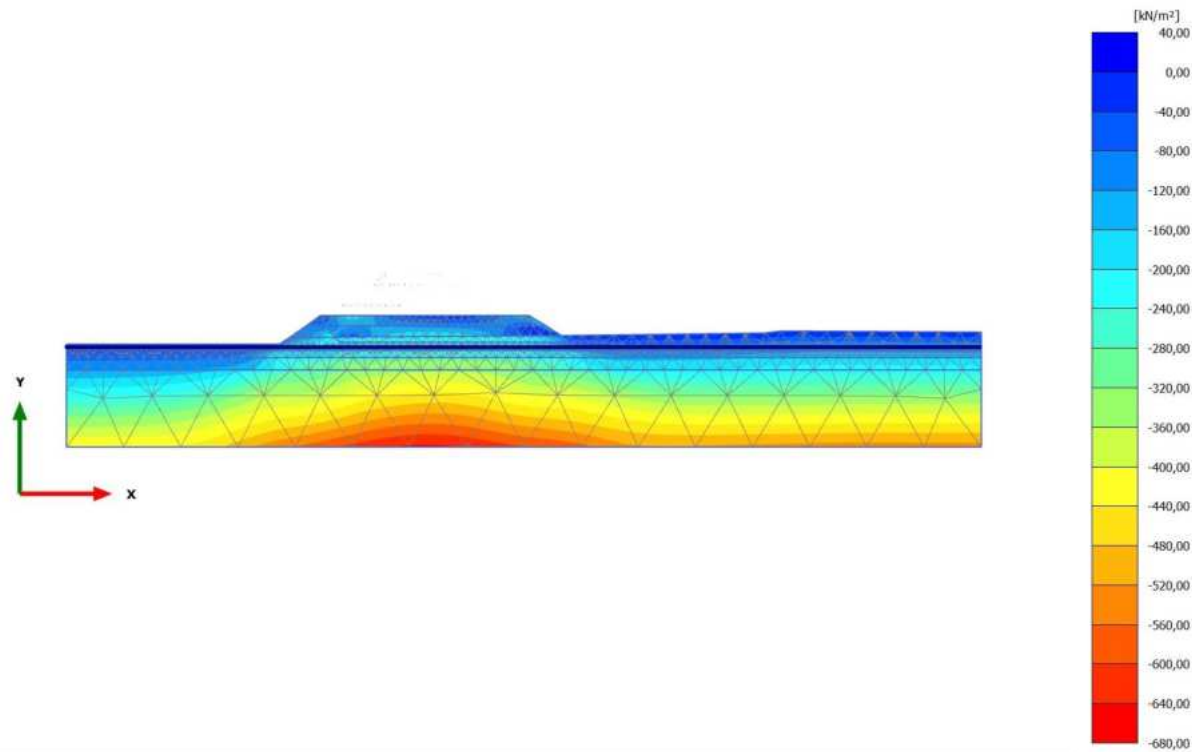
**Steady state pore pressures  $p_{steady}$  (scaled up 0,0200 times) (Pressure = negative)**  
Maximum value = 0,000 kN/m<sup>2</sup> (Element 22 at Node 458)  
Minimum value = -972,7 kN/m<sup>2</sup> (Element 1791 at Node 14485)

2.2.2.1.1 Calculation results, Initial phase [InitialPhase] (0/13), Cartesian effective stress  $\sigma'_{xx}$



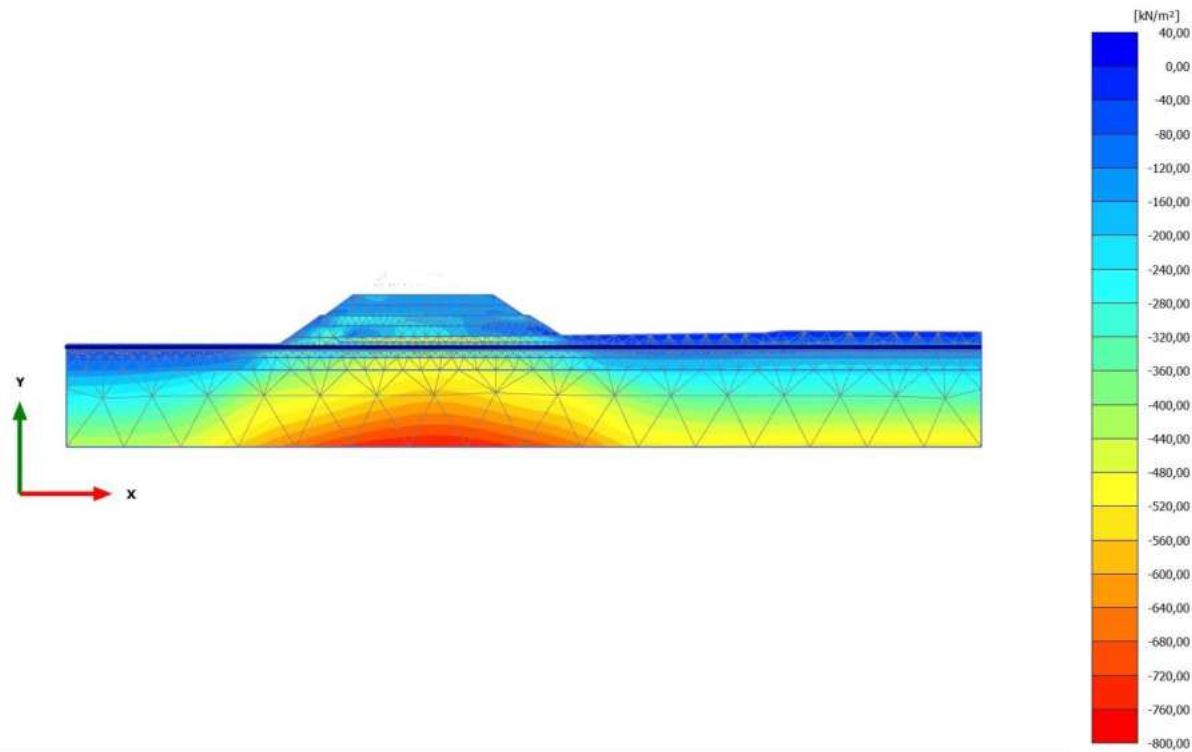
**Cartesian effective stress  $\sigma'_{xx}$  (scaled up 0,0500 times)**  
Maximum value = 3,601 kN/m<sup>2</sup> (Element 468 at Node 12406)  
Minimum value = -540,4 kN/m<sup>2</sup> (Element 1792 at Node 13903)

2.2.2.1.2 Calculation results, Phase\_1 [Phase\_1] (8/18), Cartesian effective stress  $\sigma'_{xx}$



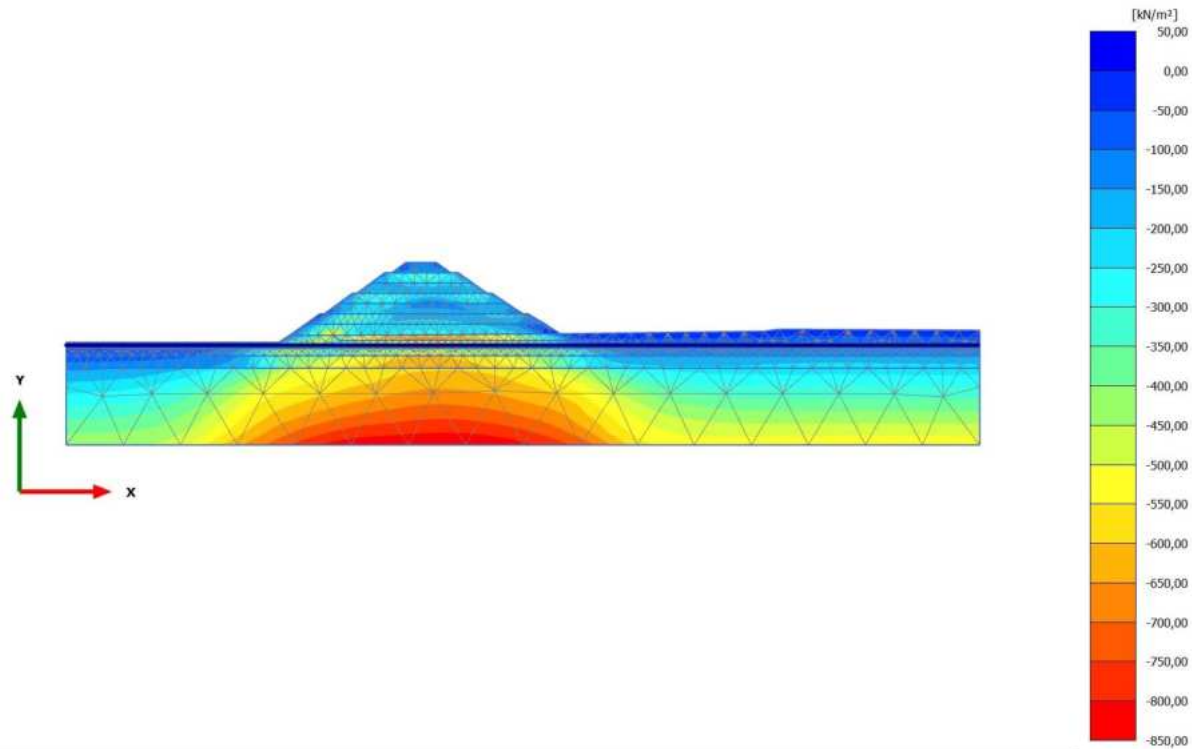
**Cartesian effective stress  $\sigma'_{xx}$  (scaled up 0,0500 times)**  
Maximum value = 4,134 kN/m<sup>2</sup> (Element 408 at Node 9851)  
Minimum value = -649,8 kN/m<sup>2</sup> (Element 1799 at Node 10011)

2.2.2.1.3 Calculation results, Phase\_2 [Phase\_2] (9/22), Cartesian effective stress  $\sigma'_{xx}$



**Cartesian effective stress  $\sigma'_{xx}$  (scaled up 0,0500 times)**  
Maximum value = 4,455 kN/m<sup>2</sup> (Element 287 at Node 8143)  
Minimum value = -763,9 kN/m<sup>2</sup> (Element 1799 at Node 10012)

2.2.2.1.4 Calculation results, Phase\_4 [Phase\_4] (11/25), Cartesian effective stress  $\sigma'_{xx}$

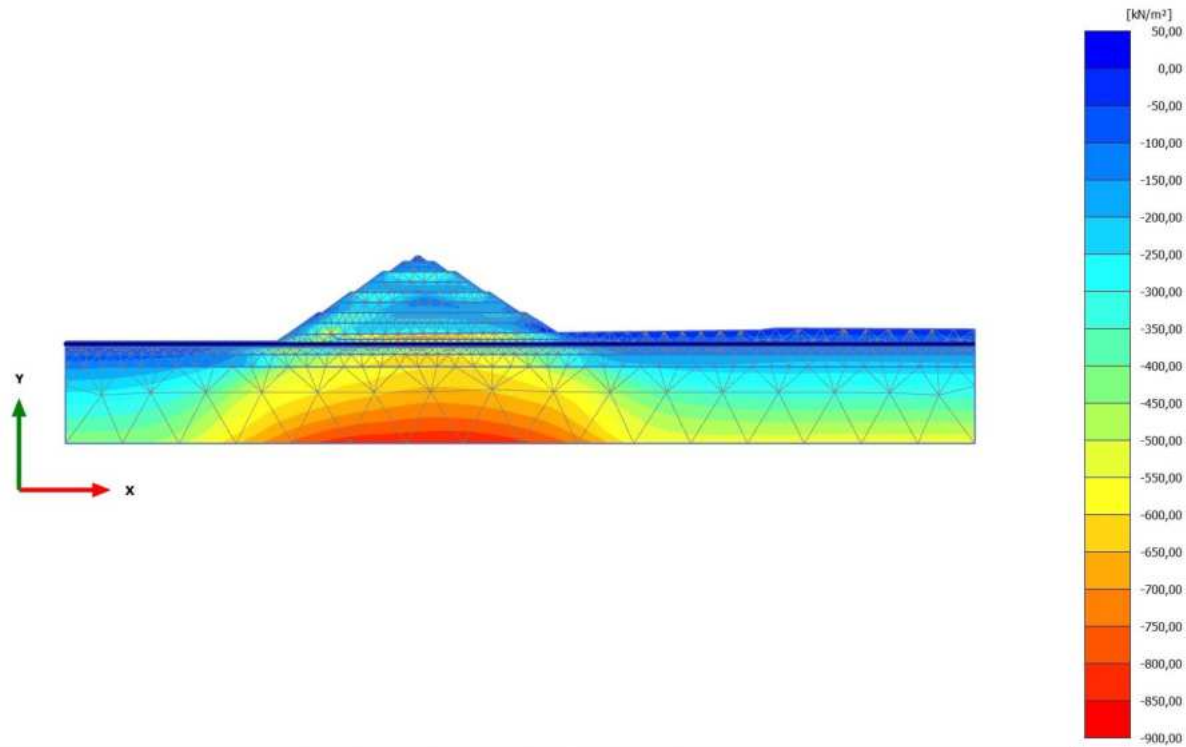


**Cartesian effective stress  $\sigma'_{xx}$  (scaled up 0,0500 times)**

Maximum value = 6,725 kN/m<sup>2</sup> (Element 253 at Node 1027)

Minimum value = -848,3 kN/m<sup>2</sup> (Element 1799 at Node 10013)

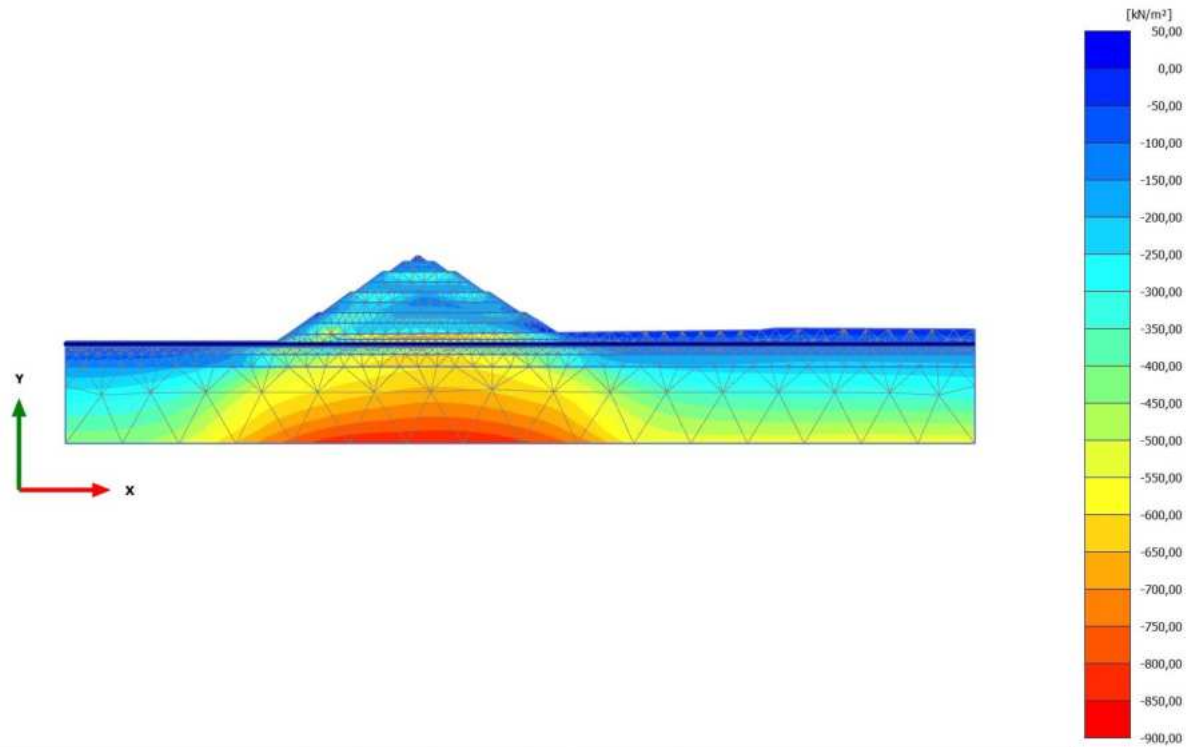
2.2.2.1.5 Calculation results, Phase\_5\_static [Phase\_5] (12/28), Cartesian effective stress  $\sigma'_{xx}$



**Cartesian effective stress  $\sigma'_{xx}$  (scaled up 0,0500 times)**  
Maximum value = 9,173 kN/m<sup>2</sup> (Element 287 at Node 8143)  
Minimum value = -849,3 kN/m<sup>2</sup> (Element 1799 at Node 10013)

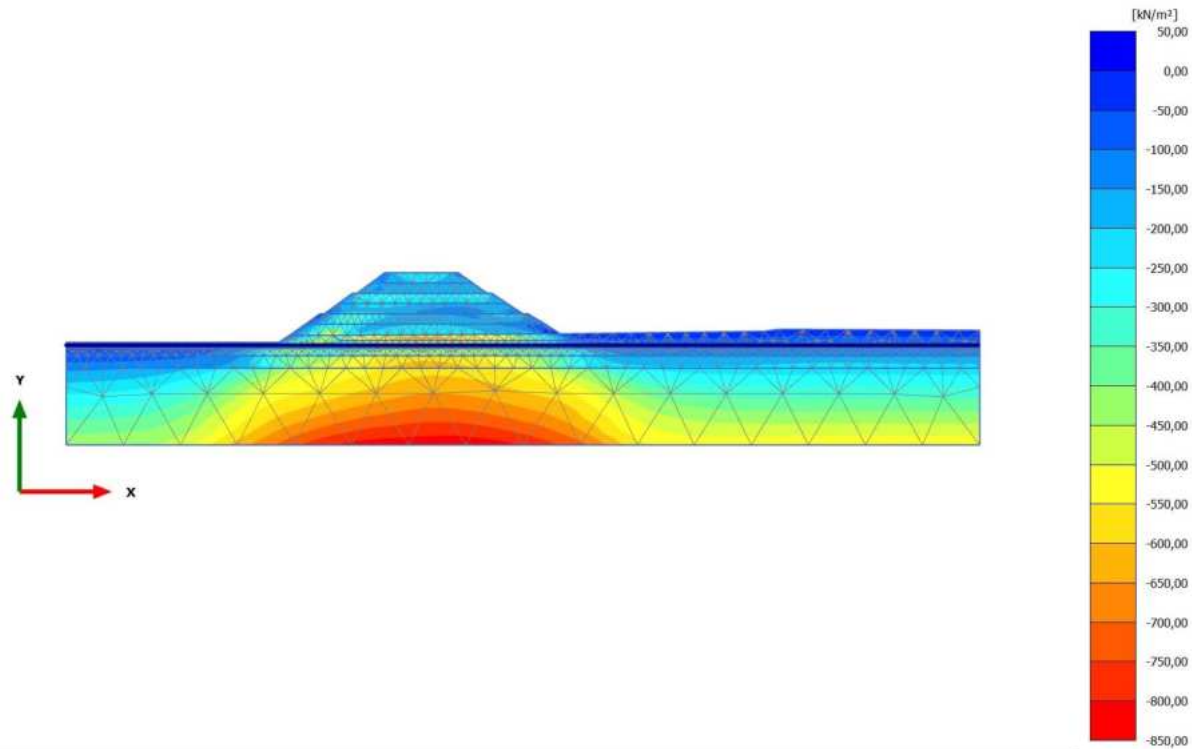


2.2.2.1.6 Calculation results, Phase\_8 \_seismic [Phase\_8] (2/32), Cartesian effective stress  $\sigma'_{xx}$



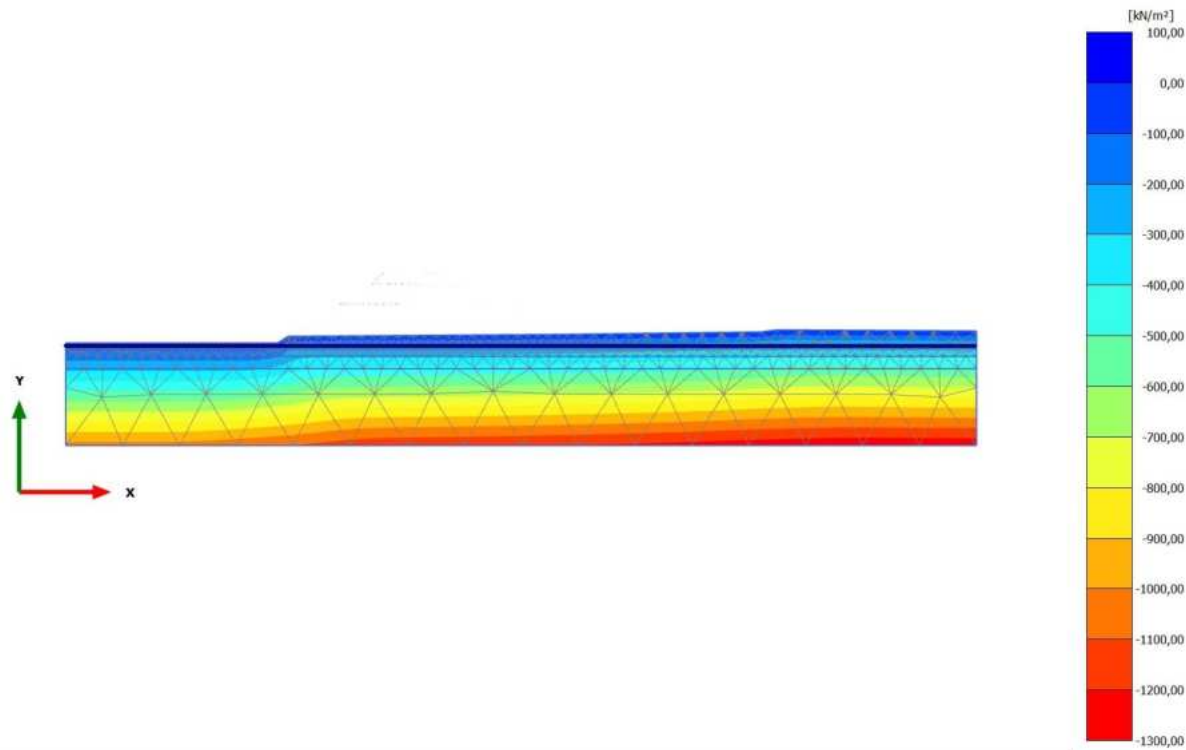
**Cartesian effective stress  $\sigma'_{xx}$  (scaled up 0,0500 times)**  
Maximum value = 7,083 kN/m<sup>2</sup> (Element 287 at Node 8143)  
Minimum value = -850,6 kN/m<sup>2</sup> (Element 1799 at Node 10012)

2.2.2.1.7 Calculation results, Phase\_3 [Phase\_3] (10/39), Cartesian effective stress  $\sigma'_{xx}$



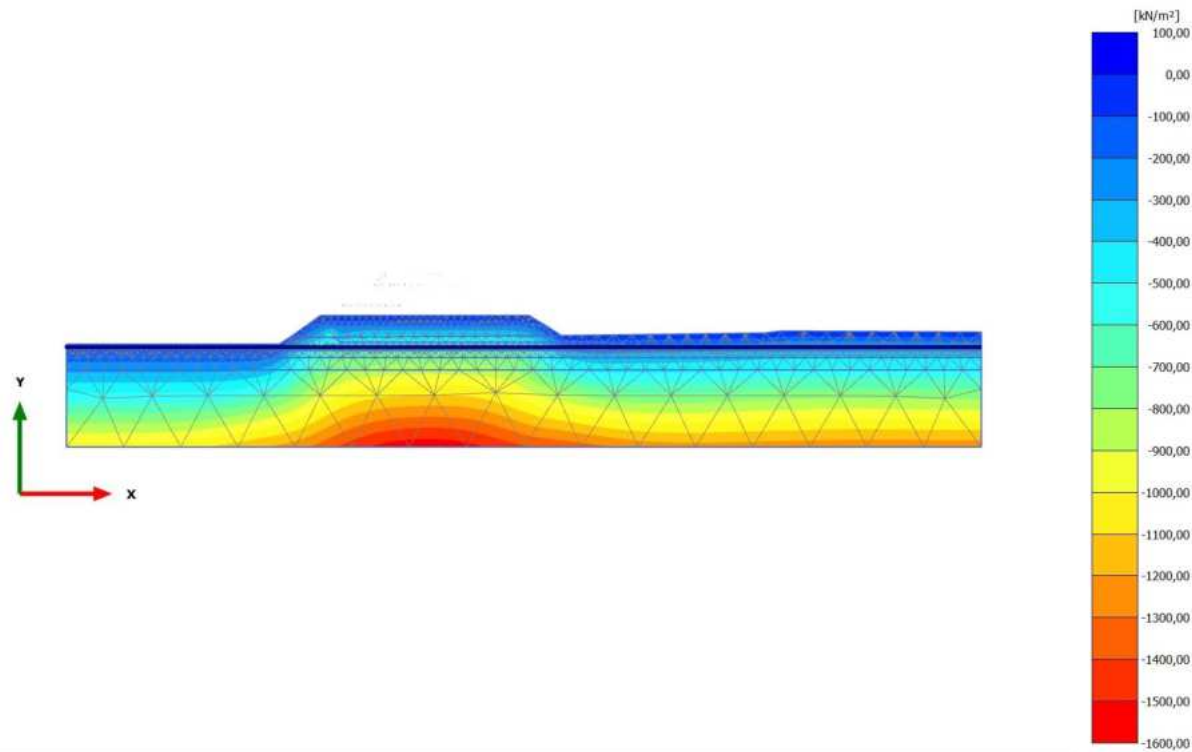
**Cartesian effective stress  $\sigma'_{xx}$  (scaled up 0,0500 times)**  
Maximum value = 4,765 kN/m<sup>2</sup> (Element 253 at Node 1027)  
Minimum value = -835,8 kN/m<sup>2</sup> (Element 1799 at Node 10013)

2.2.2.2.1 Calculation results, Initial phase [InitialPhase] (0/13), Cartesian effective stress  $\sigma'_{yy}$



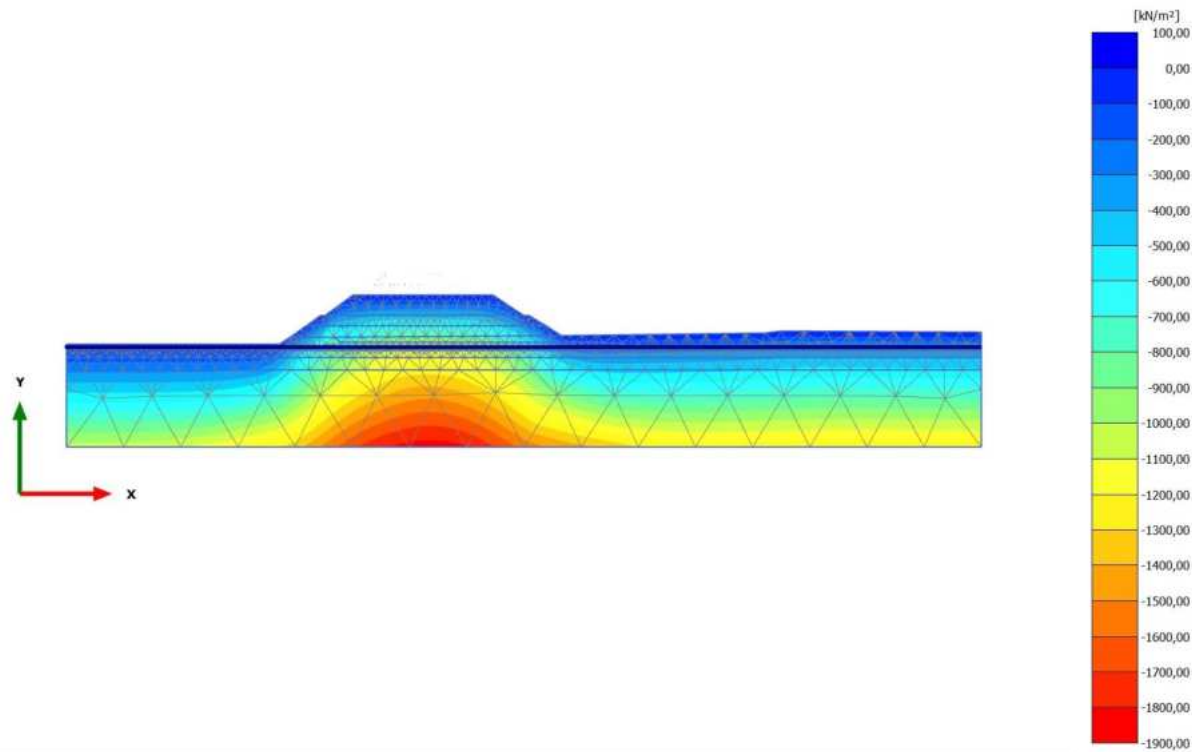
**Cartesian effective stress  $\sigma'_{yy}$  (scaled up 0,0200 times)**  
Maximum value = 3,515  $\text{kN/m}^2$  (Element 623 at Node 2765)  
Minimum value = -1277  $\text{kN/m}^2$  (Element 1792 at Node 13903)

2.2.2.2.2 Calculation results, Phase\_1 [Phase\_1] (8/18), Cartesian effective stress  $\sigma'_{yy}$



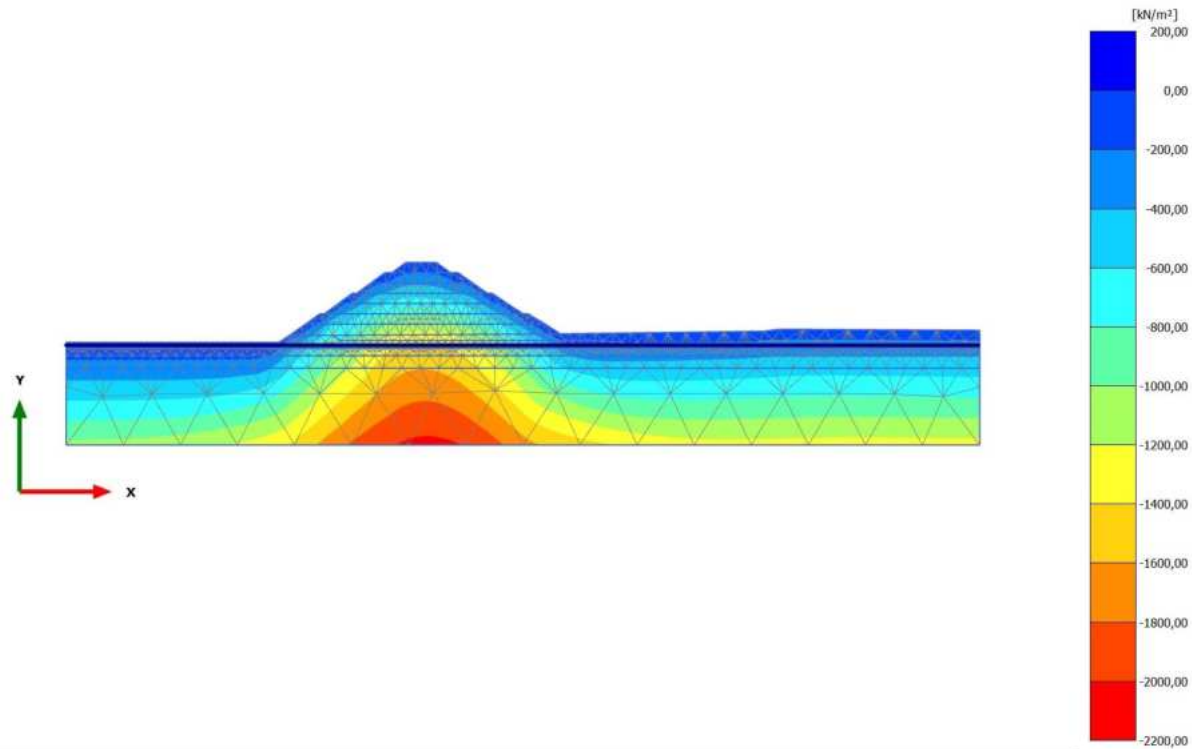
**Cartesian effective stress  $\sigma'_{yy}$  (scaled up 0,0200 times)**  
Maximum value = 1,894 kN/m<sup>2</sup> (Element 333 at Node 9031)  
Minimum value = -1571 kN/m<sup>2</sup> (Element 1799 at Node 10011)

2.2.2.2.3 Calculation results, Phase\_2 [Phase\_2] (9/22), Cartesian effective stress  $\sigma'_{yy}$



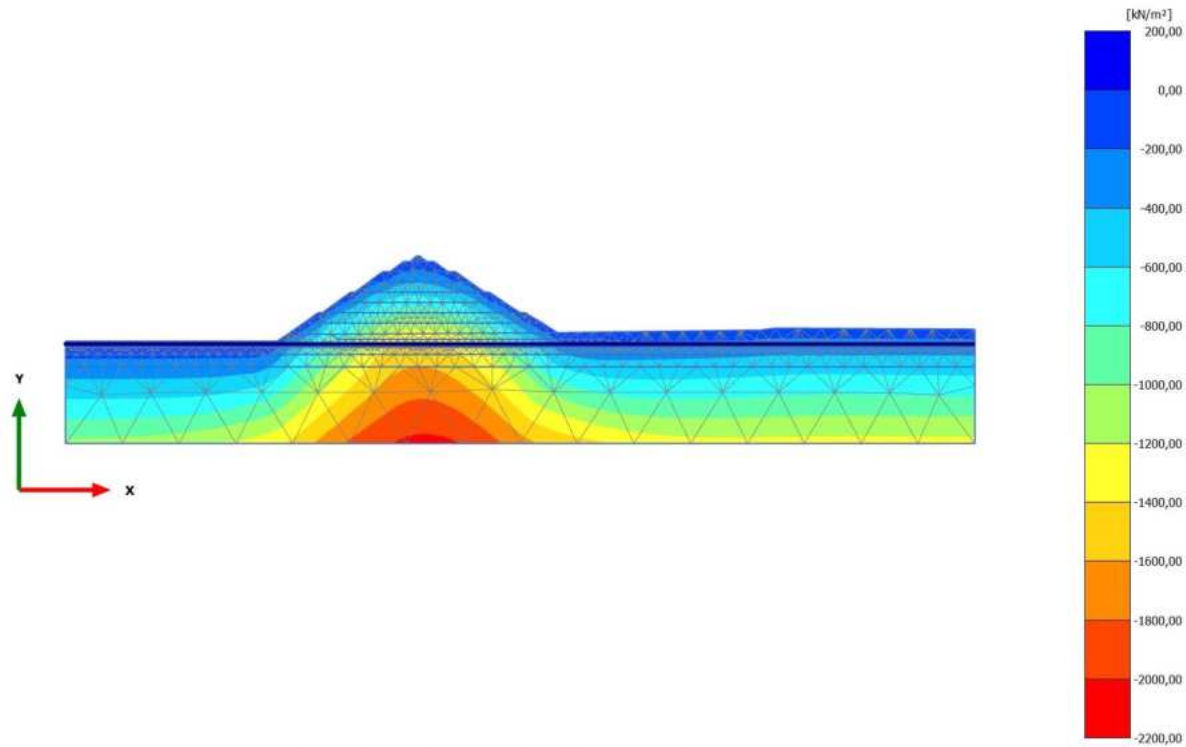
**Cartesian effective stress  $\sigma'_{yy}$  (scaled up 0,0200 times)**  
Maximum value = 1,914 kN/m<sup>2</sup> (Element 333 at Node 9031)  
Minimum value = -1848 kN/m<sup>2</sup> (Element 1799 at Node 10011)

2.2.2.2.4 Calculation results, Phase\_4 [Phase\_4] (11/25), Cartesian effective stress  $\sigma'_{yy}$



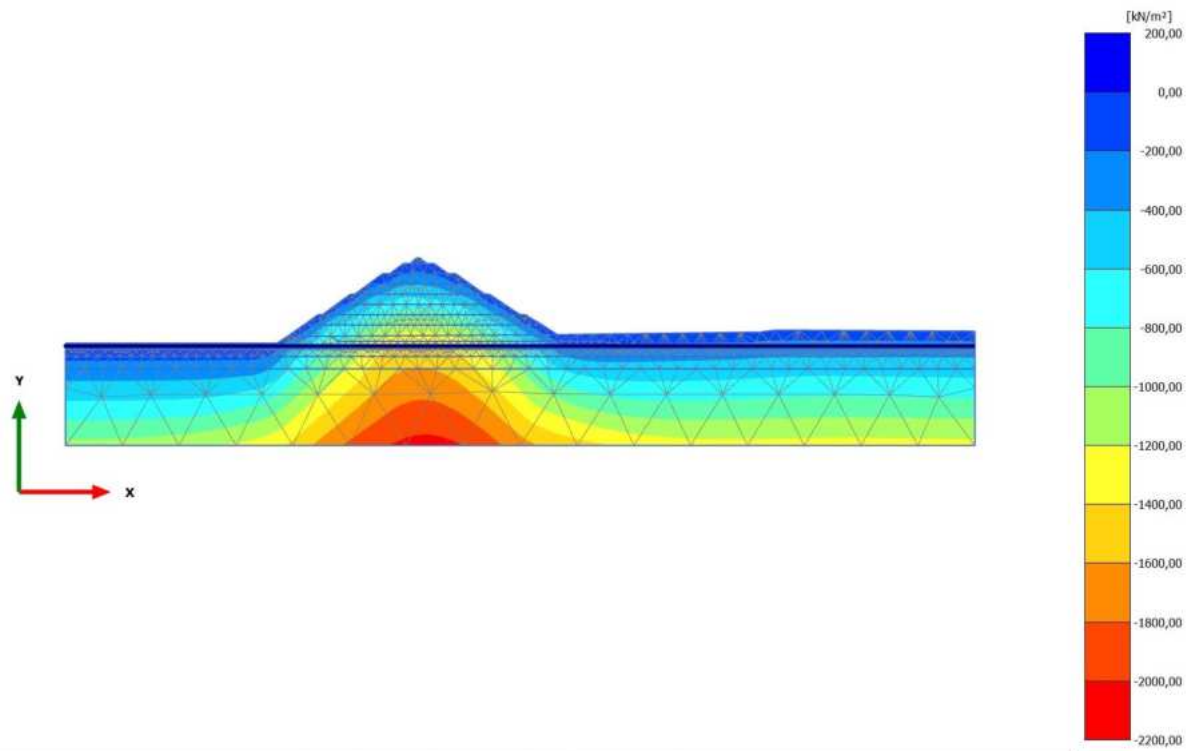
**Cartesian effective stress  $\sigma'_{yy}$  (scaled up 0,0100 times)**  
Maximum value = 7,875 kN/m<sup>2</sup> (Element 118 at Node 1421)  
Minimum value = -2048 kN/m<sup>2</sup> (Element 1799 at Node 10011)

2.2.2.2.5 Calculation results, Phase\_5\_static [Phase\_5] (12/28), Cartesian effective stress  $\sigma'_{yy}$



**Cartesian effective stress  $\sigma'_{yy}$  (scaled up 0,0100 times)**  
Maximum value = 7,742  $\text{kN/m}^2$  (Element 118 at Node 1421)  
Minimum value = -2051  $\text{kN/m}^2$  (Element 1799 at Node 10011)

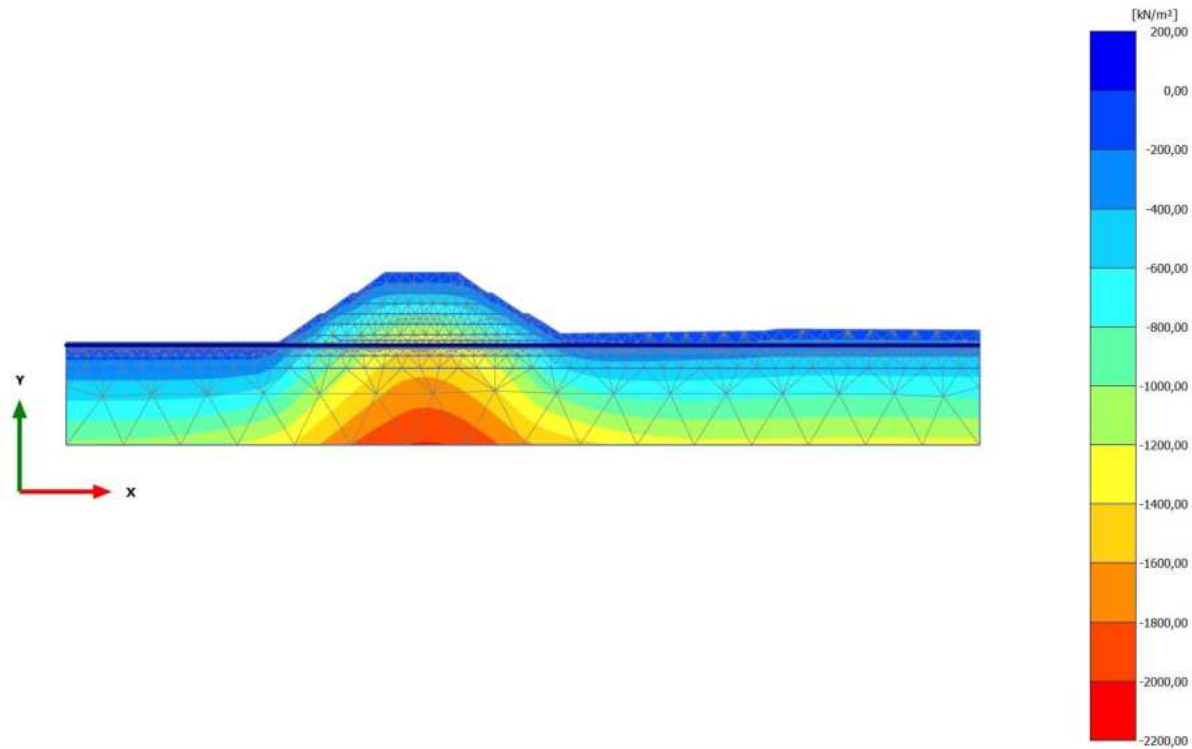
2.2.2.2.6 Calculation results, Phase\_8 \_seismic [Phase\_8] (2/32), Cartesian effective stress  $\sigma'_{yy}$



**Cartesian effective stress  $\sigma'_{yy}$  (scaled up 0,0100 times)**  
Maximum value = 7,492 kN/m<sup>2</sup> (Element 118 at Node 1421)  
Minimum value = -2059 kN/m<sup>2</sup> (Element 1799 at Node 10011)

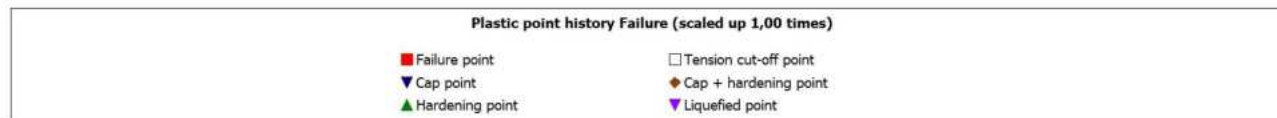
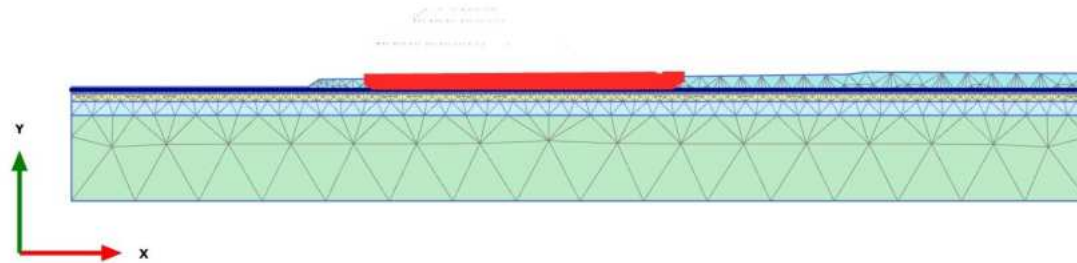


2.2.2.2.7 Calculation results, Phase\_3 [Phase\_3] (10/39), Cartesian effective stress  $\sigma'_{yy}$

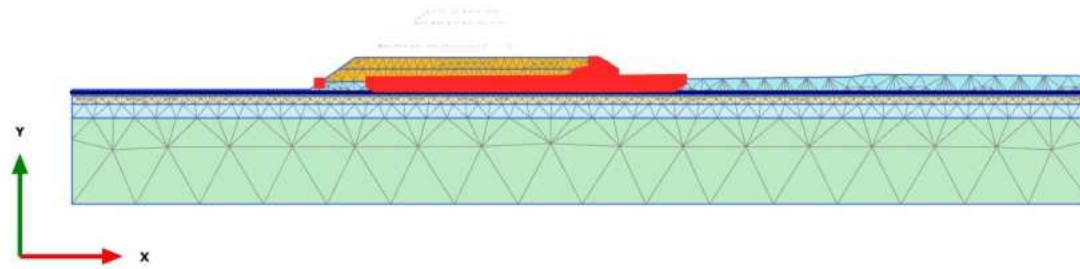


**Cartesian effective stress  $\sigma'_{yy}$  (scaled up 0,0100 times)**  
Maximum value = 8,157 kN/m<sup>2</sup> (Element 118 at Node 1421)  
Minimum value = -2016 kN/m<sup>2</sup> (Element 1799 at Node 10011)

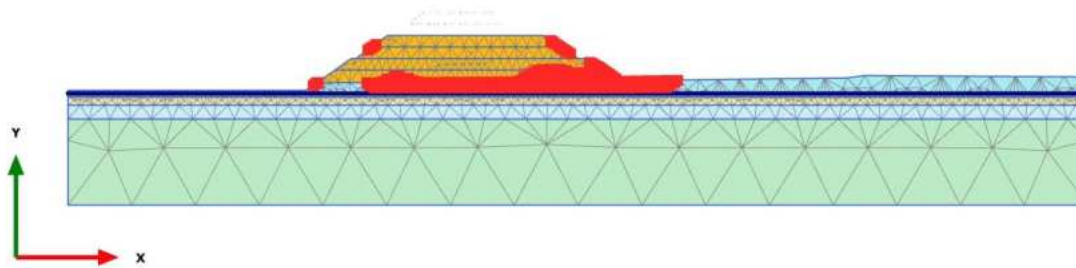
2.2.3.1.1 Calculation results, Initial phase [InitialPhase] (0/13), Plastic point history Failure



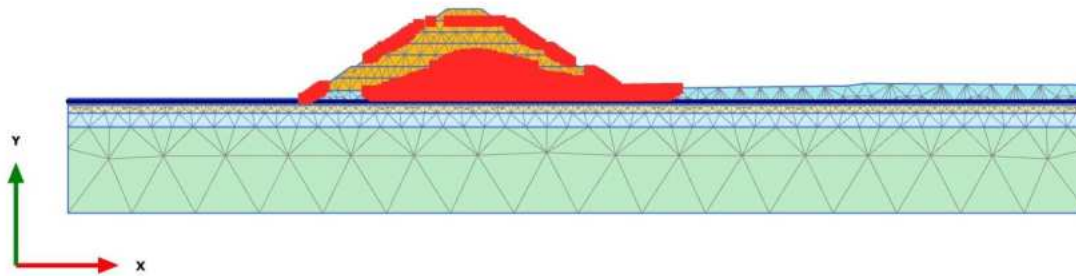
2.2.3.1.2 Calculation results, Phase\_1 [Phase\_1] (8/18), Plastic point history Failure



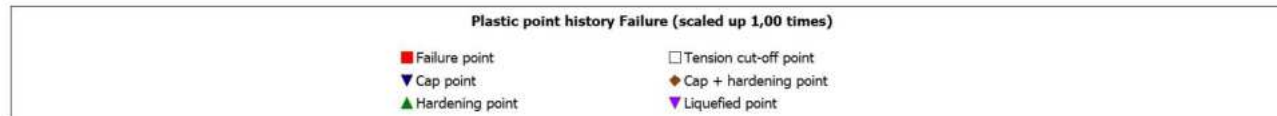
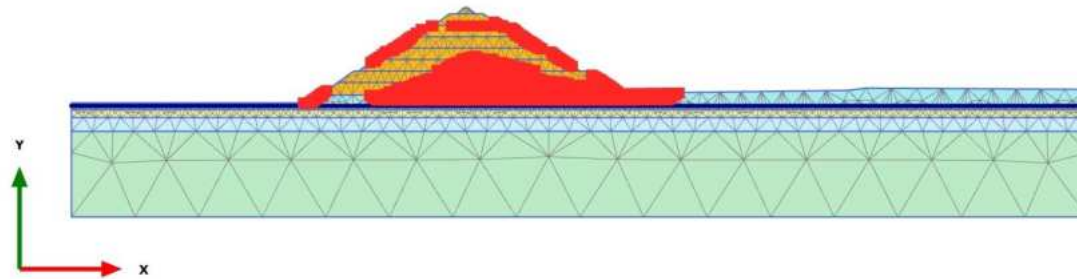
2.2.3.1.3 Calculation results, Phase\_2 [Phase\_2] (9/22), Plastic point history Failure



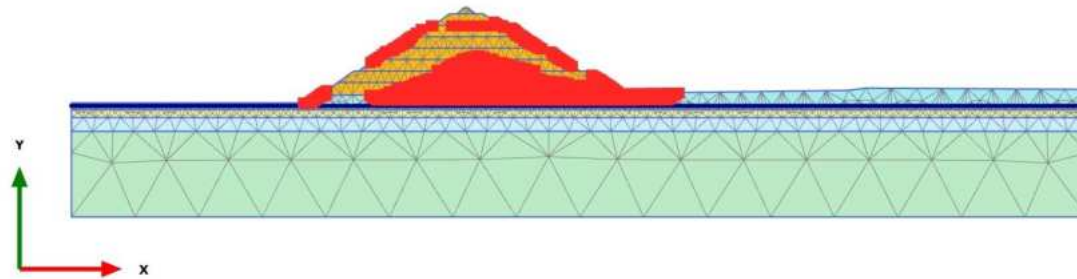
2.2.3.1.4 Calculation results, Phase\_4 [Phase\_4] (11/25), Plastic point history Failure



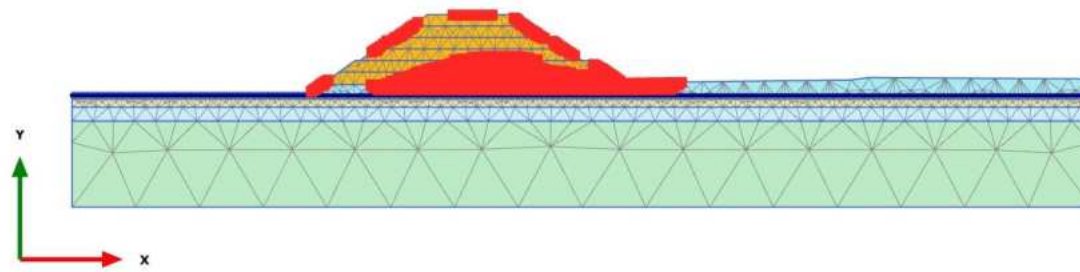
2.2.3.1.5 Calculation results, Phase\_5\_static [Phase\_5] (12/28), Plastic point history Failure



2.2.3.1.6 Calculation results, Phase\_8 \_seismic [Phase\_8] (2/32), Plastic point history Failure

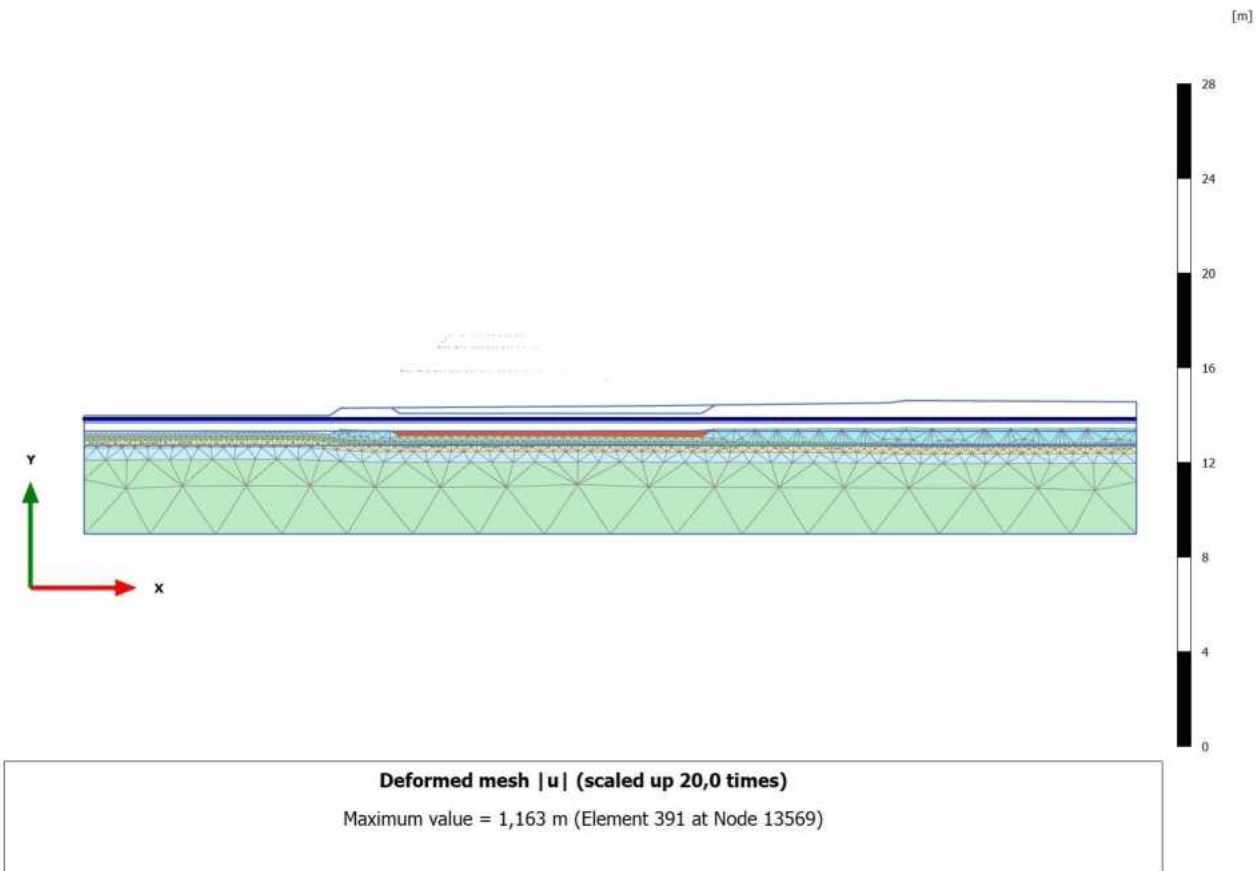


2.2.3.1.7 Calculation results, Phase\_3 [Phase\_3] (10/39), Plastic point history Failure

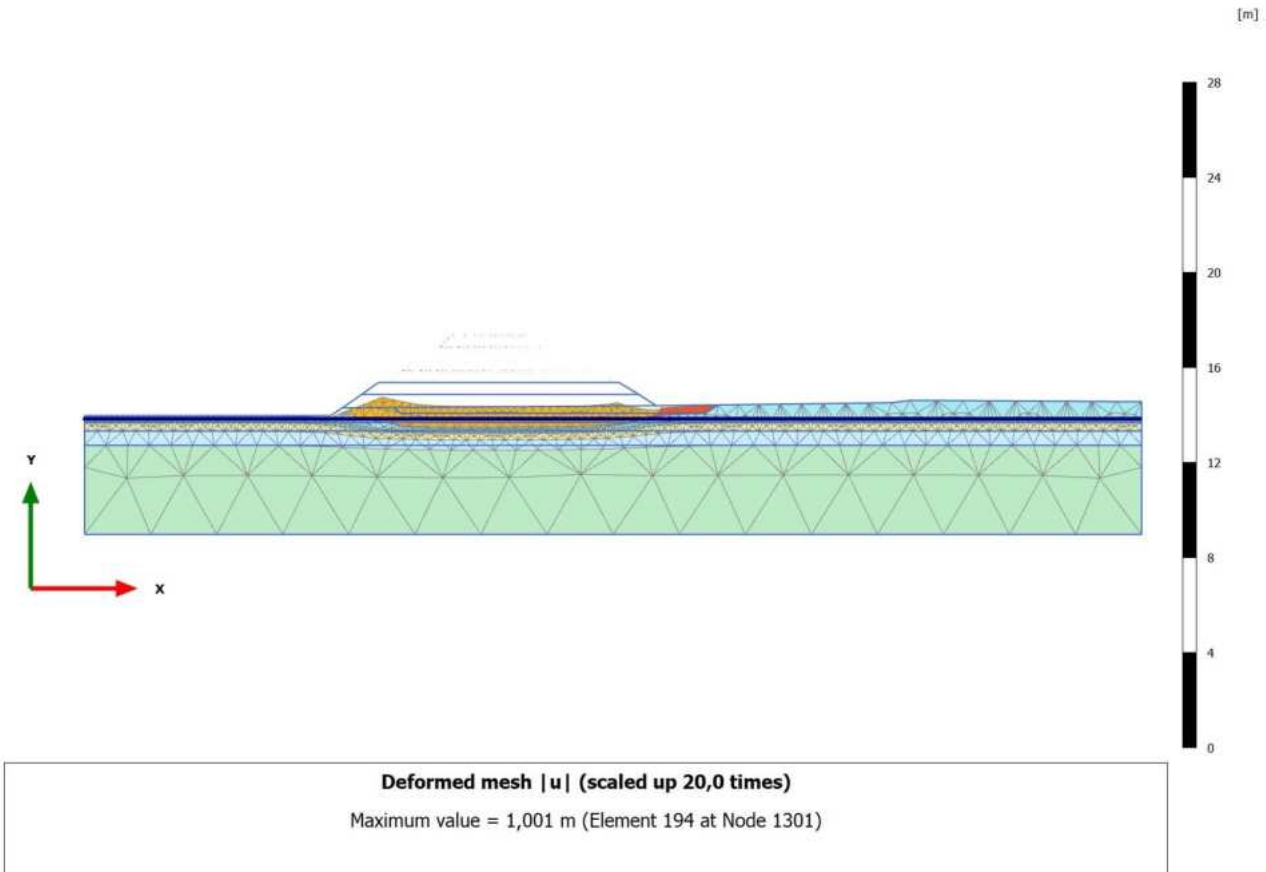




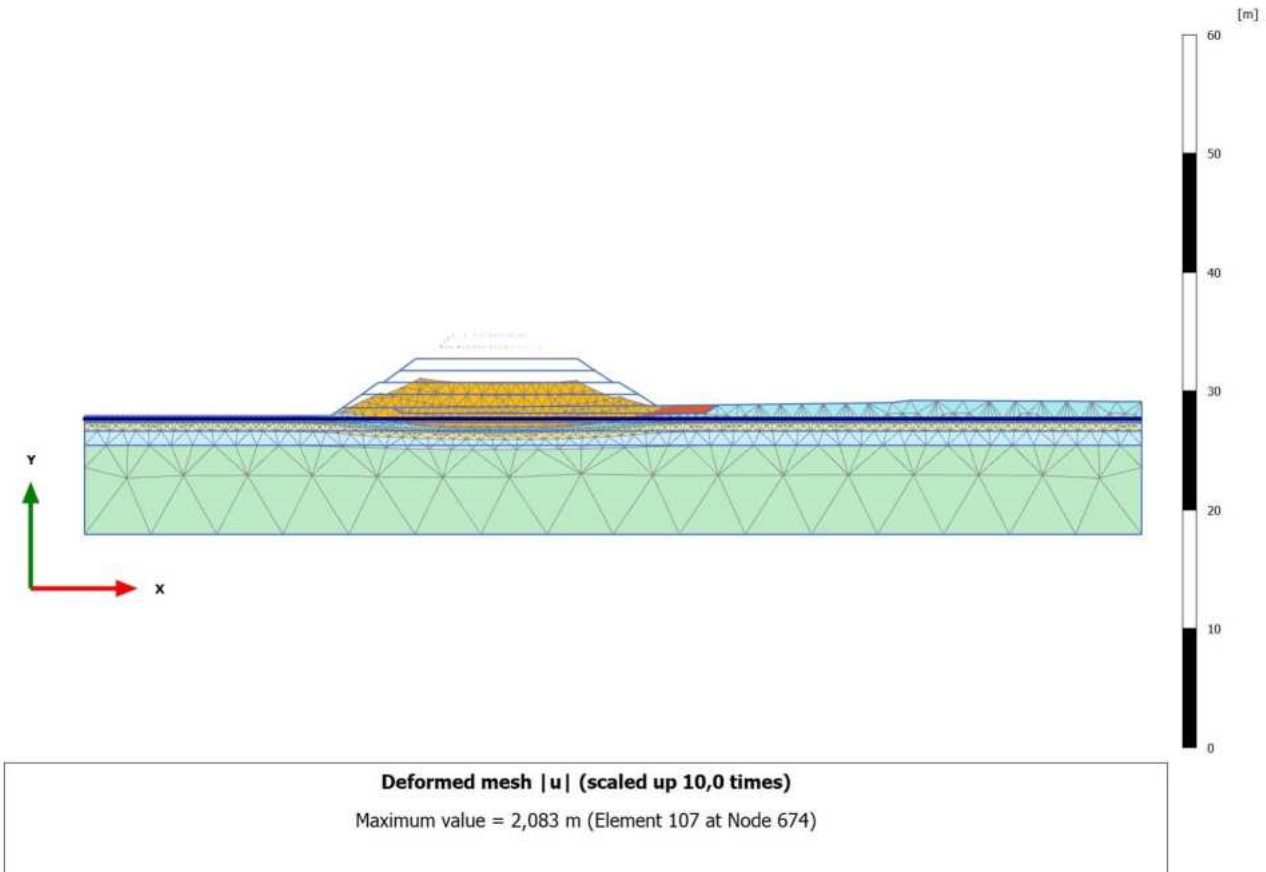
4.1.1 Calculation results, Initial phase [InitialPhase] (0/13), Deformed mesh |u|



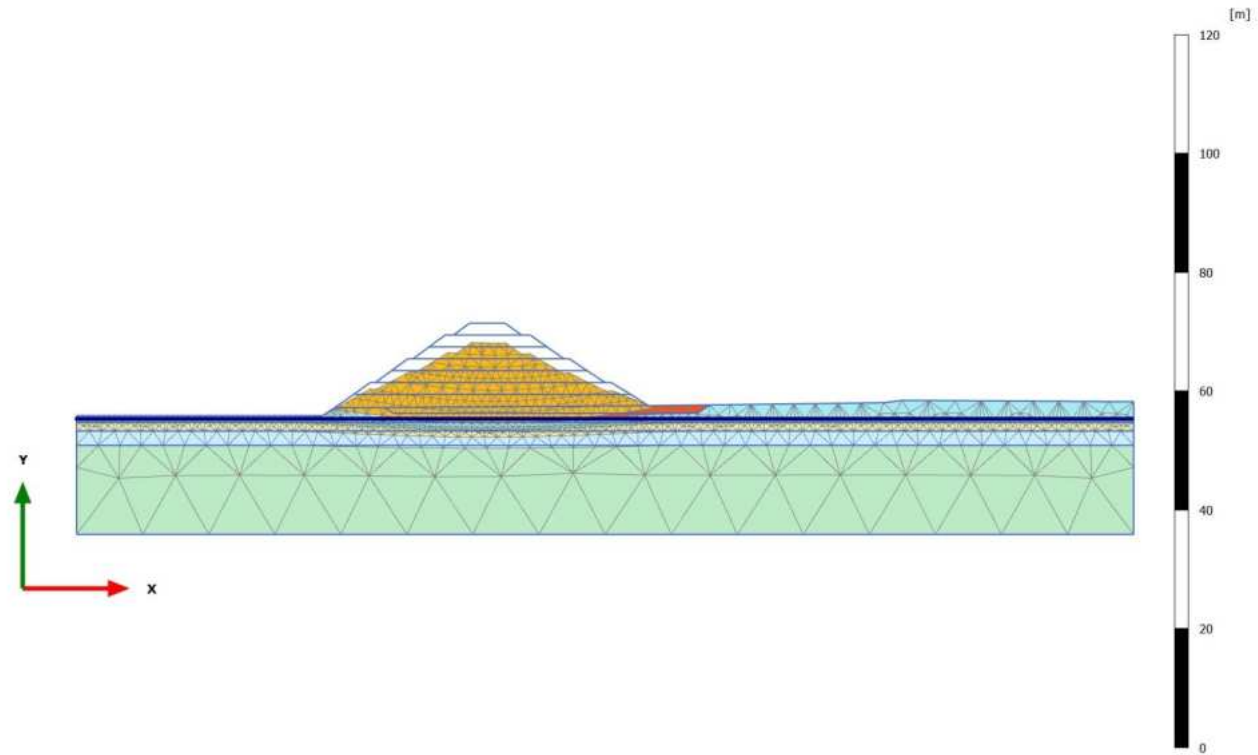
4.1.2 Calculation results, Phase\_1 [Phase\_1] (8/18), Deformed mesh |u|



4.1.3 Calculation results, Phase\_2 [Phase\_2] (9/22), Deformed mesh |u|

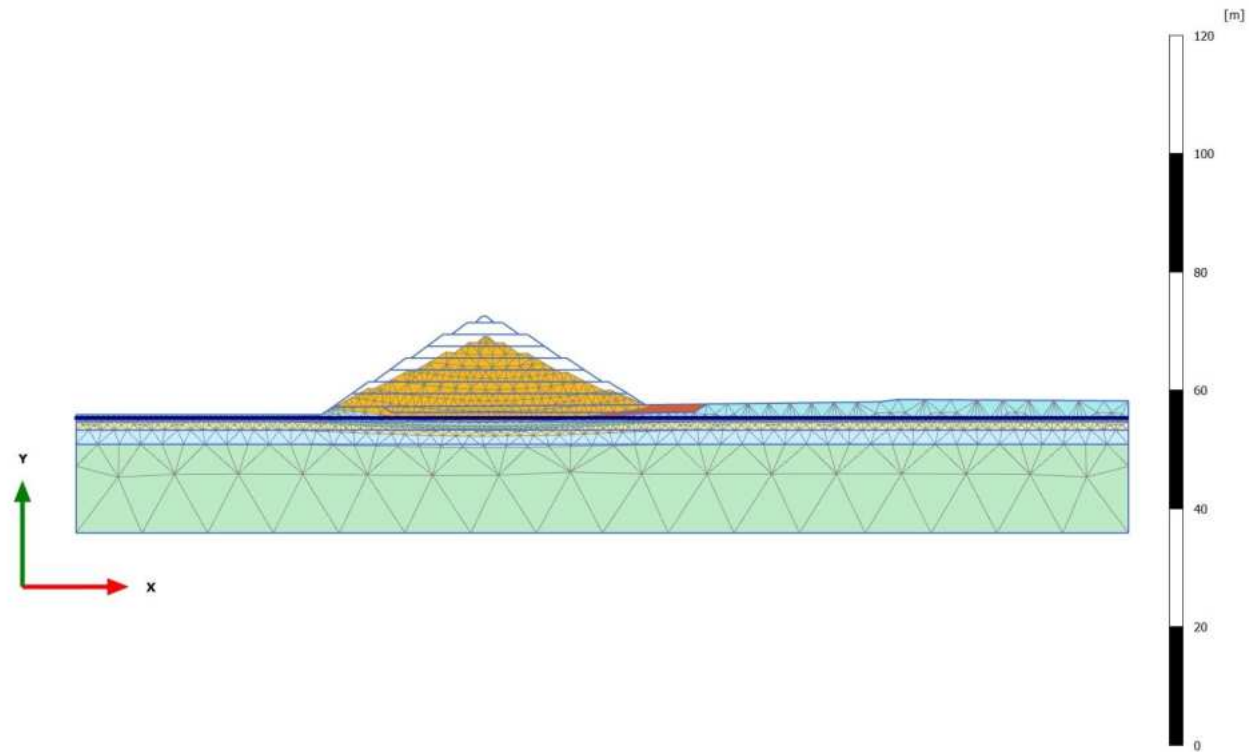


4.1.4 Calculation results, Phase\_4 [Phase\_4] (11/25), Deformed mesh |u|



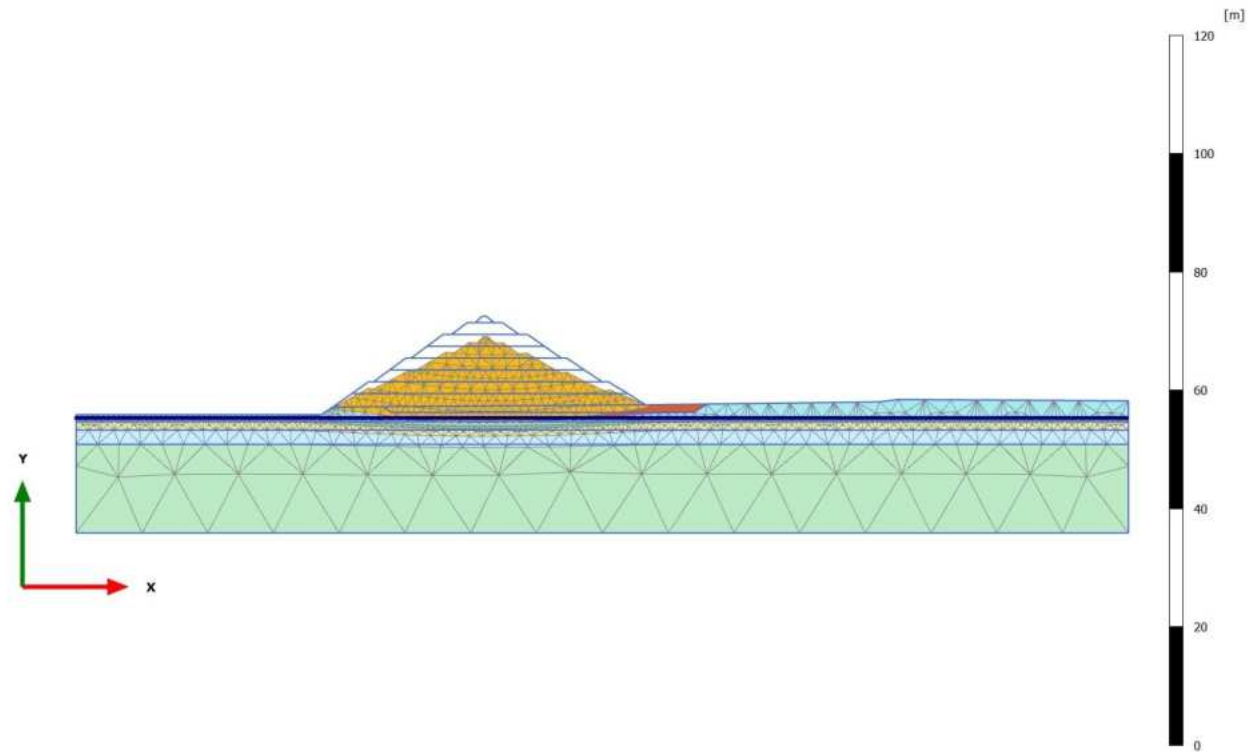
**Deformed mesh |u| (scaled up 5,00 times)**  
Maximum value = 3,388 m (Element 31 at Node 157)

4.1.5 Calculation results, Phase\_5\_static [Phase\_5] (12/28), Deformed mesh |u|



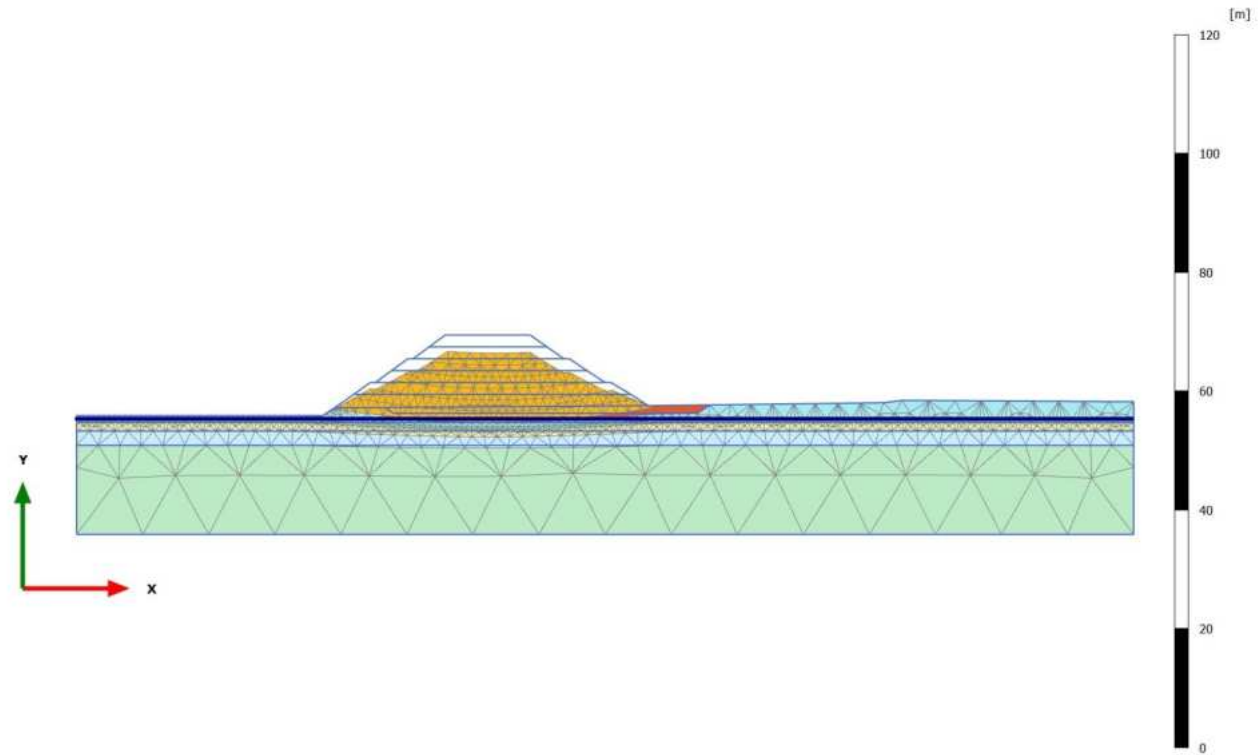
**Deformed mesh |u| (scaled up 5,00 times)**  
Maximum value = 3,445 m (Element 31 at Node 157)

4.1.6 Calculation results, Phase\_8 \_seismic [Phase\_8] (2/32), Deformed mesh |u|



**Deformed mesh |u| (scaled up 5,00 times)**  
Maximum value = 3,464 m (Element 31 at Node 157)

4.1.7 Calculation results, Phase\_3 [Phase\_3] (10/39), Deformed mesh |u|



**Deformed mesh |u| (scaled up 5,00 times)**  
Maximum value = 3,065 m (Element 26 at Node 367)

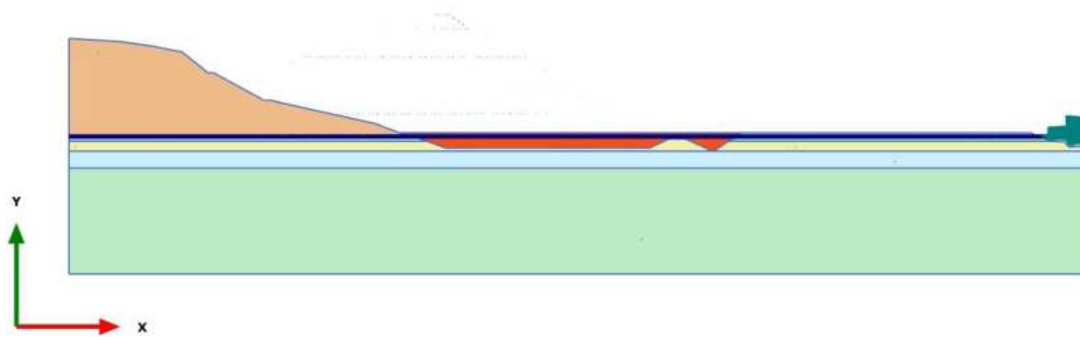
**ANHANG 4 – ERGEBNISSE DER PLAXIS SLE/SLD – ABSCHNITT 2**

**APPENDICE 4 – RISULTATI ANALISI PLAXIS SLE/SLD – SEZIONE 2**

# PLAXIS Report

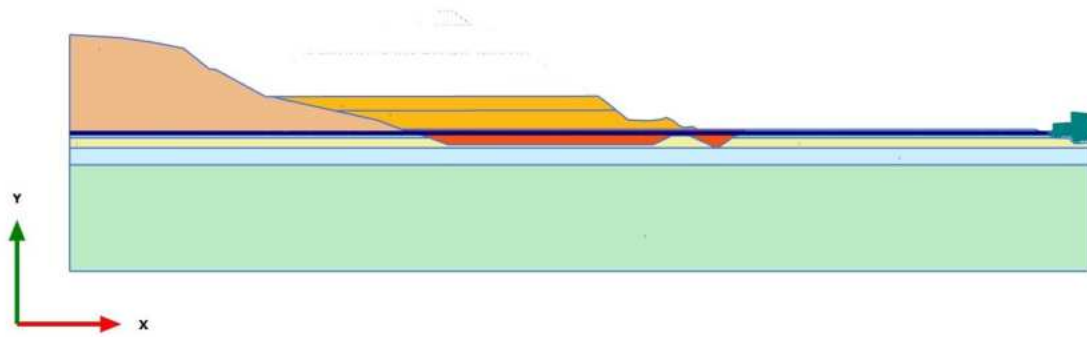


1.1.1.1 Calculation results, Initial phase [InitialPhase] (0/15), Materials plot



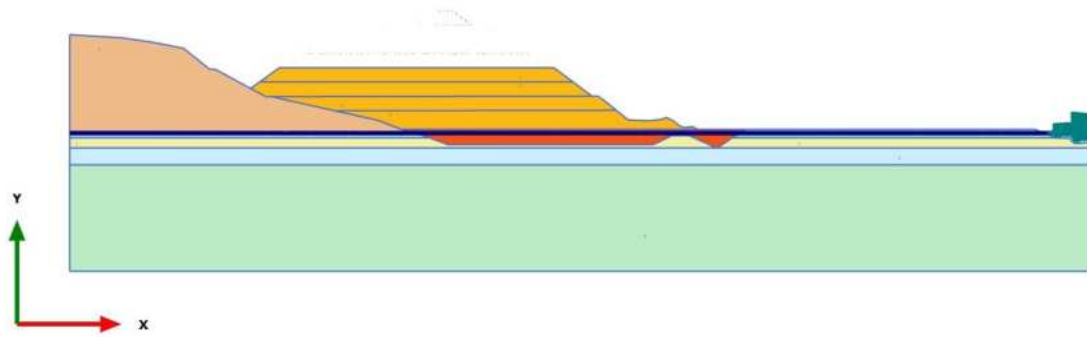
**Materials plot**

1.1.1.2 Calculation results, Phase\_1 [Phase\_1] (8/20), Materials plot



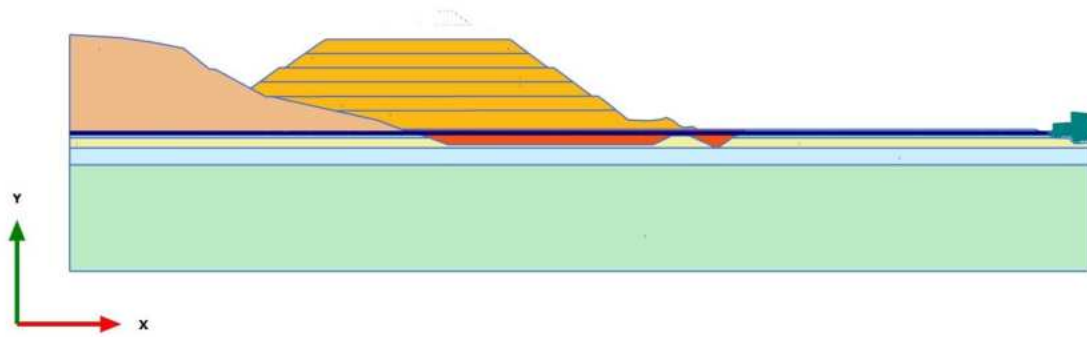
**Materials plot**

1.1.1.3 Calculation results, Phase\_2 [Phase\_2] (9/24), Materials plot



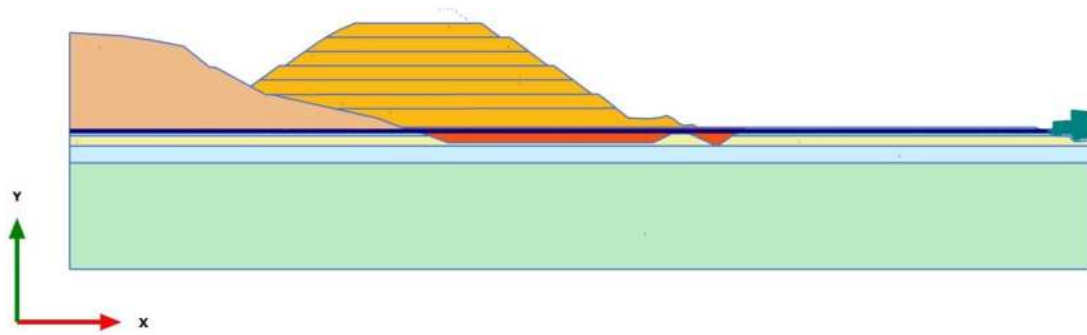
**Materials plot**

1.1.1.4 Calculation results, Phase\_3 [Phase\_3] (10/27), Materials plot



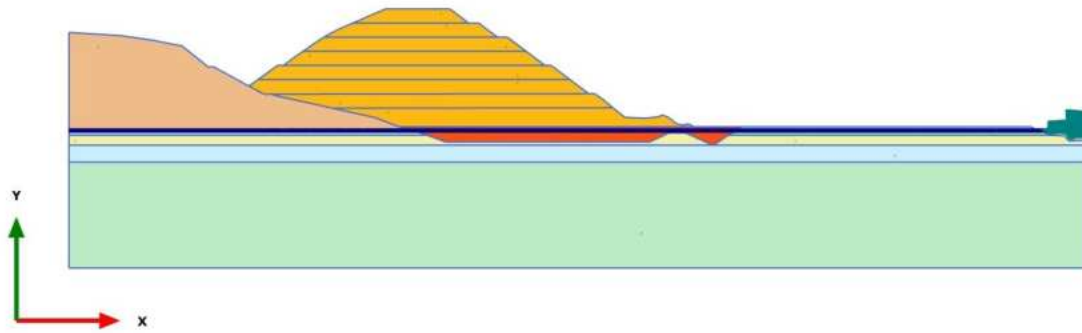
**Materials plot**

1.1.1.5 Calculation results, Phase\_4 [Phase\_4] (11/30), Materials plot



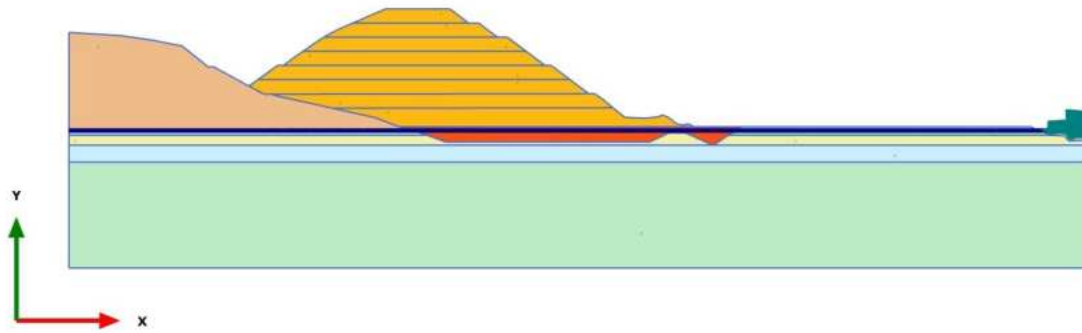
**Materials plot**

1.1.1.6 Calculation results, Phase\_5\_static [Phase\_5] (12/33), Materials plot








**Materials plot**

1.1.1.7 Calculation results, Phase\_8\_seismic [Phase\_8] (2/36), Materials plot



**Materials plot**

### 1.1.2.1.1 Materials - Soil and interfaces - Hardening soil

Identification		Strato 1	Strato 2	Strato 3	Strato 4	Strato 5
Identification number		1	2	3	4	5
Drainage type		Drained	Drained	Drained	Drained	Drained
Colour						
Comments						
$\gamma_{\text{unsat}}$	kN/m <sup>3</sup>	20,00	20,00	20,00	20,00	20,00
$\gamma_{\text{sat}}$	kN/m <sup>3</sup>	20,00	20,00	20,00	20,00	20,00
Dilatancy cut-off		No	No	No	No	No
$e_{\text{init}}$		0,5000	0,5000	0,5000	0,5000	0,5000
$e_{\text{min}}$		0,000	0,000	0,000	0,000	0,000
$e_{\text{max}}$		999,0	999,0	999,0	999,0	999,0
Rayleigh $\alpha$		0,000	0,000	0,000	0,000	0,000
Rayleigh $\beta$		0,000	0,000	0,000	0,000	0,000
$E_{50 \text{ ref}}$	kN/m <sup>2</sup>	25,00E3	40,00E3	50,00E3	30,00E3	70,00E3
$E_{\text{oed ref}}$	kN/m <sup>2</sup>	23,55E3	36,94E3	45,27E3	28,84E3	66,76E3
$E_{\text{ur ref}}$	kN/m <sup>2</sup>	75,00E3	120,0E3	150,0E3	90,00E3	210,0E3
power (m)		0,000	0,000	0,000	0,000	0,4000
Use alternatives		No	No	No	No	No
$C_c$		0,01465	9,339E-3	7,621E-3	0,01196	5,167E-3







Identification		Strato 1	Strato 2	Strato 3	Strato 4	Strato 5
$C_s$		4,140E-3	2,587E-3	2,070E-3	3,450E-3	1,479E-3
$e_{init}$		0,5000	0,5000	0,5000	0,5000	0,5000
$c_{ref}$	kN/m <sup>2</sup>	5,000	0,000	0,000	0,000	0,000
$\varphi$ (phi)	°	38,00	40,00	42,00	36,00	36,00
$\psi$ (psi)	°	0,000	0,000	0,000	0,000	0,000
Set to default values		No	No	No	No	No
$v_{ur}$		0,2000	0,2000	0,2000	0,2000	0,2000
$p_{ref}$	kN/m <sup>2</sup>	100,0	100,0	100,0	100,0	100,0
$K_{0nc}$		0,3943	0,3695	0,3449	0,4194	0,4217
$c_{inc}$	kN/m <sup>2</sup> /m	0,000	0,000	0,000	0,000	0,000
$y_{ref}$	m	0,000	0,000	0,000	0,000	608,0
$R_f$		0,9000	0,9000	0,9000	0,9000	0,9000
Tension cut-off		Yes	Yes	Yes	Yes	Yes
Tensile strength	kN/m <sup>2</sup>	0,000	0,000	0,000	0,000	0,000
Undrained behaviour		Standard	Standard	Standard	Standard	Standard
Skempton-B		0,9866	0,9866	0,9866	0,9866	0,9866
$v_u$		0,4950	0,4950	0,4950	0,4950	0,4950
$K_{w,ref} / n$	kN/m <sup>2</sup>	3,073E6	4,917E6	6,146E6	3,687E6	8,604E6
Stiffness		Standard	Standard	Standard	Standard	Standard

Strength		Rigid	Rigid	Rigid	Rigid	Rigid
$R_{inter}$		1,000	1,000	1,000	1,000	1,000
Consider gap closure		Yes	Yes	Yes	Yes	Yes
Identification		Strato 1	Strato 2	Strato 3	Strato 4	Strato 5
$\delta_{inter}$		0,000	0,000	0,000	0,000	0,000
Cross permeability		Impermeable	Impermeable	Impermeable	Impermeable	Impermeable
Drainage conductivity, dk	m <sup>3</sup> /day/m	0,000	0,000	0,000	0,000	0,000
R	m <sup>2</sup> K/kW	0,000	0,000	0,000	0,000	0,000
$K_0$ determination		Automatic	Automatic	Automatic	Automatic	Automatic
$K_{0,x} = K_{0,z}$		Yes	Yes	Yes	Yes	Yes
$K_{0,x}$		0,3943	0,3695	0,3449	0,4194	0,4217
$K_{0,z}$		0,3943	0,3695	0,3449	0,4194	0,4217
OCR		1,000	1,000	1,000	1,000	1,000
POP	kN/m <sup>2</sup>	0,000	0,000	0,000	0,000	0,000
Data set		Standard	Standard	Standard	Standard	Standard
Type		Coarse	Coarse	Coarse	Coarse	Coarse
< 2 $\mu$ m	%	10,00	10,00	10,00	10,00	10,00
2 $\mu$ m - 50 $\mu$ m	%	13,00	13,00	13,00	13,00	13,00
50 $\mu$ m - 2 mm	%	77,00	77,00	77,00	77,00	77,00
Use defaults		None	None	None	None	None

$k_x$	m/day	0,000	0,000	0,000	0,000	0,000
$k_y$	m/day	0,000	0,000	0,000	0,000	0,000
$-\psi_{\text{unsat}}$	m	10,00E3	10,00E3	10,00E3	10,00E3	10,00E3
$e_{\text{init}}$		0,5000	0,5000	0,5000	0,5000	0,5000
$S_s$	1/m	0,000	0,000	0,000	0,000	0,000
$c_k$		1000E12	1000E12	1000E12	1000E12	1000E12
Identification		Strato 1	Strato 2	Strato 3	Strato 4	Strato 5
$c_s$	kJ/t/K	0,000	0,000	0,000	0,000	0,000
$\lambda_s$	kW/m/K	0,000	0,000	0,000	0,000	0,000
$\rho_s$	t/m <sup>3</sup>	0,000	0,000	0,000	0,000	0,000
Solid thermal expansion		Volumetric	Volumetric	Volumetric	Volumetric	Volumetric
$\alpha_s$	1/K	0,000	0,000	0,000	0,000	0,000
$D_v$	m <sup>2</sup> /day	0,000	0,000	0,000	0,000	0,000
$f_{\text{TV}}$		0,000	0,000	0,000	0,000	0,000
Unfrozen water content		None	None	None	None	None

1.1.2.1.2 Materials - Soil and interfaces - Mohr-Coulomb

Identification		Rock	A	F1	GNEISS
Identification number		6	7	8	9
Drainage type		Drained	Drained	Drained	Drained
Colour					
Comments					
$\gamma_{\text{unsat}}$	kN/m <sup>3</sup>	20,00	21,00	20,00	20,00
$\gamma_{\text{sat}}$	kN/m <sup>3</sup>	20,00	21,00	20,00	20,00
Dilatancy cut-off		No	No	No	No
$e_{\text{init}}$		0,5000	0,5000	0,5000	0,5000
$e_{\text{min}}$		0,000	0,000	0,000	0,000
$e_{\text{max}}$		999,0	999,0	999,0	999,0
Rayleigh $\alpha$		0,000	0,000	0,000	0,000
Rayleigh $\beta$		0,000	0,000	0,000	0,000
E	kN/m <sup>2</sup>	100,0E3	30,00E3	5000	30,00E3
$\nu$ (nu)		0,3000	0,3000	0,3000	0,3000
G	kN/m <sup>2</sup>	38,46E3	11,54E3	1923	11,54E3
$E_{\text{oad}}$	kN/m <sup>2</sup>	134,6E3	40,38E3	6731	40,38E3

Identification		Rock	A	F1	GNEISS
$c_{ref}$	kN/m <sup>2</sup>	500,0	45,00	0,000	40,00
$\phi$ (phi)	°	35,00	37,00	20,00	36,00
$\psi$ (psi)	°	0,000	3,000	0,000	3,000
$V_s$	m/s	137,4	73,42	30,71	75,23
$V_p$	m/s	257,0	137,4	57,46	140,7
Set to default values		Yes	Yes	Yes	Yes
$E_{inc}$	kN/m <sup>2</sup> /m	0,000	0,000	0,000	0,000
$\gamma_{ref}$	m	0,000	0,000	0,000	0,000
$c_{inc}$	kN/m <sup>2</sup> /m	0,000	0,000	0,000	0,000
$\gamma_{ref}$	m	0,000	0,000	0,000	0,000
Tension cut-off		Yes	Yes	Yes	Yes
Tensile strength	kN/m <sup>2</sup>	0,000	0,000	0,000	0,000
Undrained behaviour		Standard	Standard	Standard	Standard
Skempton-B		0,9783	0,9783	0,9783	0,9783
$v_u$		0,4950	0,4950	0,4950	0,4950
$K_{w,ref} / n$	kN/m <sup>2</sup>	3,750E6	1,125E6	187,5E3	1,125E6
Stiffness		Standard	Standard	Standard	Standard

Strength		Rigid	Rigid	Rigid	Rigid
R <sub>inter</sub>		1,000	1,000	1,000	1,000
Identification		Rock	A	F1	GNEISS
Consider gap closure		Yes	Yes	Yes	Yes
$\delta_{inter}$		0,000	0,000	0,000	0,000
Cross permeability		Impermeable	Impermeable	Impermeable	Impermeable
Drainage conductivity, dk	m <sup>3</sup> /day/m	0,000	0,000	0,000	0,000
R	m <sup>2</sup> K/kW	0,000	0,000	0,000	0,000
K <sub>0</sub> determination		Automatic	Automatic	Automatic	Automatic
K <sub>0,x</sub> = K <sub>0,z</sub>		Yes	Yes	Yes	Yes
K <sub>0,x</sub>		0,4264	0,3982	0,6580	0,4122
K <sub>0,z</sub>		0,4264	0,3982	0,6580	0,4122
Data set		Standard	USDA	Standard	USDA
Model		Van Genuchten	Van Genuchten	Van Genuchten	Van Genuchten
Type		Coarse	Coarse	Coarse	Coarse
Type		Sand	Sand	Sand	Sand
< 2 μm	%	10,00	4,000	10,00	4,000
2 μm - 50 μm	%	13,00	4,000	13,00	4,000

50 $\mu\text{m}$ - 2 mm	%	77,00	92,00	77,00	92,00
Use defaults		None	None	None	None
$k_x$	m/day	0,000	0,000	0,000	0,000
$k_y$	m/day	0,000	0,000	0,000	0,000
Identification		Rock	A	F1	GNEISS
$-\psi_{\text{unsat}}$	m	10,00E3	10,00E3	10,00E3	10,00E3
$e_{\text{init}}$		0,5000	0,5000	0,5000	0,5000
$S_s$	1/m	0,000	0,000	0,000	0,000
$c_k$		1000E12	1000E12	1000E12	1000E12
$c_s$	kJ/t/K	0,000	0,000	0,000	0,000
$\lambda_s$	kW/m/K	0,000	0,000	0,000	0,000
$\rho_s$	t/m <sup>3</sup>	0,000	0,000	0,000	0,000
Solid thermal expansion		Volumetric	Volumetric	Volumetric	Volumetric
$\alpha_s$	1/K	0,000	0,000	0,000	0,000
$D_v$	m <sup>2</sup> /day	0,000	0,000	0,000	0,000
$f_{\text{TV}}$		0,000	0,000	0,000	0,000
Unfrozen water content		None	None	None	None

### 1.1.3.1 Calculation information

Calculation information				
Step info				
Phase	Initial phase [InitialPhase]			
Step	Initial			
Calculation mode	Classical mode			
Step type	Gravity loading			
Solver type	Picos			
Kernel type	64 bit			
Extrapolation factor	0,7032			
Relative stiffness	0,3553			
Design approach				
Index	1			
Name	DesignApproach_1			
Multipliers				
Soil weight			$\Sigma M_{\text{Weight}}$	1,000
Strength reduction factor	$M_{\text{sf}}$	0,000	$\Sigma M_{\text{sf}}$	1,000
Time	Increment	0,000	End time	0,000



Calculation information

Staged construction

Active proportion total area	$M_{Area}$	0,1991	$\Sigma M_{Area}$	0,8513
Active proportion of stage	$M_{Stage}$	0,2339	$\Sigma M_{Stage}$	1,000

Forces

$F_x$  0,000 kN/m

$F_y$  0,000 kN/m

Consolidation

Realised  $P_{Excess,Max}$  0,000 kN/m<sup>2</sup>

1.1.3.2 Calculation information

Calculation information				
Step info				
Phase	Phase_1 [Phase_1]			
Step	Initial			
Calculation mode	Classical mode			
Step type	Plastic			
Updated mesh	False			
Solver type	Picos			
Kernel type	64 bit			
Extrapolation factor	0,4751			
Relative stiffness	0,5382			
Design approach				
Index	1			
Name	DesignApproach_1			
Multipliers				
Soil weight			$\Sigma M_{\text{Weight}}$	1,000
Strength reduction factor	$M_{\text{sf}}$	0,000	$\Sigma M_{\text{sf}}$	1,000

Calculation information				
Time	Increment	0,000	End time	0,000
Staged construction				
Active proportion total area	$M_{Area}$	0,01198	$\Sigma M_{Area}$	0,9017
Active proportion of stage	$M_{Stage}$	0,1819	$\Sigma M_{Stage}$	1,000
Forces				
$F_x$	0,000 kN/m			
$F_y$	0,000 kN/m			
Consolidation				
Realised $P_{Excess,Max}$	0,000 kN/m <sup>2</sup>			

### 1.1.3.3 Calculation information

Calculation information				
Step info				
Phase	Phase_2 [Phase_2]			
Step	Initial			
Calculation mode	Classical mode			
Step type	Plastic			
Updated mesh	False			
Solver type	Picos			
Kernel type	64 bit			
Extrapolation factor	0,6184			
Relative stiffness	0,5182			
Design approach				
Index	1			
Name	DesignApproach_1			
Multipliers				
Soil weight			$\Sigma M_{\text{Weight}}$	1,000
Strength reduction factor	$M_{\text{sf}}$	0,000	$\Sigma M_{\text{sf}}$	1,000

Calculation information				
Time	Increment	0,000	End time	0,000
Staged construction				
Active proportion total area	$M_{Area}$	0,01445	$\Sigma M_{Area}$	0,9485
Active proportion of stage	$M_{Stage}$	0,2411	$\Sigma M_{Stage}$	1,000
Forces				
$F_x$	0,000 kN/m			
$F_y$	0,000 kN/m			
Consolidation				
Realised $P_{Excess,Max}$	0,000 kN/m <sup>2</sup>			

1.1.3.4 Calculation information

Calculation information				
Step info				
Phase	Phase_3 [Phase_3]			
Step	Initial			
Calculation mode	Classical mode			
Step type	Plastic			
Updated mesh	False			
Solver type	Picos			
Kernel type	64 bit			
Extrapolation factor	0,9219			
Relative stiffness	0,5213			
Design approach				
Index	1			
Name	DesignApproach_1			
Multipliers				
Soil weight			$\Sigma M_{\text{Weight}}$	1,000
Strength reduction factor	$M_{sf}$	0,000	$\Sigma M_{sf}$	1,000

Calculation information				
Time	Increment	0,000	End time	0,000
Staged construction				
Active proportion total area	$M_{Area}$	0,01542	$\Sigma M_{Area}$	0,9820
Active proportion of stage	$M_{Stage}$	0,3494	$\Sigma M_{Stage}$	1,000
Forces				
$F_x$	0,000 kN/m			
$F_y$	0,000 kN/m			
Consolidation				
Realised $P_{Excess,Max}$	0,000 kN/m <sup>2</sup>			

### 1.1.3.5 Calculation information

Calculation information				
Step info				
Phase	Phase_4 [Phase_4]			
Step	Initial			
Calculation mode	Classical mode			
Step type	Plastic			
Updated mesh	False			
Solver type	Picos			
Kernel type	64 bit			
Extrapolation factor	0,5001			
Relative stiffness	0,4849			
Design approach				
Index	1			
Name	DesignApproach_1			
Multipliers				
Soil weight			$\Sigma M_{\text{Weight}}$	1,000
Strength reduction factor	$M_{\text{sf}}$	0,000	$\Sigma M_{\text{sf}}$	1,000



Calculation information				
Time	Increment	0,000	End time	0,000
Staged construction				
Active proportion total area	$M_{Area}$	2,824E-3	$\Sigma M_{Area}$	0,9932
Active proportion of stage	$M_{Stage}$	0,1900	$\Sigma M_{Stage}$	1,000
Forces				
$F_x$	0,000 kN/m			
$F_y$	0,000 kN/m			
Consolidation				
Realised $P_{Excess,Max}$	0,000 kN/m <sup>2</sup>			

1.1.3.6 Calculation information

Calculation information				
Step info				
Phase	Phase_5_static [Phase_5]			
Step	Initial			
Calculation mode	Classical mode			
Step type	Plastic			
Updated mesh	False			
Solver type	Picos			
Kernel type	64 bit			
Extrapolation factor	0,4958			
Relative stiffness	0,4075			
Design approach				
Index	1			
Name	DesignApproach_1			
Multipliers				
Soil weight			$\Sigma M_{\text{Weight}}$	1,000
Strength reduction factor	$M_{\text{sf}}$	0,000	$\Sigma M_{\text{sf}}$	1,000

Calculation information				
Time	Increment	0,000	End time	0,000
Staged construction				
Active proportion total area	$M_{Area}$	1,674E-3	$\Sigma M_{Area}$	1,000
Active proportion of stage	$M_{Stage}$	0,1731	$\Sigma M_{Stage}$	1,000
Forces				
$F_x$	0,000 kN/m			
$F_y$	0,000 kN/m			
Consolidation				
Realised $P_{Excess,Max}$	0,000 kN/m <sup>2</sup>			

### 1.1.3.7 Calculation information

Calculation information				
Step info				
Phase	Phase_8_seismic [Phase_8]			
Step	Initial			
Calculation mode	Classical mode			
Step type	Plastic			
Updated mesh	False			
Solver type	Picos			
Kernel type	64 bit			
Extrapolation factor	0,3047			
Relative stiffness	0,1589			
Design approach				
Index	1			
Name	DesignApproach_1			
Multipliers				
Soil weight			$\Sigma M_{\text{Weight}}$	1,000
Strength reduction factor	$M_{\text{sf}}$	0,000	$\Sigma M_{\text{sf}}$	1,000

Calculation information				
Time	Increment	0,000	End time	0,000
Staged construction				
Active proportion total area	$M_{Area}$	0,000	$\Sigma M_{Area}$	1,000
Active proportion of stage	$M_{Stage}$	0,1100	$\Sigma M_{Stage}$	1,000
Forces				
$F_x$	0,000 kN/m			
$F_y$	0,000 kN/m			
Consolidation				
Realised $P_{Excess,Max}$	0,000 kN/m <sup>2</sup>			
Pseudo-static acceleration				
X	5,000E-3 g			
Y	3,000E-3 g			

#### 1.1.4 Calculation information per phase

Identification	Phase	Start from Calculation type	Loading input	Pore pressure	Time step [day]	First step	Last step
Initial phase [InitialPhase]	0	N/A Gravity loading	N/A	Phreatic	0,000	0	15
Phase_1 [Phase_1]	8	0 Plastic	Staged construction	Phreatic	0,000	16	20
Phase_2 [Phase_2]	9	8 Plastic	Staged construction	Phreatic	0,000	21	24
Phase_3 [Phase_3]	10	9 Plastic	Staged construction	Phreatic	0,000	25	27
Phase_4 [Phase_4]	11	10 Plastic	Staged construction	Phreatic	0,000	28	30
Phase_5_static [Phase_5]	12	11 Plastic	Staged construction	Phreatic	0,000	31	33
Phase_8_seismic [Phase_8]	2	12 Plastic	Staged construction	Phreatic	0,000	34	36

1.1.5.1 Step info

Step	Phase Step type	Extrapolation factor [ $10^{-3}$ ]	Relative stiffness [ $10^{-3}$ ]
15	0 Gravity loading	703,226	355,256
20	8 Plastic	475,076	538,223
24	9 Plastic	618,415	518,245
27	10 Plastic	921,855	521,280
30	11 Plastic	500,127	484,941
33	12 Plastic	495,798	407,497
36	2 Plastic	304,726	158,908

### 1.1.5.2 Multipliers

Step	Phase $\Sigma M_{DispX}$	$\Sigma M_{DispY}$	$\Sigma M_{Weight}$	$M_{sf}$	$\Sigma M_{sf}$
15	0 0,000	0,000	1,000	0,000	1,000
20	8 0,000	0,000	1,000	0,000	1,000
24	9 0,000	0,000	1,000	0,000	1,000
27	10 0,000	0,000	1,000	0,000	1,000
30	11 0,000	0,000	1,000	0,000	1,000
33	12 0,000	0,000	1,000	0,000	1,000
36	2 0,000	0,000	1,000	0,000	1,000



### 1.1.5.3 Time

Step	Phase Time step [day]	End time [day]
15	0 0,000	0,000
20	8 0,000	0,000
24	9 0,000	0,000
27	10 0,000	0,000
30	11 0,000	0,000
33	12 0,000	0,000
36	2 0,000	0,000

#### 1.1.5.4 Staged construction

Step	Phase M <sub>Area</sub>	$\Sigma M_{Area}$	M <sub>Stage</sub> [10 <sup>-3</sup> ]	$\Sigma M_{Stage}$
15	0 1,000	0,851	233,859	1,000
20	8 0,766	0,902	181,902	1,000
24	9 0,780	0,948	241,120	1,000
27	10 0,758	0,982	349,392	1,000
30	11 0,760	0,993	189,985	1,000
33	12 0,698	1,000	173,078	1,000
36	2 0,722	1,000	110,009	1,000

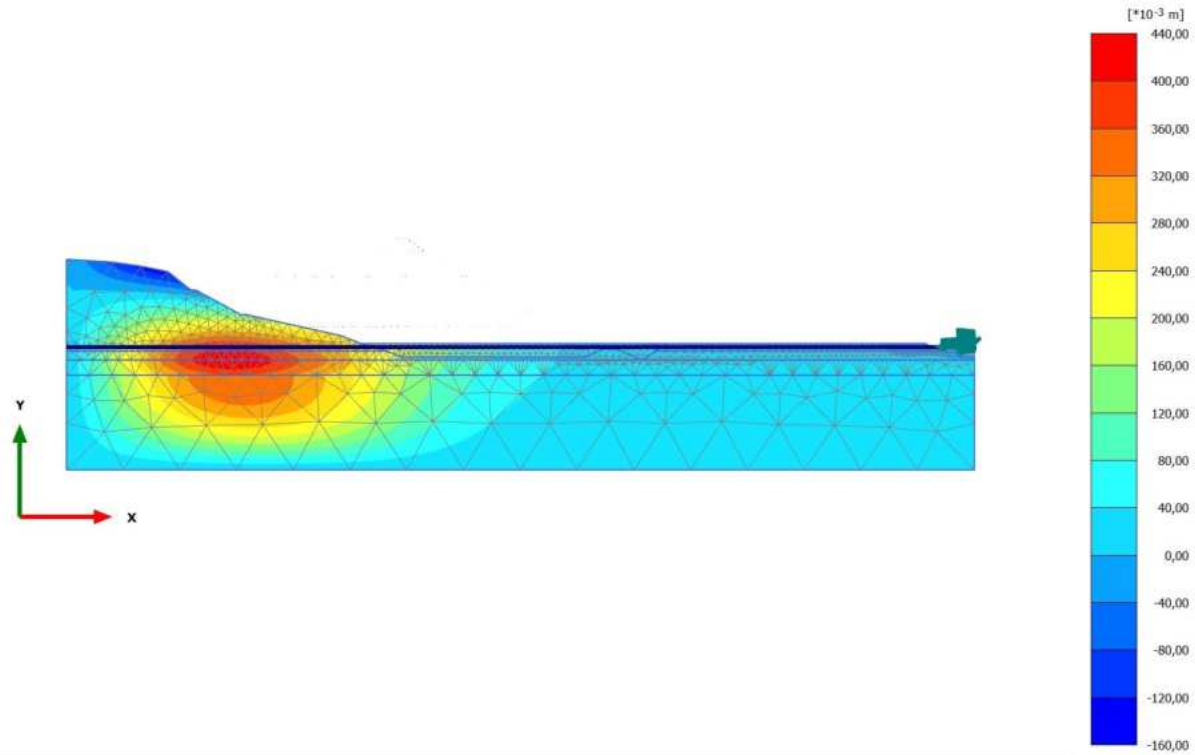
#### 1.1.5.5 Forces

Step	Phase $F_x$ [kN/m]	$F_y$ [kN/m]
15	0 0,000	0,000
20	8 0,000	0,000
24	9 0,000	0,000
27	10 0,000	0,000
30	11 0,000	0,000
33	12 0,000	0,000
36	2 0,000	0,000

#### 1.1.5.6 Consolidation

Step	Phase Rel. P <sub>Max</sub> [kN/m <sup>2</sup> ]
15	0 0,000
20	8 0,000
24	9 0,000
27	10 0,000
30	11 0,000
33	12 0,000
36	2 0,000

2.1.1.1.1 Calculation results, Initial phase [InitialPhase] (0/15), Total displacements  $u_x$

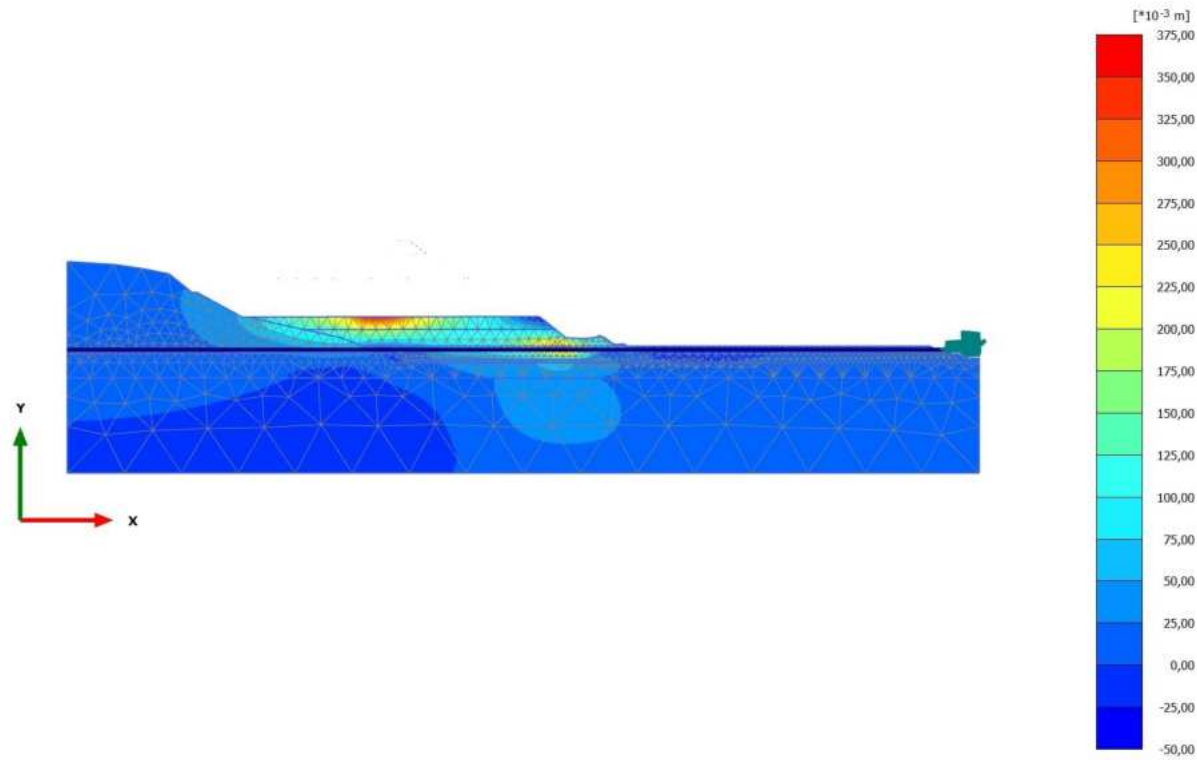


**Total displacements  $u_x$  (scaled up 50,0 times)**

Maximum value = 0,4392 m (Element 1926 at Node 11093)

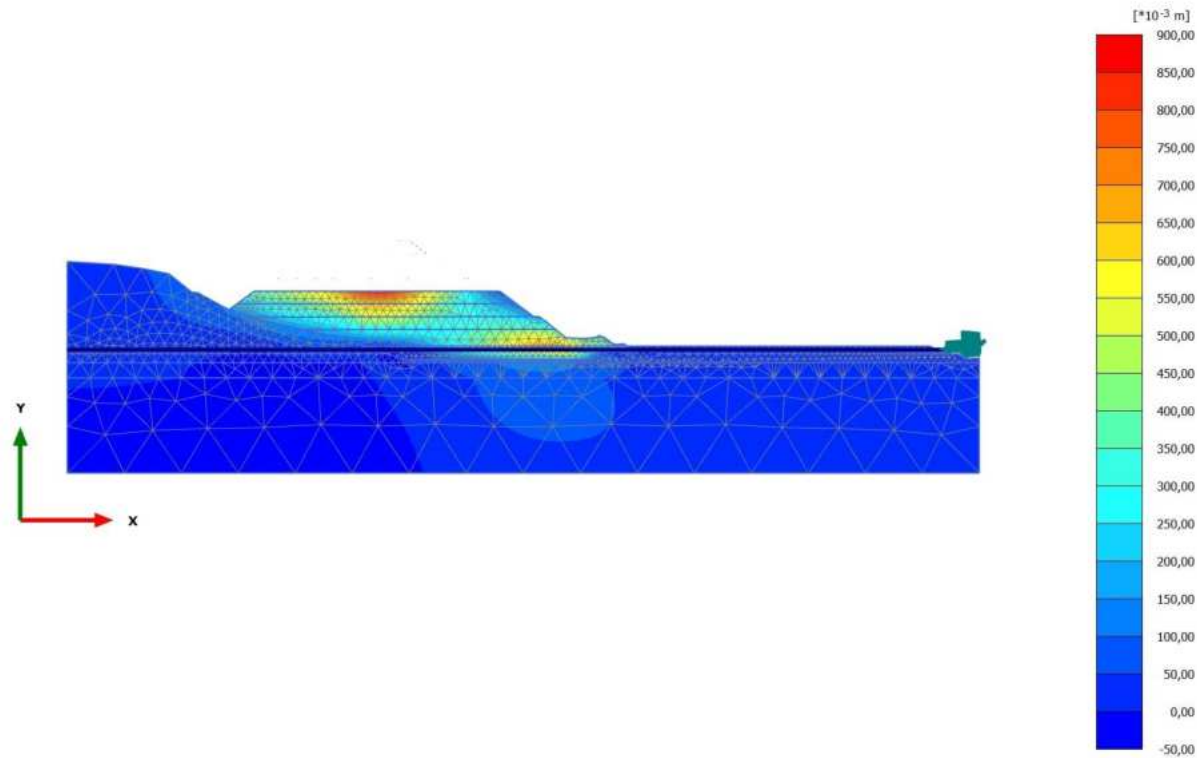
Minimum value = -0,1479 m (Element 575 at Node 9203)

2.1.1.1.2 Calculation results, Phase\_1 [Phase\_1] (8/20), Total displacements  $u_x$



**Total displacements  $u_x$  (scaled up 50,0 times)**  
Maximum value = 0,3639 m (Element 864 at Node 17603)  
Minimum value = -0,04874 m (Element 902 at Node 12153)

2.1.1.1.3 Calculation results, Phase\_2 [Phase\_2] (9/24), Total displacements  $u_x$

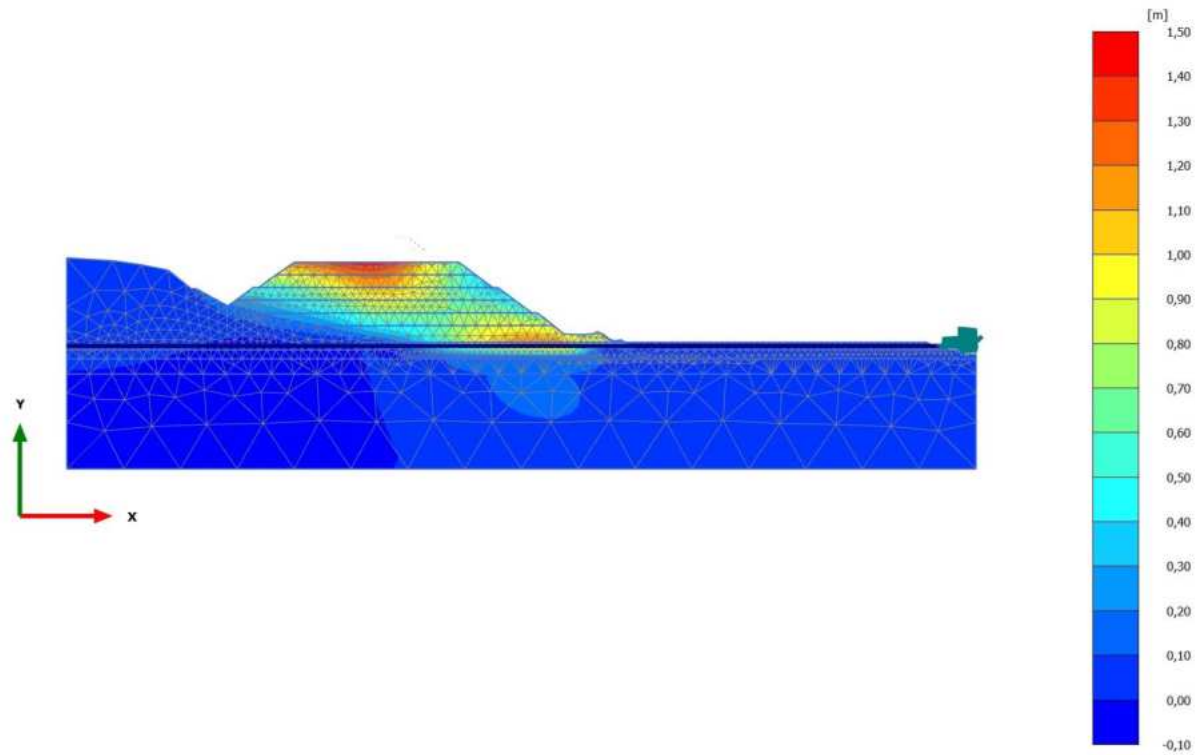


**Total displacements  $u_x$  (scaled up 20,0 times)**

Maximum value = 0,8569 m (Element 329 at Node 19360)

Minimum value = -0,04592 m (Element 1425 at Node 15092)

2.1.1.1.4 Calculation results, Phase\_3 [Phase\_3] (10/27), Total displacements  $u_x$



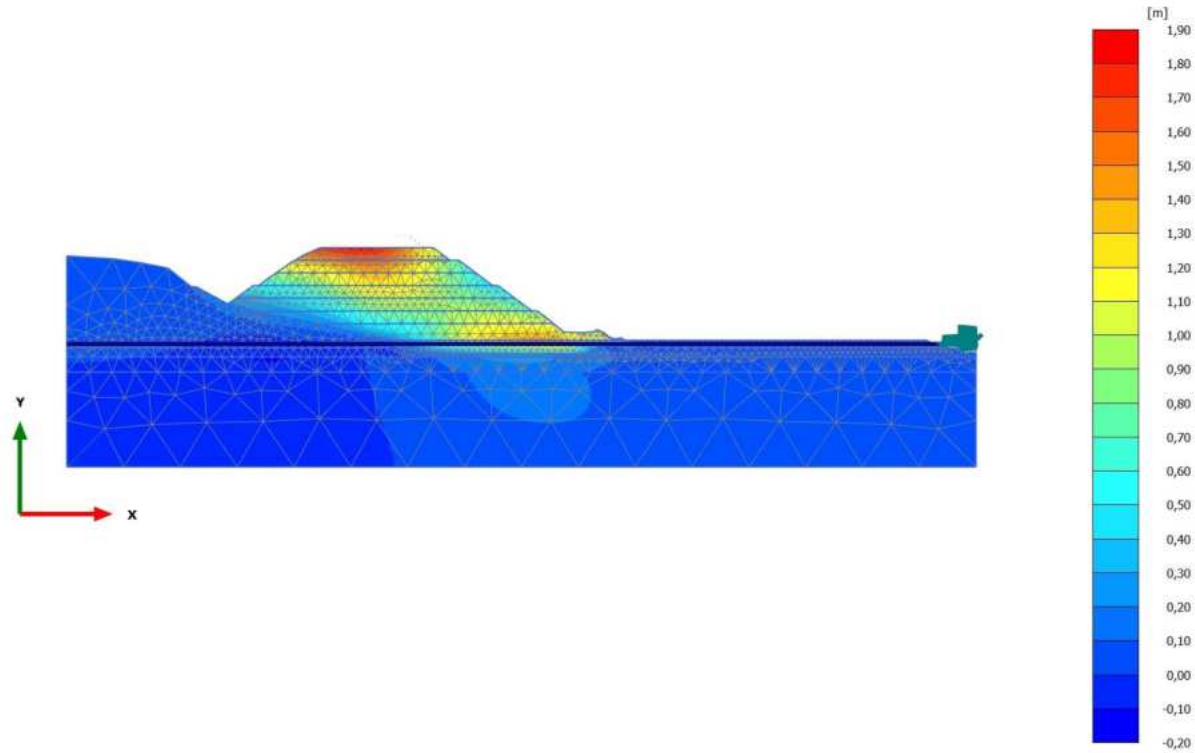
**Total displacements  $u_x$  (scaled up 20,0 times)**

Maximum value = 1,475 m (Element 185 at Node 20297)

Minimum value = -0,08457 m (Element 1930 at Node 11693)



2.1.1.1.5 Calculation results, Phase\_4 [Phase\_4] (11/30), Total displacements  $u_x$

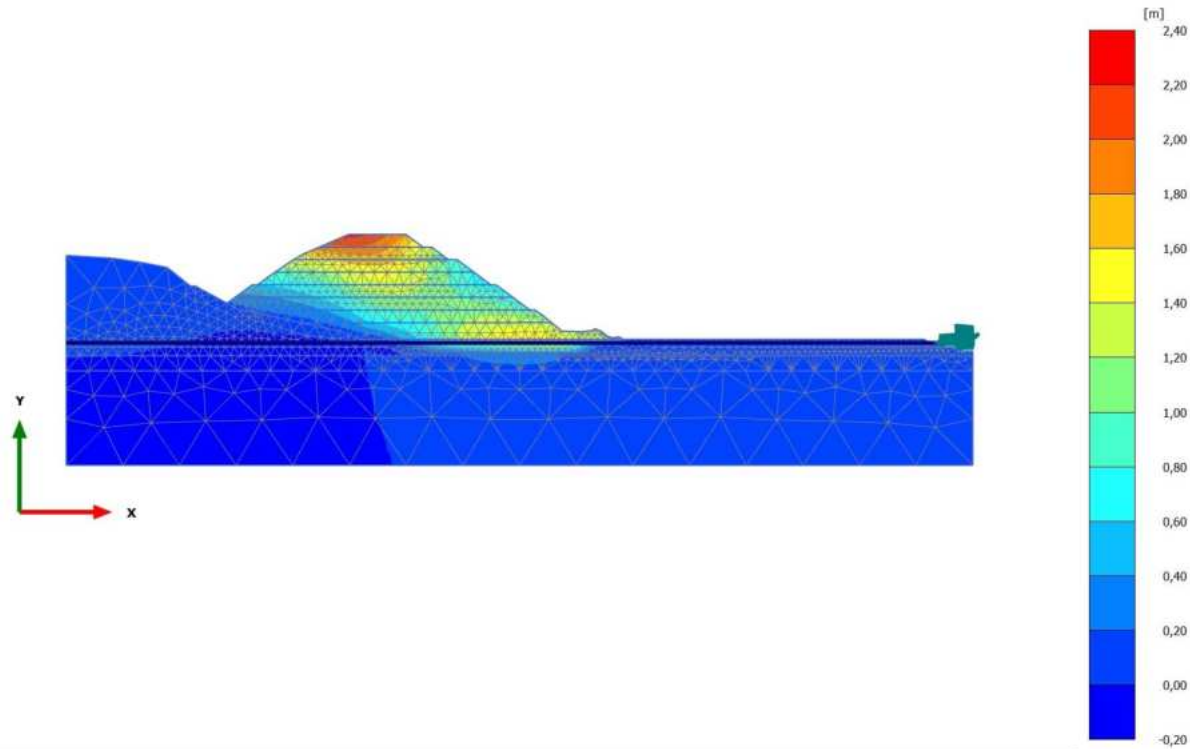


**Total displacements  $u_x$  (scaled up 10,0 times)**

Maximum value = 1,862 m (Element 41 at Node 20396)

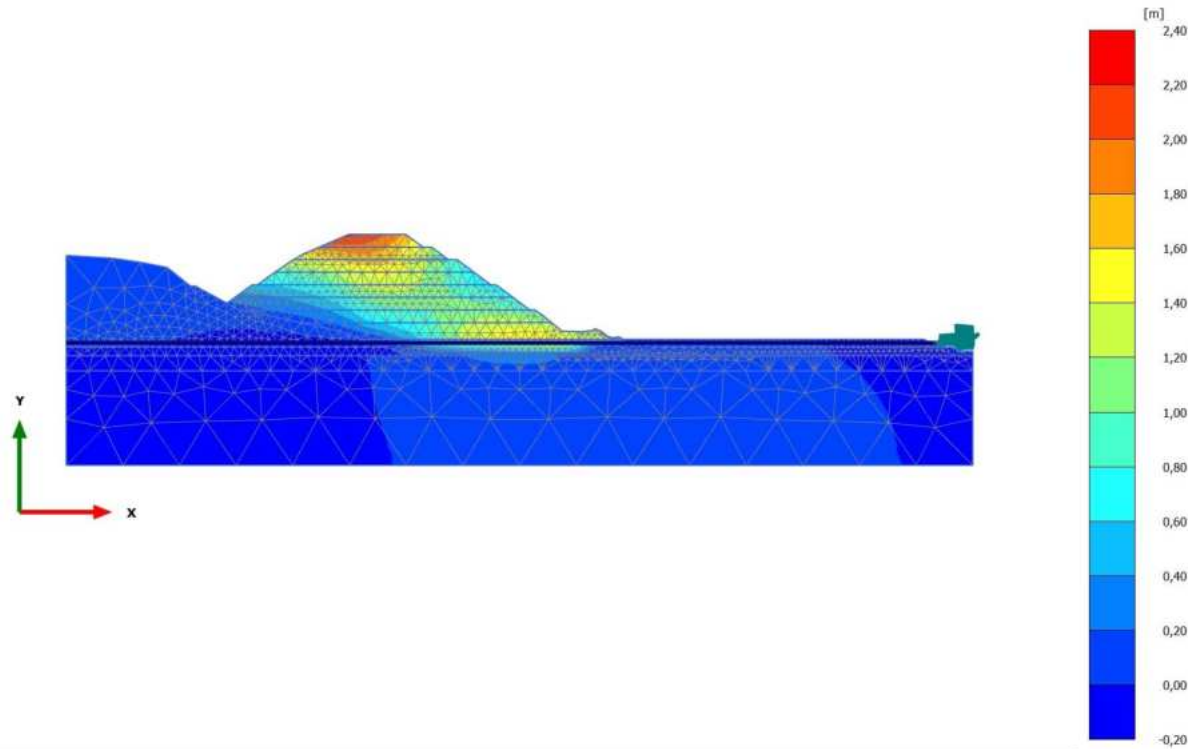
Minimum value = -0,1077 m (Element 1930 at Node 11695)

2.1.1.1.6 Calculation results, Phase\_5\_static [Phase\_5] (12/33), Total displacements  $u_x$



**Total displacements  $u_x$  (scaled up 5,00 times)**  
Maximum value = 2,293 m (Element 28 at Node 20254)  
Minimum value = -0,1254 m (Element 1930 at Node 12329)

2.1.1.1.7 Calculation results, Phase\_8\_seismic [Phase\_8] (2/36), Total displacements  $u_x$

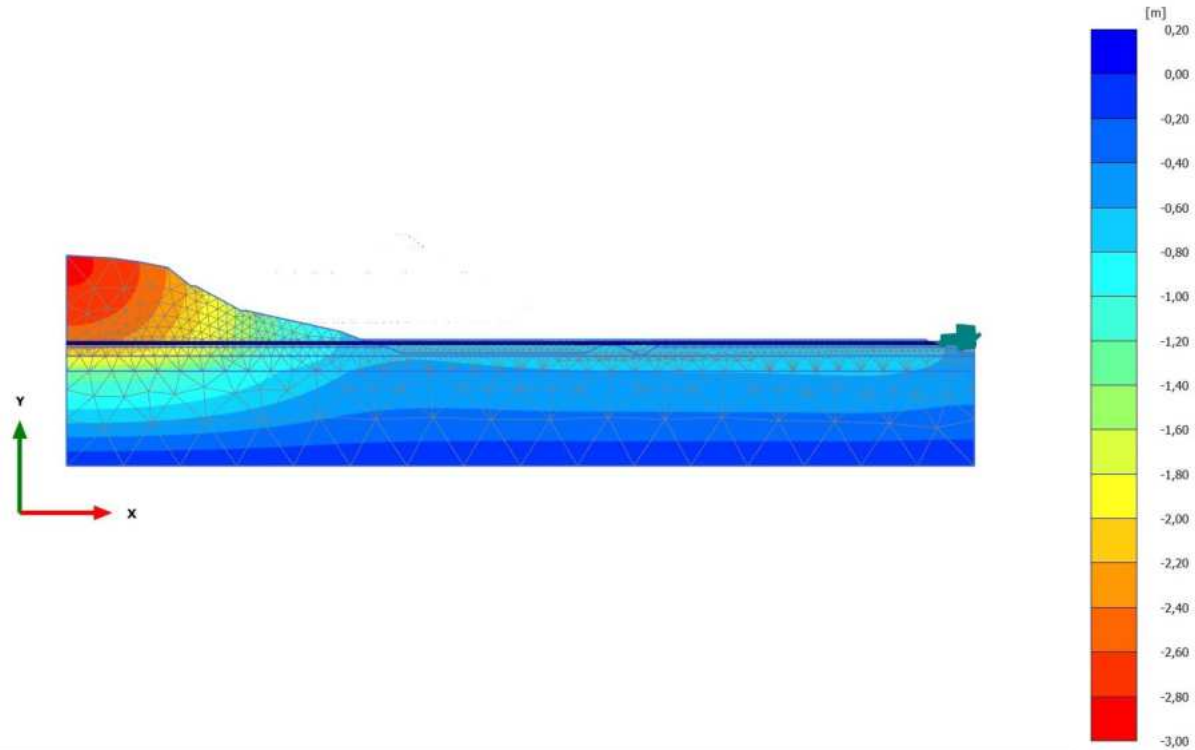


**Total displacements  $u_x$  (scaled up 5,00 times)**

Maximum value = 2,262 m (Element 28 at Node 20254)

Minimum value = -0,1361 m (Element 1930 at Node 12329)

2.1.1.2.1 Calculation results, Initial phase [InitialPhase] (0/15), Total displacements  $u_y$

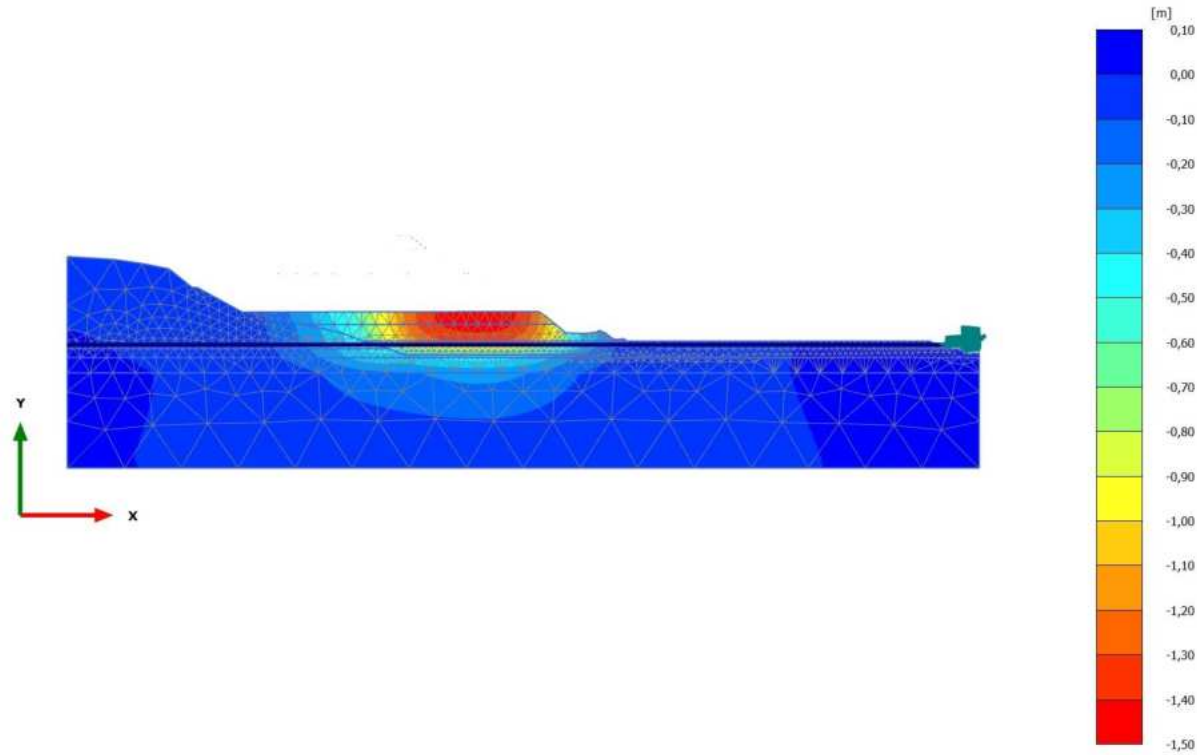


**Total displacements  $u_y$  (scaled up 5,00 times)**

Maximum value = 0,000 m (Element 2384 at Node 5345)

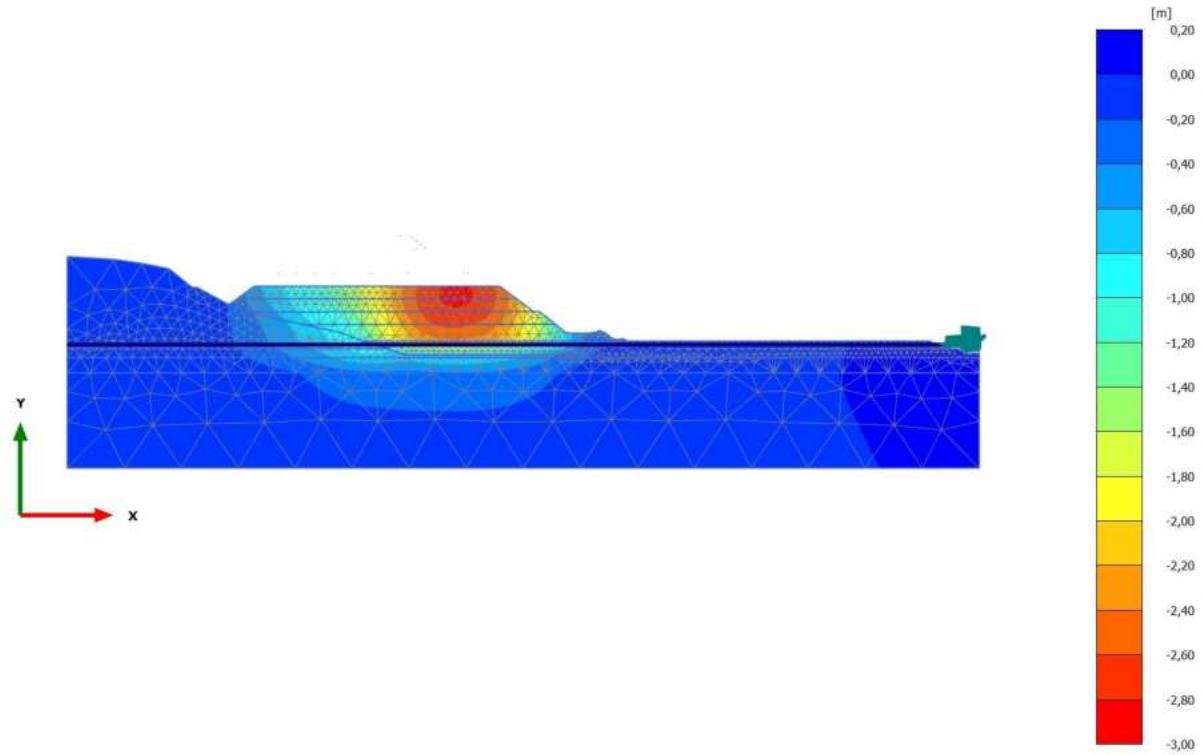
Minimum value = -2,832 m (Element 569 at Node 8841)

2.1.1.2.2 Calculation results, Phase\_1 [Phase\_1] (8/20), Total displacements  $u_y$



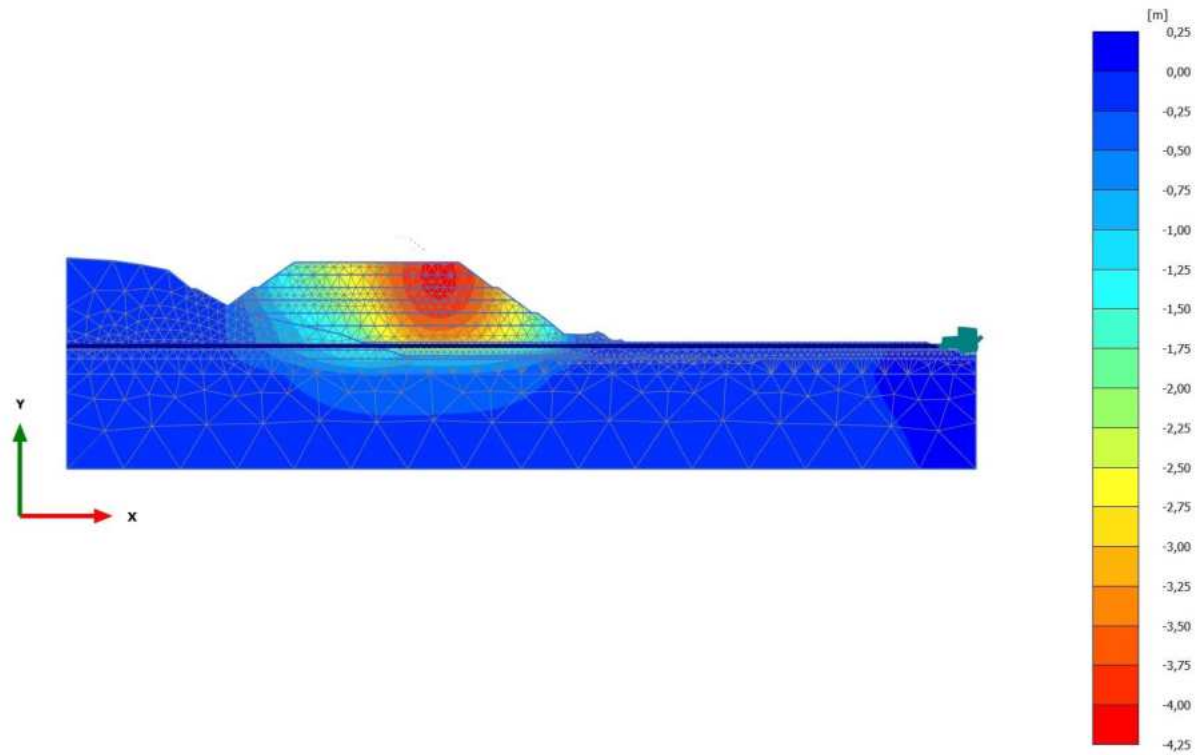
**Total displacements  $u_y$  (scaled up 20,0 times)**  
Maximum value =  $2,072 \cdot 10^{-3}$  m (Element 2150 at Node 8747)  
Minimum value = -1,464 m (Element 885 at Node 16406)

2.1.1.2.3 Calculation results, Phase\_2 [Phase\_2] (9/24), Total displacements  $u_y$



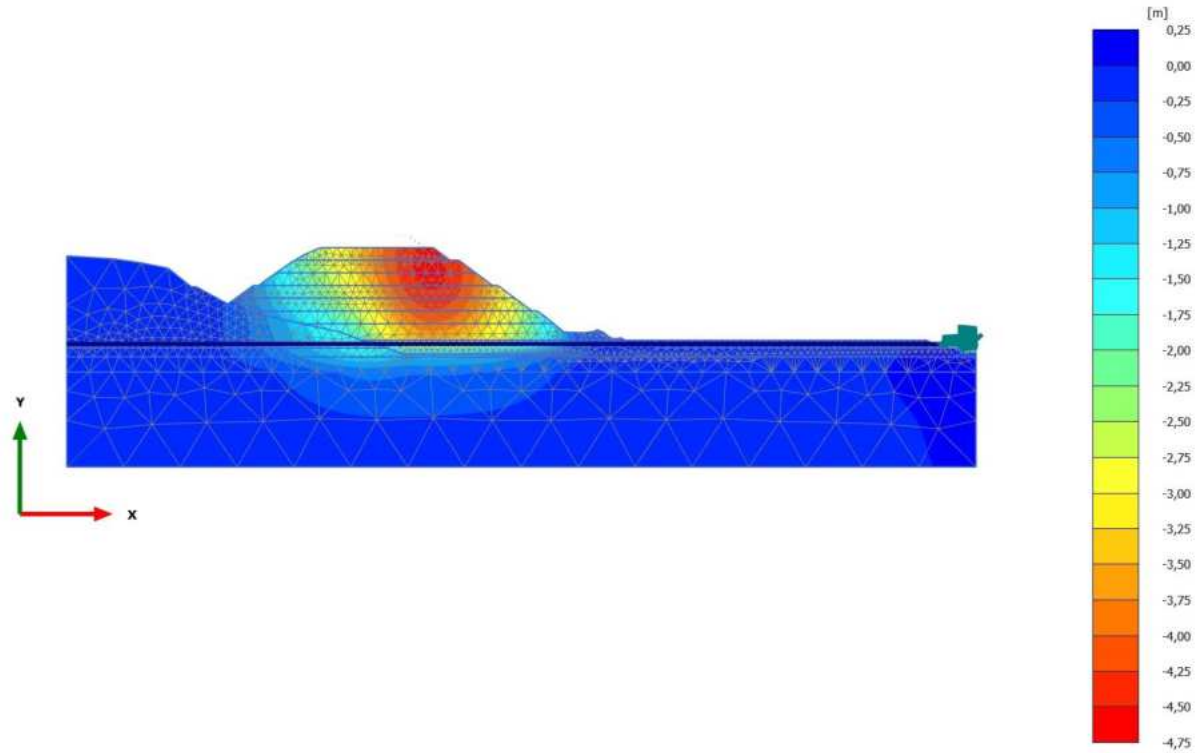
**Total displacements  $u_y$  (scaled up 5,00 times)**  
Maximum value =  $0,5590 \cdot 10^{-3}$  m (Element 2144 at Node 3405)  
Minimum value = -2,839 m (Element 307 at Node 17415)

2.1.1.2.4 Calculation results, Phase\_3 [Phase\_3] (10/27), Total displacements  $u_y$



**Total displacements  $u_y$  (scaled up 5,00 times)**  
Maximum value = 0,02819 m (Element 1466 at Node 4501)  
Minimum value = -4,085 m (Element 251 at Node 18707)

2.1.1.2.5 Calculation results, Phase\_4 [Phase\_4] (11/30), Total displacements  $u_y$



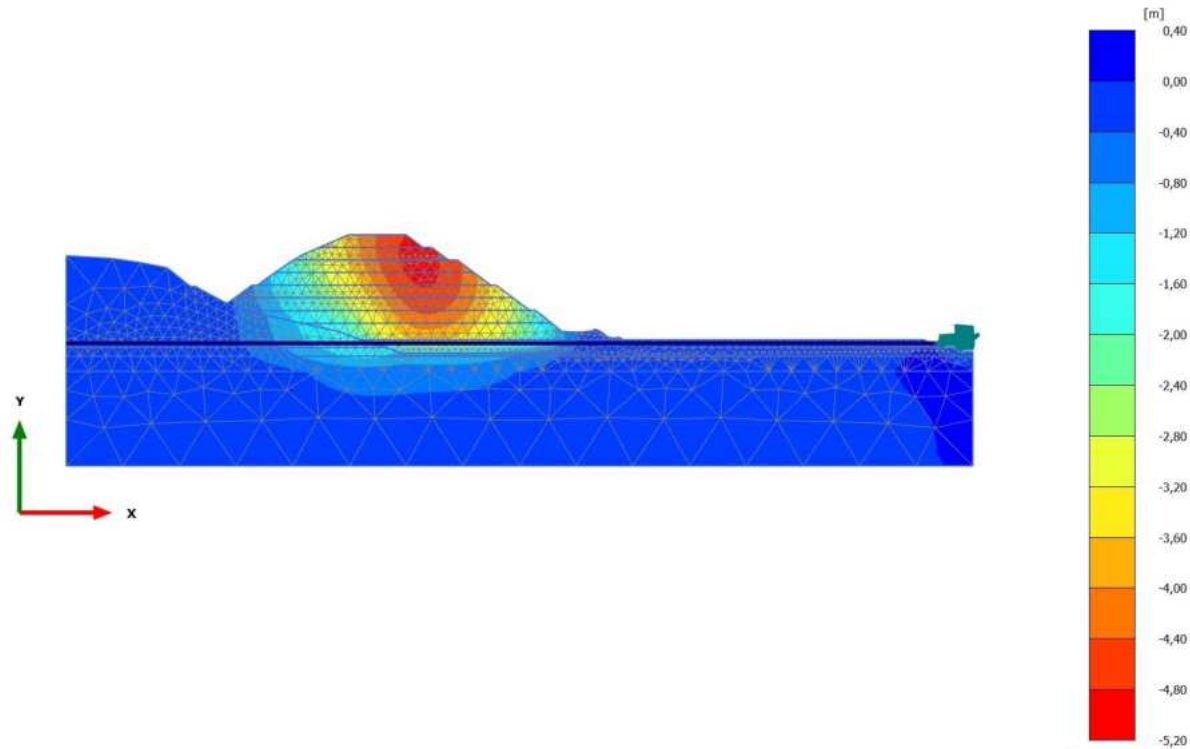
**Total displacements  $u_y$  (scaled up 5,00 times)**

Maximum value = 0,08546 m (Element 1466 at Node 4501)

Minimum value = -4,591 m (Element 154 at Node 19428)



2.1.1.2.6 Calculation results, Phase\_5\_static [Phase\_5] (12/33), Total displacements  $u_y$

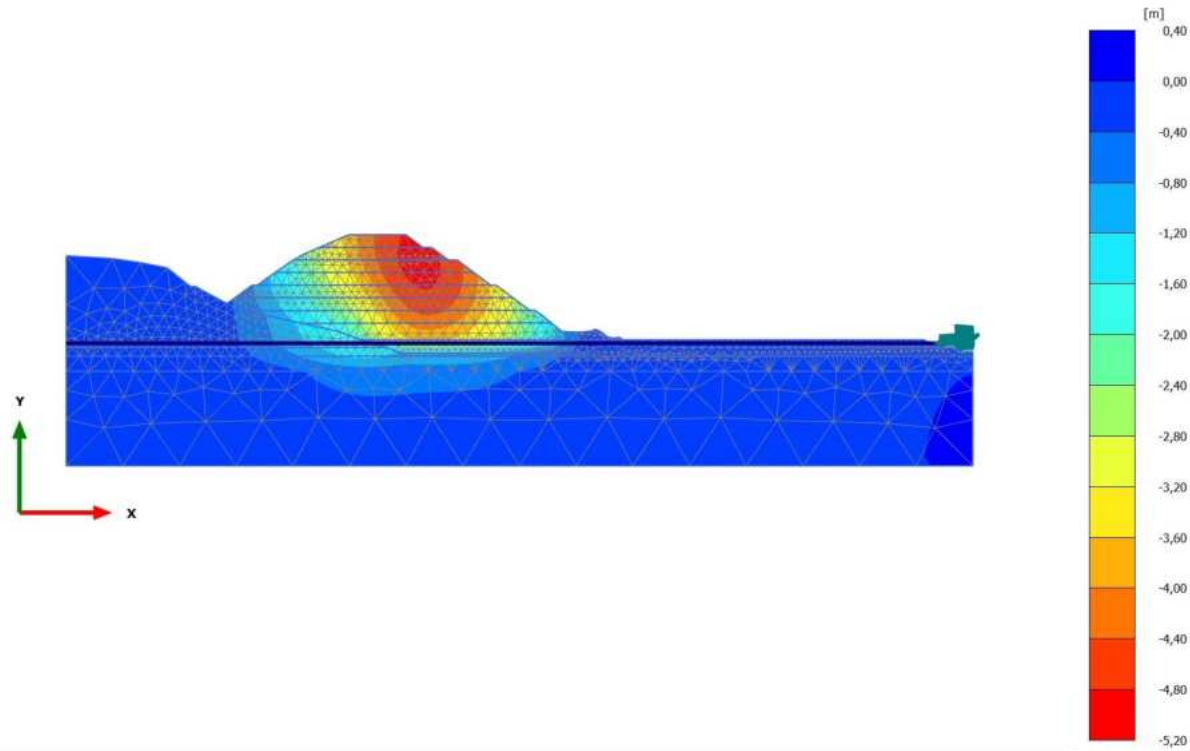


**Total displacements  $u_y$  (scaled up 5,00 times)**

Maximum value = 0,1232 m (Element 1466 at Node 4501)

Minimum value = -4,927 m (Element 204 at Node 19638)

2.1.1.2.7 Calculation results, Phase\_8\_seismic [Phase\_8] (2/36), Total displacements  $u_y$

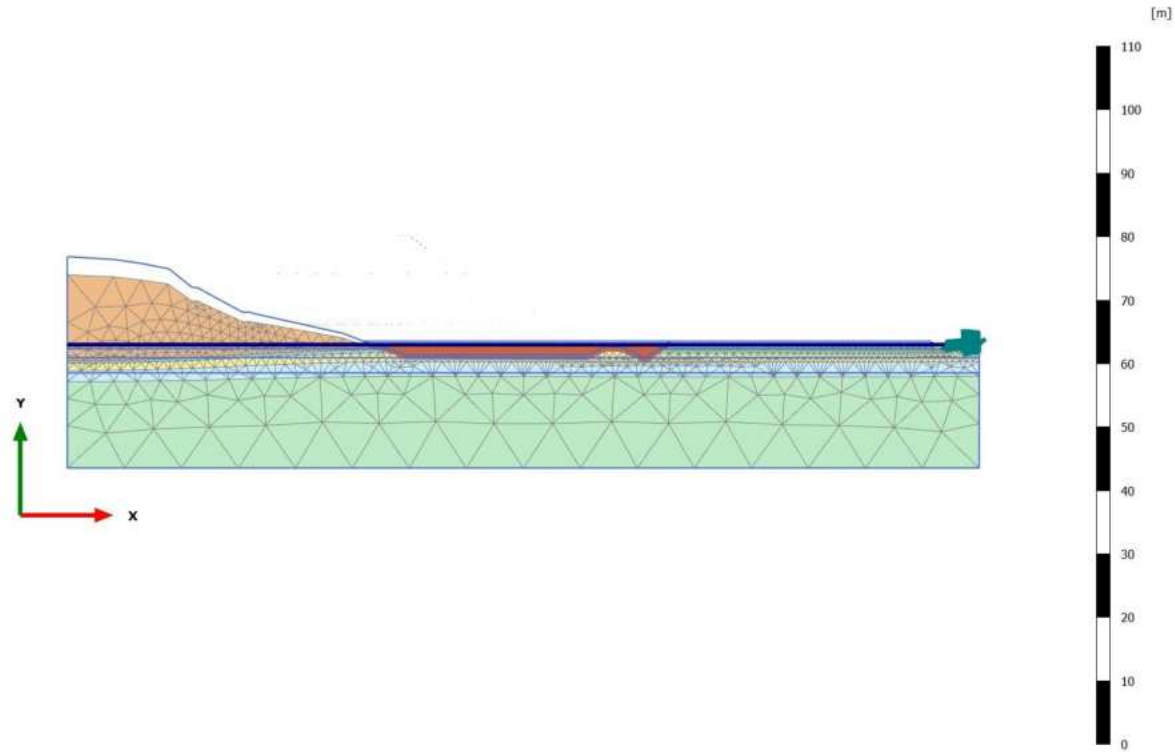


**Total displacements  $u_y$  (scaled up 5,00 times)**

Maximum value = 0,1516 m (Element 1466 at Node 4501)

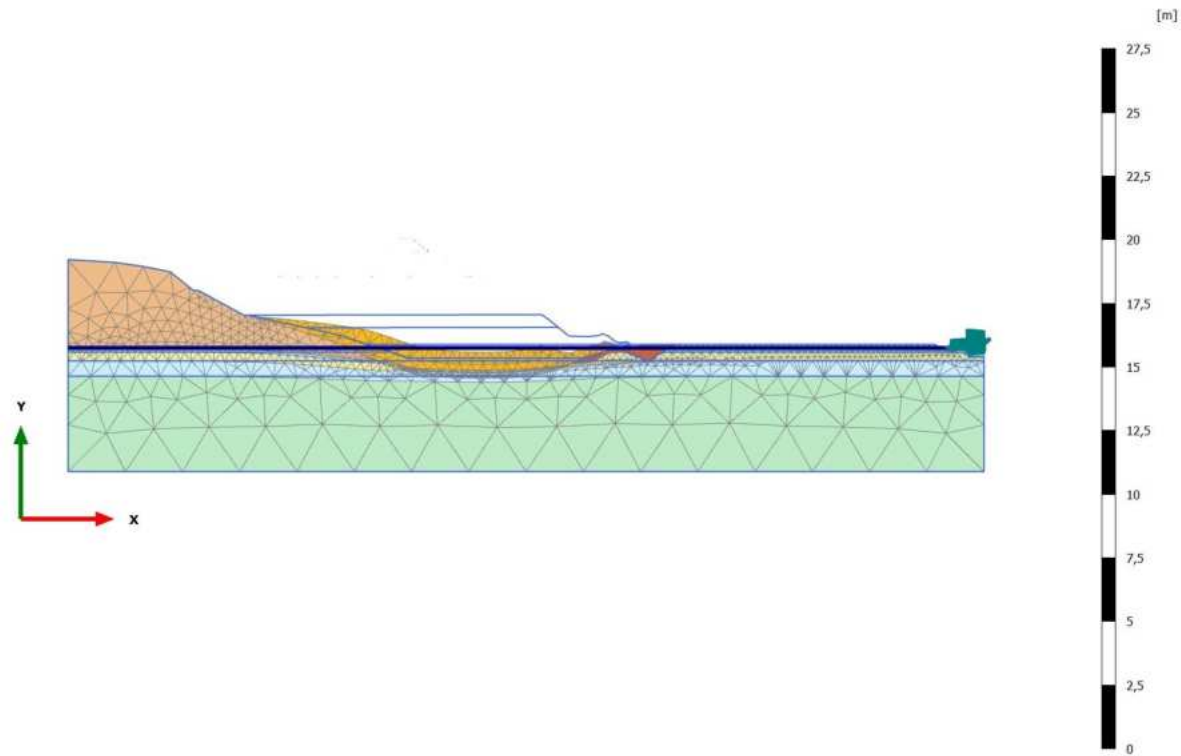
Minimum value = -4,945 m (Element 204 at Node 19638)

2.1.2.1 Calculation results, Initial phase [InitialPhase] (0/15), Deformed mesh |u|



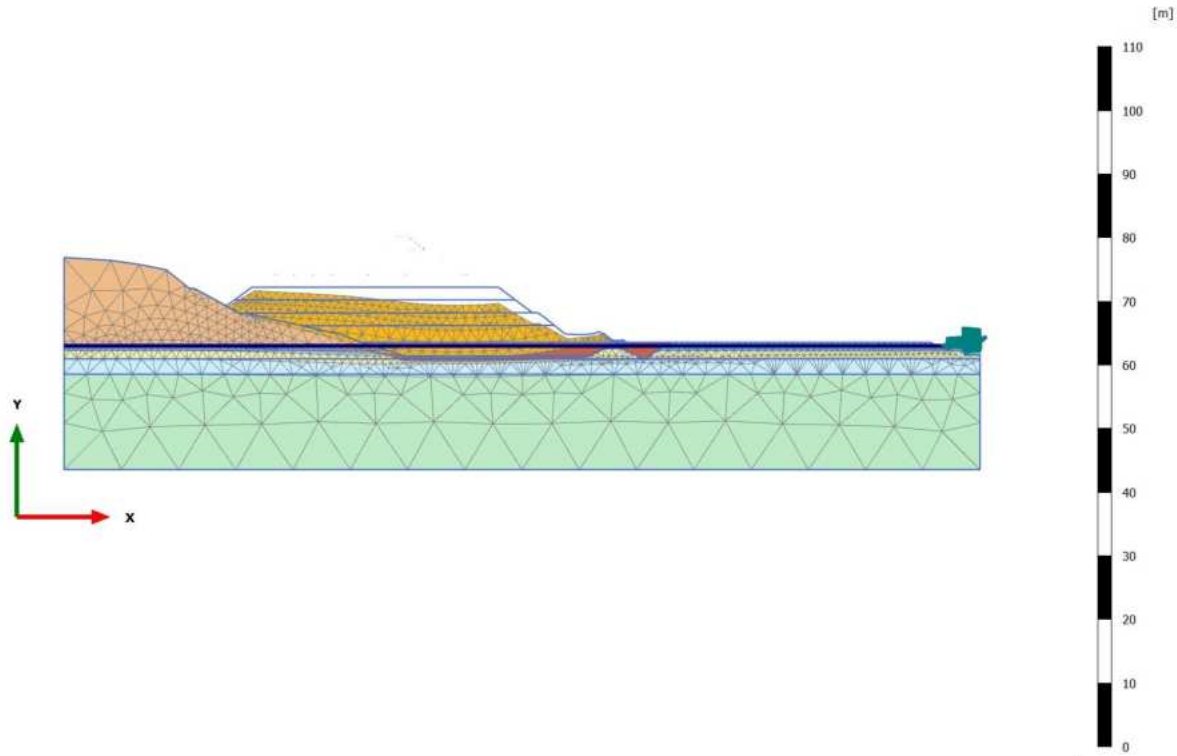
**Deformed mesh |u| (scaled up 5,00 times)**  
Maximum value = 2,832 m (Element 569 at Node 8841)

2.1.2.2 Calculation results, Phase\_1 [Phase\_1] (8/20), Deformed mesh |u|



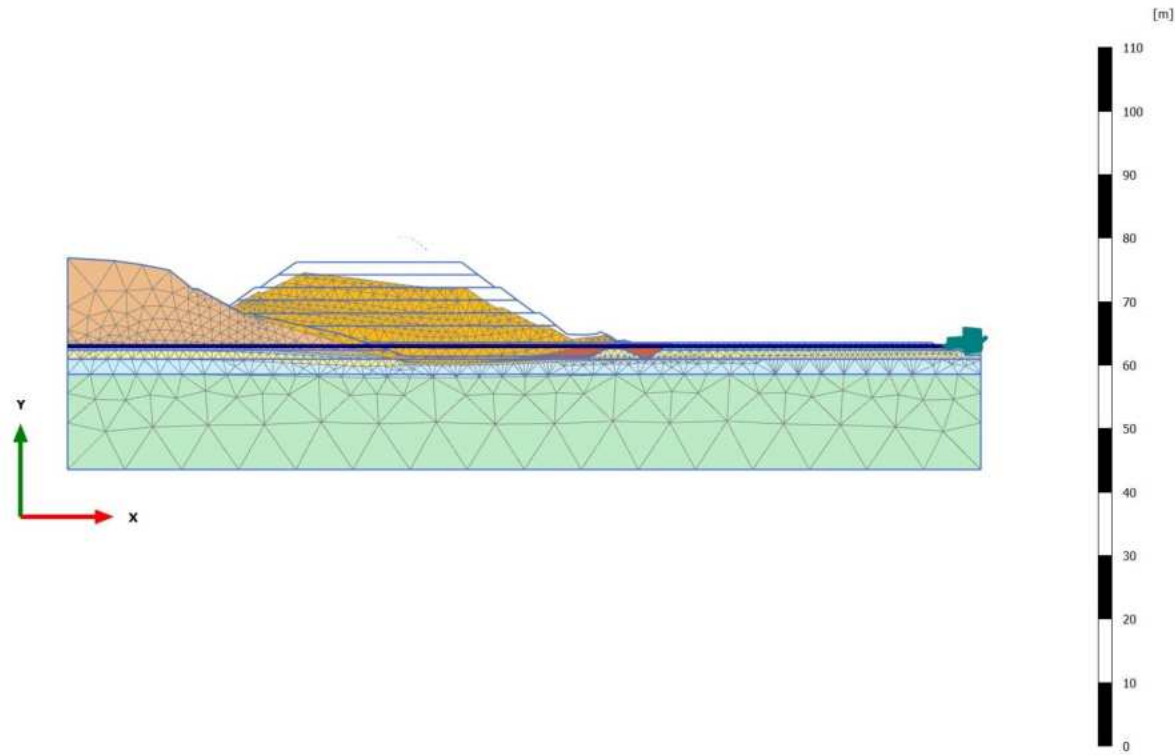
**Deformed mesh |u| (scaled up 20,0 times)**  
Maximum value = 1,468 m (Element 883 at Node 16508)

2.1.2.3 Calculation results, Phase\_2 [Phase\_2] (9/24), Deformed mesh |u|



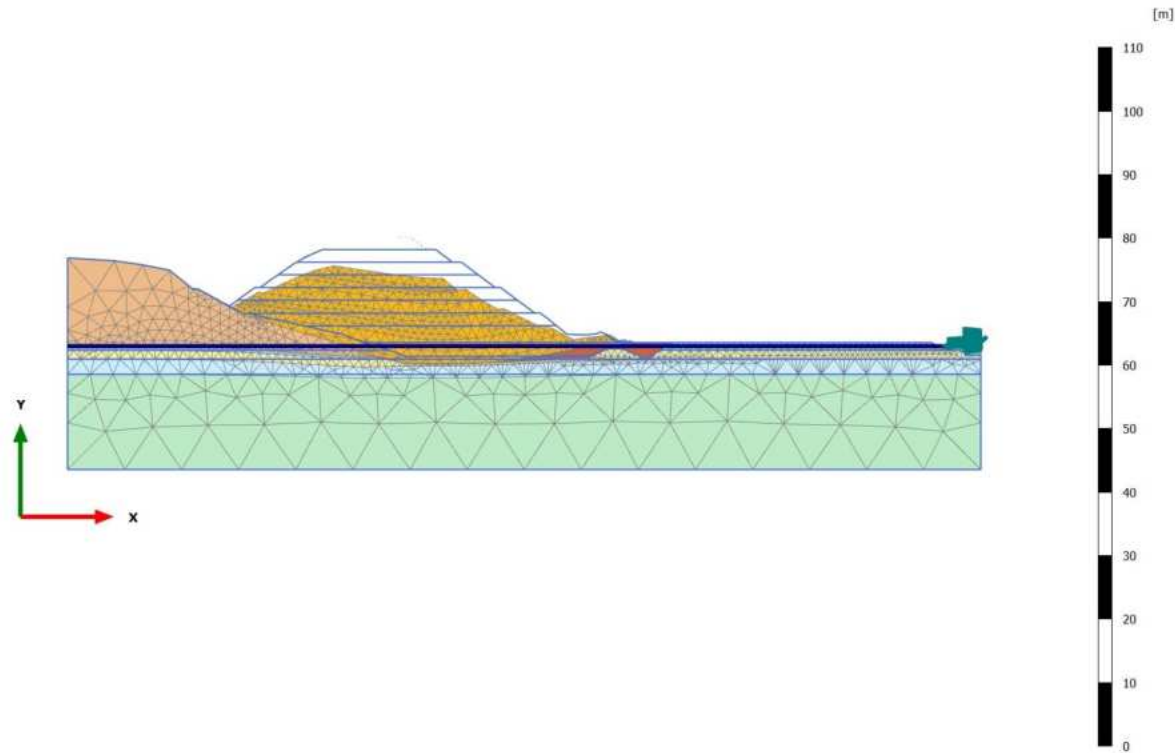
**Deformed mesh |u| (scaled up 5,00 times)**  
Maximum value = 2,863 m (Element 307 at Node 17418)

2.1.2.4 Calculation results, Phase\_3 [Phase\_3] (10/27), Deformed mesh |u|



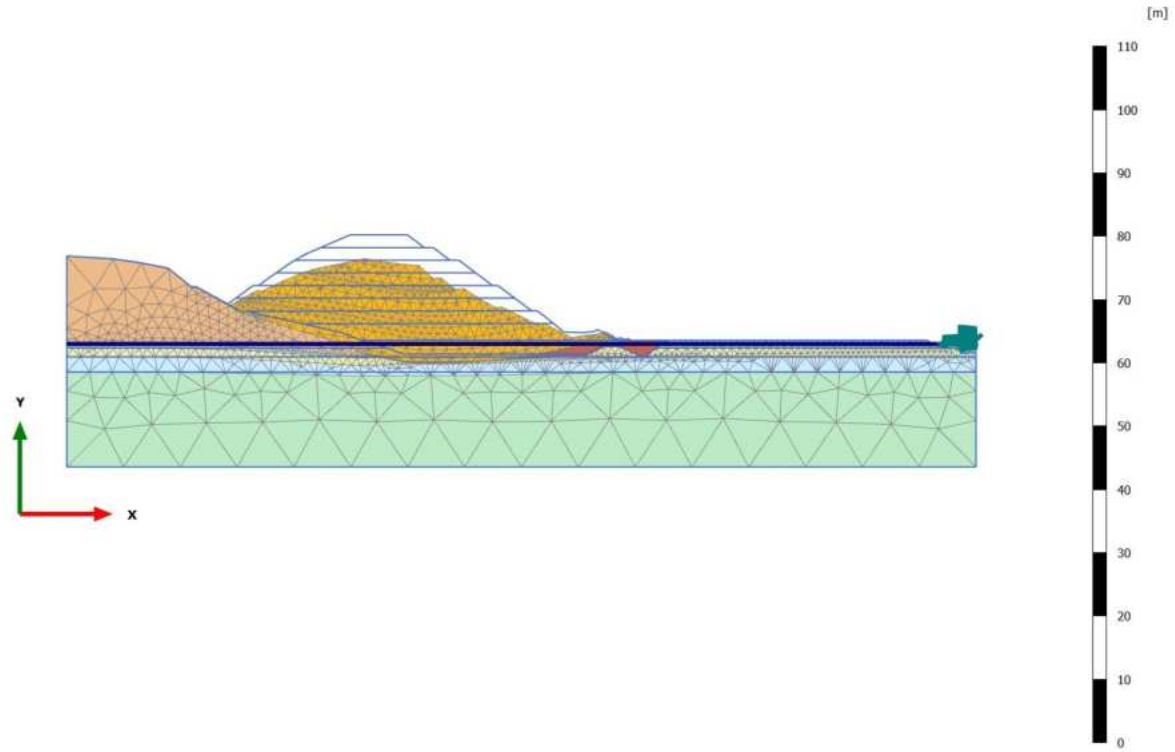
**Deformed mesh |u| (scaled up 5,00 times)**  
Maximum value = 4,168 m (Element 128 at Node 19183)

2.1.2.5 Calculation results, Phase\_4 [Phase\_4] (11/30), Deformed mesh |u|



**Deformed mesh |u| (scaled up 5,00 times)**  
Maximum value = 4,723 m (Element 171 at Node 19605)

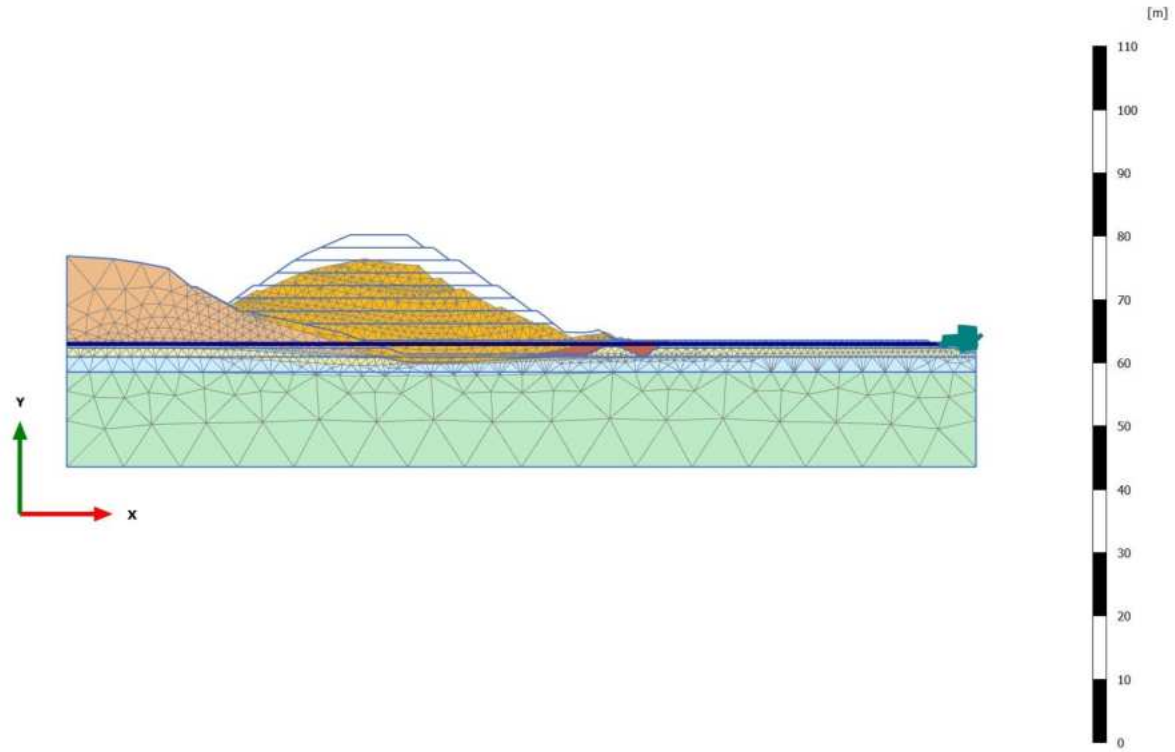
2.1.2.6 Calculation results, Phase\_5\_static [Phase\_5] (12/33), Deformed mesh |u|



**Deformed mesh |u| (scaled up 5,00 times)**  
Maximum value = 5,167 m (Element 1 at Node 20267)

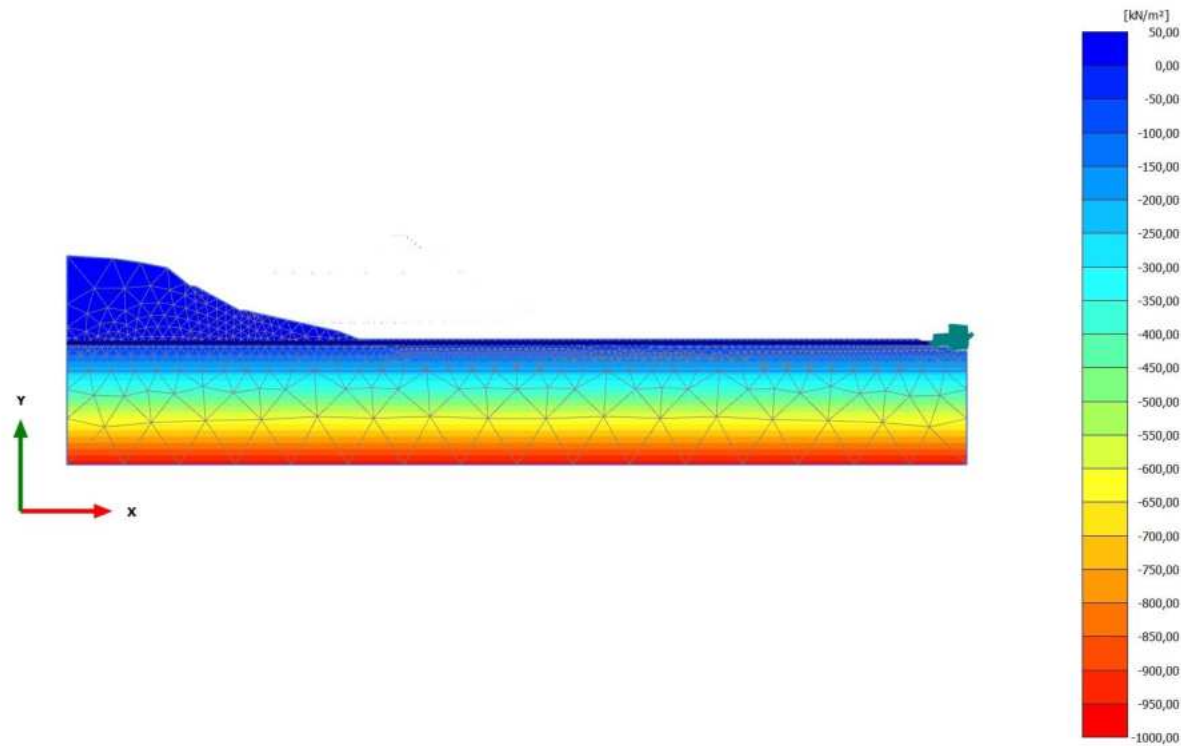


2.1.2.7 Calculation results, Phase\_8\_seismic [Phase\_8] (2/36), Deformed mesh |u|



**Deformed mesh |u| (scaled up 5,00 times)**  
Maximum value = 5,174 m (Element 1 at Node 20267)

2.2.1.1.1 Calculation results, Initial phase [InitialPhase] (0/15), Steady state pore pressures  $p_{\text{steady}}$

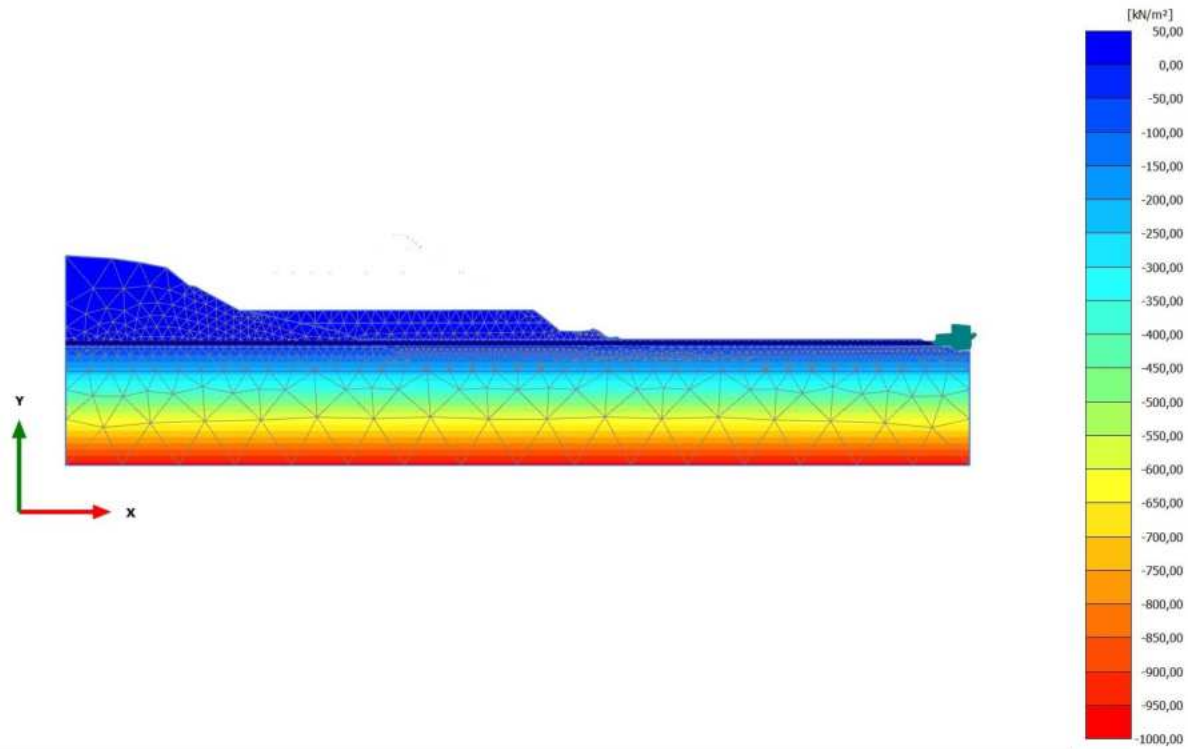


**Steady state pore pressures  $p_{\text{steady}}$  (scaled up 0,0200 times) (Pressure = negative)**

Maximum value = 0,000 kN/m<sup>2</sup> (Element 568 at Node 9027)

Minimum value = -972,7 kN/m<sup>2</sup> (Element 2398 at Node 3392)

2.2.1.1.2 Calculation results, Phase\_1 [Phase\_1] (8/20), Steady state pore pressures  $p_{steady}$

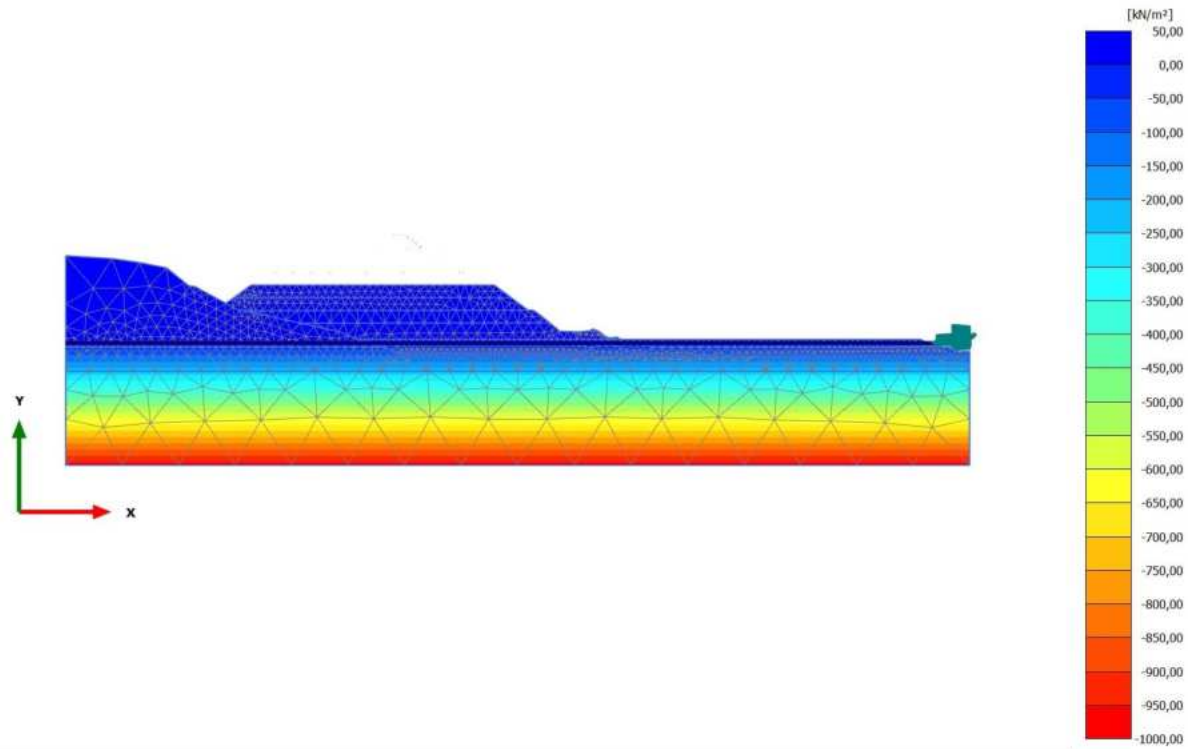


**Steady state pore pressures  $p_{steady}$  (scaled up 0,0200 times) (Pressure = negative)**

Maximum value = 0,000 kN/m<sup>2</sup> (Element 568 at Node 9027)

Minimum value = -972,7 kN/m<sup>2</sup> (Element 2398 at Node 3392)

2.2.1.1.3 Calculation results, Phase\_2 [Phase\_2] (9/24), Steady state pore pressures  $p_{steady}$

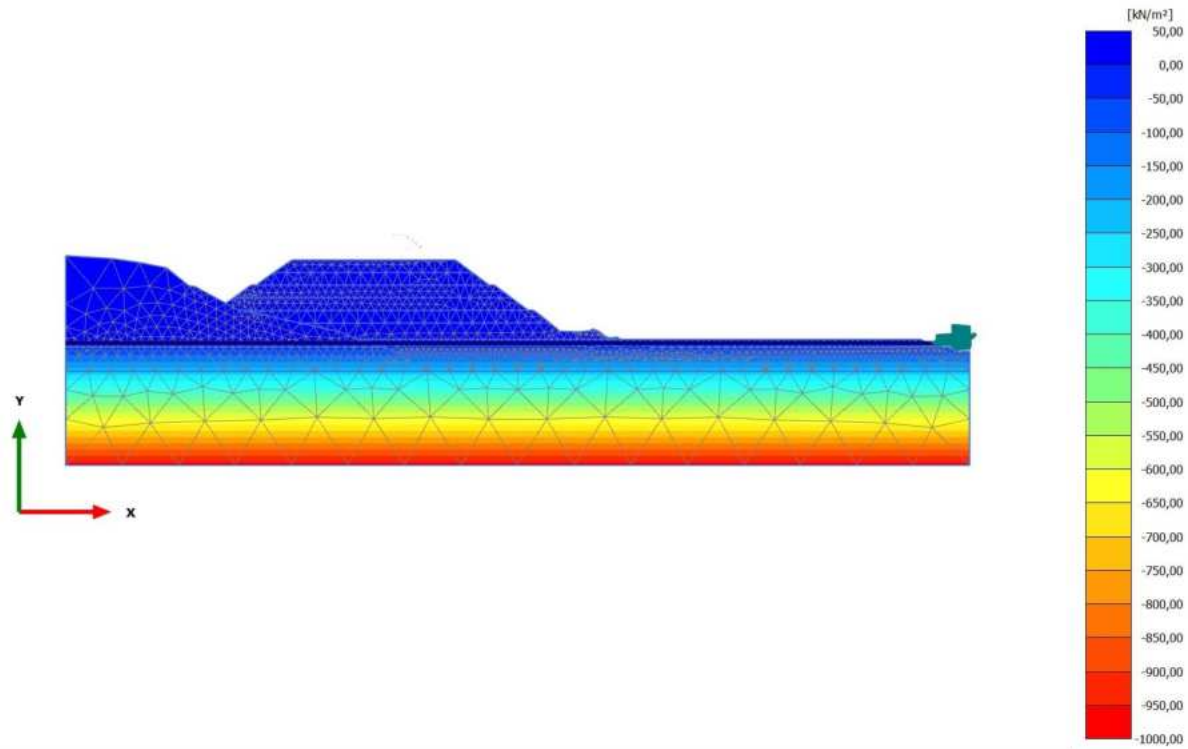


**Steady state pore pressures  $p_{steady}$  (scaled up 0,0200 times) (Pressure = negative)**

Maximum value = 0,000  $\text{kN/m}^2$  (Element 277 at Node 15735)

Minimum value = -972,7  $\text{kN/m}^2$  (Element 2398 at Node 3392)

2.2.1.1.4 Calculation results, Phase\_3 [Phase\_3] (10/27), Steady state pore pressures  $p_{\text{steady}}$

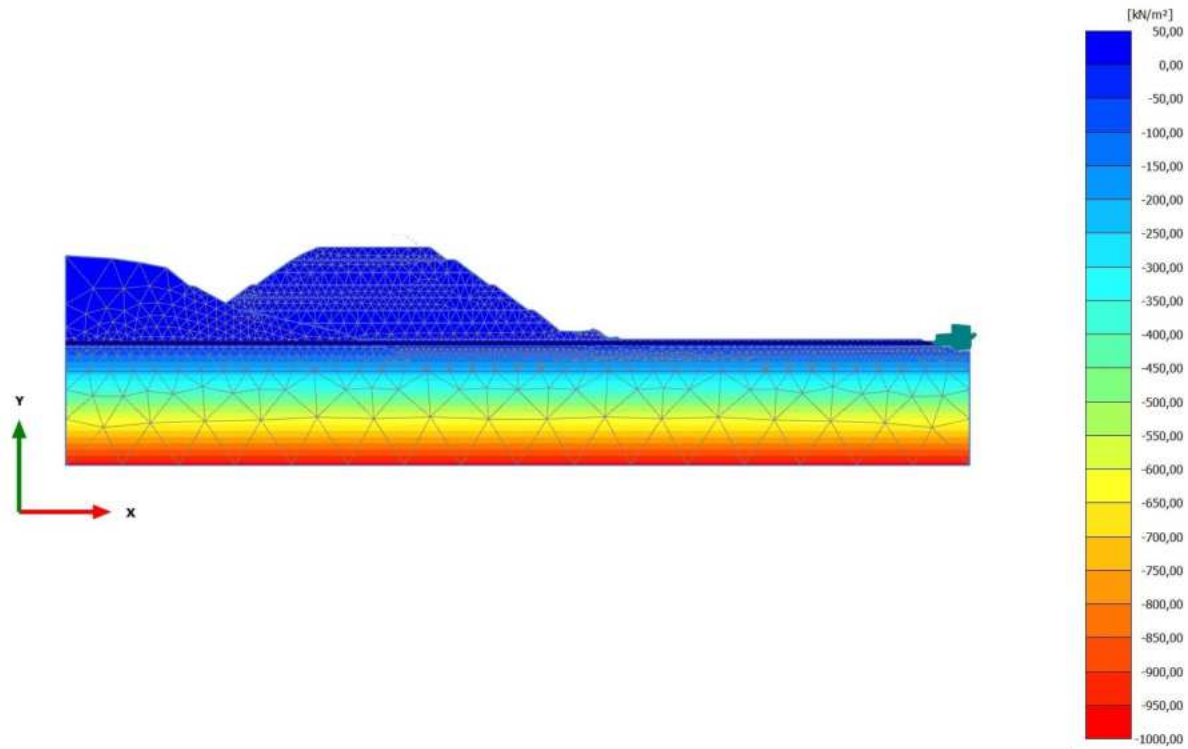


**Steady state pore pressures  $p_{\text{steady}}$  (scaled up 0,0200 times) (Pressure = negative)**

Maximum value = 0,000 kN/m<sup>2</sup> (Element 126 at Node 18753)

Minimum value = -972,7 kN/m<sup>2</sup> (Element 2398 at Node 3392)

2.2.1.1.5 Calculation results, Phase\_4 [Phase\_4] (11/30), Steady state pore pressures  $p_{steady}$

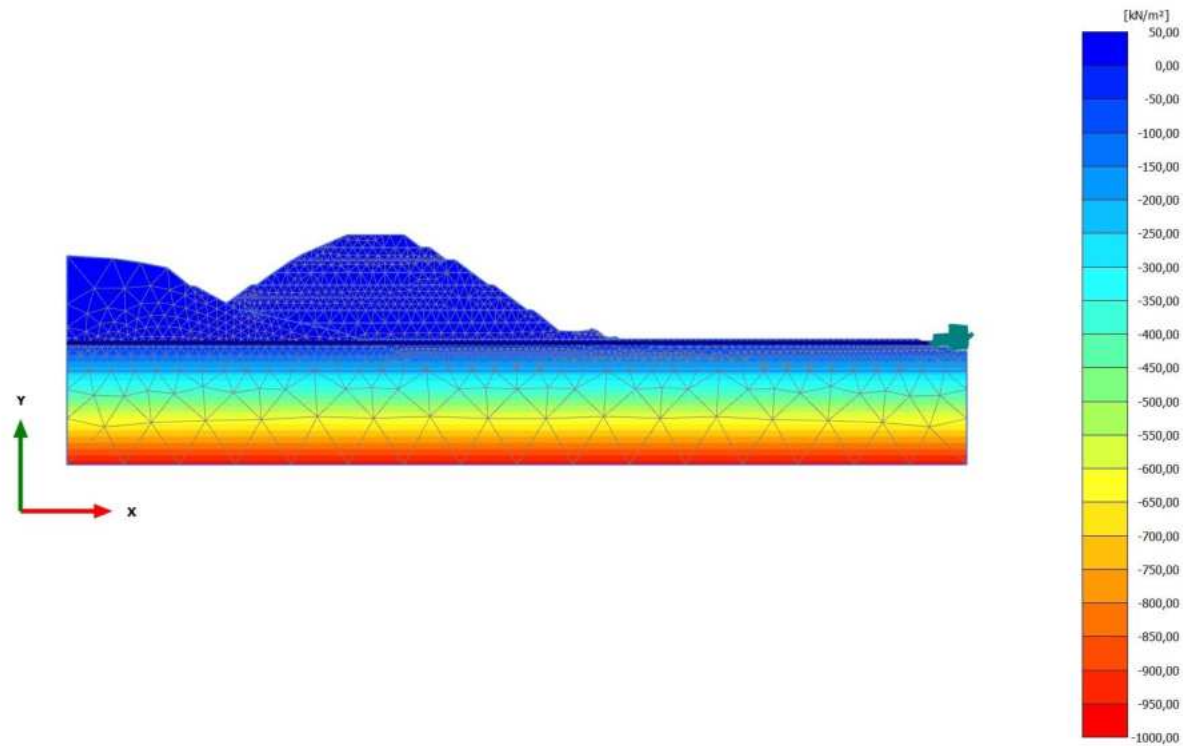


**Steady state pore pressures  $p_{steady}$  (scaled up 0,0200 times) (Pressure = negative)**

Maximum value = 0,000 kN/m<sup>2</sup> (Element 35 at Node 20427)

Minimum value = -972,7 kN/m<sup>2</sup> (Element 2398 at Node 3392)

2.2.1.1.6 Calculation results, Phase\_5\_static [Phase\_5] (12/33), Steady state pore pressures  $p_{steady}$

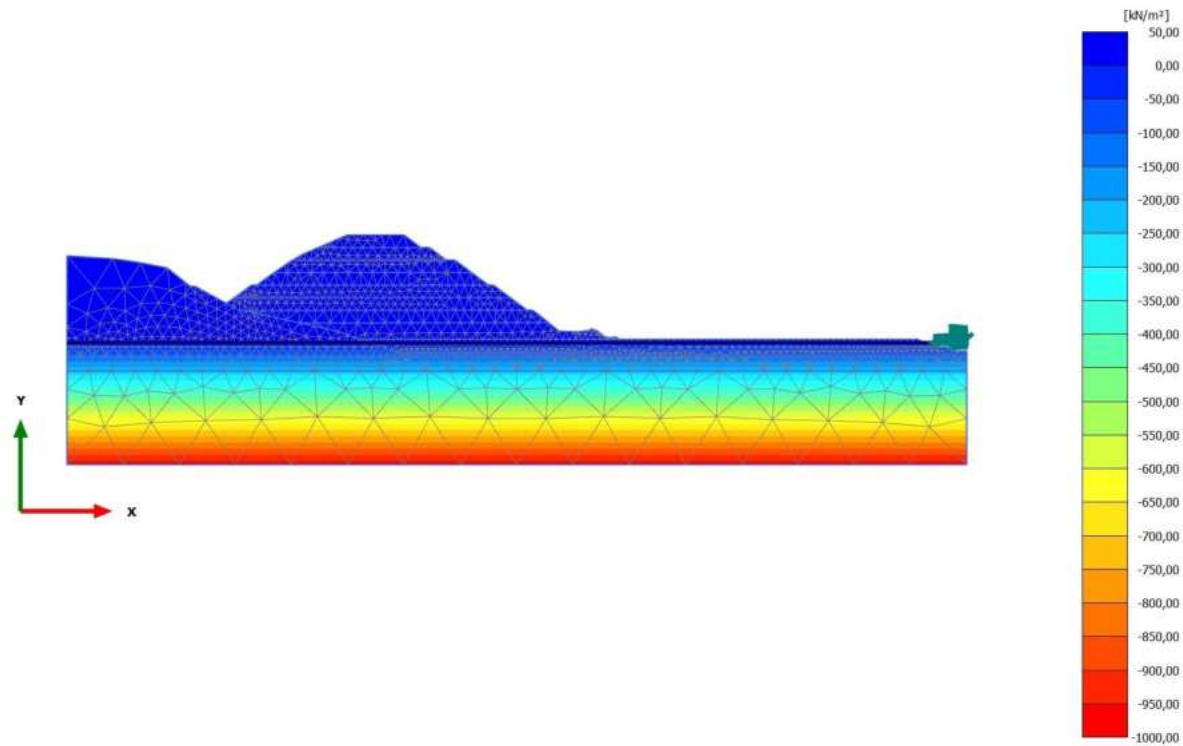


**Steady state pore pressures  $p_{steady}$  (scaled up 0,0200 times) (Pressure = negative)**

Maximum value = 0,000 kN/m<sup>2</sup> (Element 1 at Node 20261)

Minimum value = -972,7 kN/m<sup>2</sup> (Element 2398 at Node 3392)

2.2.1.1.7 Calculation results, Phase\_8\_seismic [Phase\_8] (2/36), Steady state pore pressures  $p_{\text{steady}}$



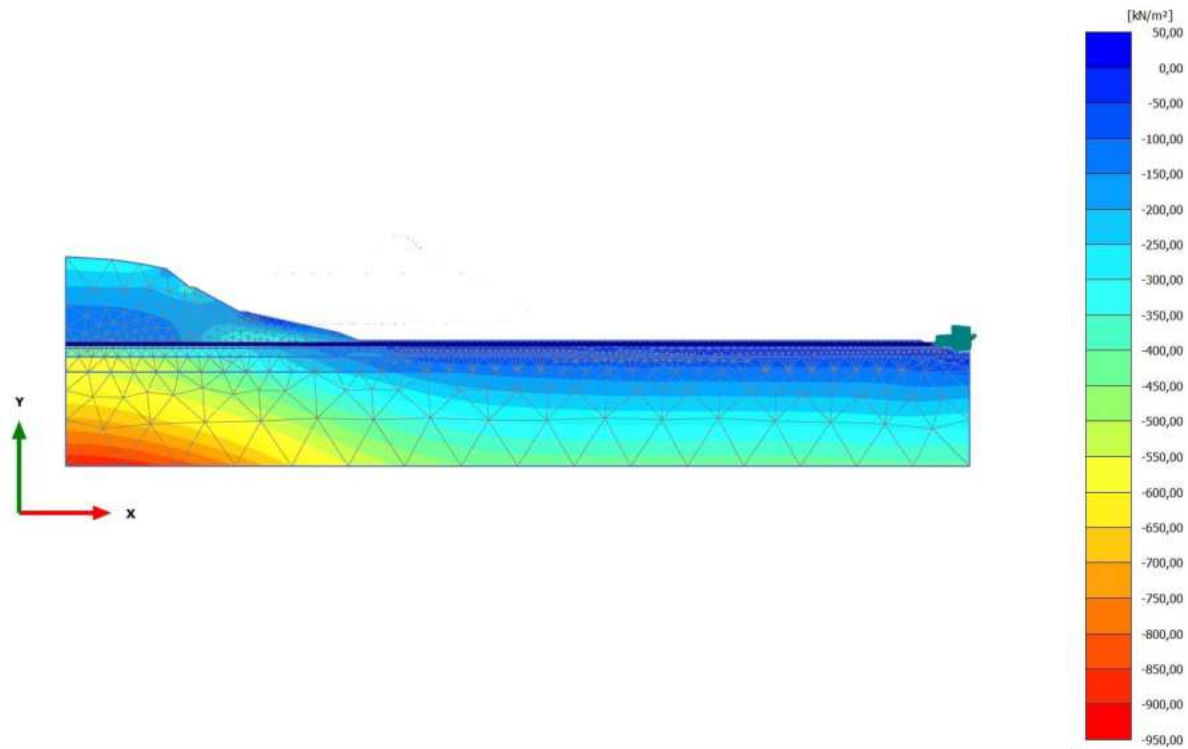
**Steady state pore pressures  $p_{\text{steady}}$  (scaled up 0,0200 times) (Pressure = negative)**

Maximum value = 0,000 kN/m<sup>2</sup> (Element 1 at Node 20261)

Minimum value = -975,6 kN/m<sup>2</sup> (Element 2398 at Node 3392)



2.2.2.1.1 Calculation results, Initial phase [InitialPhase] (0/15), Cartesian effective stress  $\sigma'_{xx}$

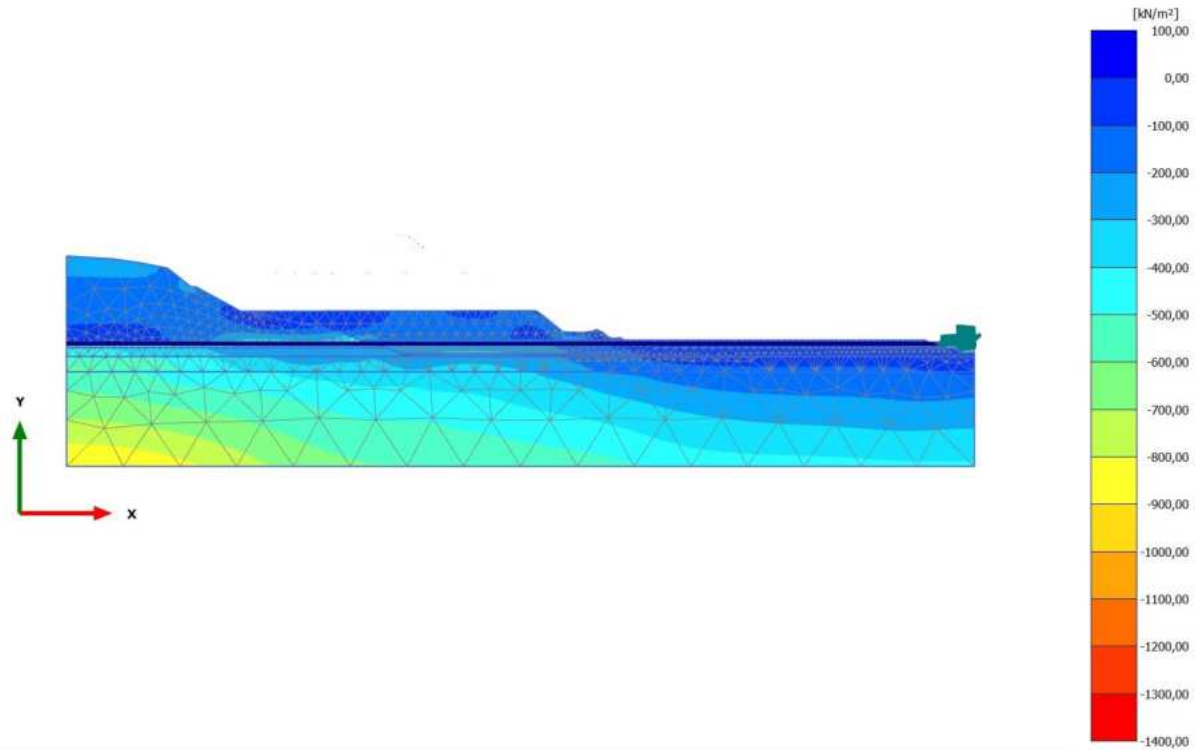


**Cartesian effective stress  $\sigma'_{xx}$  (scaled up 0,0200 times)**

Maximum value = 1,426 kN/m<sup>2</sup> (Element 1320 at Node 195)

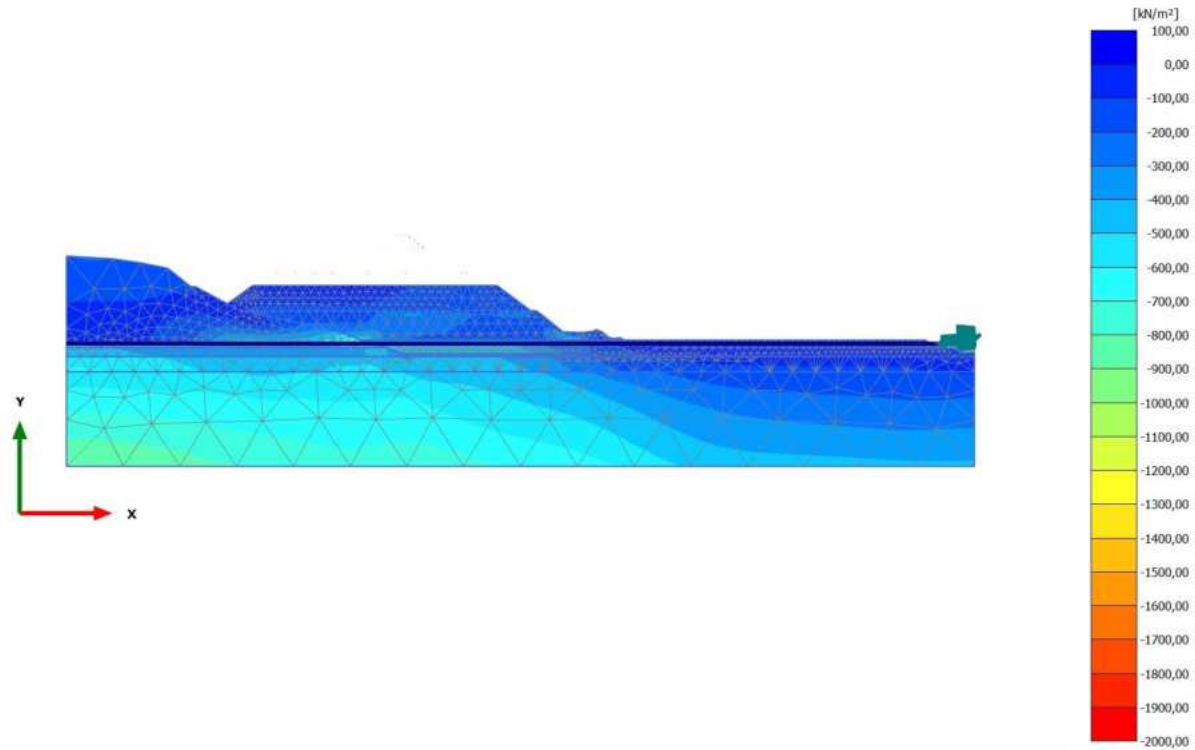
Minimum value = -903,8 kN/m<sup>2</sup> (Element 2399 at Node 8693)

2.2.2.1.2 Calculation results, Phase\_1 [Phase\_1] (8/20), Cartesian effective stress  $\sigma'_{xx}$



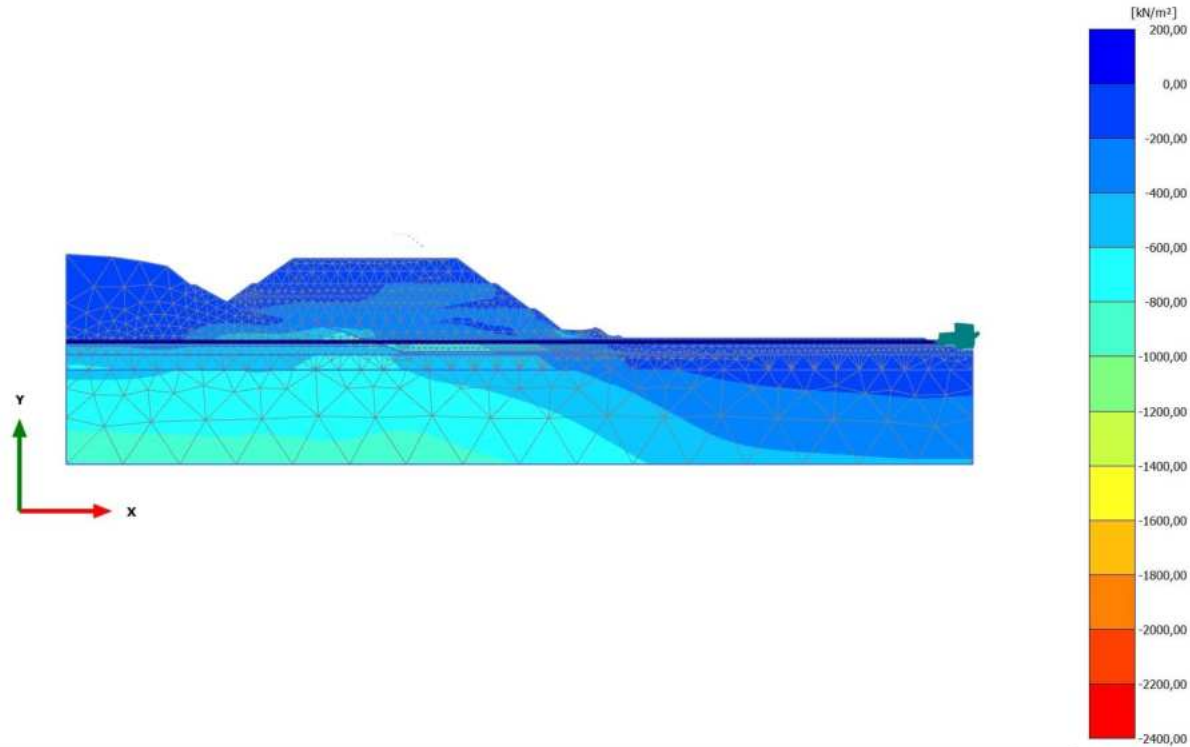
**Cartesian effective stress  $\sigma'_{xx}$  (scaled up 0,0200 times)**  
Maximum value = 4,633 kN/m<sup>2</sup> (Element 603 at Node 15801)  
Minimum value = -1317 kN/m<sup>2</sup> (Element 831 at Node 15677)

2.2.2.1.3 Calculation results, Phase\_2 [Phase\_2] (9/24), Cartesian effective stress  $\sigma'_{xx}$



**Cartesian effective stress  $\sigma'_{xx}$  (scaled up 0,0100 times)**  
Maximum value = 2,287 kN/m<sup>2</sup> (Element 328 at Node 19365)  
Minimum value = -1930 kN/m<sup>2</sup> (Element 831 at Node 15677)

2.2.2.1.4 Calculation results, Phase\_3 [Phase\_3] (10/27), Cartesian effective stress  $\sigma'_{xx}$

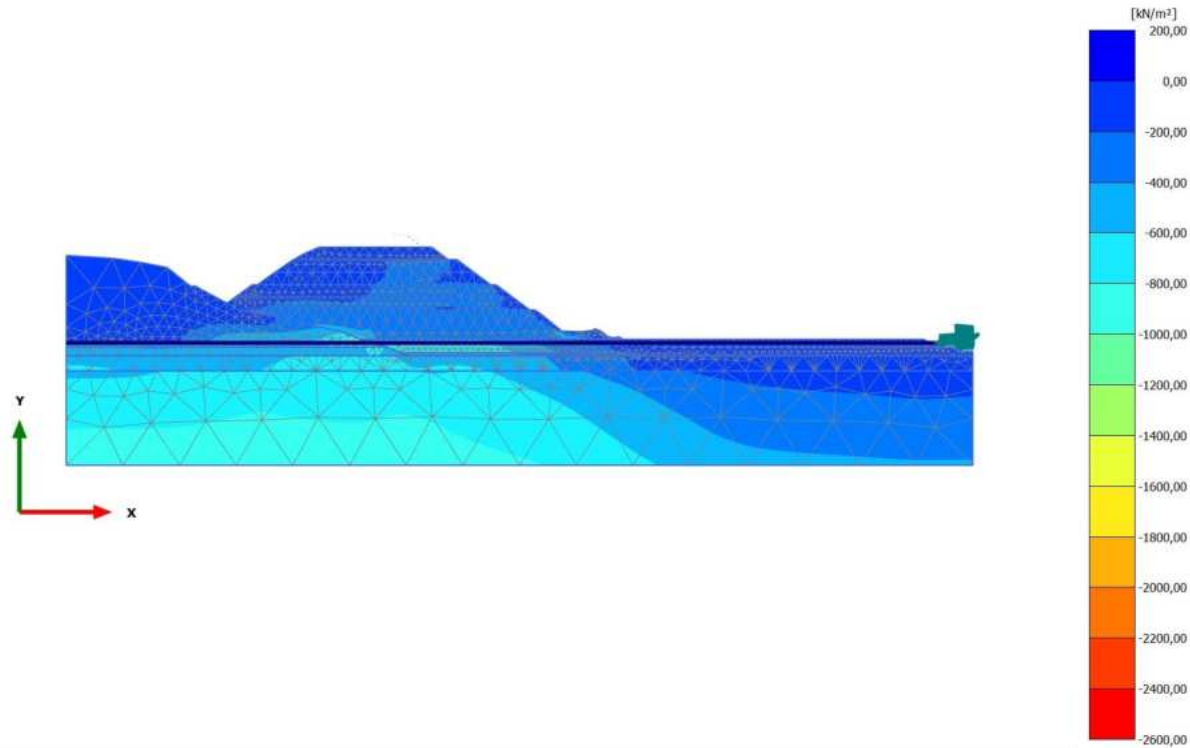


**Cartesian effective stress  $\sigma'_{xx}$  (scaled up  $5,00 \cdot 10^{-3}$  times)**

Maximum value = 2,435 kN/m<sup>2</sup> (Element 1059 at Node 4866)

Minimum value = -2324 kN/m<sup>2</sup> (Element 831 at Node 15677)

2.2.2.1.5 Calculation results, Phase\_4 [Phase\_4] (11/30), Cartesian effective stress  $\sigma'_{xx}$

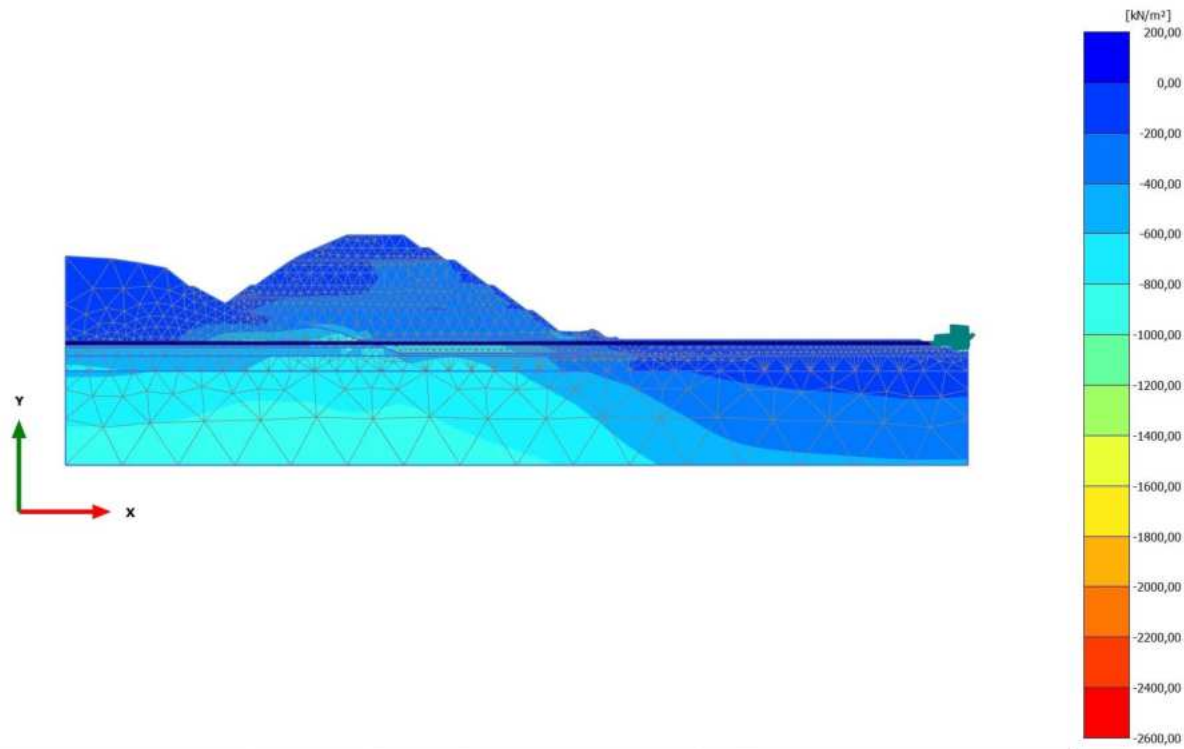


**Cartesian effective stress  $\sigma'_{xx}$  (scaled up  $5,00 \cdot 10^{-3}$  times)**

Maximum value = 16,51 kN/m<sup>2</sup> (Element 1005 at Node 7293)

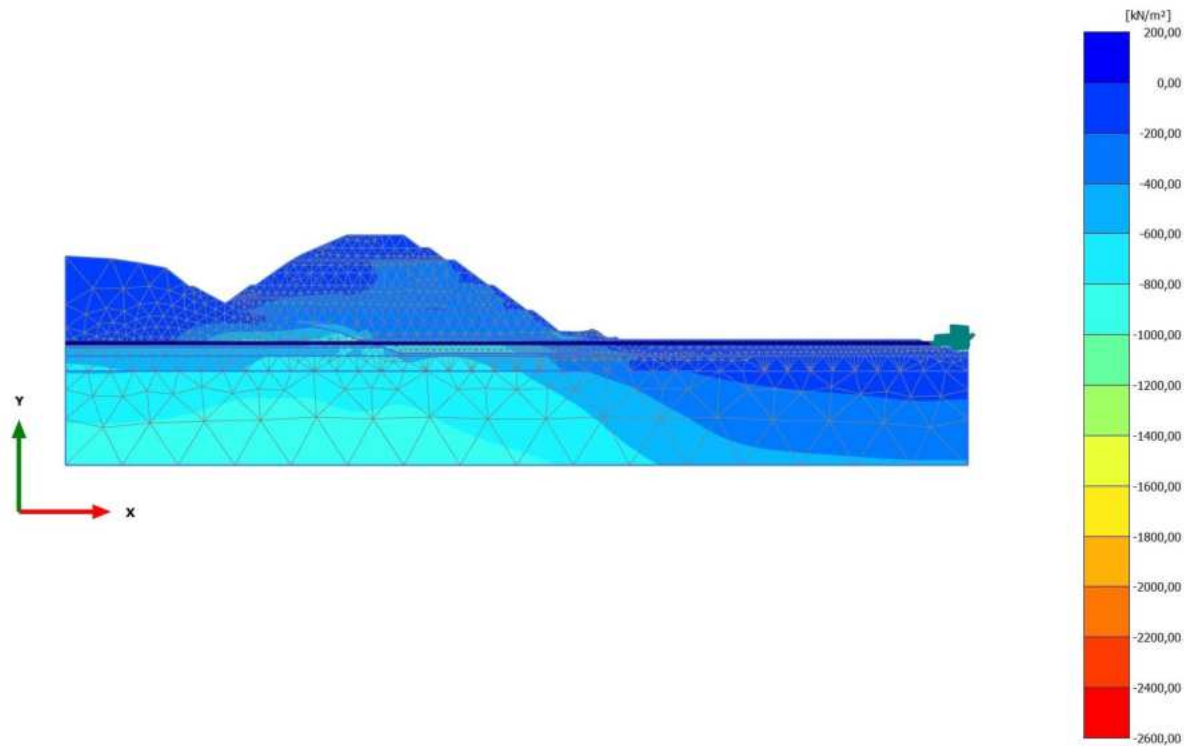
Minimum value = -2456 kN/m<sup>2</sup> (Element 831 at Node 15677)

2.2.2.1.6 Calculation results, Phase\_5\_static [Phase\_5] (12/33), Cartesian effective stress  $\sigma'_{xx}$



**Cartesian effective stress  $\sigma'_{xx}$  (scaled up  $5,00 \cdot 10^{-3}$  times)**  
Maximum value = 25,34 kN/m<sup>2</sup> (Element 1005 at Node 7297)  
Minimum value = -2495 kN/m<sup>2</sup> (Element 831 at Node 15677)

2.2.2.1.7 Calculation results, Phase\_8\_seismic [Phase\_8] (2/36), Cartesian effective stress  $\sigma'_{xx}$

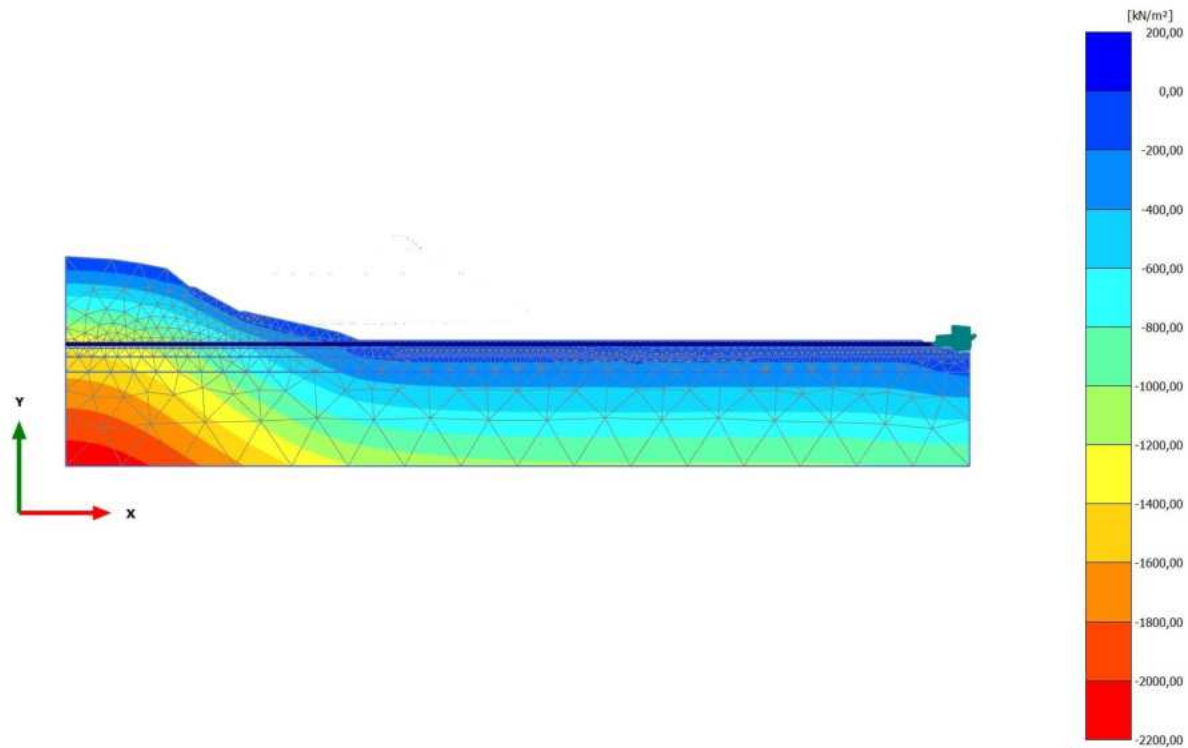


**Cartesian effective stress  $\sigma'_{xx}$  (scaled up  $5,00 \cdot 10^{-3}$  times)**

Maximum value = 36,34 kN/m<sup>2</sup> (Element 1005 at Node 7297)

Minimum value = -2447 kN/m<sup>2</sup> (Element 831 at Node 15677)

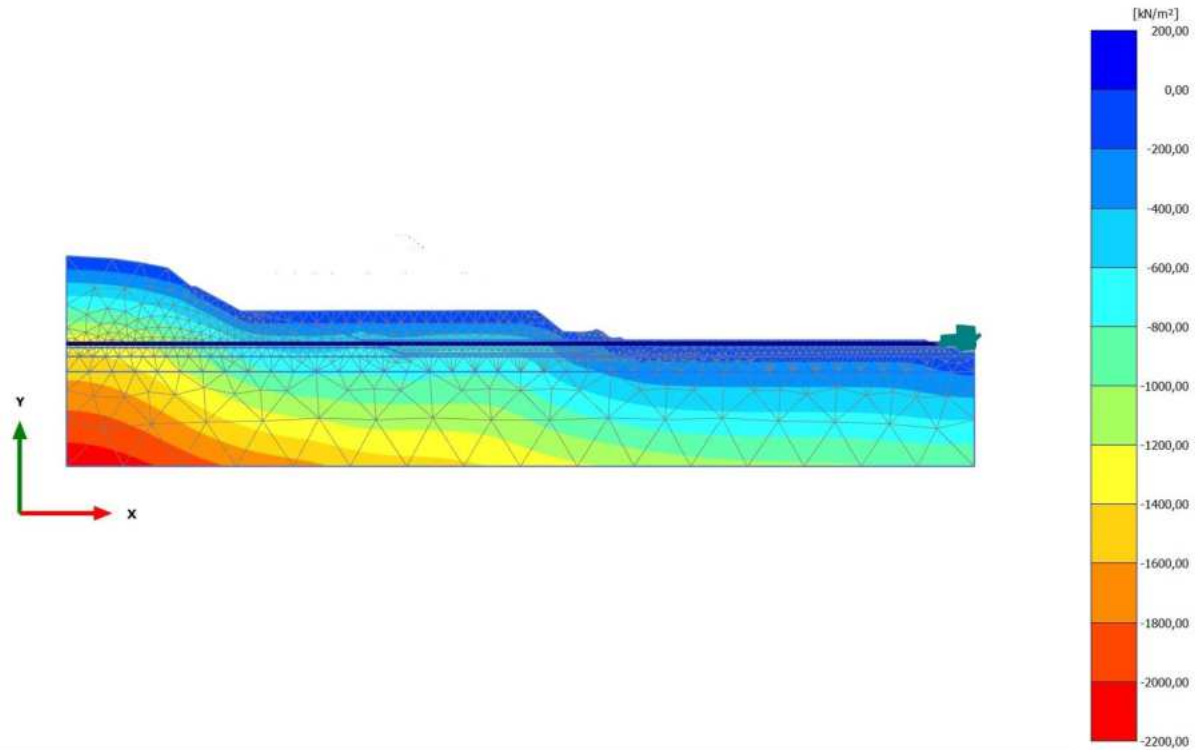
2.2.2.2.1 Calculation results, Initial phase [InitialPhase] (0/15), Cartesian effective stress  $\sigma'_{yy}$



**Cartesian effective stress  $\sigma'_{yy}$  (scaled up 0,0100 times)**  
Maximum value = 4,735 kN/m<sup>2</sup> (Element 568 at Node 8875)  
Minimum value = -2155 kN/m<sup>2</sup> (Element 2399 at Node 8693)



2.2.2.2.2 Calculation results, Phase\_1 [Phase\_1] (8/20), Cartesian effective stress  $\sigma'_{yy}$

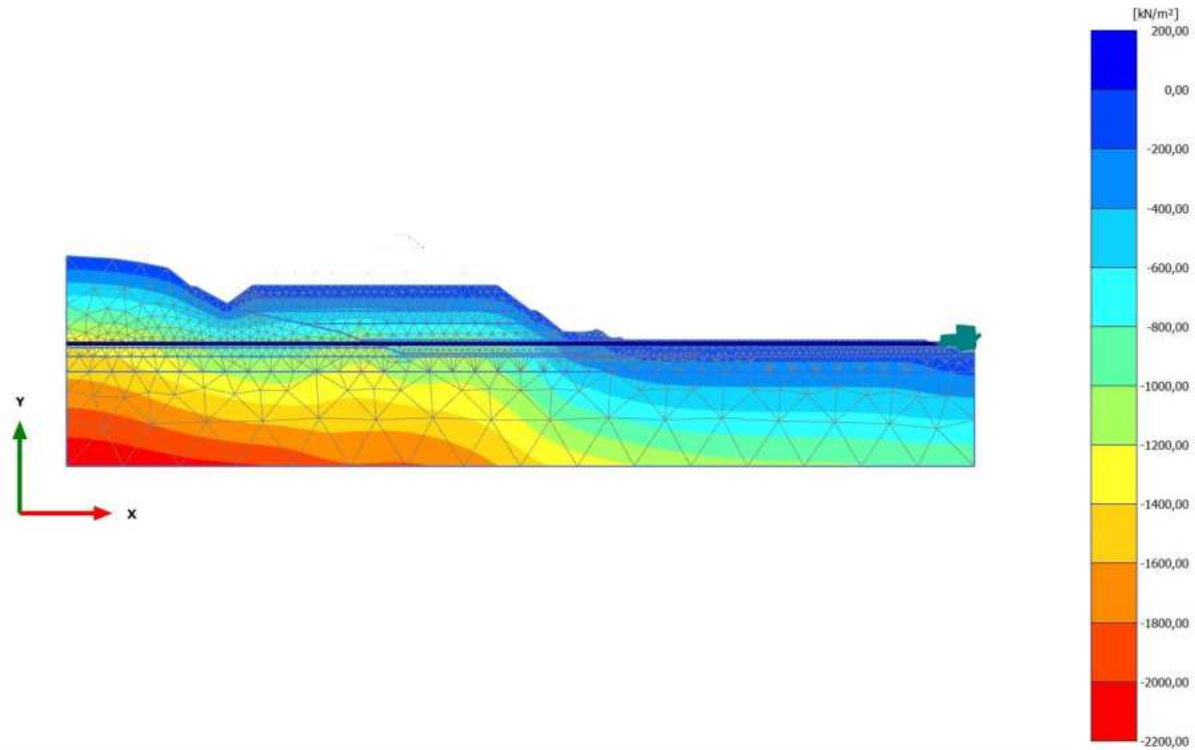


**Cartesian effective stress  $\sigma'_{yy}$  (scaled up 0,0100 times)**

Maximum value = 7,904 kN/m<sup>2</sup> (Element 1039 at Node 4802)

Minimum value = -2142 kN/m<sup>2</sup> (Element 2399 at Node 8693)

2.2.2.2.3 Calculation results, Phase\_2 [Phase\_2] (9/24), Cartesian effective stress  $\sigma'_{yy}$

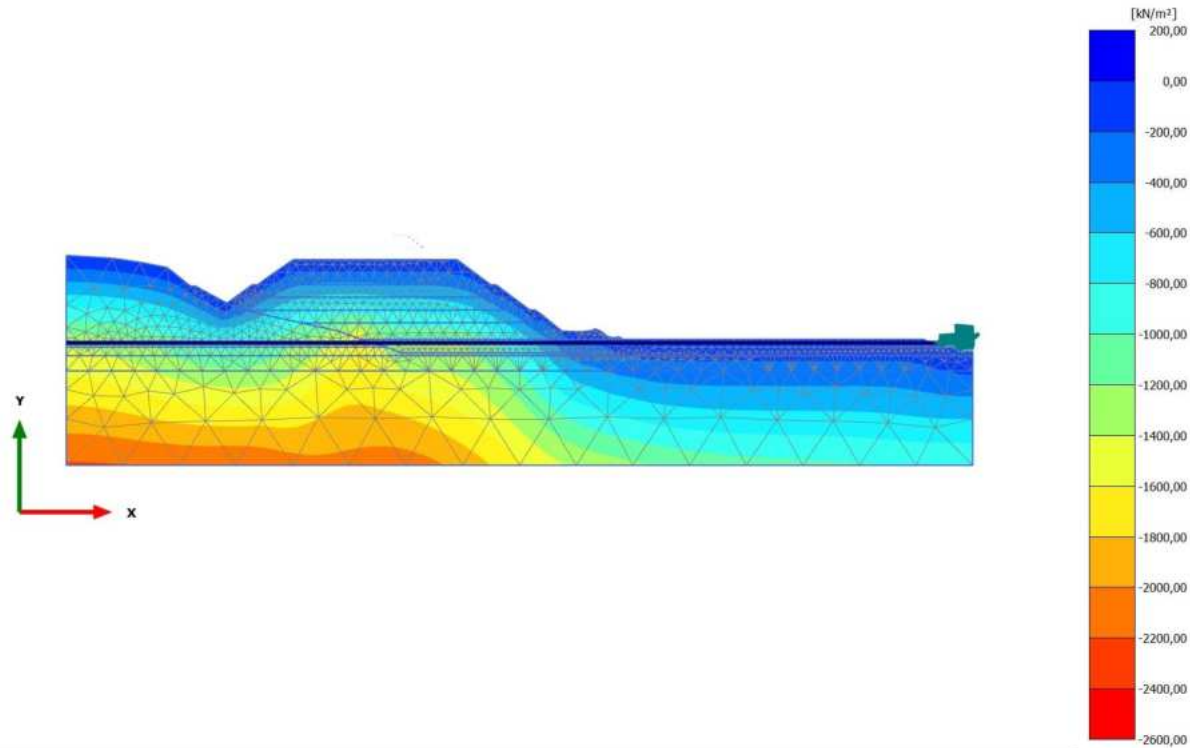


**Cartesian effective stress  $\sigma'_{yy}$  (scaled up 0,0100 times)**

Maximum value = 10,45 kN/m<sup>2</sup> (Element 1065 at Node 4807)

Minimum value = -2188 kN/m<sup>2</sup> (Element 2399 at Node 8693)

2.2.2.2.4 Calculation results, Phase\_3 [Phase\_3] (10/27), Cartesian effective stress  $\sigma'_{yy}$

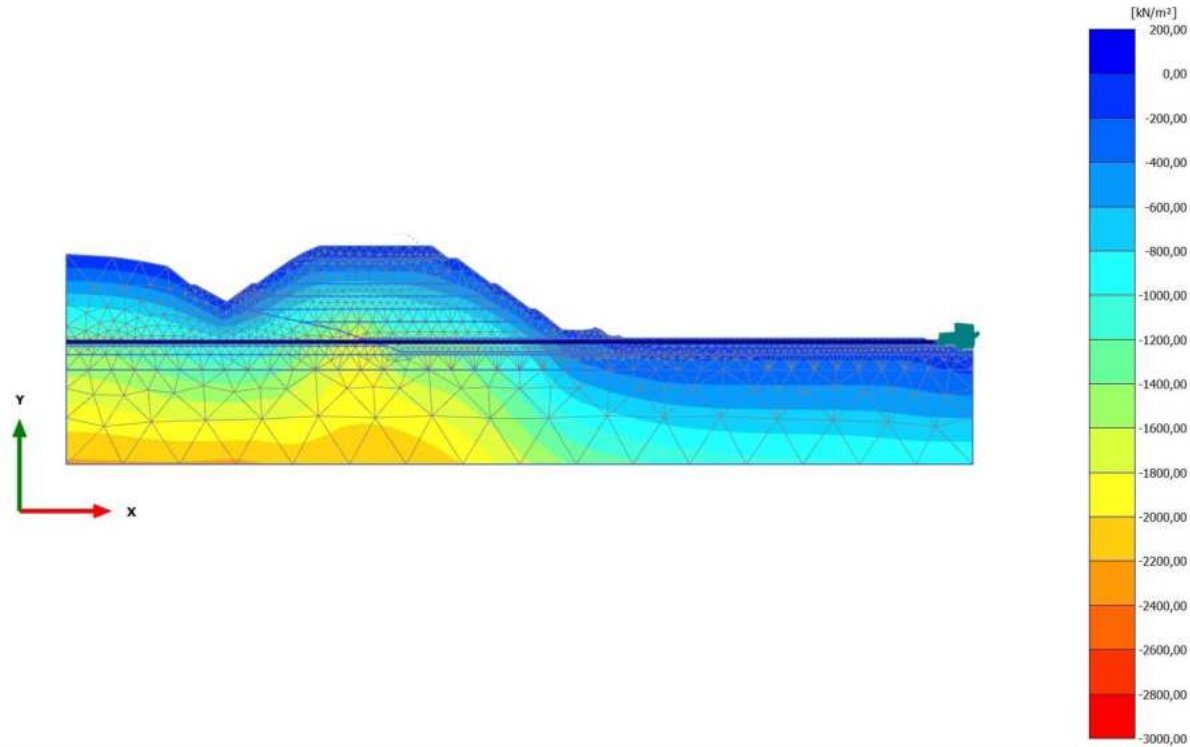


**Cartesian effective stress  $\sigma'_{yy}$  (scaled up  $5,00 \cdot 10^{-3}$  times)**

Maximum value = 10,75 kN/m<sup>2</sup> (Element 495 at Node 11405)

Minimum value = -2494 kN/m<sup>2</sup> (Element 829 at Node 16315)

2.2.2.2.5 Calculation results, Phase\_4 [Phase\_4] (11/30), Cartesian effective stress  $\sigma'_{yy}$

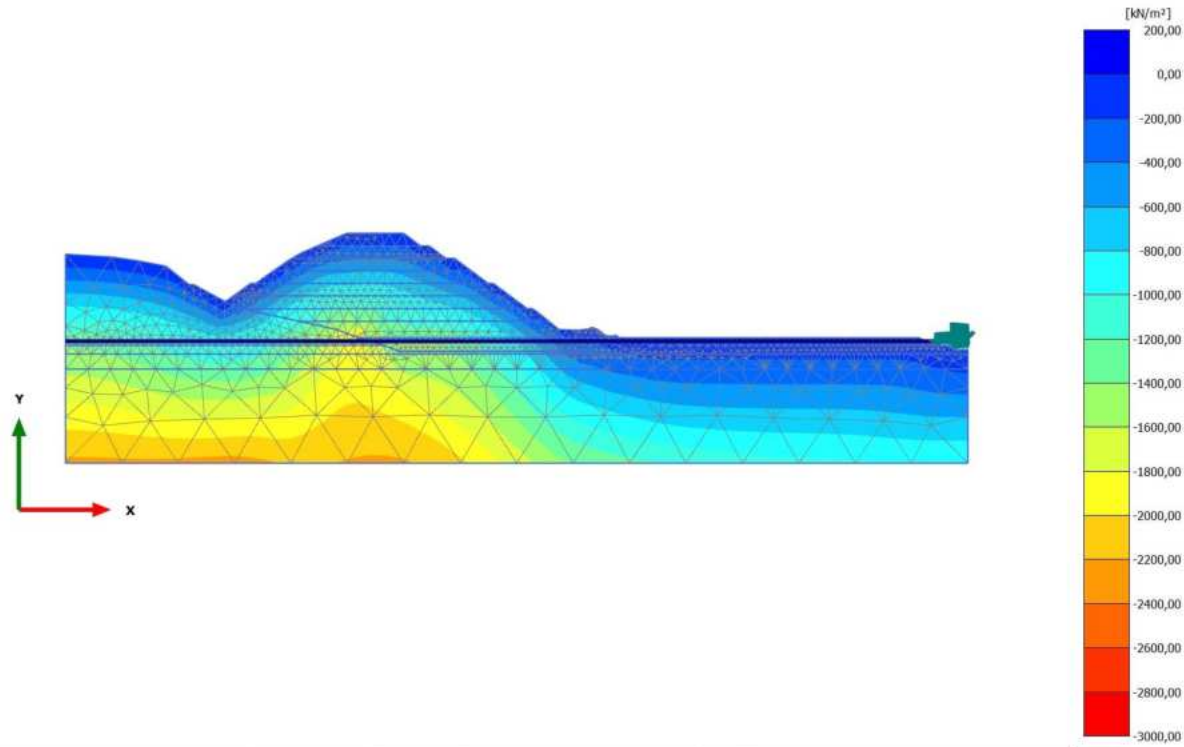


**Cartesian effective stress  $\sigma'_{yy}$  (scaled up  $5,00 \cdot 10^{-3}$  times)**

Maximum value = 8,957 kN/m<sup>2</sup> (Element 999 at Node 7568)

Minimum value = -2829 kN/m<sup>2</sup> (Element 829 at Node 16315)

2.2.2.2.6 Calculation results, Phase\_5\_static [Phase\_5] (12/33), Cartesian effective stress  $\sigma'_{yy}$

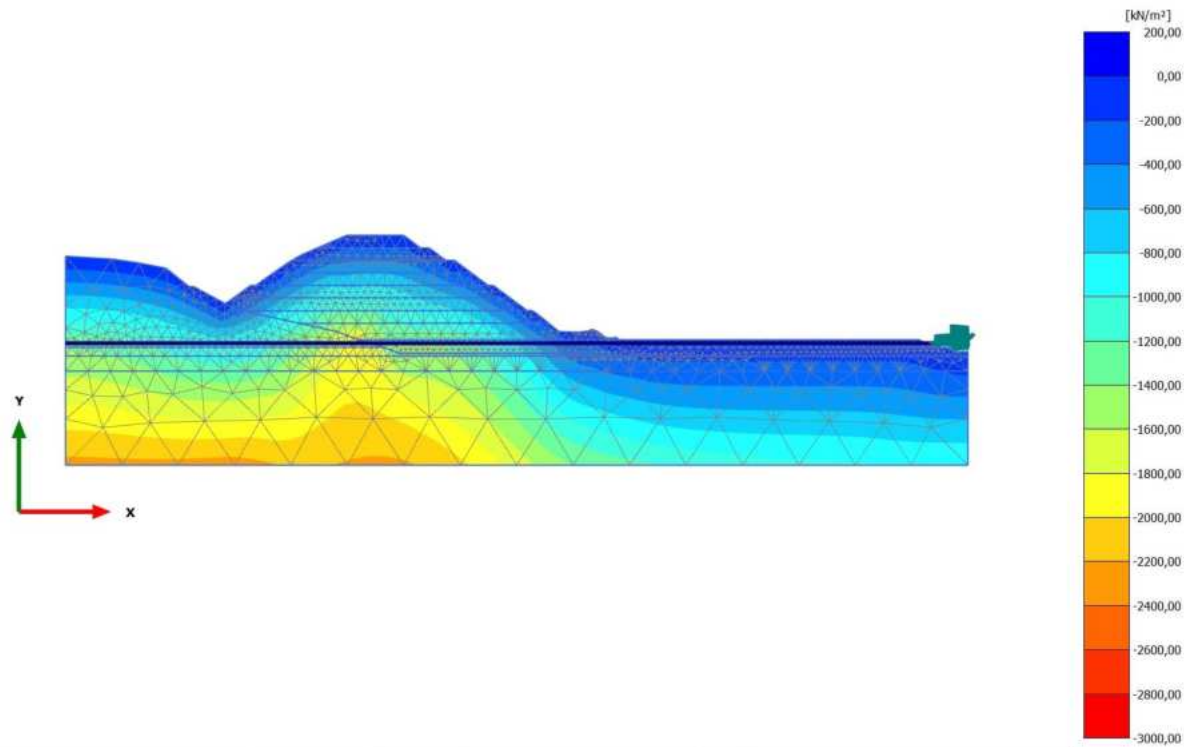


**Cartesian effective stress  $\sigma'_{yy}$  (scaled up  $5,00 \cdot 10^{-3}$  times)**

Maximum value = 8,841  $\text{kN/m}^2$  (Element 495 at Node 11405)

Minimum value = -2981  $\text{kN/m}^2$  (Element 829 at Node 16315)

2.2.2.2.7 Calculation results, Phase\_8\_seismic [Phase\_8] (2/36), Cartesian effective stress  $\sigma'_{yy}$

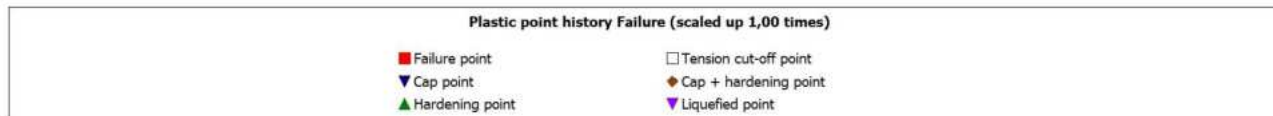
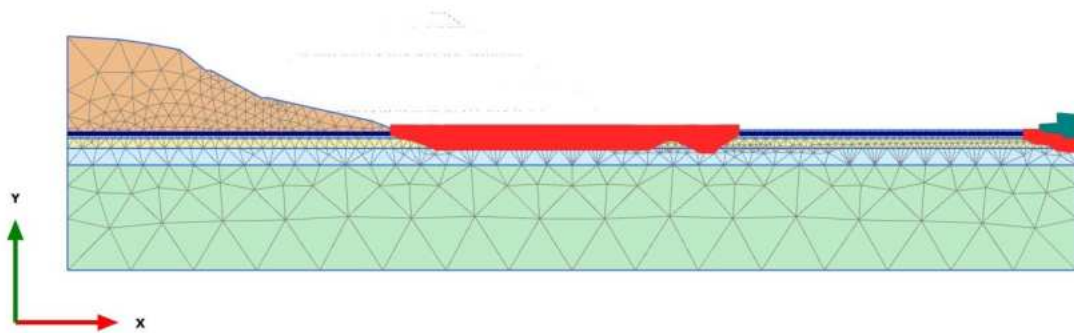


**Cartesian effective stress  $\sigma'_{yy}$  (scaled up  $5,00 \cdot 10^{-3}$  times)**

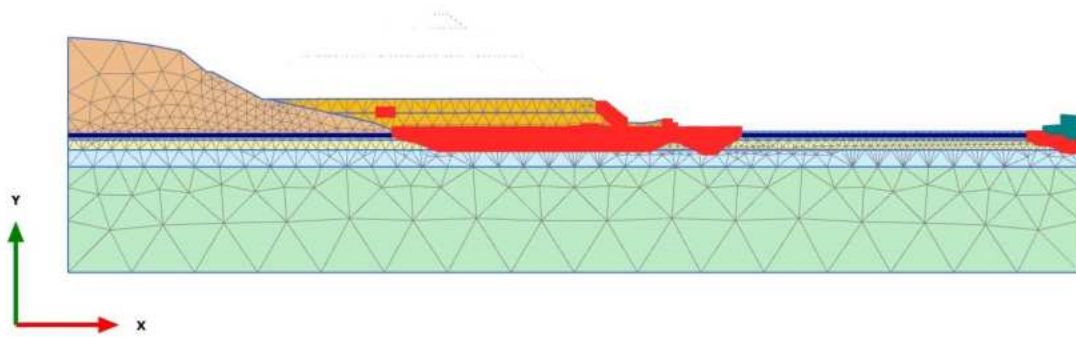
Maximum value = 6,819 kN/m<sup>2</sup> (Element 1043 at Node 4753)

Minimum value = -2964 kN/m<sup>2</sup> (Element 829 at Node 16315)

2.2.3.1.1 Calculation results, Initial phase [InitialPhase] (0/15), Plastic point history Failure

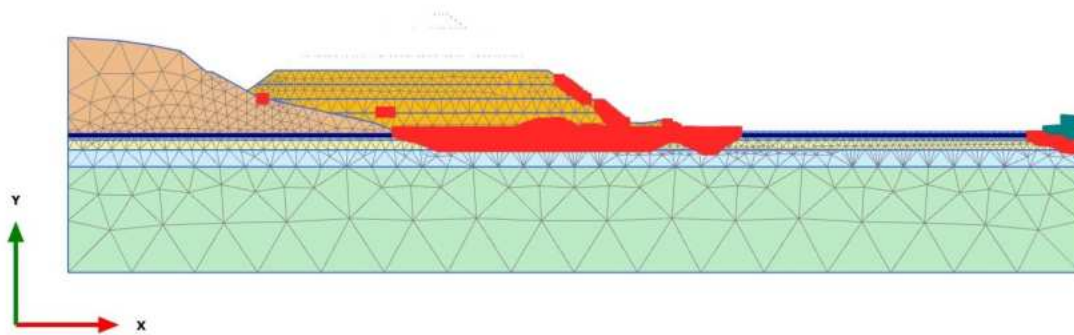


2.2.3.1.2 Calculation results, Phase\_1 [Phase\_1] (8/20), Plastic point history Failure



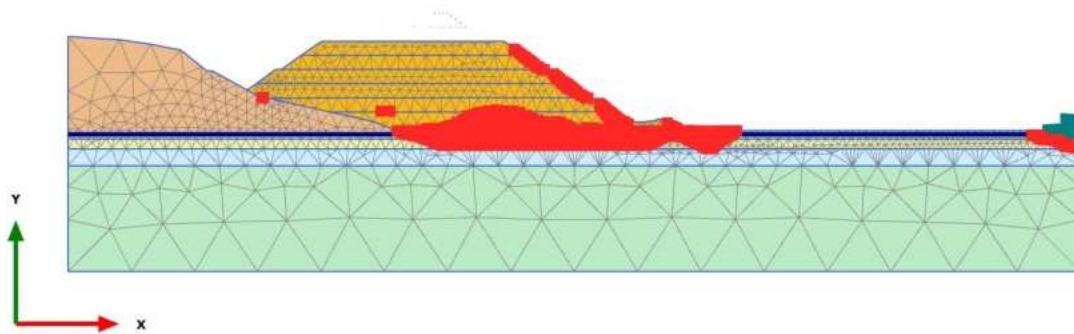


2.2.3.1.3 Calculation results, Phase\_2 [Phase\_2] (9/24), Plastic point history Failure

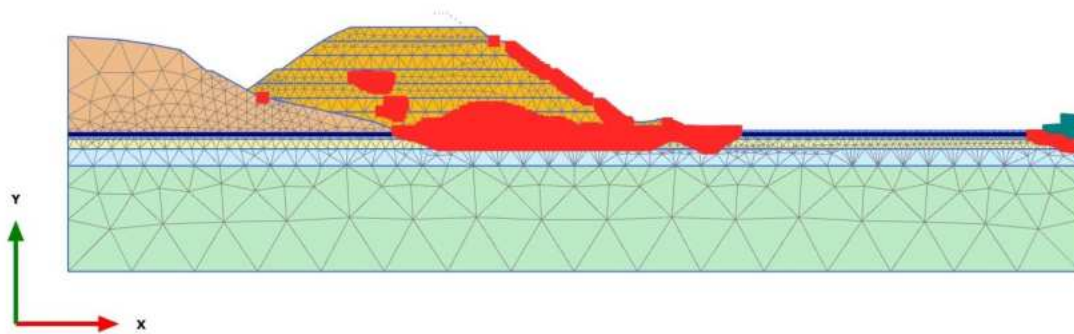


Plastic point history Failure (scaled up 1,00 times)	
■ Failure point	□ Tension cut-off point
▼ Cap point	◆ Cap + hardening point
▲ Hardening point	▼ Liquefied point

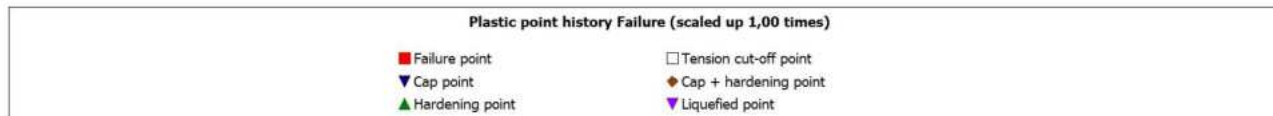
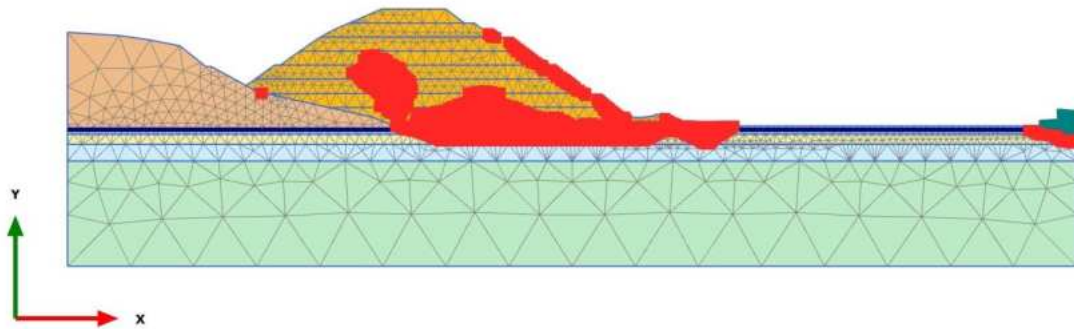
2.2.3.1.4 Calculation results, Phase\_3 [Phase\_3] (10/27), Plastic point history Failure



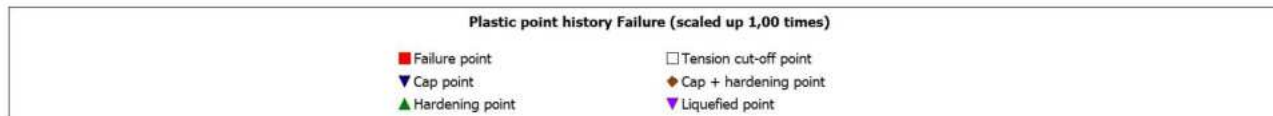
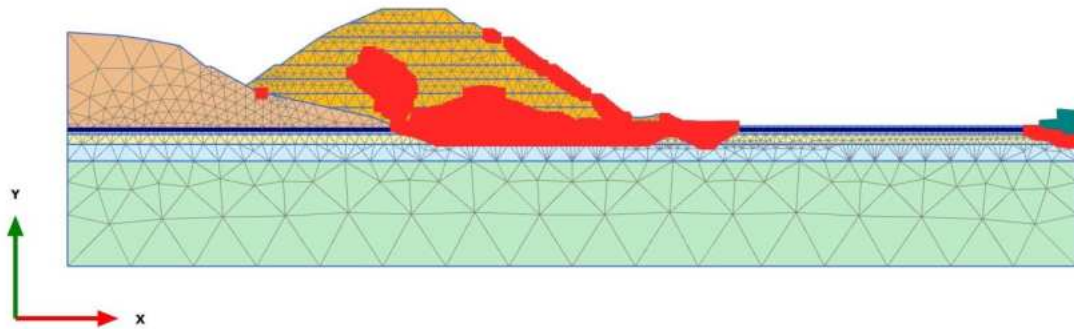
2.2.3.1.5 Calculation results, Phase\_4 [Phase\_4] (11/30), Plastic point history Failure



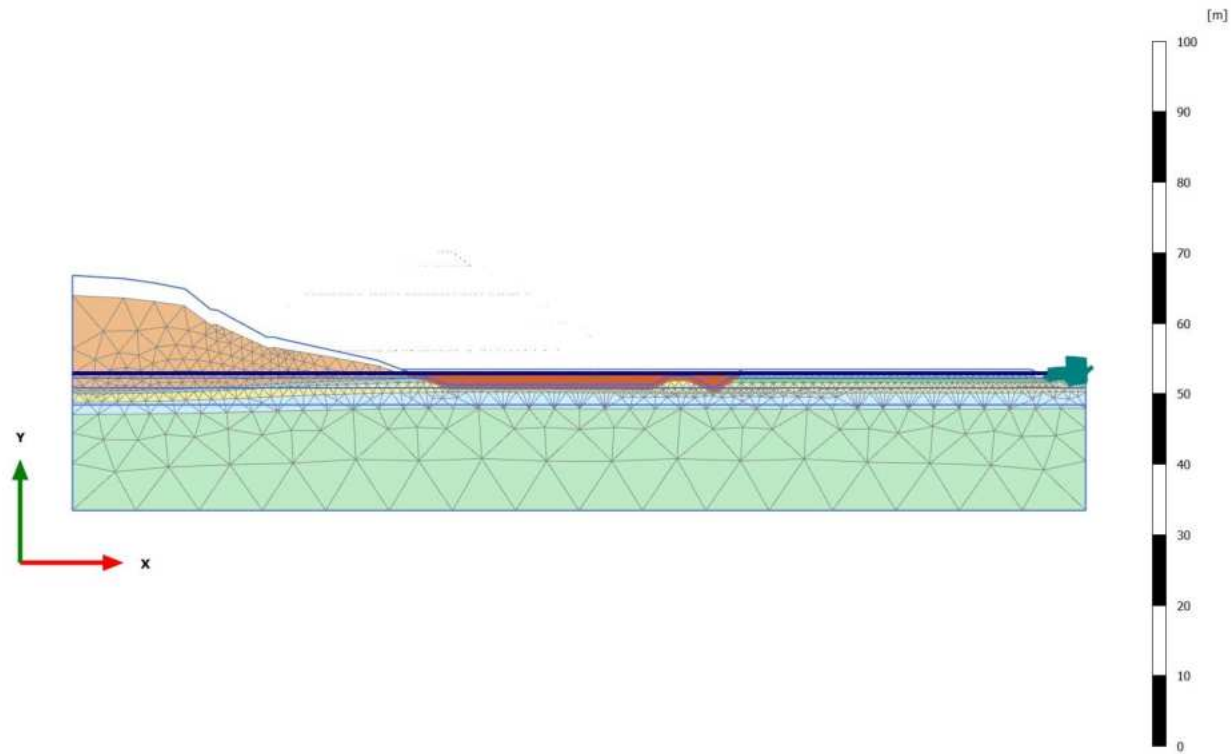
2.2.3.1.6 Calculation results, Phase\_5\_static [Phase\_5] (12/33), Plastic point history Failure



2.2.3.1.7 Calculation results, Phase\_8\_seismic [Phase\_8] (2/36), Plastic point history Failure

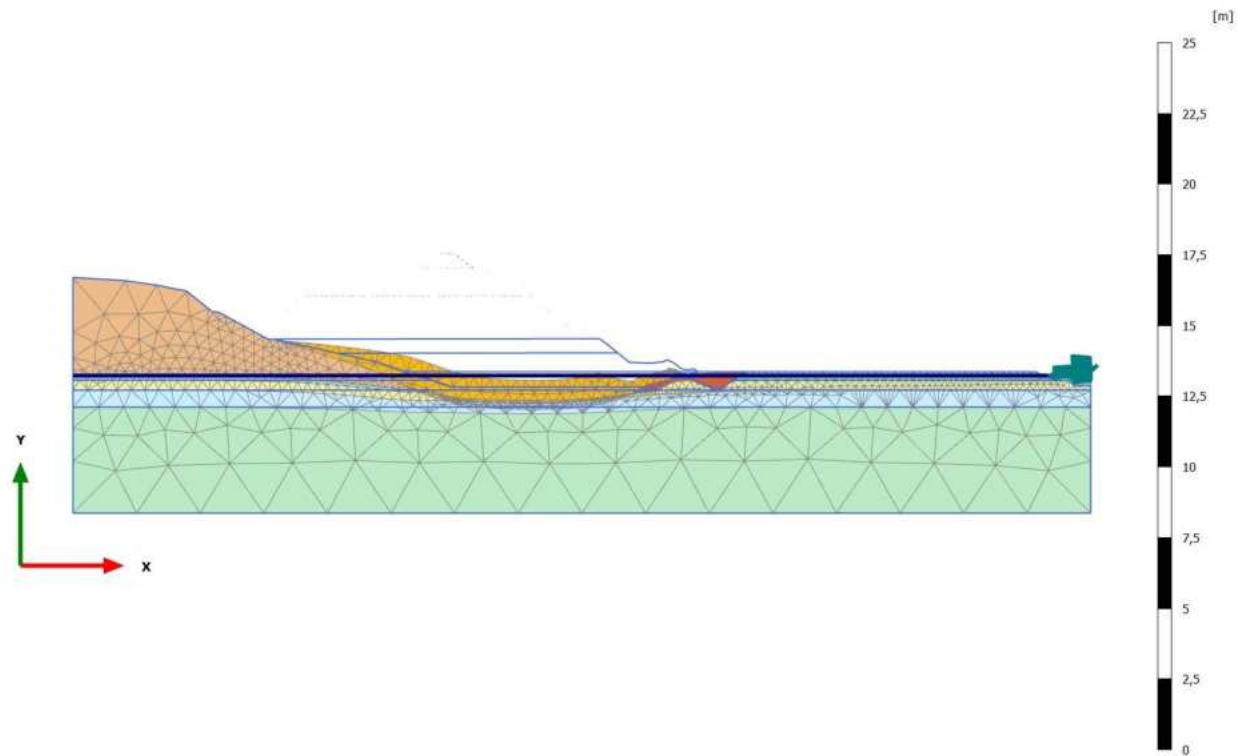


4.1.1 Calculation results, Initial phase [InitialPhase] (0/15), Deformed mesh |u|



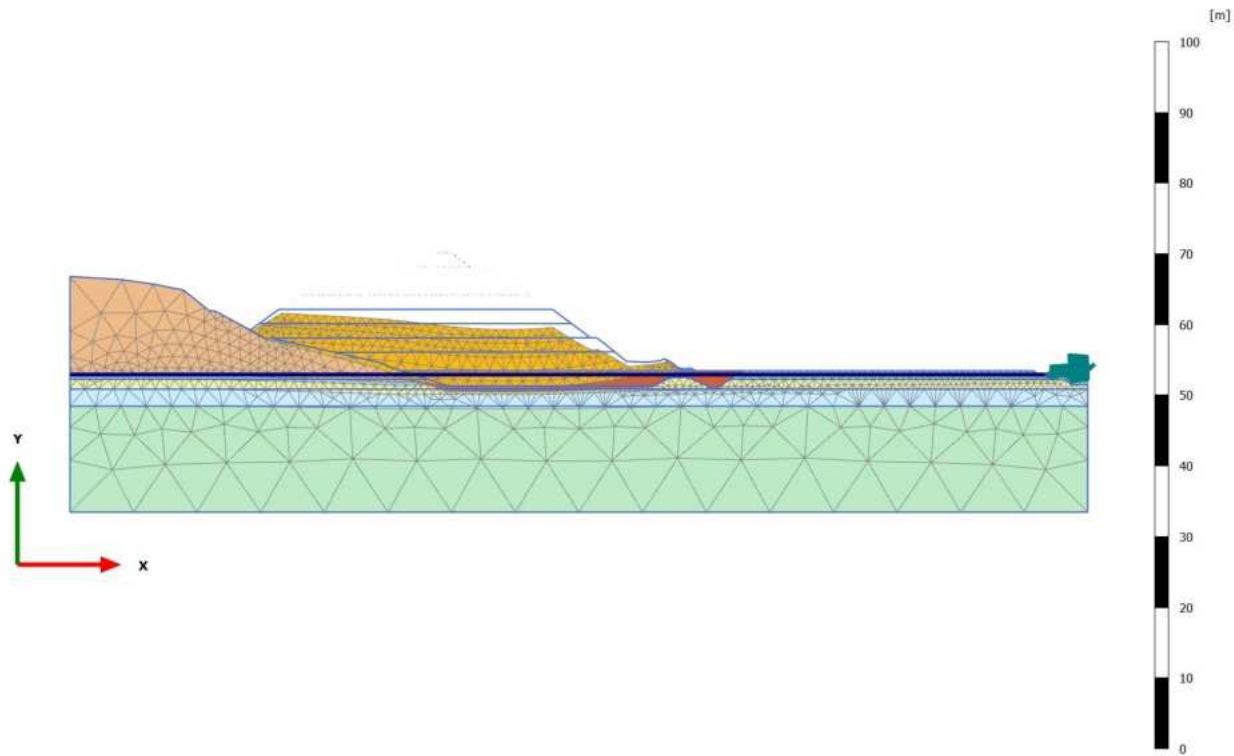
**Deformed mesh |u| (scaled up 5,00 times)**  
Maximum value = 2,832 m (Element 569 at Node 8841)

4.1.2 Calculation results, Phase\_1 [Phase\_1] (8/20), Deformed mesh |u|



**Deformed mesh |u| (scaled up 20,0 times)**  
Maximum value = 1,468 m (Element 883 at Node 16508)

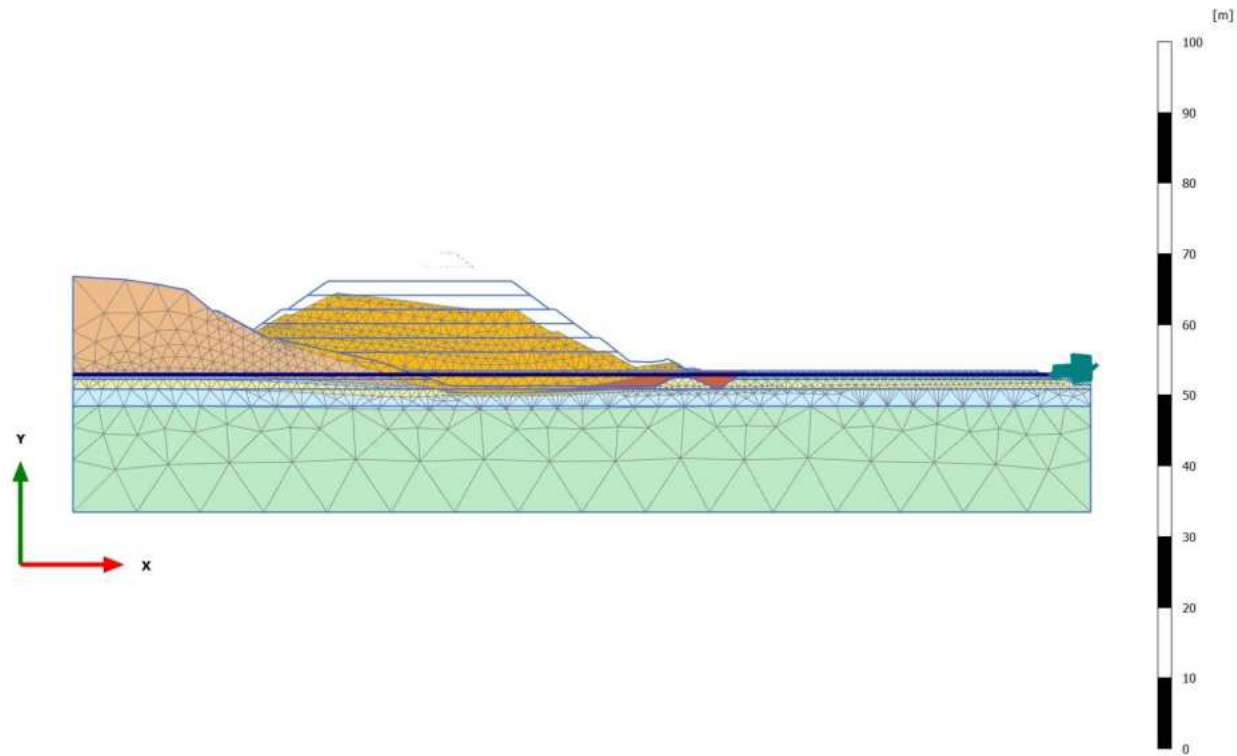
4.1.3 Calculation results, Phase\_2 [Phase\_2] (9/24), Deformed mesh |u|



**Deformed mesh |u| (scaled up 5,00 times)**  
Maximum value = 2,863 m (Element 307 at Node 17418)

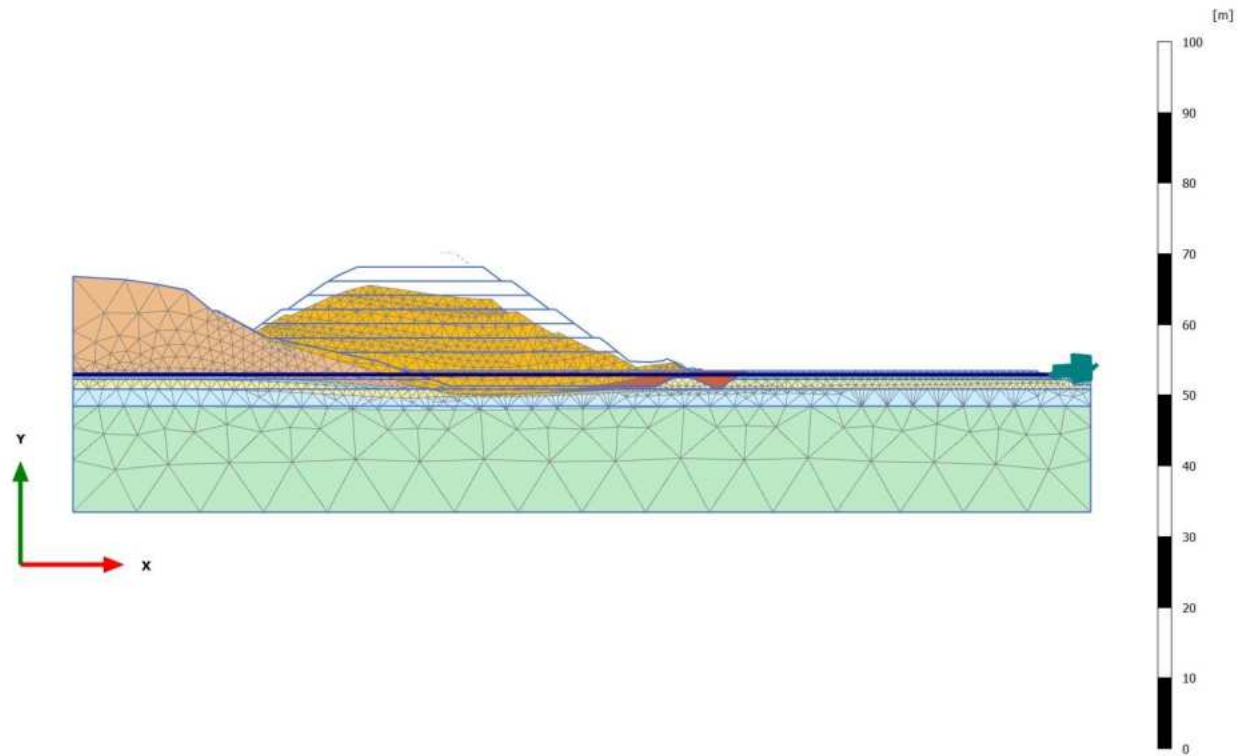


4.1.4 Calculation results, Phase\_3 [Phase\_3] (10/27), Deformed mesh |u|



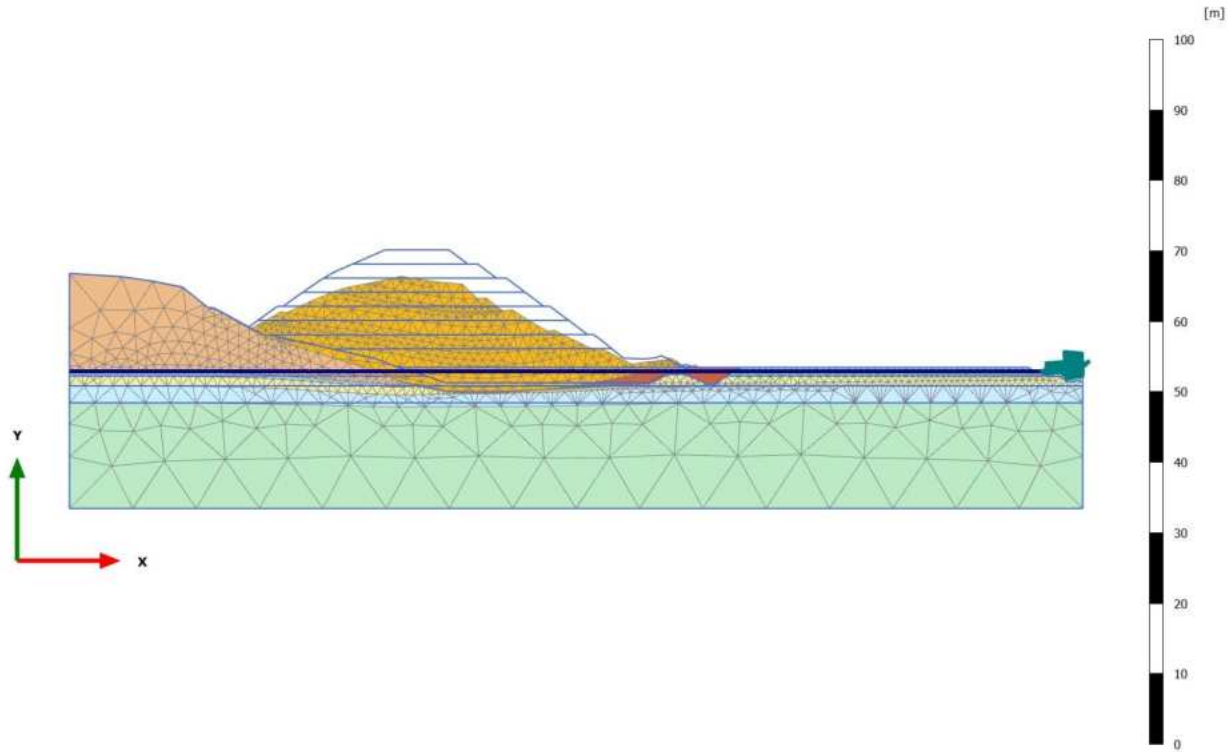
**Deformed mesh |u| (scaled up 5,00 times)**  
Maximum value = 4,168 m (Element 128 at Node 19183)

4.1.5 Calculation results, Phase\_4 [Phase\_4] (11/30), Deformed mesh |u|



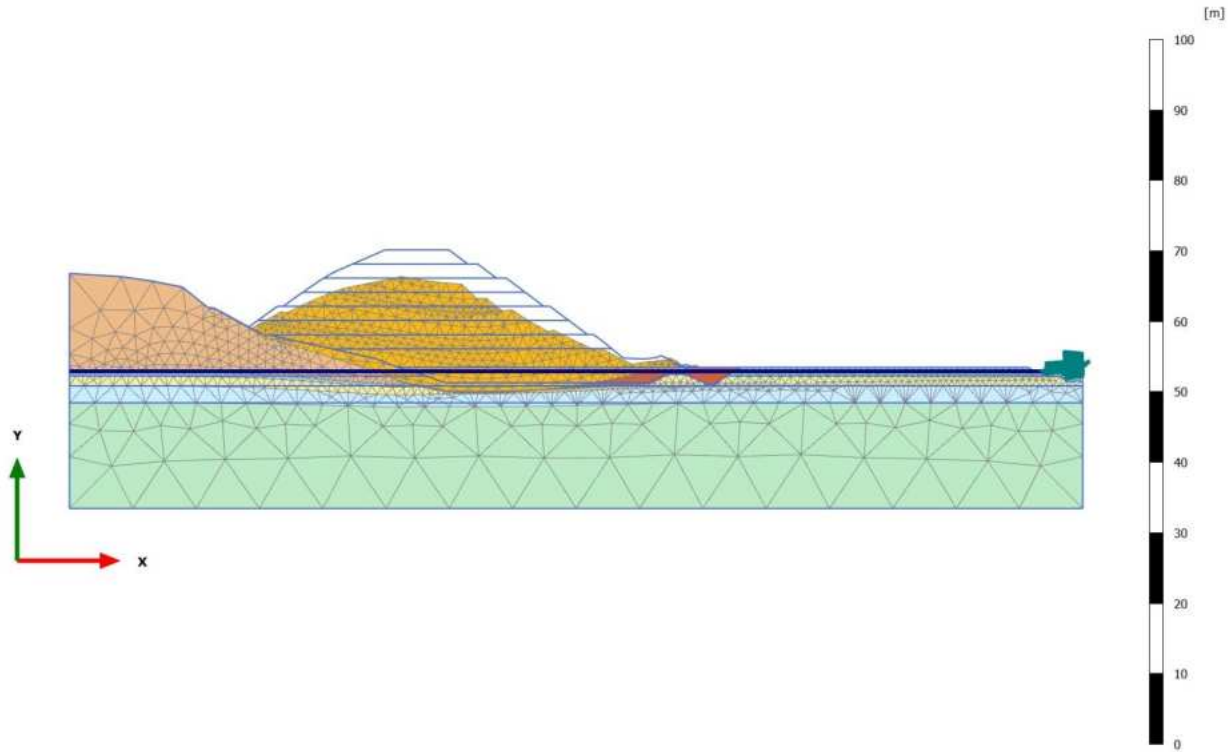
**Deformed mesh |u| (scaled up 5,00 times)**  
Maximum value = 4,723 m (Element 171 at Node 19605)

4.1.6 Calculation results, Phase\_5\_static [Phase\_5] (12/33), Deformed mesh |u|



**Deformed mesh |u| (scaled up 5,00 times)**  
Maximum value = 5,167 m (Element 1 at Node 20267)

4.1.7 Calculation results, Phase\_8\_seismic [Phase\_8] (2/36), Deformed mesh |u|



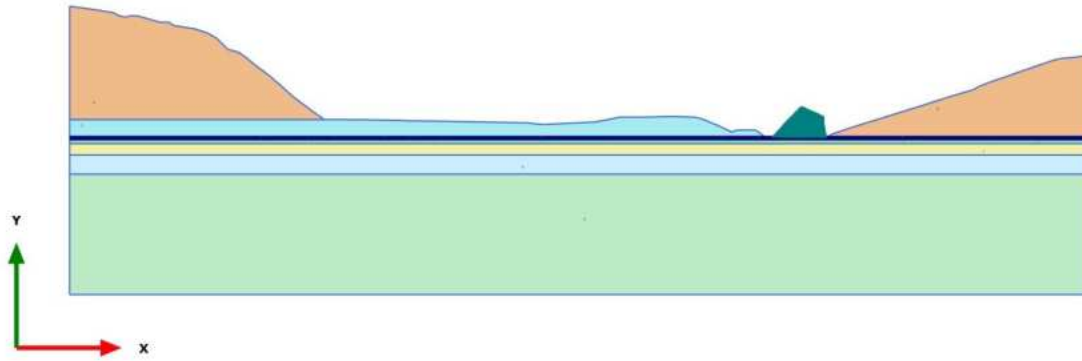
**Deformed mesh |u| (scaled up 5,00 times)**  
Maximum value = 5,174 m (Element 1 at Node 20267)

**ANHANG 5 – ERGEBNISSE DER PLAXIS SLE/SLD – ABSCHNITT 3**

**APPENDICE 5 – RISULTATI ANALISI PLAXIS SLE/SLD – SEZIONE 3**

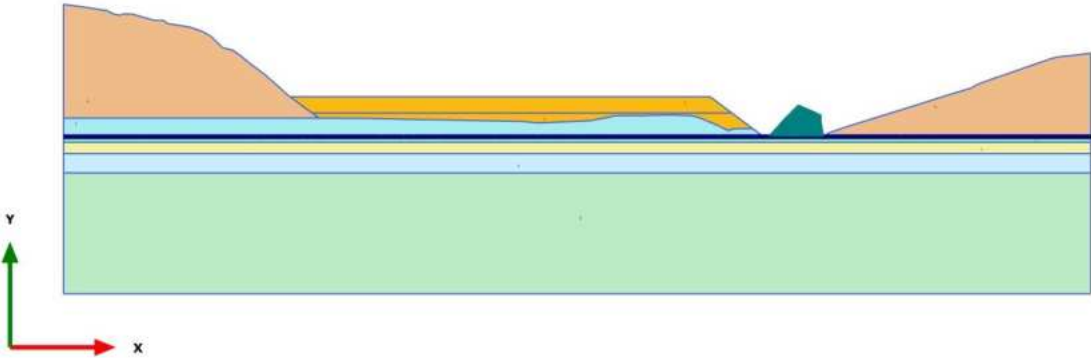
# PLAXIS Report

1.1.1.1 Calculation results, Initial phase [InitialPhase] (0/17), Materials plot



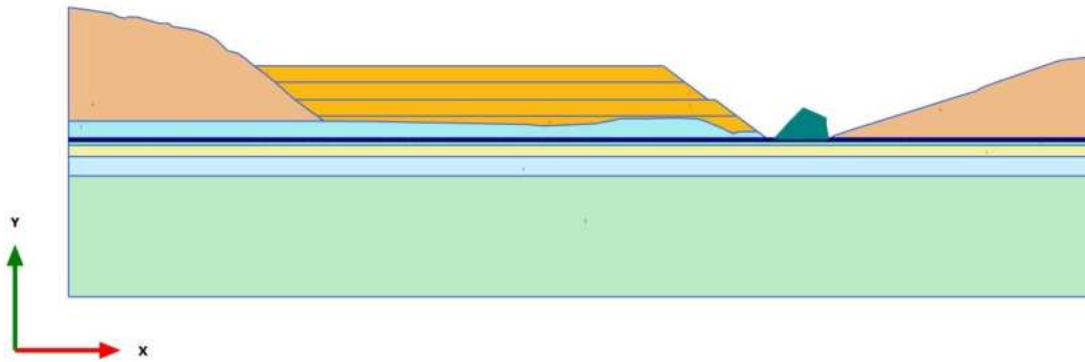
**Materials plot**

1.1.1.2 Calculation results, Phase\_1 [Phase\_1] (8/24), Materials plot



**Materials plot**

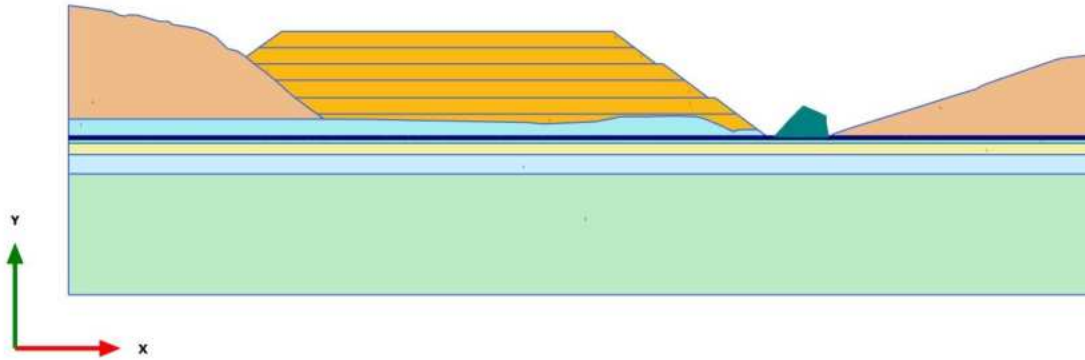
1.1.1.3 Calculation results, Phase\_2 [Phase\_2] (9/30), Materials plot



**Materials plot**

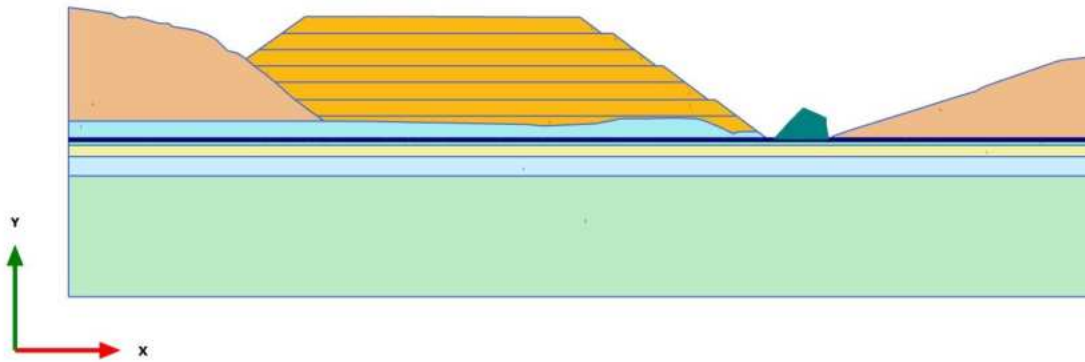


1.1.1.4 Calculation results, Phase\_3 [Phase\_3] (10/35), Materials plot



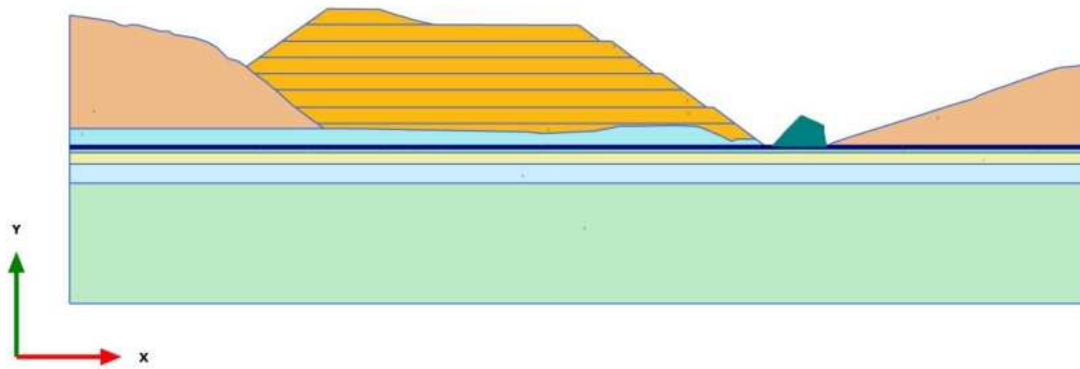
**Materials plot**

1.1.1.5 Calculation results, Phase\_4 [Phase\_4] (11/38), Materials plot



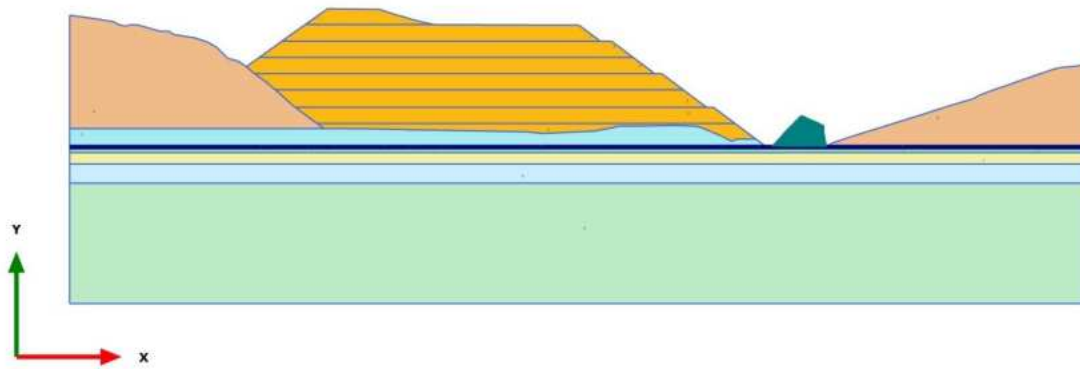
**Materials plot**

1.1.1.6 Calculation results, Phase\_5\_static [Phase\_5] (12/41), Materials plot








**Materials plot**

1.1.1.7 Calculation results, Phase\_8\_seismic [Phase\_8] (2/44), Materials plot



**Materials plot**

### 1.1.2.1.1 Materials - Soil and interfaces - Hardening soil

Identification		Strato 1	Strato 2	Strato 3	Strato 4	Strato 5
Identification number		1	2	3	4	5
Drainage type		Drained	Drained	Drained	Drained	Drained
Colour						
Comments						
$\gamma_{\text{unsat}}$	kN/m <sup>3</sup>	20,00	20,00	20,00	20,00	20,00
$\gamma_{\text{sat}}$	kN/m <sup>3</sup>	20,00	20,00	20,00	20,00	20,00
Dilatancy cut-off		No	No	No	No	No
$e_{\text{init}}$		0,5000	0,5000	0,5000	0,5000	0,5000
$e_{\text{min}}$		0,000	0,000	0,000	0,000	0,000
$e_{\text{max}}$		999,0	999,0	999,0	999,0	999,0
Rayleigh $\alpha$		0,000	0,000	0,000	0,000	0,000
Rayleigh $\beta$		0,000	0,000	0,000	0,000	0,000
$E_{50 \text{ ref}}$	kN/m <sup>2</sup>	25,00E3	40,00E3	50,00E3	30,00E3	70,00E3
$E_{\text{oed ref}}$	kN/m <sup>2</sup>	23,55E3	36,94E3	45,27E3	28,84E3	66,76E3
$E_{\text{ur ref}}$	kN/m <sup>2</sup>	75,00E3	120,0E3	150,0E3	90,00E3	210,0E3
power (m)		0,000	0,000	0,000	0,000	0,4000
Use alternatives		No	No	No	No	No
$C_c$		0,01465	9,339E-3	7,621E-3	0,01196	5,167E-3





Identification		Strato 1	Strato 2	Strato 3	Strato 4	Strato 5
$C_s$		4,140E-3	2,587E-3	2,070E-3	3,450E-3	1,479E-3
$e_{init}$		0,5000	0,5000	0,5000	0,5000	0,5000
$c_{ref}$	kN/m <sup>2</sup>	5,000	0,000	0,000	0,000	0,000
$\varphi$ (phi)	°	38,00	40,00	42,00	36,00	36,00
$\psi$ (psi)	°	0,000	0,000	0,000	0,000	0,000
Set to default values		No	No	No	No	No
$v_{ur}$		0,2000	0,2000	0,2000	0,2000	0,2000
$p_{ref}$	kN/m <sup>2</sup>	100,0	100,0	100,0	100,0	100,0
$K_{0nc}$		0,3943	0,3695	0,3449	0,4194	0,4217
$c_{inc}$	kN/m <sup>2</sup> /m	0,000	0,000	0,000	0,000	0,000
$y_{ref}$	m	0,000	0,000	0,000	0,000	608,0
$R_f$		0,9000	0,9000	0,9000	0,9000	0,9000
Tension cut-off		Yes	Yes	Yes	Yes	Yes
Tensile strength	kN/m <sup>2</sup>	0,000	0,000	0,000	0,000	0,000
Undrained behaviour		Standard	Standard	Standard	Standard	Standard
Skempton-B		0,9866	0,9866	0,9866	0,9866	0,9866
$v_u$		0,4950	0,4950	0,4950	0,4950	0,4950
$K_{w,ref} / n$	kN/m <sup>2</sup>	3,073E6	4,917E6	6,146E6	3,687E6	8,604E6
Stiffness		Standard	Standard	Standard	Standard	Standard

Strength		Rigid	Rigid	Rigid	Rigid	Rigid
$R_{inter}$		1,000	1,000	1,000	1,000	1,000
Consider gap closure		Yes	Yes	Yes	Yes	Yes
Identification		Strato 1	Strato 2	Strato 3	Strato 4	Strato 5
$\delta_{inter}$		0,000	0,000	0,000	0,000	0,000
Cross permeability		Impermeable	Impermeable	Impermeable	Impermeable	Impermeable
Drainage conductivity, dk	m <sup>3</sup> /day/m	0,000	0,000	0,000	0,000	0,000
R	m <sup>2</sup> K/kW	0,000	0,000	0,000	0,000	0,000
$K_0$ determination		Automatic	Automatic	Automatic	Automatic	Automatic
$K_{0,x} = K_{0,z}$		Yes	Yes	Yes	Yes	Yes
$K_{0,x}$		0,3943	0,3695	0,3449	0,4194	0,4217
$K_{0,z}$		0,3943	0,3695	0,3449	0,4194	0,4217
OCR		1,000	1,000	1,000	1,000	1,000
POP	kN/m <sup>2</sup>	0,000	0,000	0,000	0,000	0,000
Data set		Standard	Standard	Standard	Standard	Standard
Type		Coarse	Coarse	Coarse	Coarse	Coarse
< 2 $\mu$ m	%	10,00	10,00	10,00	10,00	10,00
2 $\mu$ m - 50 $\mu$ m	%	13,00	13,00	13,00	13,00	13,00
50 $\mu$ m - 2 mm	%	77,00	77,00	77,00	77,00	77,00
Use defaults		None	None	None	None	None

$k_x$	m/day	0,000	0,000	0,000	0,000	0,000
$k_y$	m/day	0,000	0,000	0,000	0,000	0,000
$-\psi_{\text{unsat}}$	m	10,00E3	10,00E3	10,00E3	10,00E3	10,00E3
$e_{\text{init}}$		0,5000	0,5000	0,5000	0,5000	0,5000
$S_s$	1/m	0,000	0,000	0,000	0,000	0,000
$c_k$		1000E12	1000E12	1000E12	1000E12	1000E12
Identification		Strato 1	Strato 2	Strato 3	Strato 4	Strato 5
$c_s$	kJ/t/K	0,000	0,000	0,000	0,000	0,000
$\lambda_s$	kW/m/K	0,000	0,000	0,000	0,000	0,000
$\rho_s$	t/m <sup>3</sup>	0,000	0,000	0,000	0,000	0,000
Solid thermal expansion		Volumetric	Volumetric	Volumetric	Volumetric	Volumetric
$\alpha_s$	1/K	0,000	0,000	0,000	0,000	0,000
$D_v$	m <sup>2</sup> /day	0,000	0,000	0,000	0,000	0,000
$f_{\text{TV}}$		0,000	0,000	0,000	0,000	0,000
Unfrozen water content		None	None	None	None	None



1.1.2.1.2 Materials - Soil and interfaces - Mohr-Coulomb

Identification		Rock	A	F1	GNEISS
Identification number		6	7	8	9
Drainage type		Drained	Drained	Drained	Drained
Colour					
Comments					
$\gamma_{\text{unsat}}$	kN/m <sup>3</sup>	20,00	21,00	20,00	20,00
$\gamma_{\text{sat}}$	kN/m <sup>3</sup>	20,00	21,00	20,00	20,00
Dilatancy cut-off		No	No	No	No
$e_{\text{init}}$		0,5000	0,5000	0,5000	0,5000
$e_{\text{min}}$		0,000	0,000	0,000	0,000
$e_{\text{max}}$		999,0	999,0	999,0	999,0
Rayleigh $\alpha$		0,000	0,000	0,000	0,000
Rayleigh $\beta$		0,000	0,000	0,000	0,000
E	kN/m <sup>2</sup>	100,0E3	30,00E3	5000	30,00E3
$\nu$ (nu)		0,3000	0,3000	0,3000	0,3000
G	kN/m <sup>2</sup>	38,46E3	11,54E3	1923	11,54E3
$E_{\text{oad}}$	kN/m <sup>2</sup>	134,6E3	40,38E3	6731	40,38E3

Identification		Rock	A	F1	GNEISS
$c_{ref}$	kN/m <sup>2</sup>	500,0	45,00	0,000	40,00
$\phi$ (phi)	°	35,00	37,00	20,00	36,00
$\psi$ (psi)	°	0,000	3,000	0,000	3,000
$V_s$	m/s	137,4	73,42	30,71	75,23
$V_p$	m/s	257,0	137,4	57,46	140,7
Set to default values		Yes	Yes	Yes	Yes
$E_{inc}$	kN/m <sup>2</sup> /m	0,000	0,000	0,000	0,000
$\gamma_{ref}$	m	0,000	0,000	0,000	0,000
$C_{inc}$	kN/m <sup>2</sup> /m	0,000	0,000	0,000	0,000
$\gamma_{ref}$	m	0,000	0,000	0,000	0,000
Tension cut-off		Yes	Yes	Yes	Yes
Tensile strength	kN/m <sup>2</sup>	0,000	0,000	0,000	0,000
Undrained behaviour		Standard	Standard	Standard	Standard
Skempton-B		0,9783	0,9783	0,9783	0,9783
$v_u$		0,4950	0,4950	0,4950	0,4950
$K_{w,ref} / n$	kN/m <sup>2</sup>	3,750E6	1,125E6	187,5E3	1,125E6
Stiffness		Standard	Standard	Standard	Standard

Strength		Rigid	Rigid	Rigid	Rigid
R <sub>inter</sub>		1,000	1,000	1,000	1,000
Identification		Rock	A	F1	GNEISS
Consider gap closure		Yes	Yes	Yes	Yes
δ <sub>inter</sub>		0,000	0,000	0,000	0,000
Cross permeability		Impermeable	Impermeable	Impermeable	Impermeable
Drainage conductivity, dk	m <sup>3</sup> /day/m	0,000	0,000	0,000	0,000
R	m <sup>2</sup> K/kW	0,000	0,000	0,000	0,000
K <sub>0</sub> determination		Automatic	Automatic	Automatic	Automatic
K <sub>0,x</sub> = K <sub>0,z</sub>		Yes	Yes	Yes	Yes
K <sub>0,x</sub>		0,4264	0,3982	0,6580	0,4122
K <sub>0,z</sub>		0,4264	0,3982	0,6580	0,4122
Data set		Standard	USDA	Standard	USDA
Model		Van Genuchten	Van Genuchten	Van Genuchten	Van Genuchten
Type		Coarse	Coarse	Coarse	Coarse
Type		Sand	Sand	Sand	Sand
< 2 μm	%	10,00	4,000	10,00	4,000
2 μm - 50 μm	%	13,00	4,000	13,00	4,000

50 $\mu\text{m}$ - 2 mm	%	77,00	92,00	77,00	92,00
Use defaults		None	None	None	None
$k_x$	m/day	0,000	0,000	0,000	0,000
$k_y$	m/day	0,000	0,000	0,000	0,000
Identification		Rock	A	F1	GNEISS
$-\psi_{\text{unsat}}$	m	10,00E3	10,00E3	10,00E3	10,00E3
$e_{\text{init}}$		0,5000	0,5000	0,5000	0,5000
$S_s$	1/m	0,000	0,000	0,000	0,000
$c_k$		1000E12	1000E12	1000E12	1000E12
$c_s$	kJ/t/K	0,000	0,000	0,000	0,000
$\lambda_s$	kW/m/K	0,000	0,000	0,000	0,000
$\rho_s$	t/m <sup>3</sup>	0,000	0,000	0,000	0,000
Solid thermal expansion		Volumetric	Volumetric	Volumetric	Volumetric
$\alpha_s$	1/K	0,000	0,000	0,000	0,000
$D_v$	m <sup>2</sup> /day	0,000	0,000	0,000	0,000
$f_{\text{TV}}$		0,000	0,000	0,000	0,000
Unfrozen water content		None	None	None	None

### 1.1.3.1 Calculation information

Calculation information				
Step info				
Phase	Initial phase [InitialPhase]			
Step	Initial			
Calculation mode	Classical mode			
Step type	Gravity loading			
Solver type	Picos			
Kernel type	64 bit			
Extrapolation factor	0,7119			
Relative stiffness	0,3259			
Multipliers				
Soil weight			$\Sigma M_{\text{Weight}}$	1,000
Strength reduction factor	$M_{\text{sf}}$	0,000	$\Sigma M_{\text{sf}}$	1,000
Time	Increment	0,000	End time	0,000
Staged construction				
Active proportion total area	$M_{\text{Area}}$	0,1803	$\Sigma M_{\text{Area}}$	0,8300
Active proportion of stage	$M_{\text{Stage}}$	0,2173	$\Sigma M_{\text{Stage}}$	1,000

### Calculation information

#### Forces

$F_x$  0,000 kN/m

$F_y$  0,000 kN/m

#### Consolidation

Realised P Excess,Max 0,000 kN/m<sup>2</sup>

1.1.3.2 Calculation information

Calculation information				
Step info				
Phase	Phase_1 [Phase_1]			
Step	Initial			
Calculation mode	Classical mode			
Step type	Plastic			
Updated mesh	False			
Solver type	Picos			
Kernel type	64 bit			
Extrapolation factor	0,4763			
Relative stiffness	0,3274			
Design approach				
Index	1			
Name	DesignApproach_1			
Multipliers				
Soil weight			$\Sigma M_{\text{Weight}}$	1,000
Strength reduction factor	$M_{\text{sf}}$	0,000	$\Sigma M_{\text{sf}}$	1,000

Calculation information				
Time	Increment	0,000	End time	0,000
Staged construction				
Active proportion total area	$M_{Area}$	9,299E-3	$\Sigma M_{Area}$	0,8690
Active proportion of stage	$M_{Stage}$	0,1009	$\Sigma M_{Stage}$	1,000
Forces				
$F_x$	0,000 kN/m			
$F_y$	0,000 kN/m			
Consolidation				
Realised P <small>Excess,Max</small>	0,000 kN/m <sup>2</sup>			



### 1.1.3.3 Calculation information

Calculation information				
Step info				
Phase	Phase_2 [Phase_2]			
Step	Initial			
Calculation mode	Classical mode			
Step type	Plastic			
Updated mesh	False			
Solver type	Picos			
Kernel type	64 bit			
Extrapolation factor	0,2815			
Relative stiffness	0,3677			
Design approach				
Index	1			
Name	DesignApproach_1			
Multipliers				
Soil weight			$\Sigma M_{\text{Weight}}$	1,000
Strength reduction factor	$M_{\text{sf}}$	0,000	$\Sigma M_{\text{sf}}$	1,000

Calculation information				
Time	Increment	0,000	End time	0,000
Staged construction				
Active proportion total area	$M_{Area}$	7,906E-3	$\Sigma M_{Area}$	0,9252
Active proportion of stage	$M_{Stage}$	0,07566	$\Sigma M_{Stage}$	1,000
Forces				
$F_x$	0,000 kN/m			
$F_y$	0,000 kN/m			
Consolidation				
Realised P <small>Excess,Max</small>	0,000 kN/m <sup>2</sup>			

#### 1.1.3.4 Calculation information

Calculation information				
Step info				
Phase	Phase_3 [Phase_3]			
Step	Initial			
Calculation mode	Classical mode			
Step type	Plastic			
Updated mesh	False			
Solver type	Picos			
Kernel type	64 bit			
Extrapolation factor	0,02397			
Relative stiffness	0,3772			
Design approach				
Index	1			
Name	DesignApproach_1			
Multipliers				
Soil weight			$\Sigma M_{\text{Weight}}$	1,000
Strength reduction factor	$M_{\text{sf}}$	0,000	$\Sigma M_{\text{sf}}$	1,000

Calculation information				
Time	Increment	0,000	End time	0,000
Staged construction				
Active proportion total area	$M_{Area}$	0,5901E-3	$\Sigma M_{Area}$	0,9744
Active proportion of stage	$M_{Stage}$	7,553E-3	$\Sigma M_{Stage}$	1,000
Forces				
$F_x$	0,000 kN/m			
$F_y$	0,000 kN/m			
Consolidation				
Realised $P_{Excess,Max}$	0,000 kN/m <sup>2</sup>			

### 1.1.3.5 Calculation information

Calculation information				
Step info				
Phase	Phase_4 [Phase_4]			
Step	Initial			
Calculation mode	Classical mode			
Step type	Plastic			
Updated mesh	False			
Solver type	Picos			
Kernel type	64 bit			
Extrapolation factor	0,8626			
Relative stiffness	0,4425			
Design approach				
Index	1			
Name	DesignApproach_1			
Multipliers				
Soil weight			$\Sigma M_{\text{Weight}}$	1,000
Strength reduction factor	$M_{\text{sf}}$	0,000	$\Sigma M_{\text{sf}}$	1,000

Calculation information				
Time	Increment	0,000	End time	0,000
Staged construction				
Active proportion total area	$M_{Area}$	8,626E-3	$\Sigma M_{Area}$	0,9944
Active proportion of stage	$M_{Stage}$	0,2905	$\Sigma M_{Stage}$	1,000
Forces				
$F_x$	0,000 kN/m			
$F_y$	0,000 kN/m			
Consolidation				
Realised $P_{Excess,Max}$	0,000 kN/m <sup>2</sup>			

### 1.1.3.6 Calculation information

Calculation information				
Step info				
Phase	Phase_5_static [Phase_5]			
Step	Initial			
Calculation mode	Classical mode			
Step type	Plastic			
Updated mesh	False			
Solver type	Picos			
Kernel type	64 bit			
Extrapolation factor	0,3687			
Relative stiffness	0,4771			
Design approach				
Index	1			
Name	DesignApproach_1			
Multipliers				
Soil weight			$\Sigma M_{\text{Weight}}$	1,000
Strength reduction factor	$M_{\text{sf}}$	0,000	$\Sigma M_{\text{sf}}$	1,000

Calculation information				
Time	Increment	0,000	End time	0,000
Staged construction				
Active proportion total area	$M_{Area}$	1,028E-3	$\Sigma M_{Area}$	1,000
Active proportion of stage	$M_{Stage}$	0,1469	$\Sigma M_{Stage}$	1,000
Forces				
$F_x$	0,000 kN/m			
$F_y$	0,000 kN/m			
Consolidation				
Realised $P_{Excess,Max}$	0,000 kN/m <sup>2</sup>			



1.1.3.7 Calculation information

Calculation information				
Step info				
Phase	Phase_8_seismic [Phase_8]			
Step	Initial			
Calculation mode	Classical mode			
Step type	Plastic			
Updated mesh	False			
Solver type	Picos			
Kernel type	64 bit			
Extrapolation factor	0,3428			
Relative stiffness	0,3324			
Design approach				
Index	1			
Name	DesignApproach_1			
Multipliers				
Soil weight			$\Sigma M_{\text{Weight}}$	1,000
Strength reduction factor	$M_{\text{sf}}$	0,000	$\Sigma M_{\text{sf}}$	1,000

Calculation information				
Time	Increment	0,000	End time	0,000
Staged construction				
Active proportion total area	$M_{Area}$	0,000	$\Sigma M_{Area}$	1,000
Active proportion of stage	$M_{Stage}$	0,1193	$\Sigma M_{Stage}$	1,000
Forces				
$F_x$	0,000 kN/m			
$F_y$	0,000 kN/m			
Consolidation				
Realised $P_{Excess,Max}$	0,000 kN/m <sup>2</sup>			
Pseudo-static acceleration				
X	5,000E-3 g			
Y	3,000E-3 g			

#### 1.1.4 Calculation information per phase

Identification	Phase	Start from Calculation type	Loading input	Pore pressure	Time step [day]	First step	Last step
Initial phase [InitialPhase]	0	N/A Gravity loading	N/A	Phreatic	0,000	0	17
Phase_1 [Phase_1]	8	0 Plastic	Staged construction	Phreatic	0,000	18	24
Phase_2 [Phase_2]	9	8 Plastic	Staged construction	Phreatic	0,000	25	30
Phase_3 [Phase_3]	10	9 Plastic	Staged construction	Phreatic	0,000	31	35
Phase_4 [Phase_4]	11	10 Plastic	Staged construction	Phreatic	0,000	36	38
Phase_5_static [Phase_5]	12	11 Plastic	Staged construction	Phreatic	0,000	39	41
Phase_8_seismic [Phase_8]	2	12 Plastic	Staged construction	Phreatic	0,000	42	44

1.1.5.1 Step info

Step	Phase Step type	Extrapolation factor [ $10^{-3}$ ]	Relative stiffness [ $10^{-3}$ ]
17	0 Gravity loading	711,862	325,852
24	8 Plastic	476,306	327,392
30	9 Plastic	281,514	367,652
35	10 Plastic	23,969	377,211
38	11 Plastic	862,592	442,454
41	12 Plastic	368,697	477,081
44	2 Plastic	342,810	332,433

### 1.1.5.2 Multipliers

Step	Phase $\Sigma M_{DispX}$	$\Sigma M_{DispY}$	$\Sigma M_{Weight}$	$M_{sf}$	$\Sigma M_{sf}$
17	0 0,000	0,000	1,000	0,000	1,000
24	8 0,000	0,000	1,000	0,000	1,000
30	9 0,000	0,000	1,000	0,000	1,000
35	10 0,000	0,000	1,000	0,000	1,000
38	11 0,000	0,000	1,000	0,000	1,000
41	12 0,000	0,000	1,000	0,000	1,000
44	2 0,000	0,000	1,000	0,000	1,000

### 1.1.5.3 Time

Step	Phase Time step [day]	End time [day]
17	0 0,000	0,000
24	8 0,000	0,000
30	9 0,000	0,000
35	10 0,000	0,000
38	11 0,000	0,000
41	12 0,000	0,000
44	2 0,000	0,000

1.1.5.4 Staged construction

Step	Phase M <sub>Area</sub>	ΣM <sub>Area</sub>	M <sub>Stage</sub> [10 <sup>-3</sup> ]	ΣM <sub>Stage</sub>
17	0 1,000	0,830	217,254	1,000
24	8 0,424	0,869	100,873	1,000
30	9 0,537	0,925	75,656	1,000
35	10 0,630	0,974	7,553	1,000
38	11 0,673	0,994	290,470	1,000
41	12 0,797	1,000	146,907	1,000
44	2 0,696	1,000	119,296	1,000

#### 1.1.5.5 Forces

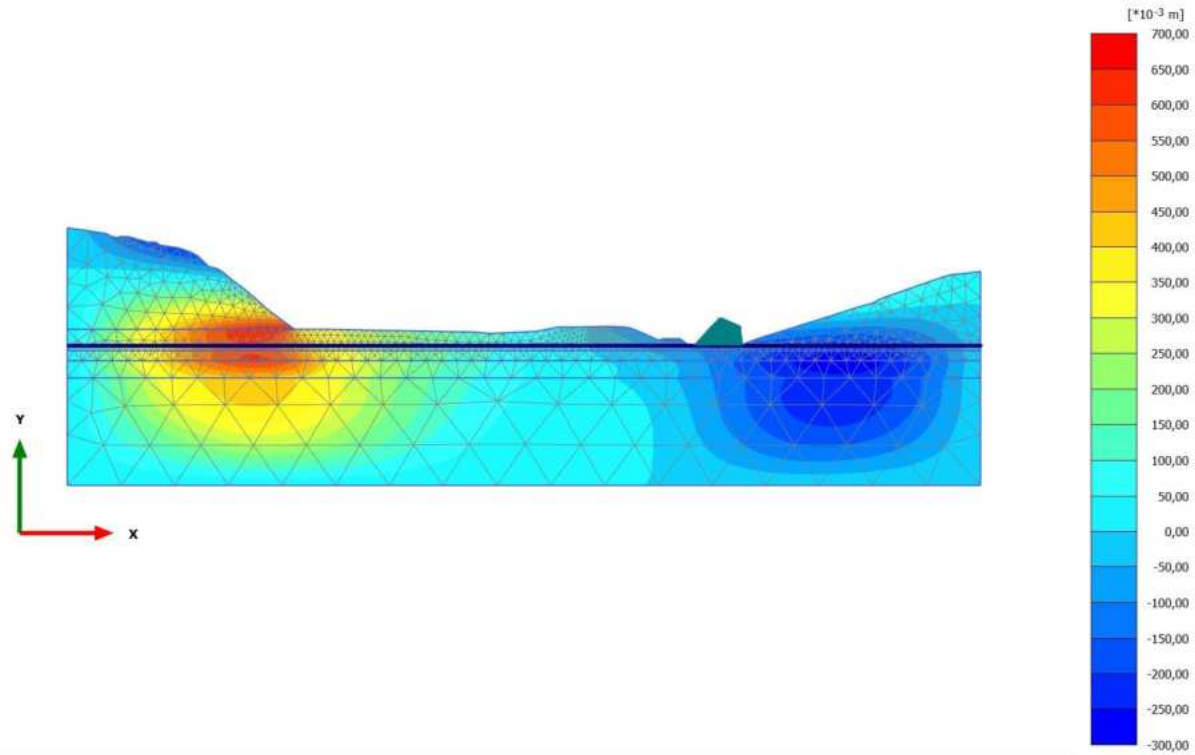
Step	Phase $F_x$ [kN/m]	$F_y$ [kN/m]
17	0 0,000	0,000
24	8 0,000	0,000
30	9 0,000	0,000
35	10 0,000	0,000
38	11 0,000	0,000
41	12 0,000	0,000
44	2 0,000	0,000



#### 1.1.5.6 Consolidation

Step	Phase Rel. P <sub>Max</sub> [kN/m <sup>2</sup> ]
17	0 0,000
24	8 0,000
30	9 0,000
35	10 0,000
38	11 0,000
41	12 0,000
44	2 0,000

2.1.1.1.1 Calculation results, Initial phase [InitialPhase] (0/17), Total displacements  $u_x$

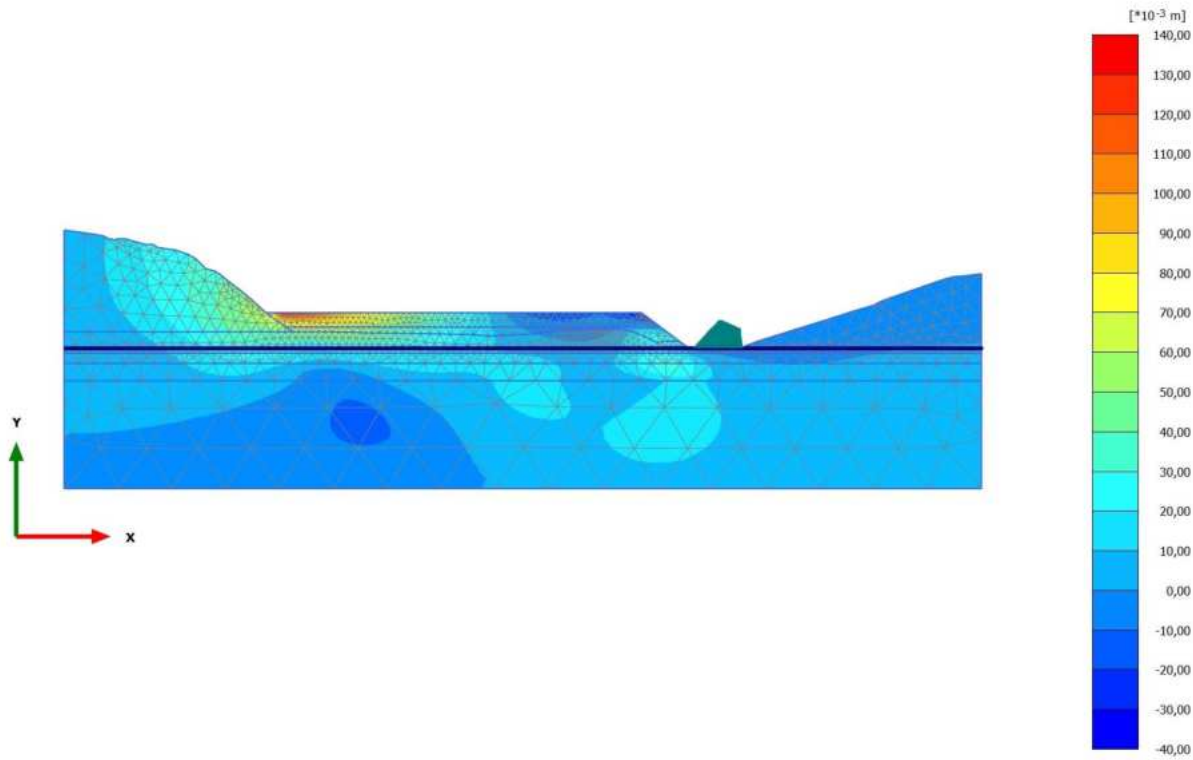


**Total displacements  $u_x$  (scaled up 20,0 times)**

Maximum value = 0,6904 m (Element 4374 at Node 27833)

Minimum value = -0,2790 m (Element 6546 at Node 43131)

2.1.1.1.2 Calculation results, Phase\_1 [Phase\_1] (8/24), Total displacements  $u_x$

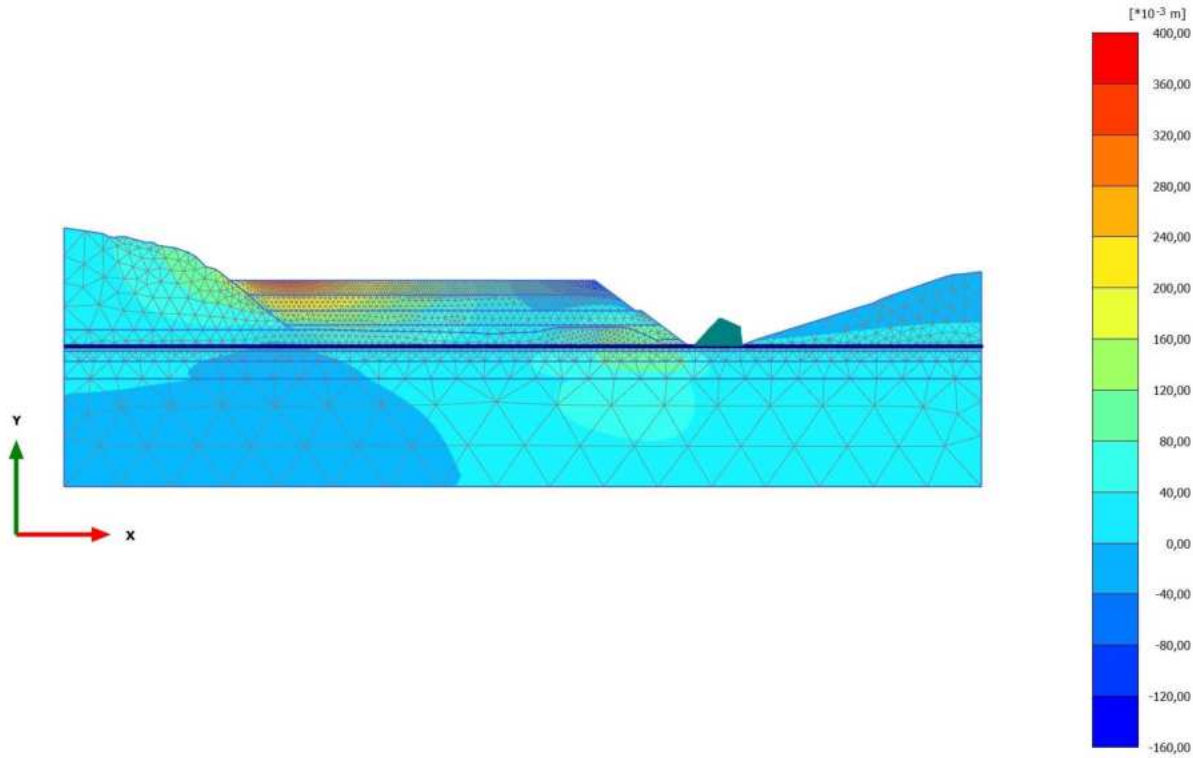


**Total displacements  $u_x$  (scaled up 100 times)**

Maximum value = 0,1328 m (Element 5189 at Node 23543)

Minimum value = -0,03799 m (Element 5233 at Node 52483)

2.1.1.1.3 Calculation results, Phase\_2 [Phase\_2] (9/30), Total displacements  $u_x$

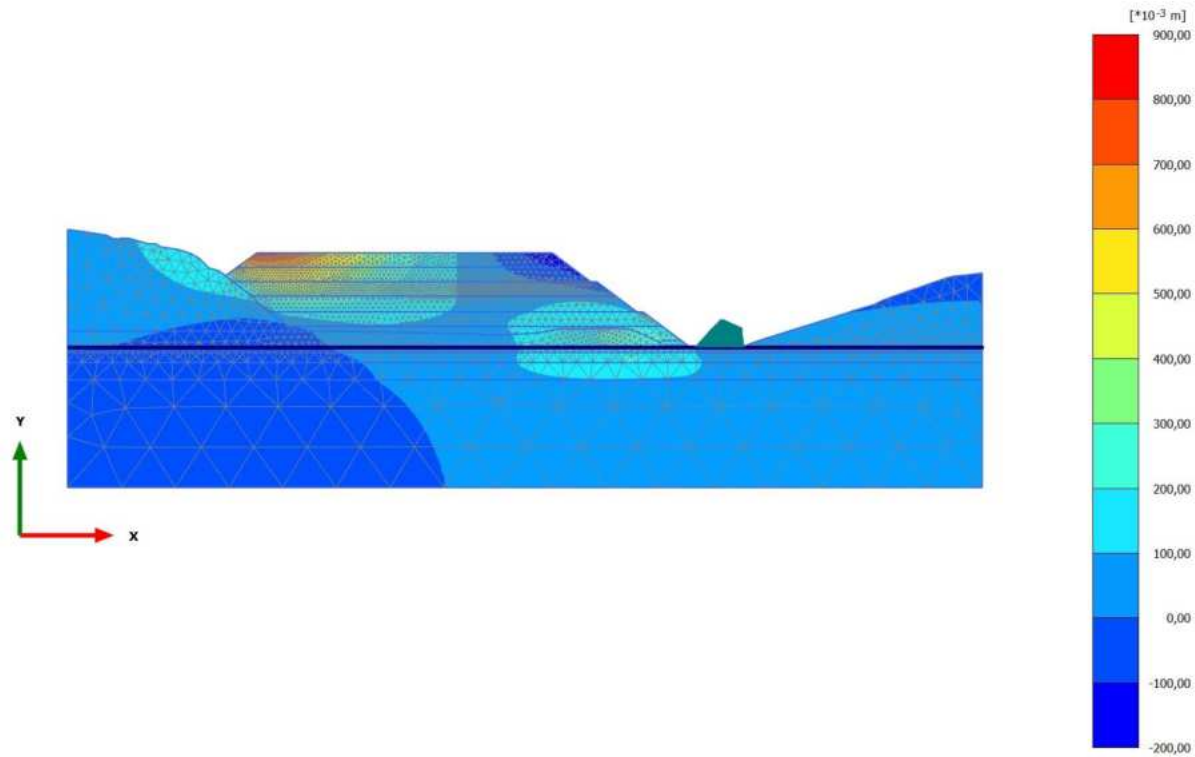


**Total displacements  $u_x$  (scaled up 50,0 times)**

Maximum value = 0,3908 m (Element 4166 at Node 12970)

Minimum value = -0,1363 m (Element 3076 at Node 56654)

2.1.1.1.4 Calculation results, Phase\_3 [Phase\_3] (10/35), Total displacements  $u_x$

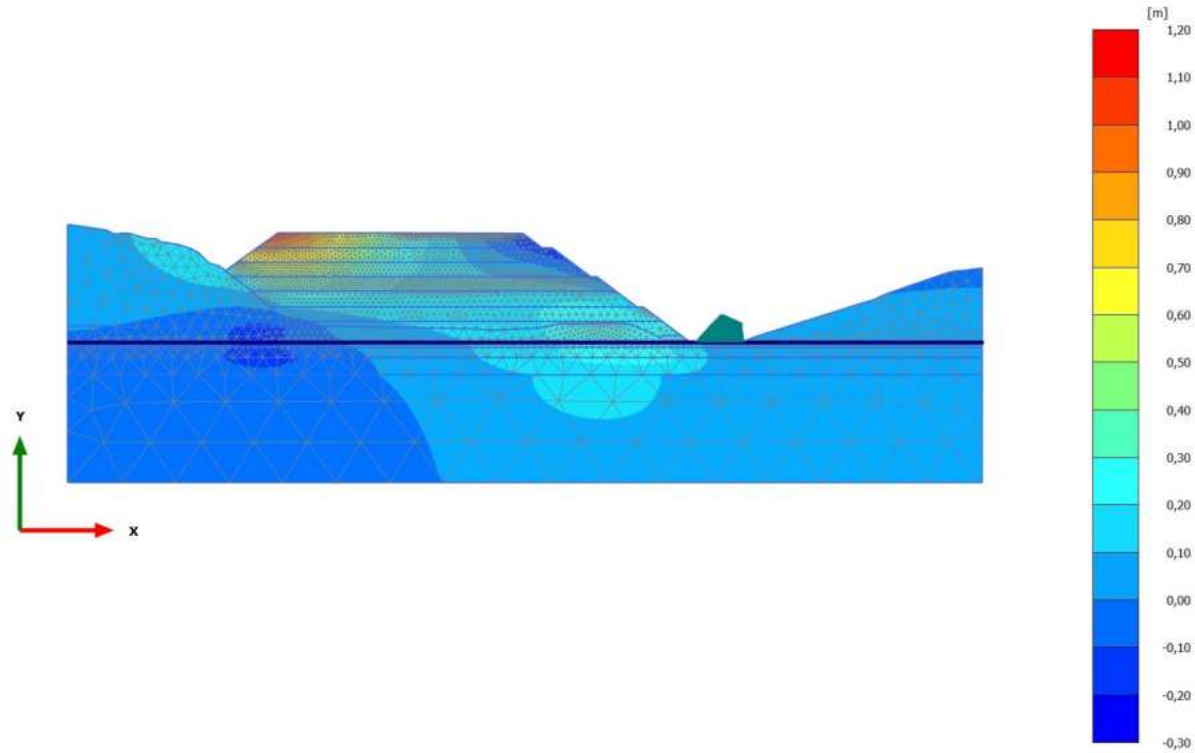


**Total displacements  $u_x$  (scaled up 20,0 times)**

Maximum value = 0,8615 m (Element 2297 at Node 7225)

Minimum value = -0,1953 m (Element 1779 at Node 55353)

2.1.1.1.5 Calculation results, Phase\_4 [Phase\_4] (11/38), Total displacements  $u_x$

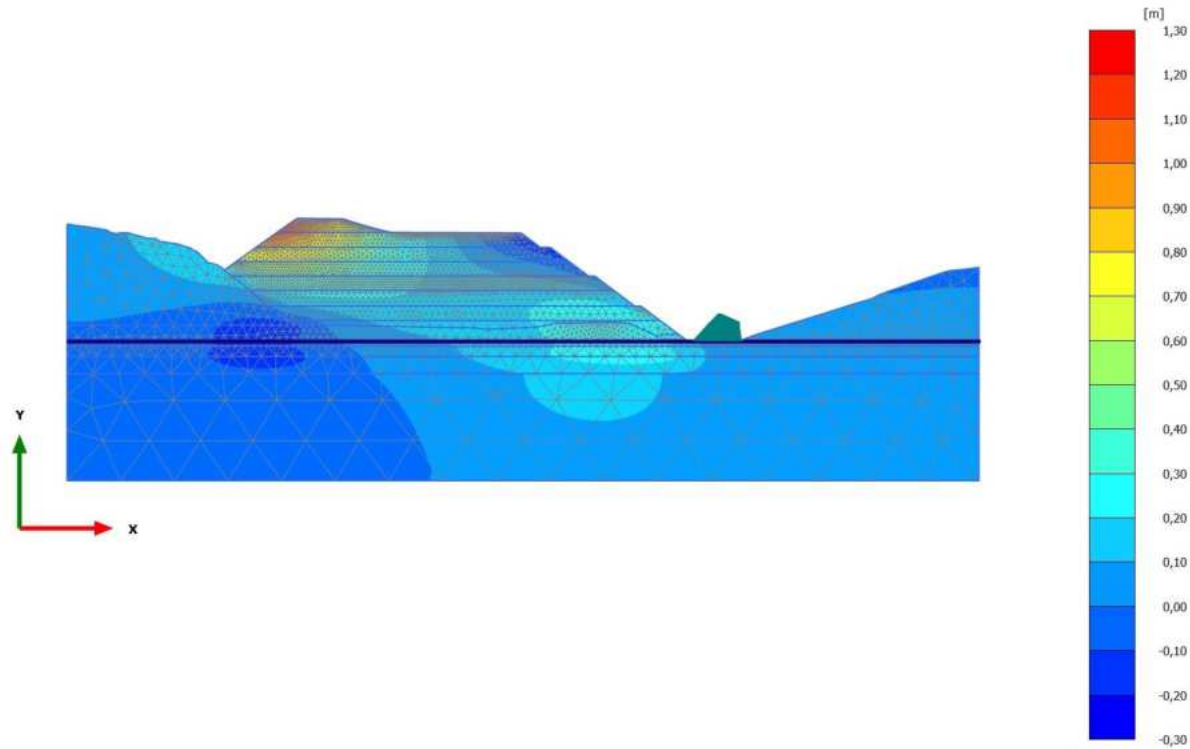


**Total displacements  $u_x$  (scaled up 20,0 times)**

Maximum value = 1,149 m (Element 832 at Node 3481)

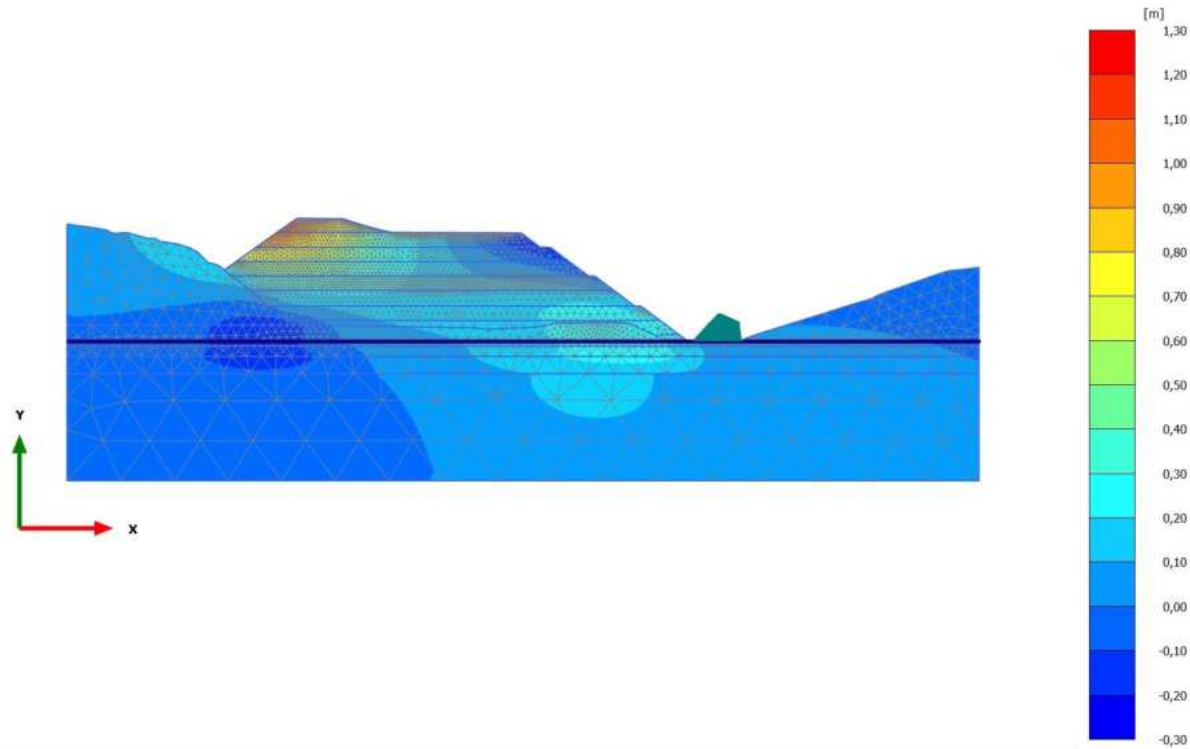
Minimum value = -0,2062 m (Element 1779 at Node 55353)

2.1.1.1.6 Calculation results, Phase\_5\_static [Phase\_5] (12/41), Total displacements  $u_x$



**Total displacements  $u_x$  (scaled up 10,0 times)**  
Maximum value = 1,236 m (Element 364 at Node 381)  
Minimum value = -0,2021 m (Element 1779 at Node 55353)

2.1.1.1.7 Calculation results, Phase\_8\_seismic [Phase\_8] (2/44), Total displacements  $u_x$



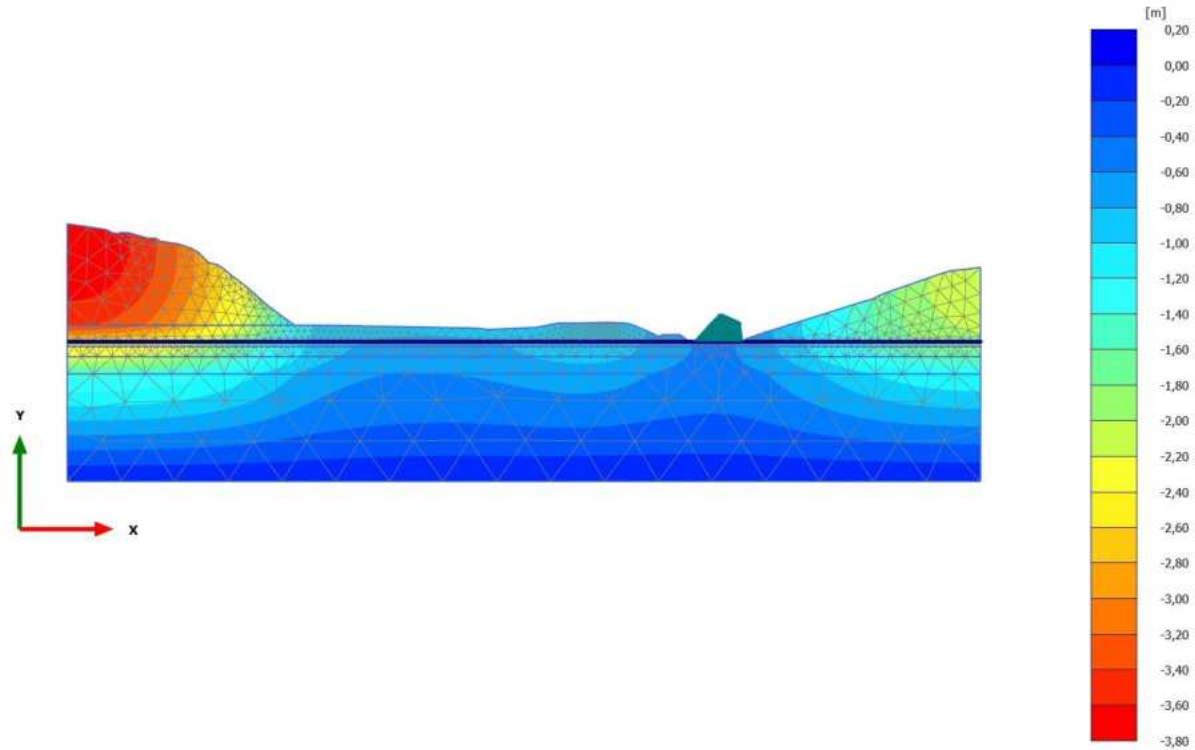
**Total displacements  $u_x$  (scaled up 10,0 times)**

Maximum value = 1,211 m (Element 364 at Node 381)

Minimum value = -0,2292 m (Element 1779 at Node 55353)



2.1.1.2.1 Calculation results, Initial phase [InitialPhase] (0/17), Total displacements  $u_y$

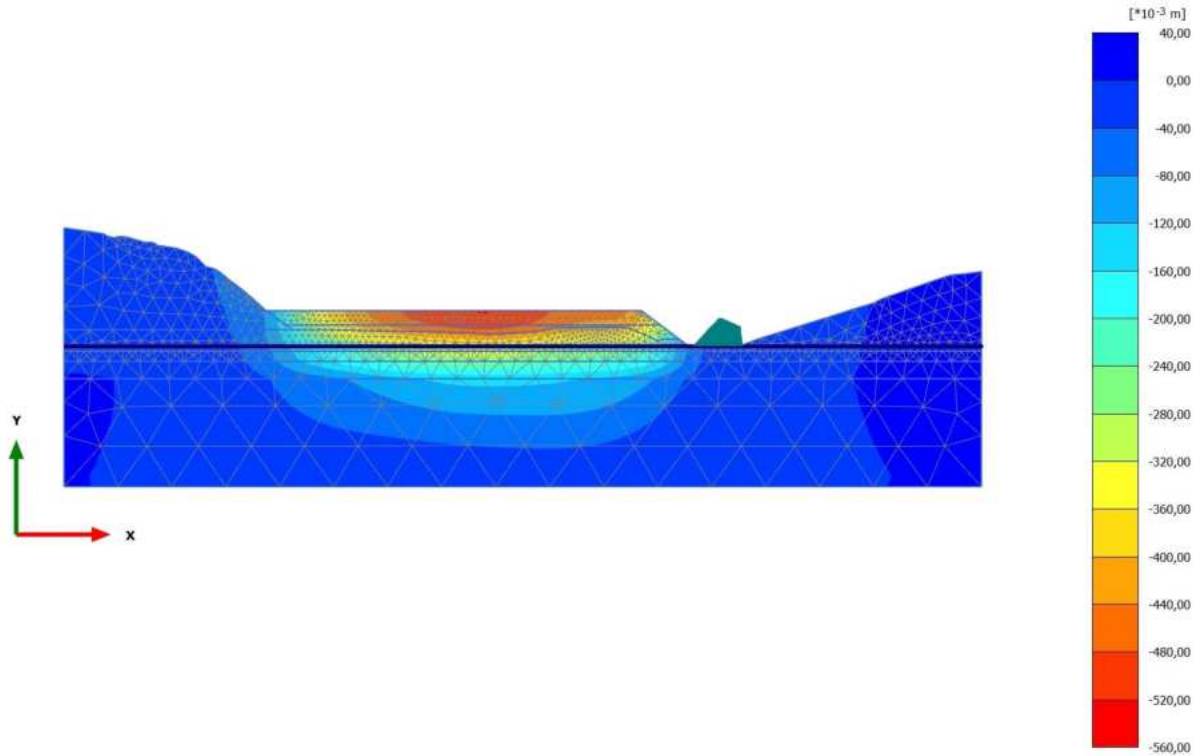


**Total displacements  $u_y$  (scaled up 5,00 times)**

Maximum value = 0,000 m (Element 6854 at Node 40221)

Minimum value = -3,792 m (Element 4219 at Node 21669)

2.1.1.2.2 Calculation results, Phase\_1 [Phase\_1] (8/24), Total displacements  $u_y$

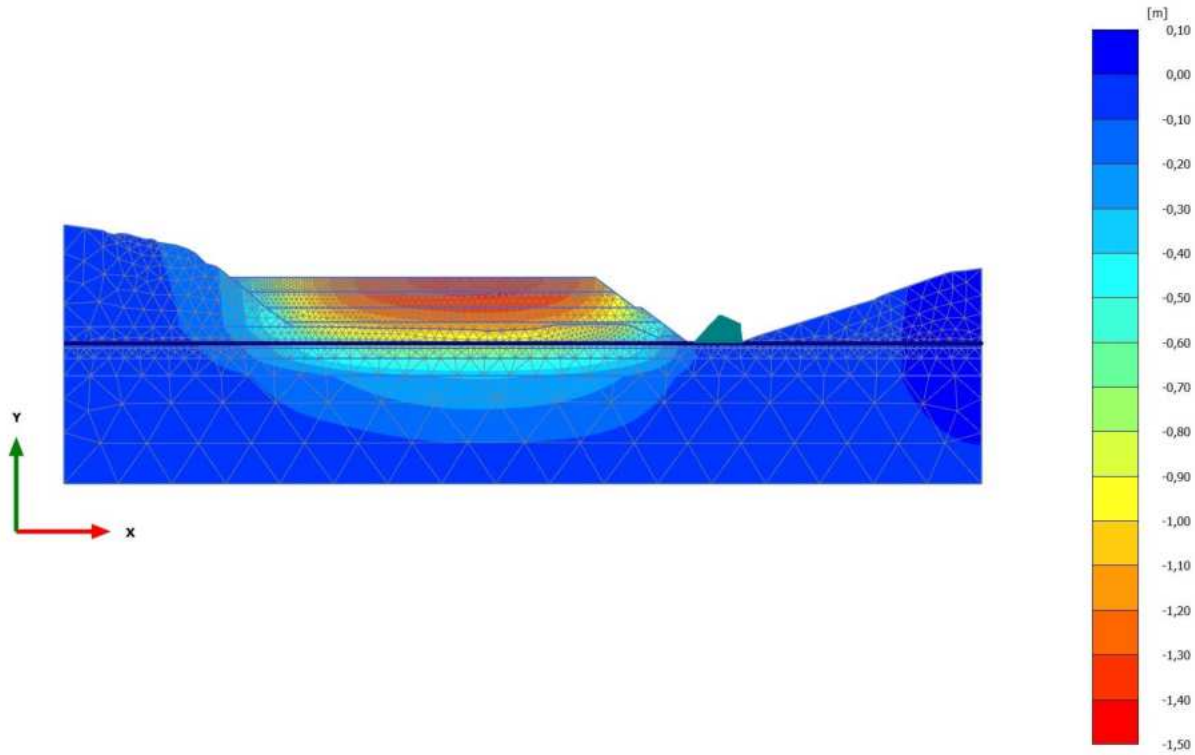


**Total displacements  $u_y$  (scaled up 50,0 times)**

Maximum value =  $1,593 \cdot 10^{-3}$  m (Element 5379 at Node 40335)

Minimum value =  $-0,5204$  m (Element 4985 at Node 39751)

2.1.1.2.3 Calculation results, Phase\_2 [Phase\_2] (9/30), Total displacements  $u_y$

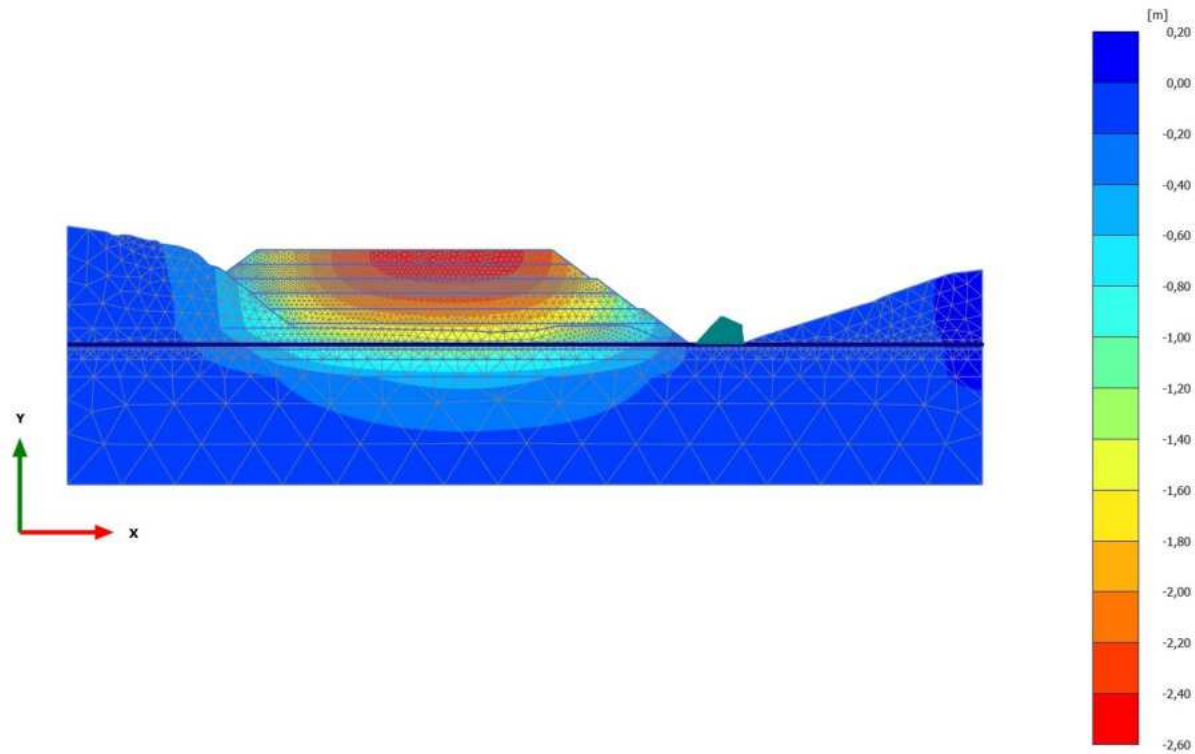


**Total displacements  $u_y$  (scaled up 10,0 times)**

Maximum value =  $1,255 \cdot 10^{-3}$  m (Element 5279 at Node 40378)

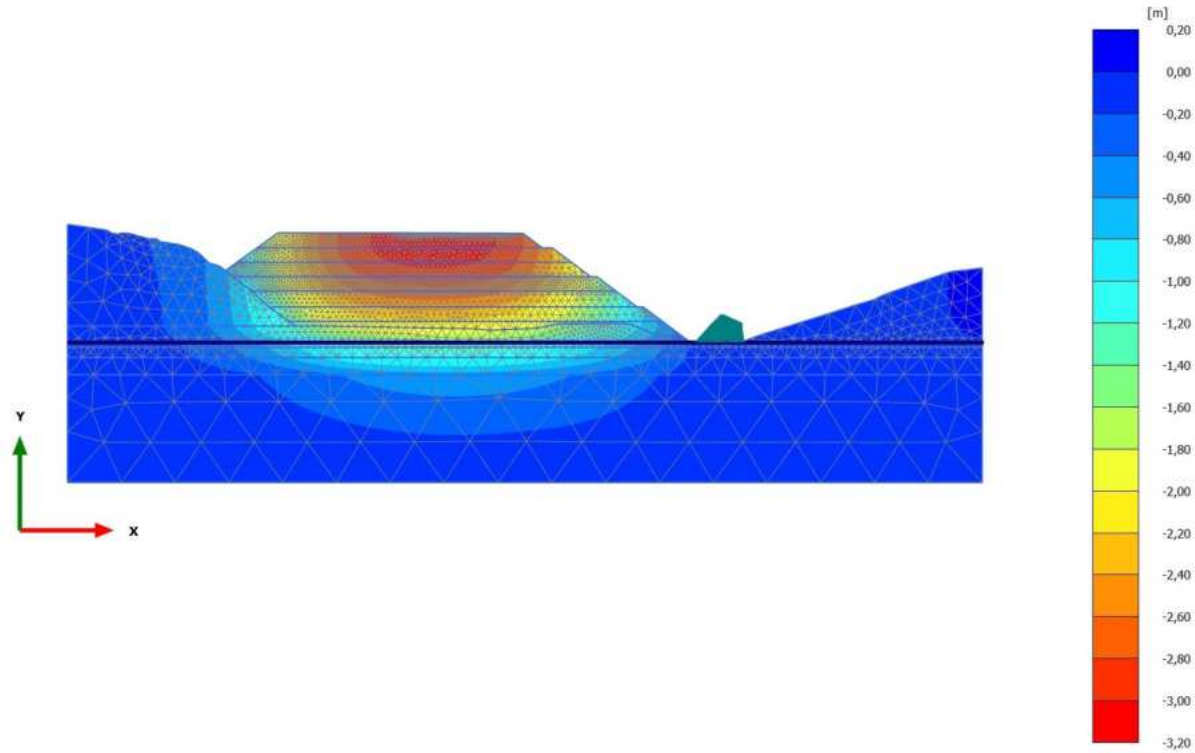
Minimum value = -1,442 m (Element 4005 at Node 39788)

2.1.1.2.4 Calculation results, Phase\_3 [Phase\_3] (10/35), Total displacements  $u_y$



**Total displacements  $u_y$  (scaled up 5,00 times)**  
Maximum value =  $0,6061 \cdot 10^{-3}$  m (Element 5258 at Node 40390)  
Minimum value = -2,519 m (Element 1890 at Node 36185)

2.1.1.2.5 Calculation results, Phase\_4 [Phase\_4] (11/38), Total displacements  $u_y$

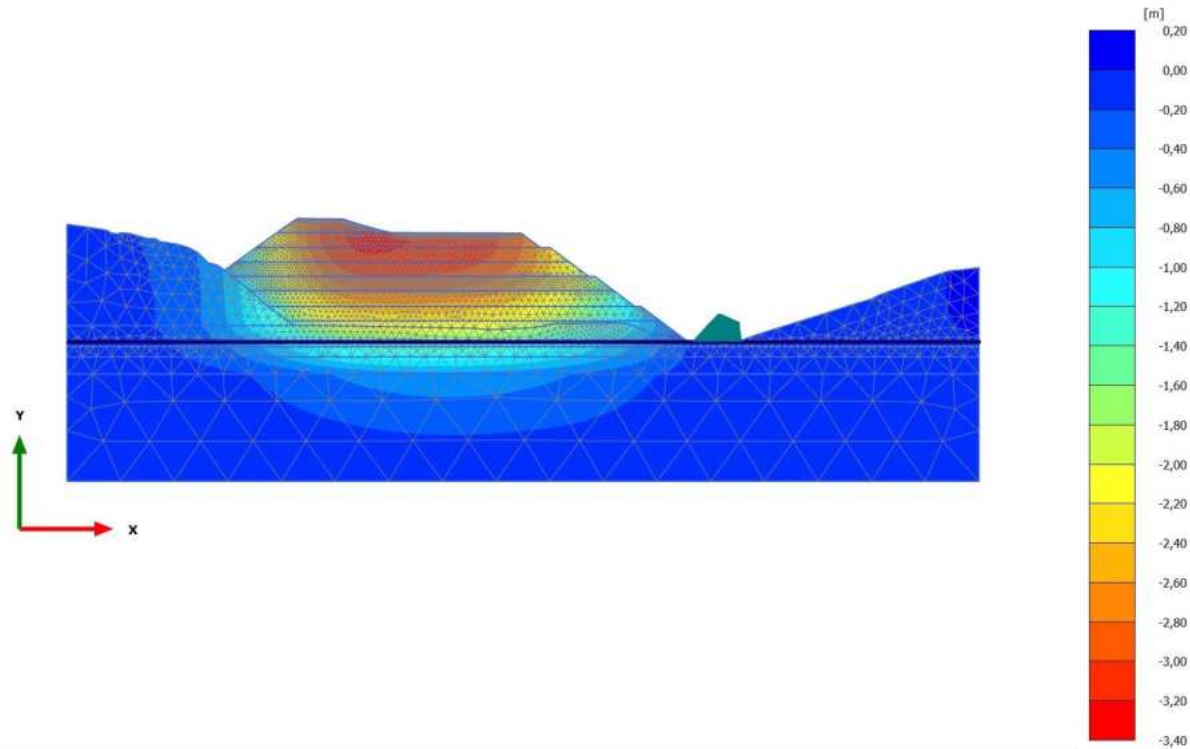


**Total displacements  $u_y$  (scaled up 5,00 times)**

Maximum value =  $0,3467 \cdot 10^{-3}$  m (Element 5251 at Node 40404)

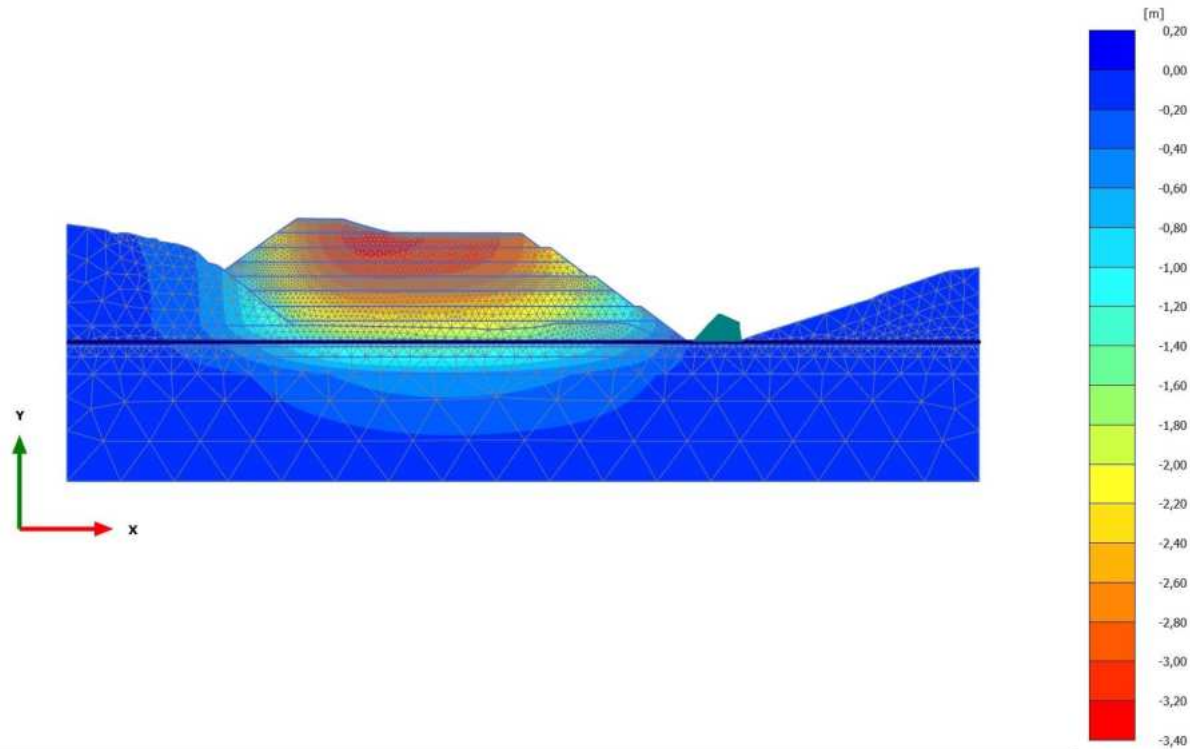
Minimum value = -3,117 m (Element 1098 at Node 28444)

2.1.1.2.6 Calculation results, Phase\_5\_static [Phase\_5] (12/41), Total displacements  $u_y$



**Total displacements  $u_y$  (scaled up 5,00 times)**  
Maximum value =  $0,3148 \cdot 10^{-3}$  m (Element 5251 at Node 40404)  
Minimum value = -3,244 m (Element 890 at Node 9212)

2.1.1.2.7 Calculation results, Phase\_8\_seismic [Phase\_8] (2/44), Total displacements  $u_y$

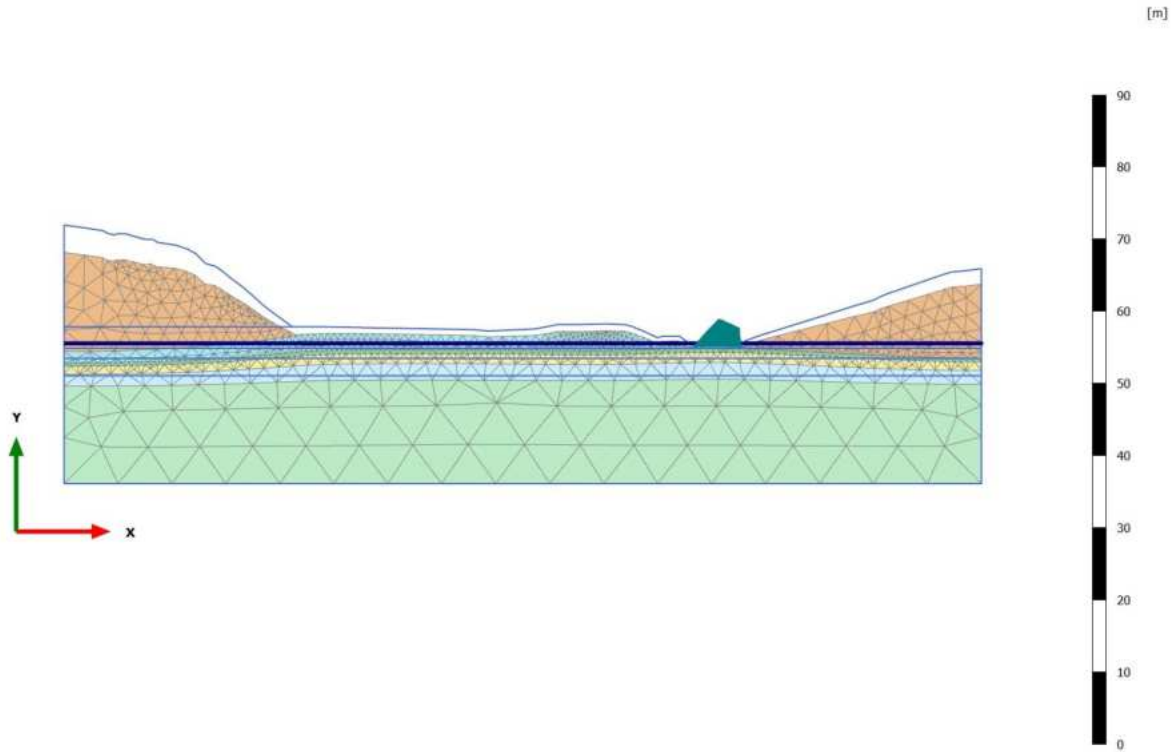


**Total displacements  $u_y$  (scaled up 5,00 times)**

Maximum value = 0,000 m (Element 6854 at Node 40221)

Minimum value = -3,260 m (Element 890 at Node 9210)

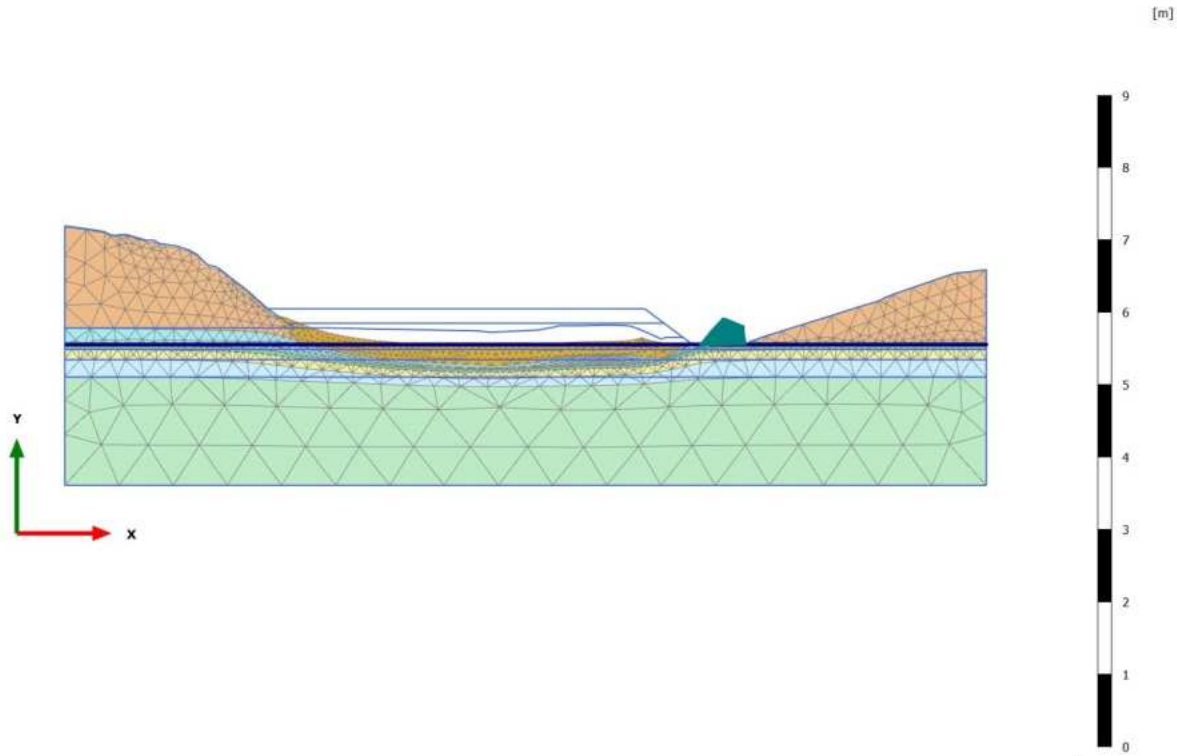
2.1.2.1 Calculation results, Initial phase [InitialPhase] (0/17), Deformed mesh |u|



**Deformed mesh |u| (scaled up 5,00 times)**  
Maximum value = 3,792 m (Element 4219 at Node 21669)

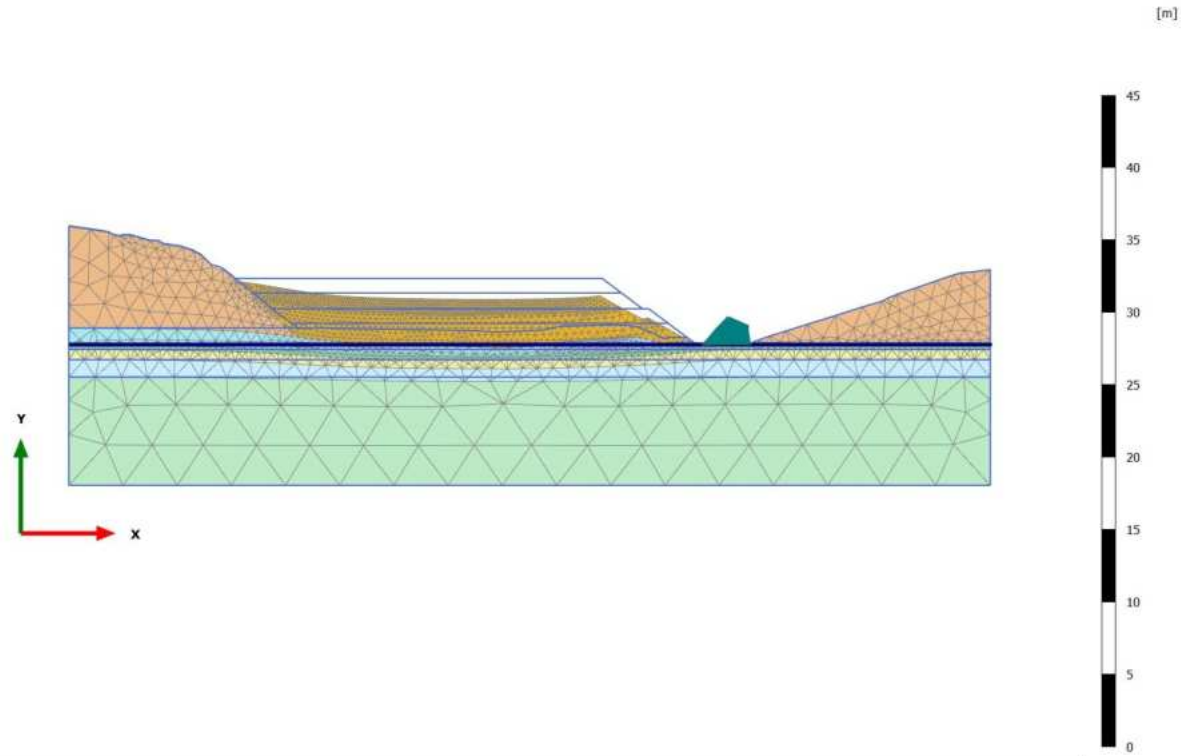


2.1.2.2 Calculation results, Phase\_1 [Phase\_1] (8/24), Deformed mesh |u|



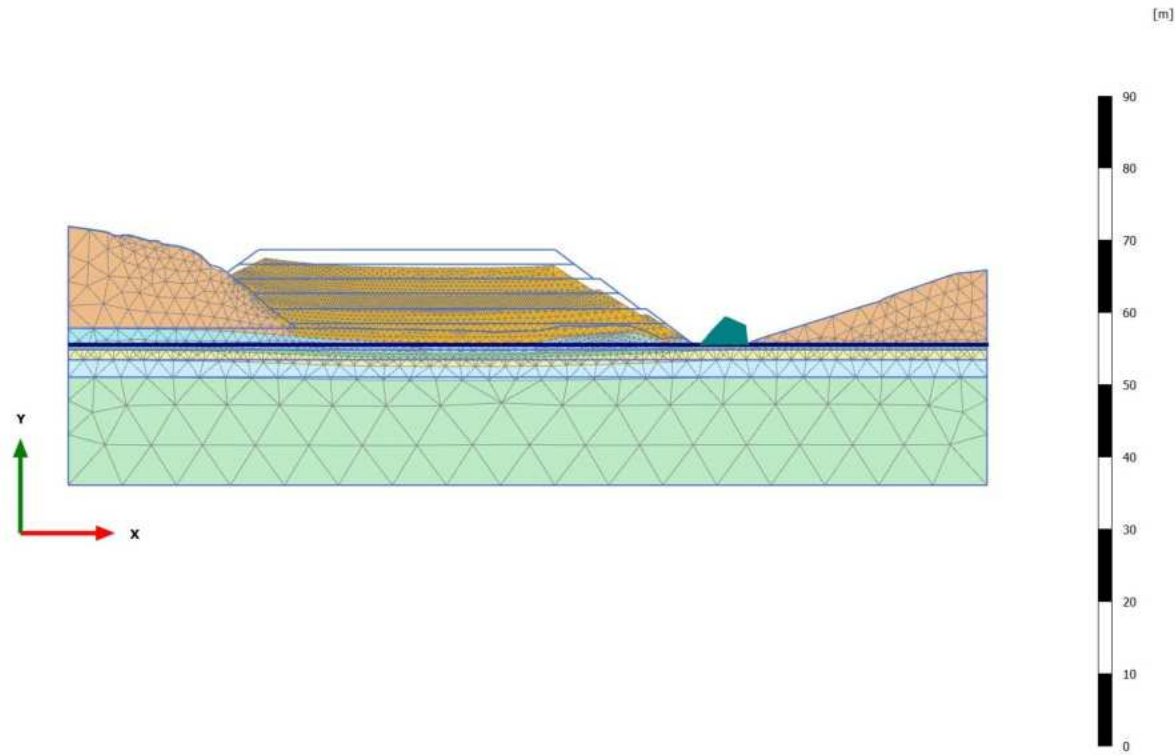
**Deformed mesh |u| (scaled up 50,0 times)**  
Maximum value = 0,5206 m (Element 4985 at Node 39746)

2.1.2.3 Calculation results, Phase\_2 [Phase\_2] (9/30), Deformed mesh |u|



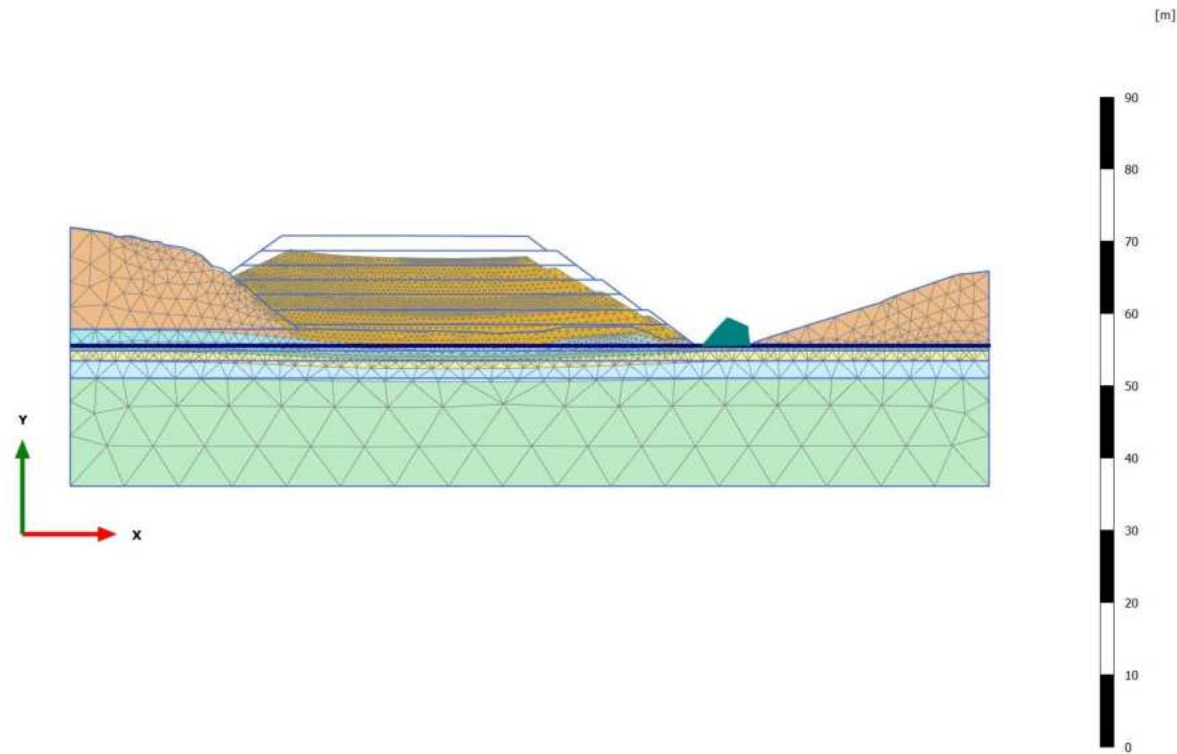
**Deformed mesh |u| (scaled up 10,0 times)**  
Maximum value = 1,442 m (Element 4012 at Node 39775)

2.1.2.4 Calculation results, Phase\_3 [Phase\_3] (10/35), Deformed mesh |u|



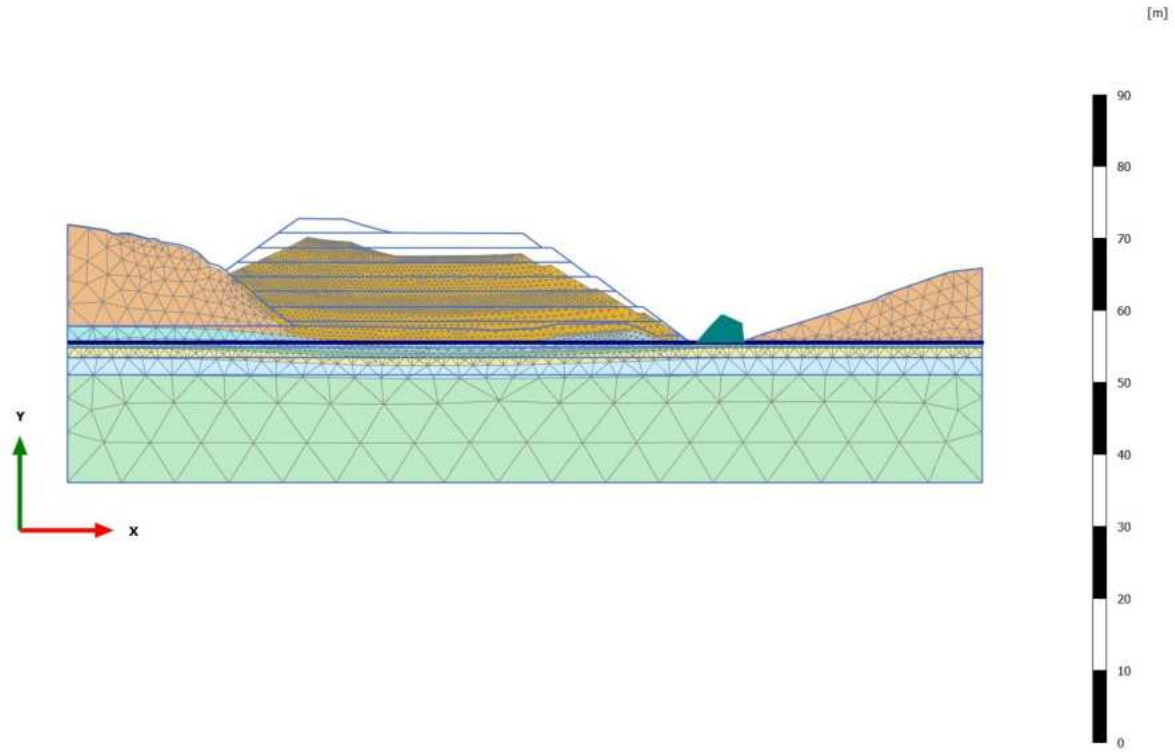
**Deformed mesh |u| (scaled up 5,00 times)**  
Maximum value = 2,521 m (Element 1902 at Node 35068)

2.1.2.5 Calculation results, Phase\_4 [Phase\_4] (11/38), Deformed mesh |u|



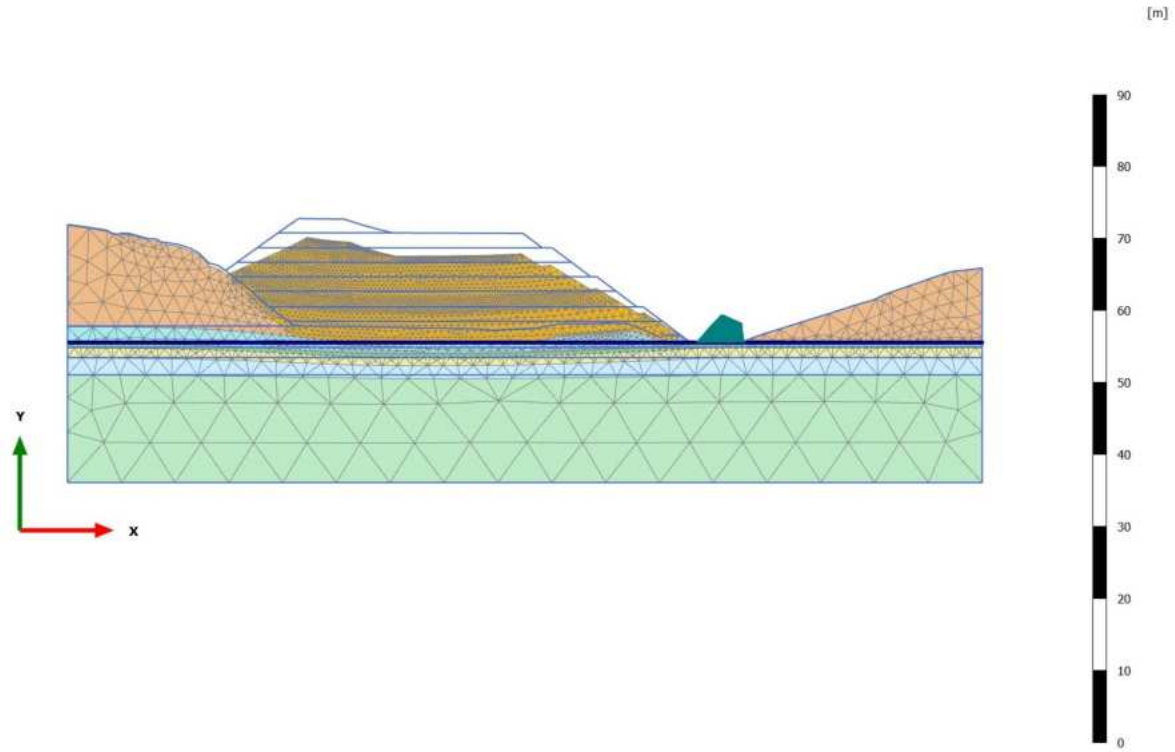
**Deformed mesh |u| (scaled up 5,00 times)**  
Maximum value = 3,122 m (Element 1053 at Node 27970)

2.1.2.6 Calculation results, Phase\_5\_static [Phase\_5] (12/41), Deformed mesh |u|



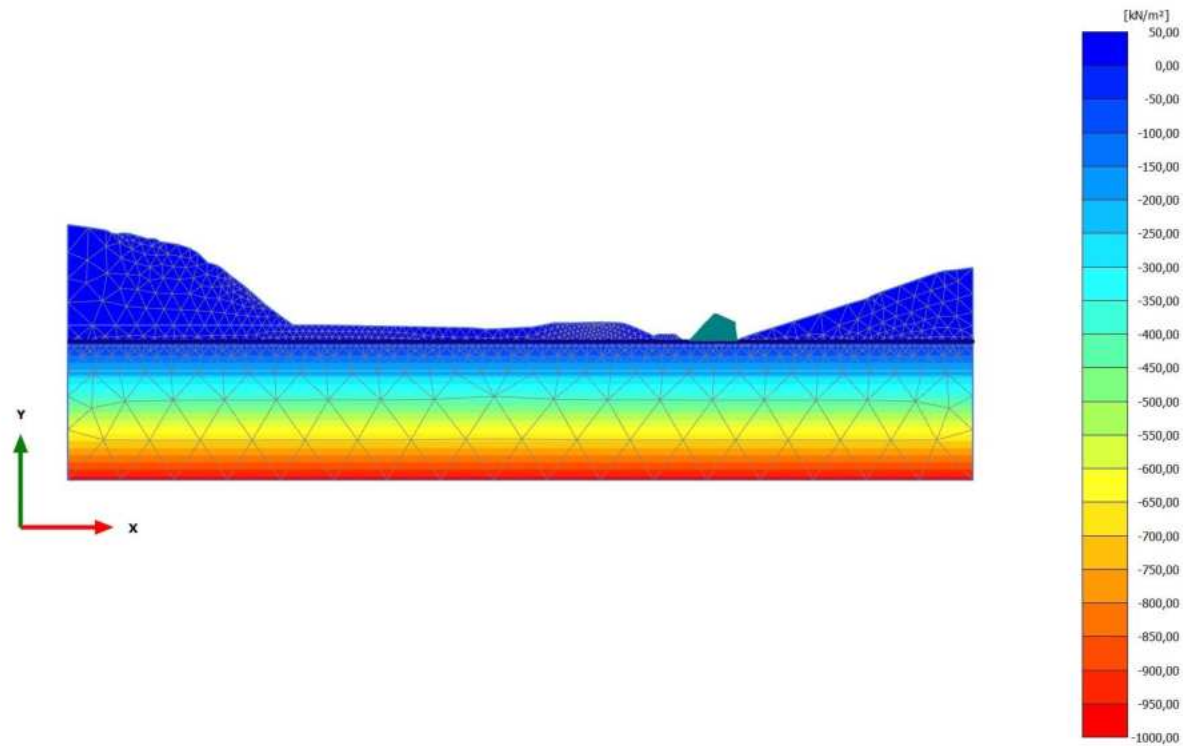
**Deformed mesh |u| (scaled up 5,00 times)**  
Maximum value = 3,291 m (Element 233 at Node 5509)

2.1.2.7 Calculation results, Phase\_8\_seismic [Phase\_8] (2/44), Deformed mesh |u|



**Deformed mesh |u| (scaled up 5,00 times)**  
Maximum value = 3,301 m (Element 166 at Node 5515)

2.2.1.1.1 Calculation results, Initial phase [InitialPhase] (0/17), Steady state pore pressures  $p_{\text{steady}}$

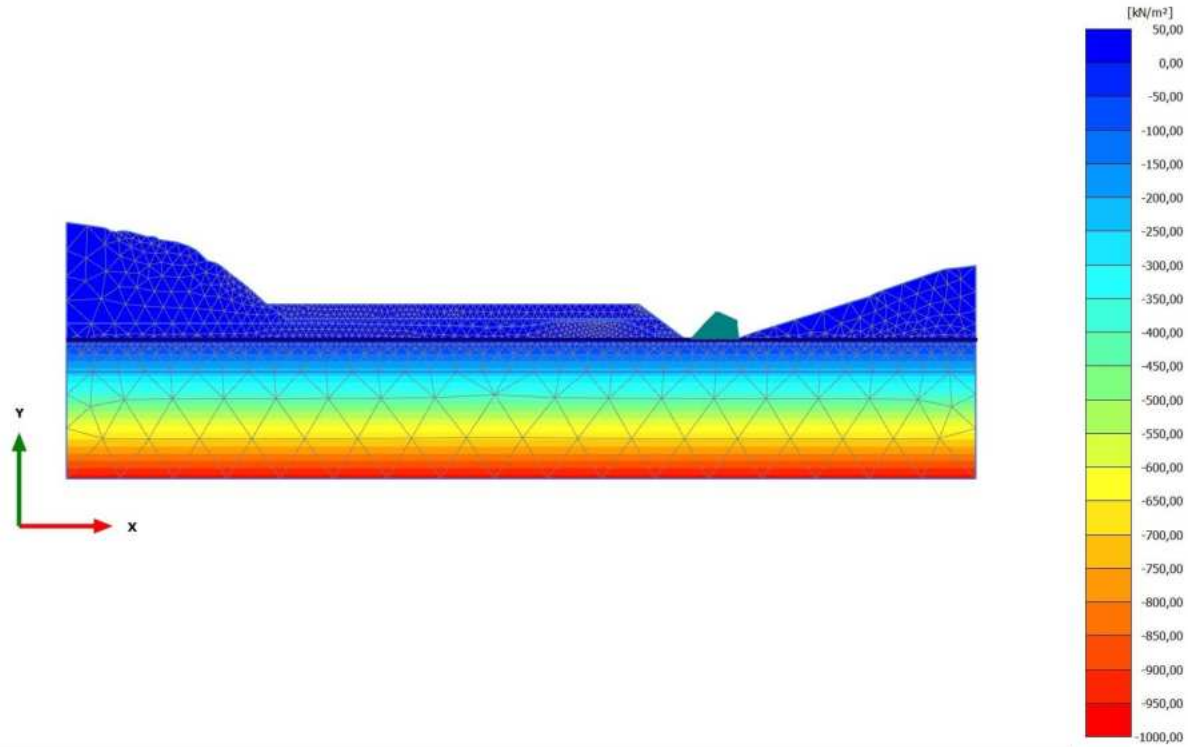


**Steady state pore pressures  $p_{\text{steady}}$  (scaled up 0,0200 times) (Pressure = negative)**

Maximum value = 0,000 kN/m<sup>2</sup> (Element 4218 at Node 21860)

Minimum value = -972,7 kN/m<sup>2</sup> (Element 6870 at Node 30709)

2.2.1.1.2 Calculation results, Phase\_1 [Phase\_1] (8/24), Steady state pore pressures  $p_{steady}$



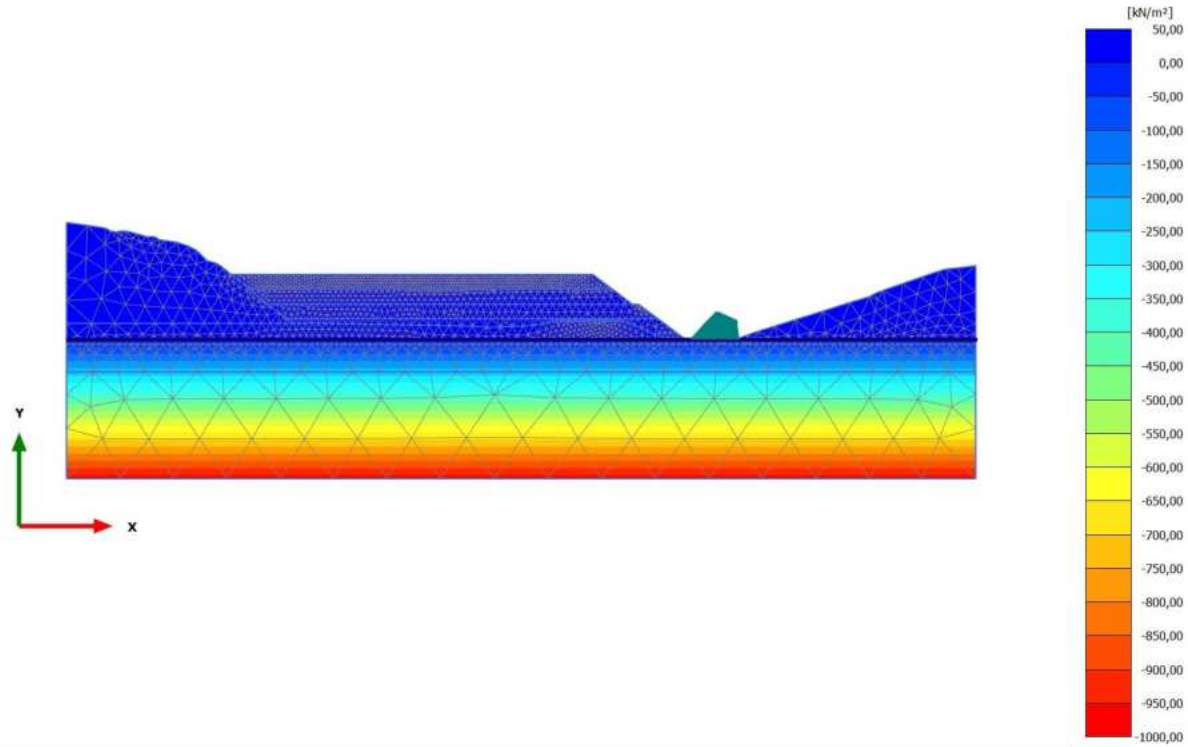
**Steady state pore pressures  $p_{steady}$  (scaled up 0,0200 times) (Pressure = negative)**

Maximum value = 0,000  $\text{kN/m}^2$  (Element 4218 at Node 21860)

Minimum value = -972,7  $\text{kN/m}^2$  (Element 6870 at Node 30709)



2.2.1.1.3 Calculation results, Phase\_2 [Phase\_2] (9/30), Steady state pore pressures  $p_{steady}$

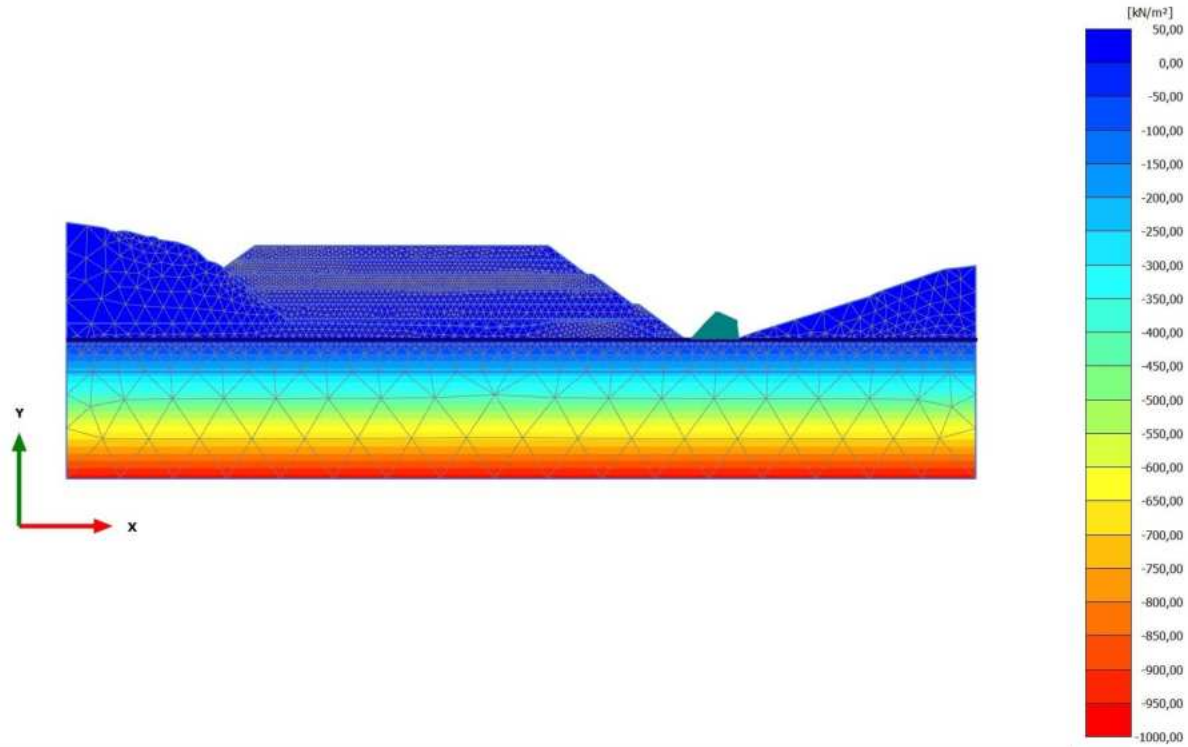


**Steady state pore pressures  $p_{steady}$  (scaled up 0,0200 times) (Pressure = negative)**

Maximum value = 0,000 kN/m<sup>2</sup> (Element 3072 at Node 20318)

Minimum value = -972,7 kN/m<sup>2</sup> (Element 6870 at Node 30709)

2.2.1.1.4 Calculation results, Phase\_3 [Phase\_3] (10/35), Steady state pore pressures  $p_{steady}$

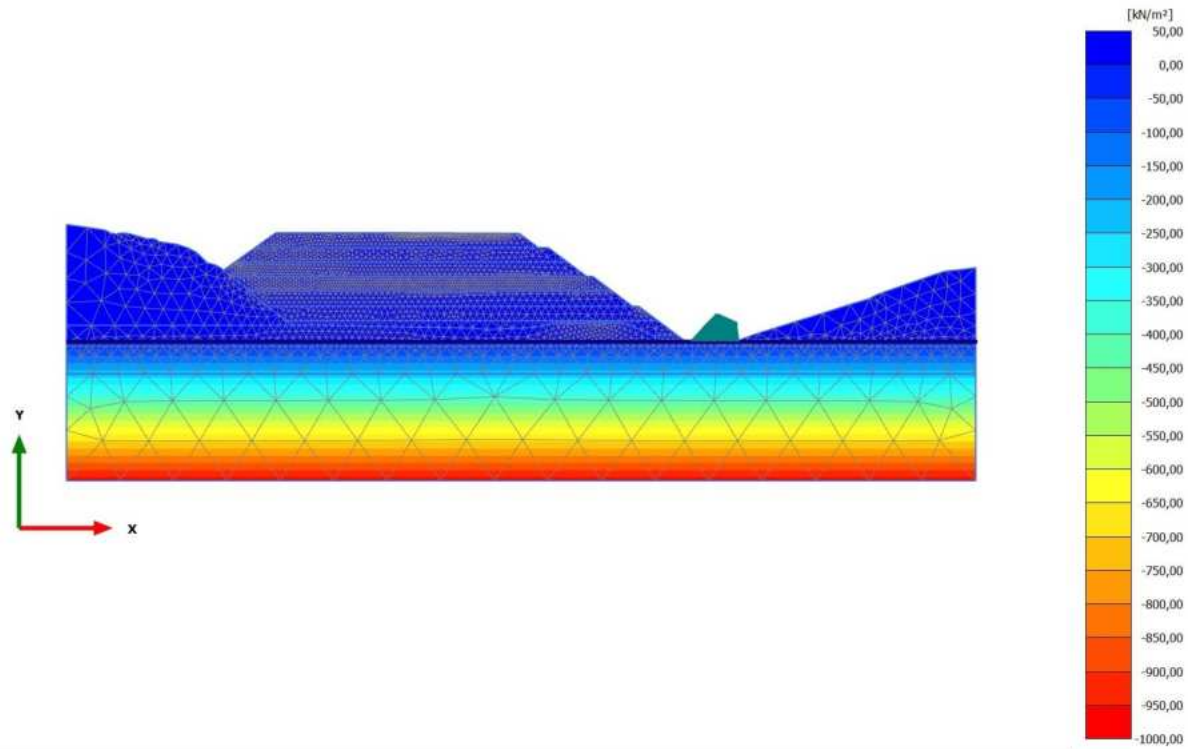


**Steady state pore pressures  $p_{steady}$  (scaled up 0,0200 times) (Pressure = negative)**

Maximum value = 0,000 kN/m<sup>2</sup> (Element 1779 at Node 55572)

Minimum value = -972,7 kN/m<sup>2</sup> (Element 6870 at Node 30709)

2.2.1.1.5 Calculation results, Phase\_4 [Phase\_4] (11/38), Steady state pore pressures  $p_{steady}$

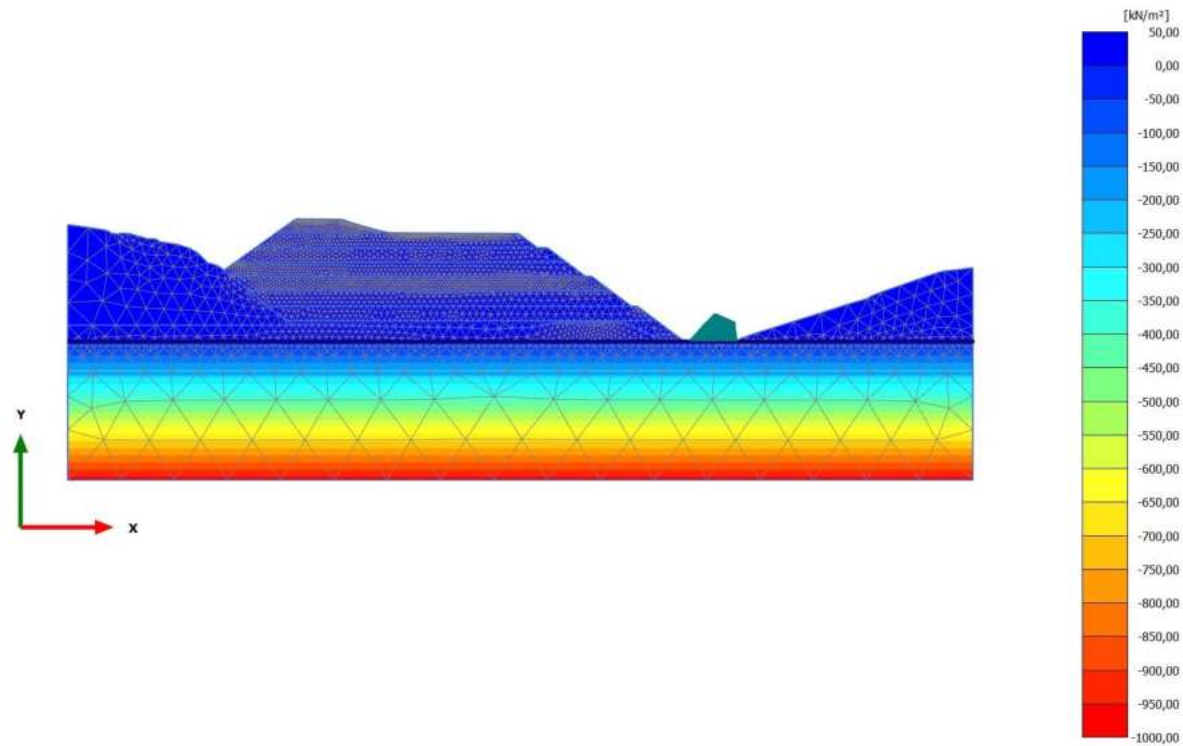


**Steady state pore pressures  $p_{steady}$  (scaled up 0,0200 times) (Pressure = negative)**

Maximum value = 0,000 kN/m<sup>2</sup> (Element 638 at Node 54386)

Minimum value = -972,7 kN/m<sup>2</sup> (Element 6870 at Node 30709)

2.2.1.1.6 Calculation results, Phase\_5\_static [Phase\_5] (12/41), Steady state pore pressures  $p_{\text{steady}}$

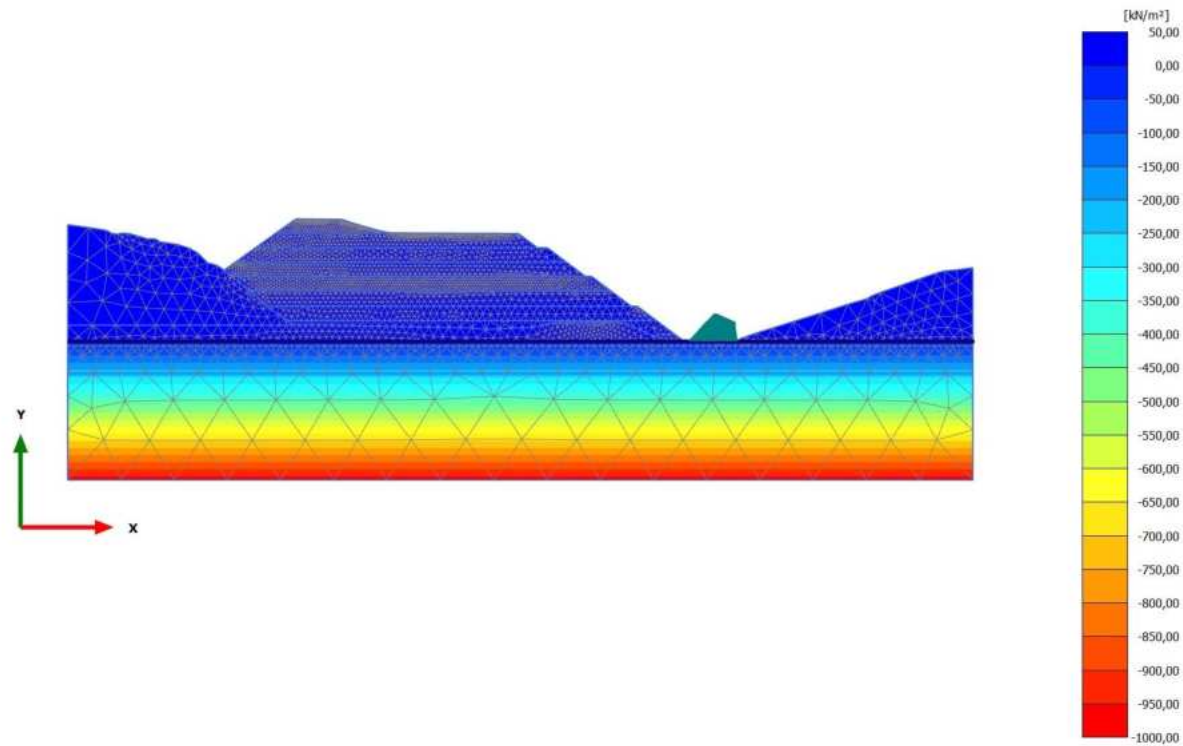


**Steady state pore pressures  $p_{\text{steady}}$  (scaled up 0,0200 times) (Pressure = negative)**

Maximum value = 0,000 kN/m<sup>2</sup> (Element 1 at Node 2873)

Minimum value = -972,7 kN/m<sup>2</sup> (Element 6870 at Node 30709)

2.2.1.1.7 Calculation results, Phase\_8\_seismic [Phase\_8] (2/44), Steady state pore pressures  $p_{\text{steady}}$

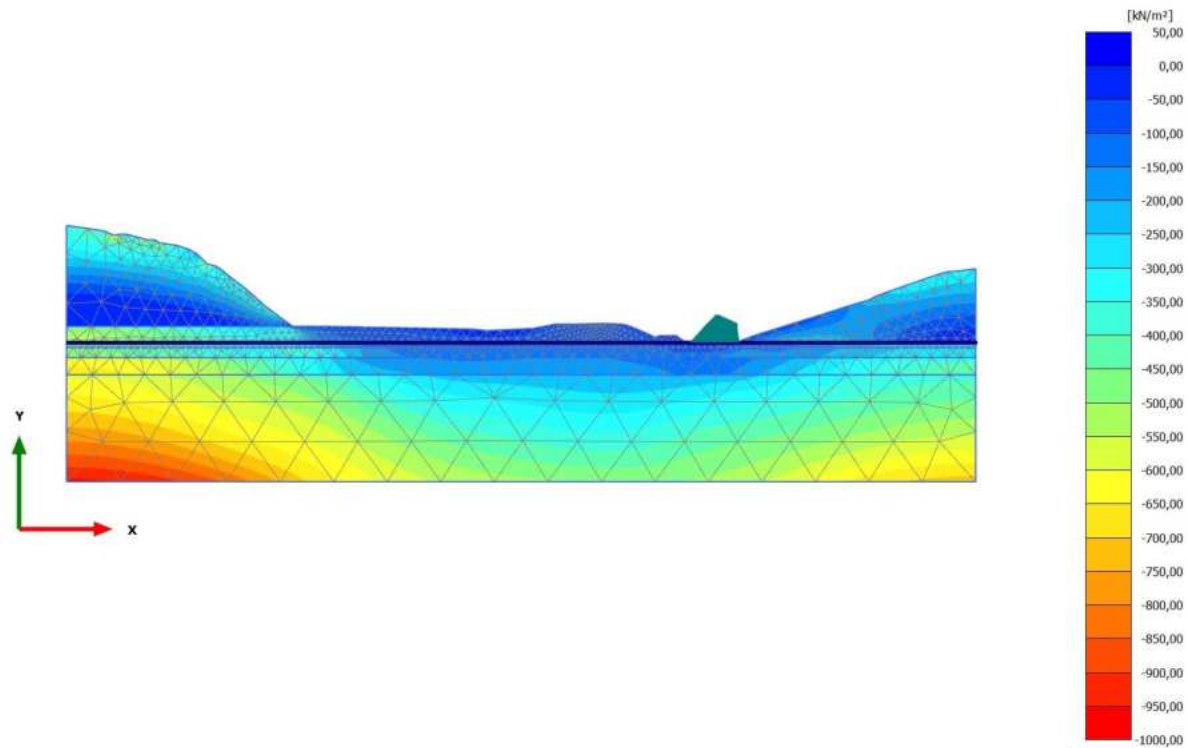


**Steady state pore pressures  $p_{\text{steady}}$  (scaled up 0,0200 times) (Pressure = negative)**

Maximum value = 0,000 kN/m<sup>2</sup> (Element 1 at Node 2873)

Minimum value = -975,6 kN/m<sup>2</sup> (Element 6870 at Node 30709)

2.2.2.1.1 Calculation results, Initial phase [InitialPhase] (0/17), Cartesian effective stress  $\sigma'_{xx}$

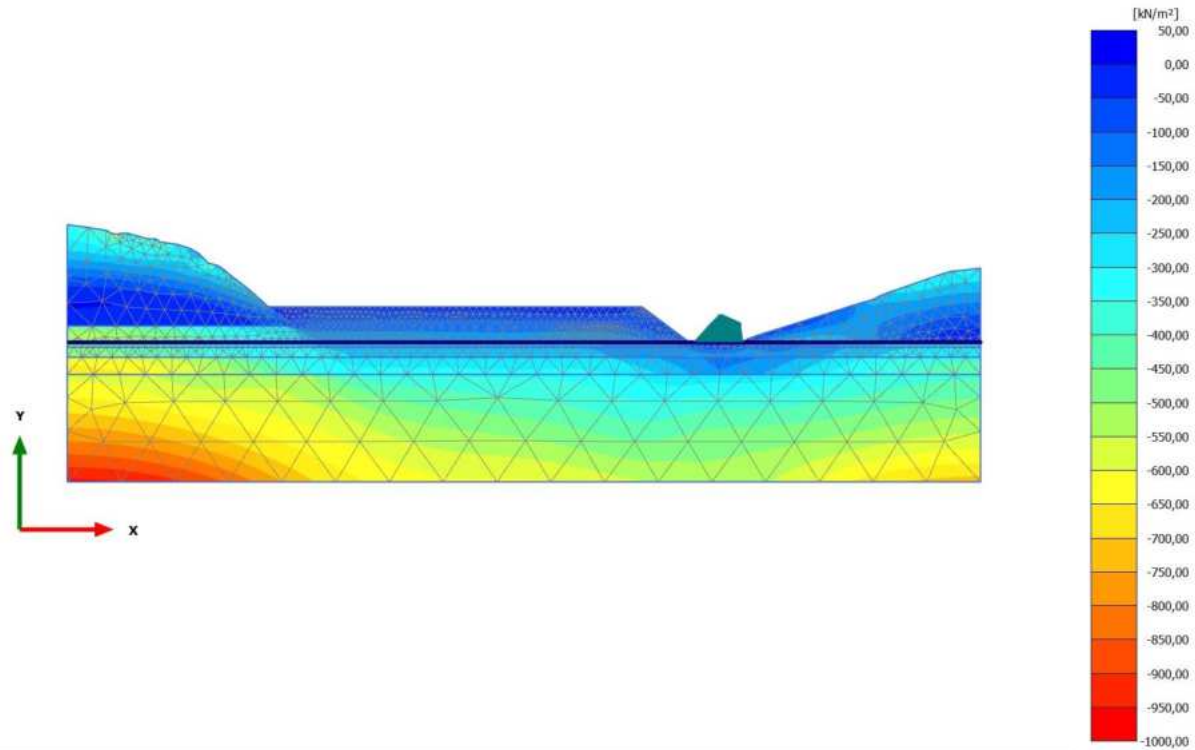


**Cartesian effective stress  $\sigma'_{xx}$  (scaled up 0,0200 times)**

Maximum value = 6,521 kN/m<sup>2</sup> (Element 6490 at Node 43438)

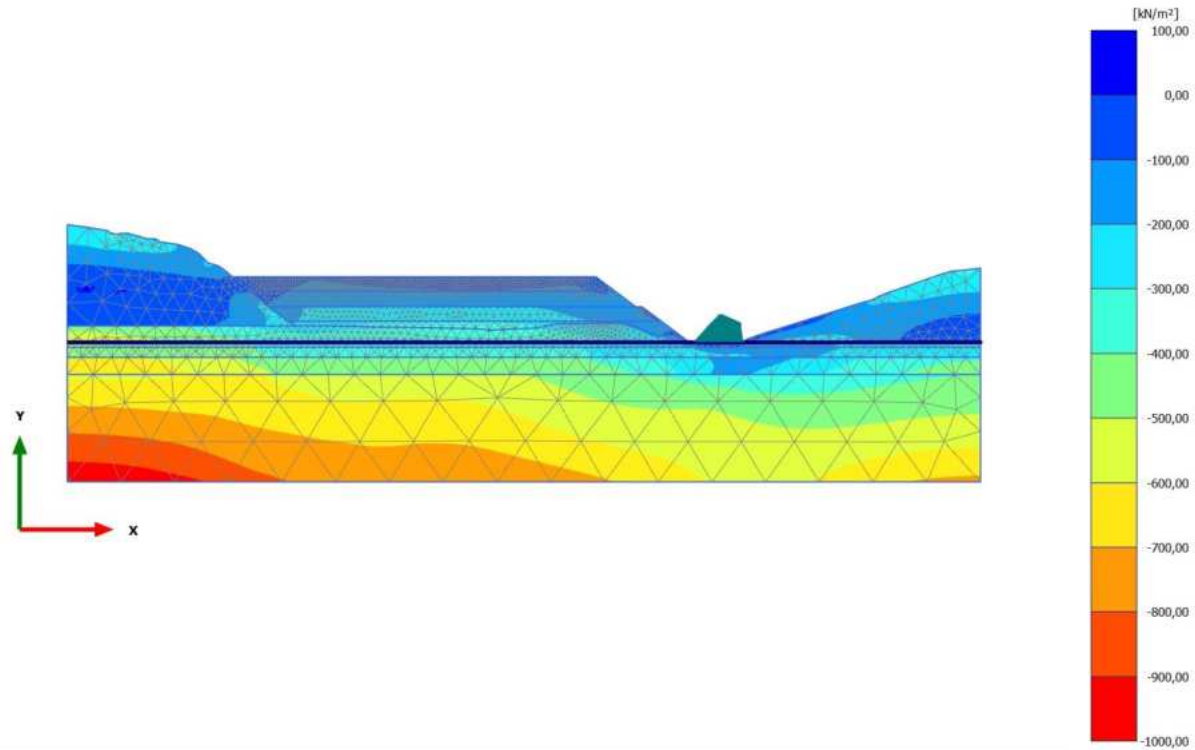
Minimum value = -963,5 kN/m<sup>2</sup> (Element 4323 at Node 21496)

2.2.2.1.2 Calculation results, Phase\_1 [Phase\_1] (8/24), Cartesian effective stress  $\sigma'_{xx}$



**Cartesian effective stress  $\sigma'_{xx}$  (scaled up 0,0200 times)**  
Maximum value = 10,84 kN/m<sup>2</sup> (Element 4323 at Node 21396)  
Minimum value = -962,1 kN/m<sup>2</sup> (Element 6870 at Node 30709)

2.2.2.1.3 Calculation results, Phase\_2 [Phase\_2] (9/30), Cartesian effective stress  $\sigma'_{xx}$



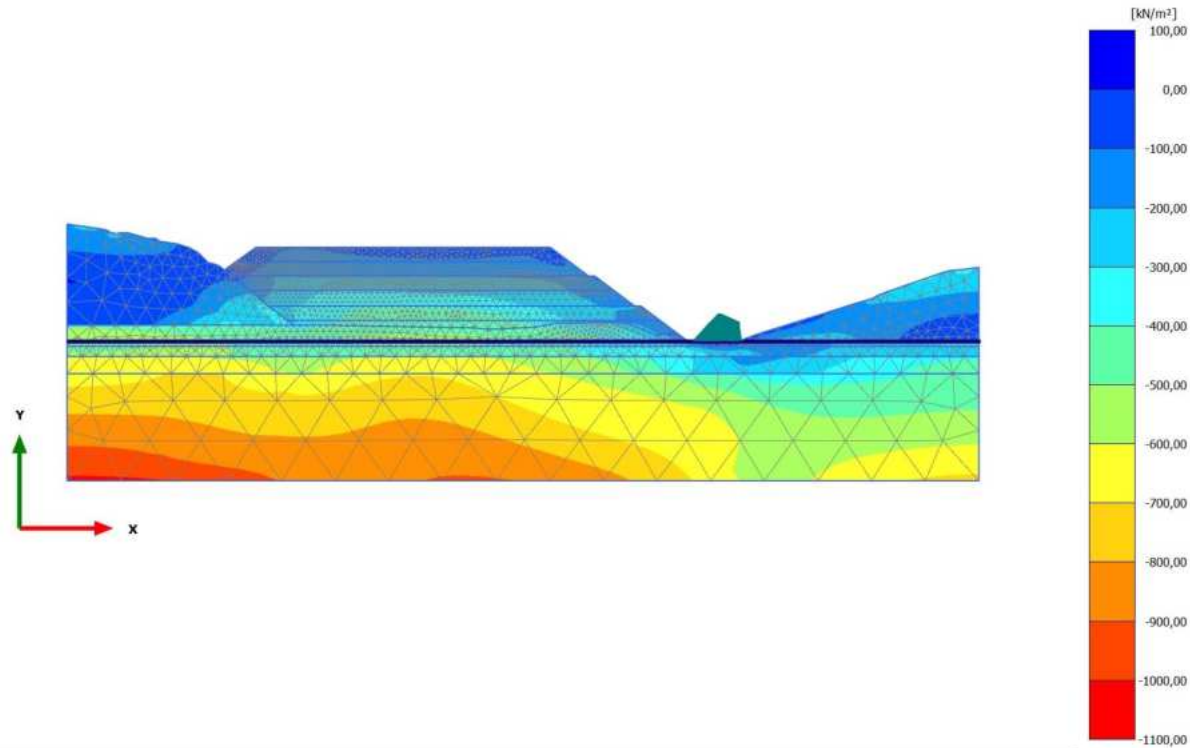
**Cartesian effective stress  $\sigma'_{xx}$  (scaled up 0,0200 times)**

Maximum value = 41,73 kN/m<sup>2</sup> (Element 4323 at Node 21396)

Minimum value = -972,0 kN/m<sup>2</sup> (Element 6870 at Node 30709)

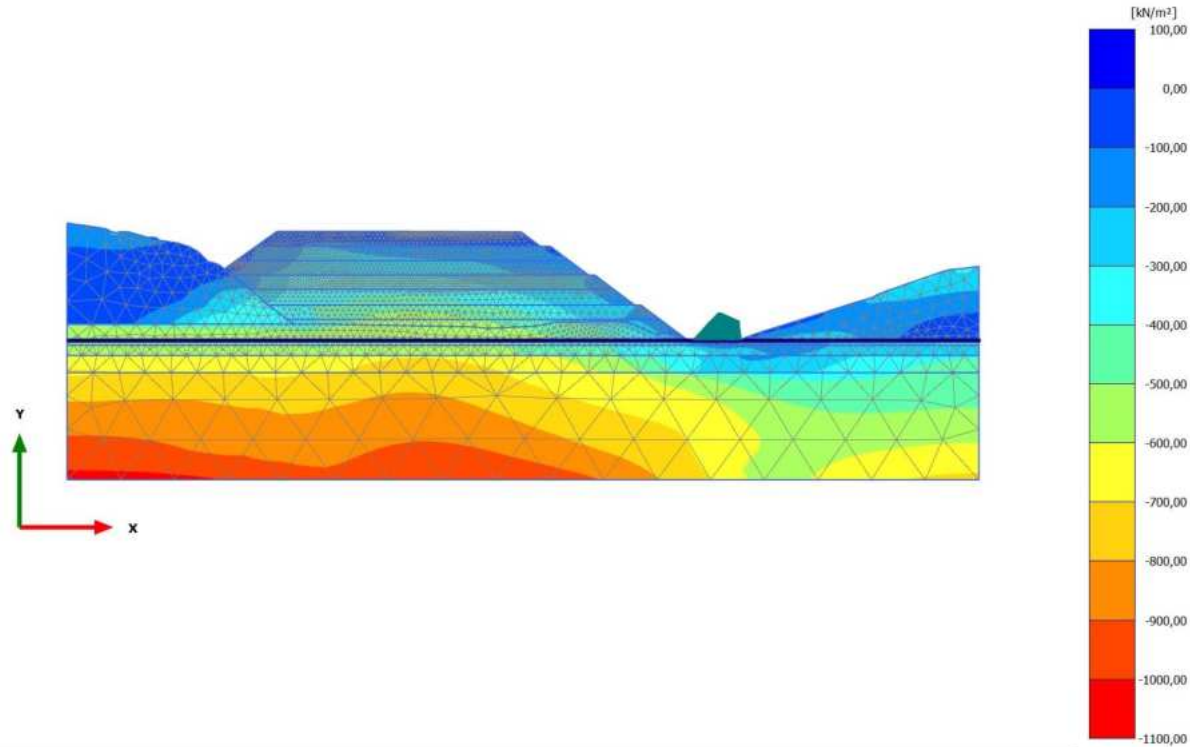


2.2.2.1.4 Calculation results, Phase\_3 [Phase\_3] (10/35), Cartesian effective stress  $\sigma'_{xx}$



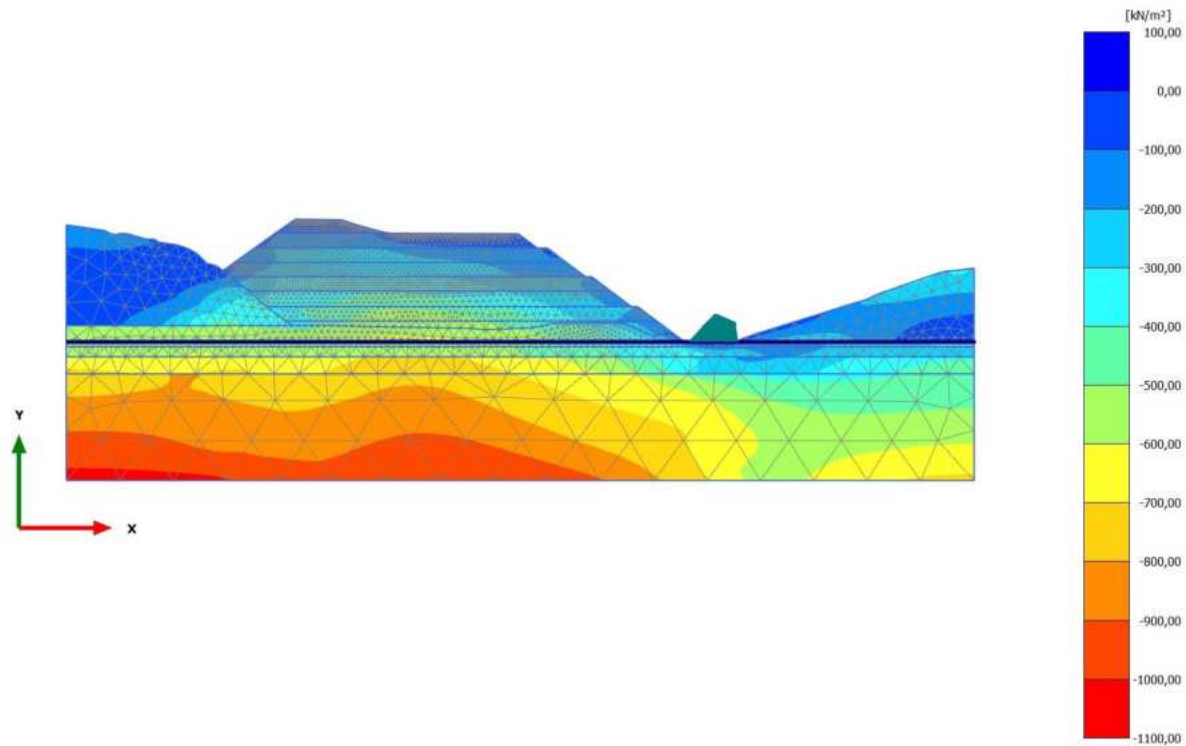
**Cartesian effective stress  $\sigma'_{xx}$  (scaled up 0,0200 times)**  
Maximum value = 64,89 kN/m<sup>2</sup> (Element 4323 at Node 21396)  
Minimum value = -1024 kN/m<sup>2</sup> (Element 6870 at Node 30713)

2.2.2.1.5 Calculation results, Phase\_4 [Phase\_4] (11/38), Cartesian effective stress  $\sigma'_{xx}$



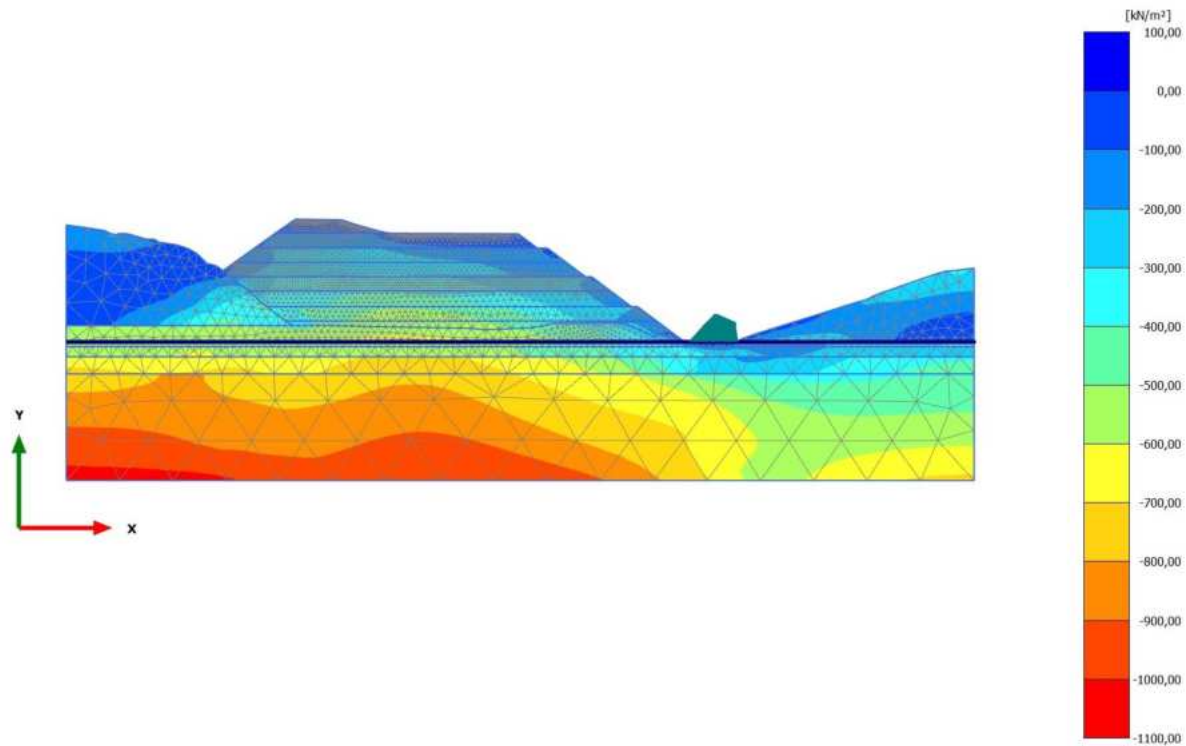
**Cartesian effective stress  $\sigma'_{xx}$  (scaled up 0,0200 times)**  
Maximum value = 51,68 kN/m<sup>2</sup> (Element 4323 at Node 21396)  
Minimum value = -1047 kN/m<sup>2</sup> (Element 6870 at Node 30713)

2.2.2.1.6 Calculation results, Phase\_5\_static [Phase\_5] (12/41), Cartesian effective stress  $\sigma'_{xx}$



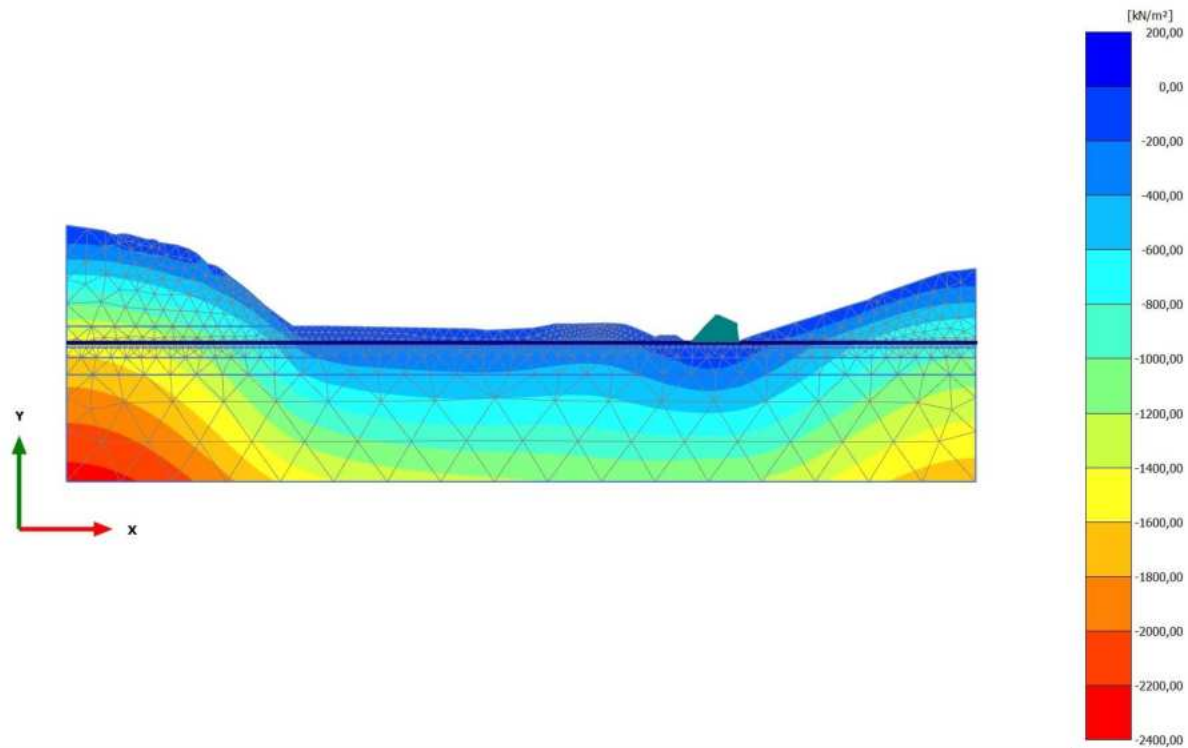
**Cartesian effective stress  $\sigma'_{xx}$  (scaled up 0,0200 times)**  
Maximum value = 46,60 kN/m<sup>2</sup> (Element 4323 at Node 21396)  
Minimum value = -1059 kN/m<sup>2</sup> (Element 6870 at Node 30713)

2.2.2.1.7 Calculation results, Phase\_8\_seismic [Phase\_8] (2/44), Cartesian effective stress  $\sigma'_{xx}$



**Cartesian effective stress  $\sigma'_{xx}$  (scaled up 0,0200 times)**  
Maximum value = 46,07 kN/m<sup>2</sup> (Element 4323 at Node 21396)  
Minimum value = -1067 kN/m<sup>2</sup> (Element 6870 at Node 30709)

2.2.2.2.1 Calculation results, Initial phase [InitialPhase] (0/17), Cartesian effective stress  $\sigma'_{yy}$

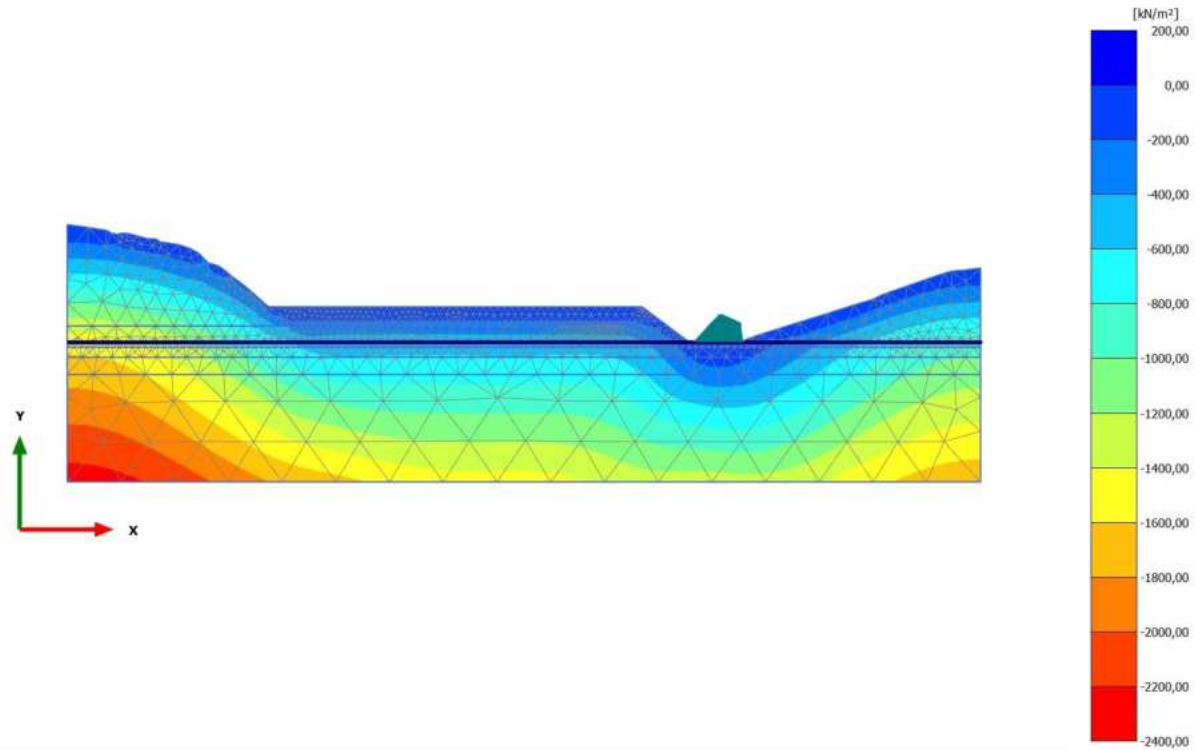


**Cartesian effective stress  $\sigma'_{yy}$  (scaled up  $5,00 \cdot 10^{-3}$  times)**

Maximum value = 8,107 kN/m<sup>2</sup> (Element 4219 at Node 21667)

Minimum value = -2296 kN/m<sup>2</sup> (Element 6870 at Node 30709)

2.2.2.2.2 Calculation results, Phase\_1 [Phase\_1] (8/24), Cartesian effective stress  $\sigma'_{yy}$

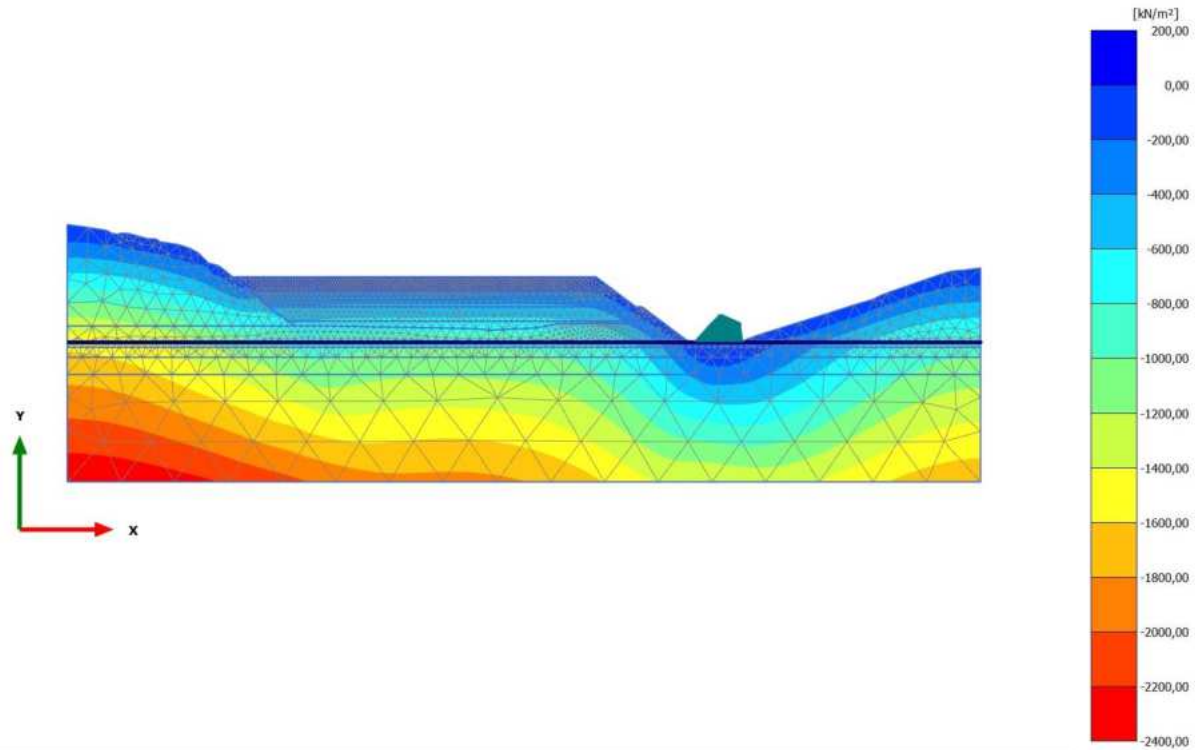


**Cartesian effective stress  $\sigma'_{yy}$  (scaled up  $5,00 \cdot 10^{-3}$  times)**

Maximum value = 7,518 kN/m<sup>2</sup> (Element 4219 at Node 21667)

Minimum value = -2294 kN/m<sup>2</sup> (Element 6870 at Node 30709)

2.2.2.2.3 Calculation results, Phase\_2 [Phase\_2] (9/30), Cartesian effective stress  $\sigma'_{yy}$

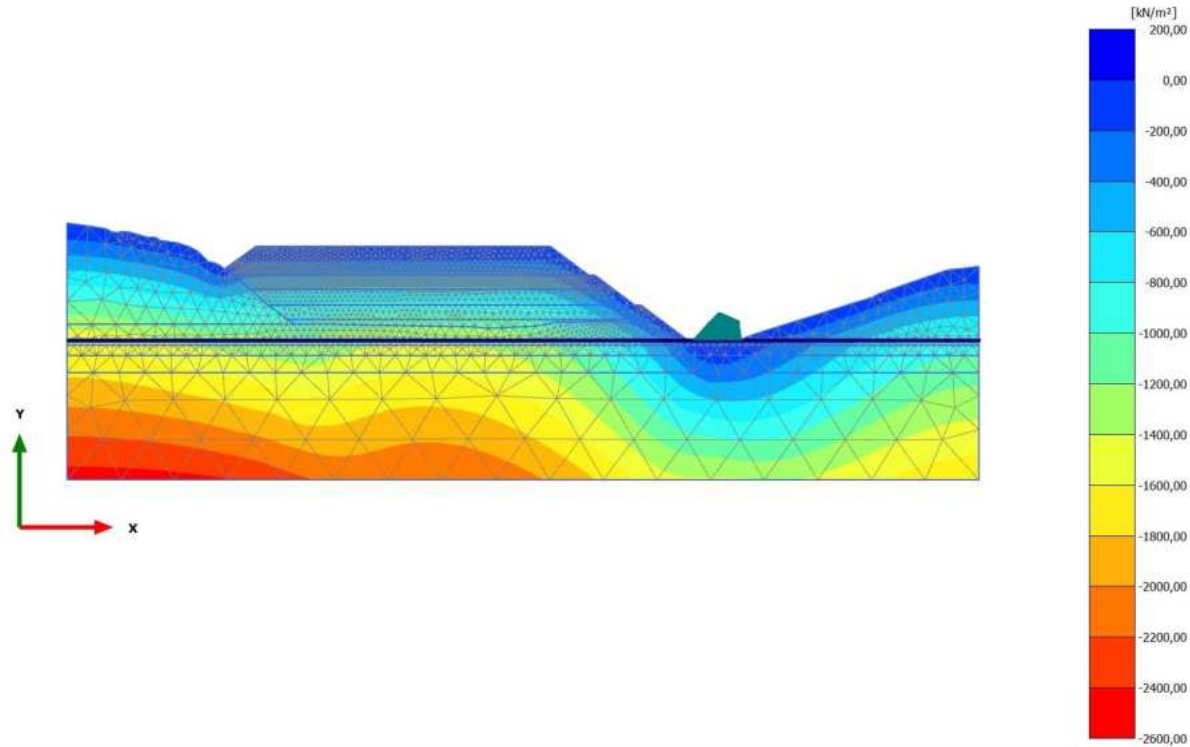


**Cartesian effective stress  $\sigma'_{yy}$  (scaled up  $5,00 \cdot 10^{-3}$  times)**

Maximum value = 6,643 kN/m<sup>2</sup> (Element 5251 at Node 40417)

Minimum value = -2362 kN/m<sup>2</sup> (Element 6870 at Node 30709)

2.2.2.2.4 Calculation results, Phase\_3 [Phase\_3] (10/35), Cartesian effective stress  $\sigma'_{yy}$



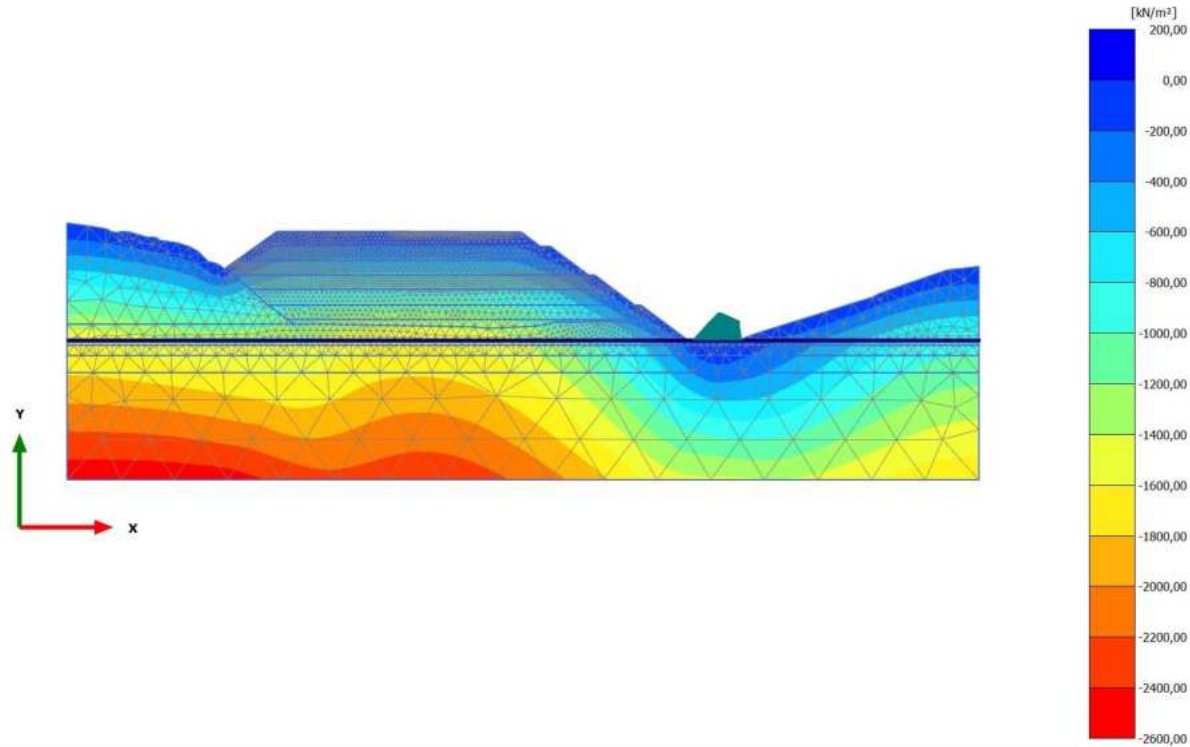
**Cartesian effective stress  $\sigma'_{yy}$  (scaled up  $5,00 \cdot 10^{-3}$  times)**

Maximum value = 6,649 kN/m<sup>2</sup> (Element 5251 at Node 40417)

Minimum value = -2488 kN/m<sup>2</sup> (Element 6870 at Node 30713)



2.2.2.2.5 Calculation results, Phase\_4 [Phase\_4] (11/38), Cartesian effective stress  $\sigma'_{yy}$

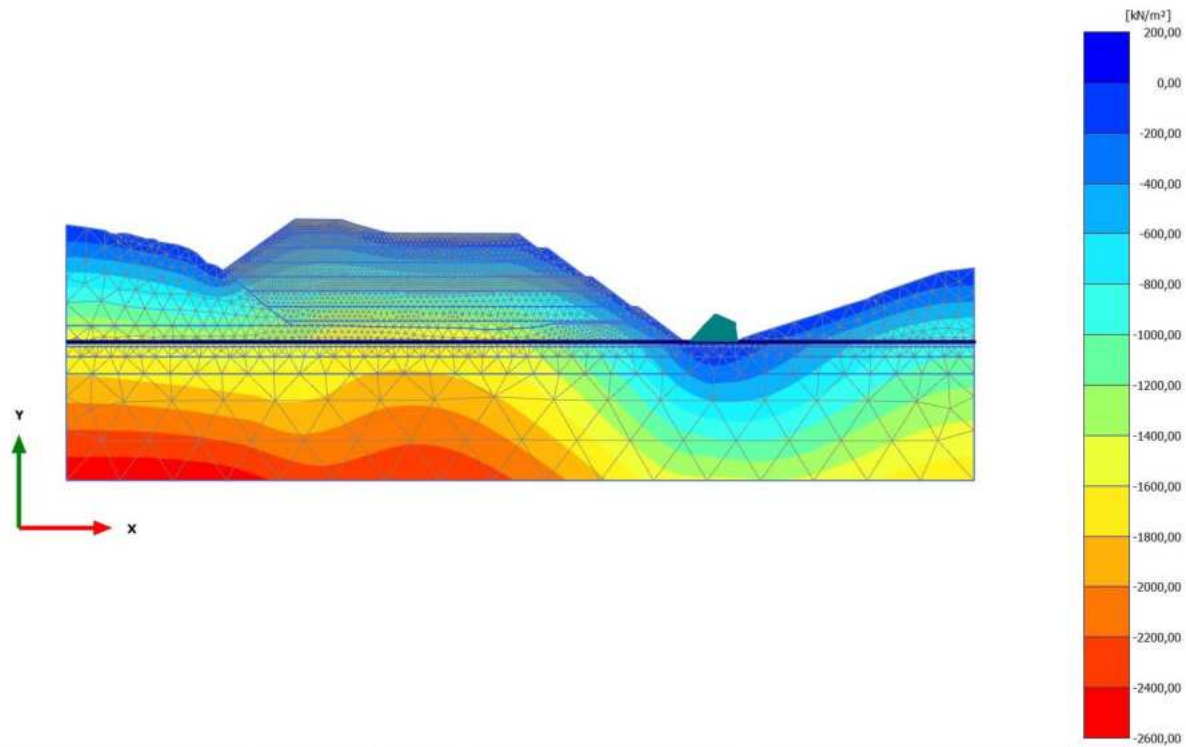


**Cartesian effective stress  $\sigma'_{yy}$  (scaled up  $5,00 \cdot 10^{-3}$  times)**

Maximum value = 6,653 kN/m<sup>2</sup> (Element 5251 at Node 40417)

Minimum value = -2544 kN/m<sup>2</sup> (Element 6855 at Node 32185)

2.2.2.2.6 Calculation results, Phase\_5\_static [Phase\_5] (12/41), Cartesian effective stress  $\sigma'_{yy}$

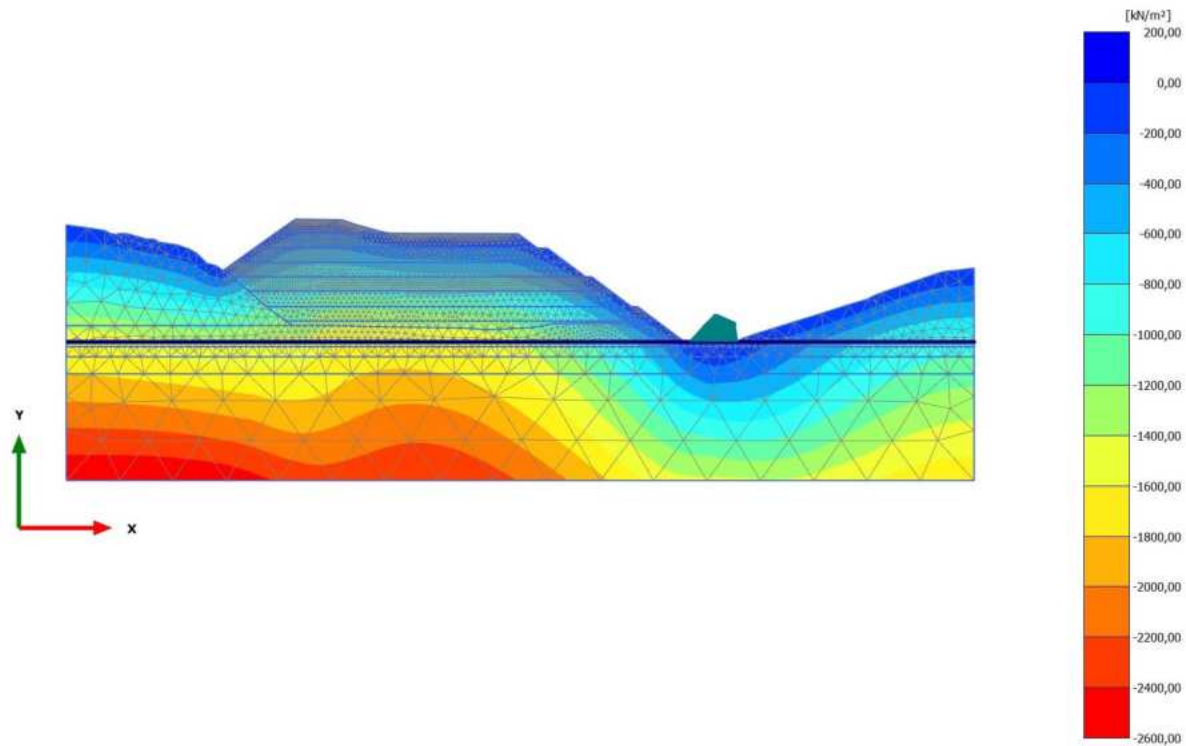


**Cartesian effective stress  $\sigma'_{yy}$  (scaled up  $5,00 \cdot 10^{-3}$  times)**

Maximum value = 6,653 kN/m<sup>2</sup> (Element 5251 at Node 40417)

Minimum value = -2576 kN/m<sup>2</sup> (Element 6855 at Node 32185)

2.2.2.2.7 Calculation results, Phase\_8\_seismic [Phase\_8] (2/44), Cartesian effective stress  $\sigma'_{yy}$

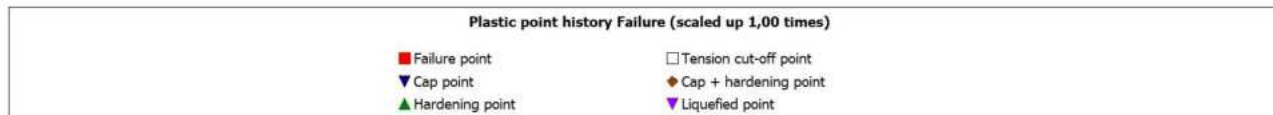
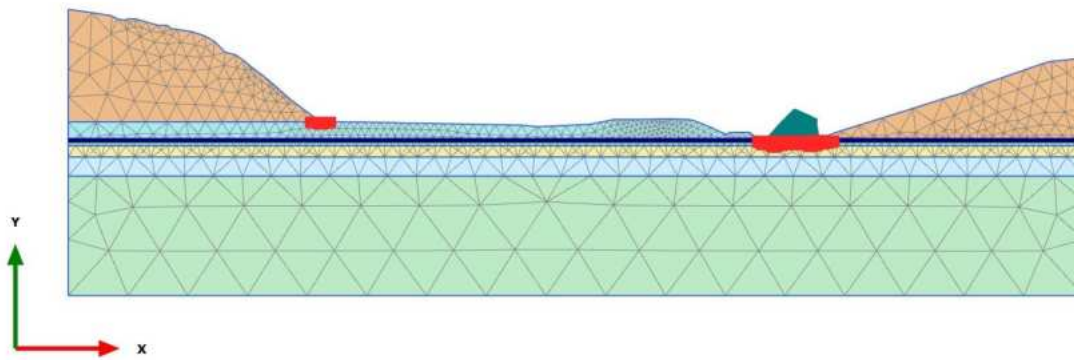


**Cartesian effective stress  $\sigma'_{yy}$  (scaled up  $5,00 \cdot 10^{-3}$  times)**

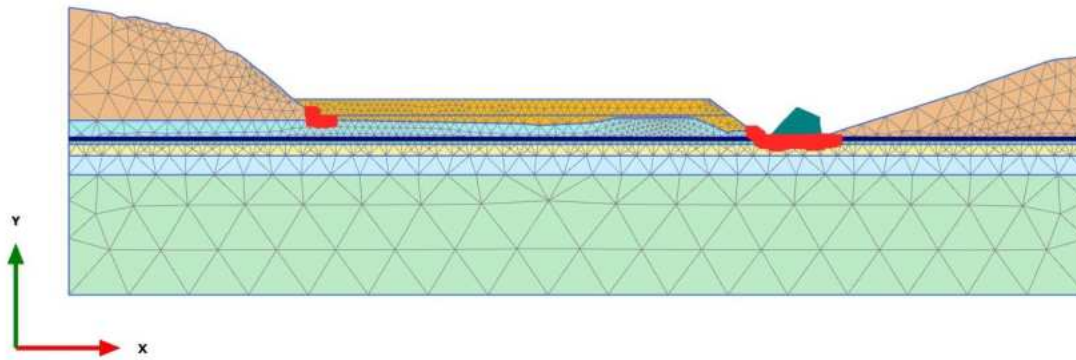
Maximum value = 6,590 kN/m<sup>2</sup> (Element 5251 at Node 40417)

Minimum value = -2594 kN/m<sup>2</sup> (Element 6855 at Node 32185)

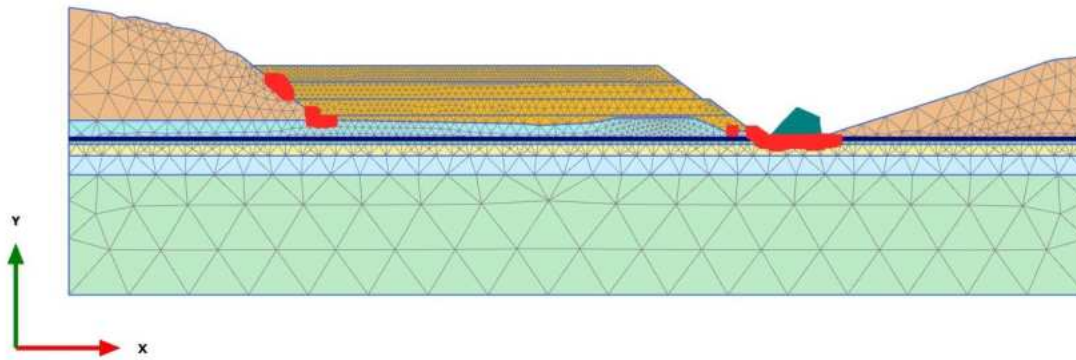
2.2.3.1.1 Calculation results, Initial phase [InitialPhase] (0/17), Plastic point history Failure



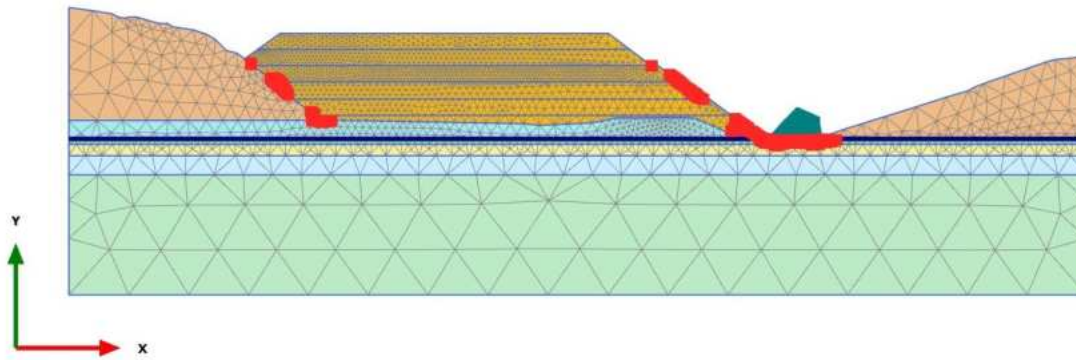
2.2.3.1.2 Calculation results, Phase\_1 [Phase\_1] (8/24), Plastic point history Failure



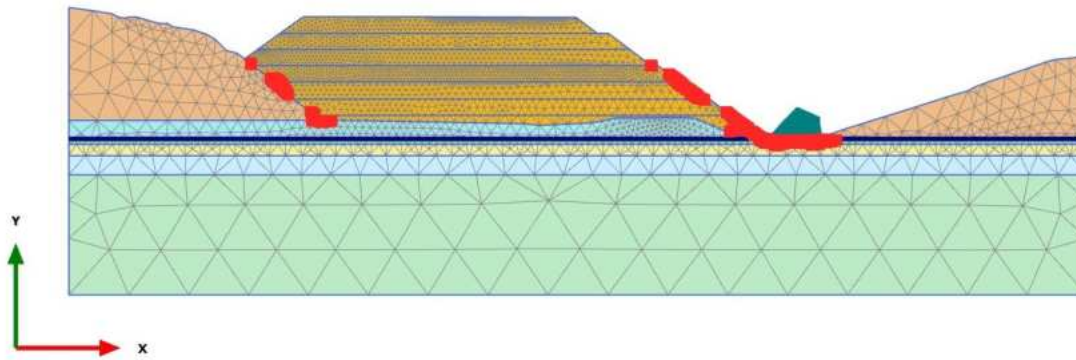
2.2.3.1.3 Calculation results, Phase\_2 [Phase\_2] (9/30), Plastic point history Failure



2.2.3.1.4 Calculation results, Phase\_3 [Phase\_3] (10/35), Plastic point history Failure

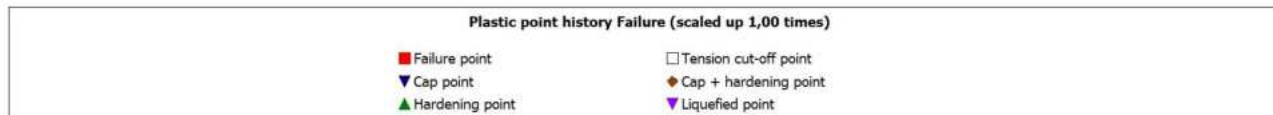
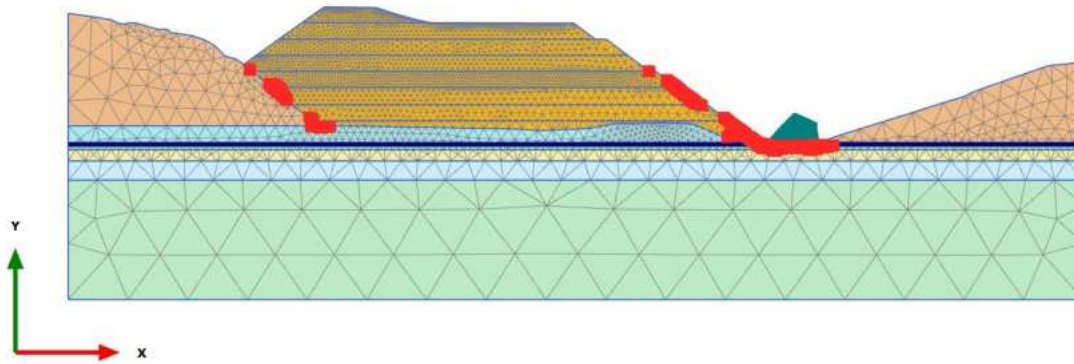


2.2.3.1.5 Calculation results, Phase\_4 [Phase\_4] (11/38), Plastic point history Failure

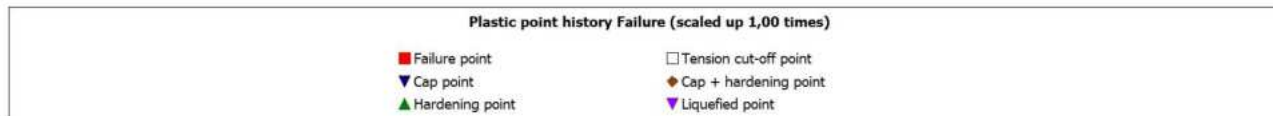
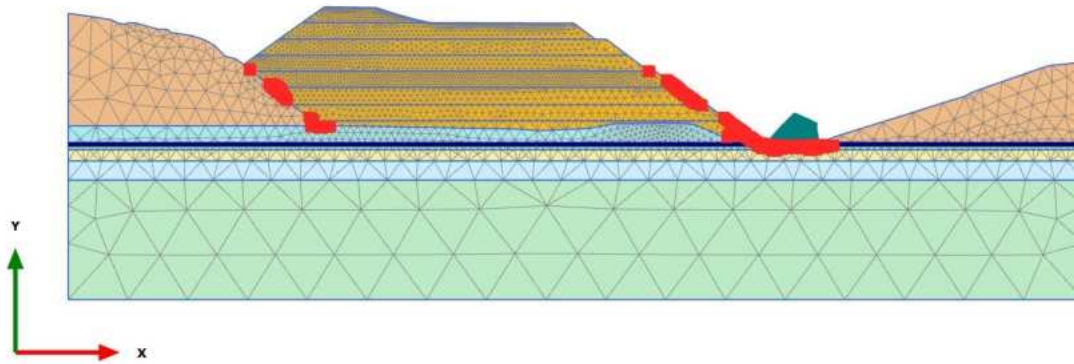




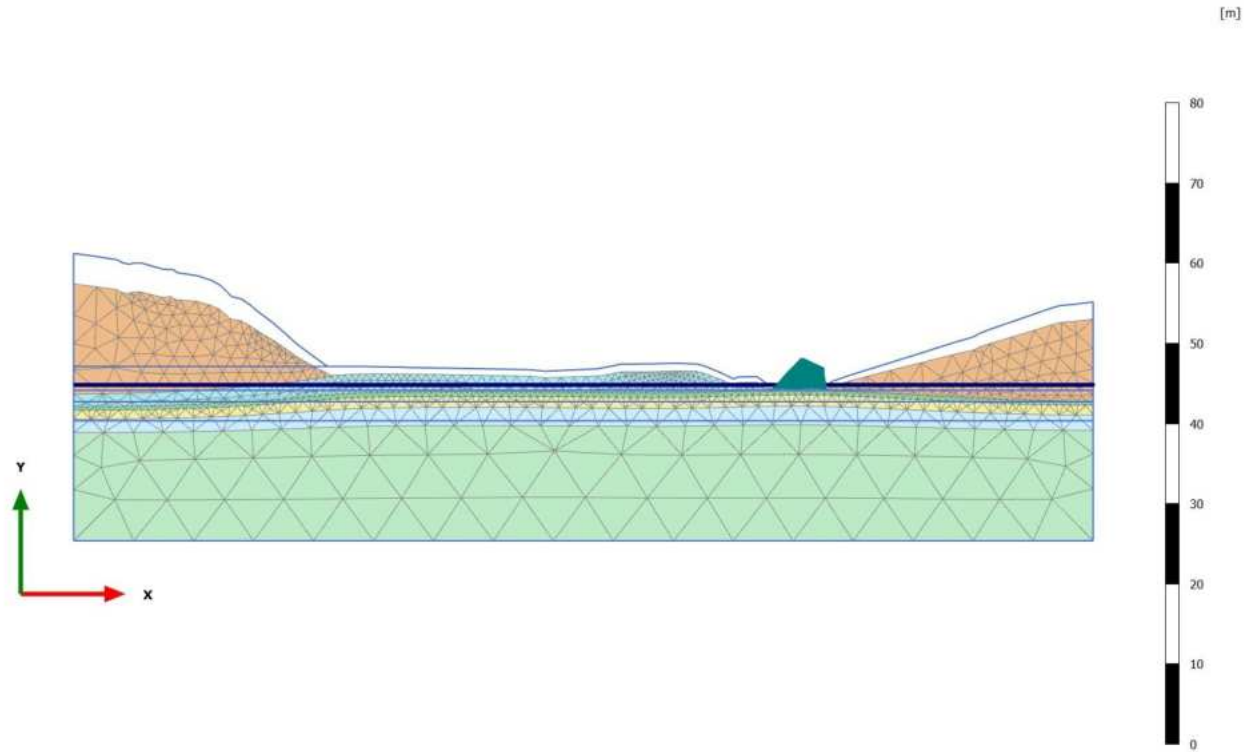
2.2.3.1.6 Calculation results, Phase\_5\_static [Phase\_5] (12/41), Plastic point history Failure



2.2.3.1.7 Calculation results, Phase\_8\_seismic [Phase\_8] (2/44), Plastic point history Failure

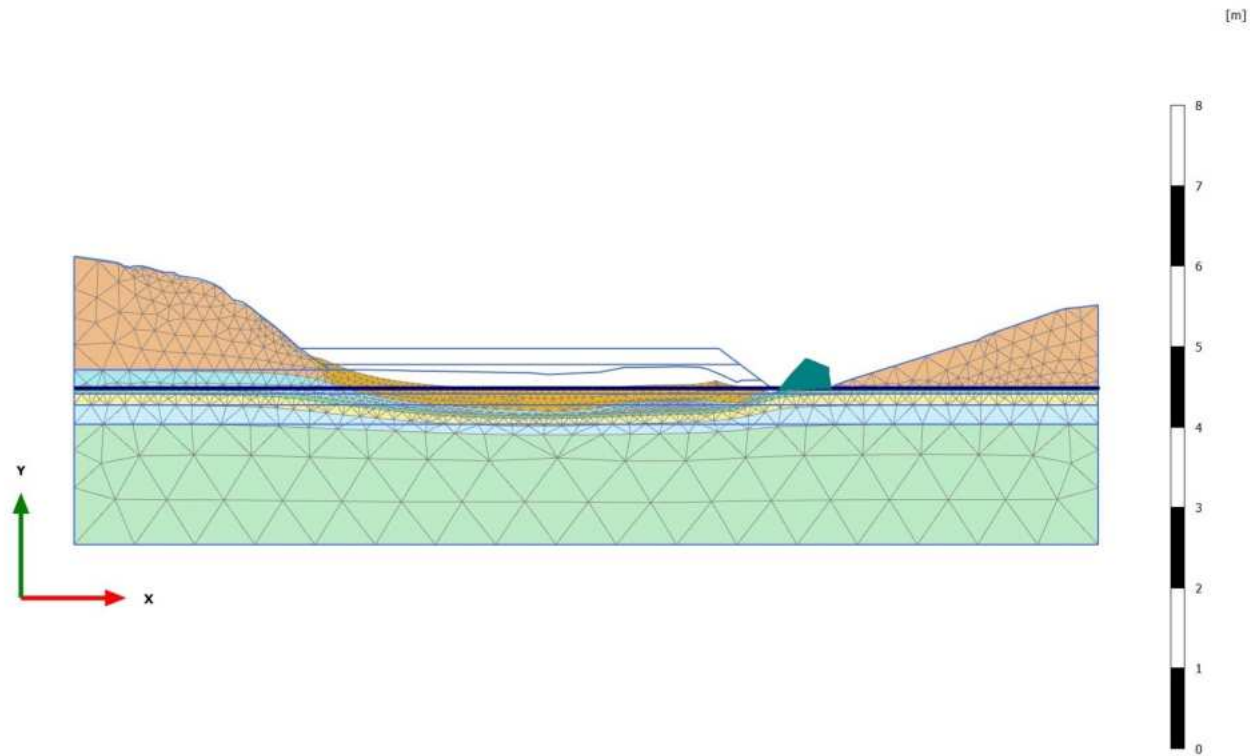


4.1.1 Calculation results, Initial phase [InitialPhase] (0/17), Deformed mesh |u|



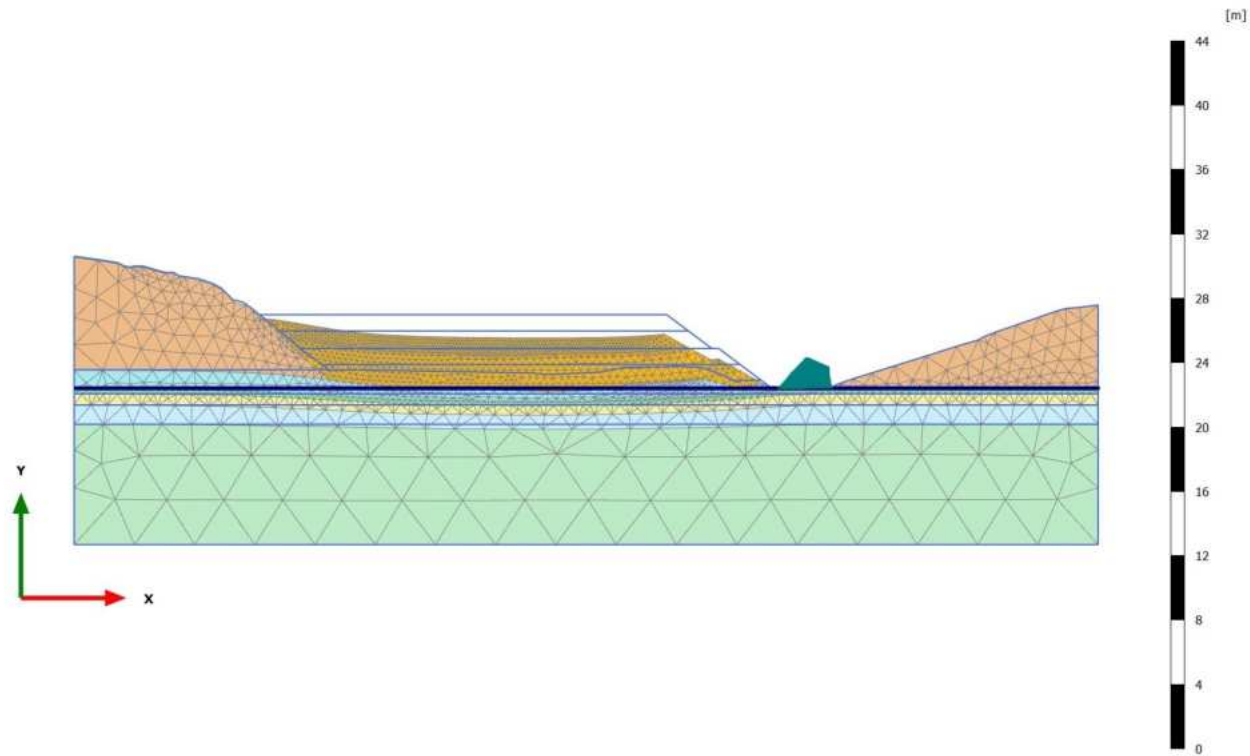
**Deformed mesh |u| (scaled up 5,00 times)**  
Maximum value = 3,792 m (Element 4219 at Node 21669)

4.1.2 Calculation results, Phase\_1 [Phase\_1] (8/24), Deformed mesh |u|



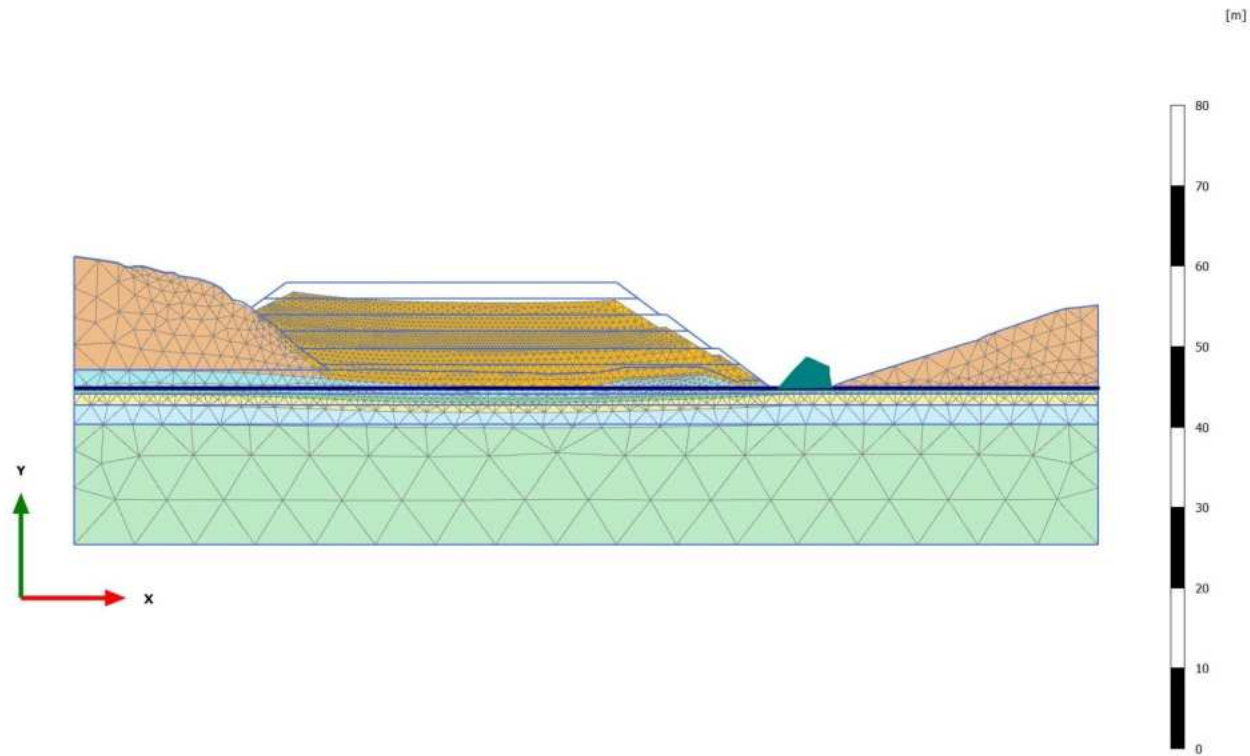
**Deformed mesh |u| (scaled up 50,0 times)**  
Maximum value = 0,5206 m (Element 4985 at Node 39746)

4.1.3 Calculation results, Phase\_2 [Phase\_2] (9/30), Deformed mesh |u|



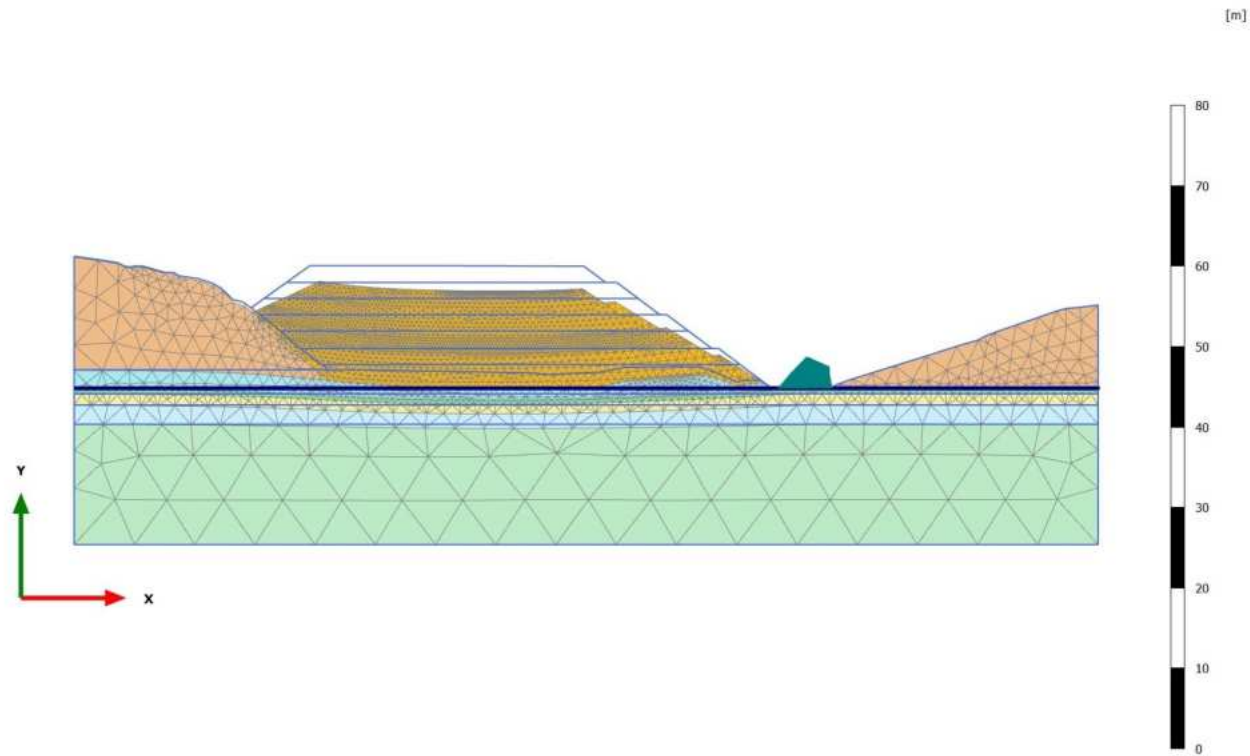
**Deformed mesh |u| (scaled up 10,0 times)**  
Maximum value = 1,442 m (Element 4012 at Node 39775)

4.1.4 Calculation results, Phase\_3 [Phase\_3] (10/35), Deformed mesh |u|



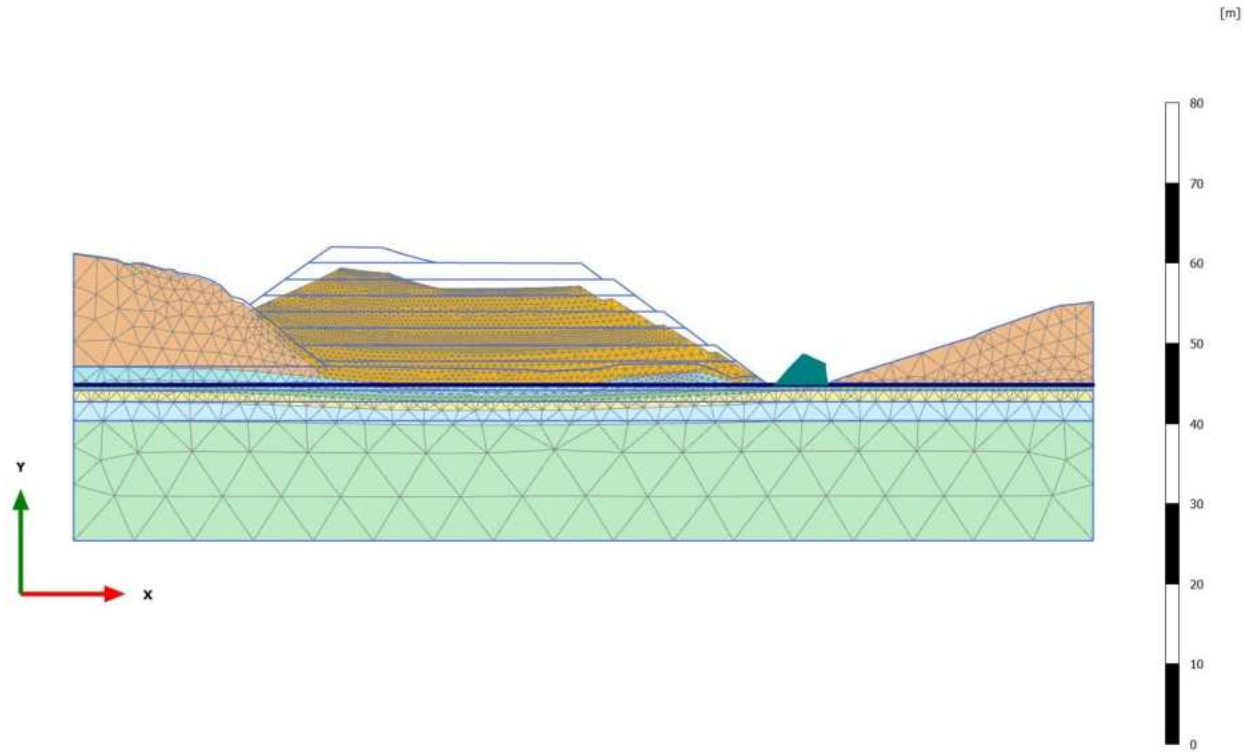
**Deformed mesh |u| (scaled up 5,00 times)**  
Maximum value = 2,521 m (Element 1902 at Node 35068)

4.1.5 Calculation results, Phase\_4 [Phase\_4] (11/38), Deformed mesh |u|



**Deformed mesh |u| (scaled up 5,00 times)**  
Maximum value = 3,122 m (Element 1053 at Node 27970)

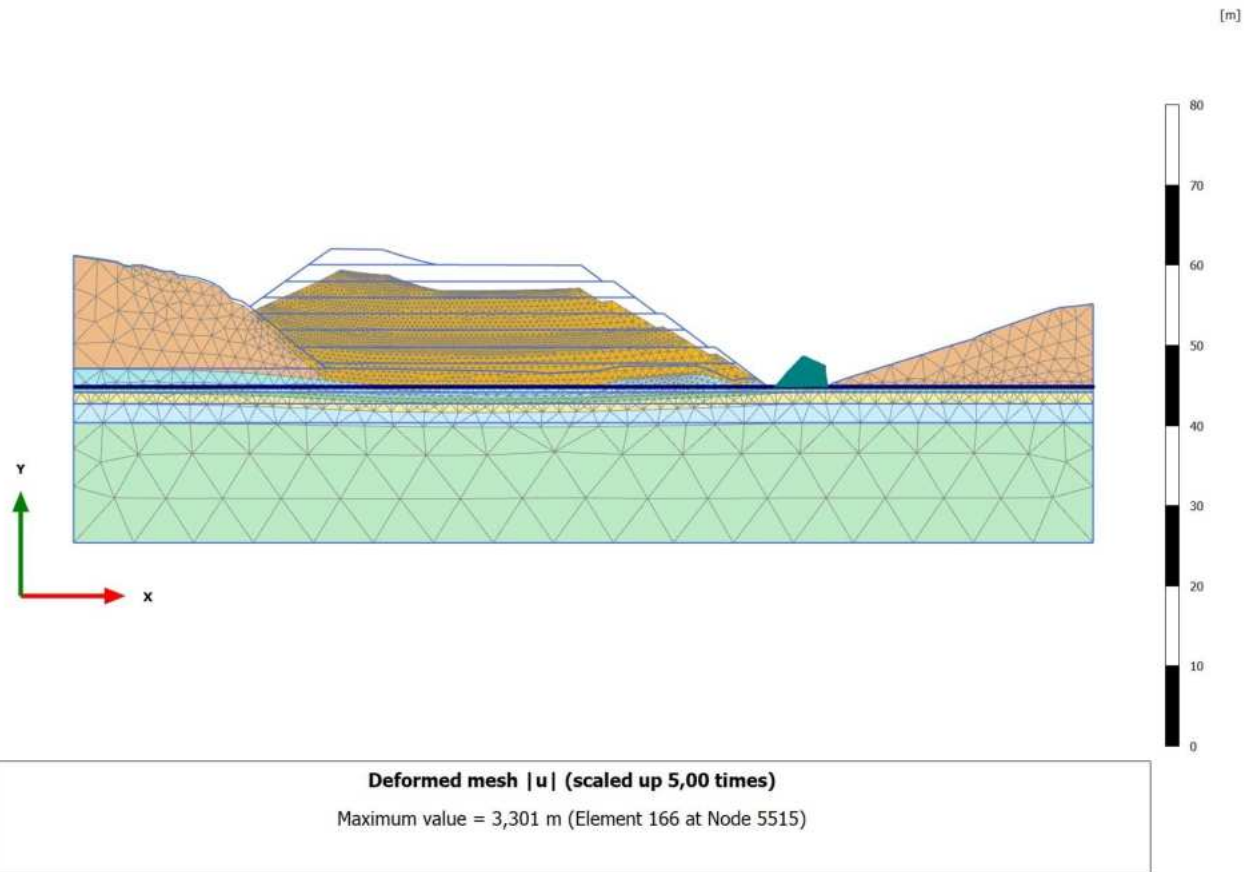
4.1.6 Calculation results, Phase\_5\_static [Phase\_5] (12/41), Deformed mesh |u|



**Deformed mesh |u| (scaled up 5,00 times)**  
Maximum value = 3,291 m (Element 233 at Node 5509)



4.1.7 Calculation results, Phase\_8\_seismic [Phase\_8] (2/44), Deformed mesh |u|

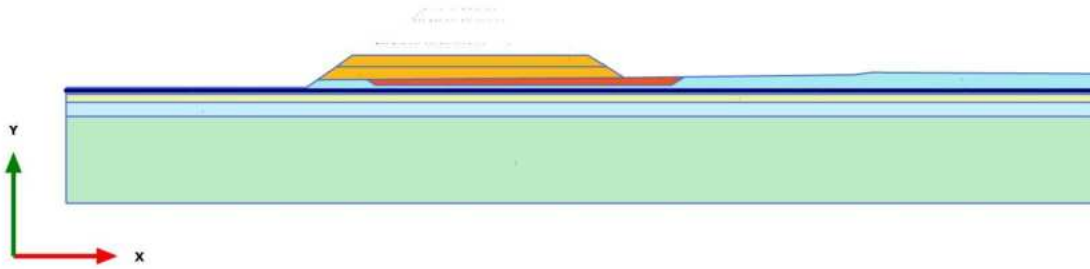


**ANHANG 6 – ERGEBNISSE DER PLAXIS SLU/SLV – ABSCHNITT 1**

**APPENDICE 6 – RISULTATI ANALISI PLAXIS SLU/SLV – SEZIONE 1**

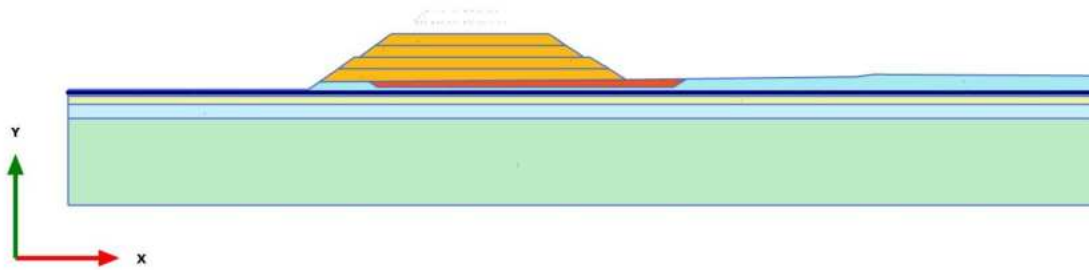
# PLAXIS Report

1.1.1.1 Calculation results, Phase\_1 [Phase\_1] (8/4), Materials plot



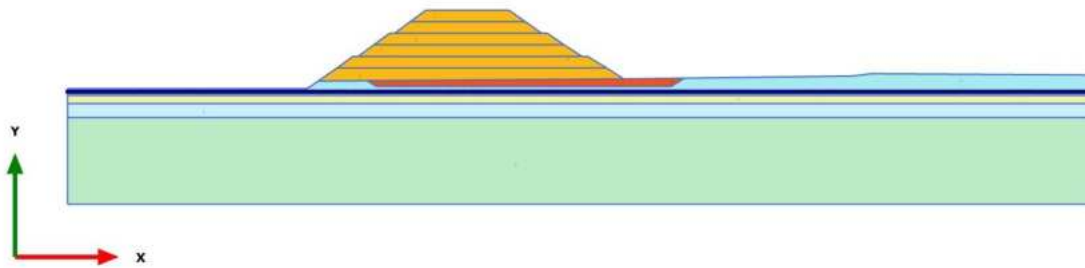
**Materials plot**

1.1.1.2 Calculation results, Phase\_2 [Phase\_2] (9/8), Materials plot



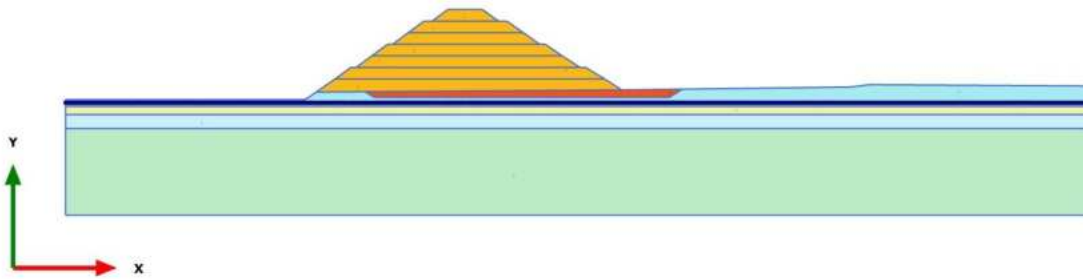
**Materials plot**

1.1.1.3 Calculation results, Phase\_3 [Phase\_3] (10/11), Materials plot



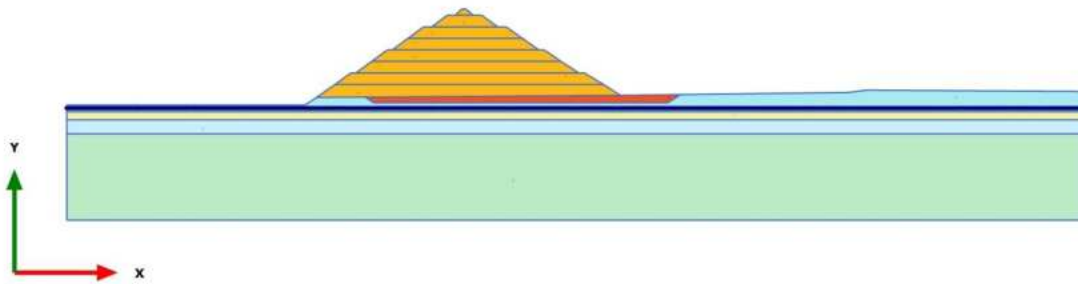
**Materials plot**

1.1.1.4 Calculation results, Phase\_4 [Phase\_4] (11/14), Materials plot



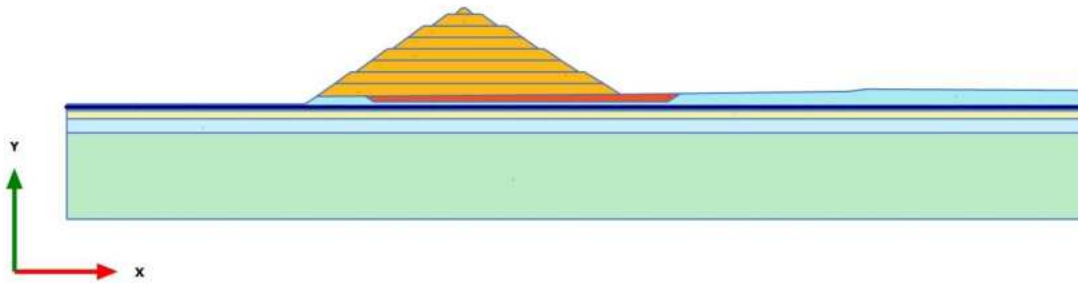
**Materials plot**

1.1.1.5 Calculation results, Phase\_5\_static [Phase\_5] (12/18), Materials plot



**Materials plot**

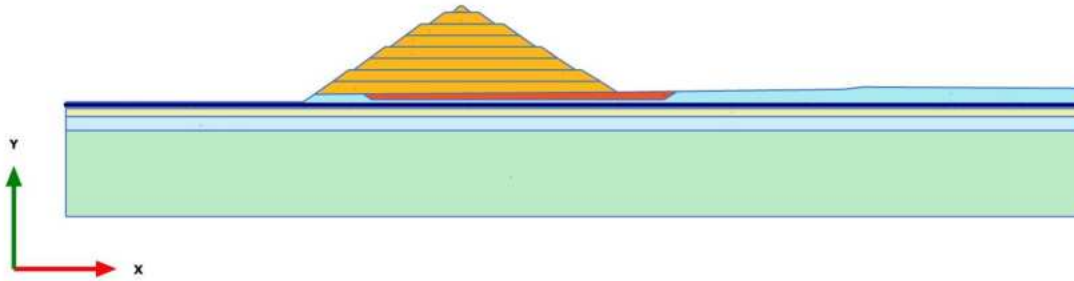
1.1.1.6 Calculation results, Phase\_8 \_seismic [Phase\_8] (2/21), Materials plot



**Materials plot**

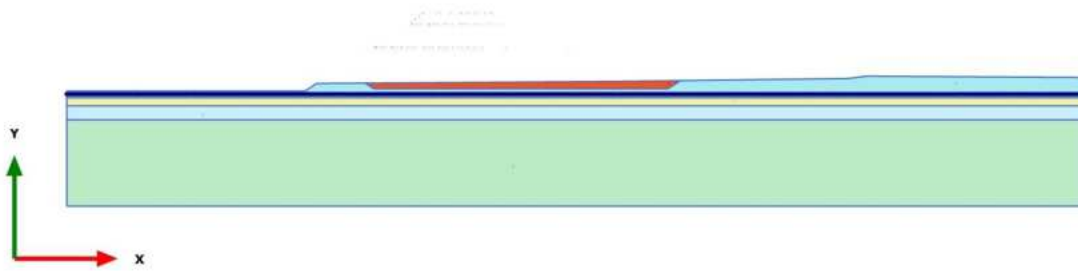


1.1.1.7 Calculation results, Phase\_6 FoS seismic [Phase\_6] (13/121), Materials plot



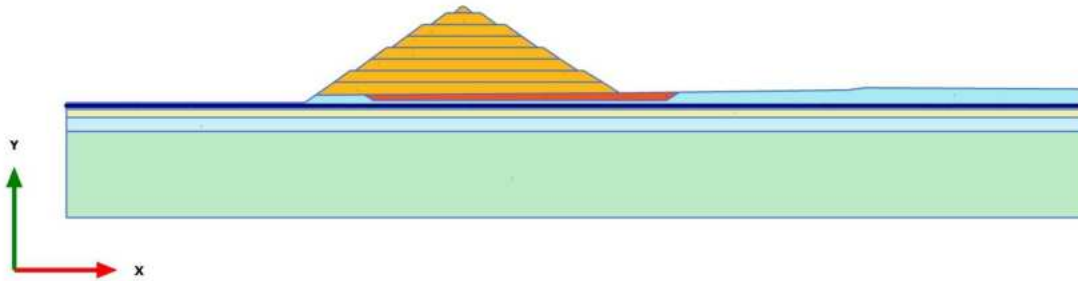
**Materials plot**

1.1.1.8 Calculation results, Initial phase [InitialPhase] (0/137), Materials plot








**Materials plot**

1.1.1.9 Calculation results, Phase\_7 FoS static [Phase\_7] (1/237), Materials plot



**Materials plot**

### 1.1.2.1.1 Materials - Soil and interfaces - Hardening soil





Identification		Strato 1	Strato 2	Strato 3	Strato 4	Strato 5
Identification number		1	2	3	4	5
Drainage type		Drained	Drained	Drained	Drained	Drained
Colour						
Comments						
$\gamma_{\text{unsat}}$	kN/m <sup>3</sup>	20,00	20,00	20,00	20,00	20,00
$\gamma_{\text{sat}}$	kN/m <sup>3</sup>	20,00	20,00	20,00	20,00	20,00
Dilatancy cut-off		No	No	No	No	No
$e_{\text{init}}$		0,5000	0,5000	0,5000	0,5000	0,5000
$e_{\text{min}}$		0,000	0,000	0,000	0,000	0,000
$e_{\text{max}}$		999,0	999,0	999,0	999,0	999,0
Rayleigh $\alpha$		0,000	0,000	0,000	0,000	0,000
Rayleigh $\beta$		0,000	0,000	0,000	0,000	0,000
$E_{50 \text{ ref}}$	kN/m <sup>2</sup>	25,00E3	40,00E3	50,00E3	30,00E3	70,00E3
$E_{\text{oed ref}}$	kN/m <sup>2</sup>	23,55E3	36,94E3	45,27E3	28,84E3	66,76E3
$E_{\text{ur ref}}$	kN/m <sup>2</sup>	75,00E3	120,0E3	150,0E3	90,00E3	210,0E3
power (m)		0,000	0,000	0,000	0,000	0,4000
Use alternatives		No	No	No	No	No
$C_c$		0,01465	9,339E-3	7,621E-3	0,01196	5,167E-3

Identification		Strato 1	Strato 2	Strato 3	Strato 4	Strato 5
$C_s$		4,140E-3	2,587E-3	2,070E-3	3,450E-3	1,479E-3
$e_{init}$		0,5000	0,5000	0,5000	0,5000	0,5000
$c_{ref}$	kN/m <sup>2</sup>	4,000	0,000	0,000	0,000	0,000
$\phi$ (phi)	°	32,01	33,87	35,77	30,17	30,17
$\psi$ (psi)	°	0,000	0,000	0,000	0,000	0,000
Set to default values		No	No	No	No	No
$v_{ur}$		0,2000	0,2000	0,2000	0,2000	0,2000
$p_{ref}$	kN/m <sup>2</sup>	100,0	100,0	100,0	100,0	100,0
$K_{0nc}$		0,3943	0,3695	0,3449	0,4194	0,4217
$c_{inc}$	kN/m <sup>2</sup> /m	0,000	0,000	0,000	0,000	0,000
$y_{ref}$	m	0,000	0,000	0,000	0,000	608,0
$R_f$		0,9000	0,9000	0,9000	0,9000	0,9000
Tension cut-off		Yes	Yes	Yes	Yes	Yes
Tensile strength	kN/m <sup>2</sup>	0,000	0,000	0,000	0,000	0,000
Undrained behaviour		Standard	Standard	Standard	Standard	Standard
Skempton-B		0,9866	0,9866	0,9866	0,9866	0,9866
$v_u$		0,4950	0,4950	0,4950	0,4950	0,4950
$K_{w,ref} / n$	kN/m <sup>2</sup>	3,073E6	4,917E6	6,146E6	3,687E6	8,604E6
Stiffness		Standard	Standard	Standard	Standard	Standard

Strength		Rigid	Rigid	Rigid	Rigid	Rigid
$R_{inter}$		1,000	1,000	1,000	1,000	1,000
Consider gap closure		Yes	Yes	Yes	Yes	Yes
Identification		Strato 1	Strato 2	Strato 3	Strato 4	Strato 5
$\delta_{inter}$		0,000	0,000	0,000	0,000	0,000
Cross permeability		Impermeable	Impermeable	Impermeable	Impermeable	Impermeable
Drainage conductivity, dk	m <sup>3</sup> /day/m	0,000	0,000	0,000	0,000	0,000
R	m <sup>2</sup> K/kW	0,000	0,000	0,000	0,000	0,000
$K_0$ determination		Automatic	Automatic	Automatic	Automatic	Automatic
$K_{0,x} = K_{0,z}$		Yes	Yes	Yes	Yes	Yes
$K_{0,x}$		0,3943	0,3695	0,3449	0,4194	0,4217
$K_{0,z}$		0,3943	0,3695	0,3449	0,4194	0,4217
OCR		1,000	1,000	1,000	1,000	1,000
POP	kN/m <sup>2</sup>	0,000	0,000	0,000	0,000	0,000
Data set		Standard	Standard	Standard	Standard	Standard
Type		Coarse	Coarse	Coarse	Coarse	Coarse
< 2 $\mu$ m	%	10,00	10,00	10,00	10,00	10,00
2 $\mu$ m - 50 $\mu$ m	%	13,00	13,00	13,00	13,00	13,00
50 $\mu$ m - 2 mm	%	77,00	77,00	77,00	77,00	77,00
Use defaults		None	None	None	None	None

$k_x$	m/day	0,000	0,000	0,000	0,000	0,000
$k_y$	m/day	0,000	0,000	0,000	0,000	0,000
$-\psi_{\text{unsat}}$	m	10,00E3	10,00E3	10,00E3	10,00E3	10,00E3
$e_{\text{init}}$		0,5000	0,5000	0,5000	0,5000	0,5000
$S_s$	1/m	0,000	0,000	0,000	0,000	0,000
$c_k$		1000E12	1000E12	1000E12	1000E12	1000E12
Identification		Strato 1	Strato 2	Strato 3	Strato 4	Strato 5
$c_s$	kJ/t/K	0,000	0,000	0,000	0,000	0,000
$\lambda_s$	kW/m/K	0,000	0,000	0,000	0,000	0,000
$\rho_s$	t/m <sup>3</sup>	0,000	0,000	0,000	0,000	0,000
Solid thermal expansion		Volumetric	Volumetric	Volumetric	Volumetric	Volumetric
$\alpha_s$	1/K	0,000	0,000	0,000	0,000	0,000
$D_v$	m <sup>2</sup> /day	0,000	0,000	0,000	0,000	0,000
$f_{\text{TV}}$		0,000	0,000	0,000	0,000	0,000
Unfrozen water content		None	None	None	None	None

1.1.2.1.2 Materials - Soil and interfaces - Mohr-Coulomb

Identification		Rock	A	F1	GNEISS
Identification number		6	7	8	9
Drainage type		Drained	Drained	Drained	Drained
Colour					
Comments					
$\gamma_{\text{unsat}}$	kN/m <sup>3</sup>	20,00	21,00	20,00	20,00
$\gamma_{\text{sat}}$	kN/m <sup>3</sup>	20,00	21,00	20,00	20,00
Dilatancy cut-off		No	No	No	No
$e_{\text{init}}$		0,5000	0,5000	0,5000	0,5000
$e_{\text{min}}$		0,000	0,000	0,000	0,000
$e_{\text{max}}$		999,0	999,0	999,0	999,0
Rayleigh $\alpha$		0,000	0,000	0,000	0,000
Rayleigh $\beta$		0,000	0,000	0,000	0,000
E	kN/m <sup>2</sup>	100,0E3	30,00E3	5000	30,00E3
$\nu$ (nu)		0,3000	0,3000	0,3000	0,3000
G	kN/m <sup>2</sup>	38,46E3	11,54E3	1923	11,54E3
$E_{\text{oad}}$	kN/m <sup>2</sup>	134,6E3	40,38E3	6731	40,38E3



Identification		Rock	A	F1	GNEISS
$c_{ref}$	kN/m <sup>2</sup>	500,0	36,00	0,000	40,00
$\phi$ (phi)	°	35,00	31,08	20,00	36,00
$\psi$ (psi)	°	0,000	3,000	0,000	3,000
$V_s$	m/s	137,4	73,42	30,71	75,23
$V_p$	m/s	257,0	137,4	57,46	140,7
Set to default values		Yes	Yes	Yes	Yes
$E_{inc}$	kN/m <sup>2</sup> /m	0,000	0,000	0,000	0,000
$\gamma_{ref}$	m	0,000	0,000	0,000	0,000
$c_{inc}$	kN/m <sup>2</sup> /m	0,000	0,000	0,000	0,000
$\gamma_{ref}$	m	0,000	0,000	0,000	0,000
Tension cut-off		Yes	Yes	Yes	Yes
Tensile strength	kN/m <sup>2</sup>	0,000	0,000	0,000	0,000
Undrained behaviour		Standard	Standard	Standard	Standard
Skempton-B		0,9783	0,9783	0,9783	0,9783
$v_u$		0,4950	0,4950	0,4950	0,4950
$K_{w,ref} / n$	kN/m <sup>2</sup>	3,750E6	1,125E6	187,5E3	1,125E6
Stiffness		Standard	Standard	Standard	Standard

Strength		Rigid	Rigid	Rigid	Rigid
R <sub>inter</sub>		1,000	1,000	1,000	1,000
Identification		Rock	A	F1	GNEISS
Consider gap closure		Yes	Yes	Yes	Yes
δ <sub>inter</sub>		0,000	0,000	0,000	0,000
Cross permeability		Impermeable	Impermeable	Impermeable	Impermeable
Drainage conductivity, dk	m <sup>3</sup> /day/m	0,000	0,000	0,000	0,000
R	m <sup>2</sup> K/kW	0,000	0,000	0,000	0,000
K <sub>0</sub> determination		Automatic	Automatic	Automatic	Automatic
K <sub>0,x</sub> = K <sub>0,z</sub>		Yes	Yes	Yes	Yes
K <sub>0,x</sub>		0,4264	0,4837	0,6580	0,4122
K <sub>0,z</sub>		0,4264	0,4837	0,6580	0,4122
Data set		Standard	USDA	Standard	USDA
Model		Van Genuchten	Van Genuchten	Van Genuchten	Van Genuchten
Type		Coarse	Coarse	Coarse	Coarse
Type		Sand	Sand	Sand	Sand
< 2 μm	%	10,00	4,000	10,00	4,000
2 μm - 50 μm	%	13,00	4,000	13,00	4,000

50 $\mu\text{m}$ - 2 mm	%	77,00	92,00	77,00	92,00
Use defaults		None	None	None	None
$k_x$	m/day	0,000	0,000	0,000	0,000
$k_y$	m/day	0,000	0,000	0,000	0,000
Identification		Rock	A	F1	GNEISS
$-\psi_{\text{unsat}}$	m	10,00E3	10,00E3	10,00E3	10,00E3
$e_{\text{init}}$		0,5000	0,5000	0,5000	0,5000
$S_s$	1/m	0,000	0,000	0,000	0,000
$c_k$		1000E12	1000E12	1000E12	1000E12
$c_s$	kJ/t/K	0,000	0,000	0,000	0,000
$\lambda_s$	kW/m/K	0,000	0,000	0,000	0,000
$\rho_s$	t/m <sup>3</sup>	0,000	0,000	0,000	0,000
Solid thermal expansion		Volumetric	Volumetric	Volumetric	Volumetric
$\alpha_s$	1/K	0,000	0,000	0,000	0,000
$D_v$	m <sup>2</sup> /day	0,000	0,000	0,000	0,000
$f_{\text{TV}}$		0,000	0,000	0,000	0,000
Unfrozen water content		None	None	None	None

1.1.3.1 Calculation information

Calculation information				
Step info				
Phase	Phase_1 [Phase_1]			
Step	Initial			
Calculation mode	Classical mode			
Step type	Plastic			
Updated mesh	False			
Solver type	Picos			
Kernel type	64 bit			
Extrapolation factor	0,9152			
Relative stiffness	0,4110			
Design approach				
Index	1			
Name	DesignApproach_1			
Multipliers				
Soil weight			$\Sigma M_{\text{Weight}}$	1,000
Strength reduction factor	$M_{\text{sf}}$	0,000	$\Sigma M_{\text{sf}}$	1,000

Calculation information				
Time	Increment	0,000	End time	0,000
Staged construction				
Active proportion total area	$M_{Area}$	0,02054	$\Sigma M_{Area}$	0,9455
Active proportion of stage	$M_{Stage}$	0,2933	$\Sigma M_{Stage}$	1,000
Forces				
$F_x$	0,000 kN/m			
$F_y$	0,000 kN/m			
Consolidation				
Realised $P_{Excess,Max}$	0,000 kN/m <sup>2</sup>			

1.1.3.2 Calculation information

Calculation information				
Step info				
Phase	Phase_2 [Phase_2]			
Step	Initial			
Calculation mode	Classical mode			
Step type	Plastic			
Updated mesh	False			
Solver type	Picos			
Kernel type	64 bit			
Extrapolation factor	0,6184			
Relative stiffness	0,4513			
Design approach				
Index	1			
Name	DesignApproach_1			
Multipliers				
Soil weight			$\Sigma M_{\text{Weight}}$	1,000
Strength reduction factor	$M_{\text{sf}}$	0,000	$\Sigma M_{\text{sf}}$	1,000

Calculation information				
Time	Increment	0,000	End time	0,000
Staged construction				
Active proportion total area	$M_{Area}$	9,614E-3	$\Sigma M_{Area}$	0,9766
Active proportion of stage	$M_{Stage}$	0,2116	$\Sigma M_{Stage}$	1,000
Forces				
$F_x$	0,000 kN/m			
$F_y$	0,000 kN/m			
Consolidation				
Realised $P_{Excess,Max}$	0,000 kN/m <sup>2</sup>			

1.1.3.3 Calculation information

Calculation information				
Step info				
Phase	Phase_3 [Phase_3]			
Step	Initial			
Calculation mode	Classical mode			
Step type	Plastic			
Updated mesh	False			
Solver type	Picos			
Kernel type	64 bit			
Extrapolation factor	0,8424			
Relative stiffness	0,4486			
Design approach				
Index	1			
Name	DesignApproach_1			
Multipliers				
Soil weight			$\Sigma M_{\text{Weight}}$	1,000
Strength reduction factor	$M_{\text{sf}}$	0,000	$\Sigma M_{\text{sf}}$	1,000



Calculation information				
Time	Increment	0,000	End time	0,000
Staged construction				
Active proportion total area	$M_{Area}$	7,897E-3	$\Sigma M_{Area}$	0,9954
Active proportion of stage	$M_{Stage}$	0,2916	$\Sigma M_{Stage}$	1,000
Forces				
$F_x$	0,000 kN/m			
$F_y$	0,000 kN/m			
Consolidation				
Realised $P_{Excess,Max}$	0,000 kN/m <sup>2</sup>			

#### 1.1.3.4 Calculation information

Calculation information				
Step info				
Phase	Phase_4 [Phase_4]			
Step	Initial			
Calculation mode	Classical mode			
Step type	Plastic			
Updated mesh	False			
Solver type	Picos			
Kernel type	64 bit			
Extrapolation factor	0,8958			
Relative stiffness	0,3412			
Design approach				
Index	1			
Name	DesignApproach_1			
Multipliers				
Soil weight			$\Sigma M_{\text{Weight}}$	1,000
Strength reduction factor	$M_{\text{sf}}$	0,000	$\Sigma M_{\text{sf}}$	1,000

Calculation information				
Time	Increment	0,000	End time	0,000
Staged construction				
Active proportion total area	$M_{Area}$	1,842E-3	$\Sigma M_{Area}$	0,9995
Active proportion of stage	$M_{Stage}$	0,2652	$\Sigma M_{Stage}$	1,000
Forces				
$F_x$	0,000 kN/m			
$F_y$	0,000 kN/m			
Consolidation				
Realised $P_{Excess,Max}$	0,000 kN/m <sup>2</sup>			

1.1.3.5 Calculation information

Calculation information				
Step info				
Phase	Phase_5_static [Phase_5]			
Step	Initial			
Calculation mode	Classical mode			
Step type	Plastic			
Updated mesh	False			
Solver type	Picos			
Kernel type	64 bit			
Extrapolation factor	0,1016			
Relative stiffness	0,08394			
Design approach				
Index	1			
Name	DesignApproach_1			
Multipliers				
Soil weight			$\Sigma M_{\text{Weight}}$	1,000
Strength reduction factor	$M_{sf}$	0,000	$\Sigma M_{sf}$	1,000

Calculation information				
Time	Increment	0,000	End time	0,000
Staged construction				
Active proportion total area	$M_{Area}$	0,02772E-3	$\Sigma M_{Area}$	1,000
Active proportion of stage	$M_{Stage}$	0,01238	$\Sigma M_{Stage}$	1,000
Forces				
$F_x$	0,000 kN/m			
$F_y$	0,000 kN/m			
Consolidation				
Realised $P_{Excess,Max}$	0,000 kN/m <sup>2</sup>			

1.1.3.6 Calculation information

Calculation information				
Step info				
Phase	Phase_8 _seismic [Phase_8]			
Step	Initial			
Calculation mode	Classical mode			
Step type	Plastic			
Updated mesh	False			
Solver type	Picos			
Kernel type	64 bit			
Extrapolation factor	1,000			
Relative stiffness	0,2067			
Design approach				
Index	1			
Name	DesignApproach_1			
Multipliers				
Soil weight			$\Sigma M_{\text{Weight}}$	1,000
Strength reduction factor	$M_{\text{sf}}$	0,000	$\Sigma M_{\text{sf}}$	1,000

Calculation information				
Time	Increment	0,000	End time	0,000
Staged construction				
Active proportion total area	$M_{Area}$	0,000	$\Sigma M_{Area}$	1,000
Active proportion of stage	$M_{Stage}$	0,2870	$\Sigma M_{Stage}$	1,000
Forces				
$F_x$	0,000 kN/m			
$F_y$	0,000 kN/m			
Consolidation				
Realised $P_{Excess,Max}$	0,000 kN/m <sup>2</sup>			
Pseudo-static acceleration				
X	0,01300 g			
Y	3,000E-3 g			
1.1.3.7 Calculation information				
Calculation information				
Step info				
Phase	Phase_6 FoS seismic [Phase_6]			
Step	Initial			

Calculation mode	Classical mode			
Step type	Safety			
Updated mesh	False			
Solver type	Picos			
Kernel type	64 bit			
Extrapolation factor	0,5000			
Relative stiffness	0,07759E-6			
Design approach				
Index	1			
Name	DesignApproach_1			
Multipliers				
Soil weight			$\Sigma M_{\text{Weight}}$	1,000
Strength reduction factor	$M_{\text{sf}}$	0,1461E-3	$\Sigma M_{\text{sf}}$	1,169
Calculation information				
Time	Increment	0,000	End time	0,000
Staged construction				
Active proportion total area	$M_{\text{Area}}$	0,000	$\Sigma M_{\text{Area}}$	1,000
Active proportion of stage	$M_{\text{Stage}}$	0,000	$\Sigma M_{\text{Stage}}$	0,000



## Forces

$F_x$	0,000 kN/m
-------	------------

$F_y$	0,000 kN/m
-------	------------

## Consolidation

Realised $P_{\text{Excess,Max}}$	0,000 kN/m <sup>2</sup>
----------------------------------	-------------------------

## Pseudo-static acceleration

X	0,01300 g
---	-----------

Y	3,000E-3 g
---	------------

### 1.1.3.8 Calculation information

#### Calculation information

#### Step info

Phase	Initial phase [InitialPhase]
-------	------------------------------

Step	Initial
------	---------

Calculation mode	Classical mode
------------------	----------------

Step type	Gravity loading
-----------	-----------------

Solver type	Picos
-------------	-------

Kernel type	64 bit
-------------	--------

Extrapolation factor	1,422
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Relative stiffness 0,3748

Design approach

Index 1

Name DesignApproach\_1

Multipliers

Soil weight  $\Sigma M_{Weight}$  1,000

Strength reduction factor  $M_{sf}$  0,000  $\Sigma M_{sf}$  1,000

Time Increment 0,000 End time 0,000

Calculation information

Staged construction

Active proportion total area  $M_{Area}$  0,3558  $\Sigma M_{Area}$  0,9007

Active proportion of stage  $M_{Stage}$  0,3951  $\Sigma M_{Stage}$  1,000

Forces

$F_x$  0,000 kN/m

$F_y$  0,000 kN/m

Consolidation

Realised P  $P_{Excess,Max}$  0,000 kN/m<sup>2</sup>

1.1.3.9 Calculation information

Calculation information				
Step info				
Phase	Phase_7 FoS static [Phase_7]			
Step	Initial			
Calculation mode	Classical mode			
Step type	Safety			
Updated mesh	False			
Solver type	Picos			
Kernel type	64 bit			
Extrapolation factor	0,5000			
Relative stiffness	-0,07007E-6			
Design approach				
Index	1			
Name	DesignApproach_1			
Multipliers				
Soil weight			$\Sigma M_{\text{Weight}}$	1,000
Strength reduction factor	$M_{sf}$	-0,1022E-3	$\Sigma M_{sf}$	1,150

Calculation information					
Time	Increment		0,000	End time	0,000
Staged construction					
Active proportion total area	$M_{Area}$		0,000	$\Sigma M_{Area}$	1,000
Active proportion of stage	$M_{Stage}$		0,000	$\Sigma M_{Stage}$	0,000
Forces					
$F_x$		0,000 kN/m			
$F_y$		0,000 kN/m			
Consolidation					
Realised $P_{Excess,Max}$		0,000 kN/m <sup>2</sup>			

#### 1.1.4 Calculation information per phase

Identification	Phase	Start from	Calculation type	Loading input	Pore pressure	Time step [day]	First step	Last step	Log
Initial phase [InitialPhase]	0	N/A	Gravity loading	N/A	Phreatic	0,000	122	137	
Phase_1 [Phase_1]	8	0	Plastic	Staged construction	Phreatic	0,000	0	4	
Phase_2 [Phase_2]	9	8	Plastic	Staged construction	Phreatic	0,000	5	8	
Phase_3 [Phase_3]	10	9	Plastic	Staged construction	Phreatic	0,000	9	11	
Phase_4 [Phase_4]	11	10	Plastic	Staged construction	Phreatic	0,000	12	14	
Phase_5_static [Phase_5]	12	11	Plastic	Staged construction	Phreatic	0,000	15	18	
Phase_7 FoS static [Phase_7]	1	12	Safety	Incremental multipliers	Use pressures from previous phase	0,000	138	237	
Phase_8 _seismic [Phase_8]	2	12	Plastic	Staged construction	Phreatic	0,000	19	21	
Phase_6 FoS seismic [Phase_6]	13	2	Safety	Incremental multipliers	Use pressures from previous phase	0,000	22	121	

1.1.5.1 Step info

Step	Phase Step type	Extrapolation factor	Relative stiffness [ $10^{-3}$ ]
137	0 Gravity loading	1,422	374,818
4	8 Plastic	0,915	411,042
8	9 Plastic	0,618	451,338
11	10 Plastic	0,842	448,564
14	11 Plastic	0,896	341,176
18	12 Plastic	0,102	83,944
237	1 Safety	0,500	0,000
21	2 Plastic	1,000	206,677
121	13 Safety	0,500	0,000

### 1.1.5.2 Multipliers

Step	Phase $\Sigma M_{DispX}$	$\Sigma M_{DispY}$	$\Sigma M_{Weight}$	$M_{sf} [10^{-6}]$	$\Sigma M_{sf}$
137	0 0,000	0,000	1,000	0,000	1,000
4	8 0,000	0,000	1,000	0,000	1,000
8	9 0,000	0,000	1,000	0,000	1,000
11	10 0,000	0,000	1,000	0,000	1,000
14	11 0,000	0,000	1,000	0,000	1,000
18	12 0,000	0,000	1,000	0,000	1,000
237	1 0,000	0,000	1,000	-102,197	1,150
21	2 0,000	0,000	1,000	0,000	1,000
121	13 0,000	0,000	1,000	146,069	1,169

### 1.1.5.3 Time

Step	Phase Time step [day]	End time [day]
137	0 0,000	0,000
4	8 0,000	0,000
8	9 0,000	0,000
11	10 0,000	0,000
14	11 0,000	0,000
18	12 0,000	0,000
237	1 0,000	0,000
21	2 0,000	0,000
121	13 0,000	0,000



1.1.5.4 Staged construction

Step	Phase M <sub>Area</sub>	ΣM <sub>Area</sub>	M <sub>Stage</sub>	ΣM <sub>Stage</sub>
137	0 1,000	0,901	0,395	1,000
4	8 0,641	0,946	0,293	1,000
8	9 0,684	0,977	0,212	1,000
11	10 0,692	0,995	0,292	1,000
14	11 0,592	1,000	0,265	1,000
18	12 0,221	1,000	0,012	1,000
237	1 -0,021	1,000	0,000	0,000
21	2 0,574	1,000	0,287	1,000
121	13 0,029	1,000	0,000	0,000

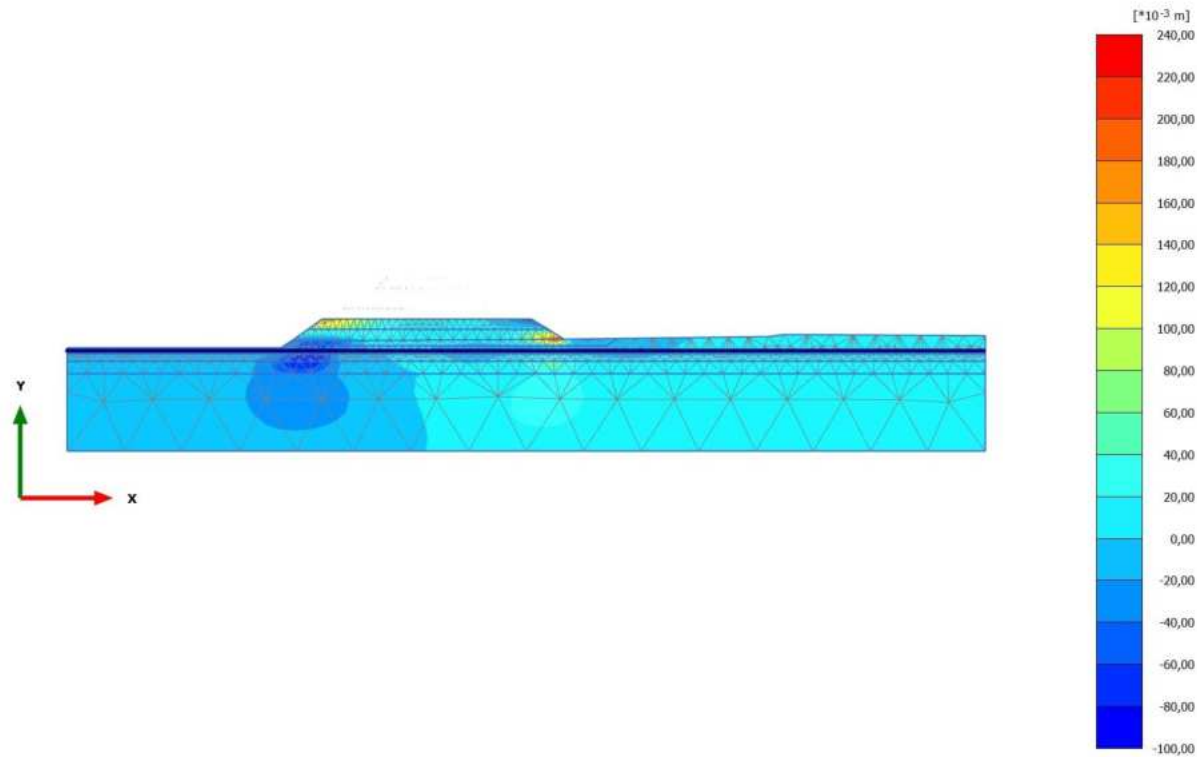
#### 1.1.5.5 Forces

Step	Phase $F_x$ [kN/m]	$F_y$ [kN/m]
137	0 0,000	0,000
4	8 0,000	0,000
8	9 0,000	0,000
11	10 0,000	0,000
14	11 0,000	0,000
18	12 0,000	0,000
237	1 0,000	0,000
21	2 0,000	0,000
121	13 0,000	0,000

#### 1.1.5.6 Consolidation

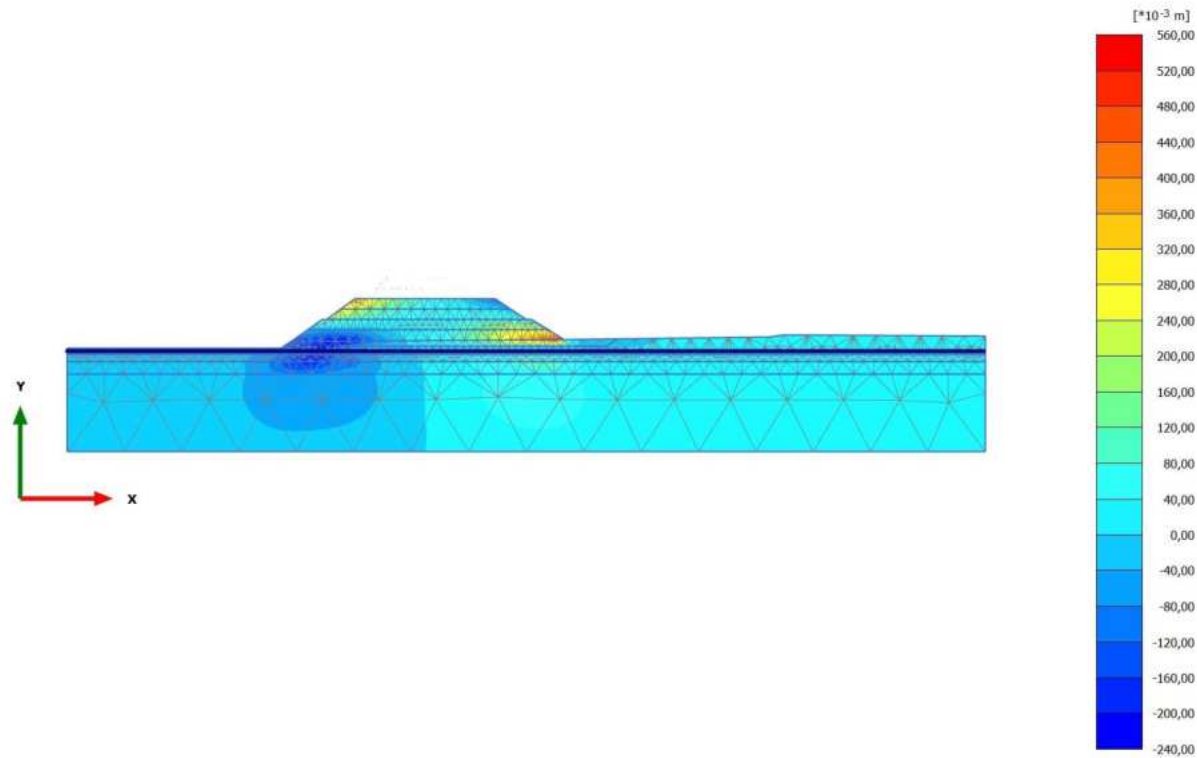
Step	Phase Rel. P <sub>Max</sub> [kN/m <sup>2</sup> ]
137	0 0,000
4	8 0,000
8	9 0,000
11	10 0,000
14	11 0,000
18	12 0,000
237	1 0,000
21	2 0,000
121	13 0,000

2.1.1.1.1 Calculation results, Phase\_1 [Phase\_1] (8/4), Total displacements  $u_x$



**Total displacements  $u_x$  (scaled up 50,0 times)**  
Maximum value = 0,2372 m (Element 287 at Node 8163)  
Minimum value = -0,08251 m (Element 1228 at Node 7668)

2.1.1.1.2 Calculation results, Phase\_2 [Phase\_2] (9/8), Total displacements  $u_x$

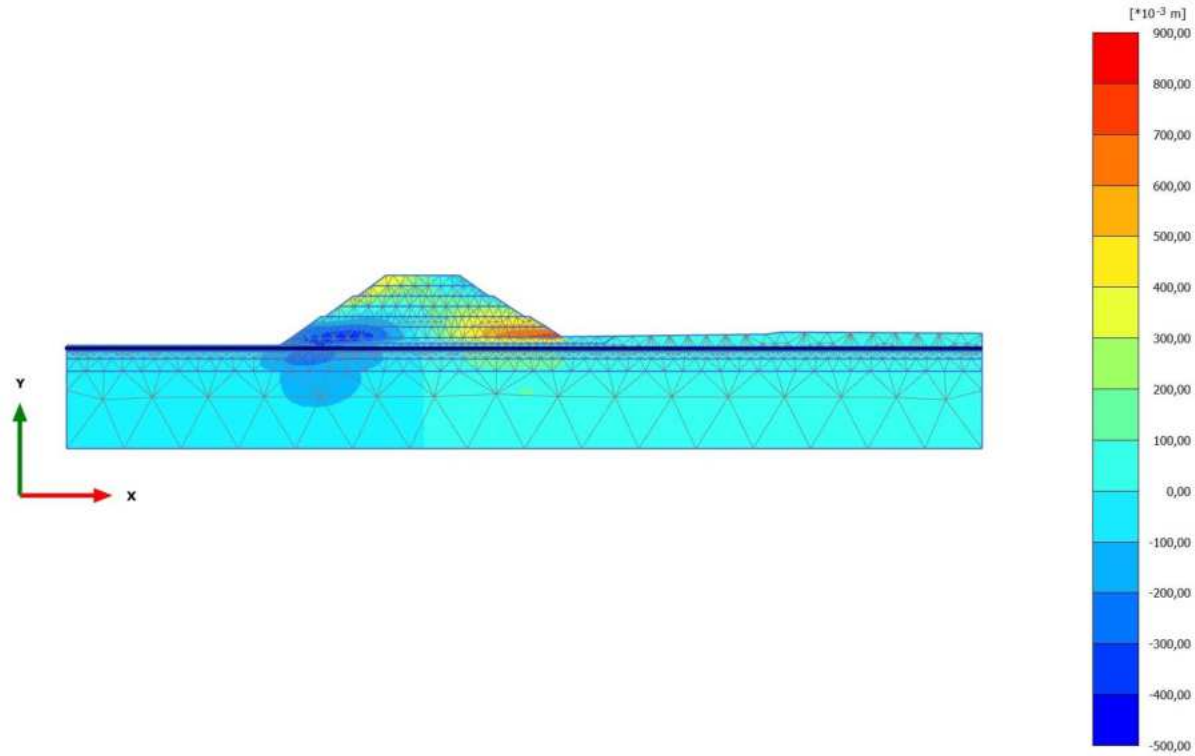


**Total displacements  $u_x$  (scaled up 50,0 times)**

Maximum value = 0,5446 m (Element 287 at Node 8163)

Minimum value = -0,2196 m (Element 268 at Node 2230)

2.1.1.1.3 Calculation results, Phase\_3 [Phase\_3] (10/11), Total displacements  $u_x$

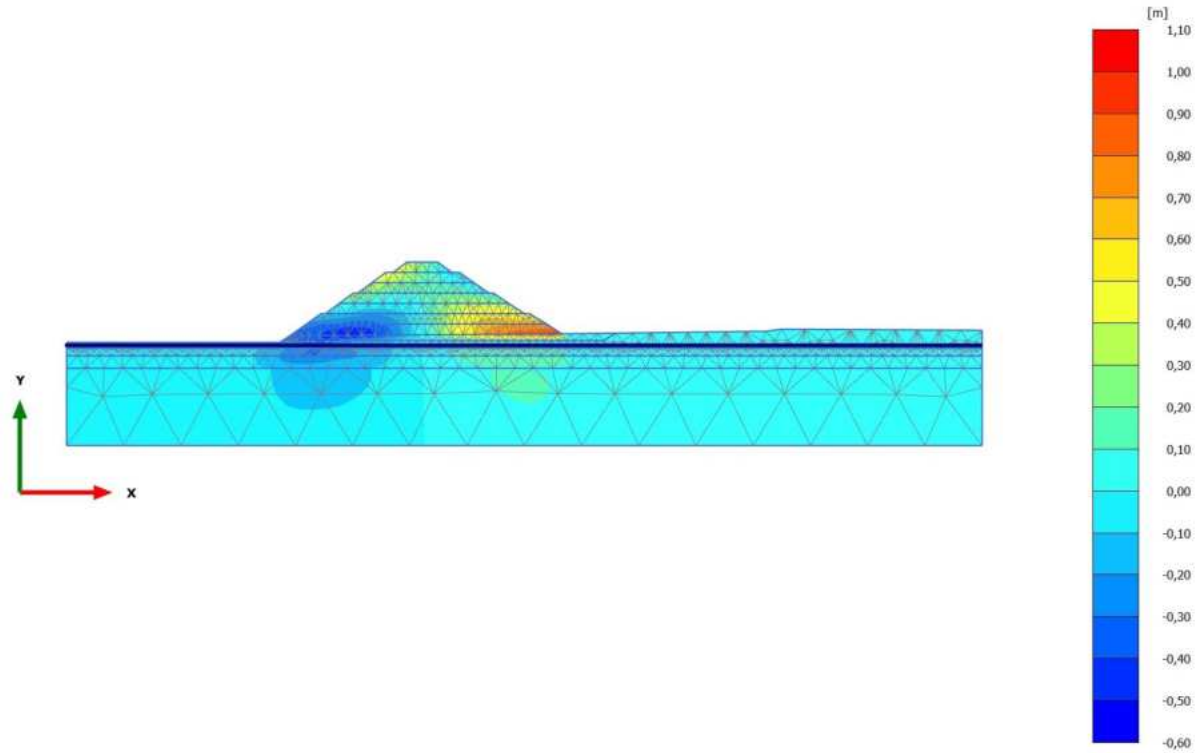


**Total displacements  $u_x$  (scaled up 20,0 times)**

Maximum value = 0,8913 m (Element 287 at Node 8163)

Minimum value = -0,4442 m (Element 268 at Node 2497)

2.1.1.1.4 Calculation results, Phase\_4 [Phase\_4] (11/14), Total displacements  $u_x$

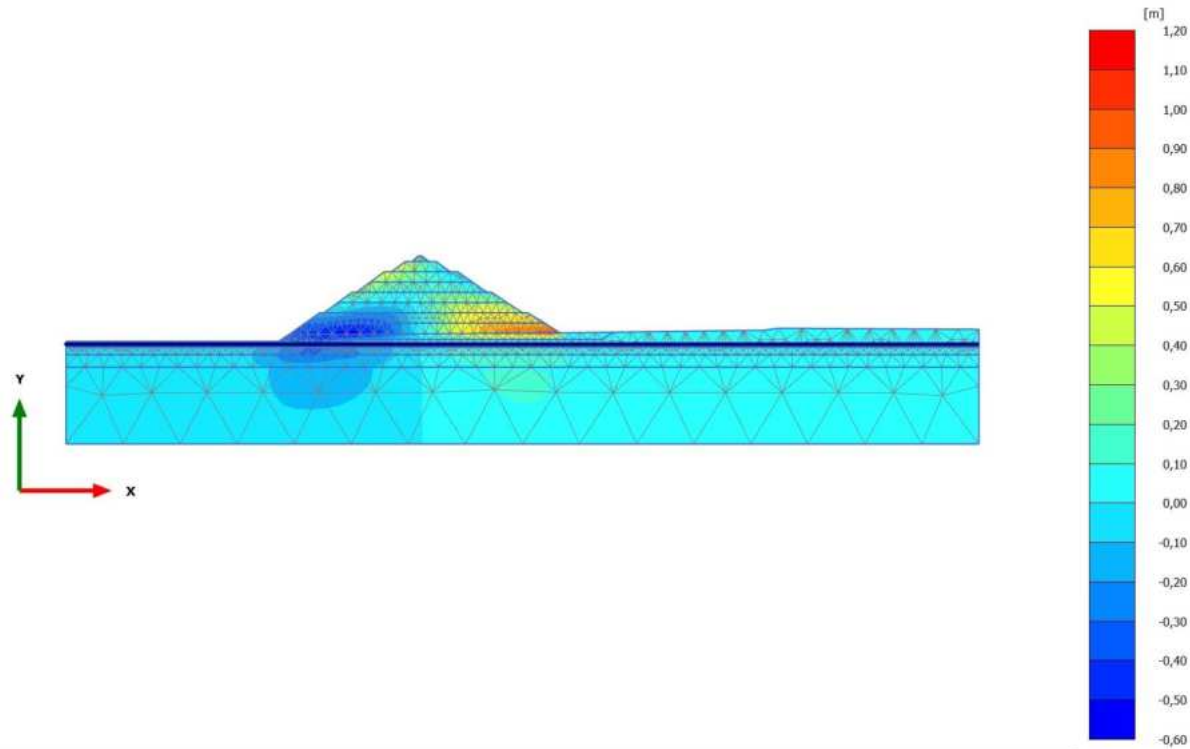


**Total displacements  $u_x$  (scaled up 20,0 times)**

Maximum value = 1,062 m (Element 287 at Node 8163)

Minimum value = -0,5430 m (Element 268 at Node 2497)

2.1.1.1.5 Calculation results, Phase\_5\_static [Phase\_5] (12/18), Total displacements  $u_x$



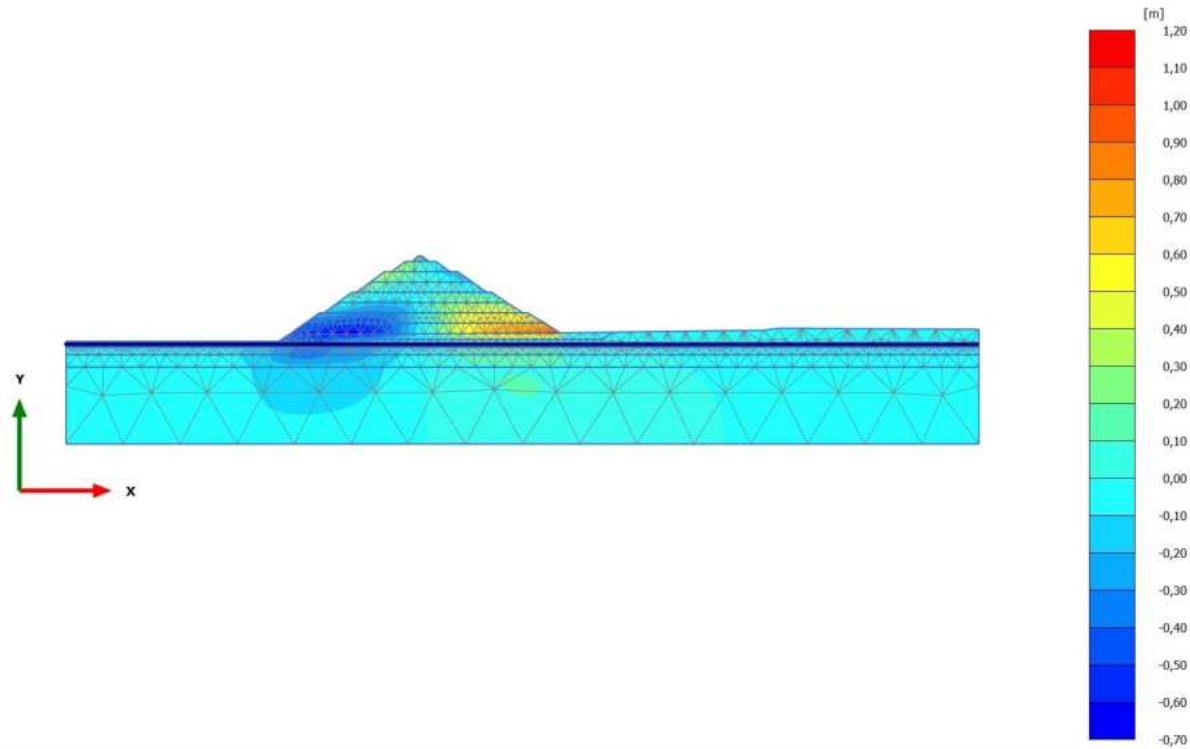
**Total displacements  $u_x$  (scaled up 20,0 times)**

Maximum value = 1,128 m (Element 287 at Node 8163)

Minimum value = -0,5713 m (Element 268 at Node 2497)

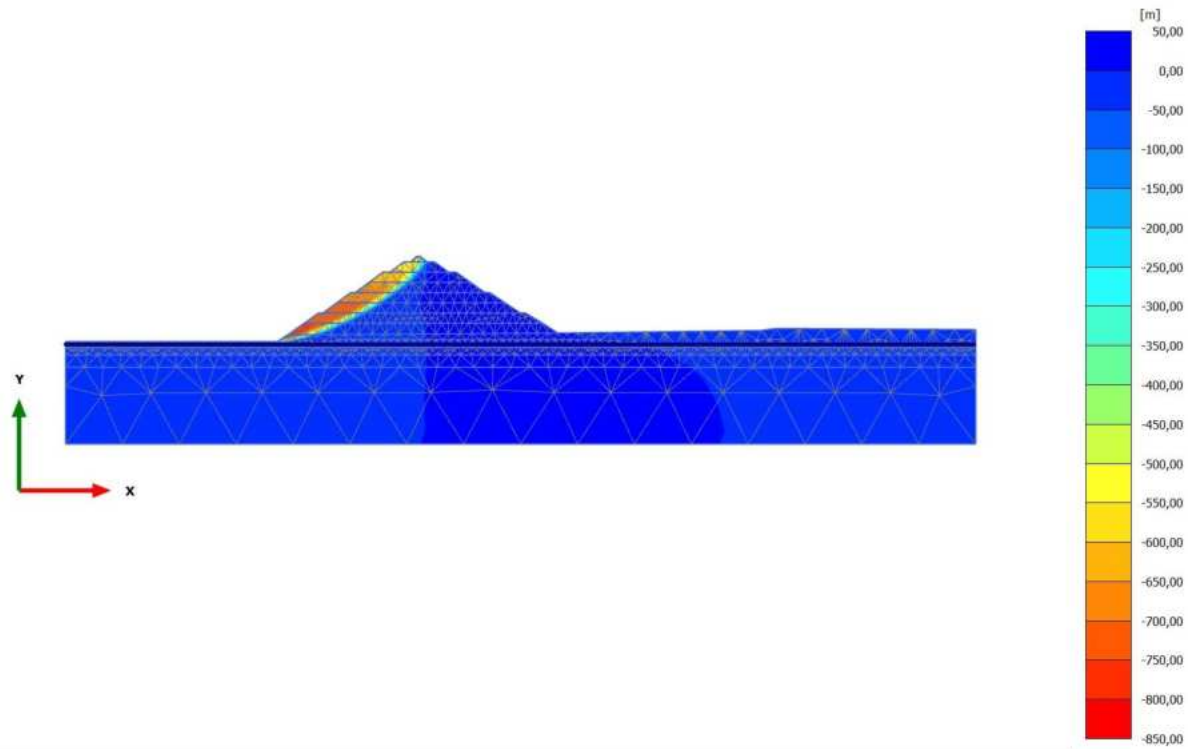


2.1.1.1.6 Calculation results, Phase\_8 \_seismic [Phase\_8] (2/21), Total displacements  $u_x$



**Total displacements  $u_x$  (scaled up 20,0 times)**  
Maximum value = 1,100 m (Element 287 at Node 8163)  
Minimum value = -0,6705 m (Element 268 at Node 2497)

2.1.1.1.7 Calculation results, Phase\_6 FoS seismic [Phase\_6] (13/121), Total displacements  $u_x$

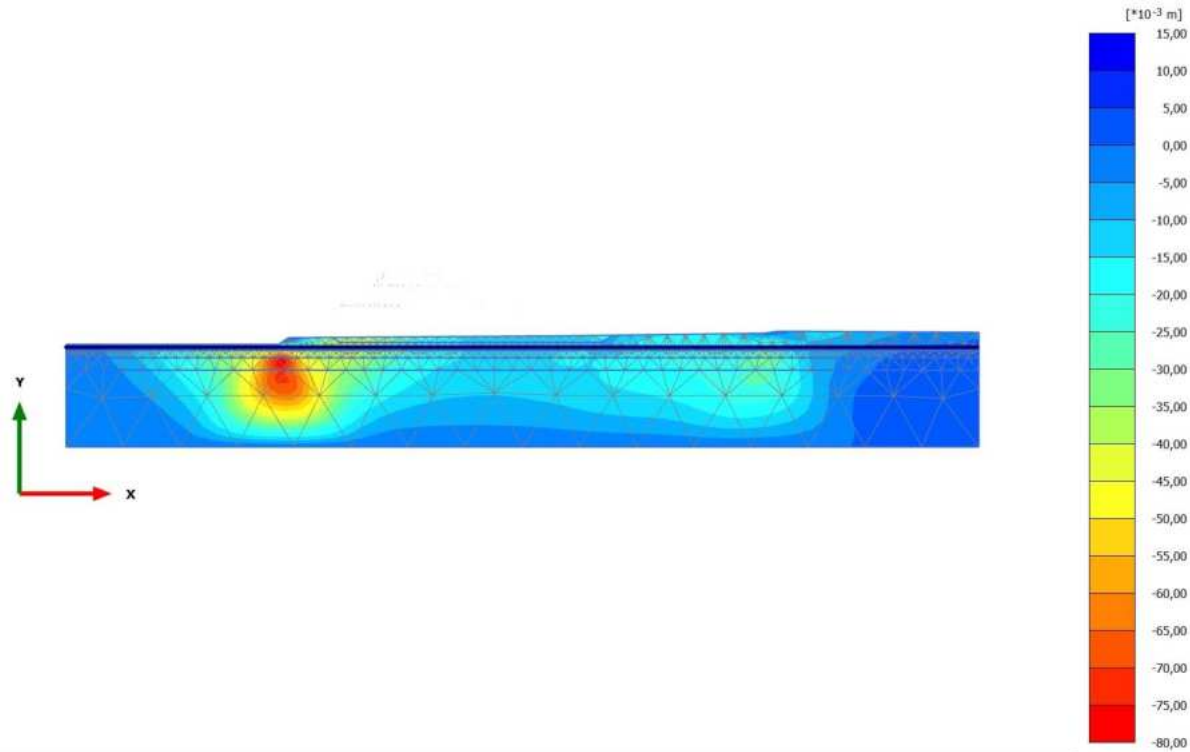


**Total displacements  $u_x$  (scaled up 0,0500 times)**

Maximum value = 4,318 m (Element 287 at Node 8163)

Minimum value = -816,7 m (Element 631 at Node 2092)

2.1.1.1.8 Calculation results, Initial phase [InitialPhase] (0/137), Total displacements  $u_x$

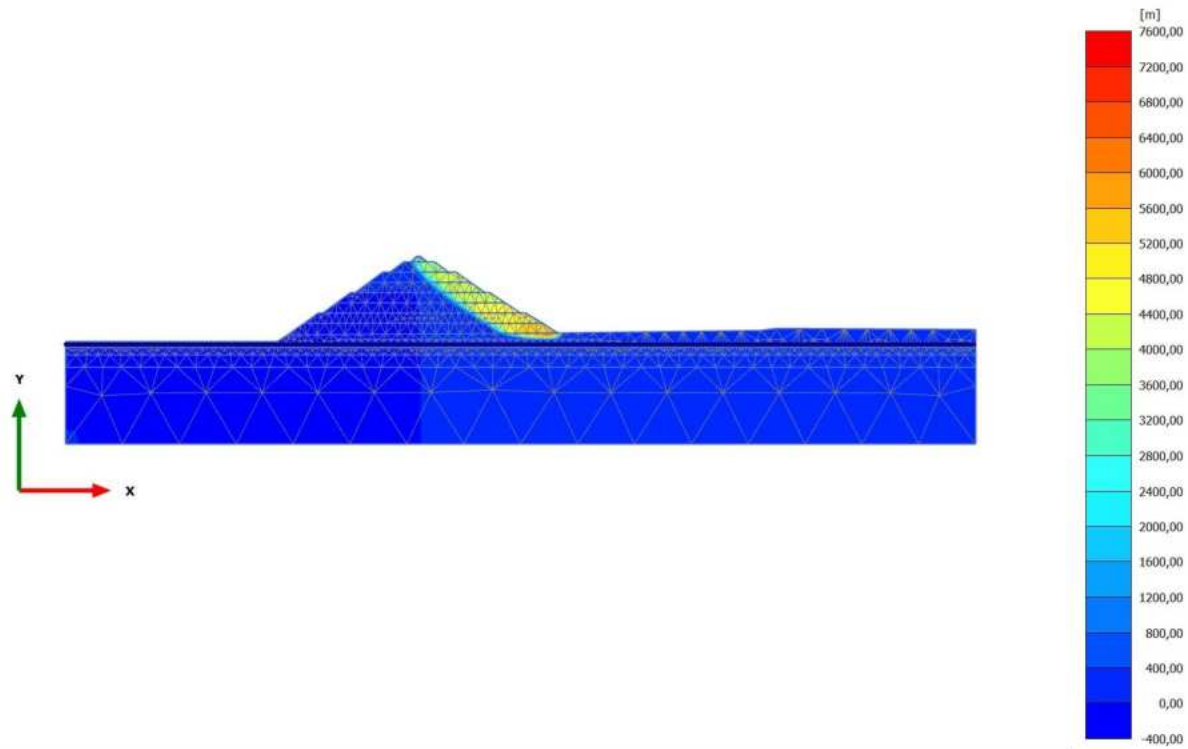


**Total displacements  $u_x$  (scaled up 200 times)**

Maximum value = 0,01378 m (Element 731 at Node 1549)

Minimum value = -0,07743 m (Element 1773 at Node 7688)

2.1.1.1.9 Calculation results, Phase\_7 FoS static [Phase\_7] (1/237), Total displacements  $u_x$

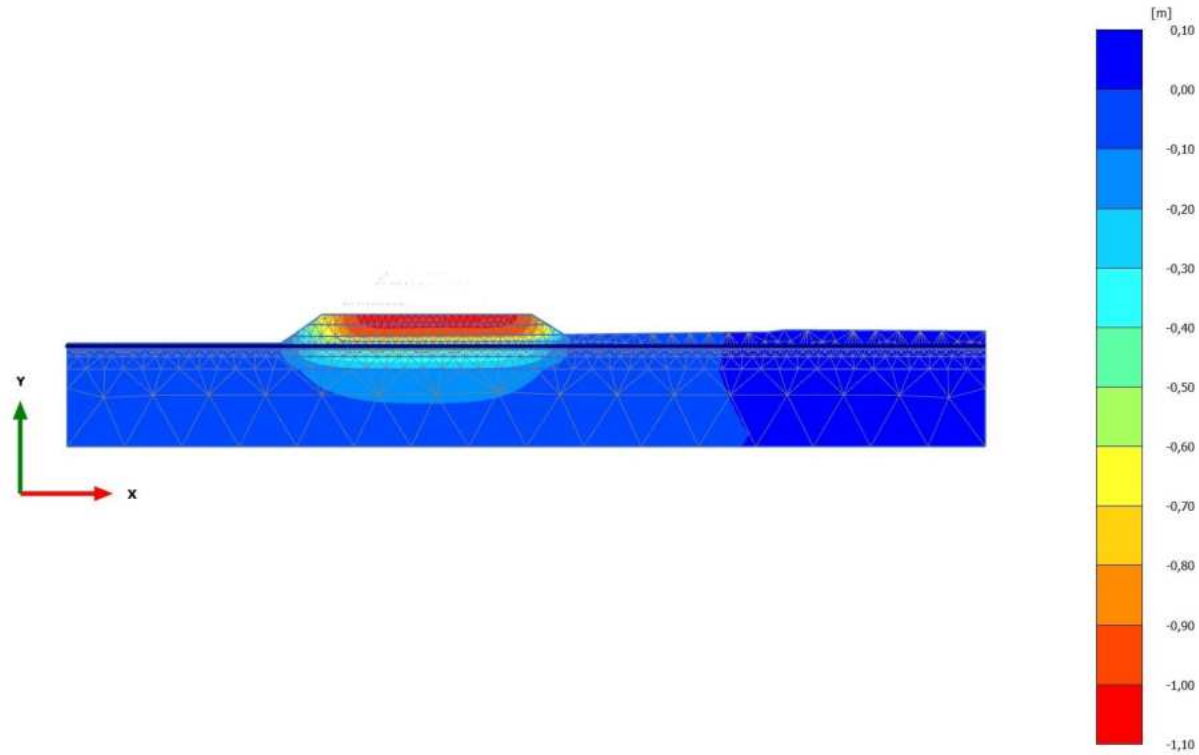


**Total displacements  $u_x$  (scaled up  $5,00 \cdot 10^{-3}$  times)**

Maximum value = 7218 m (Element 287 at Node 8163)

Minimum value = -1,443 m (Element 330 at Node 1549)

2.1.1.2.1 Calculation results, Phase\_1 [Phase\_1] (8/4), Total displacements  $u_y$

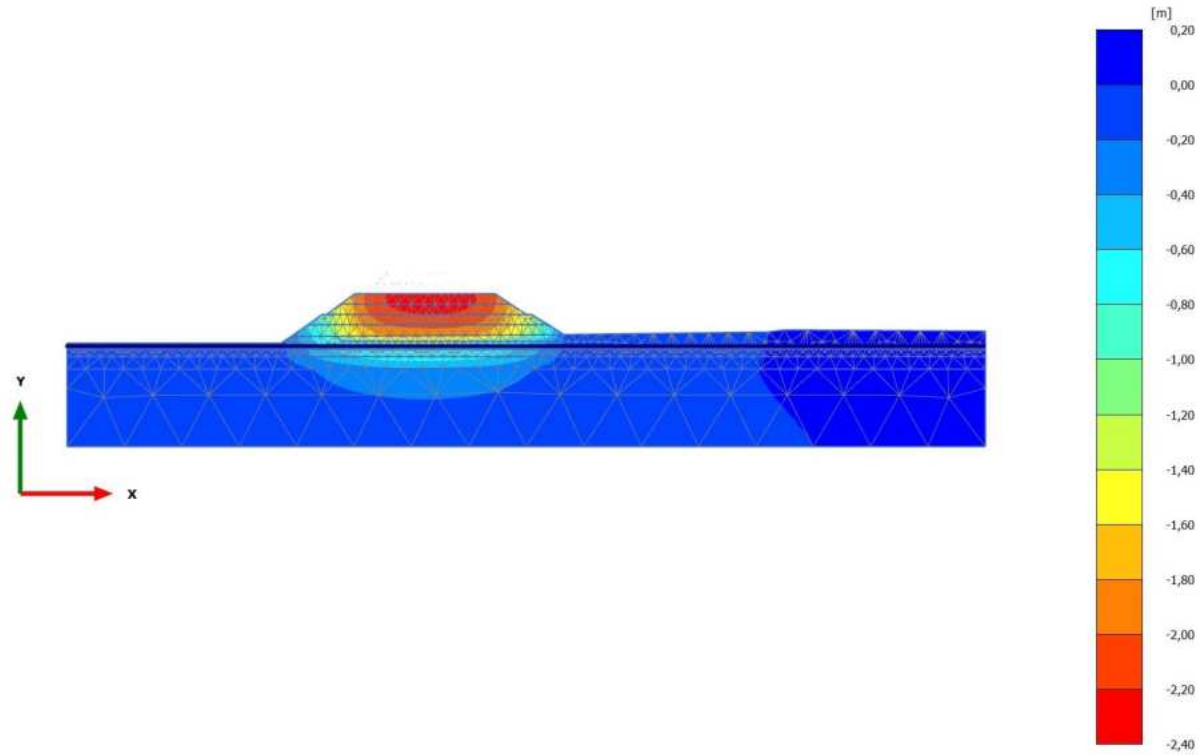


**Total displacements  $u_y$  (scaled up 20,0 times)**

Maximum value =  $0,4934 \cdot 10^{-3}$  m (Element 1562 at Node 12990)

Minimum value = -1,047 m (Element 198 at Node 1565)

2.1.1.2.2 Calculation results, Phase\_2 [Phase\_2] (9/8), Total displacements  $u_y$

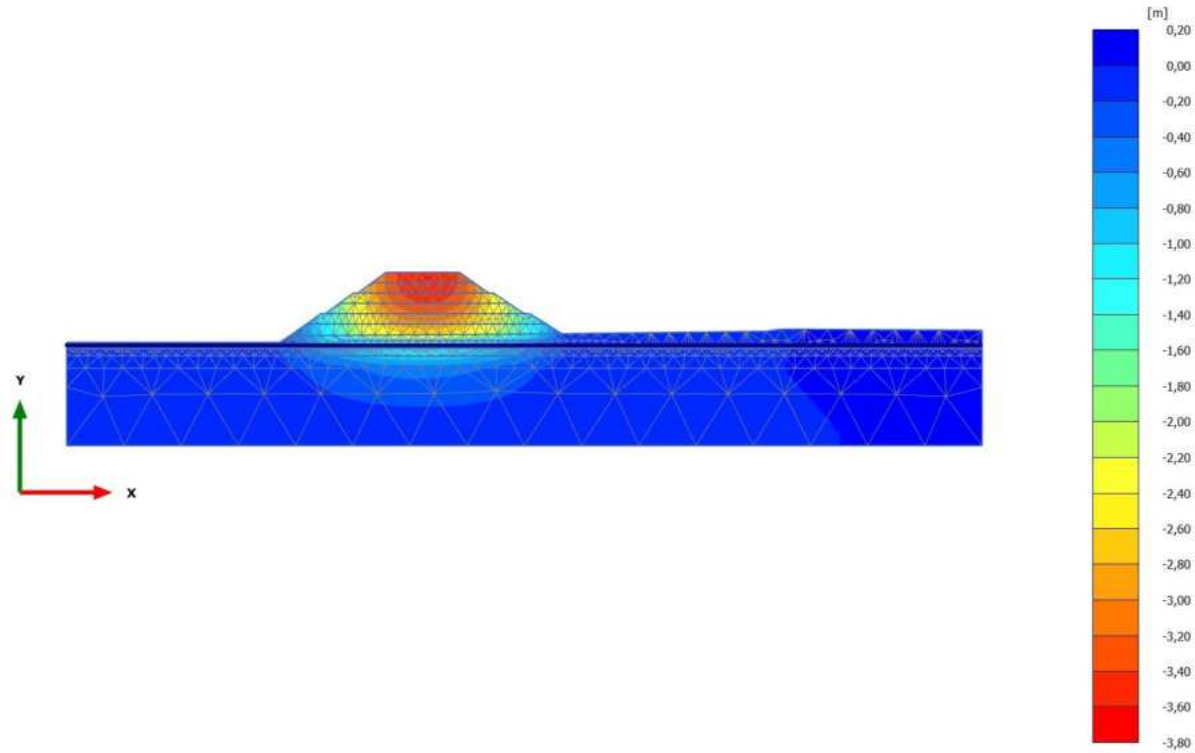


**Total displacements  $u_y$  (scaled up 10,0 times)**

Maximum value =  $0,3883 \cdot 10^{-3}$  m (Element 1680 at Node 13545)

Minimum value = -2,297 m (Element 107 at Node 673)

2.1.1.2.3 Calculation results, Phase\_3 [Phase\_3] (10/11), Total displacements  $u_y$

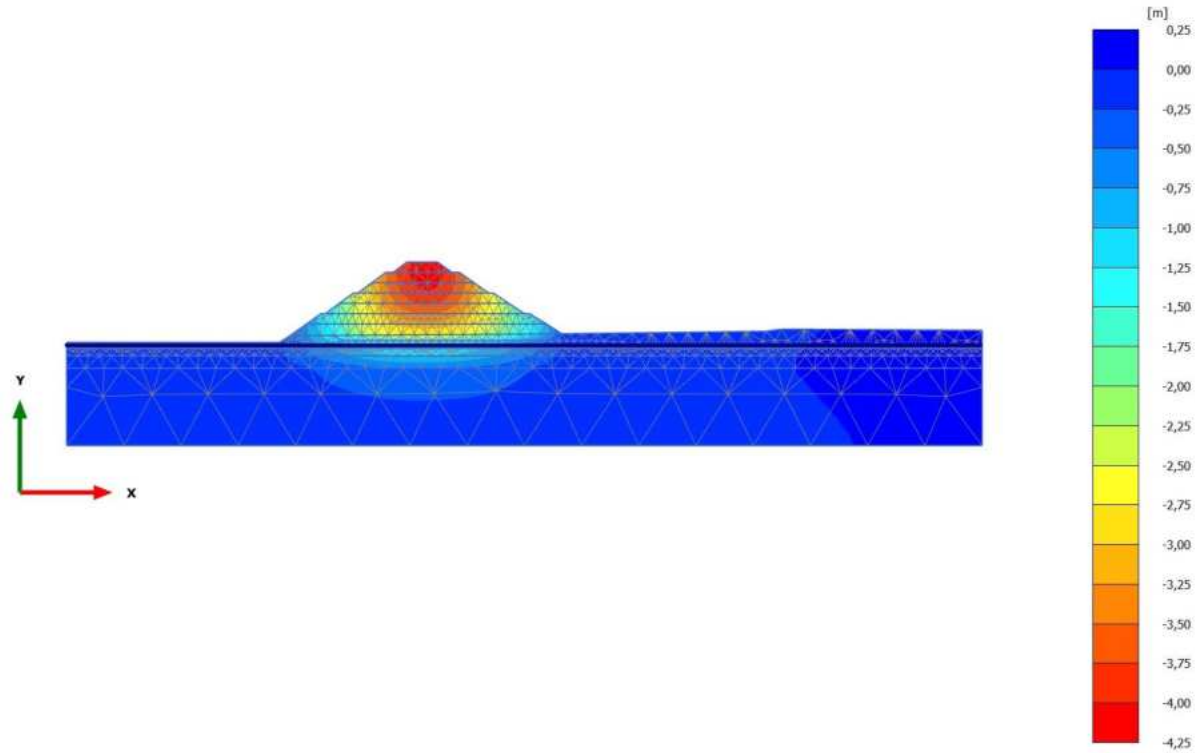


**Total displacements  $u_y$  (scaled up 5,00 times)**

Maximum value = 0,06672 m (Element 385 at Node 8166)

Minimum value = -3,602 m (Element 30 at Node 180)

2.1.1.2.4 Calculation results, Phase\_4 [Phase\_4] (11/14), Total displacements  $u_y$



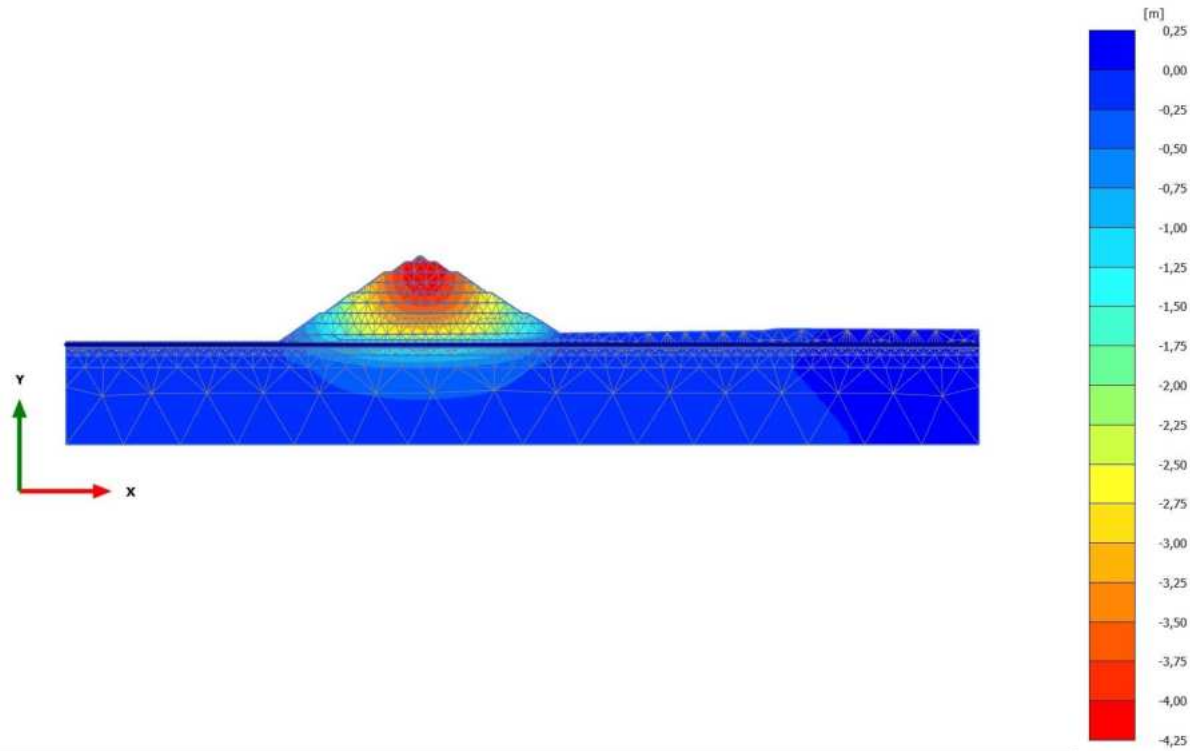
**Total displacements  $u_y$  (scaled up 5,00 times)**

Maximum value = 0,1188 m (Element 385 at Node 8166)

Minimum value = -4,122 m (Element 11 at Node 155)

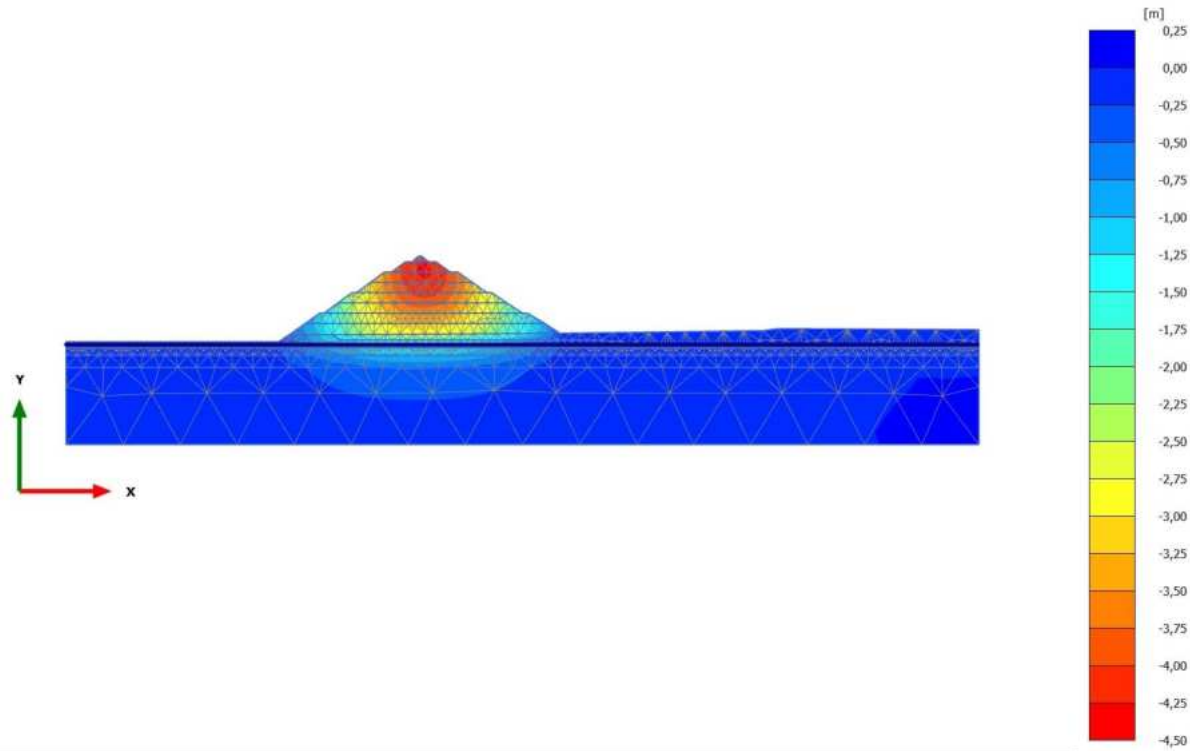


2.1.1.2.5 Calculation results, Phase\_5\_static [Phase\_5] (12/18), Total displacements  $u_y$



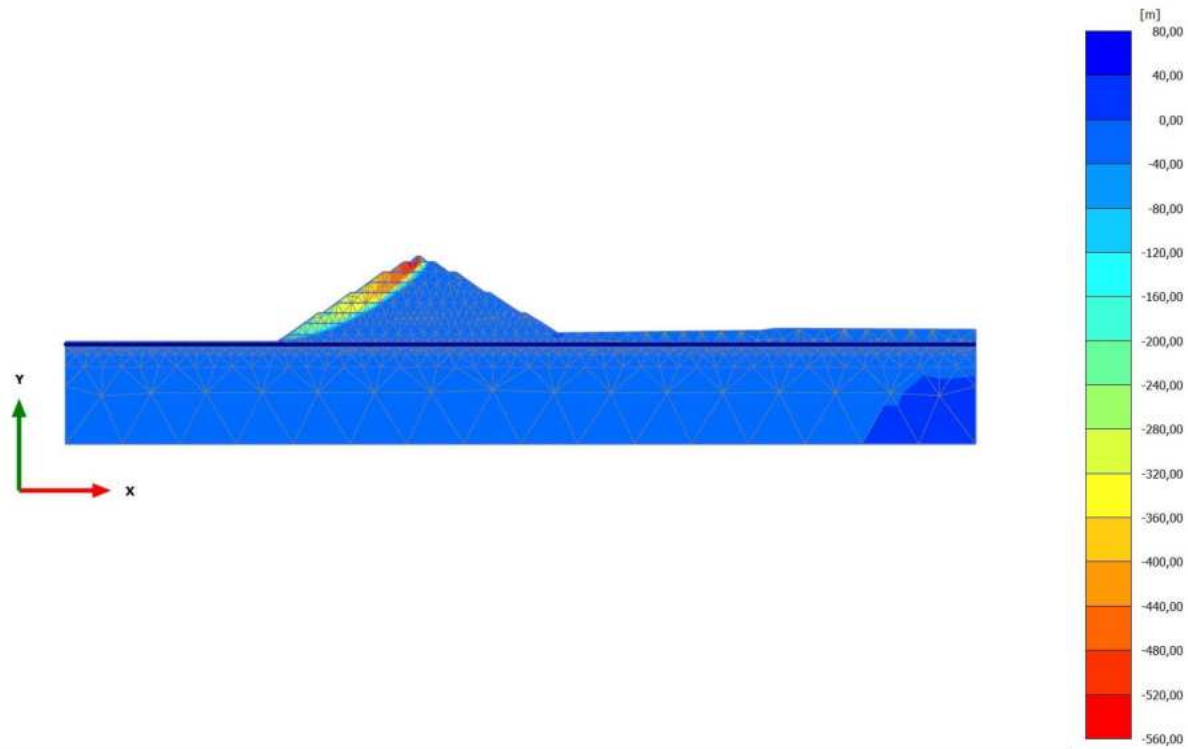
**Total displacements  $u_y$  (scaled up 5,00 times)**  
Maximum value = 0,1511 m (Element 385 at Node 8166)  
Minimum value = -4,231 m (Element 11 at Node 92)

2.1.1.2.6 Calculation results, Phase\_8 \_seismic [Phase\_8] (2/21), Total displacements  $u_y$



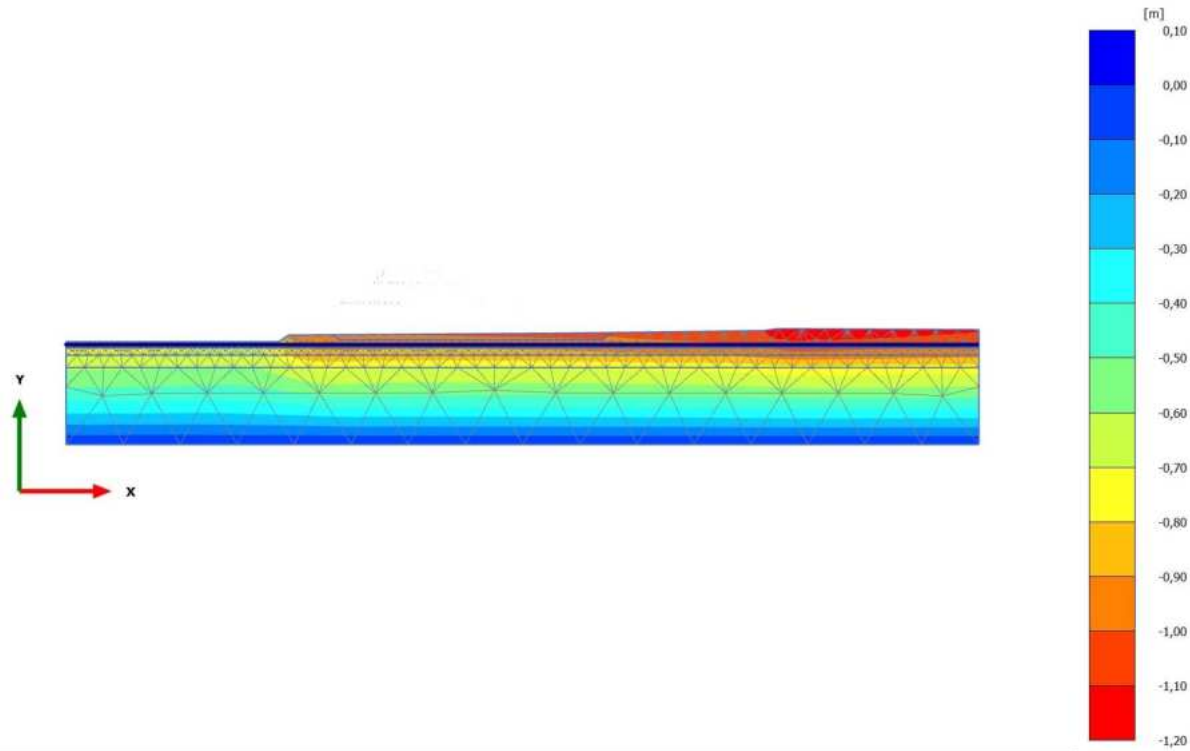
**Total displacements  $u_y$  (scaled up 5,00 times)**  
Maximum value = 0,1563 m (Element 385 at Node 8166)  
Minimum value = -4,278 m (Element 11 at Node 155)

2.1.1.2.7 Calculation results, Phase\_6 FoS seismic [Phase\_6] (13/121), Total displacements  $u_y$



**Total displacements  $u_y$  (scaled up 0,0500 times)**  
Maximum value = 67,39 m (Element 621 at Node 2443)  
Minimum value = -550,2 m (Element 2 at Node 36)

2.1.1.2.8 Calculation results, Initial phase [InitialPhase] (0/137), Total displacements  $u_y$

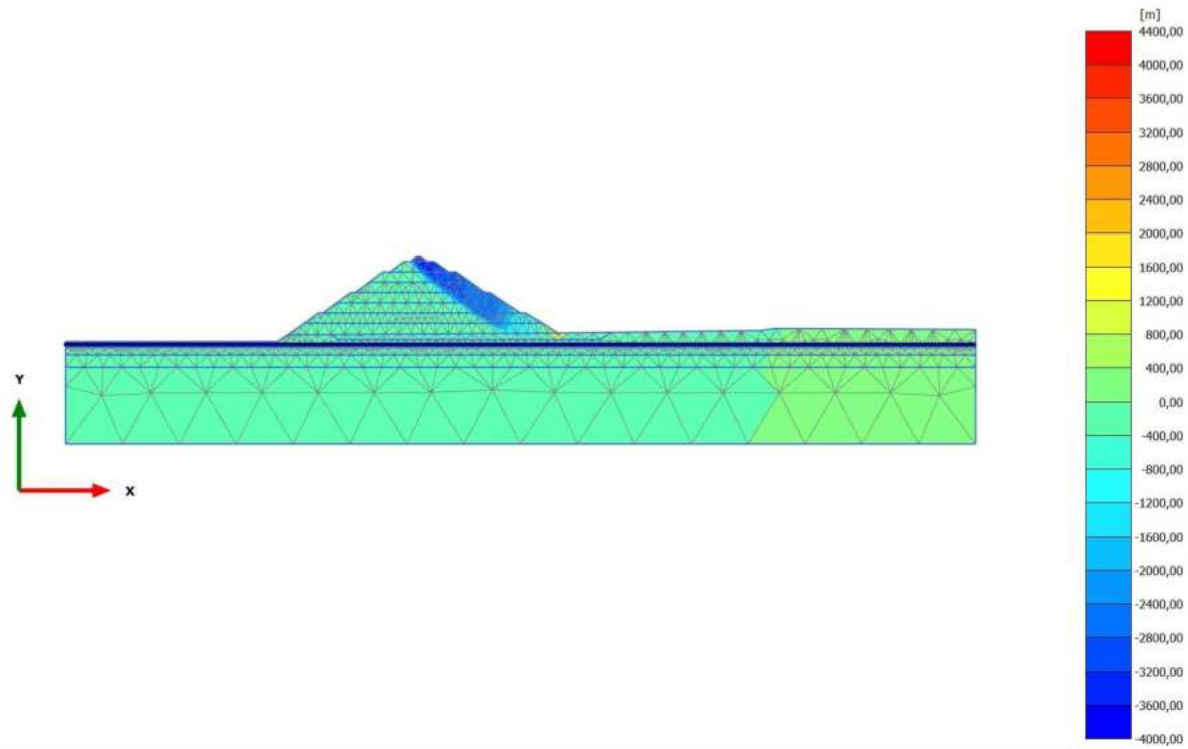


**Total displacements  $u_y$  (scaled up 20,0 times)**

Maximum value = 0,000 m (Element 1790 at Node 5189)

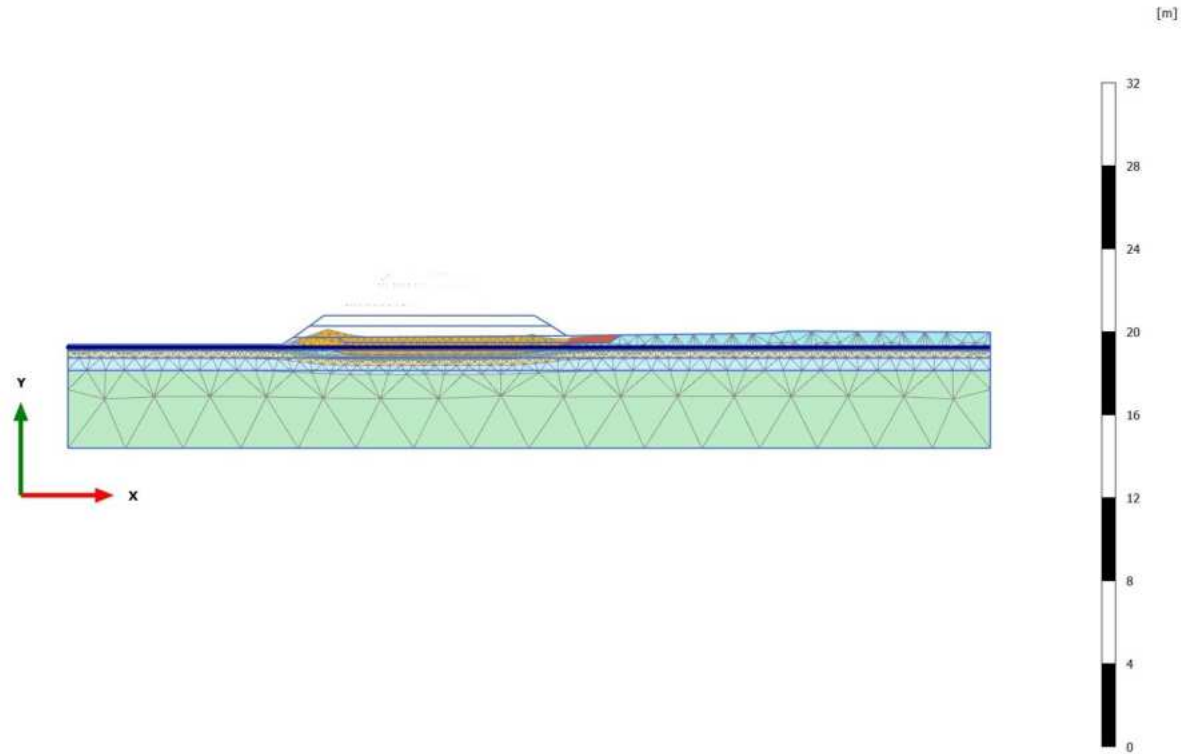
Minimum value = -1,158 m (Element 398 at Node 13241)

2.1.1.2.9 Calculation results, Phase\_7 FoS static [Phase\_7] (1/237), Total displacements  $u_y$



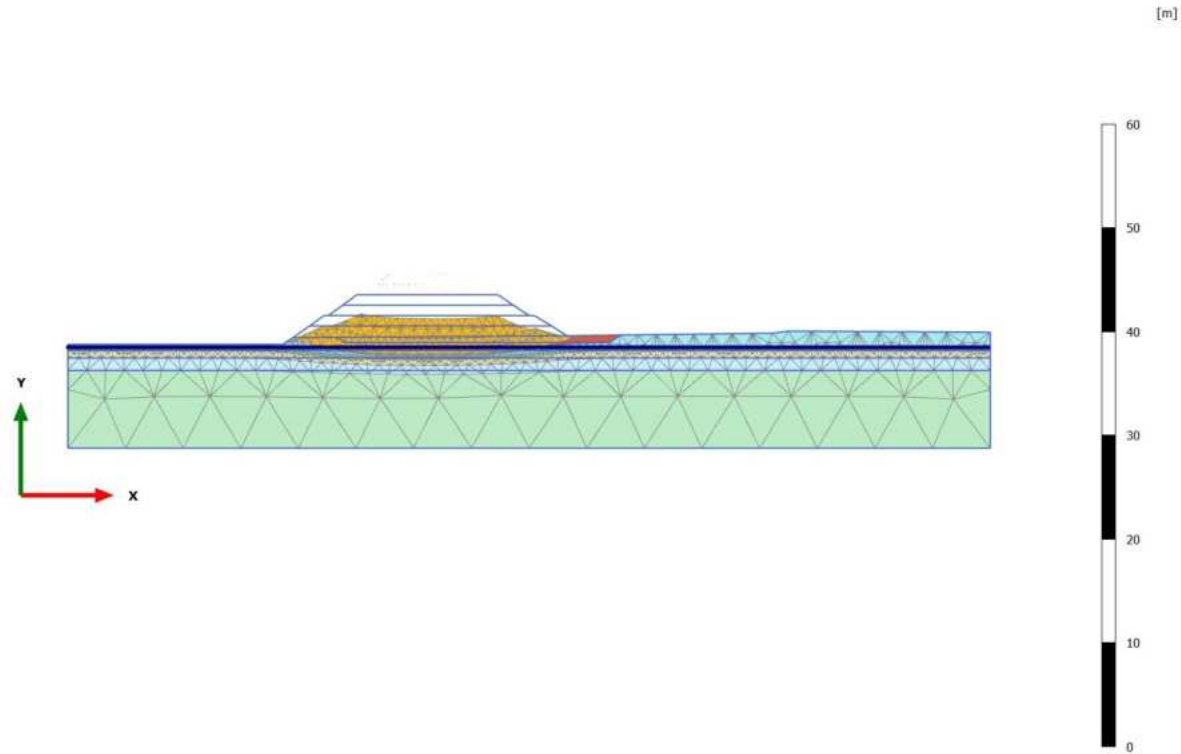
**Total displacements  $u_y$  (scaled up  $5,00 \cdot 10^{-3}$  times)**  
Maximum value = 4271 m (Element 385 at Node 8166)  
Minimum value = -3693 m (Element 3 at Node 29)

2.1.2.1 Calculation results, Phase\_1 [Phase\_1] (8/4), Deformed mesh |u|



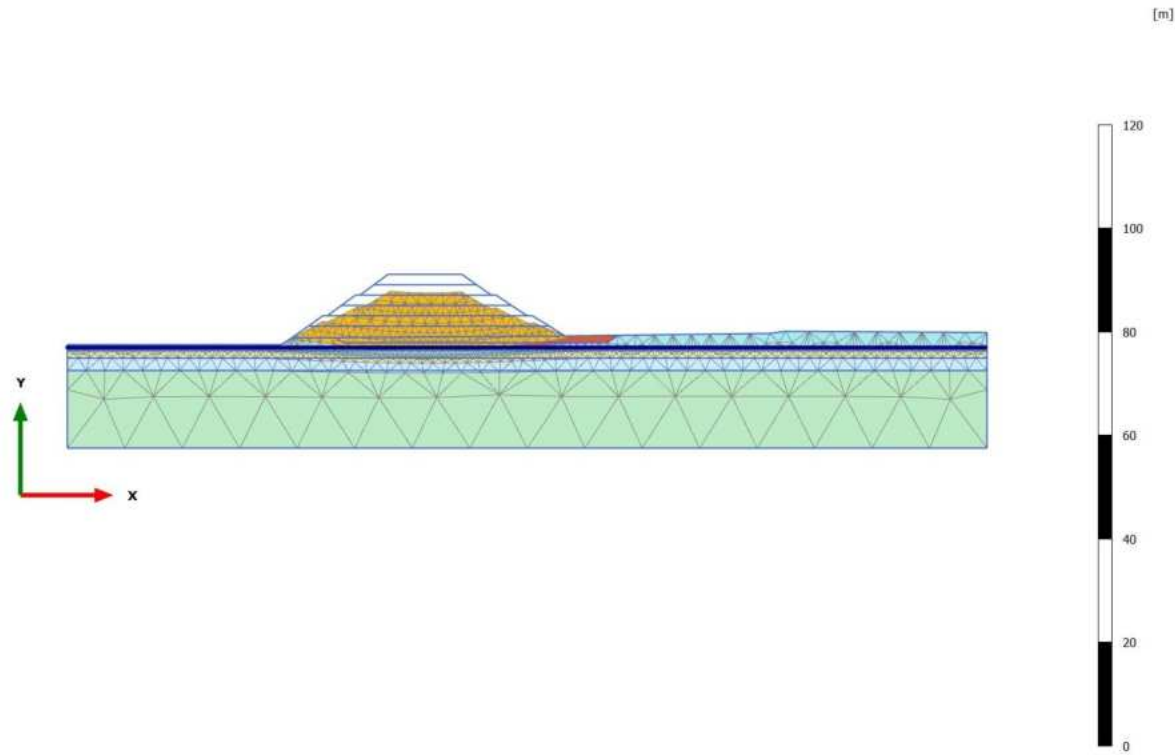
**Deformed mesh |u| (scaled up 20,0 times)**  
Maximum value = 1,047 m (Element 198 at Node 1565)

2.1.2.2 Calculation results, Phase\_2 [Phase\_2] (9/8), Deformed mesh |u|



**Deformed mesh |u| (scaled up 10,0 times)**  
Maximum value = 2,297 m (Element 107 at Node 673)

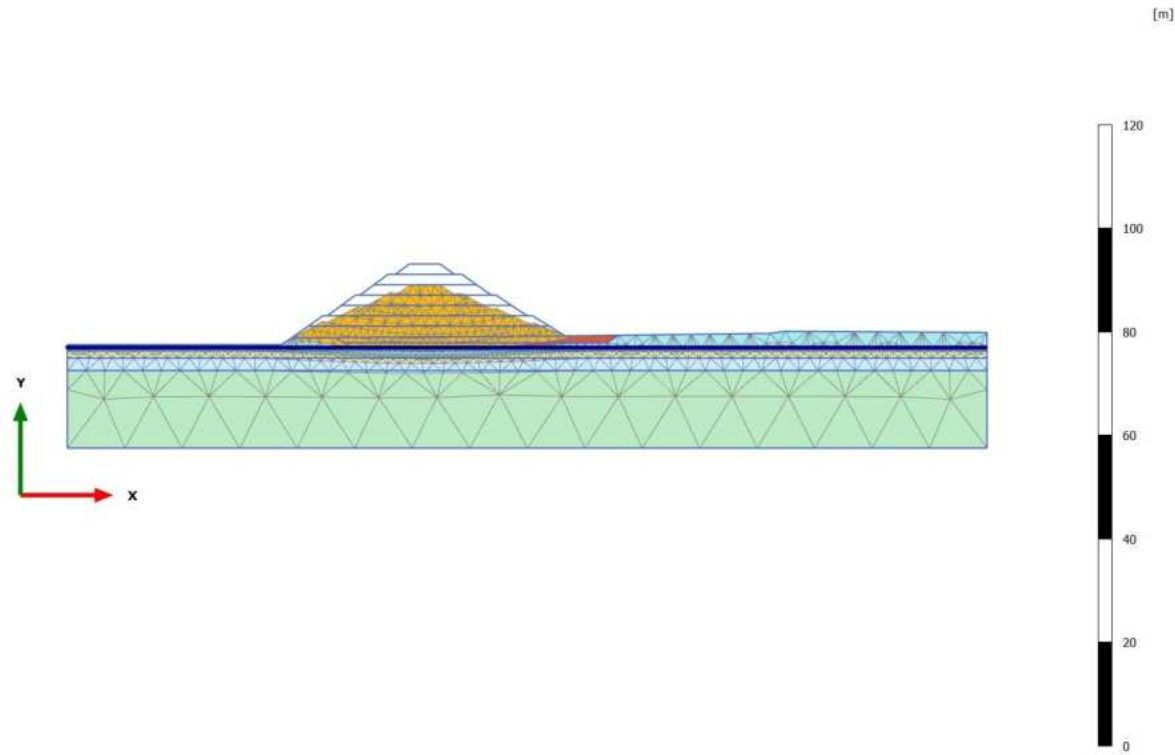
2.1.2.3 Calculation results, Phase\_3 [Phase\_3] (10/11), Deformed mesh |u|



**Deformed mesh |u| (scaled up 5,00 times)**  
Maximum value = 3,605 m (Element 30 at Node 180)

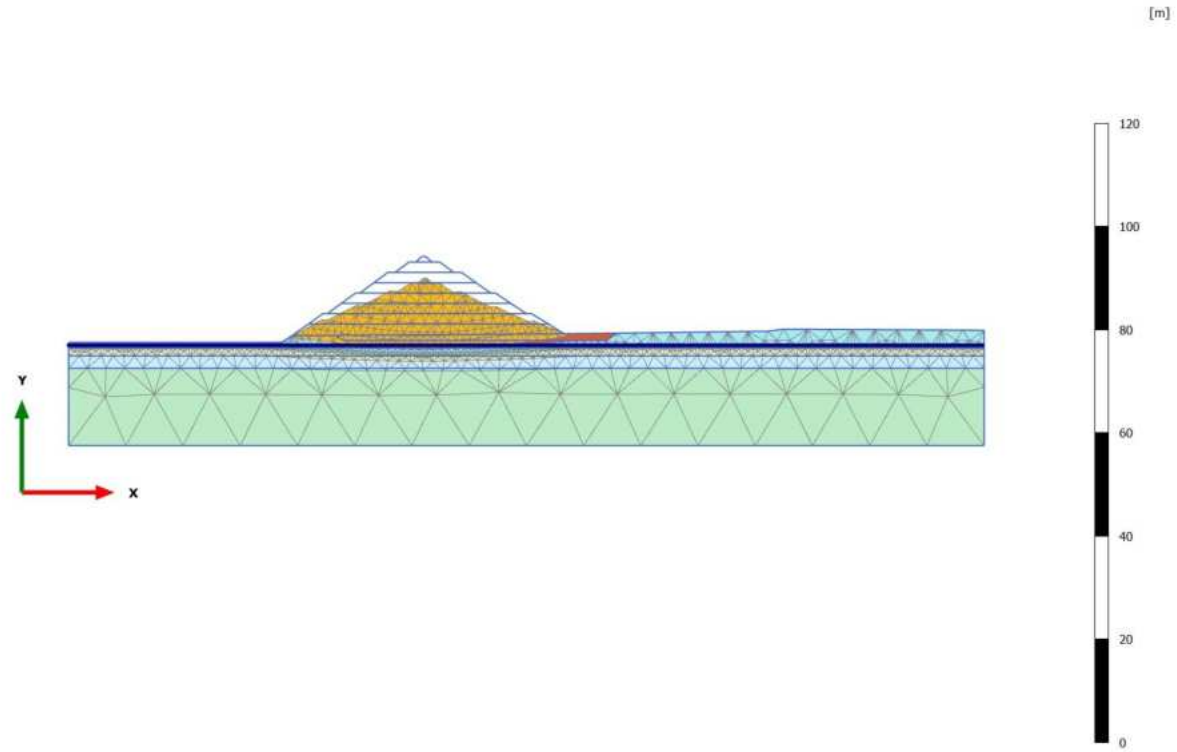


2.1.2.4 Calculation results, Phase\_4 [Phase\_4] (11/14), Deformed mesh |u|



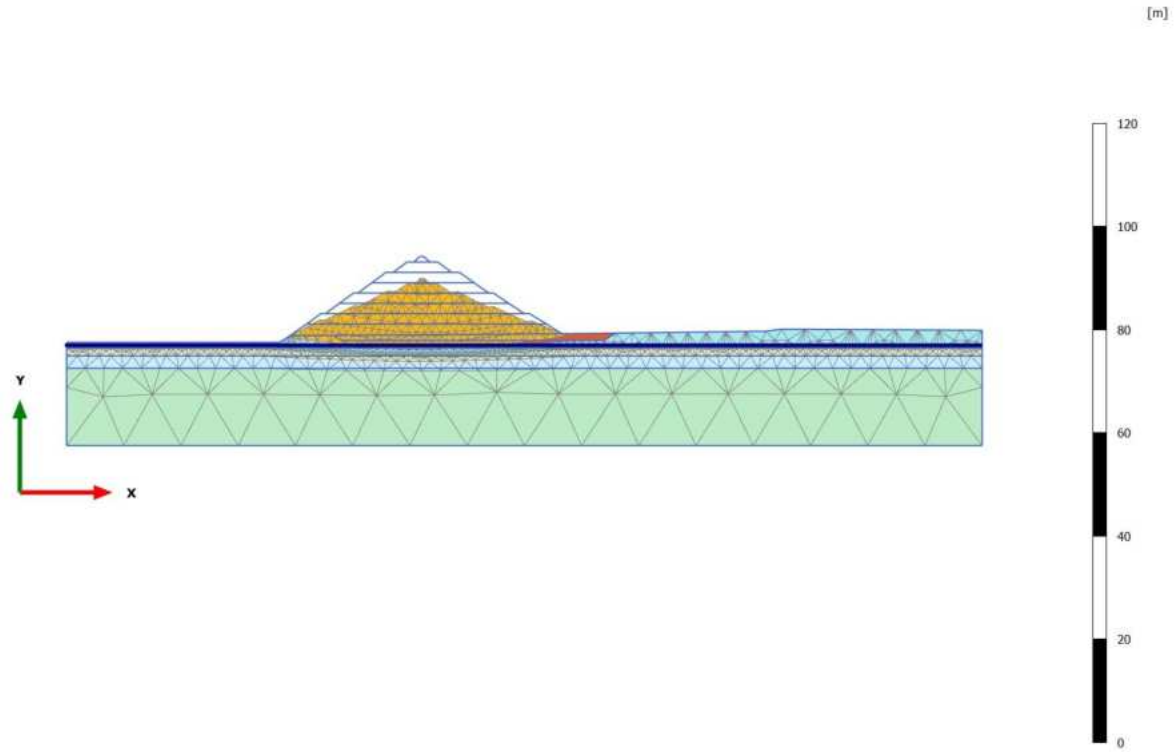
**Deformed mesh |u| (scaled up 5,00 times)**  
Maximum value = 4,126 m (Element 11 at Node 155)

2.1.2.5 Calculation results, Phase\_5\_static [Phase\_5] (12/18), Deformed mesh |u|



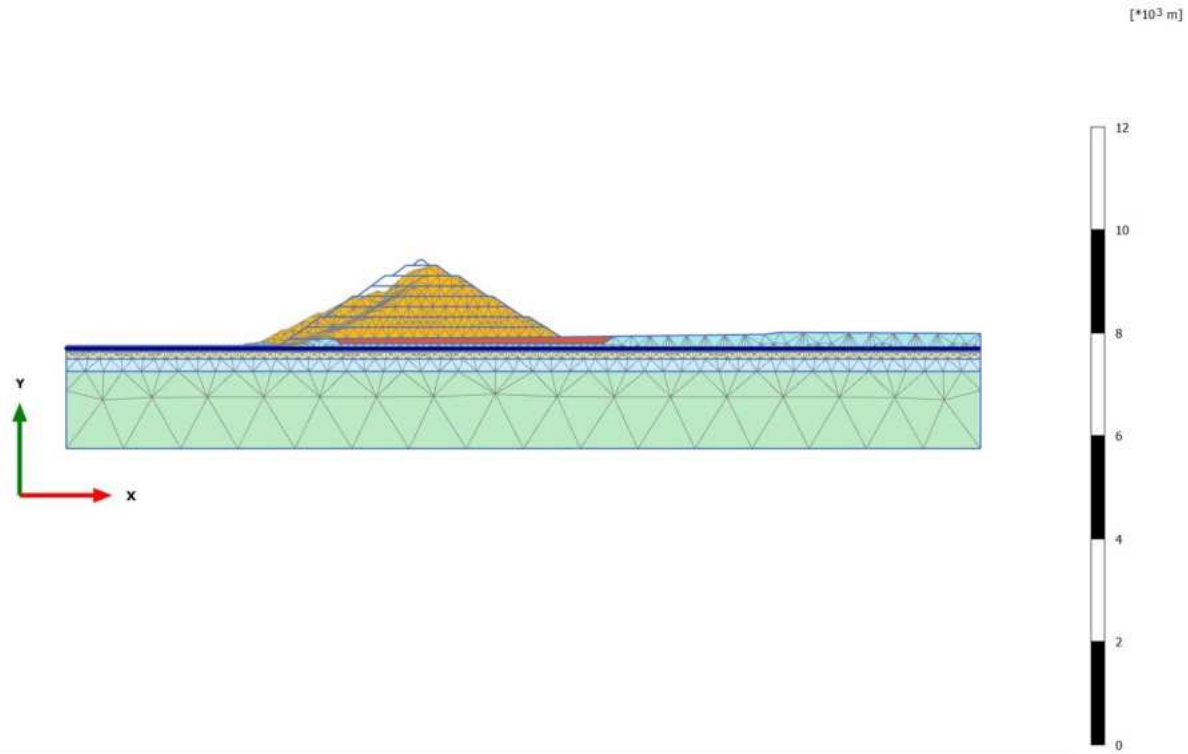
**Deformed mesh |u| (scaled up 5,00 times)**  
Maximum value = 4,235 m (Element 11 at Node 93)

2.1.2.6 Calculation results, Phase\_8 \_seismic [Phase\_8] (2/21), Deformed mesh |u|



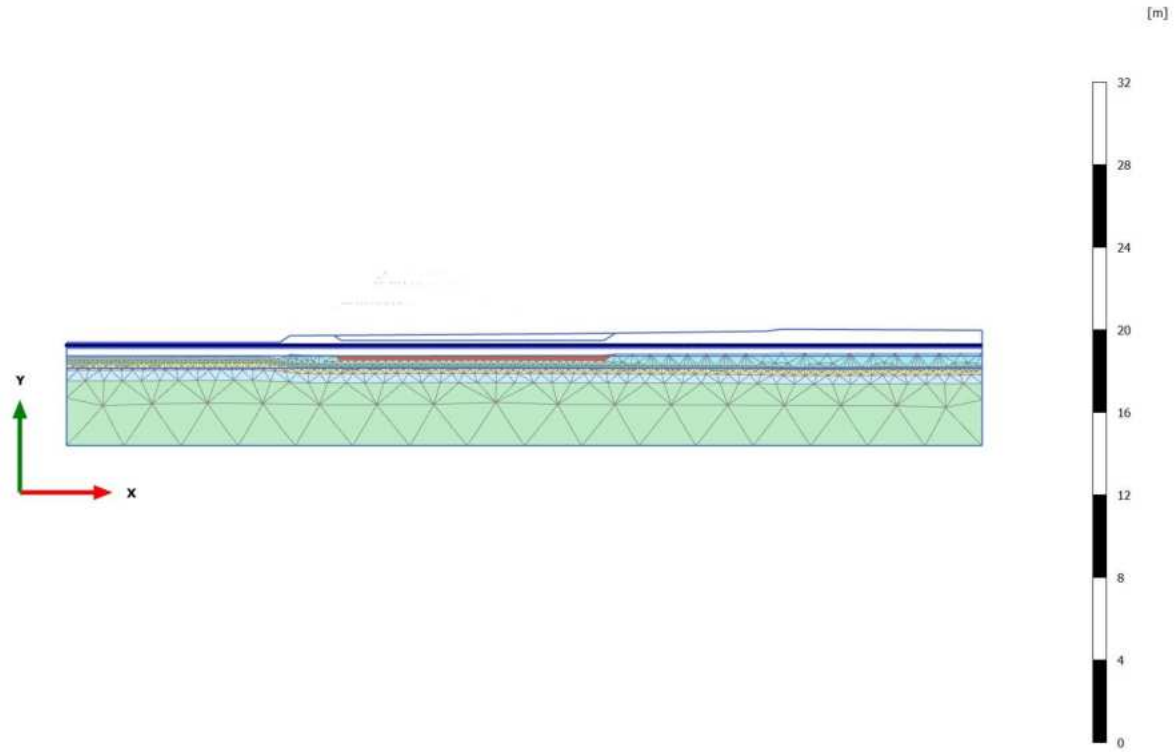
**Deformed mesh |u| (scaled up 5,00 times)**  
Maximum value = 4,278 m (Element 11 at Node 155)

2.1.2.7 Calculation results, Phase\_6 FoS seismic [Phase\_6] (13/121), Deformed mesh |u|



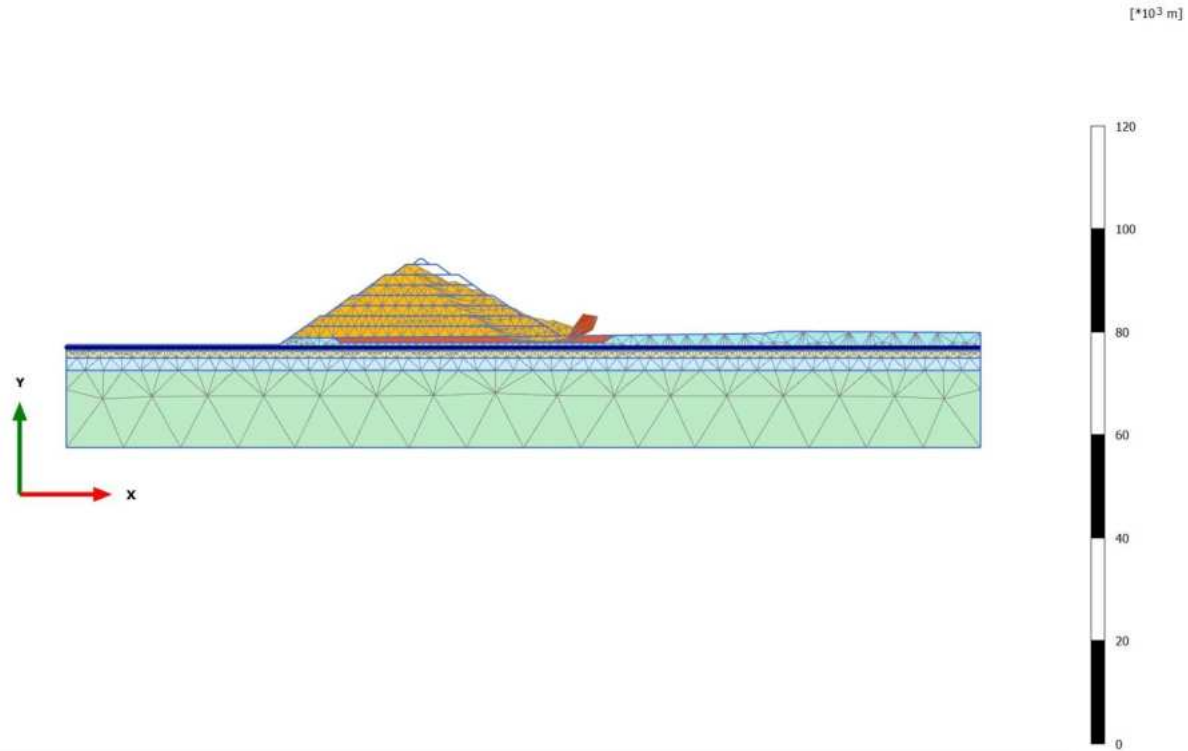
**Deformed mesh |u| (scaled up 0,0500 times)**  
Maximum value = 820,4 m (Element 631 at Node 2092)

2.1.2.8 Calculation results, Initial phase [InitialPhase] (0/137), Deformed mesh |u|



**Deformed mesh |u| (scaled up 20,0 times)**  
Maximum value = 1,158 m (Element 398 at Node 13241)

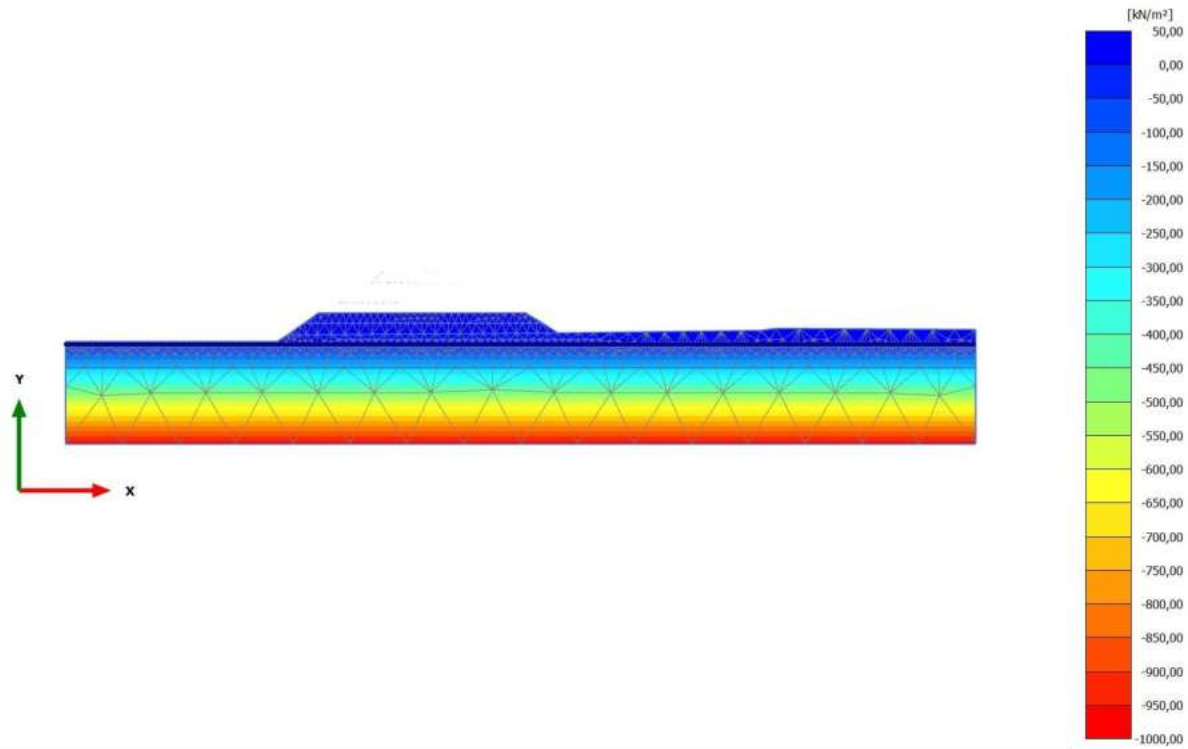
2.1.2.9 Calculation results, Phase\_7 FoS static [Phase\_7] (1/237), Deformed mesh |u|



**Deformed mesh |u| (scaled up  $5,00 \cdot 10^{-3}$  times)**

Maximum value = 8135 m (Element 287 at Node 8163)

2.2.1.1.1 Calculation results, Phase\_1 [Phase\_1] (8/4), Steady state pore pressures  $p_{steady}$

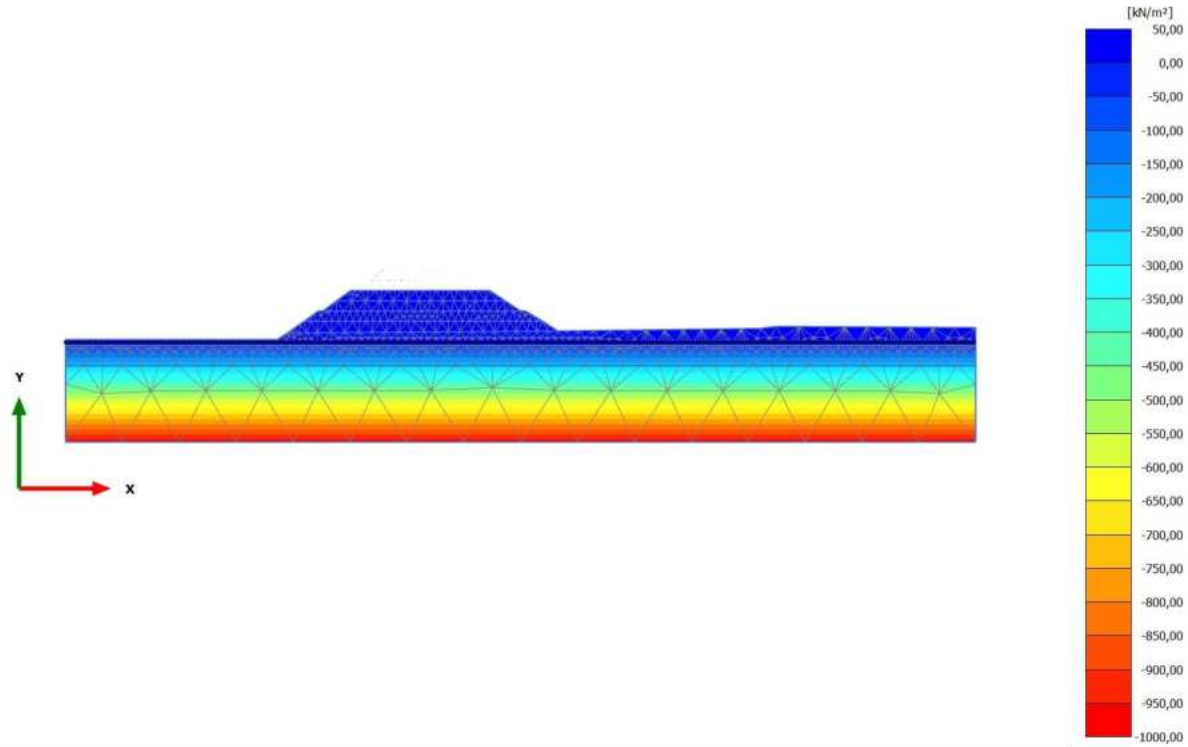


**Steady state pore pressures  $p_{steady}$  (scaled up 0,0200 times) (Pressure = negative)**

Maximum value = 0,000  $\text{kN/m}^2$  (Element 169 at Node 5713)

Minimum value = -972,7  $\text{kN/m}^2$  (Element 1791 at Node 14485)

2.2.1.1.2 Calculation results, Phase\_2 [Phase\_2] (9/8), Steady state pore pressures  $p_{steady}$



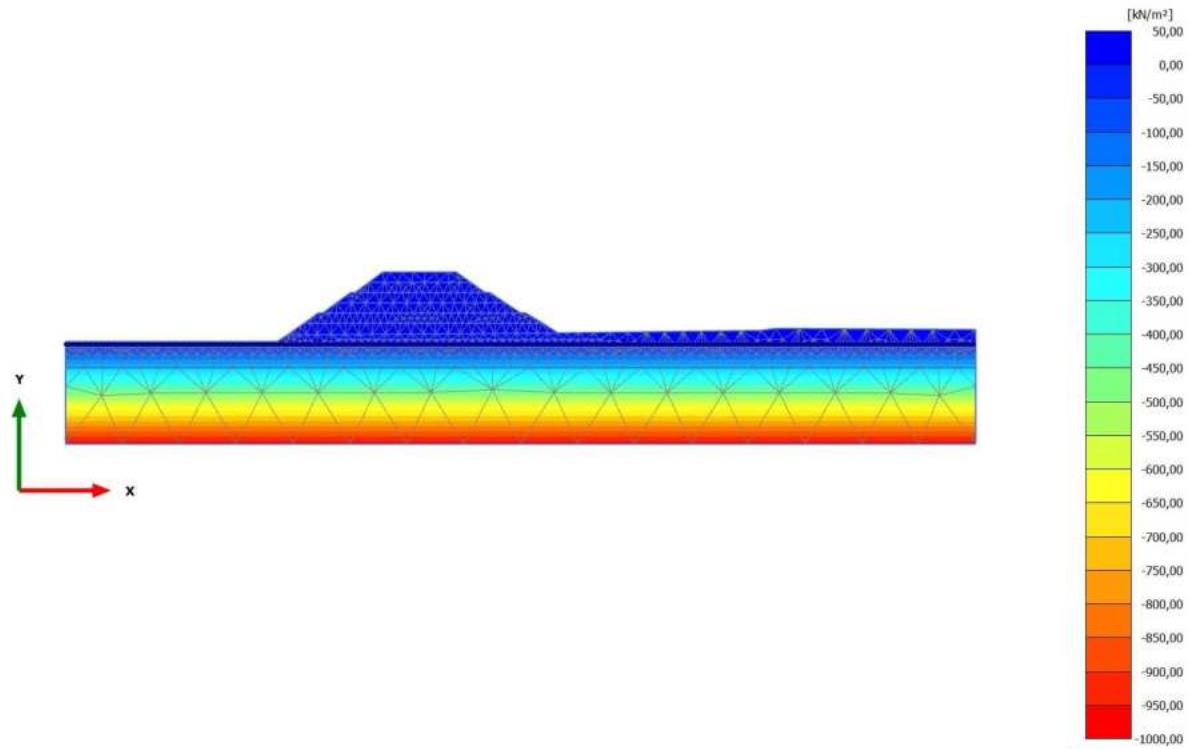
**Steady state pore pressures  $p_{steady}$  (scaled up 0,0200 times) (Pressure = negative)**

Maximum value = 0,000 kN/m<sup>2</sup> (Element 81 at Node 895)

Minimum value = -972,7 kN/m<sup>2</sup> (Element 1791 at Node 14485)



2.2.1.1.3 Calculation results, Phase\_3 [Phase\_3] (10/11), Steady state pore pressures  $p_{steady}$

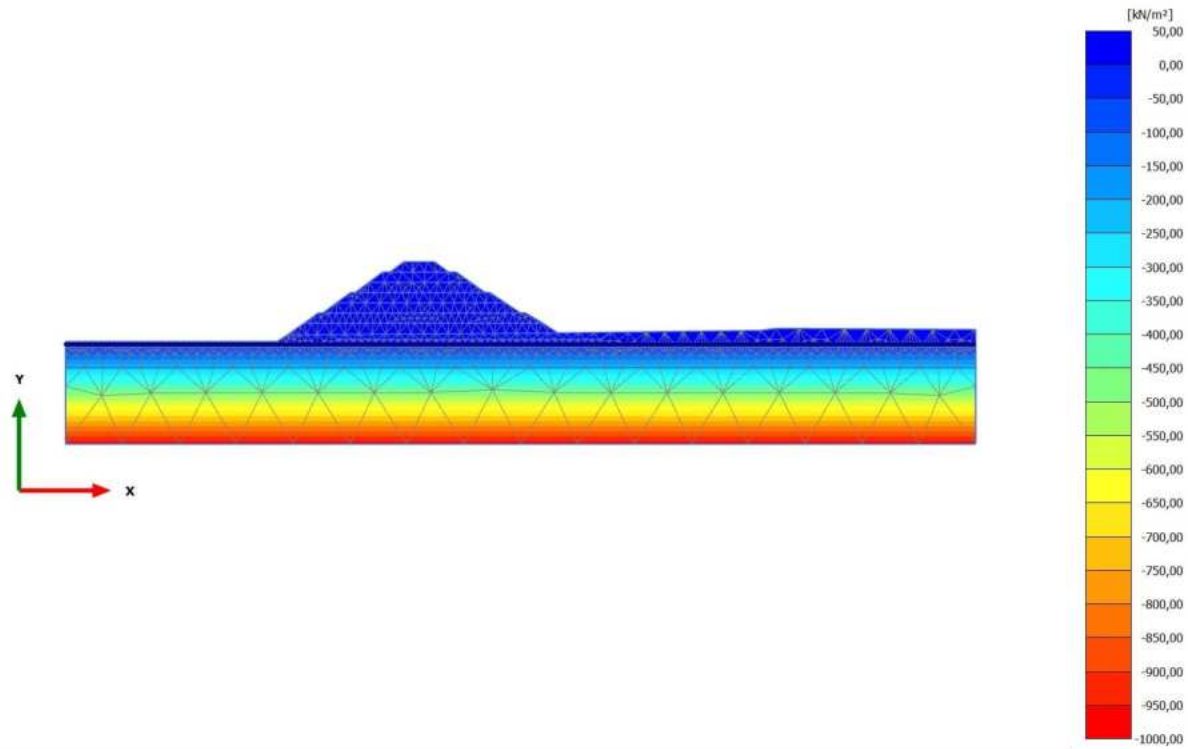


**Steady state pore pressures  $p_{steady}$  (scaled up 0,0200 times) (Pressure = negative)**

Maximum value = 0,000 kN/m<sup>2</sup> (Element 22 at Node 458)

Minimum value = -972,7 kN/m<sup>2</sup> (Element 1791 at Node 14485)

2.2.1.1.4 Calculation results, Phase\_4 [Phase\_4] (11/14), Steady state pore pressures  $p_{steady}$

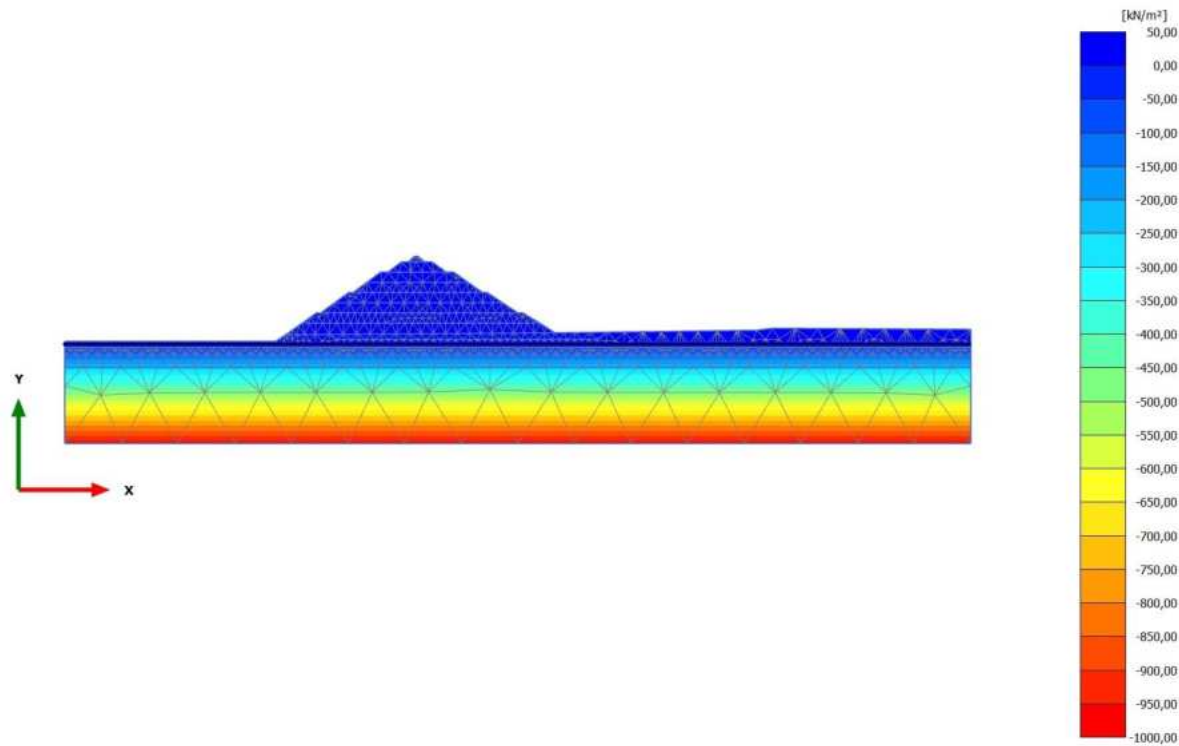


**Steady state pore pressures  $p_{steady}$  (scaled up 0,0200 times) (Pressure = negative)**

Maximum value = 0,000 kN/m<sup>2</sup> (Element 10 at Node 175)

Minimum value = -972,7 kN/m<sup>2</sup> (Element 1791 at Node 14485)

2.2.1.1.5 Calculation results, Phase\_5\_static [Phase\_5] (12/18), Steady state pore pressures  $p_{\text{steady}}$

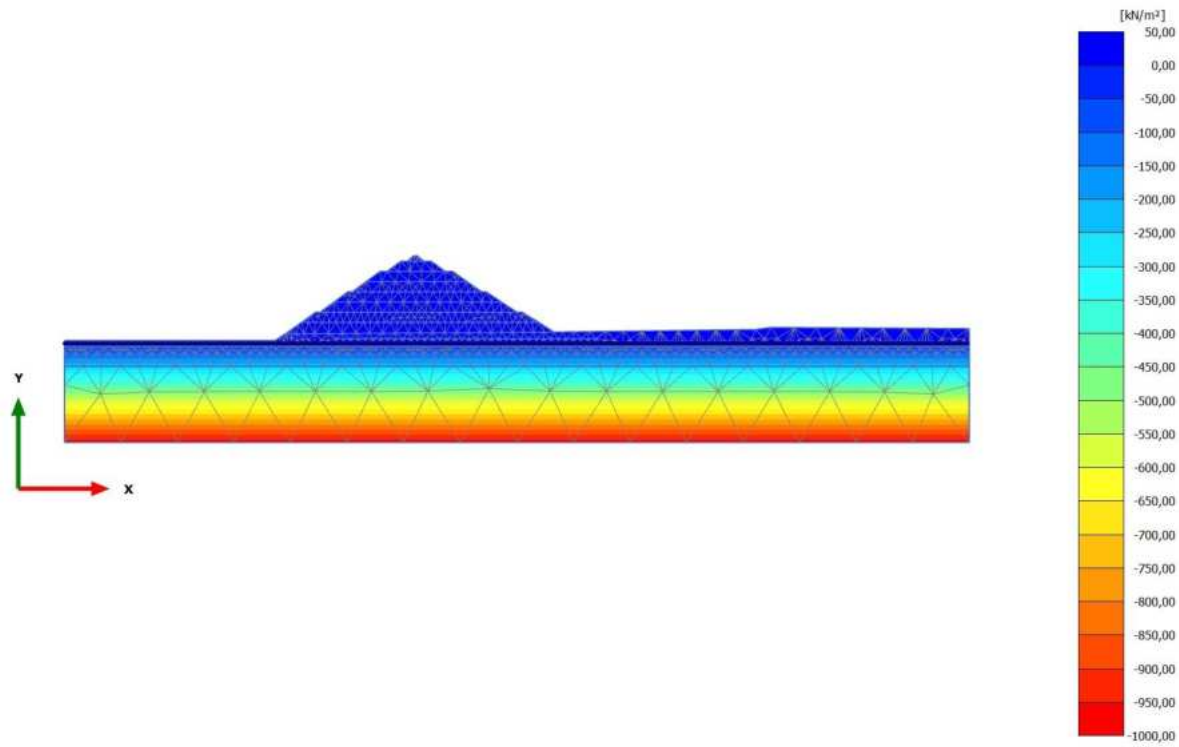


**Steady state pore pressures  $p_{\text{steady}}$  (scaled up 0,0200 times) (Pressure = negative)**

Maximum value = 0,000 kN/m<sup>2</sup> (Element 1 at Node 13)

Minimum value = -972,7 kN/m<sup>2</sup> (Element 1791 at Node 14485)

2.2.1.1.6 Calculation results, Phase\_8 \_seismic [Phase\_8] (2/21), Steady state pore pressures  $p_{\text{steady}}$

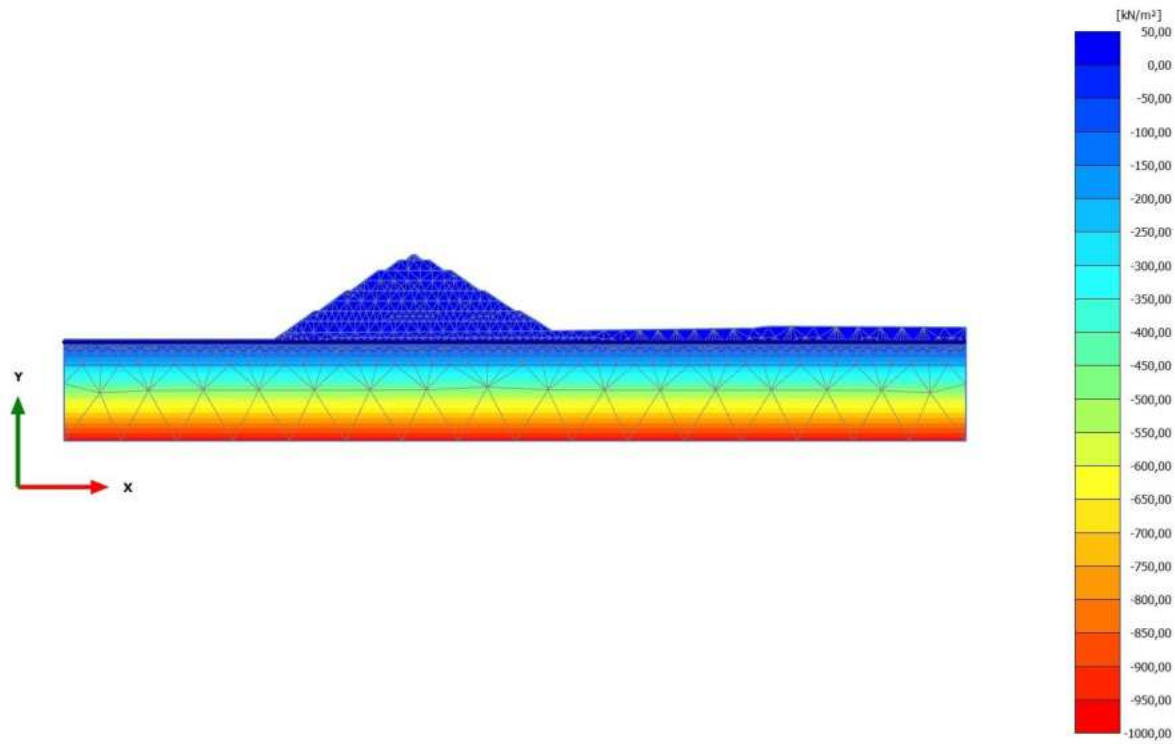


**Steady state pore pressures  $p_{\text{steady}}$  (scaled up 0,0200 times) (Pressure = negative)**

Maximum value = 0,000 kN/m<sup>2</sup> (Element 1 at Node 13)

Minimum value = -975,7 kN/m<sup>2</sup> (Element 1791 at Node 14485)

2.2.1.1.7 Calculation results, Phase\_6 FoS seismic [Phase\_6] (13/121), Steady state pore pressures  $p_{steady}$

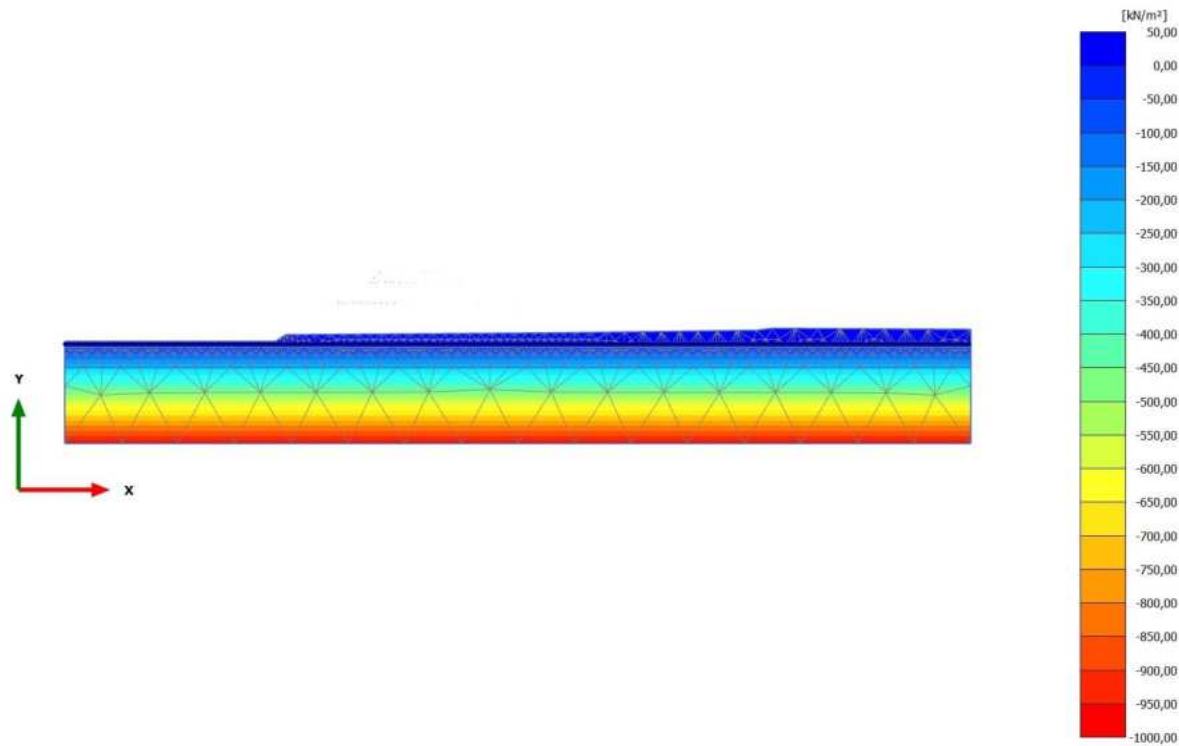


**Steady state pore pressures  $p_{steady}$  (scaled up 0,0200 times) (Pressure = negative)**

Maximum value = 0,000 kN/m<sup>2</sup> (Element 1 at Node 13)

Minimum value = -975,7 kN/m<sup>2</sup> (Element 1791 at Node 14485)

2.2.1.1.8 Calculation results, Initial phase [InitialPhase] (0/137), Steady state pore pressures  $p_{\text{steady}}$

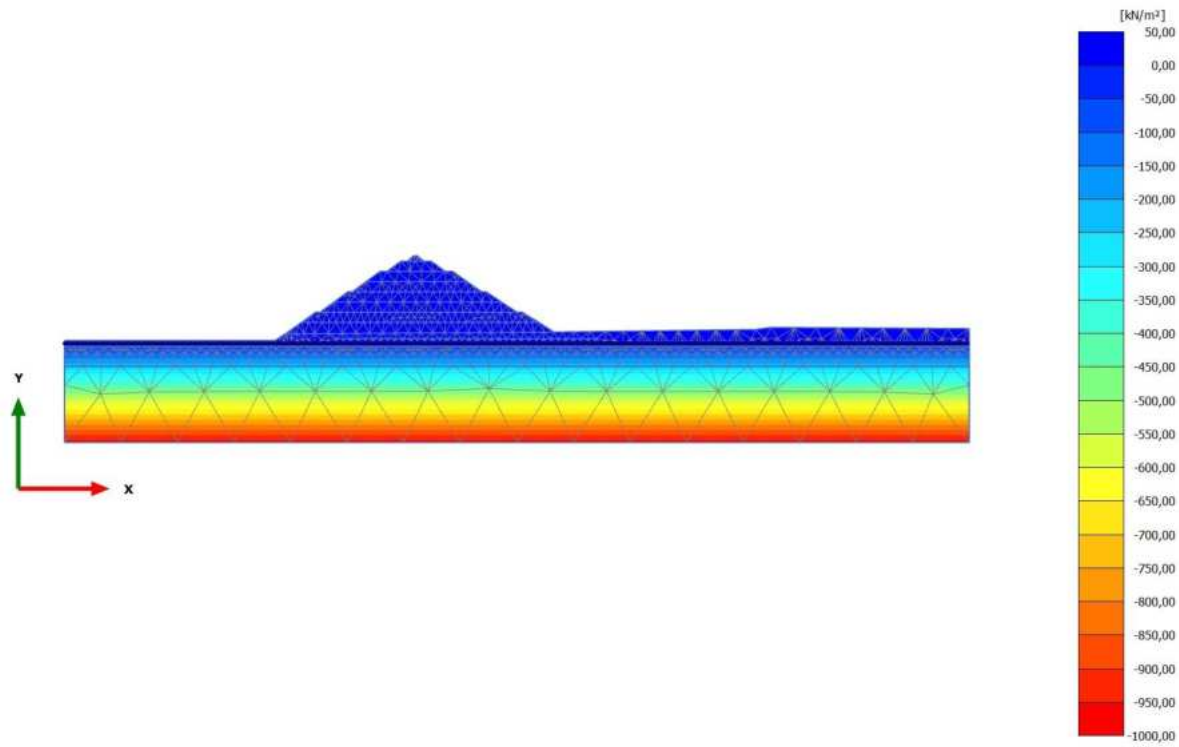


**Steady state pore pressures  $p_{\text{steady}}$  (scaled up 0,0200 times) (Pressure = negative)**

Maximum value = 0,000 kN/m<sup>2</sup> (Element 333 at Node 9763)

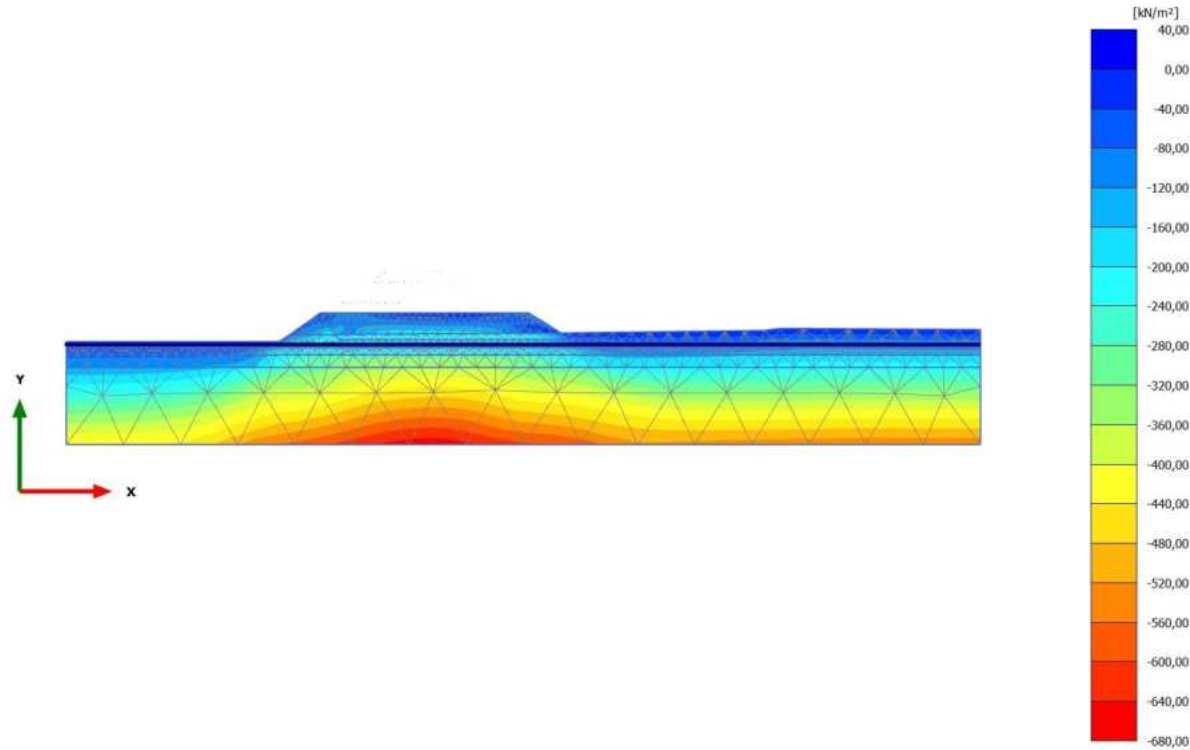
Minimum value = -972,7 kN/m<sup>2</sup> (Element 1791 at Node 14485)

2.2.1.1.9 Calculation results, Phase\_7 FoS static [Phase\_7] (1/237), Steady state pore pressures  $p_{\text{steady}}$



**Steady state pore pressures  $p_{\text{steady}}$  (scaled up 0,0200 times) (Pressure = negative)**  
Maximum value = 0,000 kN/m<sup>2</sup> (Element 1 at Node 13)  
Minimum value = -972,7 kN/m<sup>2</sup> (Element 1791 at Node 14485)

2.2.2.1.1 Calculation results, Phase\_1 [Phase\_1] (8/4), Cartesian effective stress  $\sigma'_{xx}$



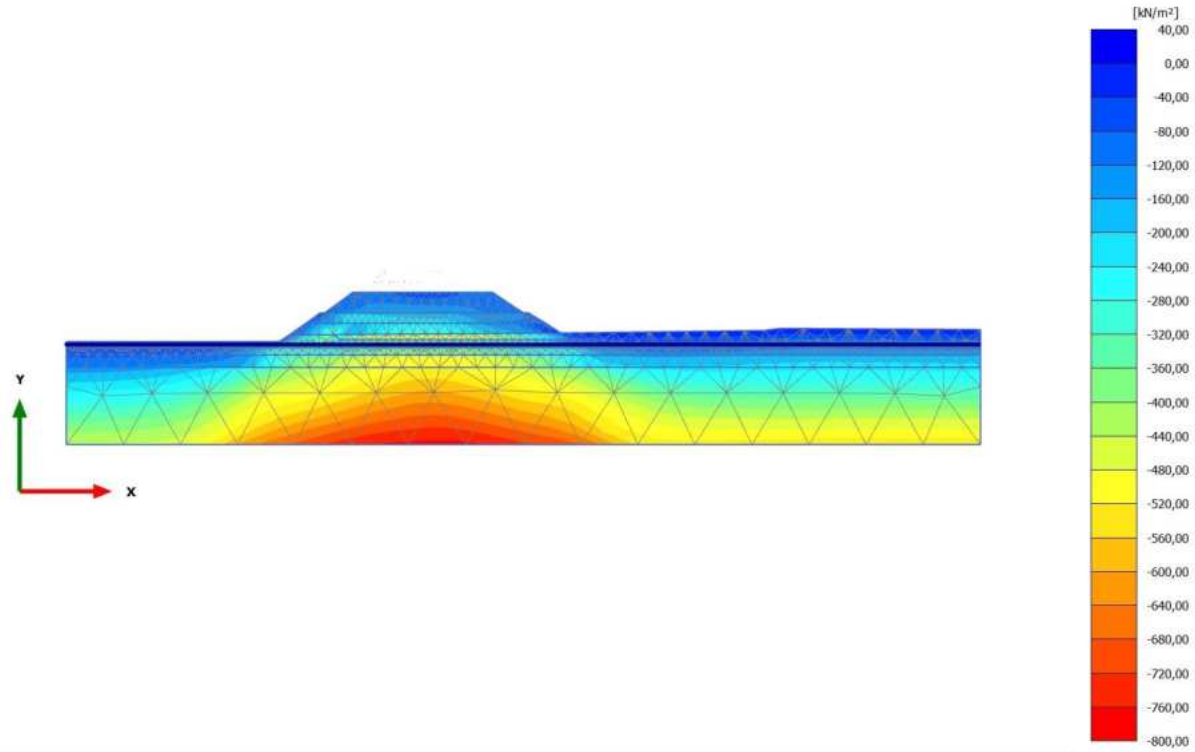
**Cartesian effective stress  $\sigma'_{xx}$  (scaled up 0,0500 times)**

Maximum value = 4,793 kN/m<sup>2</sup> (Element 404 at Node 12805)

Minimum value = -663,8 kN/m<sup>2</sup> (Element 1799 at Node 10011)



2.2.2.1.2 Calculation results, Phase\_2 [Phase\_2] (9/8), Cartesian effective stress  $\sigma'_{xx}$

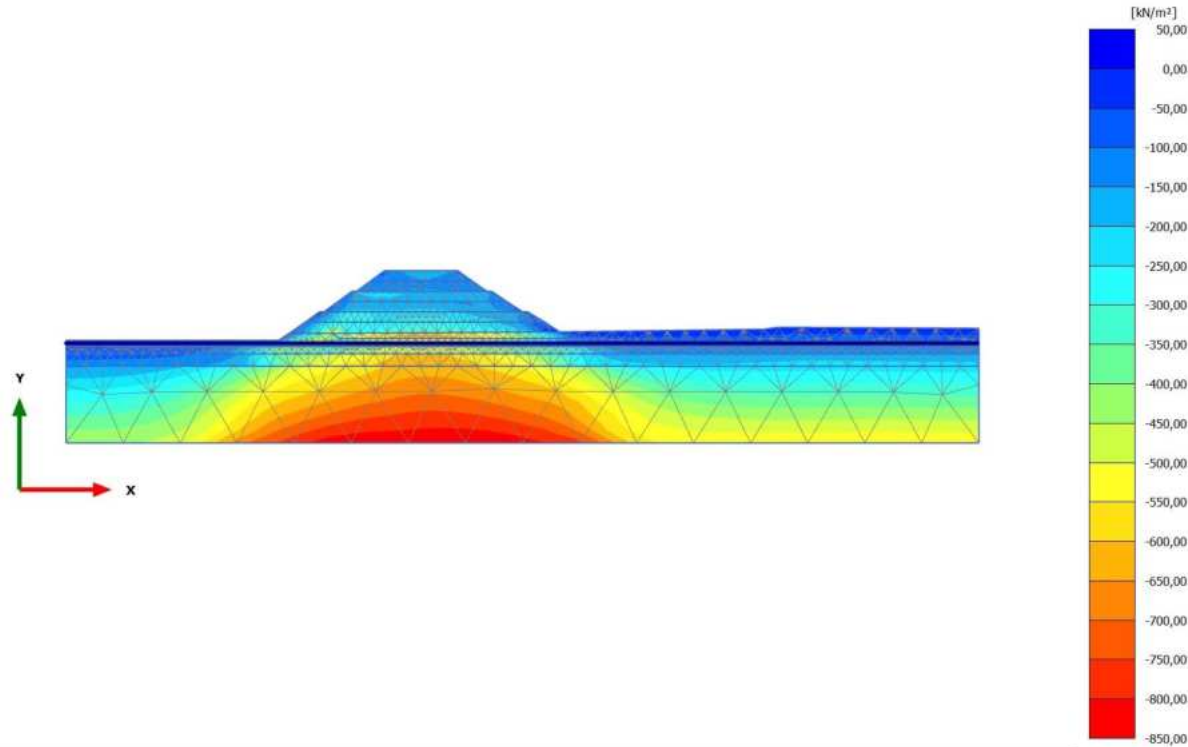


**Cartesian effective stress  $\sigma'_{xx}$  (scaled up 0,0500 times)**

Maximum value = 4,138 kN/m<sup>2</sup> (Element 404 at Node 12805)

Minimum value = -774,3 kN/m<sup>2</sup> (Element 1799 at Node 10012)

2.2.2.1.3 Calculation results, Phase\_3 [Phase\_3] (10/11), Cartesian effective stress  $\sigma'_{xx}$

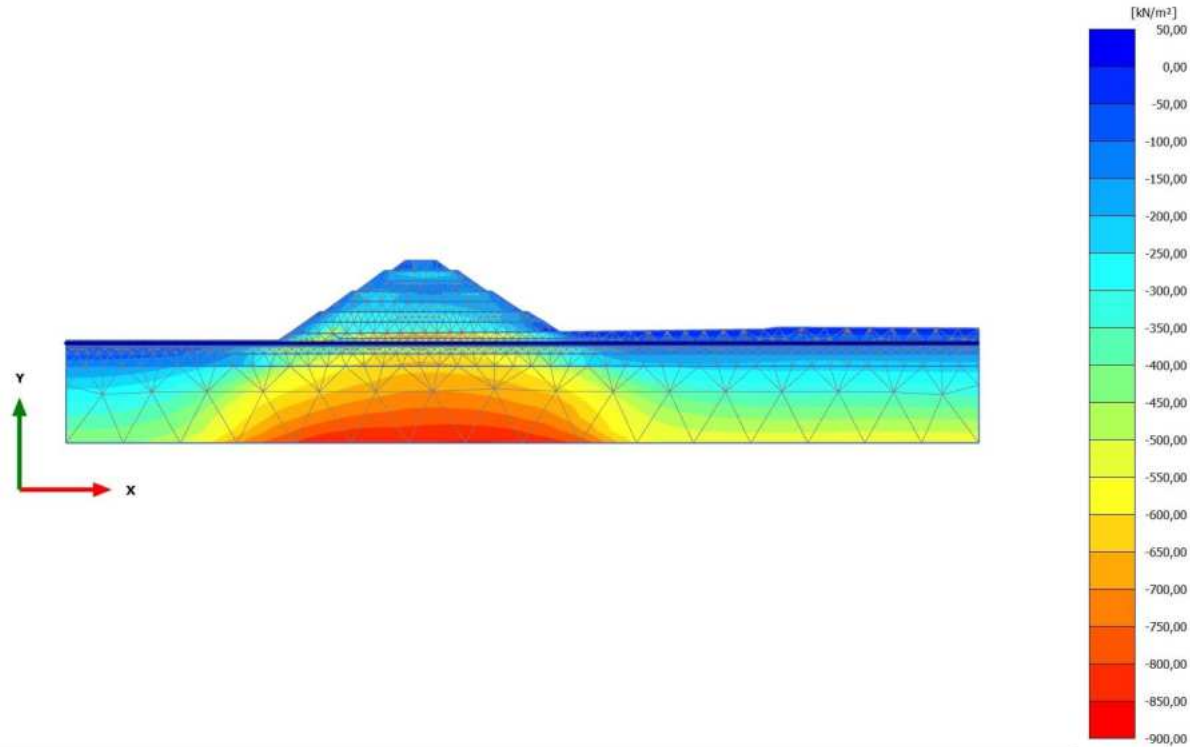


**Cartesian effective stress  $\sigma'_{xx}$  (scaled up 0,0500 times)**

Maximum value = 3,272 kN/m<sup>2</sup> (Element 404 at Node 12805)

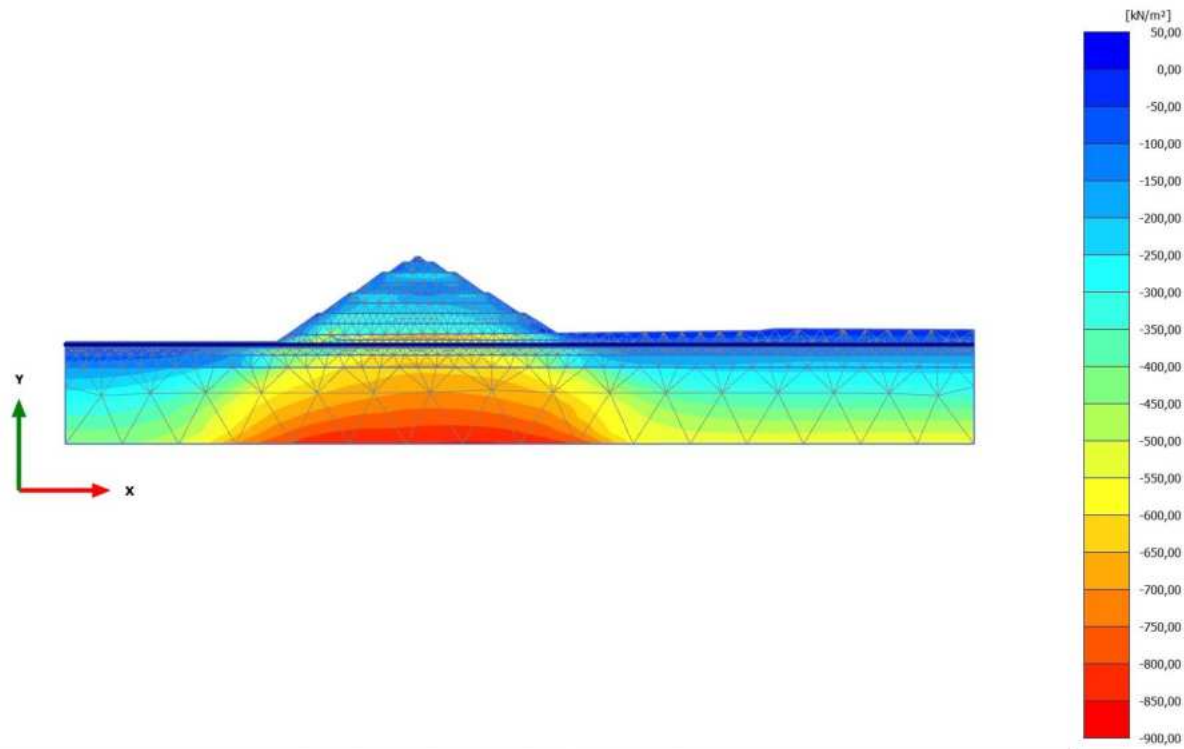
Minimum value = -846,2 kN/m<sup>2</sup> (Element 1798 at Node 10697)

2.2.2.1.4 Calculation results, Phase\_4 [Phase\_4] (11/14), Cartesian effective stress  $\sigma'_{xx}$



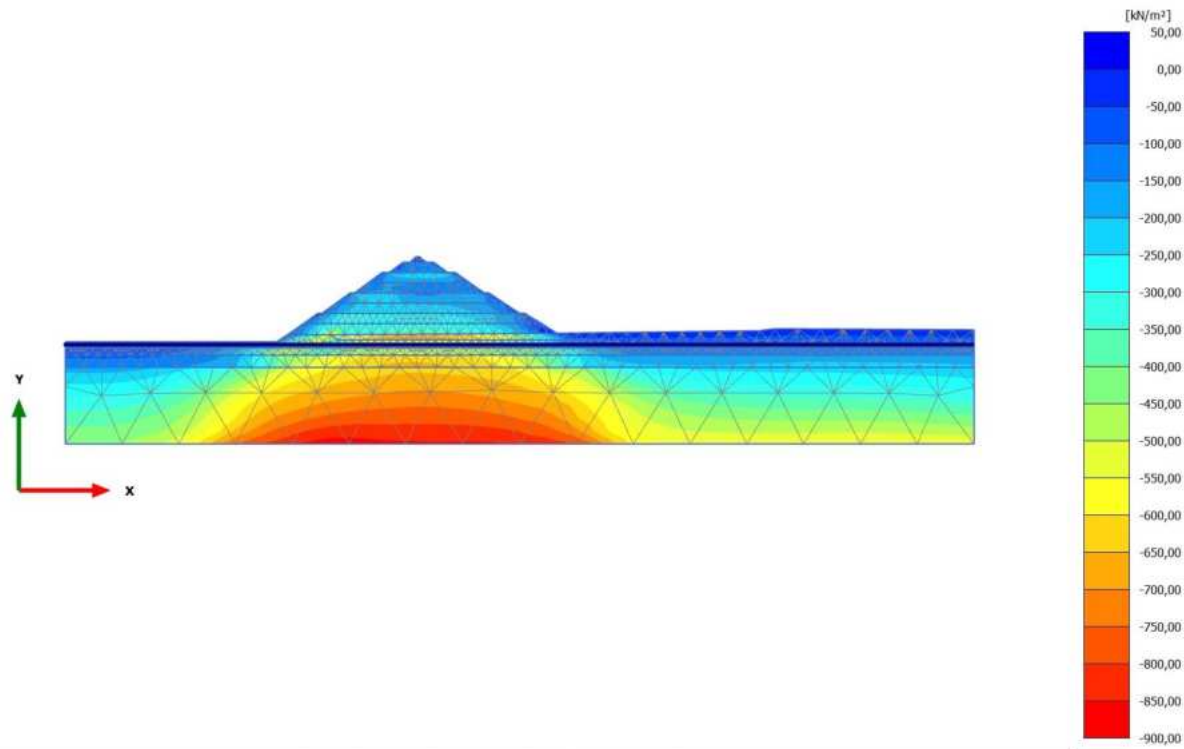
**Cartesian effective stress  $\sigma'_{xx}$  (scaled up 0,0500 times)**  
Maximum value = 2,953  $\text{kN/m}^2$  (Element 404 at Node 12805)  
Minimum value = -857,9  $\text{kN/m}^2$  (Element 1798 at Node 10701)

2.2.2.1.5 Calculation results, Phase\_5\_static [Phase\_5] (12/18), Cartesian effective stress  $\sigma'_{xx}$



**Cartesian effective stress  $\sigma'_{xx}$  (scaled up 0,0200 times)**  
Maximum value = 2,900 kN/m<sup>2</sup> (Element 404 at Node 12805)  
Minimum value = -858,7 kN/m<sup>2</sup> (Element 1798 at Node 10701)

2.2.2.1.6 Calculation results, Phase\_8 \_seismic [Phase\_8] (2/21), Cartesian effective stress  $\sigma'_{xx}$

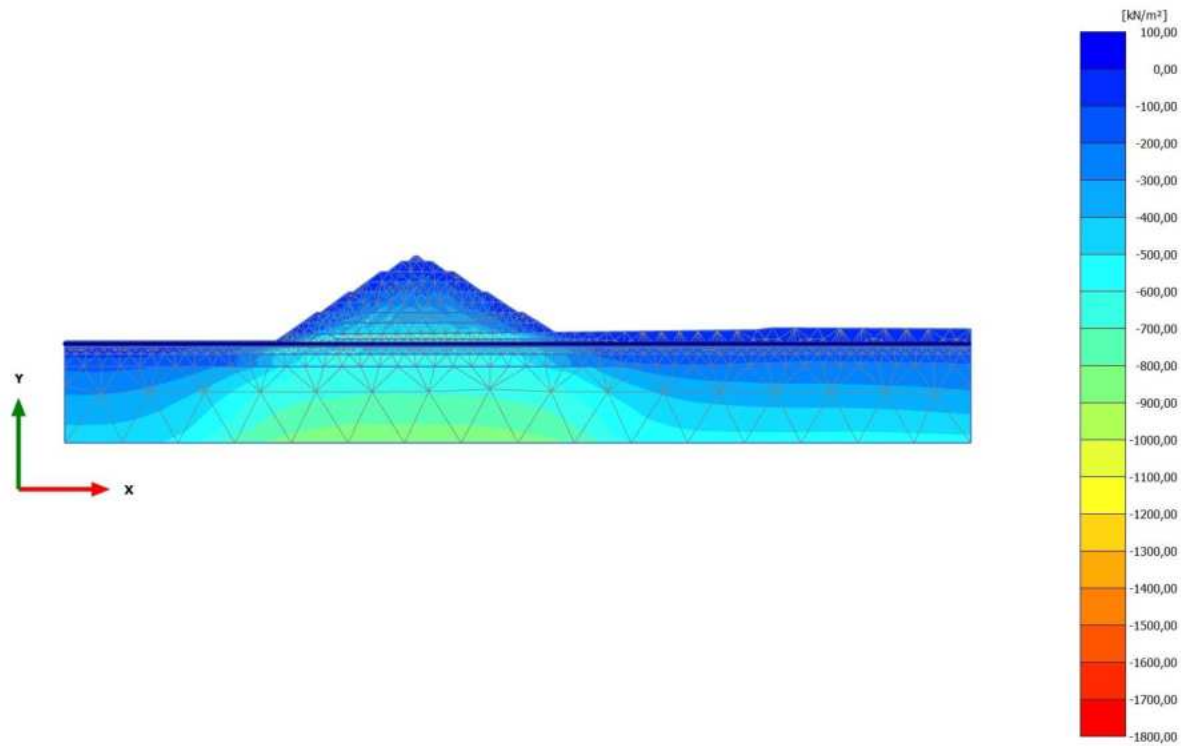


**Cartesian effective stress  $\sigma'_{xx}$  (scaled up 0,0200 times)**

Maximum value = 5,001 kN/m<sup>2</sup> (Element 385 at Node 8165)

Minimum value = -875,2 kN/m<sup>2</sup> (Element 1801 at Node 8443)

2.2.2.1.7 Calculation results, Phase\_6 FoS seismic [Phase\_6] (13/121), Cartesian effective stress  $\sigma'_{xx}$

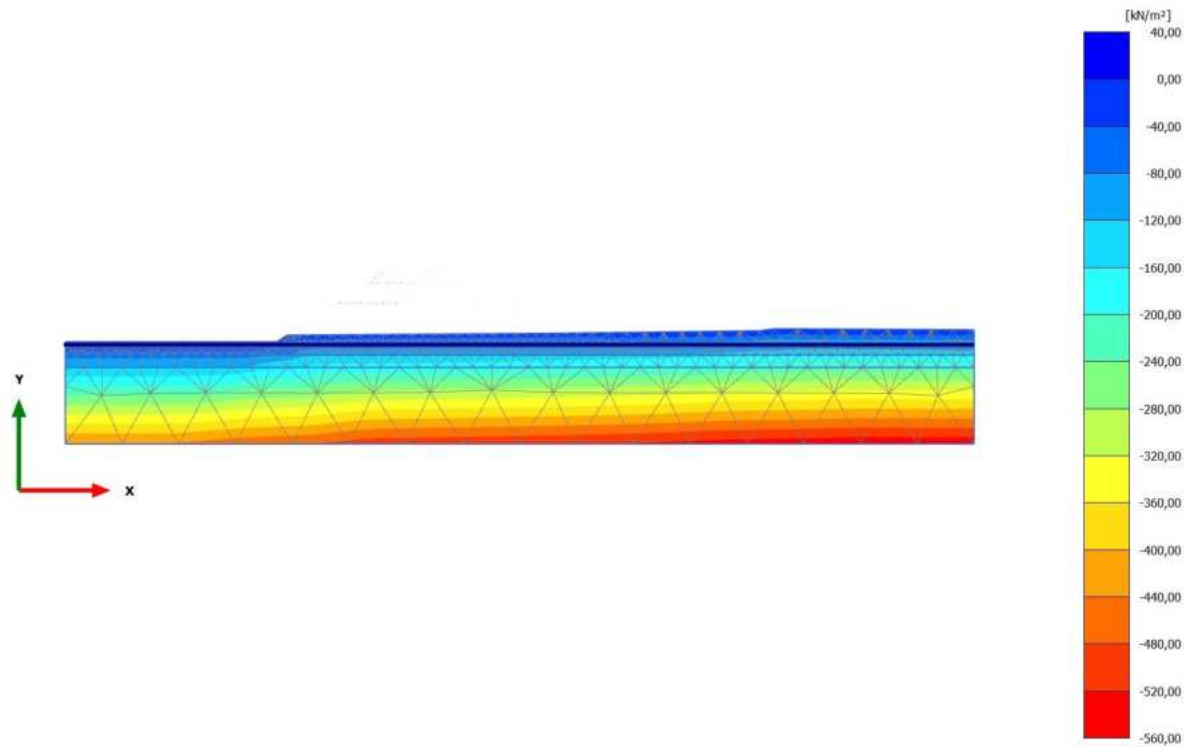


**Cartesian effective stress  $\sigma'_{xx}$  (scaled up 0,0200 times)**

Maximum value = 14,31 kN/m<sup>2</sup> (Element 246 at Node 1462)

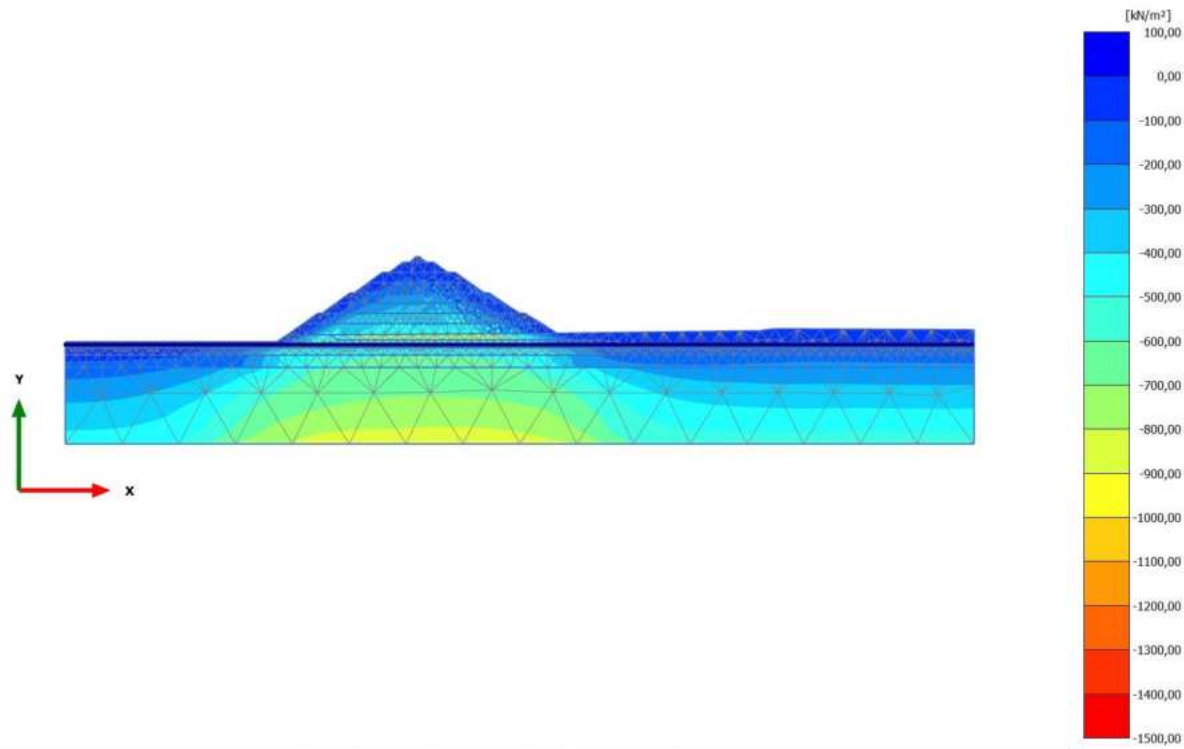
Minimum value = -1721 kN/m<sup>2</sup> (Element 1116 at Node 5483)

2.2.2.1.8 Calculation results, Initial phase [InitialPhase] (0/137), Cartesian effective stress  $\sigma'_{xx}$



**Cartesian effective stress  $\sigma'_{xx}$  (scaled up 0,0500 times)**  
Maximum value = 4,914 kN/m<sup>2</sup> (Element 404 at Node 12805)  
Minimum value = -548,9 kN/m<sup>2</sup> (Element 1805 at Node 13907)

2.2.2.1.9 Calculation results, Phase\_7 FoS static [Phase\_7] (1/237), Cartesian effective stress  $\sigma'_{xx}$



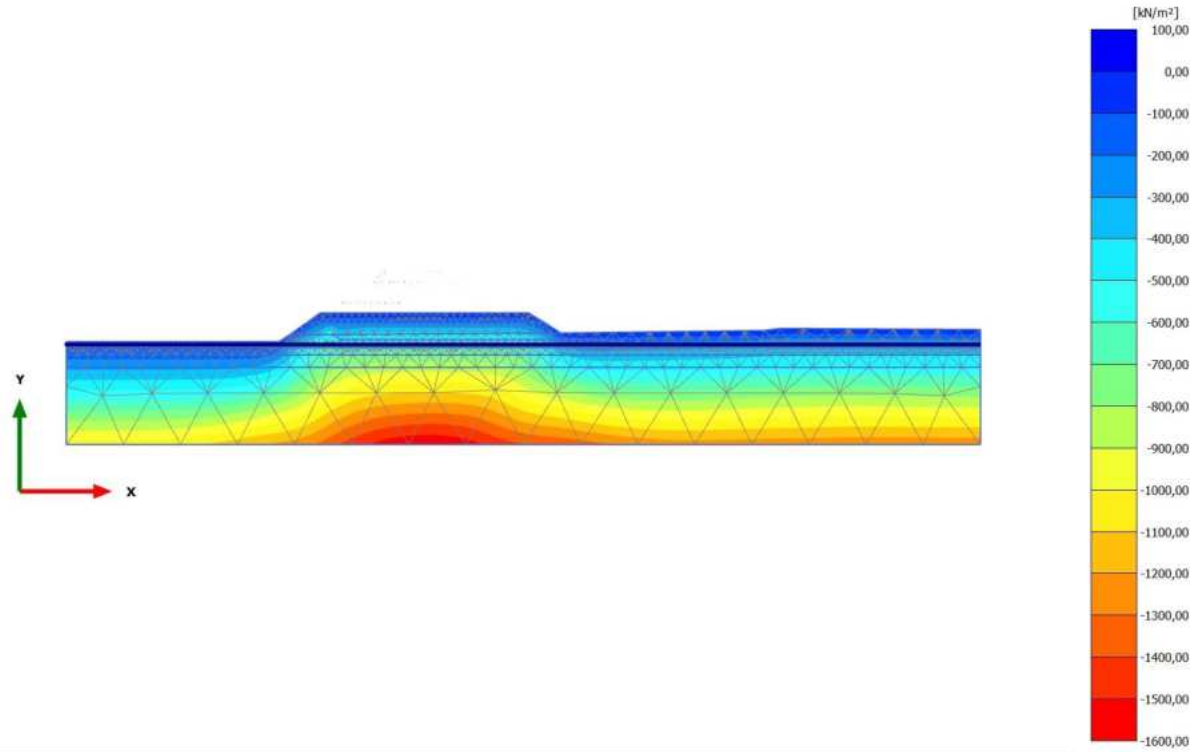
**Cartesian effective stress  $\sigma'_{xx}$  (scaled up 0,0200 times)**

Maximum value = 14,53 kN/m<sup>2</sup> (Element 1 at Node 78)

Minimum value = -1471 kN/m<sup>2</sup> (Element 376 at Node 8415)



2.2.2.2.1 Calculation results, Phase\_1 [Phase\_1] (8/4), Cartesian effective stress  $\sigma'_{yy}$

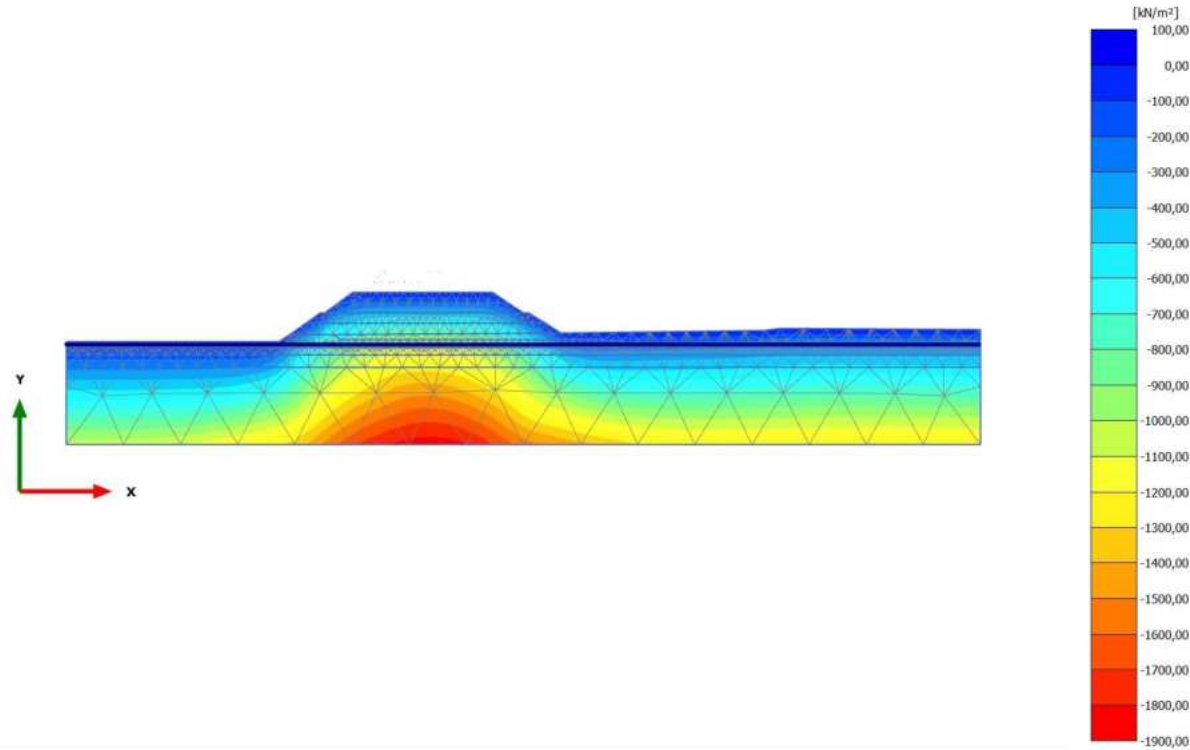


**Cartesian effective stress  $\sigma'_{yy}$  (scaled up 0,0200 times)**

Maximum value = 1,716 kN/m<sup>2</sup> (Element 333 at Node 9031)

Minimum value = -1586 kN/m<sup>2</sup> (Element 1799 at Node 10011)

2.2.2.2.2 Calculation results, Phase\_2 [Phase\_2] (9/8), Cartesian effective stress  $\sigma'_{yy}$

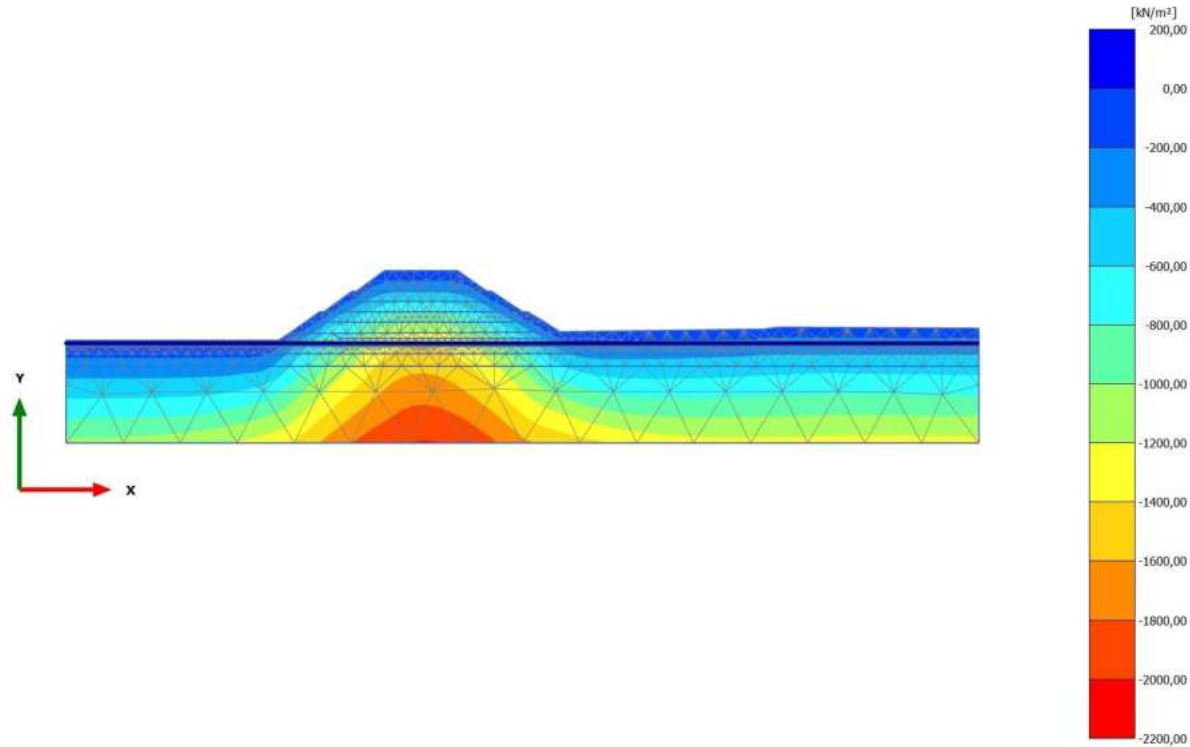


**Cartesian effective stress  $\sigma'_{yy}$  (scaled up 0,0200 times)**

Maximum value = 1,765 kN/m<sup>2</sup> (Element 333 at Node 9031)

Minimum value = -1850 kN/m<sup>2</sup> (Element 1799 at Node 10011)

2.2.2.2.3 Calculation results, Phase\_3 [Phase\_3] (10/11), Cartesian effective stress  $\sigma'_{yy}$

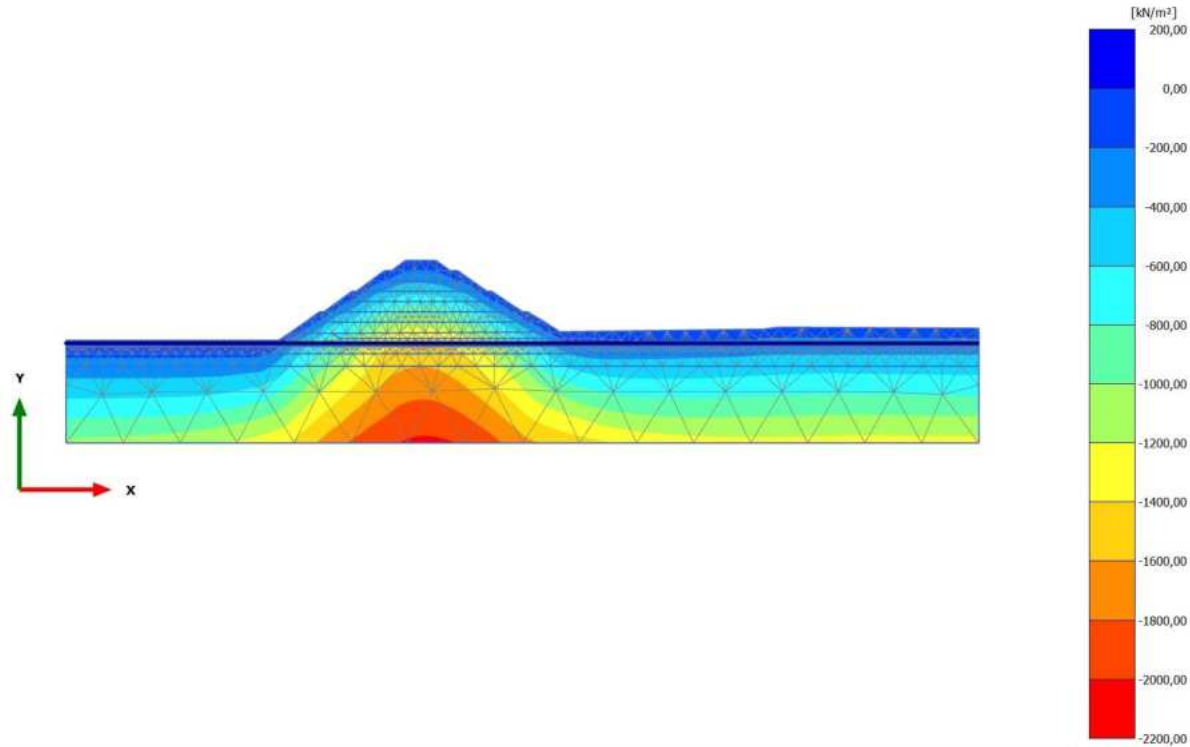


**Cartesian effective stress  $\sigma'_{yy}$  (scaled up 0,0100 times)**

Maximum value = 5,300 kN/m<sup>2</sup> (Element 118 at Node 1421)

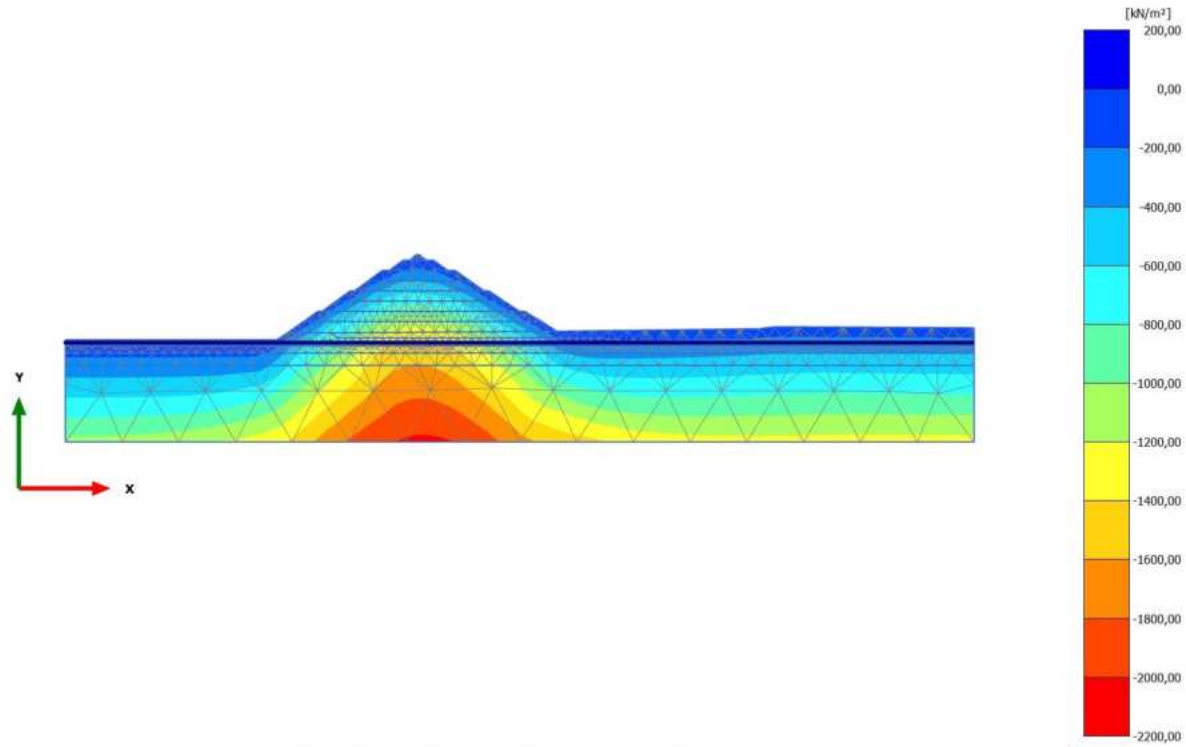
Minimum value = -2012 kN/m<sup>2</sup> (Element 1799 at Node 10011)

2.2.2.2.4 Calculation results, Phase\_4 [Phase\_4] (11/14), Cartesian effective stress  $\sigma'_{yy}$



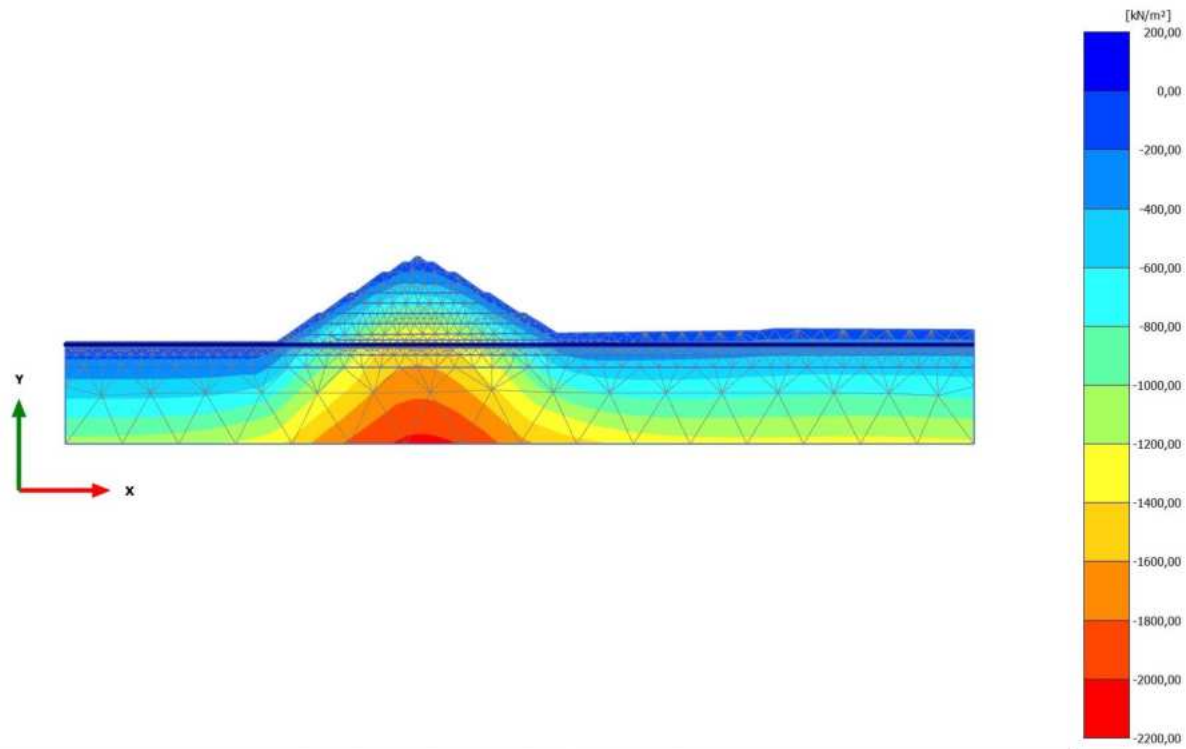
**Cartesian effective stress  $\sigma'_{yy}$  (scaled up 0,0100 times)**  
Maximum value = 4,899 kN/m<sup>2</sup> (Element 118 at Node 1421)  
Minimum value = -2037 kN/m<sup>2</sup> (Element 1799 at Node 10011)

2.2.2.2.5 Calculation results, Phase\_5\_static [Phase\_5] (12/18), Cartesian effective stress  $\sigma'_{yy}$



**Cartesian effective stress  $\sigma'_{yy}$  (scaled up 0,0100 times)**  
Maximum value = 4,755 kN/m<sup>2</sup> (Element 118 at Node 1421)  
Minimum value = -2038 kN/m<sup>2</sup> (Element 1799 at Node 10011)

2.2.2.2.6 Calculation results, Phase\_8 \_seismic [Phase\_8] (2/21), Cartesian effective stress  $\sigma'_{yy}$

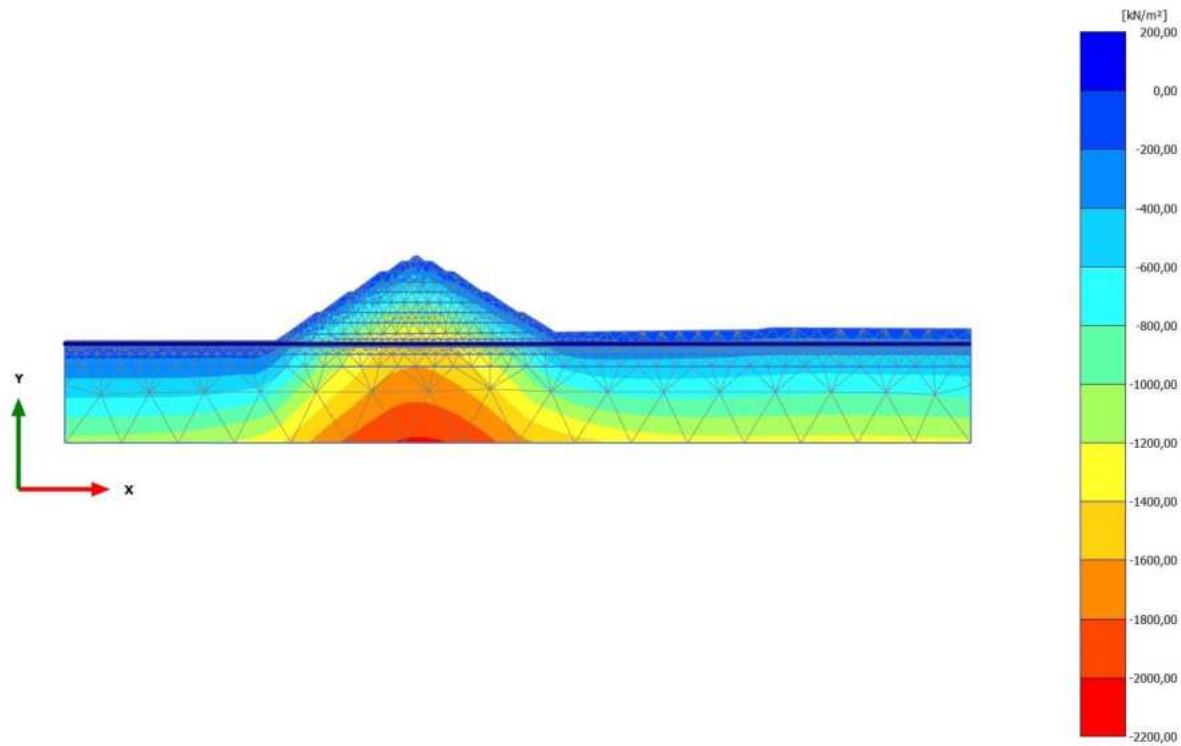


**Cartesian effective stress  $\sigma'_{yy}$  (scaled up 0,0100 times)**

Maximum value = 4,136 kN/m<sup>2</sup> (Element 118 at Node 1421)

Minimum value = -2055 kN/m<sup>2</sup> (Element 1799 at Node 10011)

2.2.2.2.7 Calculation results, Phase\_6 FoS seismic [Phase\_6] (13/121), Cartesian effective stress  $\sigma'_{yy}$

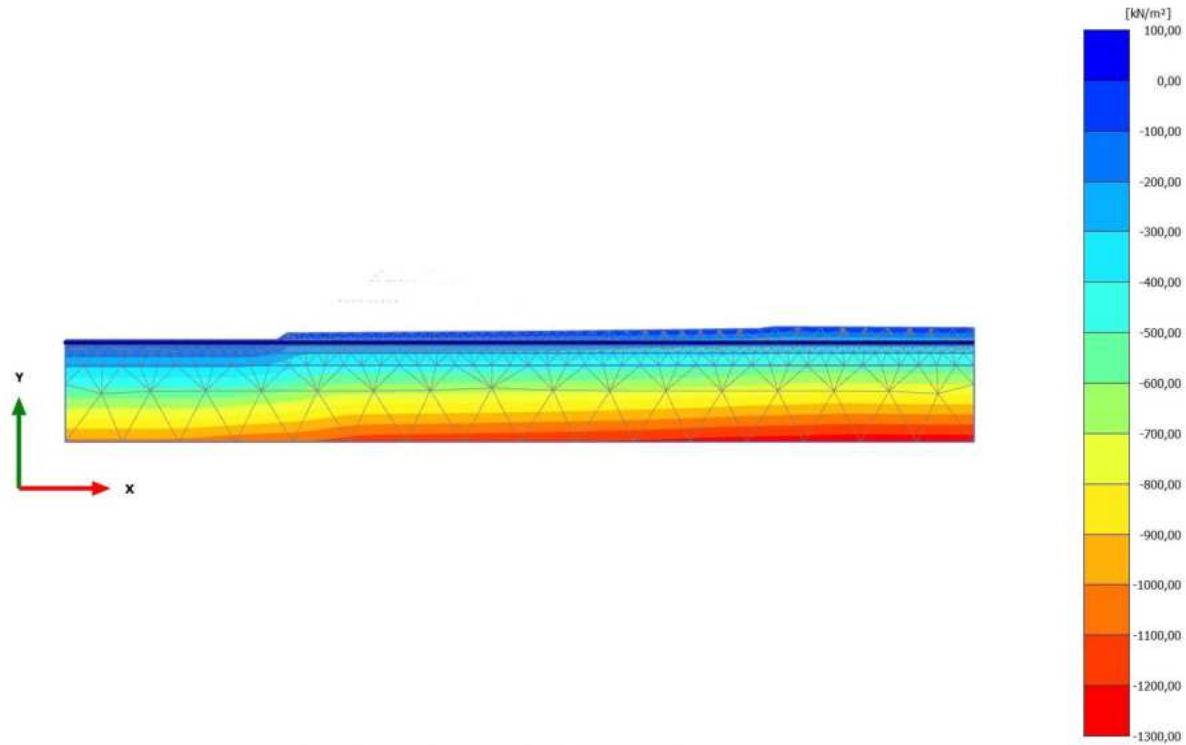


**Cartesian effective stress  $\sigma'_{yy}$  (scaled up 0,0100 times)**

Maximum value = 29,50 kN/m<sup>2</sup> (Element 17 at Node 117)

Minimum value = -2034 kN/m<sup>2</sup> (Element 1799 at Node 10011)

2.2.2.2.8 Calculation results, Initial phase [InitialPhase] (0/137), Cartesian effective stress  $\sigma'_{yy}$



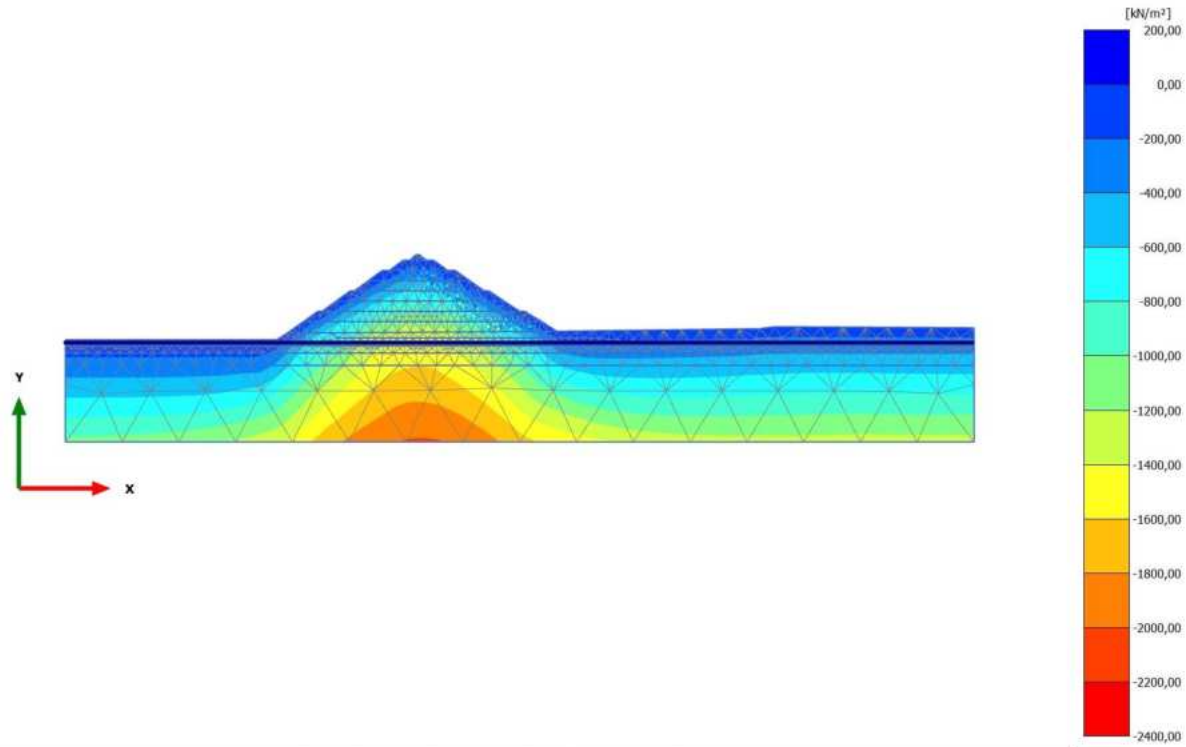
**Cartesian effective stress  $\sigma'_{yy}$  (scaled up 0,0200 times)**

Maximum value = 2,901  $\text{kN/m}^2$  (Element 336 at Node 2535)

Minimum value = -1275  $\text{kN/m}^2$  (Element 1792 at Node 13903)

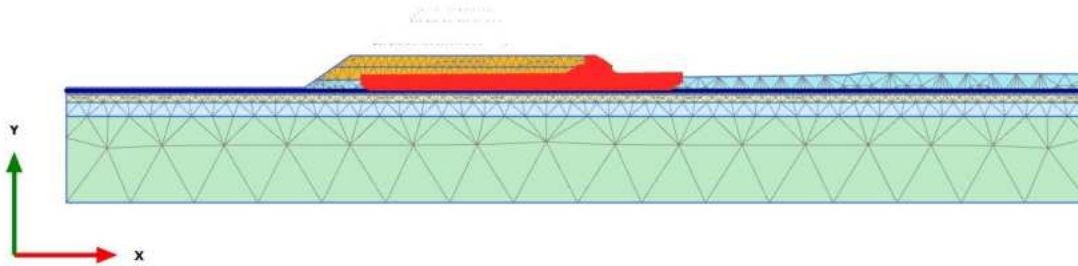


2.2.2.2.9 Calculation results, Phase\_7 FoS static [Phase\_7] (1/237), Cartesian effective stress  $\sigma'_{yy}$

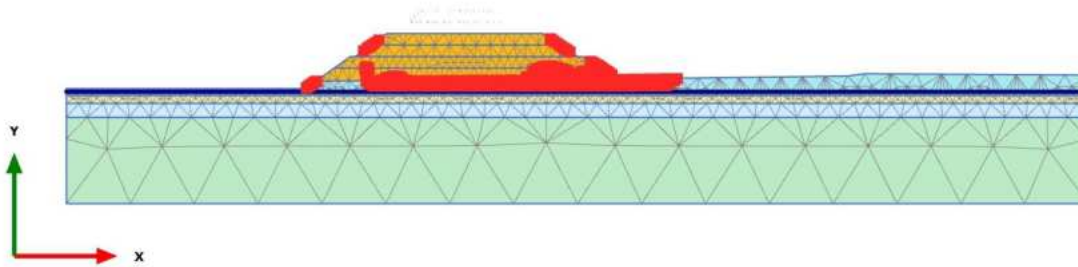


**Cartesian effective stress  $\sigma'_{yy}$  (scaled up 0,0100 times)**  
Maximum value = 23,65 kN/m<sup>2</sup> (Element 118 at Node 1422)  
Minimum value = -2257 kN/m<sup>2</sup> (Element 192 at Node 2301)

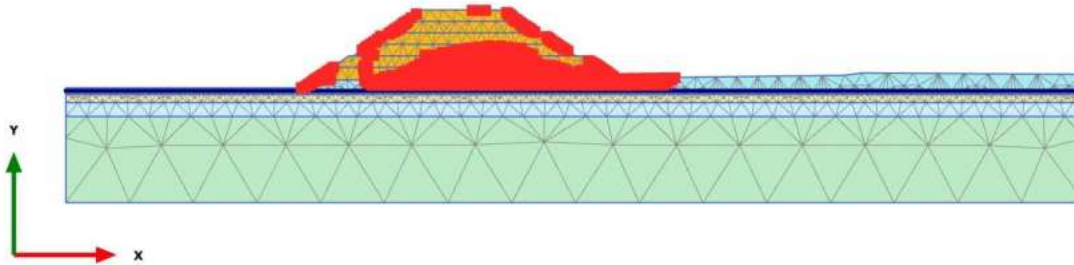
2.2.3.1.1 Calculation results, Phase\_1 [Phase\_1] (8/4), Plastic point history Failure



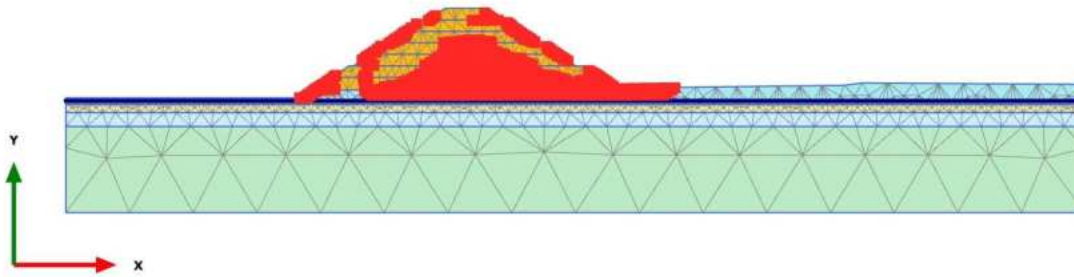
2.2.3.1.2 Calculation results, Phase\_2 [Phase\_2] (9/8), Plastic point history Failure



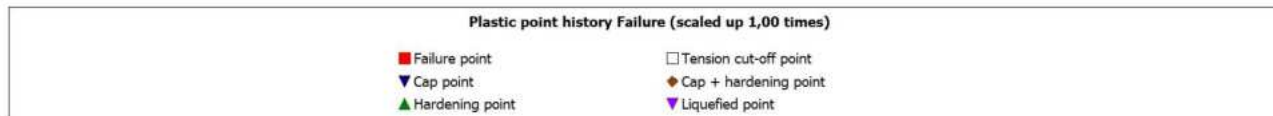
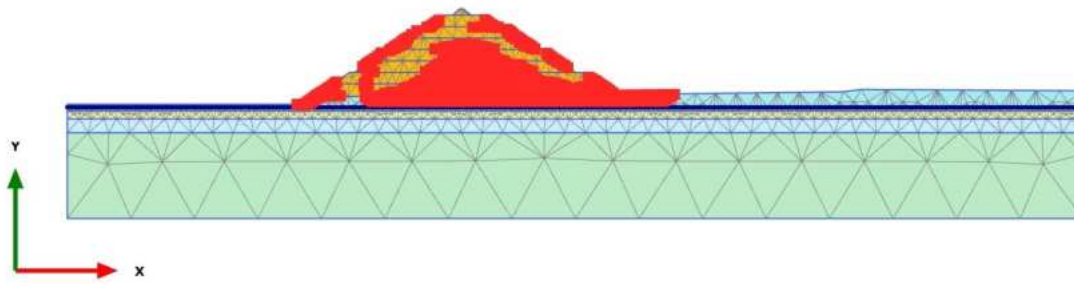
2.2.3.1.3 Calculation results, Phase\_3 [Phase\_3] (10/11), Plastic point history Failure



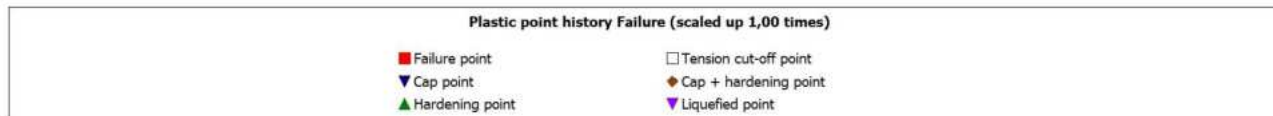
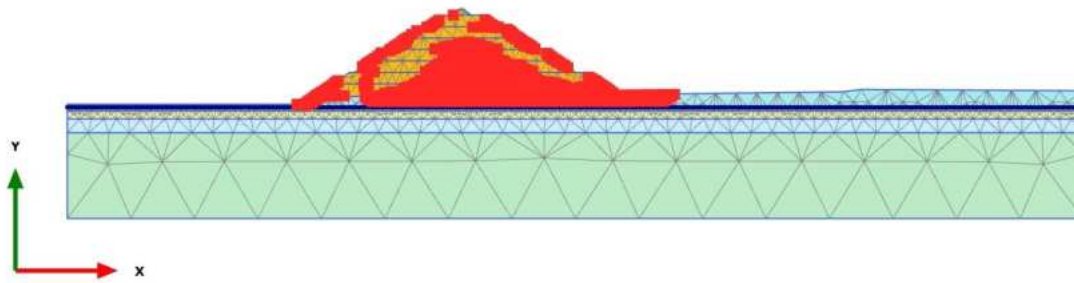
2.2.3.1.4 Calculation results, Phase\_4 [Phase\_4] (11/14), Plastic point history Failure



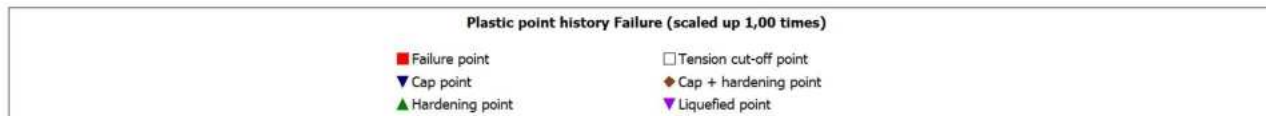
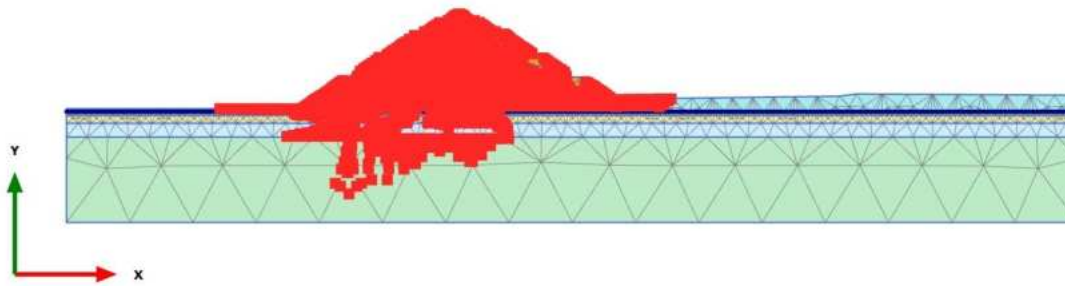
2.2.3.1.5 Calculation results, Phase\_5\_static [Phase\_5] (12/18), Plastic point history Failure



2.2.3.1.6 Calculation results, Phase\_8 \_seismic [Phase\_8] (2/21), Plastic point history Failure

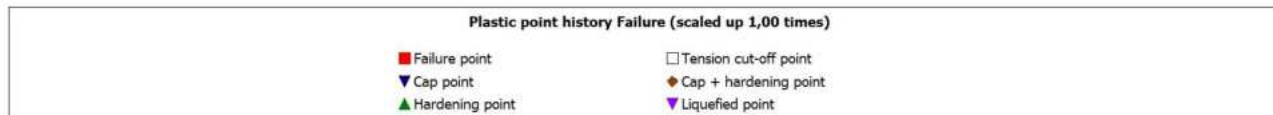
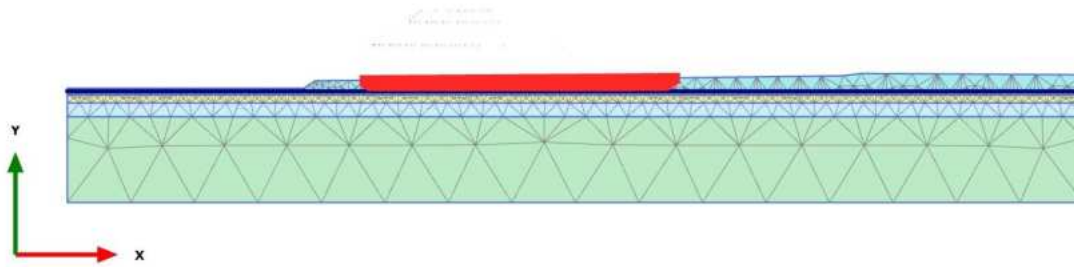


2.2.3.1.7 Calculation results, Phase\_6 FoS seismic [Phase\_6] (13/121), Plastic point history Failure

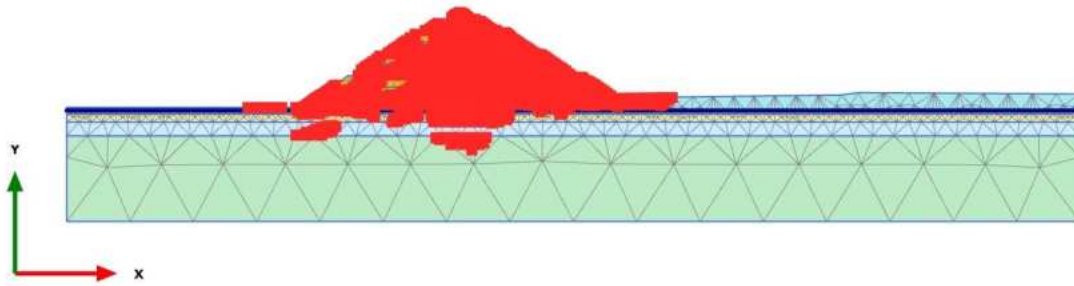




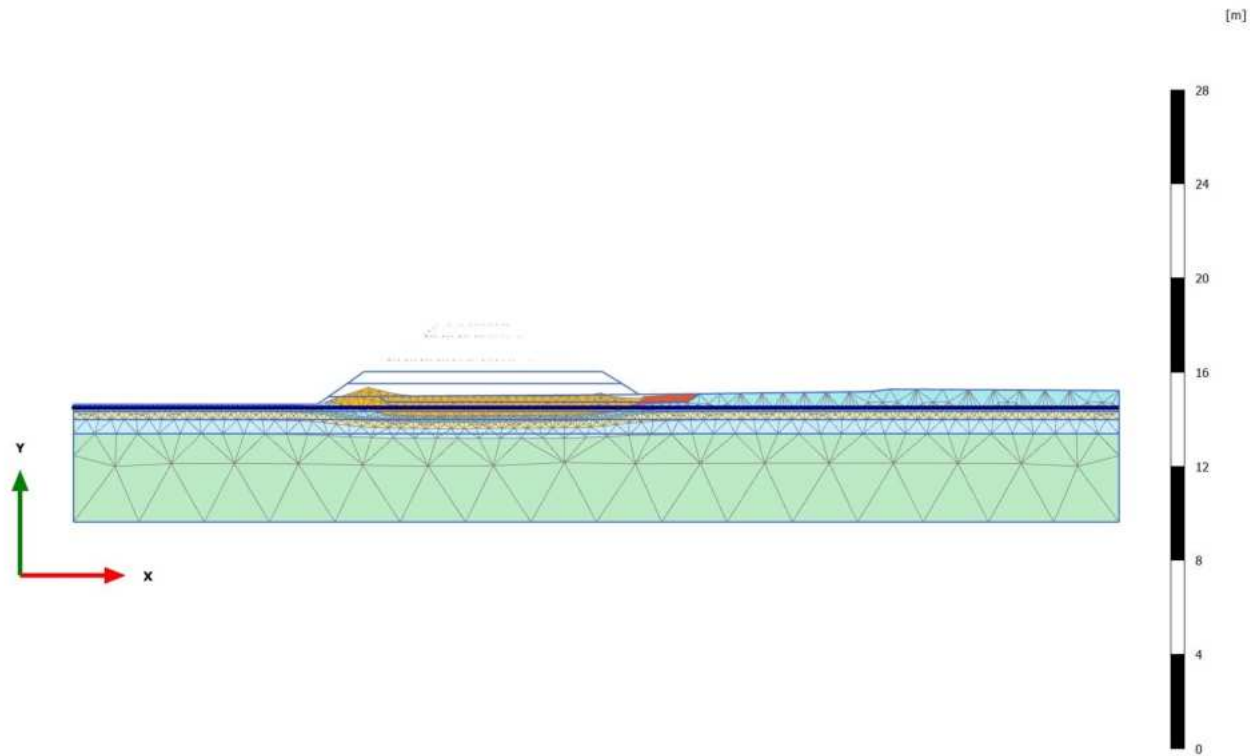
2.2.3.1.8 Calculation results, Initial phase [InitialPhase] (0/137), Plastic point history Failure



2.2.3.1.9 Calculation results, Phase\_7 FoS static [Phase\_7] (1/237), Plastic point history Failure

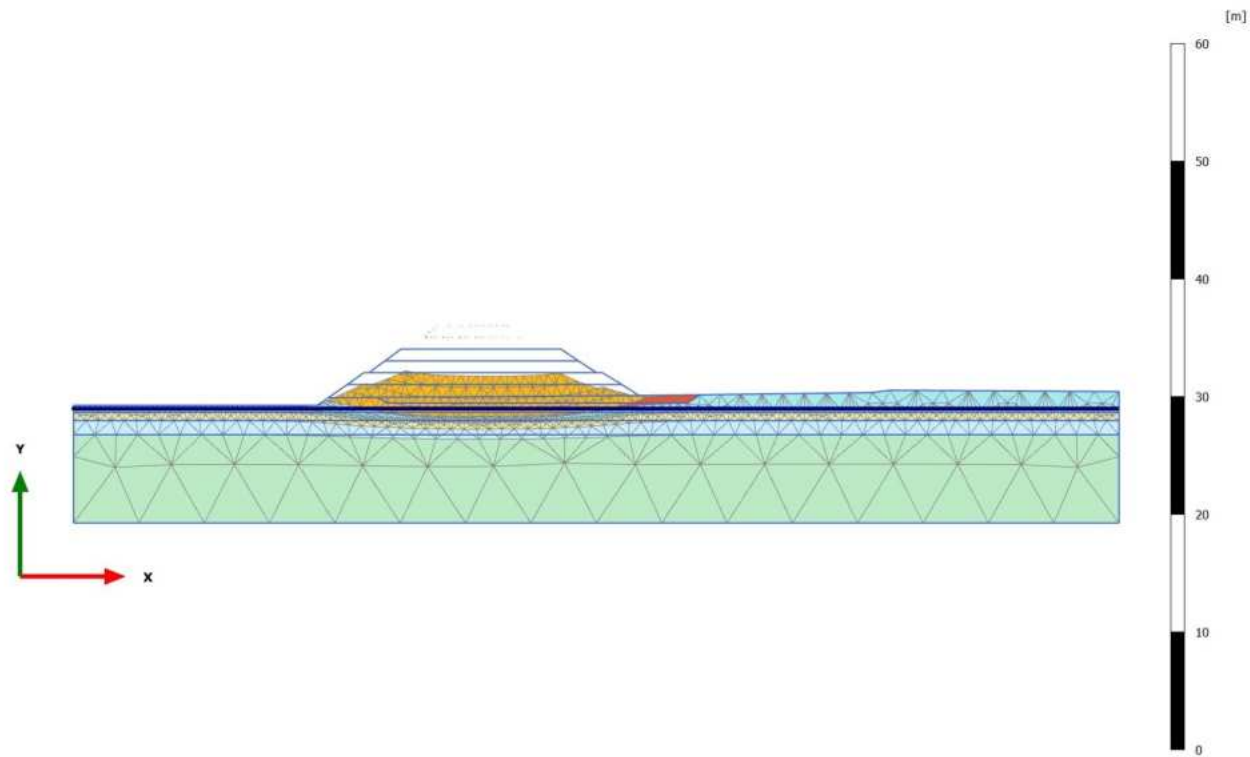


4.1.1 Calculation results, Phase\_1 [Phase\_1] (8/4), Deformed mesh |u|



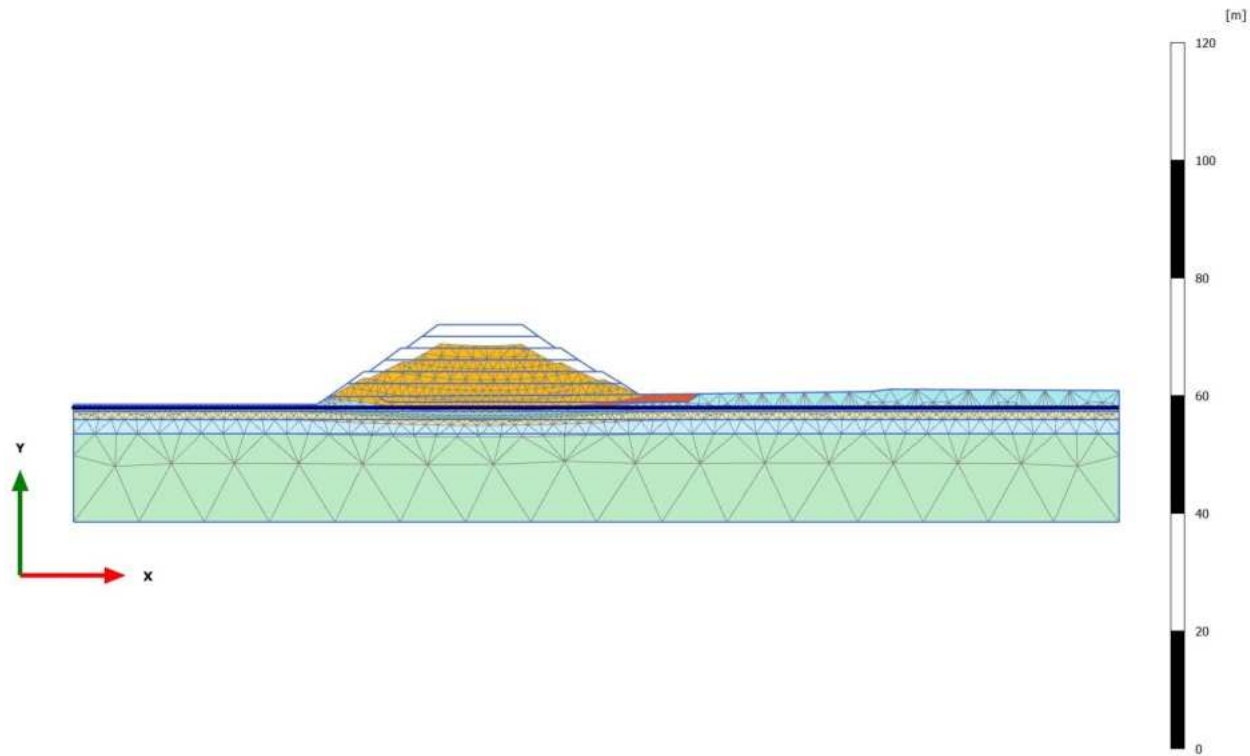
**Deformed mesh |u| (scaled up 20,0 times)**  
Maximum value = 1,047 m (Element 198 at Node 1565)

4.1.2 Calculation results, Phase\_2 [Phase\_2] (9/8), Deformed mesh |u|



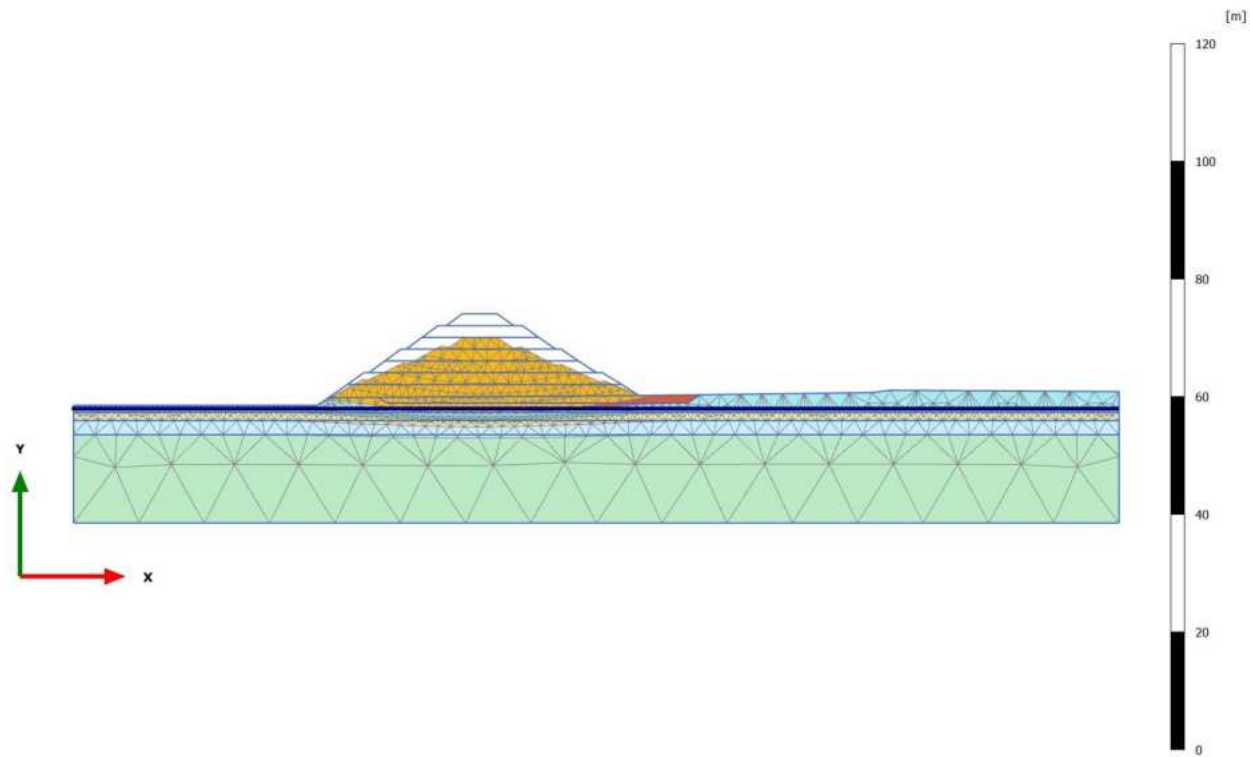
**Deformed mesh |u| (scaled up 10,0 times)**  
Maximum value = 2,297 m (Element 107 at Node 673)

4.1.3 Calculation results, Phase\_3 [Phase\_3] (10/11), Deformed mesh |u|



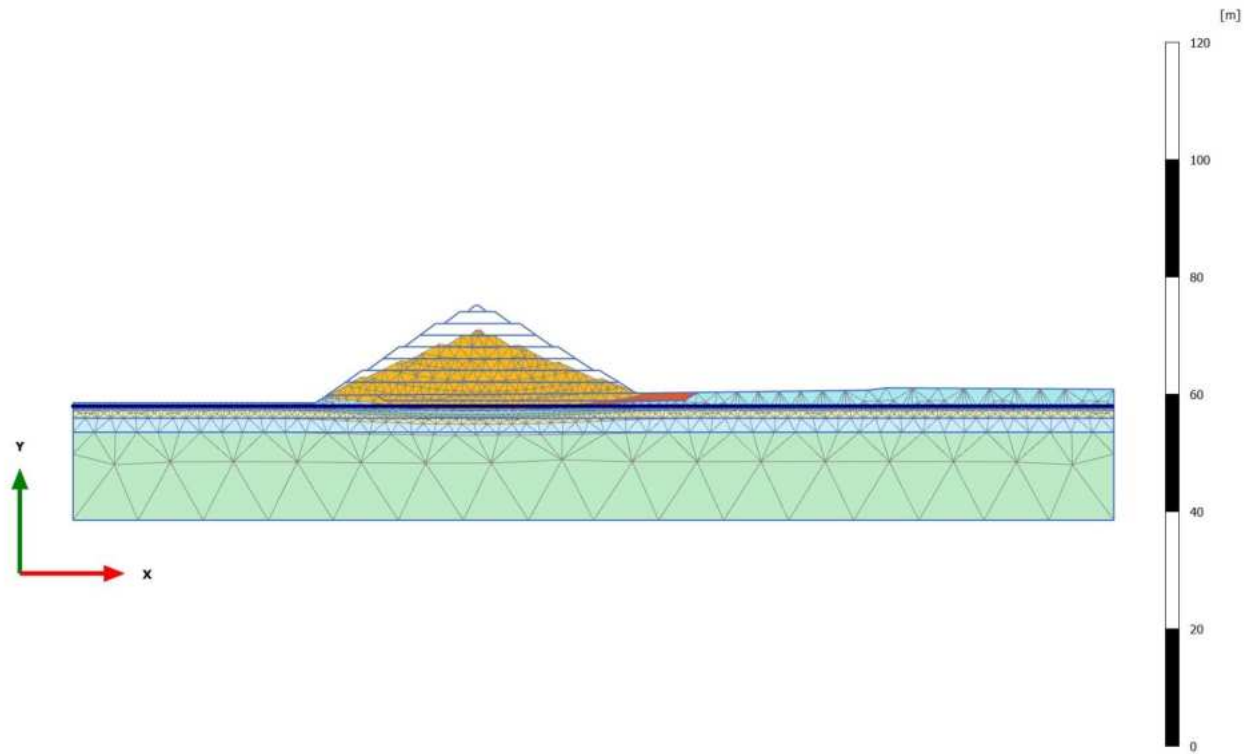
**Deformed mesh |u| (scaled up 5,00 times)**  
Maximum value = 3,605 m (Element 30 at Node 180)

4.1.4 Calculation results, Phase\_4 [Phase\_4] (11/14), Deformed mesh |u|



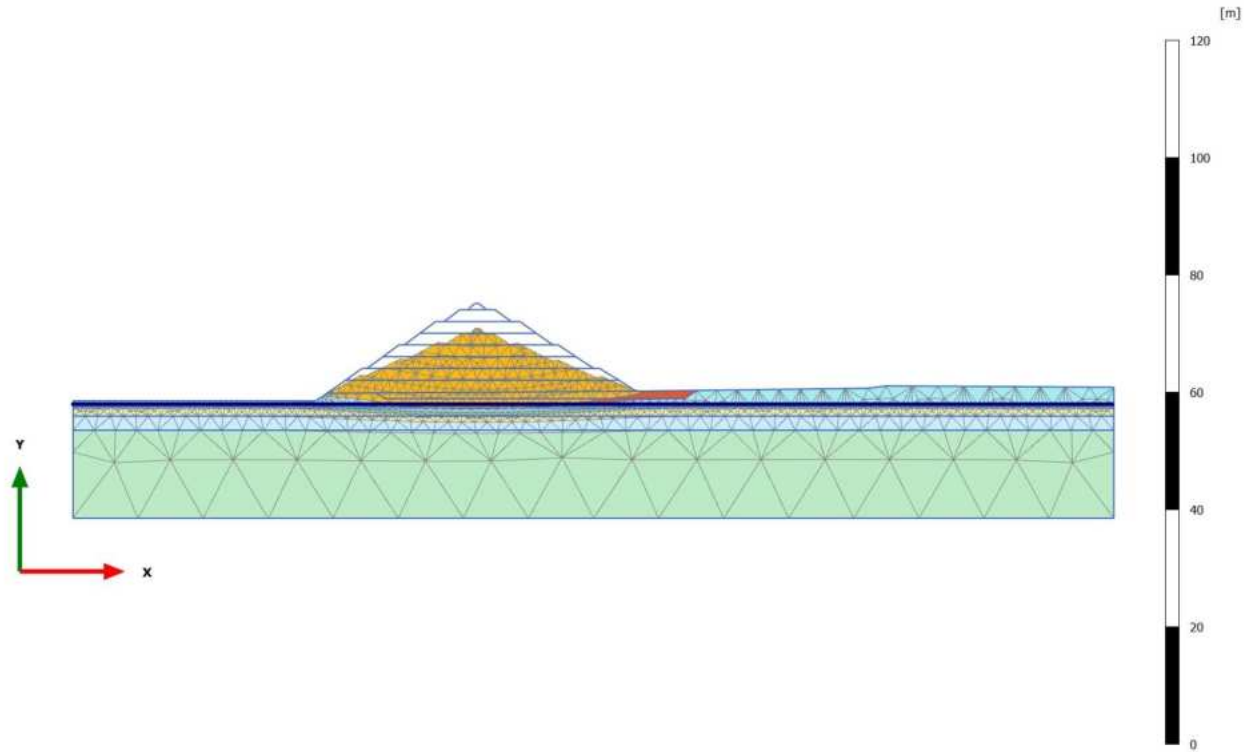
**Deformed mesh |u| (scaled up 5,00 times)**  
Maximum value = 4,126 m (Element 11 at Node 155)

4.1.5 Calculation results, Phase\_5\_static [Phase\_5] (12/18), Deformed mesh |u|



**Deformed mesh |u| (scaled up 5,00 times)**  
Maximum value = 4,235 m (Element 11 at Node 93)

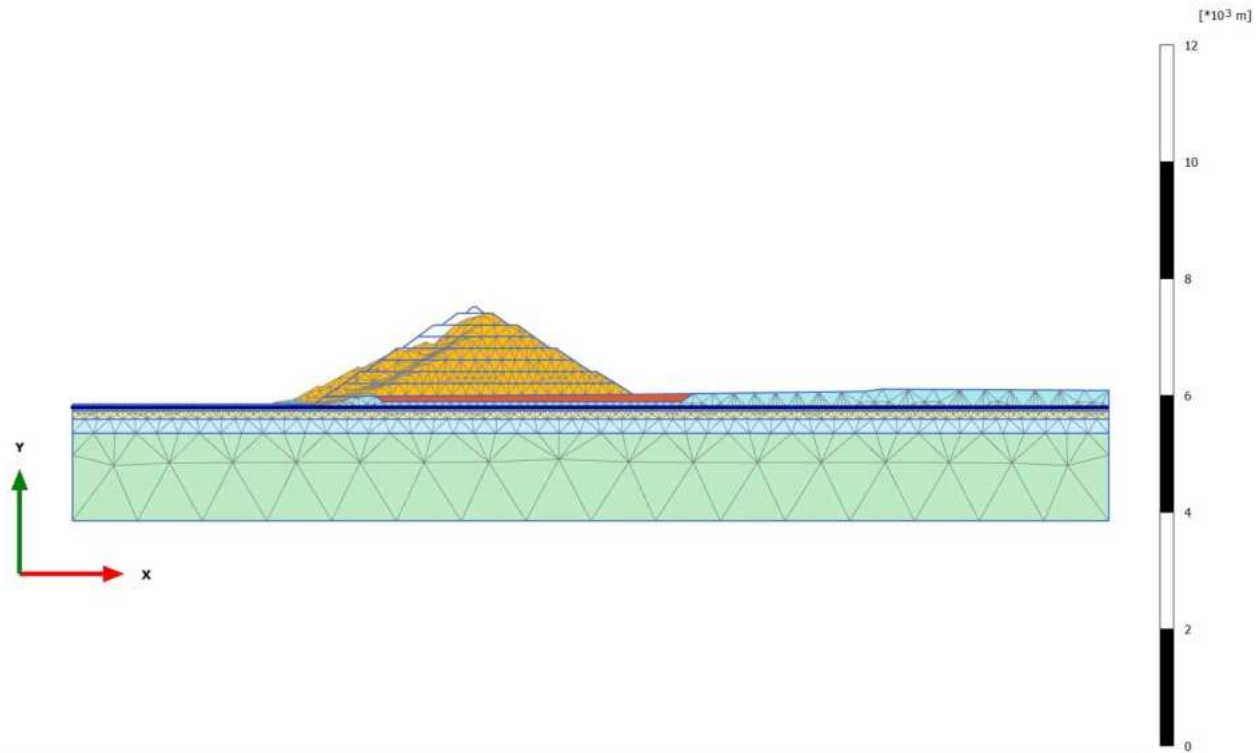
4.1.6 Calculation results, Phase\_8 \_seismic [Phase\_8] (2/21), Deformed mesh |u|



**Deformed mesh |u| (scaled up 5,00 times)**  
Maximum value = 4,278 m (Element 11 at Node 155)

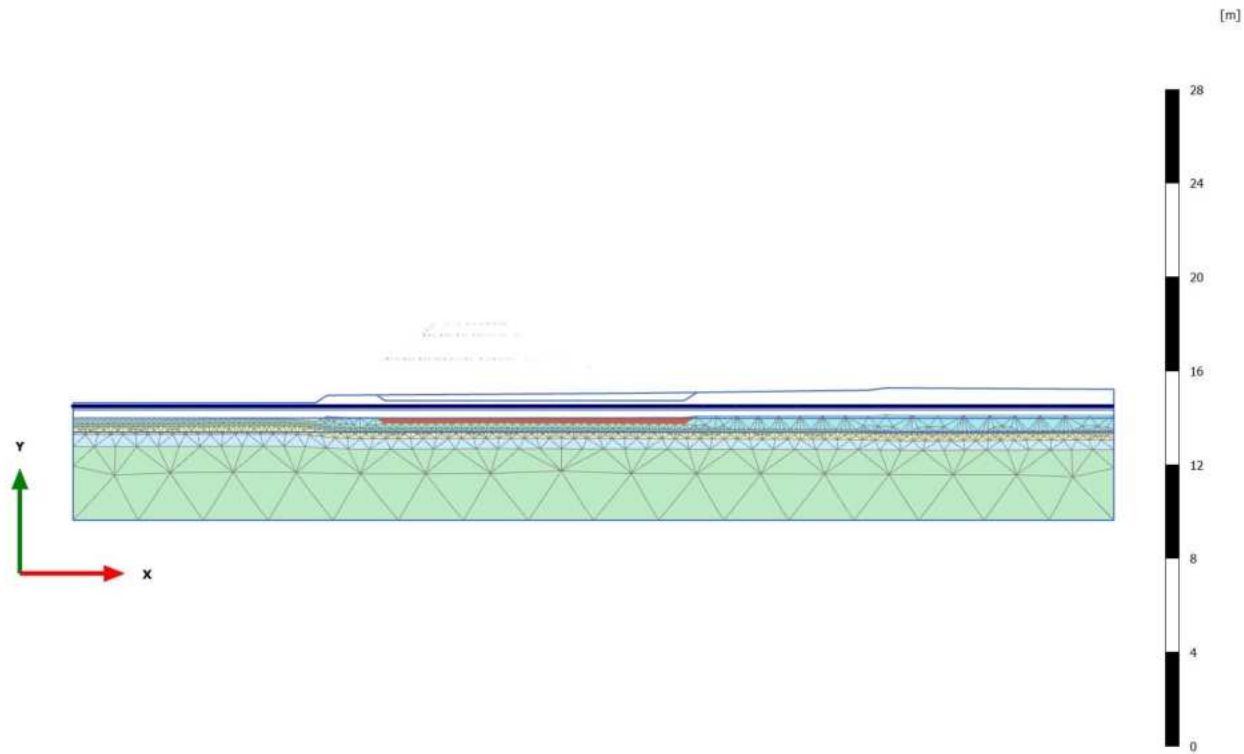


4.1.7 Calculation results, Phase\_6 FoS seismic [Phase\_6] (13/121), Deformed mesh |u|



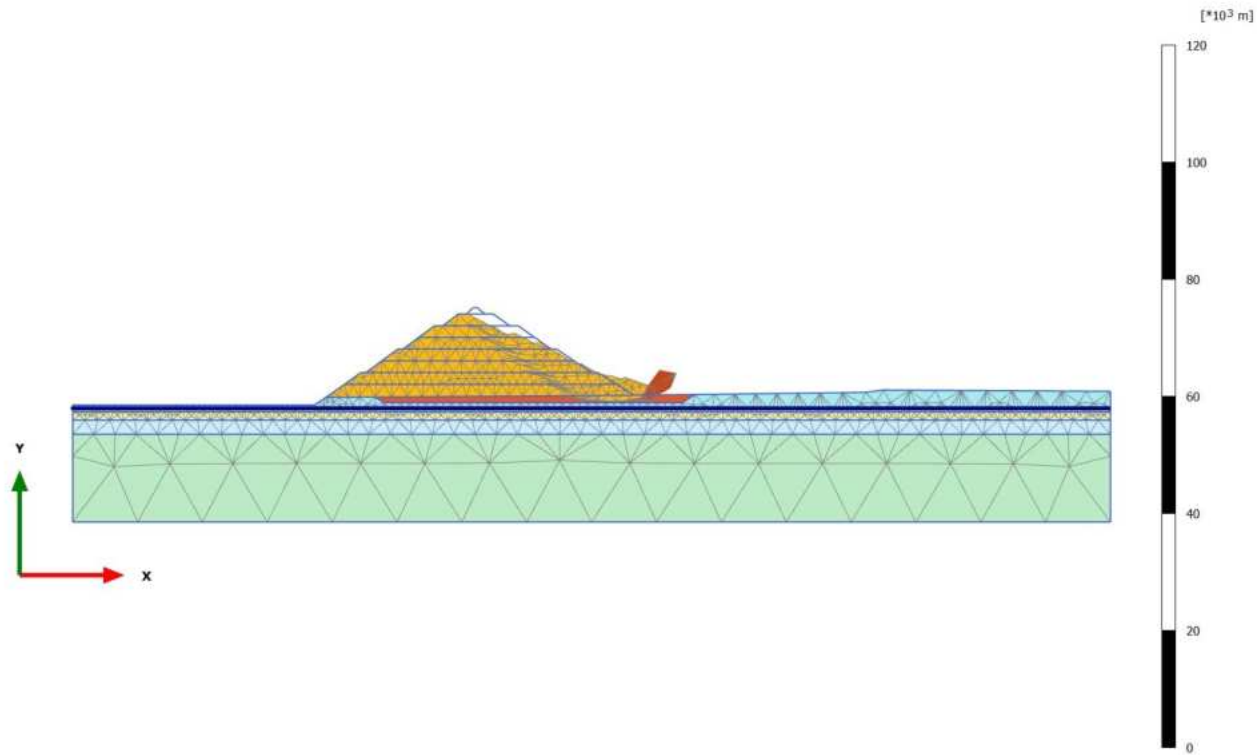
**Deformed mesh |u| (scaled up 0,0500 times)**  
Maximum value = 820,4 m (Element 631 at Node 2092)

4.1.8 Calculation results, Initial phase [InitialPhase] (0/137), Deformed mesh |u|



**Deformed mesh |u| (scaled up 20,0 times)**  
Maximum value = 1,158 m (Element 398 at Node 13241)

4.1.9 Calculation results, Phase\_7 FoS static [Phase\_7] (1/237), Deformed mesh |u|



**Deformed mesh |u| (scaled up  $5,00 \cdot 10^{-3}$  times)**  
Maximum value = 8135 m (Element 287 at Node 8163)

## ANHANG 7 – ERGEBNISSE DER SLIDE SLU – ABSCHNITT 1

## APPENDICE 7 – RISULTATI ANALISI SLIDE SLU – SEZIONE 1

SLIDE - An Interactive Slope Stability Program

Date Created: 16/11/2018, 18:41:47

Software Version: 9.023

### Table of Contents

Project Summary .....	3
General Settings .....	4
Design Standard .....	5
Analysis Options .....	6
Groundwater Analysis .....	7
Random Numbers .....	8
Surface Options .....	9
Seismic Loading .....	10
Materials .....	11
Global Minimums .....	13
Method: bishop simplified .....	13
Valid and Invalid Surfaces .....	14
Method: bishop simplified .....	14
Slice Data .....	15
Global Minimum Query (bishop simplified) - Safety Factor: 1.20384 .....	15
Interslice Data .....	16
Global Minimum Query (bishop simplified) - Safety Factor: 1.20384 .....	16
Entity Information .....	17
Water Table .....	17
External Boundary .....	17
Material Boundary .....	18

# Slide2 Analysis Information

## SLIDE - An Interactive Slope Stability Program

### 1. PROJECT SUMMARY

---

Slide2 Modeler Version:	9.023
Compute Time:	00h:00m:00.359s
Date Created:	16/11/2018, 18:41:47

## 2. GENERAL SETTINGS

---

Units of Measurement:	Metric Units
Time Units:	days
Permeability Units:	meters/second
Data Output:	Standard
Failure Direction:	Left to Right

## 3. DESIGN STANDARD

Selected Type:	Eurocode 7 (User Defined)	
Name:	User Defined 1	
	Type	Partial Factor
Permanent Actions: Unfavourable	1	
Permanent Actions: Favourable	1	
Variable Actions: Unfavourable	1	
Variable Actions: Favourable	1	
Effective cohesion	1.25	
Coefficient of shearing resistance	1.25	
Undrained strength	1	
Weight density	1	
Shear strength (other models)	1	
Earth resistance	1	
Tensile and plate strength	1	
Shear strength	1	
Compressive strength	1	
Bond strength	1	
Seismic Coefficient	1	

#### 4. ANALYSIS OPTIONS

---

Slices Type:	Vertical
	Analysis Methods Used
	Bishop simplified
Number of slices:	25
Tolerance:	0.005
Maximum number of iterations:	50
Check malpha < 0.2:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

## 5. GROUNDWATER ANALYSIS

---

Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [kN/m <sup>3</sup> ]:	9.81
Use negative pore pressure cutoff:	Yes
Maximum negative pore pressure [kPa]:	0
Advanced Groundwater Method:	None



## 6. RANDOM NUMBERS

---

Pseudo-random Seed:	10116
Random Number Generation Method:	Park and Miller v.3

## 7. SURFACE OPTIONS

---

Surface Type:	Circular
Search Method:	Auto Refine Search
Divisions along slope:	10
Circles per division:	10
Number of iterations:	10
Divisions to use in next iteration:	50%
Composite Surfaces:	Disabled
Minimum Elevation:	Not Defined
Minimum Depth:	Not Defined
Minimum Area:	Not Defined
Minimum Weight:	Not Defined

## 8. SEISMIC LOADING

---

Advanced seismic analysis:	No
Staged pseudostatic analysis:	No

## 9. MATERIALS

A

Color	
Strength Type	Mohr-Coulomb
Unit Weight [kN/m3]	21
Cohesion [kPa]	45
Friction Angle [deg]	37
Water Surface	Water Table
Hu Value	Automatically Calculated

Strato 1

Color	
Strength Type	Mohr-Coulomb
Unit Weight [kN/m3]	20
Cohesion [kPa]	5
Friction Angle [deg]	38
Water Surface	Water Table
Hu Value	Automatically Calculated

Strato 2

Color	
Strength Type	Mohr-Coulomb
Unit Weight [kN/m3]	20
Cohesion [kPa]	0
Friction Angle [deg]	40
Water Surface	Water Table
Hu Value	Automatically Calculated

Strato 3

Color	
Strength Type	Mohr-Coulomb
Unit Weight [kN/m3]	20
Cohesion [kPa]	0
Friction Angle [deg]	42
Water Surface	Water Table
Hu Value	Automatically Calculated

Strato 4


Color	
Strength Type	Mohr-Coulomb
Unit Weight [kN/m3]	20
Cohesion [kPa]	0
Friction Angle [deg]	36
Water Surface	Water Table
Hu Value	Automatically Calculated

Strato 5

Color	
-------	---

---

Strength Type	Mohr-Coulomb
Unit Weight [kN/m <sup>3</sup> ]	20
Cohesion [kPa]	0

Friction Angle [deg]	36
Water Surface	Water Table
Hu Value	Automatically Calculated
F1	
Color	
Strength Type	Mohr-Coulomb
Unit Weight [kN/m3]	20
Cohesion [kPa]	0
Friction Angle [deg]	20
Water Surface	Water Table
Hu Value	1

## 10. GLOBAL MINIMUMS

---

### 10.1 METHOD: BISHOP SIMPLIFIED

---

	FS	1.203840
Center:		625.397, 706.814
Radius:		84.217
Left Slip Surface Endpoint:		543.191, 688.516
Right Slip Surface Endpoint:		658.222, 629.257
Resisting Moment:		1.91176e+06 kN-m
Driving Moment:		1.58805e+06 kN-m
Total Slice Area:		2252.24 m <sup>2</sup>
Surface Horizontal Width:		115.03 m
Surface Average Height:		19.5796 m

# Global Minimum Support Data

---

No Supports Present

## 11. VALID AND INVALID SURFACES

---

### 11.1 METHOD: BISHOP SIMPLIFIED

---

Number of Valid Surfaces:	3017
Number of Invalid Surfaces:	0



## 12. SLICE DATA

Global Minimum Query (bishop simplified) - Safety Factor: 1.20384

Slice Number	Width [m]	Weight [kN]	Angle of Slice Base [deg]	Base Material	Base Cohesion [kPa]	Base Friction Angle [deg]	Shear Stress [kPa]	Shear Strength [kPa]	Base Normal Stress [kPa]	Pore Pressure [kPa]	Effective Normal Stress [kPa]	Base Vertical Stress [kPa]	Effective Vertical Stress [kPa]
1	4.60531	627.073	-72.2934	A	36	31.0834	38.2239	46.0155	16.6138	0	16.6138	136.338	136.338
2	4.60531	1472.15	-63.6091	A	36	31.0834	94.6255	113.914	129.245	0	129.245	319.942	319.942
3	4.60531	1950.69	-57.1901	A	36	31.0834	136.301	164.084	212.466	0	212.466	423.883	423.883
4	4.60531	2263.76	-51.7656	A	36	31.0834	168.88	203.304	277.524	0	277.524	491.867	491.867
5	4.60531	2471.31	-46.9385	A	36	31.0834	194.536	234.19	328.759	0	328.759	536.925	536.925
6	4.60531	2601.96	-42.5176	A	36	31.0834	214.492	258.214	368.611	0	368.611	565.278	565.278
7	4.60531	2714.56	-38.3926	A	36	31.0834	232.827	280.286	405.224	0	405.224	589.711	589.711
8	4.60531	2969.3	-34.4923	A	36	31.0834	262.567	316.089	464.614	0	464.614	645.02	645.02
9	4.60531	2991.1	-30.7678	A	36	31.0834	273.674	329.46	486.792	0	486.792	649.726	649.726
10	4.60531	2934.39	-27.1829	A	36	31.0834	277.675	334.276	494.782	0	494.782	637.383	637.383
11	4.60531	2843.46	-23.7103	A	36	31.0834	278.034	334.709	495.5	0	495.5	617.609	617.609
12	4.74217	2804.18	-20.2791	F1	0	16.2343	131.308	158.074	542.882	0	542.882	591.4	591.4
13	4.74217	2648.76	-16.8732	F1	0	16.2343	125.878	151.537	520.429	0	520.429	558.609	558.609
14	4.74217	2465.92	-13.5279	F1	0	16.2343	118.866	143.096	491.441	0	491.441	520.04	520.04
15	4.74217	2421.4	-10.2291	F1	0	16.2343	118.345	142.468	489.285	0	489.285	510.641	510.641
16	4.74217	2343.31	-6.96435	F1	0	16.2343	116.094	139.759	479.981	0	479.981	494.162	494.162
17	4.74217	2097.68	-3.72227	F1	0	16.2343	105.336	126.808	435.502	0	435.502	442.355	442.355
18	6.18832	2337.69	0	F1	0	16.2343	91.3693	109.994	377.759	0	377.759	377.759	377.759
19	4.24722	1303.69	3.55322	F1	0	16.2343	75.3737	90.7379	311.625	0	311.625	306.945	306.945
20	4.24722	1028.66	6.45505	F1	0	16.2343	60.2264	72.5029	248.999	0	248.999	242.185	242.185
21	4.24722	735.049	9.37365	F1	0	16.2343	43.5982	52.4852	180.252	0	180.252	173.055	173.055
22	4.24722	436.799	12.3171	F1	0	16.2343	26.2599	31.6127	108.569	0	108.569	102.835	102.835
23	4.24722	298.643	15.294	F1	0	16.2343	18.21	21.9219	75.2872	0	75.2872	70.3075	70.3075
24	4.24722	194.167	18.314	F1	0	16.2343	12.0182	14.468	49.6884	0	49.6884	45.7105	45.7105
25	4.24722	68.3697	21.3878	F1	0	16.2343	4.30033	5.17691	17.7793	0	17.7793	16.0951	16.0951

## 13. INTERSLICE DATA

Global Minimum Query (bishop simplified) - Safety Factor: 1.20384

Slice Number	X coordinate [m]	Y coordinate - Bottom [m]	Normal Force [kN]	Shear Force [kN]	Force Angle [deg]
1	543.191	688.516	0	0	0
2	547.797	674.091	63.8715	0	0
3	552.402	664.81	828.247	0	0
4	557.007	657.667	1719.18	0	0
5	561.613	651.822	2564.72	0	0
6	566.218	646.894	3290.25	0	0
7	570.823	642.671	3860.38	0	0
8	575.428	639.022	4268.42	0	0
9	580.034	635.858	4531.13	0	0
10	584.639	633.116	4607.31	0	0
11	589.244	630.751	4500.59	0	0
12	593.85	628.728	4224.21	0	0

13	598.592	626.976	4553.68	0	0
14	603.334	625.538	4706.18	0	0
15	608.076	624.397	4704.03	0	0
16	612.818	623.541	4562.33	0	0
17	617.561	622.962	4290.64	0	0
18	622.303	622.653	3926.2	0	0
19	628.491	622.653	3361.6	0	0
20	632.738	622.917	2959.75	0	0
21	636.985	623.398	2584.68	0	0
22	641.233	624.099	2273.4	0	0
23	645.48	625.026	2061.35	0	0
24	649.727	626.188	1896.68	0	0
25	653.974	627.593	1775.86	0	0
26	658.222	629.257	0	0	0

## Discharge Sections

---

### 14. ENTITY INFORMATION

---

#### 14.1 WATER TABLE

	X	Y
150		618
1100		618

#### 14.2 EXTERNAL BOUNDARY

	X	Y
644.036		629.078
634.789		635.016
629.34		638.516
625.671		640.872
624.34		641.511
620.205		644.016
616.815		645.981
615.328		646.929

613.014	648.516
607.86	648.516
597.806	655.016
592.456	658.516
584.389	664.016
577.788	668.516
573.141	668.516
568.162	671.925
564.477	674.516
558.79	678.516
551.729	683.516
549.003	685.448
544.745	688.516
537.403	688.516
531.002	693.076
523.502	698.516
516.257	698.516
511.994	702.013
511.148	702.722
509.56	704.051
505.978	703.817
501.869	699.925
500.598	698.516
493.557	698.516
485.705	692.661
480.145	688.516
473.075	688.516
459.527	678.516
445.979	668.516
441.584	668.516
427.943	658.516
414.301	648.516
409.898	648.516
399.736	641.132
396.024	638.516

392.123	635.766
381.002	628.021
379.881	627.24
377.985	625.927
370.145	620.734
163.025	620.734
163.025	617.753
163.025	614.879
163.025	607.753
163.025	595.753
163.025	520.734
1052.4	520.734
1052.4	595.753
1052.4	607.753
1052.4	614.879
1052.4	617.753
1052.4	632.463
857.838	633.579
842.181	631.581
696.243	629.737

14.3 MATERIAL BOUNDARY

X	Y
422.339	627.535
429.765	622.653
685.065	622.653
696.243	629.737

Material Boundary

X	Y
163.025	617.753
1052.4	617.753

Material Boundary

X	Y
163.025	614.879
1052.4	614.879

Material Boundary

X	Y
163.025	607.753
1052.4	607.753

Material Boundary

X	Y
163.025	595.753
1052.4	595.753

Material Boundary

X	Y
379.881	627.24
422.339	627.535
644.036	629.078

Material Boundary

X	Y
414.301	648.516
607.86	648.516

Material Boundary

X	Y
445.979	668.516
573.141	668.516

Material Boundary

X	Y
480.145	688.516
537.403	688.516

Material Boundary

X	Y
500.598	698.516
516.257	698.516

Material Boundary

X	Y
396.024	638.516
629.34	638.516

Material Boundary

X	Y
427.943	658.516
592.456	658.516

Material Boundary

	X	Y
459.527		678.516
558.79		678.516

## ANHANG 8 – ERGEBNISSE DER SLIDE SLV – ABSCHNITT 1

## APPENDICE 8 – RISULTATI ANALISI SLIDE SLV – SEZIONE 1

SLIDE - An Interactive Slope Stability Program

Date Created: 16/11/2018, 18:41:47

Software Version: 9.023

### Table of Contents

Project Summary .....	3
General Settings .....	4
Design Standard .....	5
Analysis Options .....	6
Groundwater Analysis .....	7
Random Numbers .....	8
Surface Options .....	9
Seismic Loading .....	10
Materials .....	11
Global Minimums .....	13
Method: bishop simplified .....	13
Valid and Invalid Surfaces .....	14
Method: bishop simplified .....	14
Slice Data .....	15
Global Minimum Query (bishop simplified) - Safety Factor: 1.16777 .....	15
Interslice Data .....	16
Global Minimum Query (bishop simplified) - Safety Factor: 1.16777 .....	16
Entity Information .....	17
Water Table .....	17
External Boundary .....	17
Material Boundary .....	18

# Slide2 Analysis Information

## SLIDE - An Interactive Slope Stability Program

### Project Summary

---

Slide2 Modeler Version:	9.023
Compute Time:	00h:00m:00.358s
Date Created:	16/11/2018, 18:41:47



## General Settings

---

Units of Measurement:	Metric Units
Time Units:	days
Permeability Units:	meters/second
Data Output:	Standard
Failure Direction:	Left to Right

## Design Standard

Selected Type:	Eurocode 7 (User Defined)	
Name:	User Defined 1	
	Type	Partial Factor
Permanent Actions: Unfavourable	1	
Permanent Actions: Favourable	1	
Variable Actions: Unfavourable	1	
Variable Actions: Favourable	1	
Effective cohesion	1.25	
Coefficient of shearing resistance	1.25	
Undrained strength	1	
Weight density	1	
Shear strength (other models)	1	
Earth resistance	1	
Tensile and plate strength	1	
Shear strength	1	
Compressive strength	1	
Bond strength	1	
Seismic Coefficient	1	

## Analysis Options

---

Slices Type:	Vertical
	Analysis Methods Used
	Bishop simplified
Number of slices:	25
Tolerance:	0.005
Maximum number of iterations:	50
Check malpha < 0.2:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

## Groundwater Analysis

---

Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [kN/m <sup>3</sup> ]:	9.81
Use negative pore pressure cutoff:	Yes
Maximum negative pore pressure [kPa]:	0
Advanced Groundwater Method:	None

## Random Numbers

---

Pseudo-random Seed:

10116

Random Number Generation Method:

Park and Miller v.3

## Surface Options

---

Surface Type:	Circular
Search Method:	Auto Refine Search
Divisions along slope:	10
Circles per division:	10
Number of iterations:	10
Divisions to use in next iteration:	50%
Composite Surfaces:	Disabled
Minimum Elevation:	Not Defined
Minimum Depth:	Not Defined
Minimum Area:	Not Defined
Minimum Weight:	Not Defined

## Seismic Loading

---

Advanced seismic analysis:	No
Staged pseudostatic analysis:	No
Seismic Load Coefficient (Horizontal):	0.013
Seismic Load Coefficient (Vertical):	0.0065

## Materials

A

Color	
Strength Type	Mohr-Coulomb
Unit Weight [kN/m3]	21
Cohesion [kPa]	45
Friction Angle [deg]	37
Water Surface	Water Table
Hu Value	Automatically Calculated

Strato 1

Color	
Strength Type	Mohr-Coulomb
Unit Weight [kN/m3]	20
Cohesion [kPa]	5
Friction Angle [deg]	38
Water Surface	Water Table
Hu Value	Automatically Calculated

Strato 2

Color	
Strength Type	Mohr-Coulomb
Unit Weight [kN/m3]	20
Cohesion [kPa]	0
Friction Angle [deg]	40
Water Surface	Water Table
Hu Value	Automatically Calculated

Strato 3

Color	
Strength Type	Mohr-Coulomb
Unit Weight [kN/m3]	20
Cohesion [kPa]	0
Friction Angle [deg]	42
Water Surface	Water Table
Hu Value	Automatically Calculated

Strato 4

Color	
Strength Type	Mohr-Coulomb
Unit Weight [kN/m3]	20
Cohesion [kPa]	0
Friction Angle [deg]	36
Water Surface	Water Table
Hu Value	Automatically Calculated


Strato 5

Color	
-------	---

---

Strength Type	Mohr-Coulomb
Unit Weight [kN/m <sup>3</sup> ]	20
Cohesion [kPa]	0



Friction Angle [deg]	36
Water Surface	Water Table
Hu Value	Automatically Calculated
F1	
Color	
Strength Type	Mohr-Coulomb
Unit Weight [kN/m3]	20
Cohesion [kPa]	0
Friction Angle [deg]	20
Water Surface	Water Table
Hu Value	1

# Global Minimums

---

Method: bishop simplified

---

	FS	1.167770
Center:	625.578, 706.822	
Radius:	84.236	
Left Slip Surface Endpoint:	543.354, 688.516	
Right Slip Surface Endpoint:	658.439, 629.260	
Resisting Moment:	1.90194e+06 kN-m	
Driving Moment:	1.6287e+06 kN-m	
Total Slice Area:	2243.4 m <sup>2</sup>	
Surface Horizontal Width:	115.085 m	
Surface Average Height:	19.4935 m	

# Global Minimum Support Data

---

No Supports Present

## Valid and Invalid Surfaces

---

Method: bishop simplified

---

Number of Valid Surfaces:	3246
Number of Invalid Surfaces:	0

## Slice Data

Global Minimum Query (bishop simplified) - Safety Factor: 1.16777

Slice Number	Width [m]	Weight [kN]	Angle of Slice Base [deg]	Base Material	Base Cohesion [kPa]	Base Friction Angle [deg]	Shear Stress [kPa]	Shear Strength [kPa]	Base Normal Stress [kPa]	Pore Pressure [kPa]	Effective Normal Stress [kPa]	Base Vertical Stress [kPa]	Effective Vertical Stress [kPa]
1	4.60382	618.97	-72.2937	A	36	31.0834	38.4983	44.9572	14.8582	0	14.8582	135.444	135.444
2	4.60382	1460.12	-63.6135	A	36	31.0834	95.9144	112.006	126.079	0	126.079	319.412	319.412
3	4.60382	1938.58	-57.1969	A	36	31.0834	138.666	161.93	208.894	0	208.894	424.036	424.036
4	4.60382	2251.68	-51.7744	A	36	31.0834	172.203	201.094	273.86	0	273.86	492.49	492.49
5	4.60382	2459.29	-46.949	A	36	31.0834	198.697	232.032	325.178	0	325.178	537.874	537.874
6	4.60382	2590.19	-42.5296	A	36	31.0834	219.381	256.186	365.246	0	365.246	566.48	566.48
7	4.60382	2708.23	-38.4061	A	36	31.0834	238.836	278.905	402.932	0	402.932	592.272	592.272
8	4.60382	2962.87	-34.5073	A	36	31.0834	269.628	314.863	462.578	0	462.578	647.939	647.939
9	4.60382	2979.85	-30.7841	A	36	31.0834	280.851	327.969	484.32	0	484.32	651.635	651.635
10	4.60382	2923.35	-27.2006	A	36	31.0834	285.175	333.019	492.696	0	492.696	639.26	639.26
11	4.60382	2832.78	-23.7294	A	36	31.0834	285.757	333.699	493.825	0	493.825	619.438	619.438
12	4.69916	2769.98	-20.3145	F1	0	16.2343	135.444	158.168	543.204	0	543.204	593.345	593.345
13	4.69916	2617.86	-16.9392	F1	0	16.2343	129.951	151.753	521.173	0	521.173	560.753	560.753
14	4.69916	2439.06	-13.6237	F1	0	16.2343	122.844	143.454	492.672	0	492.672	522.445	522.445
15	4.69916	2397.43	-10.3543	F1	0	16.2343	122.464	143.01	491.146	0	491.146	513.521	513.521
16	4.69916	2323.44	-7.11873	F1	0	16.2343	120.342	140.532	482.638	0	482.638	497.667	497.667
17	4.69916	2083.32	-3.9059	F1	0	16.2343	109.402	127.756	438.759	0	438.759	446.229	446.229
18	6.77238	2542.43	0	F1	0	16.2343	94.2146	110.021	377.852	0	377.852	377.852	377.852
19	4.21076	1266.19	3.73908	F1	0	16.2343	76.7147	89.5851	307.666	0	307.666	302.652	302.652
20	4.21076	994.775	6.61611	F1	0	16.2343	61.0533	71.2962	244.856	0	244.856	237.774	237.774
21	4.21076	705.245	9.51004	F1	0	16.2343	43.8635	51.2225	175.916	0	175.916	168.568	168.568
22	4.21076	418.77	12.4288	F1	0	16.2343	26.4088	30.8394	105.913	0	105.913	100.093	100.093
23	4.21076	294.497	15.3807	F1	0	16.2343	18.8434	22.0048	75.5721	0	75.5721	70.3885	70.3885
24	4.21076	191.308	18.3753	F1	0	16.2343	12.4307	14.5162	49.8536	0	49.8536	45.7244	45.7244
25	4.21076	67.3262	21.4229	F1	0	16.2343	4.44735	5.19348	17.8362	0	17.8362	16.0913	16.0913

## Interslice Data

Global Minimum Query (bishop simplified) - Safety Factor: 1.16777

Slice Number	X coordinate [m]	Y coordinate - Bottom [m]	Normal Force [kN]	Shear Force [kN]	Force Angle [deg]
1	543.354	688.516	0	0	0
2	547.958	674.096	45.2467	0	0
3	552.562	664.816	793.099	0	0
4	557.166	657.673	1672.67	0	0
5	561.77	651.828	2510.67	0	0
6	566.374	646.9	3231.35	0	0
7	570.977	642.677	3798.5	0	0
8	575.581	639.027	4205.87	0	0
9	580.185	635.862	4468.39	0	0
10	584.789	633.119	4543.8	0	0
11	589.393	630.753	4436.02	0	0
12	593.997	628.729	4157.99	0	0
13	598.696	626.99	4503.14	0	0

14	603.395	625.559	4673.05	0	0
15	608.094	624.42	4689.19	0	0
16	612.793	623.561	4567.16	0	0
17	617.492	622.974	4315.67	0	0
18	622.191	622.653	3969.96	0	0
19	628.964	622.653	3365.6	0	0
20	633.175	622.929	2974.7	0	0
21	637.385	623.417	2611.22	0	0
22	641.596	624.122	2311.79	0	0
23	645.807	625.05	2107.86	0	0
24	650.018	626.209	1944.89	0	0
25	654.228	627.607	1825.35	0	0
26	658.439	629.26	0	0	0

## Discharge Sections

---

## Entity Information

---

### Water Table

	X	Y
150		618
1100		618

### External Boundary

	X	Y
644.036		629.078
634.789		635.016
629.34		638.516
625.671		640.872
624.34		641.511
620.205		644.016
616.815		645.981
615.328		646.929
613.014		648.516
607.86		648.516

597.806	655.016
592.456	658.516
584.389	664.016
577.788	668.516
573.141	668.516
568.162	671.925
564.477	674.516
558.79	678.516
551.729	683.516
549.003	685.448
544.745	688.516
537.403	688.516
531.002	693.076
523.502	698.516
516.257	698.516
511.994	702.013
511.148	702.722
509.56	704.051
505.978	703.817
501.869	699.925
500.598	698.516
493.557	698.516
485.705	692.661
480.145	688.516
473.075	688.516
459.527	678.516
445.979	668.516
441.584	668.516
427.943	658.516
414.301	648.516
409.898	648.516
399.736	641.132
396.024	638.516
392.123	635.766
381.002	628.021

379.881	627.24
377.985	625.927
370.145	620.734
163.025	620.734
163.025	617.753
163.025	614.879
163.025	607.753
163.025	595.753
163.025	520.734
1052.4	520.734
1052.4	595.753
1052.4	607.753
1052.4	614.879
1052.4	617.753
1052.4	632.463
857.838	633.579
842.181	631.581
696.243	629.737

Material Boundary

X	Y
422.339	627.535
429.765	622.653
685.065	622.653
696.243	629.737

Material Boundary

X	Y
163.025	617.753
1052.4	617.753

Material Boundary

X	Y
163.025	614.879
1052.4	614.879

Material Boundary

X	Y
163.025	607.753

1052.4	607.753
--------	---------

Material Boundary

X	Y
163.025	595.753
1052.4	595.753

Material Boundary

X	Y
379.881	627.24
422.339	627.535
644.036	629.078

Material Boundary

X	Y
414.301	648.516
607.86	648.516

Material Boundary

X	Y
445.979	668.516
573.141	668.516

Material Boundary

X	Y
480.145	688.516
537.403	688.516

Material Boundary

X	Y
500.598	698.516
516.257	698.516

Material Boundary

X	Y
396.024	638.516
629.34	638.516

Material Boundary

X	Y
427.943	658.516
592.456	658.516

Material Boundary

X	Y
---	---



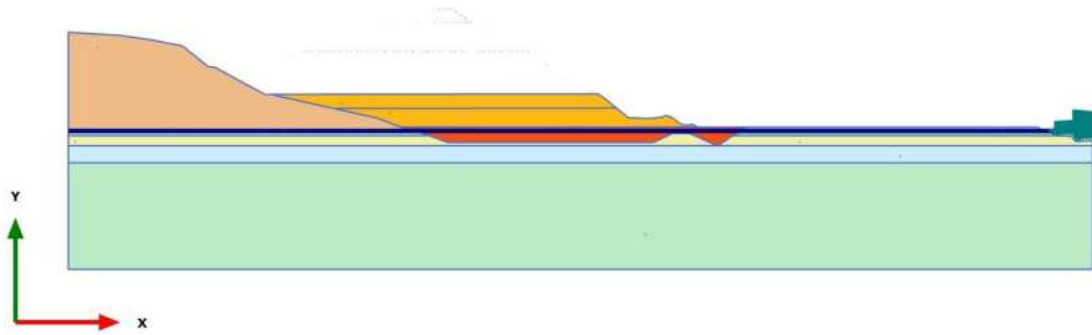
459.527	678.516
558.79	678.516

**ANHANG 9 – ERGEBNISSE DER PLAXIS SLU/SLV – ABSCHNITT 2**

**APPENDICE 9 – RISULTATI ANALISI PLAXIS SLU/SLV – SEZIONE 2**

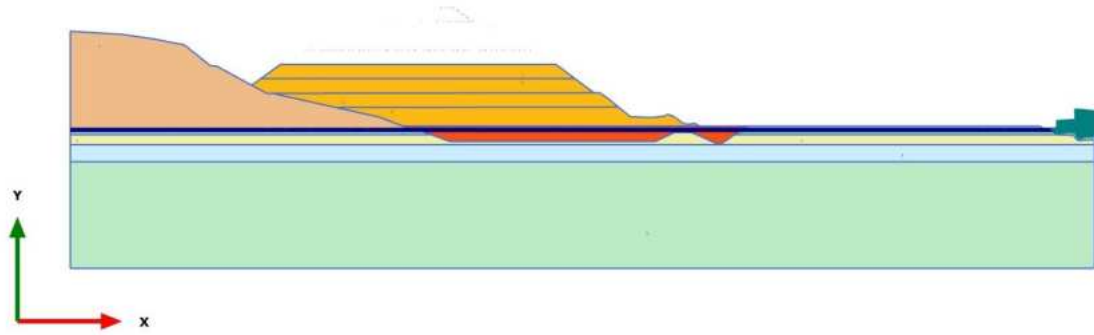
# PLAXIS Report

1.1.1.1 Calculation results, Phase\_1 [Phase\_1] (8/4), Materials plot



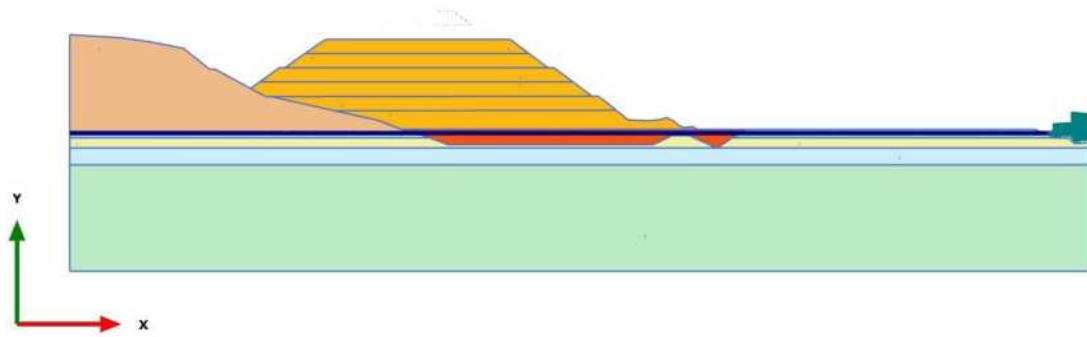
**Materials plot**

1.1.1.2 Calculation results, Phase\_2 [Phase\_2] (9/8), Materials plot



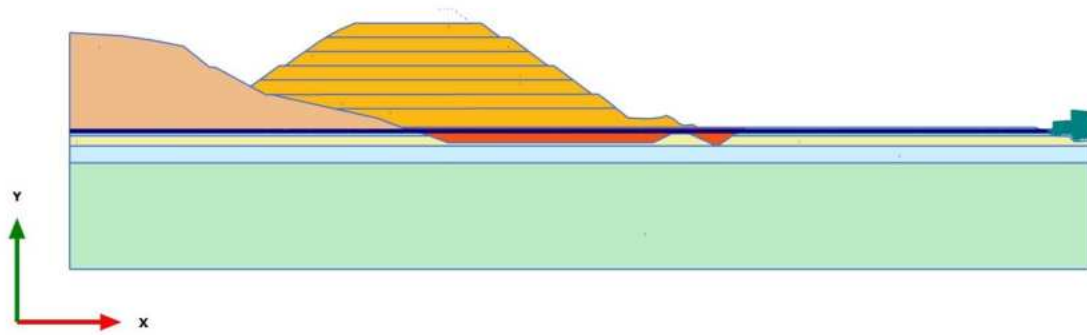
**Materials plot**

1.1.1.3 Calculation results, Phase\_3 [Phase\_3] (10/12), Materials plot



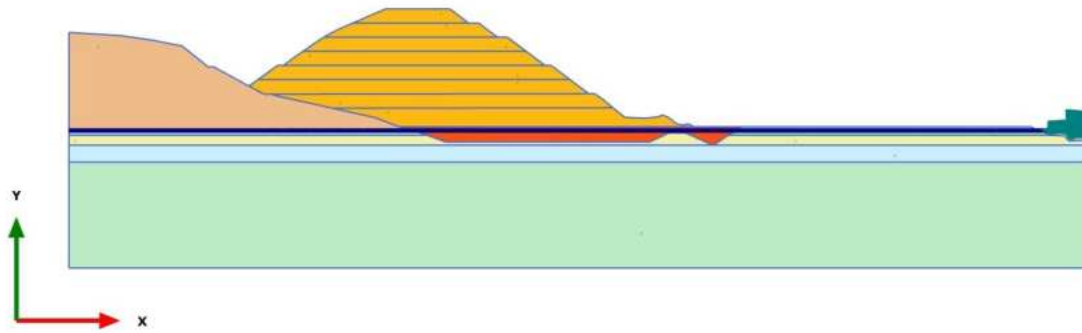
**Materials plot**

1.1.1.4 Calculation results, Phase\_4 [Phase\_4] (11/15), Materials plot



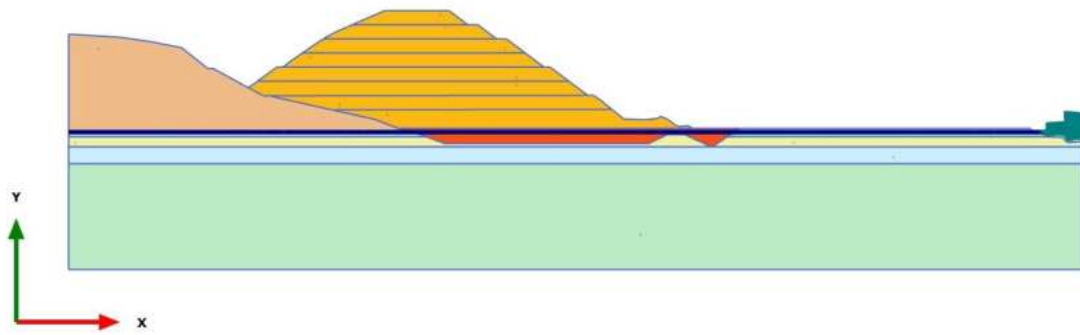
**Materials plot**

1.1.1.5 Calculation results, Phase\_5\_static [Phase\_5] (12/19), Materials plot



**Materials plot**

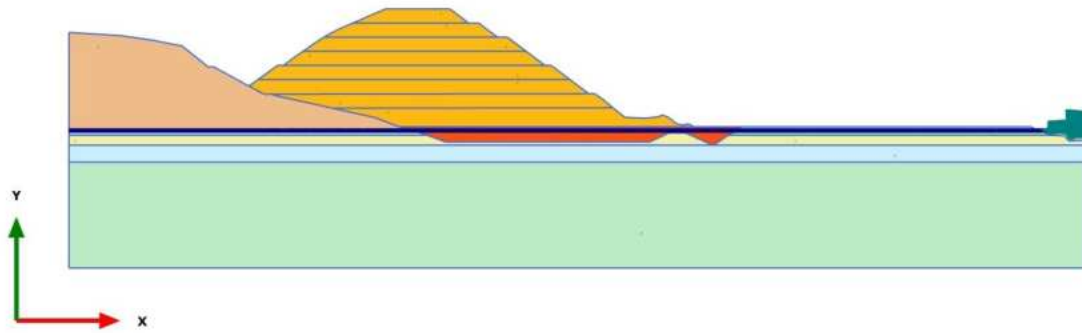
1.1.1.6 Calculation results, Phase\_6 FoS static [Phase\_6] (13/119), Materials plot



**Materials plot**

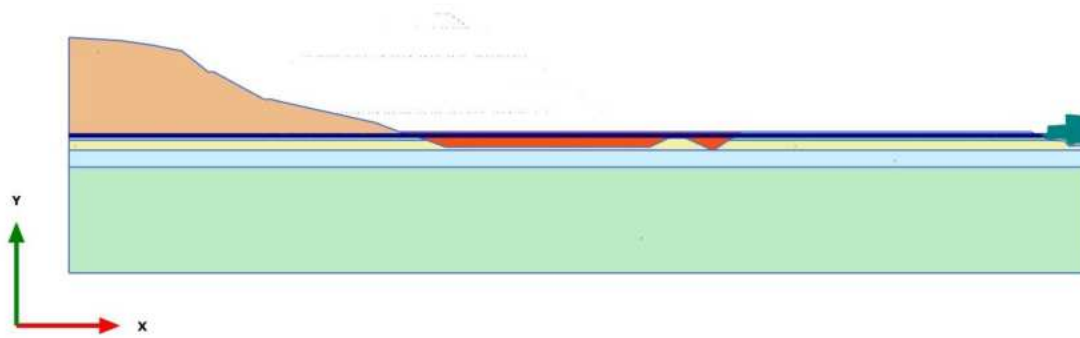


1.1.1.7 Calculation results, Phase\_8\_seismic [Phase\_8] (2/122), Materials plot



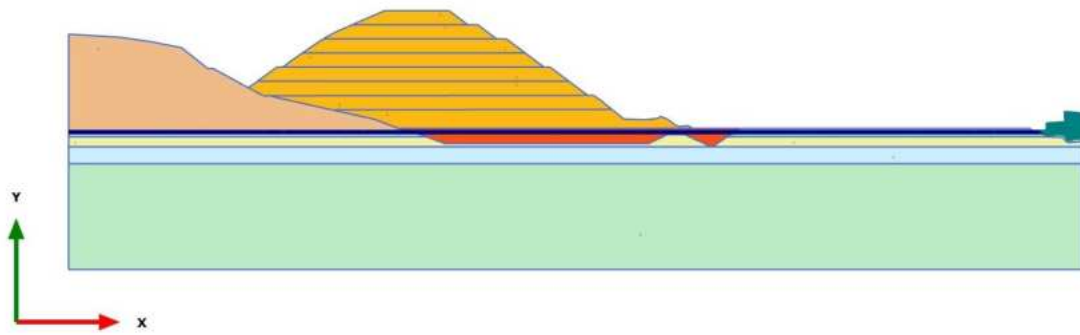
**Materials plot**

1.1.1.8 Calculation results, Initial phase [InitialPhase] (0/171), Materials plot








**Materials plot**

1.1.1.9 Calculation results, Phase\_7 FoS seismic [Phase\_7] (1/271), Materials plot



**Materials plot**

### 1.1.2.1.1 Materials - Soil and interfaces - Hardening soil





Identification		Strato 1	Strato 2	Strato 3	Strato 4	Strato 5
Identification number		1	2	3	4	5
Drainage type		Drained	Drained	Drained	Drained	Drained
Colour						
Comments						
$\gamma_{\text{unsat}}$	kN/m <sup>3</sup>	20,00	20,00	20,00	20,00	20,00
$\gamma_{\text{sat}}$	kN/m <sup>3</sup>	20,00	20,00	20,00	20,00	20,00
Dilatancy cut-off		No	No	No	No	No
$e_{\text{init}}$		0,5000	0,5000	0,5000	0,5000	0,5000
$e_{\text{min}}$		0,000	0,000	0,000	0,000	0,000
$e_{\text{max}}$		999,0	999,0	999,0	999,0	999,0
Rayleigh $\alpha$		0,000	0,000	0,000	0,000	0,000
Rayleigh $\beta$		0,000	0,000	0,000	0,000	0,000
$E_{50 \text{ ref}}$	kN/m <sup>2</sup>	25,00E3	40,00E3	50,00E3	30,00E3	70,00E3
$E_{\text{oed ref}}$	kN/m <sup>2</sup>	23,55E3	36,94E3	45,27E3	28,84E3	66,76E3
$E_{\text{ur ref}}$	kN/m <sup>2</sup>	75,00E3	120,0E3	150,0E3	90,00E3	210,0E3
power (m)		0,000	0,000	0,000	0,000	0,4000
Use alternatives		No	No	No	No	No
$C_c$		0,01465	9,339E-3	7,621E-3	0,01196	5,167E-3

Identification		Strato 1	Strato 2	Strato 3	Strato 4	Strato 5
$C_s$		4,140E-3	2,587E-3	2,070E-3	3,450E-3	1,479E-3
$e_{init}$		0,5000	0,5000	0,5000	0,5000	0,5000
$C_{ref}$	kN/m <sup>2</sup>	4,000	0,000	0,000	0,000	0,000
$\phi$ (phi)	°	32,01	33,87	35,77	30,17	30,17
$\psi$ (psi)	°	0,000	0,000	0,000	0,000	0,000
Set to default values		No	No	No	No	No
$v_{ur}$		0,2000	0,2000	0,2000	0,2000	0,2000
$p_{ref}$	kN/m <sup>2</sup>	100,0	100,0	100,0	100,0	100,0
$K_{0nc}$		0,3943	0,3695	0,3449	0,4194	0,4217
$C_{inc}$	kN/m <sup>2</sup> /m	0,000	0,000	0,000	0,000	0,000
$y_{ref}$	m	0,000	0,000	0,000	0,000	608,0
$R_f$		0,9000	0,9000	0,9000	0,9000	0,9000
Tension cut-off		Yes	Yes	Yes	Yes	Yes
Tensile strength	kN/m <sup>2</sup>	0,000	0,000	0,000	0,000	0,000
Undrained behaviour		Standard	Standard	Standard	Standard	Standard
Skempton-B		0,9866	0,9866	0,9866	0,9866	0,9866
$v_u$		0,4950	0,4950	0,4950	0,4950	0,4950
$K_{w,ref} / n$	kN/m <sup>2</sup>	3,073E6	4,917E6	6,146E6	3,687E6	8,604E6
Stiffness		Standard	Standard	Standard	Standard	Standard

Strength		Rigid	Rigid	Rigid	Rigid	Rigid
$R_{inter}$		1,000	1,000	1,000	1,000	1,000
Consider gap closure		Yes	Yes	Yes	Yes	Yes
Identification		Strato 1	Strato 2	Strato 3	Strato 4	Strato 5
$\delta_{inter}$		0,000	0,000	0,000	0,000	0,000
Cross permeability		Impermeable	Impermeable	Impermeable	Impermeable	Impermeable
Drainage conductivity, dk	m <sup>3</sup> /day/m	0,000	0,000	0,000	0,000	0,000
R	m <sup>2</sup> K/kW	0,000	0,000	0,000	0,000	0,000
$K_0$ determination		Automatic	Automatic	Automatic	Automatic	Automatic
$K_{0,x} = K_{0,z}$		Yes	Yes	Yes	Yes	Yes
$K_{0,x}$		0,3943	0,3695	0,3449	0,4194	0,4217
$K_{0,z}$		0,3943	0,3695	0,3449	0,4194	0,4217
OCR		1,000	1,000	1,000	1,000	1,000
POP	kN/m <sup>2</sup>	0,000	0,000	0,000	0,000	0,000
Data set		Standard	Standard	Standard	Standard	Standard
Type		Coarse	Coarse	Coarse	Coarse	Coarse
< 2 $\mu$ m	%	10,00	10,00	10,00	10,00	10,00
2 $\mu$ m - 50 $\mu$ m	%	13,00	13,00	13,00	13,00	13,00
50 $\mu$ m - 2 mm	%	77,00	77,00	77,00	77,00	77,00
Use defaults		None	None	None	None	None

$k_x$	m/day	0,000	0,000	0,000	0,000	0,000
$k_y$	m/day	0,000	0,000	0,000	0,000	0,000
$-\psi_{\text{unsat}}$	m	10,00E3	10,00E3	10,00E3	10,00E3	10,00E3
$e_{\text{init}}$		0,5000	0,5000	0,5000	0,5000	0,5000
$S_s$	1/m	0,000	0,000	0,000	0,000	0,000
$c_k$		1000E12	1000E12	1000E12	1000E12	1000E12
Identification		Strato 1	Strato 2	Strato 3	Strato 4	Strato 5
$c_s$	kJ/t/K	0,000	0,000	0,000	0,000	0,000
$\lambda_s$	kW/m/K	0,000	0,000	0,000	0,000	0,000
$\rho_s$	t/m <sup>3</sup>	0,000	0,000	0,000	0,000	0,000
Solid thermal expansion		Volumetric	Volumetric	Volumetric	Volumetric	Volumetric
$\alpha_s$	1/K	0,000	0,000	0,000	0,000	0,000
$D_v$	m <sup>2</sup> /day	0,000	0,000	0,000	0,000	0,000
$f_{\text{TV}}$		0,000	0,000	0,000	0,000	0,000
Unfrozen water content		None	None	None	None	None

1.1.2.1.2 Materials - Soil and interfaces - Mohr-Coulomb

Identification		Rock	A	F1	GNEISS
Identification number		6	7	8	9
Drainage type		Drained	Drained	Drained	Drained
Colour					
Comments					
$\gamma_{\text{unsat}}$	kN/m <sup>3</sup>	20,00	21,00	20,00	20,00
$\gamma_{\text{sat}}$	kN/m <sup>3</sup>	20,00	21,00	20,00	20,00
Dilatancy cut-off		No	No	No	No
$e_{\text{init}}$		0,5000	0,5000	0,5000	0,5000
$e_{\text{min}}$		0,000	0,000	0,000	0,000
$e_{\text{max}}$		999,0	999,0	999,0	999,0
Rayleigh $\alpha$		0,000	0,000	0,000	0,000
Rayleigh $\beta$		0,000	0,000	0,000	0,000
E	kN/m <sup>2</sup>	100,0E3	30,00E3	5000	30,00E3
$\nu$ (nu)		0,3000	0,3000	0,3000	0,3000
G	kN/m <sup>2</sup>	38,46E3	11,54E3	1923	11,54E3
$E_{\text{oad}}$	kN/m <sup>2</sup>	134,6E3	40,38E3	6731	40,38E3



Identification		Rock	A	F1	GNEISS
$c_{ref}$	kN/m <sup>2</sup>	500,0	36,00	0,000	40,00
$\phi$ (phi)	°	35,00	31,08	20,00	36,00
$\psi$ (psi)	°	0,000	3,000	0,000	3,000
$V_s$	m/s	137,4	73,42	30,71	75,23
$V_p$	m/s	257,0	137,4	57,46	140,7
Set to default values		Yes	Yes	Yes	Yes
$E_{inc}$	kN/m <sup>2</sup> /m	0,000	0,000	0,000	0,000
$\gamma_{ref}$	m	0,000	0,000	0,000	0,000
$C_{inc}$	kN/m <sup>2</sup> /m	0,000	0,000	0,000	0,000
$\gamma_{ref}$	m	0,000	0,000	0,000	0,000
Tension cut-off		Yes	Yes	Yes	Yes
Tensile strength	kN/m <sup>2</sup>	0,000	0,000	0,000	0,000
Undrained behaviour		Standard	Standard	Standard	Standard
Skempton-B		0,9783	0,9783	0,9783	0,9783
$\nu_u$		0,4950	0,4950	0,4950	0,4950
$K_{w,ref} / n$	kN/m <sup>2</sup>	3,750E6	1,125E6	187,5E3	1,125E6
Stiffness		Standard	Standard	Standard	Standard

Strength		Rigid	Rigid	Rigid	Rigid
R <sub>inter</sub>		1,000	1,000	1,000	1,000
Identification		Rock	A	F1	GNEISS
Consider gap closure		Yes	Yes	Yes	Yes
δ <sub>inter</sub>		0,000	0,000	0,000	0,000
Cross permeability		Impermeable	Impermeable	Impermeable	Impermeable
Drainage conductivity, dk	m <sup>3</sup> /day/m	0,000	0,000	0,000	0,000
R	m <sup>2</sup> K/kW	0,000	0,000	0,000	0,000
K <sub>0</sub> determination		Automatic	Automatic	Automatic	Automatic
K <sub>0,x</sub> = K <sub>0,z</sub>		Yes	Yes	Yes	Yes
K <sub>0,x</sub>		0,4264	0,4837	0,6580	0,4122
K <sub>0,z</sub>		0,4264	0,4837	0,6580	0,4122
Data set		Standard	USDA	Standard	USDA
Model		Van Genuchten	Van Genuchten	Van Genuchten	Van Genuchten
Type		Coarse	Coarse	Coarse	Coarse
Type		Sand	Sand	Sand	Sand
< 2 μm	%	10,00	4,000	10,00	4,000
2 μm - 50 μm	%	13,00	4,000	13,00	4,000

50 $\mu\text{m}$ - 2 mm	%	77,00	92,00	77,00	92,00
Use defaults		None	None	None	None
$k_x$	m/day	0,000	0,000	0,000	0,000
$k_y$	m/day	0,000	0,000	0,000	0,000
Identification		Rock	A	F1	GNEISS
$-\psi_{\text{unsat}}$	m	10,00E3	10,00E3	10,00E3	10,00E3
$e_{\text{init}}$		0,5000	0,5000	0,5000	0,5000
$S_s$	1/m	0,000	0,000	0,000	0,000
$c_k$		1000E12	1000E12	1000E12	1000E12
$c_s$	kJ/t/K	0,000	0,000	0,000	0,000
$\lambda_s$	kW/m/K	0,000	0,000	0,000	0,000
$\rho_s$	t/m <sup>3</sup>	0,000	0,000	0,000	0,000
Solid thermal expansion		Volumetric	Volumetric	Volumetric	Volumetric
$\alpha_s$	1/K	0,000	0,000	0,000	0,000
$D_v$	m <sup>2</sup> /day	0,000	0,000	0,000	0,000
$f_{\text{TV}}$		0,000	0,000	0,000	0,000
Unfrozen water content		None	None	None	None

1.1.3.1 Calculation information

Calculation information					
Step info					
Phase	Phase_1 [Phase_1]				
Step	Initial				
Calculation mode	Classical mode				
Step type	Plastic				
Updated mesh	False				
Solver type	Picos				
Kernel type	64 bit				
Extrapolation factor	0,5010				
Relative stiffness	0,5309				
Design approach					
Index	1				
Name	DesignApproach_1				
Multipliers					
Soil weight				$\Sigma M_{\text{Weight}}$	1,000
Strength reduction factor	$M_{\text{sf}}$	0,000	$\Sigma M_{\text{sf}}$	1,000	

Calculation information				
Time	Increment	0,000	End time	0,000
Staged construction				
Active proportion total area	$M_{Area}$	0,01263	$\Sigma M_{Area}$	0,9017
Active proportion of stage	$M_{Stage}$	0,1919	$\Sigma M_{Stage}$	1,000
Forces				
$F_x$	0,000 kN/m			
$F_y$	0,000 kN/m			
Consolidation				
Realised $P_{Excess,Max}$	0,000 kN/m <sup>2</sup>			

### 1.1.3.2 Calculation information

Calculation information				
Step info				
Phase	Phase_2 [Phase_2]			
Step	Initial			
Calculation mode	Classical mode			
Step type	Plastic			
Updated mesh	False			
Solver type	Picos			
Kernel type	64 bit			
Extrapolation factor	0,6881			
Relative stiffness	0,5066			
Design approach				
Index	1			
Name	DesignApproach_1			
Multipliers				
Soil weight			$\Sigma M_{\text{Weight}}$	1,000
Strength reduction factor	$M_{\text{sf}}$	0,000	$\Sigma M_{\text{sf}}$	1,000

Calculation information				
Time	Increment	0,000	End time	0,000
Staged construction				
Active proportion total area	$M_{Area}$	0,01608	$\Sigma M_{Area}$	0,9485
Active proportion of stage	$M_{Stage}$	0,2611	$\Sigma M_{Stage}$	1,000
Forces				
$F_x$	0,000 kN/m			
$F_y$	0,000 kN/m			
Consolidation				
Realised $P_{Excess,Max}$	0,000 kN/m <sup>2</sup>			

1.1.3.3 Calculation information

Calculation information				
Step info				
Phase	Phase_3 [Phase_3]			
Step	Initial			
Calculation mode	Classical mode			
Step type	Plastic			
Updated mesh	False			
Solver type	Picos			
Kernel type	64 bit			
Extrapolation factor	0,1242			
Relative stiffness	0,4413			
Design approach				
Index	1			
Name	DesignApproach_1			
Multipliers				
Soil weight			$\Sigma M_{\text{Weight}}$	1,000
Strength reduction factor	$M_{\text{sf}}$	0,000	$\Sigma M_{\text{sf}}$	1,000



Calculation information				
Time	Increment	0,000	End time	0,000
Staged construction				
Active proportion total area	$M_{Area}$	2,078E-3	$\Sigma M_{Area}$	0,9820
Active proportion of stage	$M_{Stage}$	0,04311	$\Sigma M_{Stage}$	1,000
Forces				
$F_x$	0,000 kN/m			
$F_y$	0,000 kN/m			
Consolidation				
Realised $P_{Excess,Max}$	0,000 kN/m <sup>2</sup>			

#### 1.1.3.4 Calculation information

Calculation information				
Step info				
Phase	Phase_4 [Phase_4]			
Step	Initial			
Calculation mode	Classical mode			
Step type	Plastic			
Updated mesh	False			
Solver type	Picos			
Kernel type	64 bit			
Extrapolation factor	0,7857			
Relative stiffness	0,4236			
Design approach				
Index	1			
Name	DesignApproach_1			
Multipliers				
Soil weight			$\Sigma M_{\text{Weight}}$	1,000
Strength reduction factor	$M_{\text{sf}}$	0,000	$\Sigma M_{\text{sf}}$	1,000

Calculation information				
Time	Increment	0,000	End time	0,000
Staged construction				
Active proportion total area	$M_{Area}$	4,437E-3	$\Sigma M_{Area}$	0,9932
Active proportion of stage	$M_{Stage}$	0,2614	$\Sigma M_{Stage}$	1,000
Forces				
$F_x$	0,000 kN/m			
$F_y$	0,000 kN/m			
Consolidation				
Realised P <small>Excess,Max</small>	0,000 kN/m <sup>2</sup>			

1.1.3.5 Calculation information

Calculation information				
Step info				
Phase	Phase_5_static [Phase_5]			
Step	Initial			
Calculation mode	Classical mode			
Step type	Plastic			
Updated mesh	False			
Solver type	Picos			
Kernel type	64 bit			
Extrapolation factor	0,3140			
Relative stiffness	0,1432			
Design approach				
Index	1			
Name	DesignApproach_1			
Multipliers				
Soil weight			$\Sigma M_{\text{Weight}}$	1,000
Strength reduction factor	$M_{sf}$	0,000	$\Sigma M_{sf}$	1,000

Calculation information				
Time	Increment	0,000	End time	0,000
Staged construction				
Active proportion total area	$M_{Area}$	1,060E-3	$\Sigma M_{Area}$	1,000
Active proportion of stage	$M_{Stage}$	0,07465	$\Sigma M_{Stage}$	1,000
Forces				
$F_x$	0,000 kN/m			
$F_y$	0,000 kN/m			
Consolidation				
Realised $P_{Excess,Max}$	0,000 kN/m <sup>2</sup>			

1.1.3.6 Calculation information

Calculation information				
Step info				
Phase	Phase_6 FoS static [Phase_6]			
Step	Initial			
Calculation mode	Classical mode			
Step type	Safety			
Updated mesh	False			
Solver type	Picos			
Kernel type	64 bit			
Extrapolation factor	1,000			
Relative stiffness	0,02271E-3			
Design approach				
Index	1			
Name	DesignApproach_1			
Multipliers				
Soil weight			$\Sigma M_{\text{Weight}}$	1,000
Strength reduction factor	$M_{sf}$	-0,05615E-3	$\Sigma M_{sf}$	1,103

Calculation information					
Time	Increment		0,000	End time	0,000
Staged construction					
Active proportion total area	$M_{Area}$		0,000	$\Sigma M_{Area}$	1,000
Active proportion of stage	$M_{Stage}$		0,000	$\Sigma M_{Stage}$	0,000
Forces					
$F_x$		0,000 kN/m			
$F_y$		0,000 kN/m			
Consolidation					
Realised $P_{Excess,Max}$		0,000 kN/m <sup>2</sup>			

1.1.3.7 Calculation information

Calculation information				
Step info				
Phase	Phase_8_seismic [Phase_8]			
Step	Initial			
Calculation mode	Classical mode			
Step type	Plastic			
Updated mesh	False			
Solver type	Picos			
Kernel type	64 bit			
Extrapolation factor	0,1869			
Relative stiffness	0,3870			
Design approach				
Index	1			
Name	DesignApproach_1			
Multipliers				
Soil weight			$\Sigma M_{Weight}$	1,000
Strength reduction factor	$M_{sf}$	0,000	$\Sigma M_{sf}$	1,000



Calculation information					
Time	Increment	0,000	End time	0,000	
Staged construction					
Active proportion total area	$M_{Area}$	0,000	$\Sigma M_{Area}$	1,000	
Active proportion of stage	$M_{Stage}$	0,07485	$\Sigma M_{Stage}$	1,000	
Forces					
$F_x$	0,000 kN/m				
$F_y$	0,000 kN/m				
Consolidation					
Realised $P_{Excess,Max}$	0,000 kN/m <sup>2</sup>				
Pseudo-static acceleration					
X	0,01300 g				
Y	6,000E-3 g				
1.1.3.8 Calculation information					
Calculation information					
Step info					
Phase	Initial phase [InitialPhase]				
Step	Initial				

Calculation mode	Classical mode			
Step type	Gravity loading			
Solver type	Picos			
Kernel type	64 bit			
Extrapolation factor	0,9229			
Relative stiffness	0,3494			
Design approach				
Index	1			
Name	DesignApproach_1			
Multipliers				
Soil weight			$\Sigma M_{Weight}$	1,000
Strength reduction factor	$M_{sf}$	0,000	$\Sigma M_{sf}$	1,000
Time	Increment	0,000	End time	0,000
Calculation information				
Staged construction				
Active proportion total area	$M_{Area}$	0,2185	$\Sigma M_{Area}$	0,8513
Active proportion of stage	$M_{Stage}$	0,2566	$\Sigma M_{Stage}$	1,000
Forces				

$F_x$  0,000 kN/m

$F_y$  0,000 kN/m

Consolidation

Realised P Excess,Max 0,000 kN/m<sup>2</sup>

1.1.3.9 Calculation information

Calculation information				
Step info				
Phase	Phase_7 FoS seismic [Phase_7]			
Step	Initial			
Calculation mode	Classical mode			
Step type	Safety			
Updated mesh	False			
Solver type	Picos			
Kernel type	64 bit			
Extrapolation factor	2,000			
Relative stiffness	1,120E-6			
Design approach				
Index	1			
Name	DesignApproach_1			
Multipliers				
Soil weight			$\Sigma M_{\text{Weight}}$	1,000
Strength reduction factor	$M_{\text{sf}}$	-1,275E-3	$\Sigma M_{\text{sf}}$	1,142

Calculation information					
Time	Increment	0,000	End time	0,000	
Staged construction					
Active proportion total area	$M_{Area}$	0,000	$\Sigma M_{Area}$	1,000	
Active proportion of stage	$M_{Stage}$	0,000	$\Sigma M_{Stage}$	0,000	
Forces					
$F_x$	0,000 kN/m				
$F_y$	0,000 kN/m				
Consolidation					
Realised $P_{Excess,Max}$	0,000 kN/m <sup>2</sup>				
Pseudo-static acceleration					
X	0,01300 g				
Y	6,000E-3 g				

#### 1.1.4 Calculation information per phase

Identification	Phase	Start from	Calculation type	Loading input	Pore pressure	Time step [day]	First step	Last step	Log
Initial phase [InitialPhase]	0	N/A	Gravity loading	N/A	Phreatic	0,000	153	171	
Phase_1 [Phase_1]	8	0	Plastic	Staged construction	Phreatic	0,000	0	4	
Phase_2 [Phase_2]	9	8	Plastic	Staged construction	Phreatic	0,000	5	8	
Phase_3 [Phase_3]	10	9	Plastic	Staged construction	Phreatic	0,000	9	12	
Phase_4 [Phase_4]	11	10	Plastic	Staged construction	Phreatic	0,000	13	15	
Phase_5_static [Phase_5]	12	11	Plastic	Staged construction	Phreatic	0,000	16	19	
Phase_6 FoS static [Phase_6]	13	12	Safety	Incremental multipliers	Use pressures from previous phase	0,000	20	119	
Phase_8_seismic [Phase_8]	2	12	Plastic	Staged construction	Phreatic	0,000	120	122	
Phase_7 FoS seismic [Phase_7]	1	2	Safety	Incremental multipliers	Use pressures from previous phase	0,000	172	271	

1.1.5.1 Step info

Step	Phase Step type	Extrapolation factor	Relative stiffness [ $10^{-3}$ ]
171	0 Gravity loading	0,923	349,374
4	8 Plastic	0,501	530,929
8	9 Plastic	0,688	506,559
12	10 Plastic	0,124	441,304
15	11 Plastic	0,786	423,637
19	12 Plastic	0,314	143,187
119	13 Safety	1,000	0,023
122	2 Plastic	0,187	386,980
271	1 Safety	2,000	0,001

1.1.5.2 Multipliers

Step	Phase $\Sigma M_{DispX}$	$\Sigma M_{DispY}$	$\Sigma M_{Weight}$	$M_{sf}$	$\Sigma M_{sf}$
171	0 0,000	0,000	1,000	0,000	1,000
4	8 0,000	0,000	1,000	0,000	1,000
8	9 0,000	0,000	1,000	0,000	1,000
12	10 0,000	0,000	1,000	0,000	1,000
15	11 0,000	0,000	1,000	0,000	1,000
19	12 0,000	0,000	1,000	0,000	1,000
119	13 0,000	0,000	1,000	0,000	1,103
122	2 0,000	0,000	1,000	0,000	1,000
271	1 0,000	0,000	1,000	-0,001	1,142



### 1.1.5.3 Time

Step	Phase Time step [day]	End time [day]
171	0 0,000	0,000
4	8 0,000	0,000
8	9 0,000	0,000
12	10 0,000	0,000
15	11 0,000	0,000
19	12 0,000	0,000
119	13 0,000	0,000
122	2 0,000	0,000
271	1 0,000	0,000

1.1.5.4 Staged construction

Step	Phase M <sub>Area</sub>	ΣM <sub>Area</sub>	M <sub>Stage</sub>	ΣM <sub>Stage</sub>
171	0 1,000	0,851	0,257	1,000
4	8 0,766	0,902	0,192	1,000
8	9 0,759	0,948	0,261	1,000
12	10 0,694	0,982	0,043	1,000
15	11 0,665	0,993	0,261	1,000
19	12 0,475	1,000	0,075	1,000
119	13 -0,011	1,000	0,000	0,000
122	2 0,801	1,000	0,075	1,000
271	1 -0,256	1,000	0,000	0,000

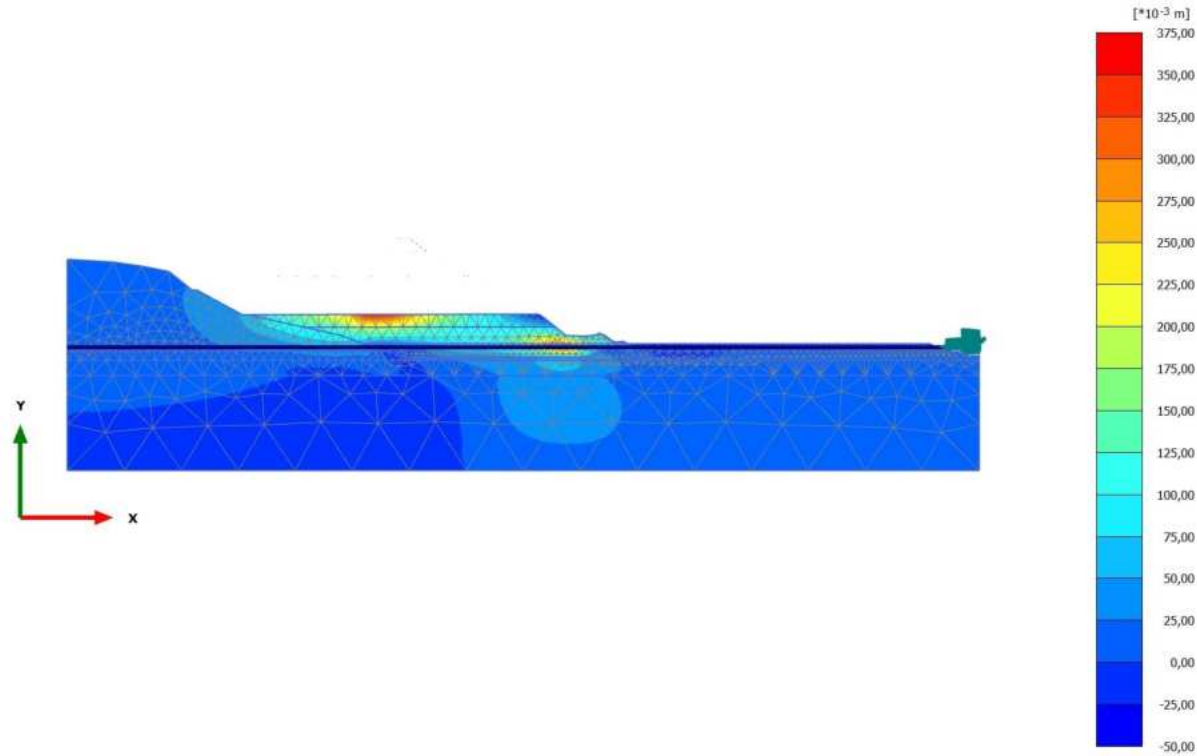
#### 1.1.5.5 Forces

Step	Phase $F_x$ [kN/m]	$F_y$ [kN/m]
171	0 0,000	0,000
4	8 0,000	0,000
8	9 0,000	0,000
12	10 0,000	0,000
15	11 0,000	0,000
19	12 0,000	0,000
119	13 0,000	0,000
122	2 0,000	0,000
271	1 0,000	0,000

#### 1.1.5.6 Consolidation

Step	Phase Rel. P <sub>Max</sub> [kN/m <sup>2</sup> ]
171	0 0,000
4	8 0,000
8	9 0,000
12	10 0,000
15	11 0,000
19	12 0,000
119	13 0,000
122	2 0,000
271	1 0,000

2.1.1.1.1 Calculation results, Phase\_1 [Phase\_1] (8/4), Total displacements  $u_x$

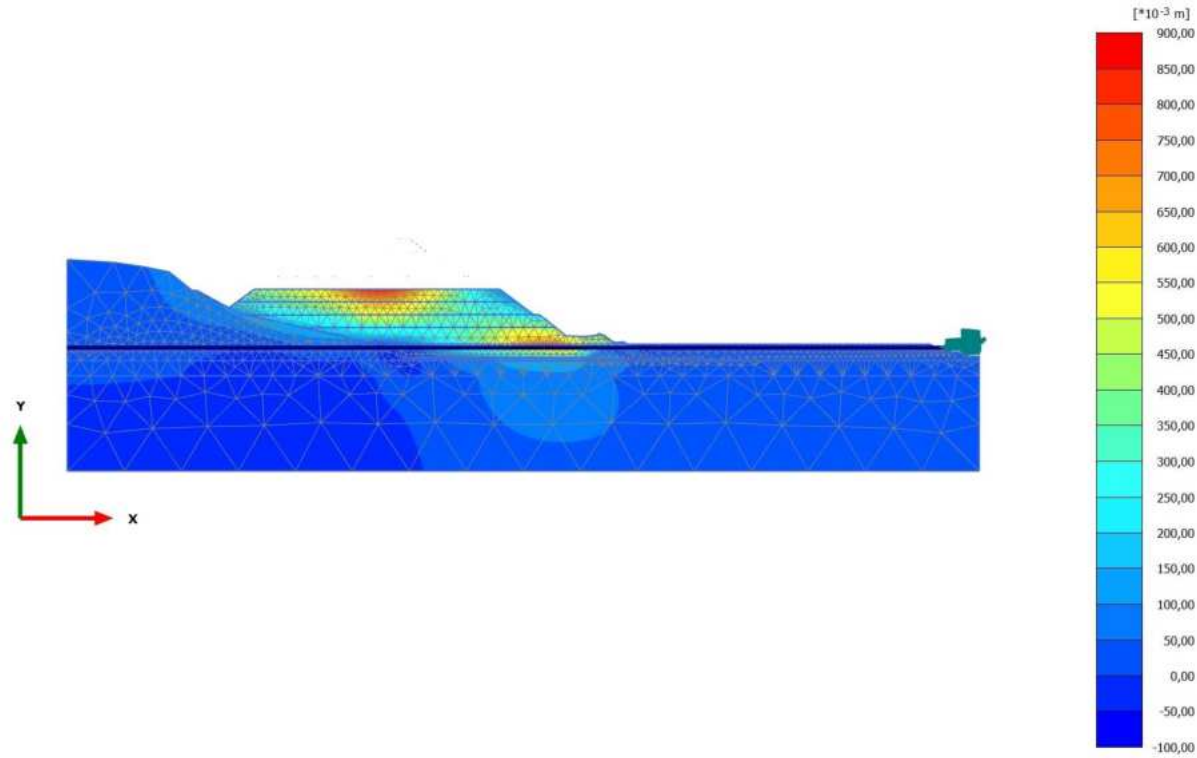


**Total displacements  $u_x$  (scaled up 50,0 times)**

Maximum value = 0,3646 m (Element 864 at Node 17602)

Minimum value = -0,04405 m (Element 902 at Node 12153)

2.1.1.1.2 Calculation results, Phase\_2 [Phase\_2] (9/8), Total displacements  $u_x$

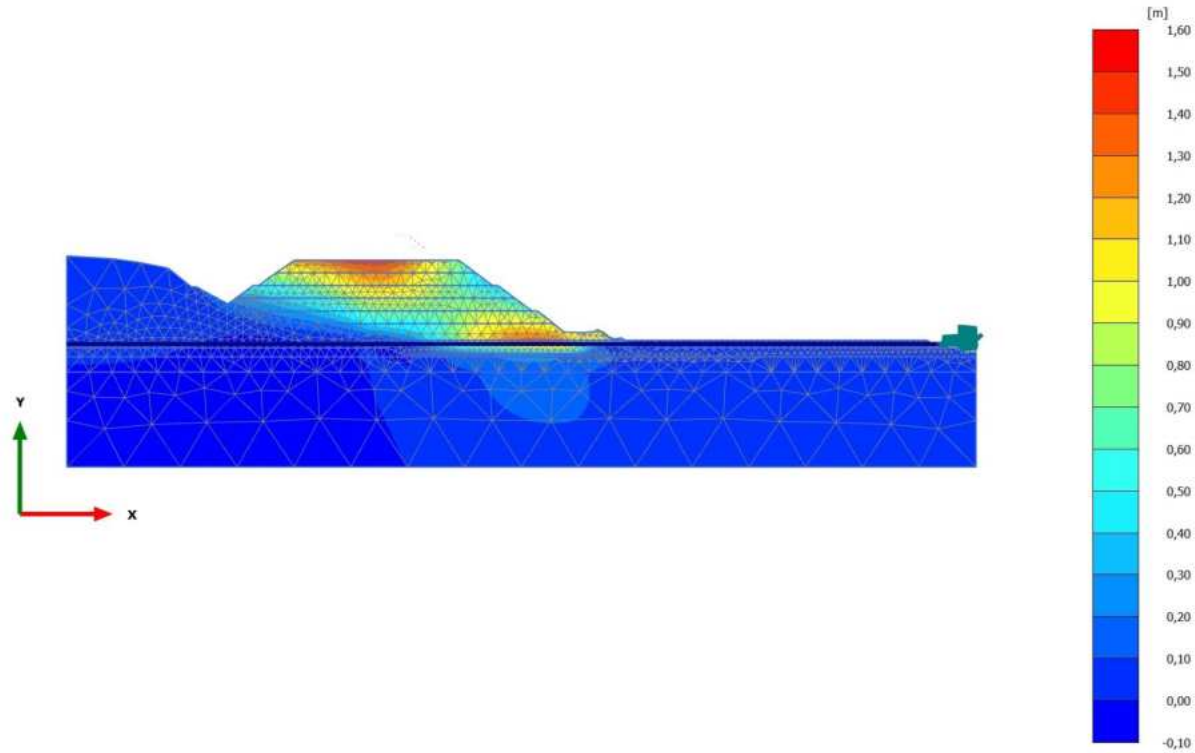


**Total displacements  $u_x$  (scaled up 20,0 times)**

Maximum value = 0,8625 m (Element 329 at Node 19359)

Minimum value = -0,06433 m (Element 1425 at Node 15091)

2.1.1.1.3 Calculation results, Phase\_3 [Phase\_3] (10/12), Total displacements  $u_x$

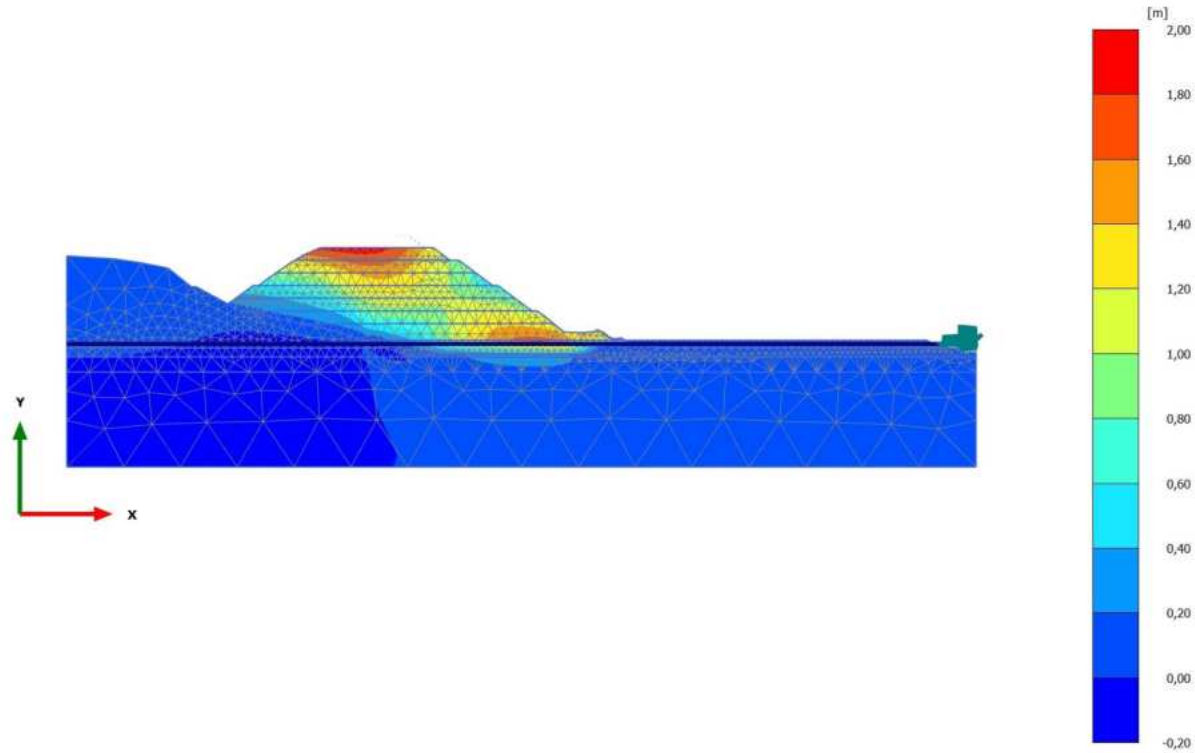


**Total displacements  $u_x$  (scaled up 10,0 times)**

Maximum value = 1,515 m (Element 187 at Node 20316)

Minimum value = -0,09508 m (Element 1930 at Node 11693)

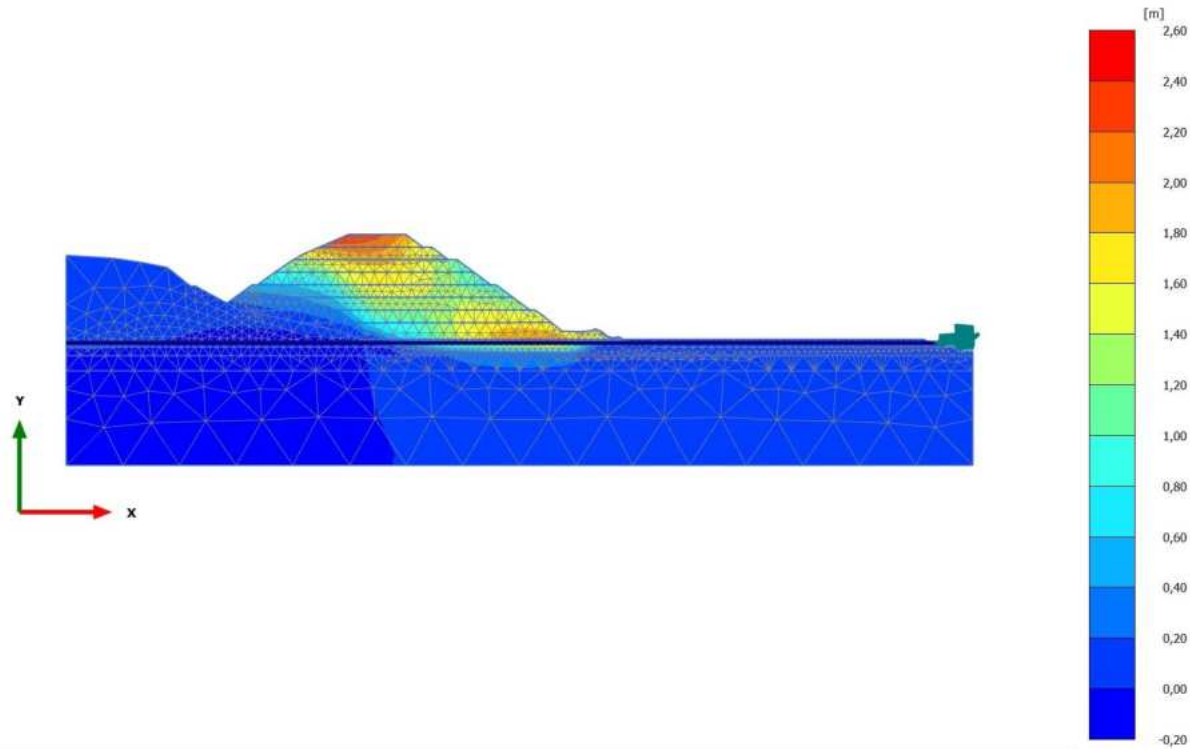
2.1.1.1.4 Calculation results, Phase\_4 [Phase\_4] (11/15), Total displacements  $u_x$



**Total displacements  $u_x$  (scaled up 10,0 times)**  
Maximum value = 1,939 m (Element 41 at Node 20396)  
Minimum value = -0,1268 m (Element 1930 at Node 11695)



2.1.1.1.5 Calculation results, Phase\_5\_static [Phase\_5] (12/19), Total displacements  $u_x$

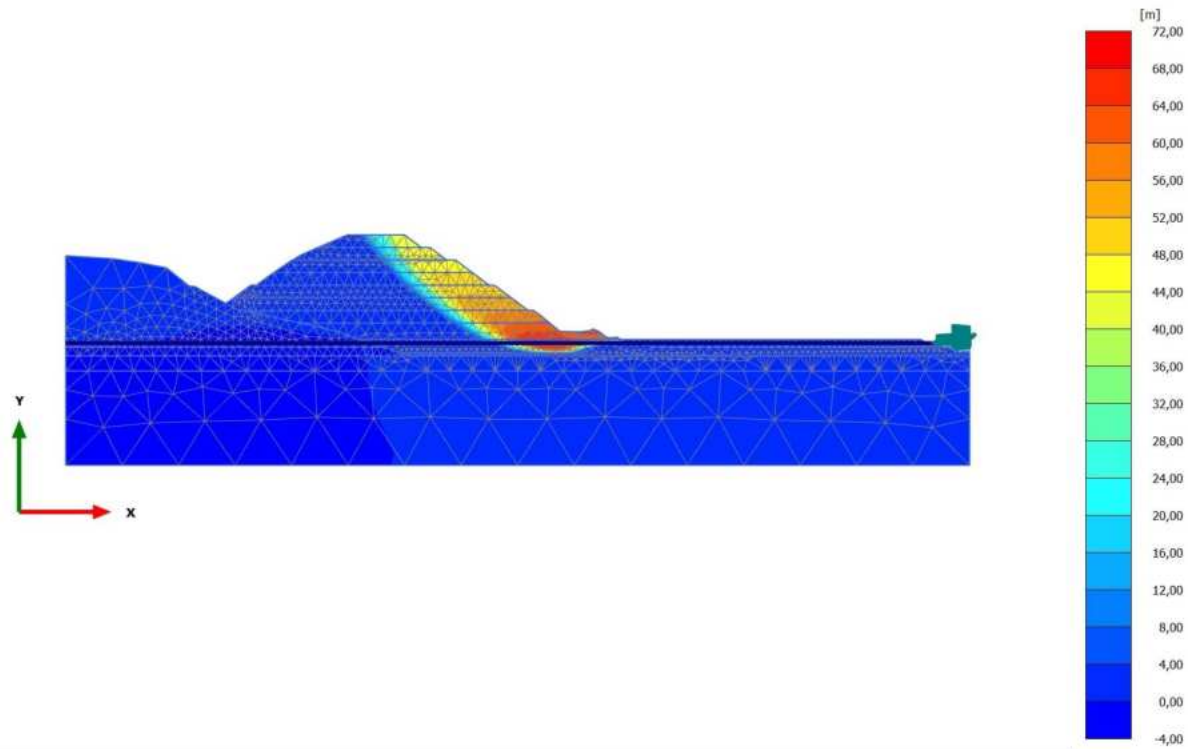


**Total displacements  $u_x$  (scaled up 5,00 times)**

Maximum value = 2,439 m (Element 28 at Node 20254)

Minimum value = -0,1554 m (Element 1930 at Node 12329)

2.1.1.1.6 Calculation results, Phase\_6 FoS static [Phase\_6] (13/119), Total displacements  $u_x$

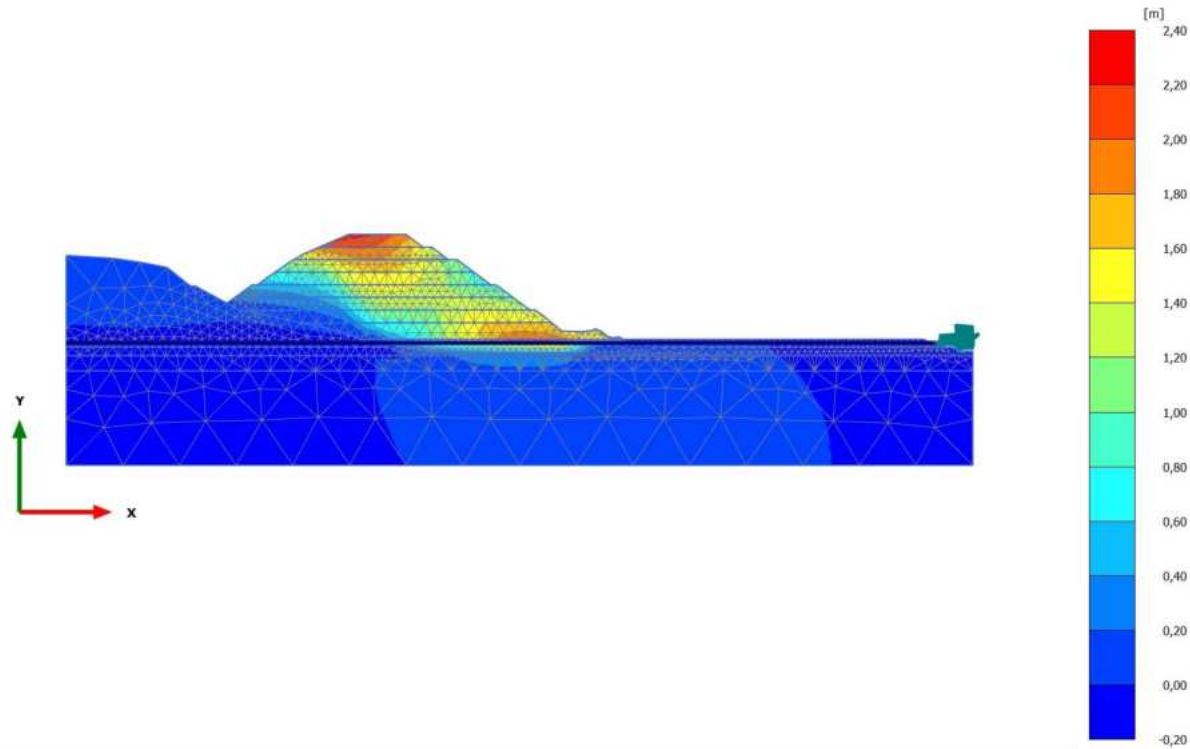


**Total displacements  $u_x$  (scaled up 0,500 times)**

Maximum value = 69,36 m (Element 999 at Node 7573)

Minimum value = -0,1586 m (Element 1930 at Node 12329)

2.1.1.1.7 Calculation results, Phase\_8\_seismic [Phase\_8] (2/122), Total displacements  $u_x$

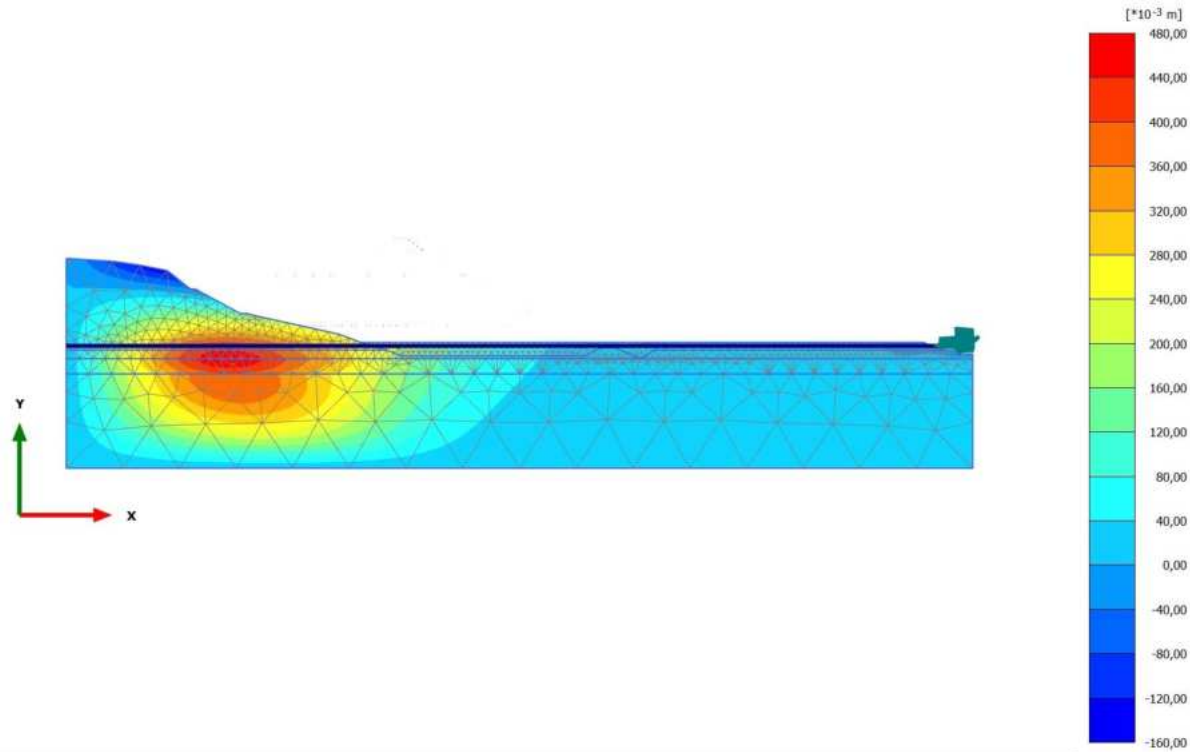


**Total displacements  $u_x$  (scaled up 5,00 times)**

Maximum value = 2,339 m (Element 28 at Node 20254)

Minimum value = -0,1783 m (Element 1930 at Node 12329)

2.1.1.1.8 Calculation results, Initial phase [InitialPhase] (0/171), Total displacements  $u_x$

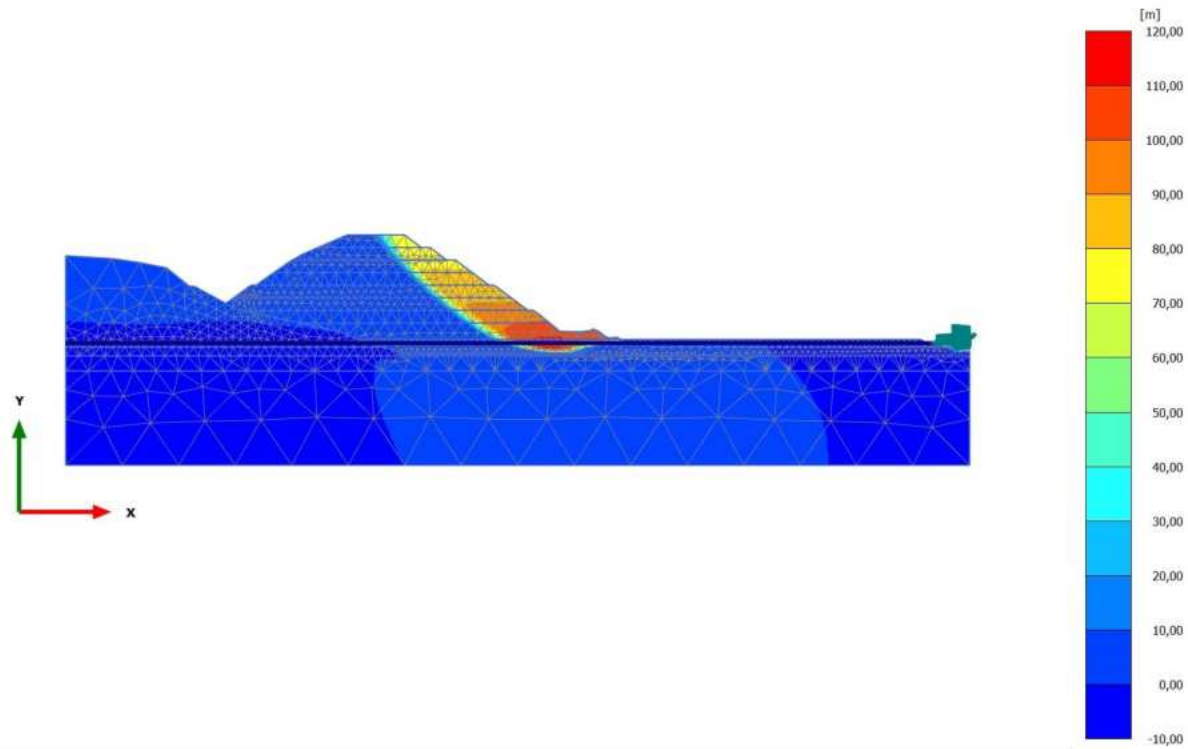


**Total displacements  $u_x$  (scaled up 50,0 times)**

Maximum value = 0,4726 m (Element 1926 at Node 11073)

Minimum value = -0,1462 m (Element 575 at Node 9203)

2.1.1.1.9 Calculation results, Phase\_7 FoS seismic [Phase\_7] (1/271), Total displacements  $u_x$

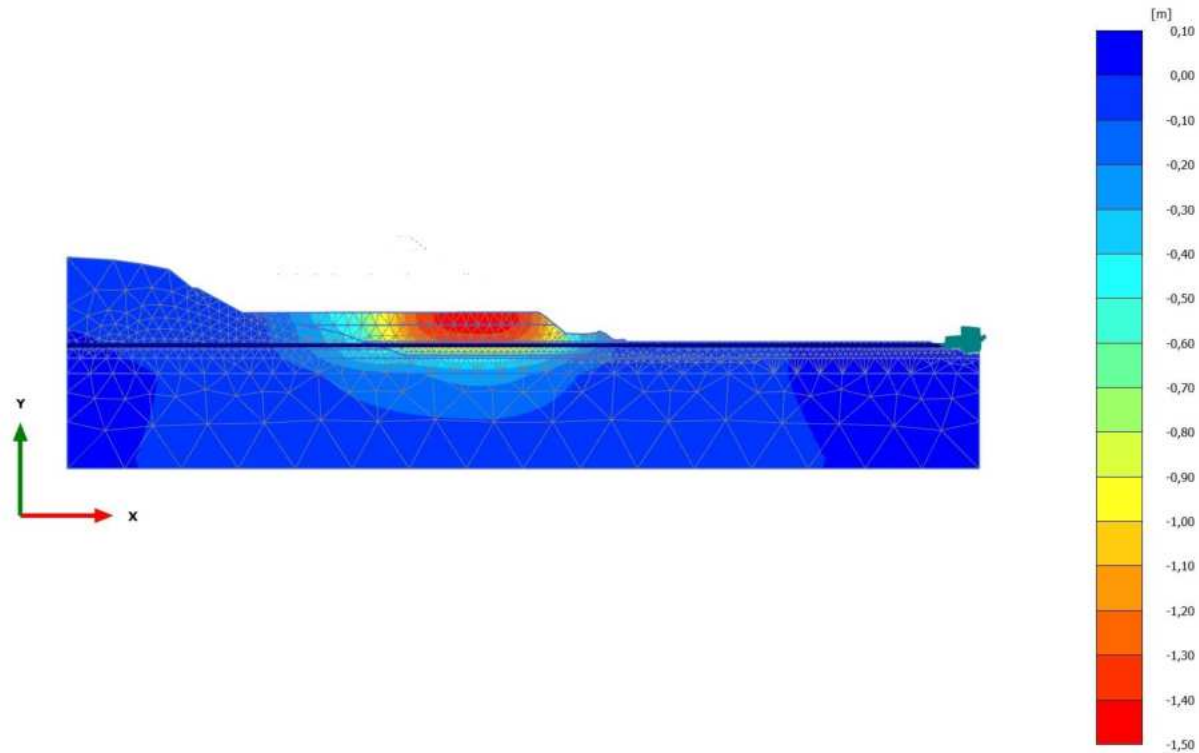


**Total displacements  $u_x$  (scaled up 0,200 times)**

Maximum value = 115,4 m (Element 1006 at Node 7574)

Minimum value = -0,1835 m (Element 1930 at Node 12329)

2.1.1.2.1 Calculation results, Phase\_1 [Phase\_1] (8/4), Total displacements  $u_y$

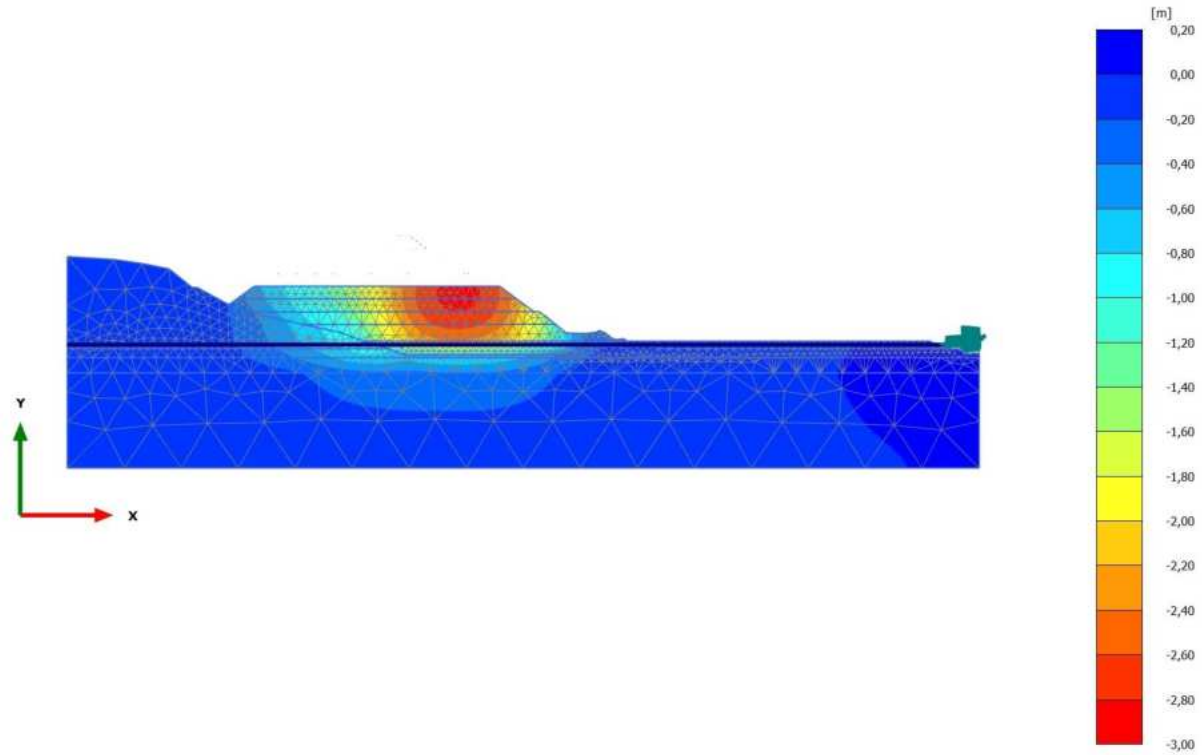


**Total displacements  $u_y$  (scaled up 20,0 times)**

Maximum value =  $1,813 \cdot 10^{-3}$  m (Element 2150 at Node 8747)

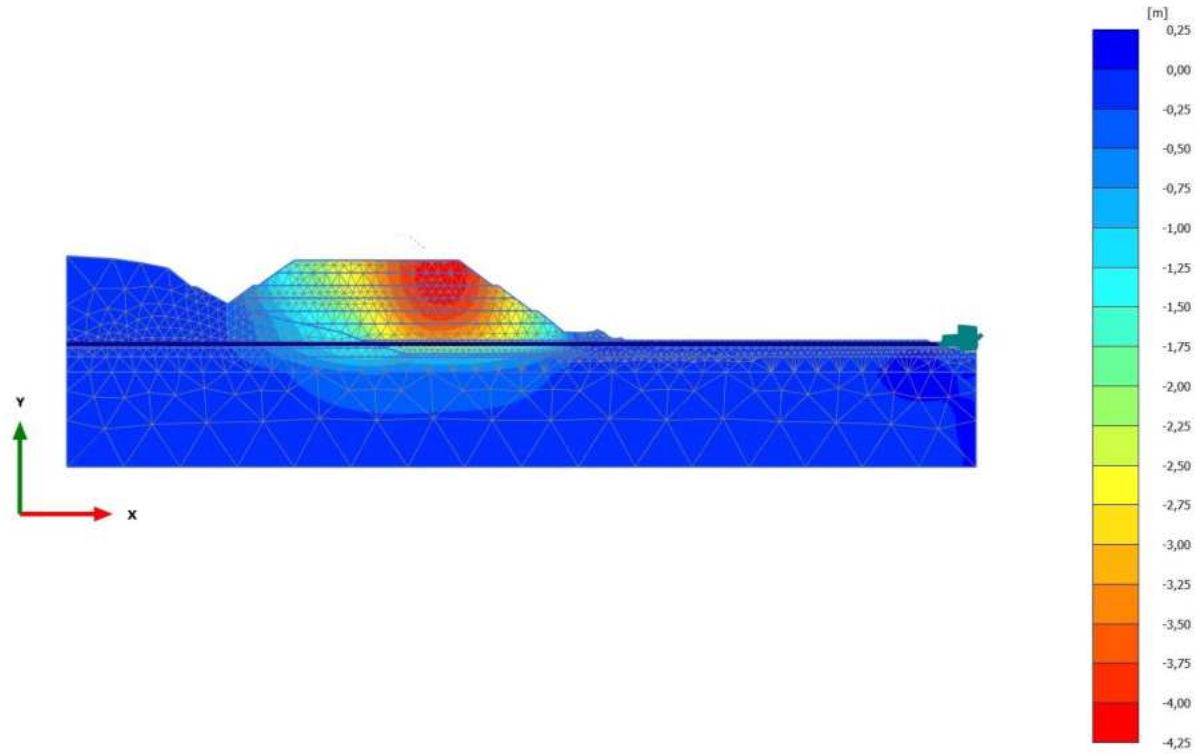
Minimum value = -1,472 m (Element 885 at Node 16408)

2.1.1.2.2 Calculation results, Phase\_2 [Phase\_2] (9/8), Total displacements  $u_y$



**Total displacements  $u_y$  (scaled up 5,00 times)**  
Maximum value =  $0,3755 \cdot 10^{-3}$  m (Element 2144 at Node 3405)  
Minimum value = -2,865 m (Element 291 at Node 17652)

2.1.1.2.3 Calculation results, Phase\_3 [Phase\_3] (10/12), Total displacements  $u_y$



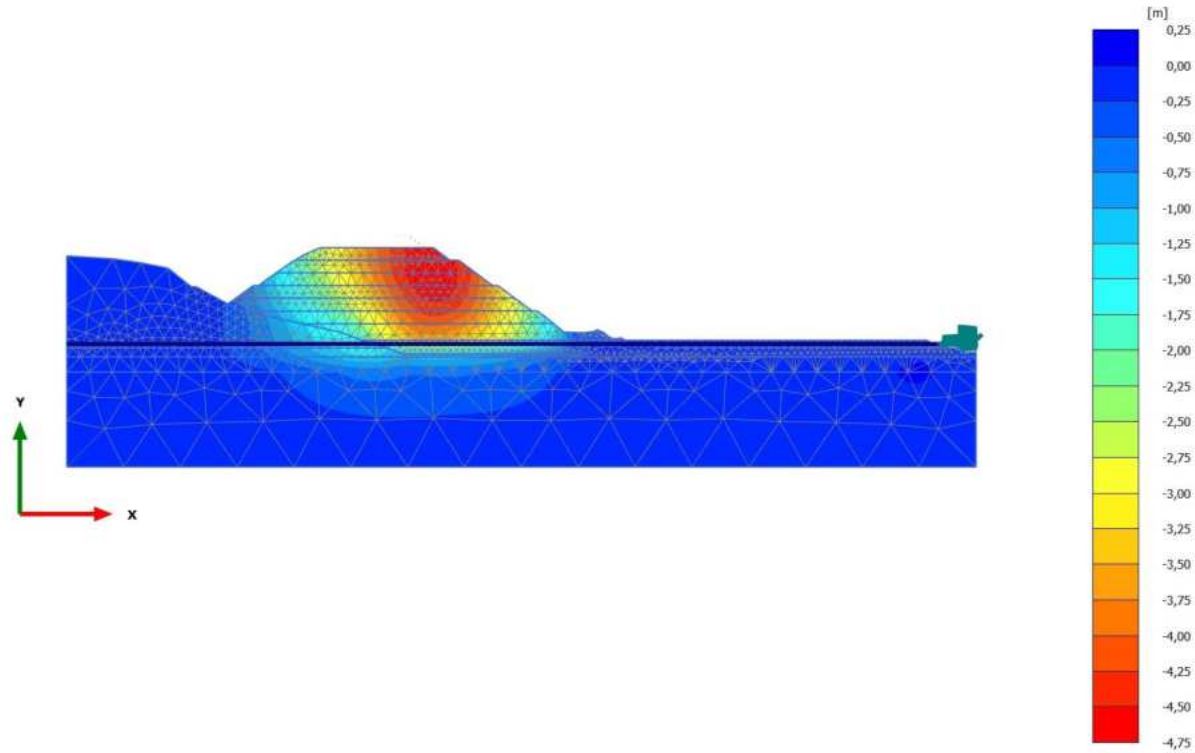
**Total displacements  $u_y$  (scaled up 5,00 times)**

Maximum value = 0,04988 m (Element 1466 at Node 4501)

Minimum value = -4,182 m (Element 251 at Node 18708)



2.1.1.2.4 Calculation results, Phase\_4 [Phase\_4] (11/15), Total displacements  $u_y$

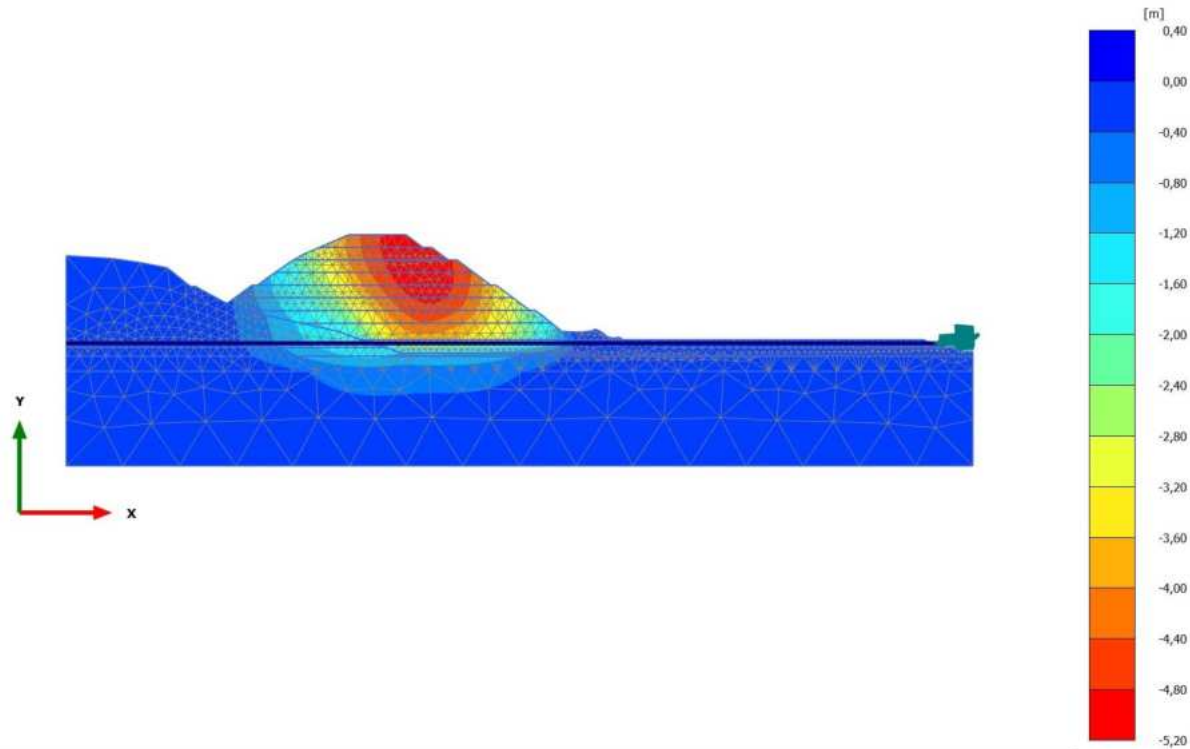


**Total displacements  $u_y$  (scaled up 5,00 times)**

Maximum value = 0,1060 m (Element 1466 at Node 4501)

Minimum value = -4,727 m (Element 128 at Node 19425)

2.1.1.2.5 Calculation results, Phase\_5\_static [Phase\_5] (12/19), Total displacements  $u_y$

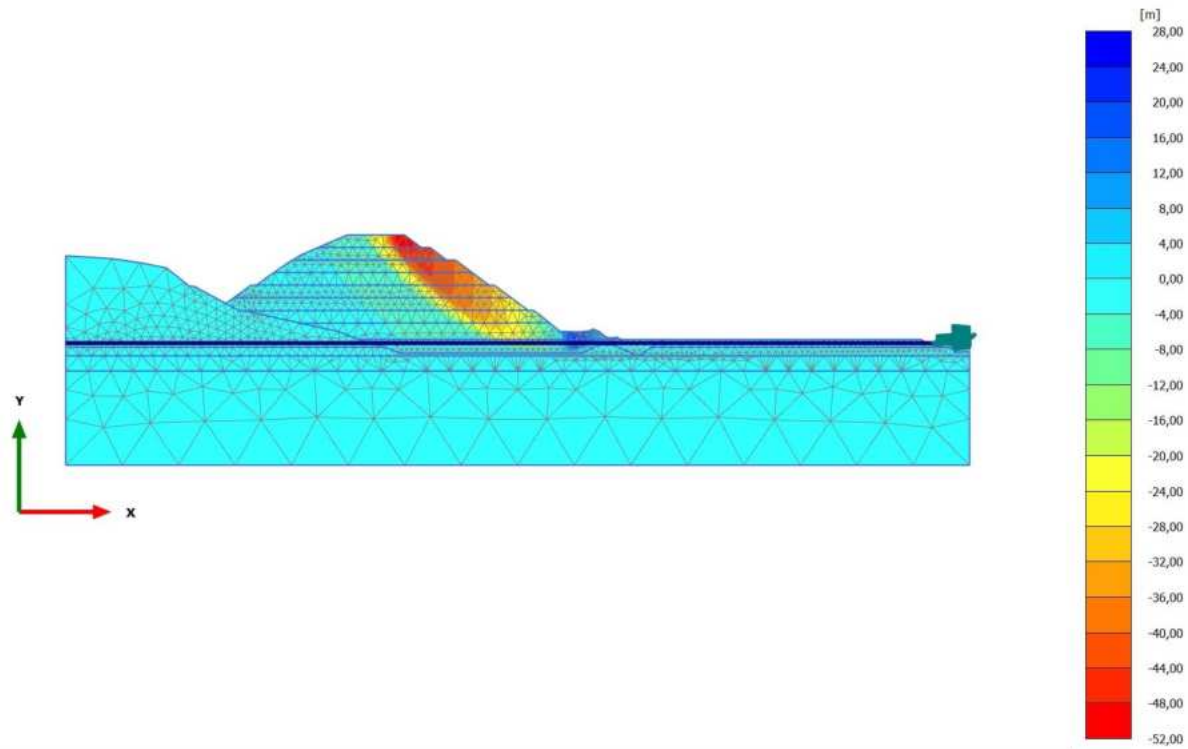


**Total displacements  $u_y$  (scaled up 5,00 times)**

Maximum value = 0,2166 m (Element 1466 at Node 4501)

Minimum value = -5,154 m (Element 114 at Node 19820)

2.1.1.2.6 Calculation results, Phase\_6 FoS static [Phase\_6] (13/119), Total displacements  $u_y$

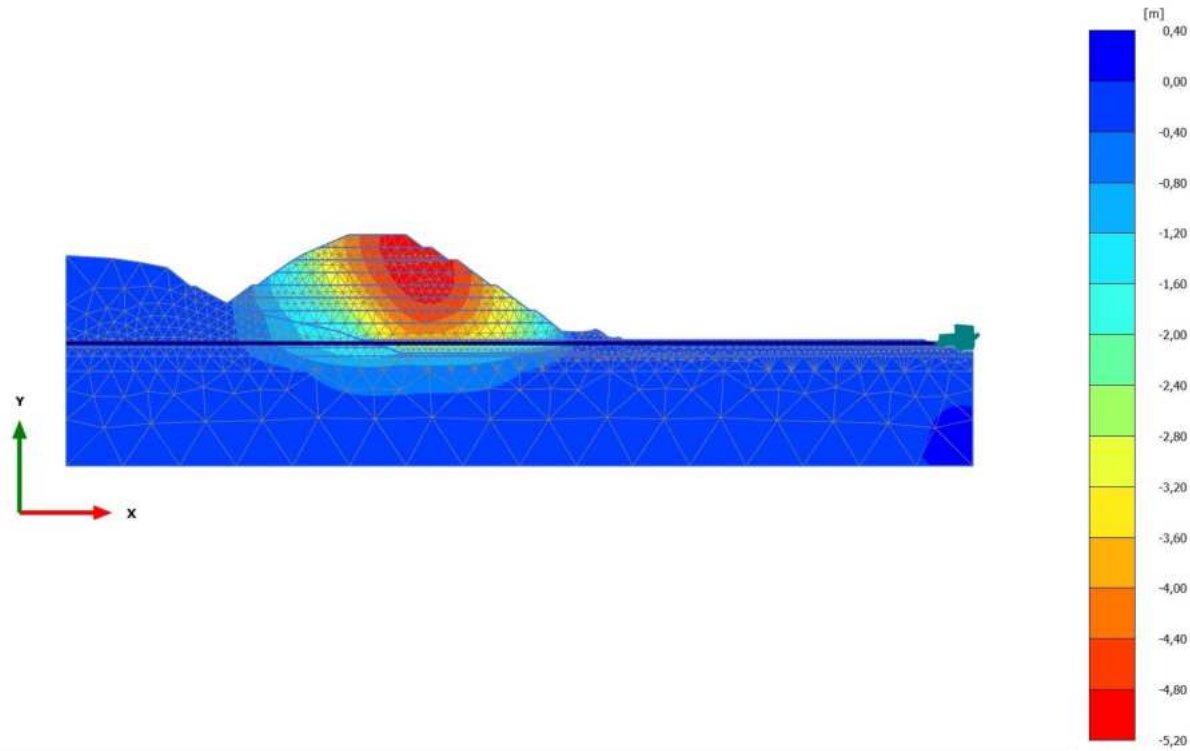


**Total displacements  $u_y$  (scaled up 0,200 times)**

Maximum value = 27,02 m (Element 1466 at Node 4501)

Minimum value = -49,68 m (Element 2 at Node 20435)

2.1.1.2.7 Calculation results, Phase\_8\_seismic [Phase\_8] (2/122), Total displacements  $u_y$

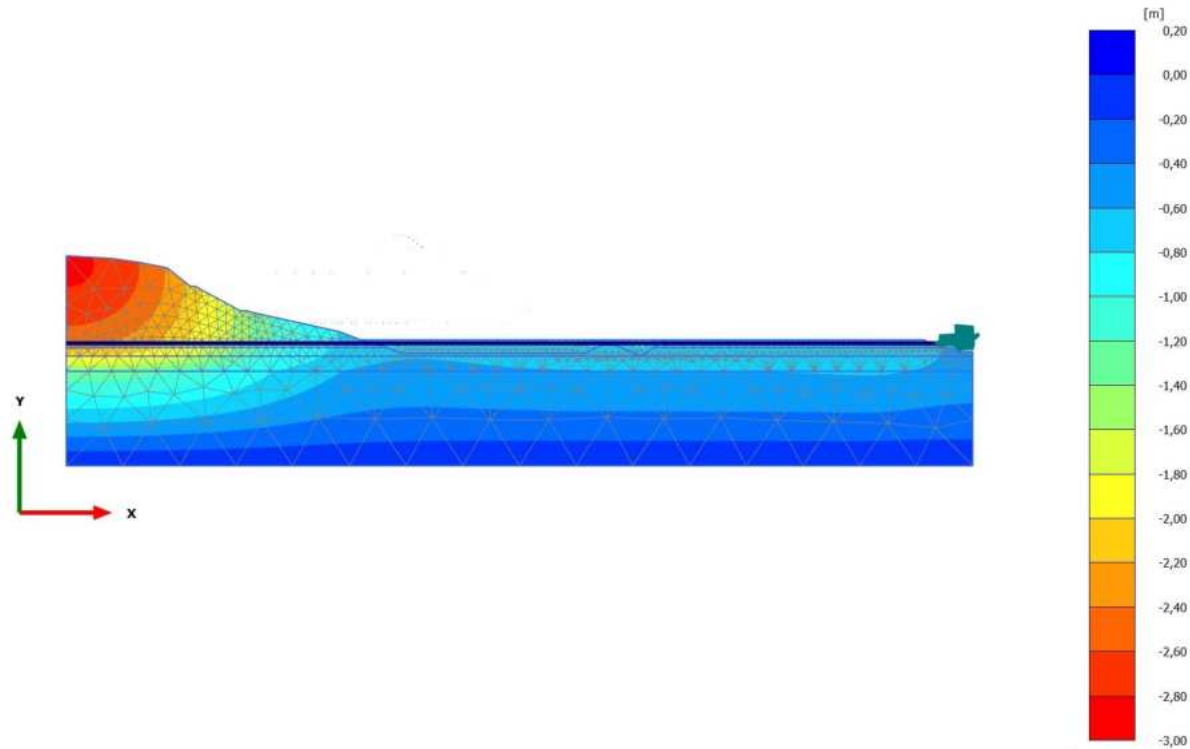


**Total displacements  $u_y$  (scaled up 5,00 times)**

Maximum value = 0,2296 m (Element 1466 at Node 4501)

Minimum value = -5,167 m (Element 114 at Node 19820)

2.1.1.2.8 Calculation results, Initial phase [InitialPhase] (0/171), Total displacements  $u_y$

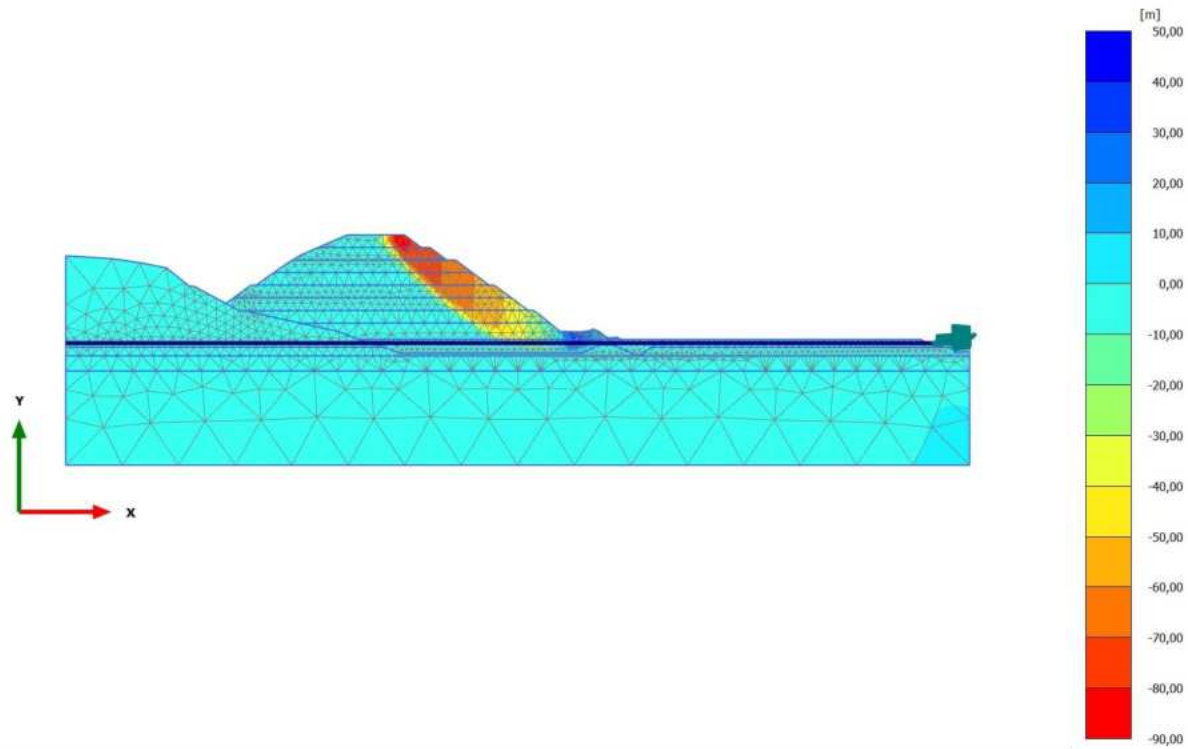


**Total displacements  $u_y$  (scaled up 5,00 times)**

Maximum value = 0,000 m (Element 2384 at Node 5345)

Minimum value = -2,833 m (Element 569 at Node 8841)

2.1.1.2.9 Calculation results, Phase\_7 FoS seismic [Phase\_7] (1/271), Total displacements  $u_y$

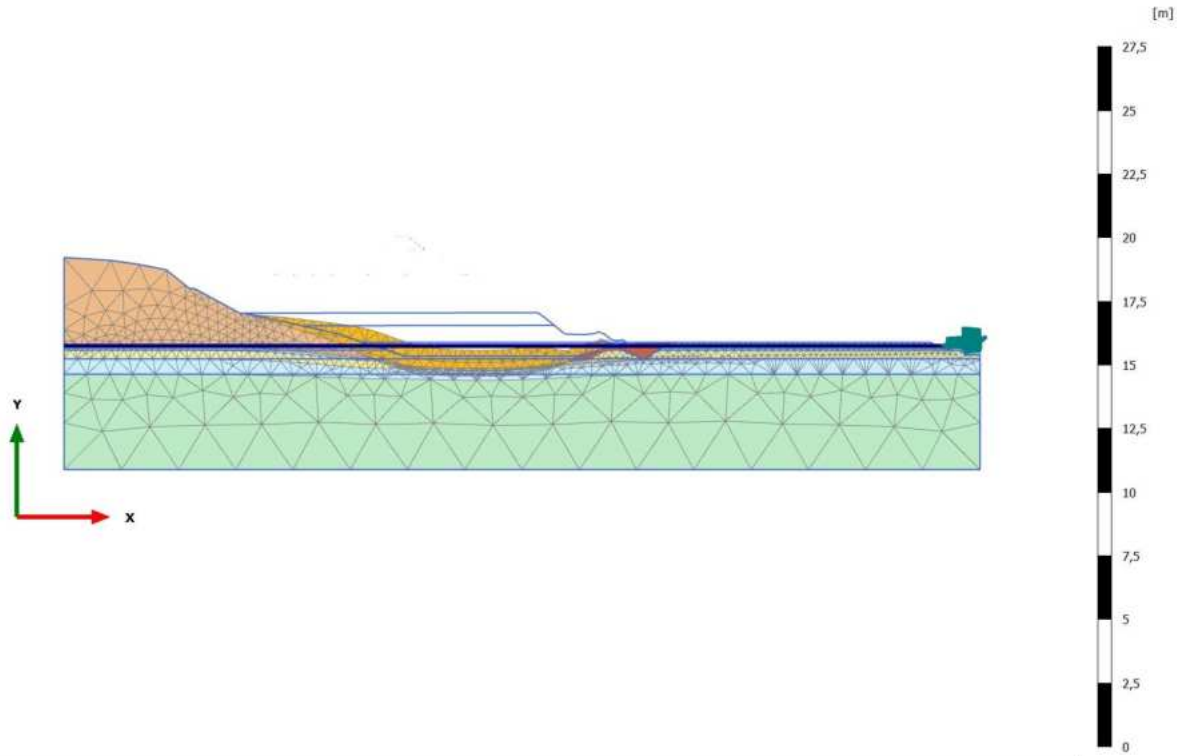


**Total displacements  $u_y$  (scaled up 0,200 times)**

Maximum value = 45,86 m (Element 1466 at Node 4501)

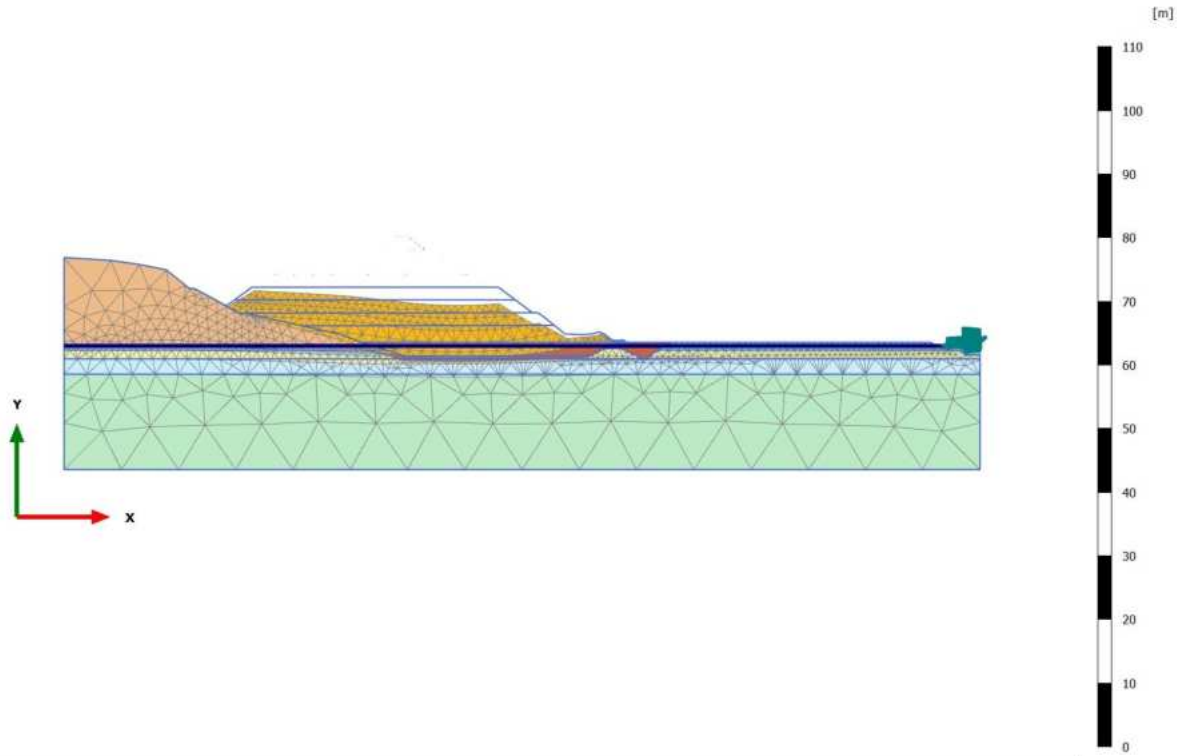
Minimum value = -83,22 m (Element 3 at Node 20491)

2.1.2.1 Calculation results, Phase\_1 [Phase\_1] (8/4), Deformed mesh |u|



**Deformed mesh |u| (scaled up 20,0 times)**  
Maximum value = 1,476 m (Element 885 at Node 16406)

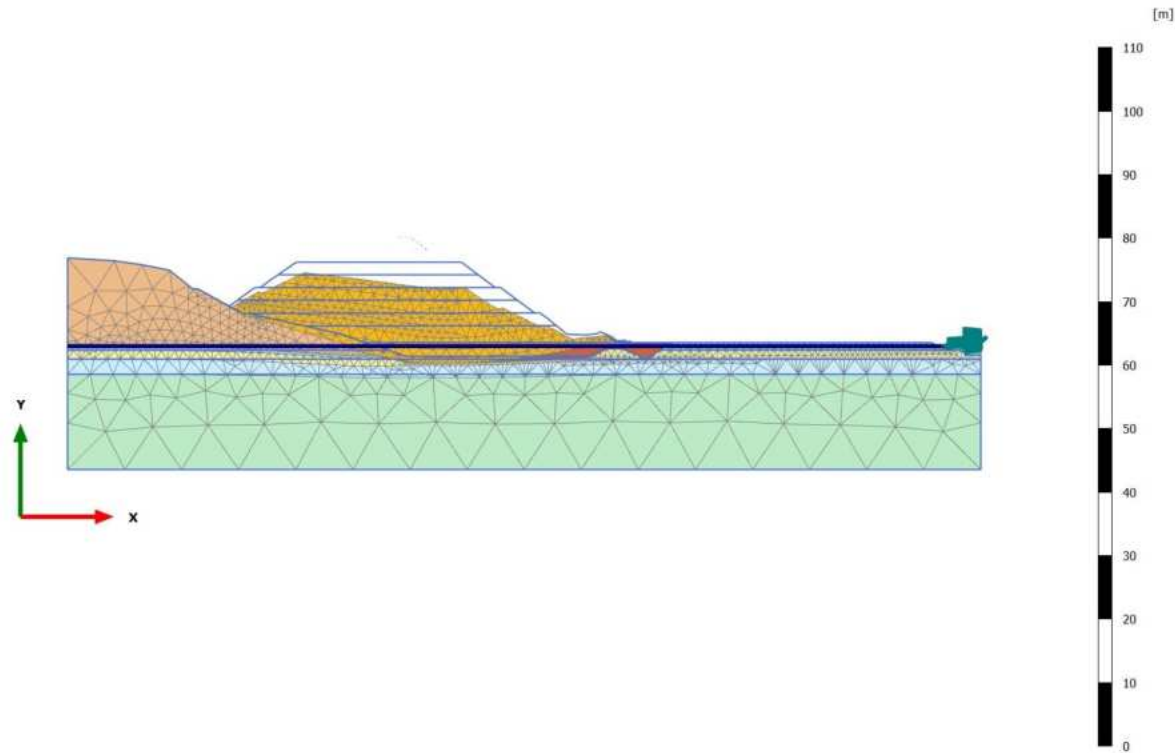
2.1.2.2 Calculation results, Phase\_2 [Phase\_2] (9/8), Deformed mesh |u|



**Deformed mesh |u| (scaled up 5,00 times)**  
Maximum value = 2,888 m (Element 307 at Node 17417)

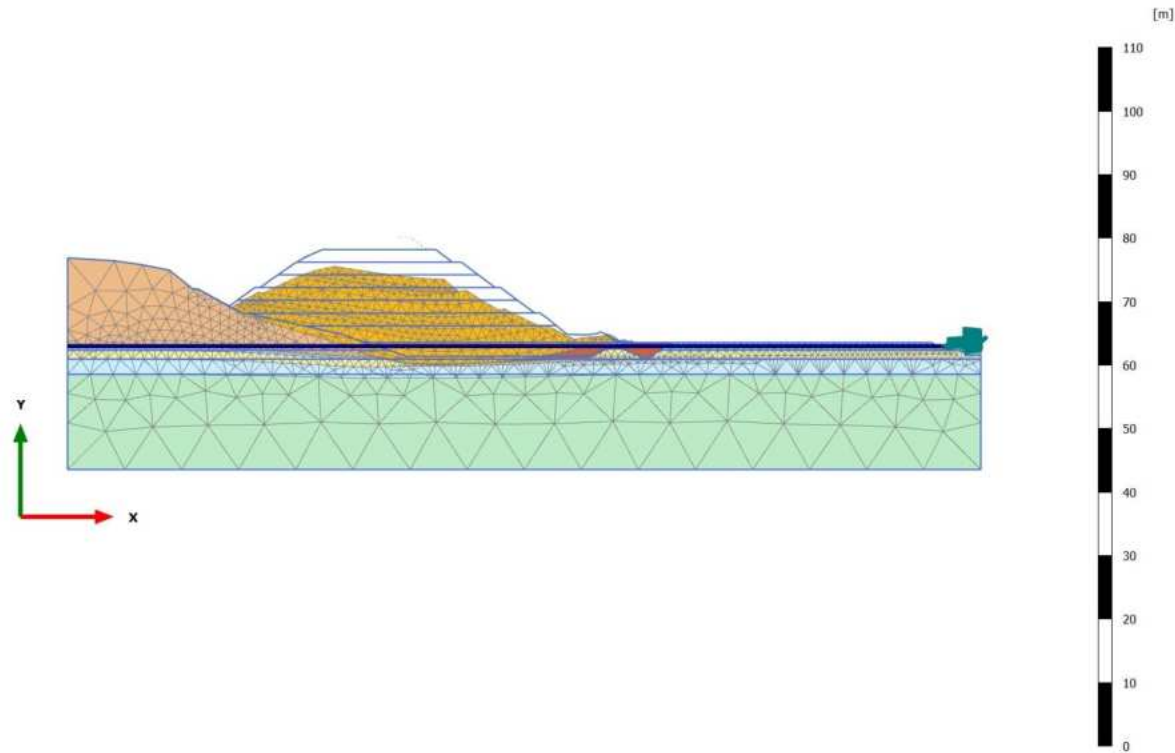


2.1.2.3 Calculation results, Phase\_3 [Phase\_3] (10/12), Deformed mesh |u|



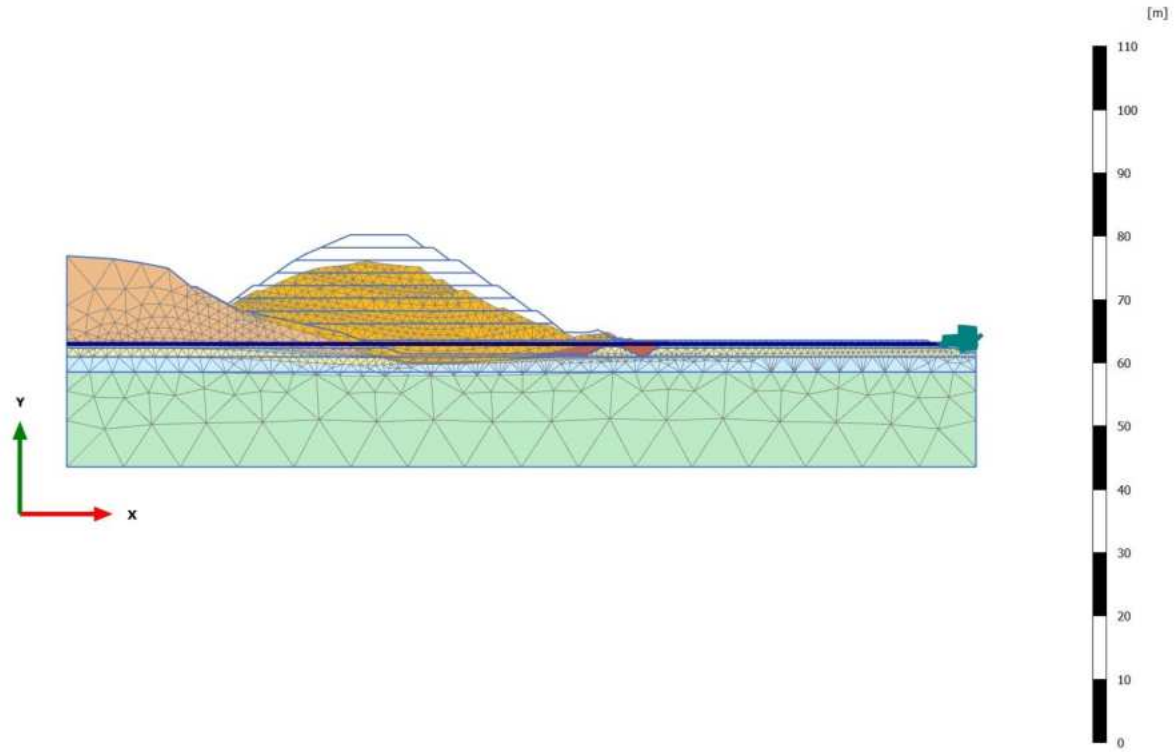
**Deformed mesh |u| (scaled up 5,00 times)**  
Maximum value = 4,273 m (Element 127 at Node 19189)

2.1.2.4 Calculation results, Phase\_4 [Phase\_4] (11/15), Deformed mesh |u|



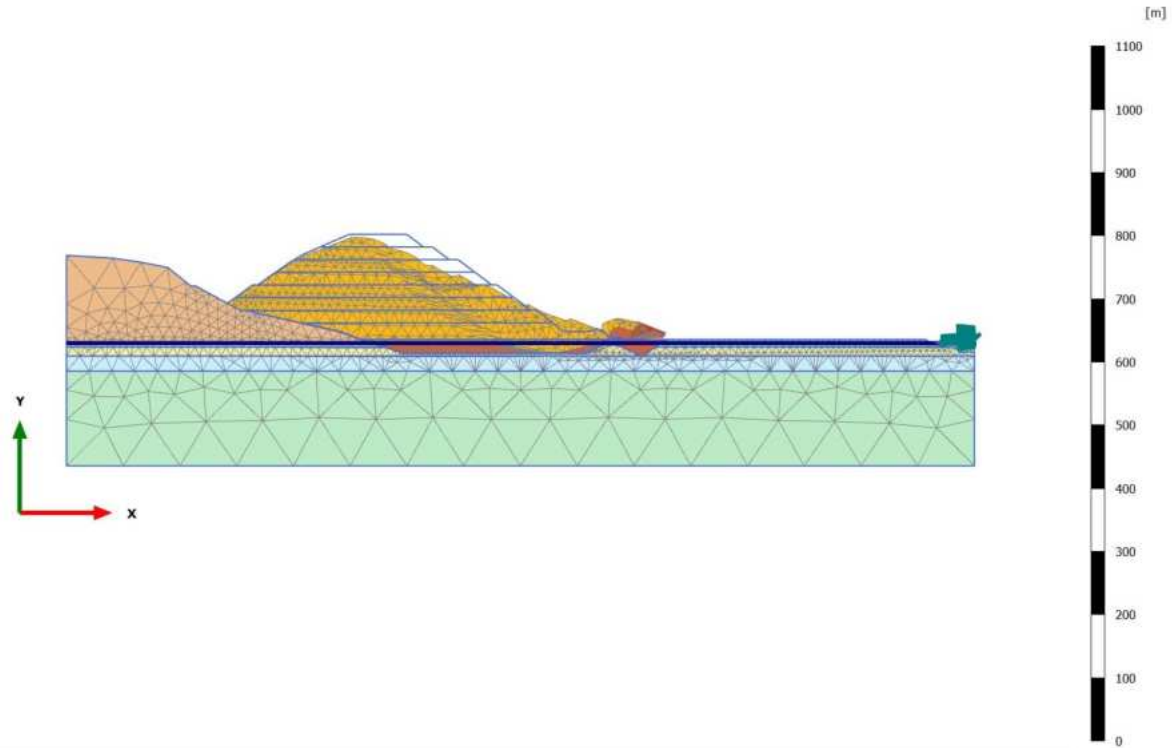
**Deformed mesh |u| (scaled up 5,00 times)**  
Maximum value = 4,883 m (Element 154 at Node 19435)

2.1.2.5 Calculation results, Phase\_5\_static [Phase\_5] (12/19), Deformed mesh |u|



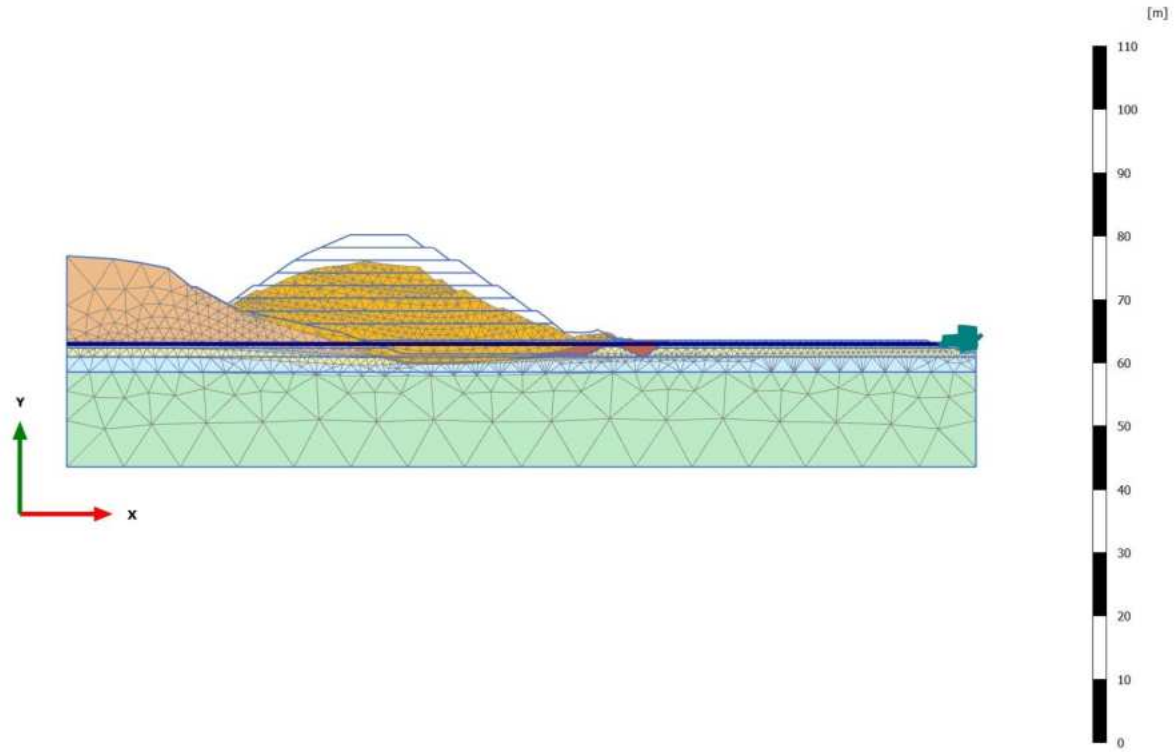
**Deformed mesh |u| (scaled up 5,00 times)**  
Maximum value = 5,458 m (Element 1 at Node 20267)

2.1.2.6 Calculation results, Phase\_6 FoS static [Phase\_6] (13/119), Deformed mesh |u|



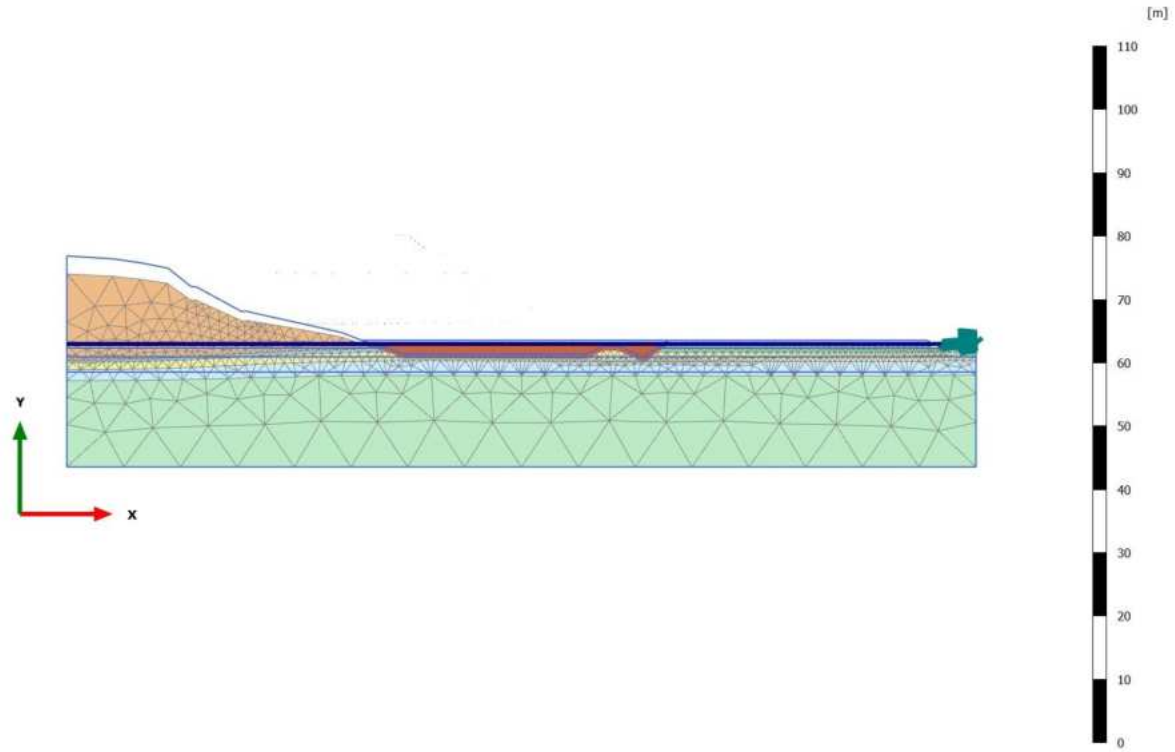
**Deformed mesh |u| (scaled up 0,500 times)**  
Maximum value = 69,70 m (Element 999 at Node 7573)

2.1.2.7 Calculation results, Phase\_8\_seismic [Phase\_8] (2/122), Deformed mesh |u|



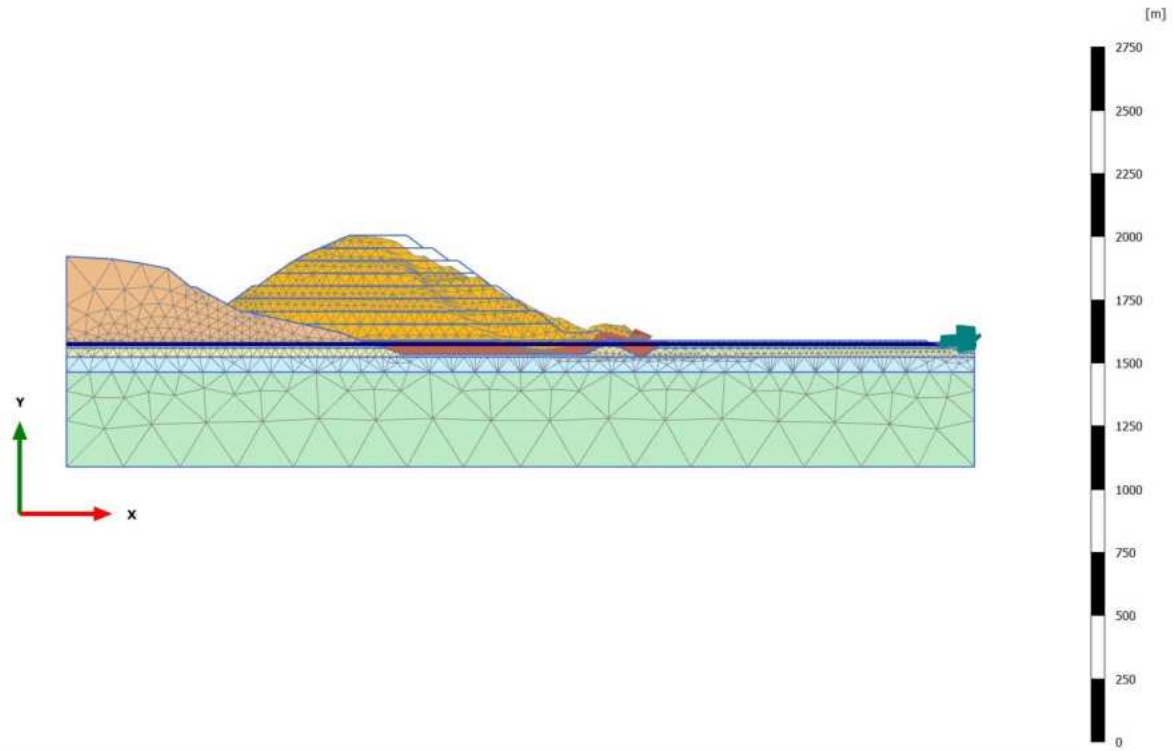
**Deformed mesh |u| (scaled up 5,00 times)**  
Maximum value = 5,436 m (Element 1 at Node 20267)

2.1.2.8 Calculation results, Initial phase [InitialPhase] (0/171), Deformed mesh |u|



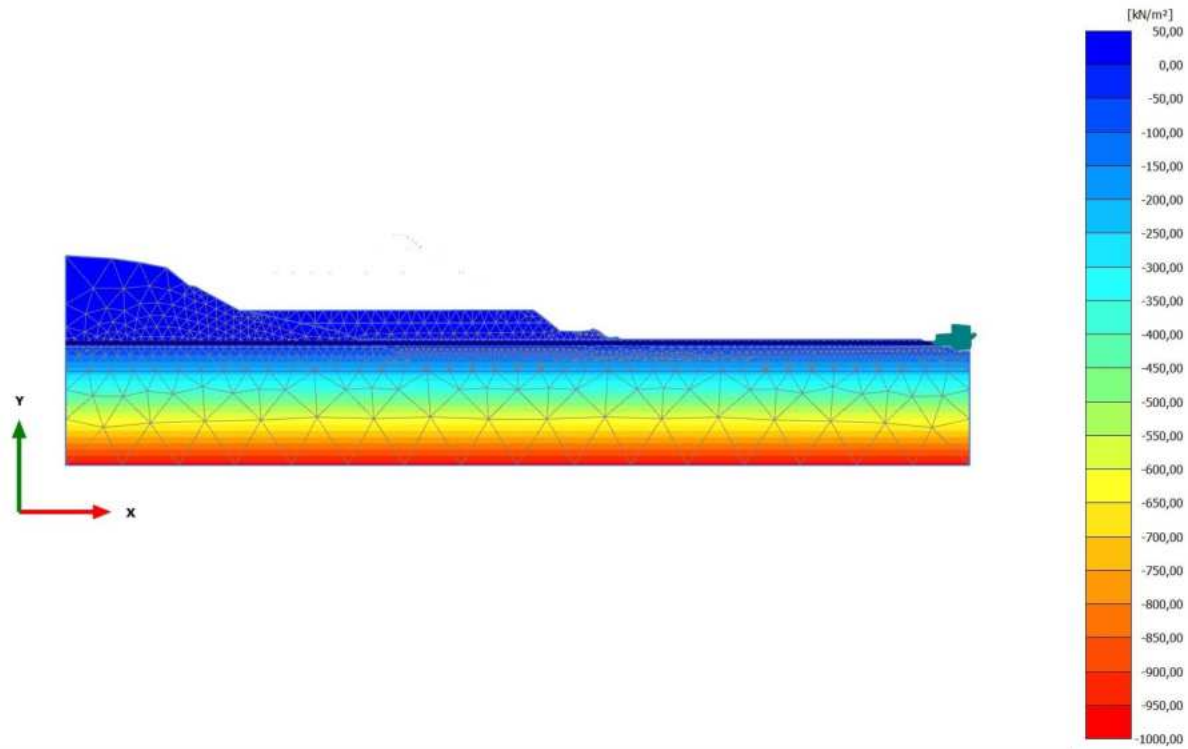
**Deformed mesh |u| (scaled up 5,00 times)**  
Maximum value = 2,833 m (Element 569 at Node 8841)

2.1.2.9 Calculation results, Phase\_7 FoS seismic [Phase\_7] (1/271), Deformed mesh |u|



**Deformed mesh |u| (scaled up 0,200 times)**  
Maximum value = 115,7 m (Element 999 at Node 7573)

2.2.1.1.1 Calculation results, Phase\_1 [Phase\_1] (8/4), Steady state pore pressures  $p_{steady}$



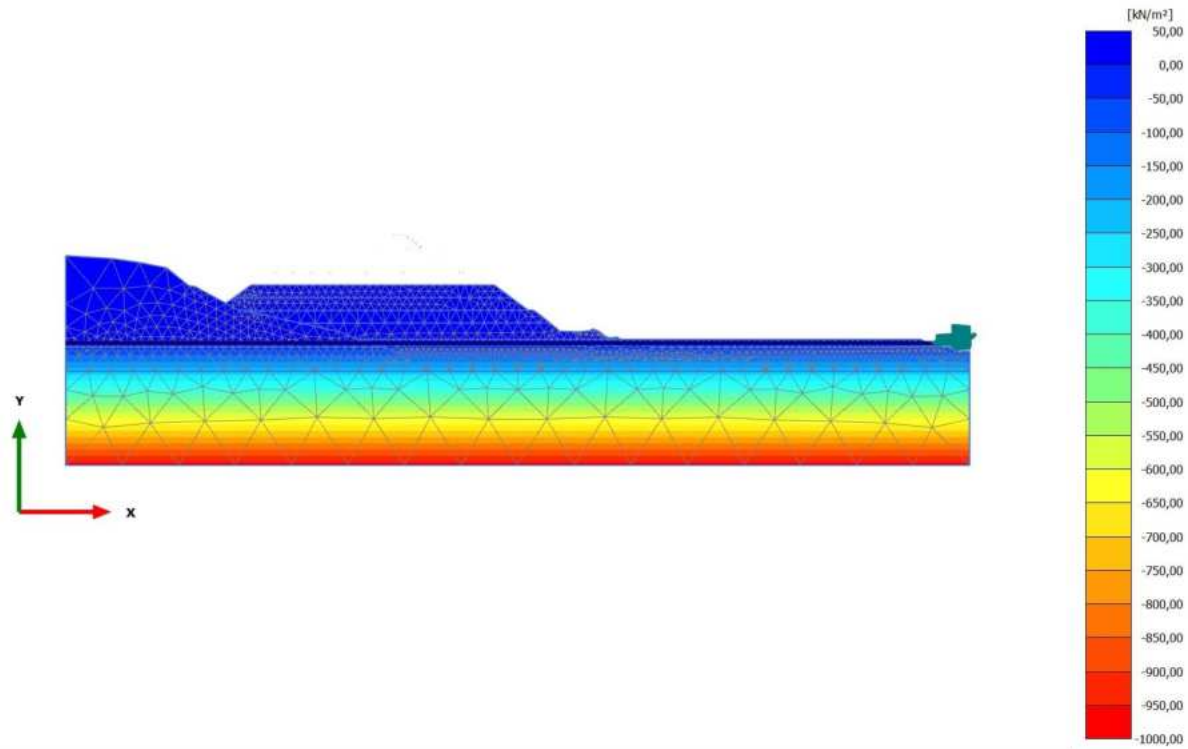
**Steady state pore pressures  $p_{steady}$  (scaled up 0,0200 times) (Pressure = negative)**

Maximum value = 0,000 kN/m<sup>2</sup> (Element 568 at Node 9027)

Minimum value = -972,7 kN/m<sup>2</sup> (Element 2398 at Node 3392)



2.2.1.1.2 Calculation results, Phase\_2 [Phase\_2] (9/8), Steady state pore pressures  $p_{steady}$

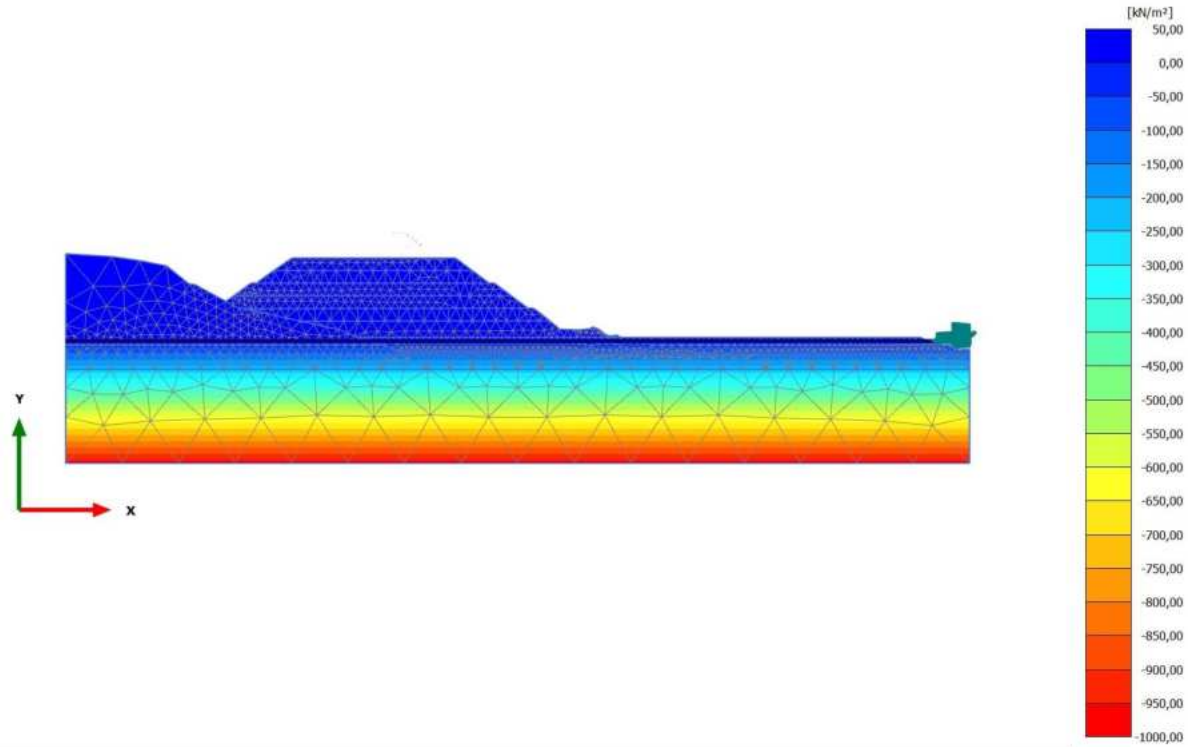


**Steady state pore pressures  $p_{steady}$  (scaled up 0,0200 times) (Pressure = negative)**

Maximum value = 0,000 kN/m<sup>2</sup> (Element 277 at Node 15735)

Minimum value = -972,7 kN/m<sup>2</sup> (Element 2398 at Node 3392)

2.2.1.1.3 Calculation results, Phase\_3 [Phase\_3] (10/12), Steady state pore pressures  $p_{steady}$

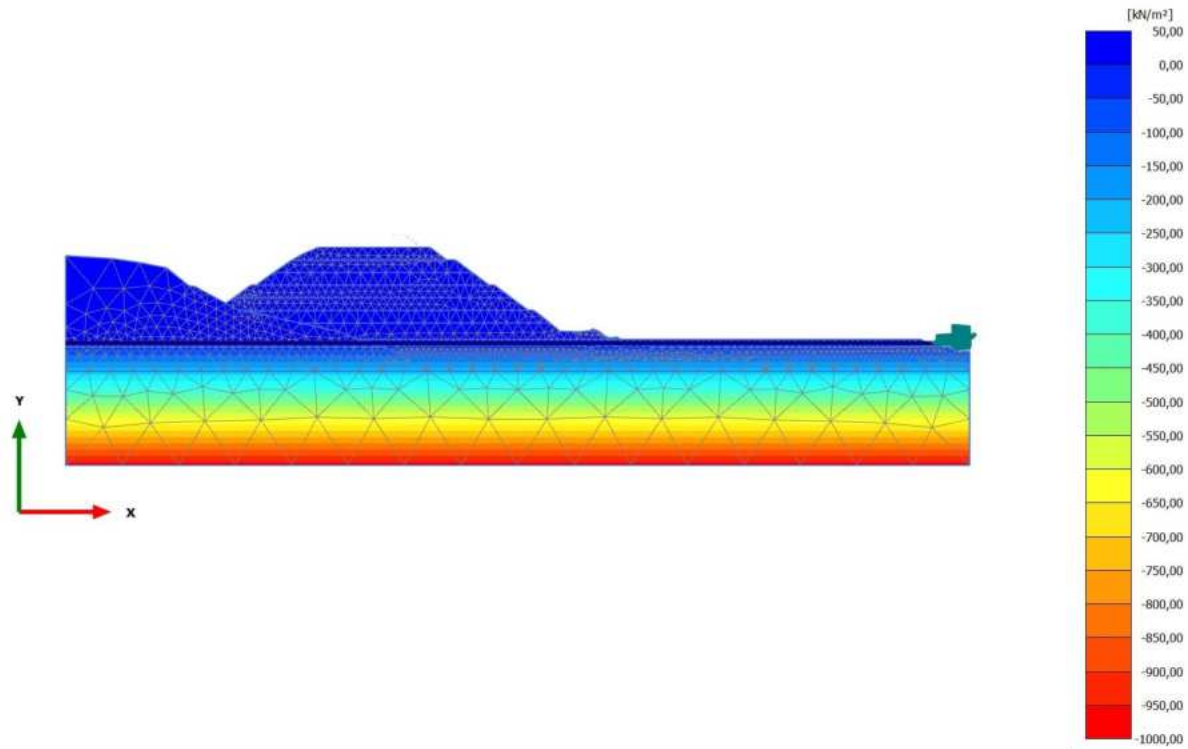


**Steady state pore pressures  $p_{steady}$  (scaled up 0,0200 times) (Pressure = negative)**

Maximum value = 0,000 kN/m<sup>2</sup> (Element 126 at Node 18753)

Minimum value = -972,7 kN/m<sup>2</sup> (Element 2398 at Node 3392)

2.2.1.1.4 Calculation results, Phase\_4 [Phase\_4] (11/15), Steady state pore pressures  $p_{\text{steady}}$

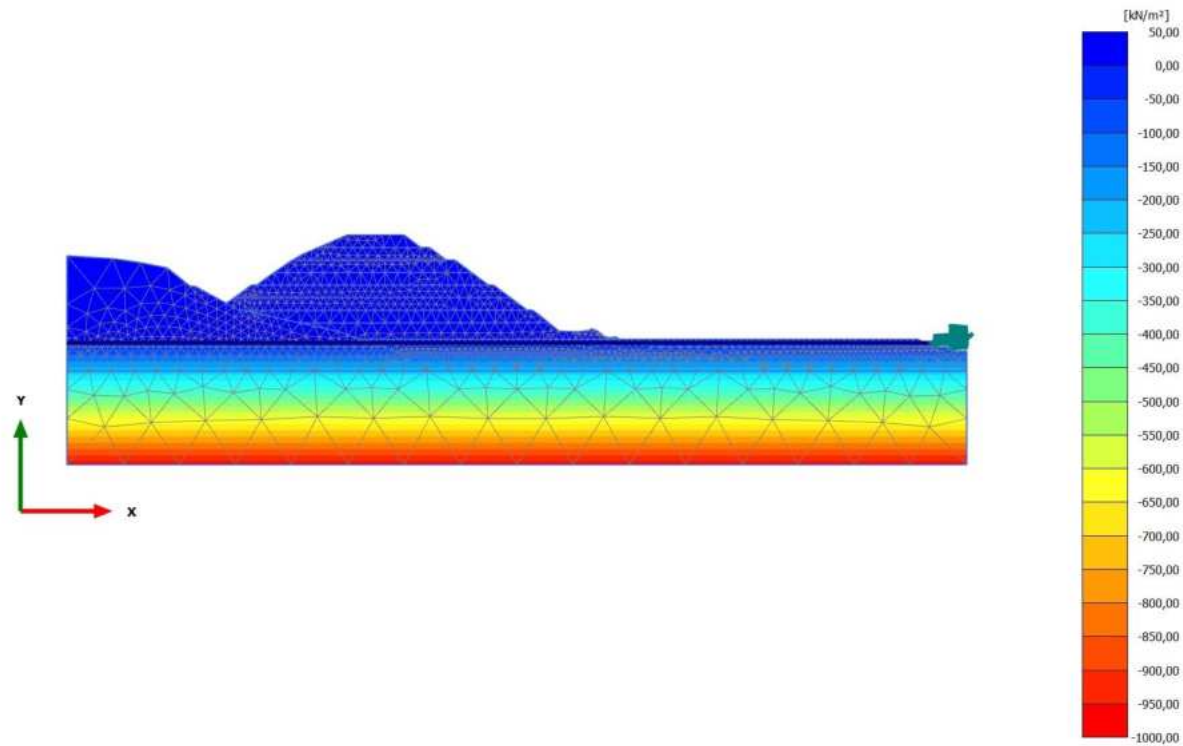


**Steady state pore pressures  $p_{\text{steady}}$  (scaled up 0,0200 times) (Pressure = negative)**

Maximum value = 0,000 kN/m<sup>2</sup> (Element 35 at Node 20427)

Minimum value = -972,7 kN/m<sup>2</sup> (Element 2398 at Node 3392)

2.2.1.1.5 Calculation results, Phase\_5\_static [Phase\_5] (12/19), Steady state pore pressures  $p_{\text{steady}}$

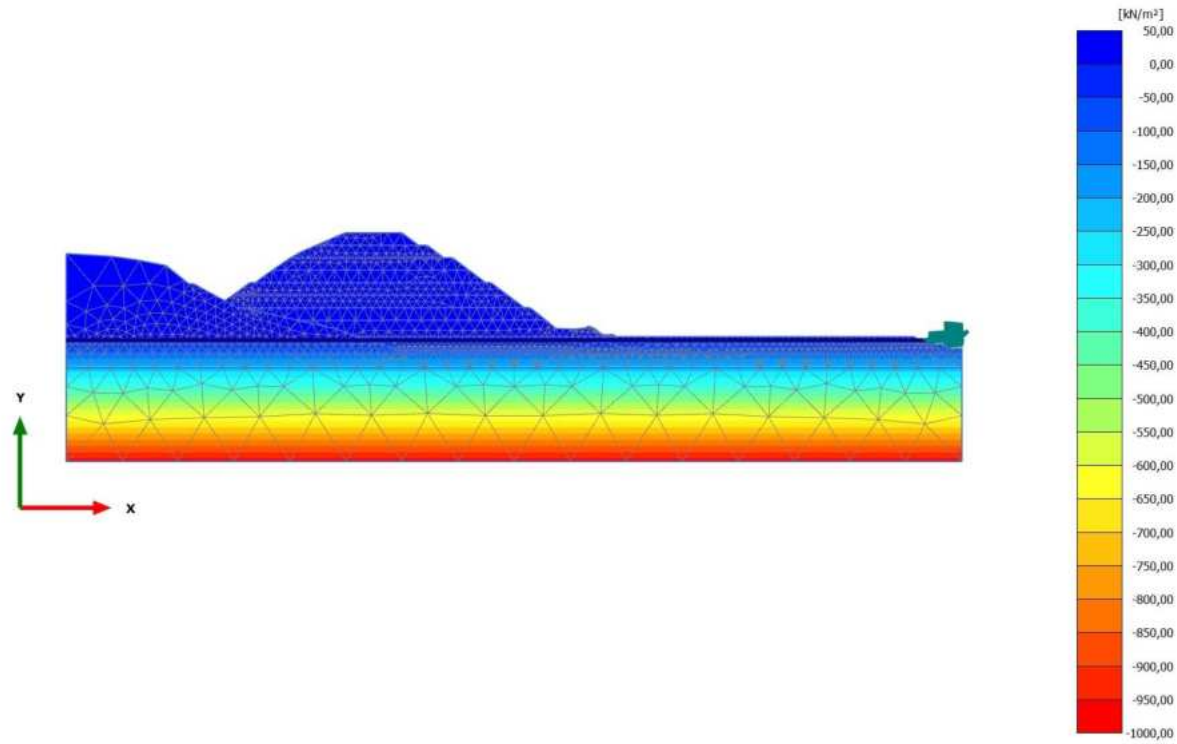


**Steady state pore pressures  $p_{\text{steady}}$  (scaled up 0,0200 times) (Pressure = negative)**

Maximum value = 0,000  $\text{kN/m}^2$  (Element 1 at Node 20261)

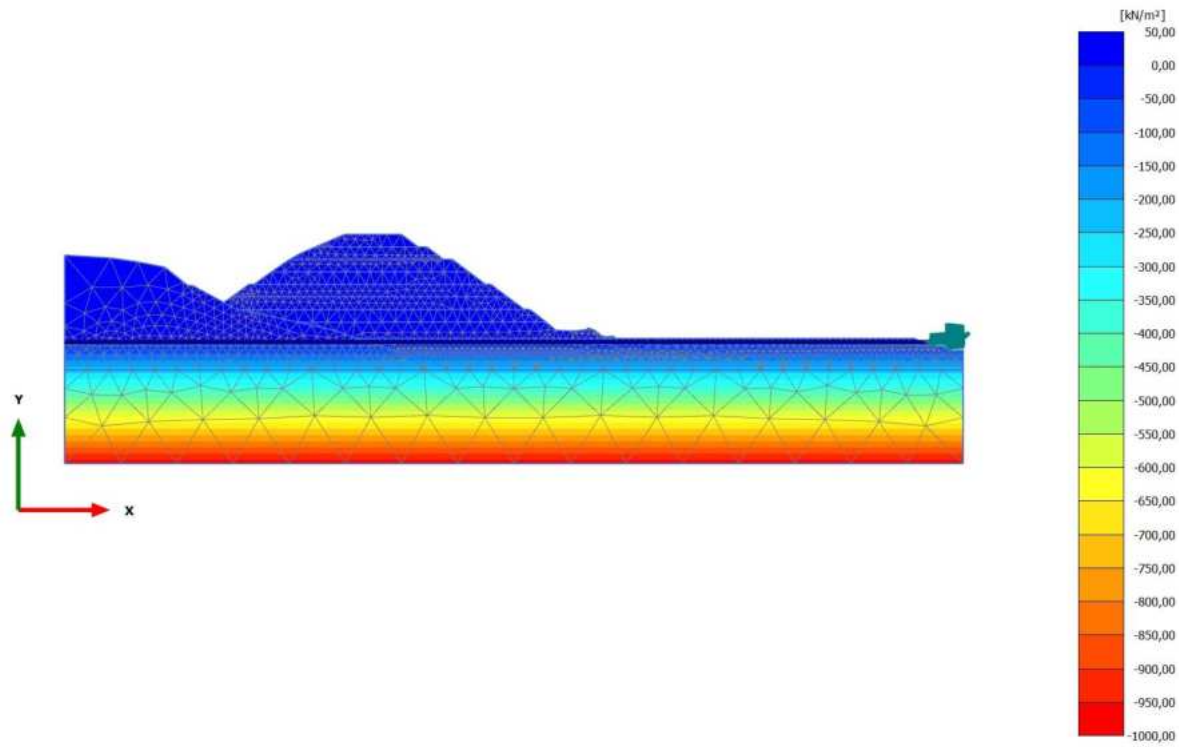
Minimum value = -972,7  $\text{kN/m}^2$  (Element 2398 at Node 3392)

2.2.1.1.6 Calculation results, Phase\_6 FoS static [Phase\_6] (13/119), Steady state pore pressures  $p_{\text{steady}}$



**Steady state pore pressures  $p_{\text{steady}}$  (scaled up 0,0200 times) (Pressure = negative)**  
Maximum value = 0,000 kN/m<sup>2</sup> (Element 1 at Node 20261)  
Minimum value = -972,7 kN/m<sup>2</sup> (Element 2398 at Node 3392)

2.2.1.1.7 Calculation results, Phase\_8\_seismic [Phase\_8] (2/122), Steady state pore pressures  $p_{\text{steady}}$

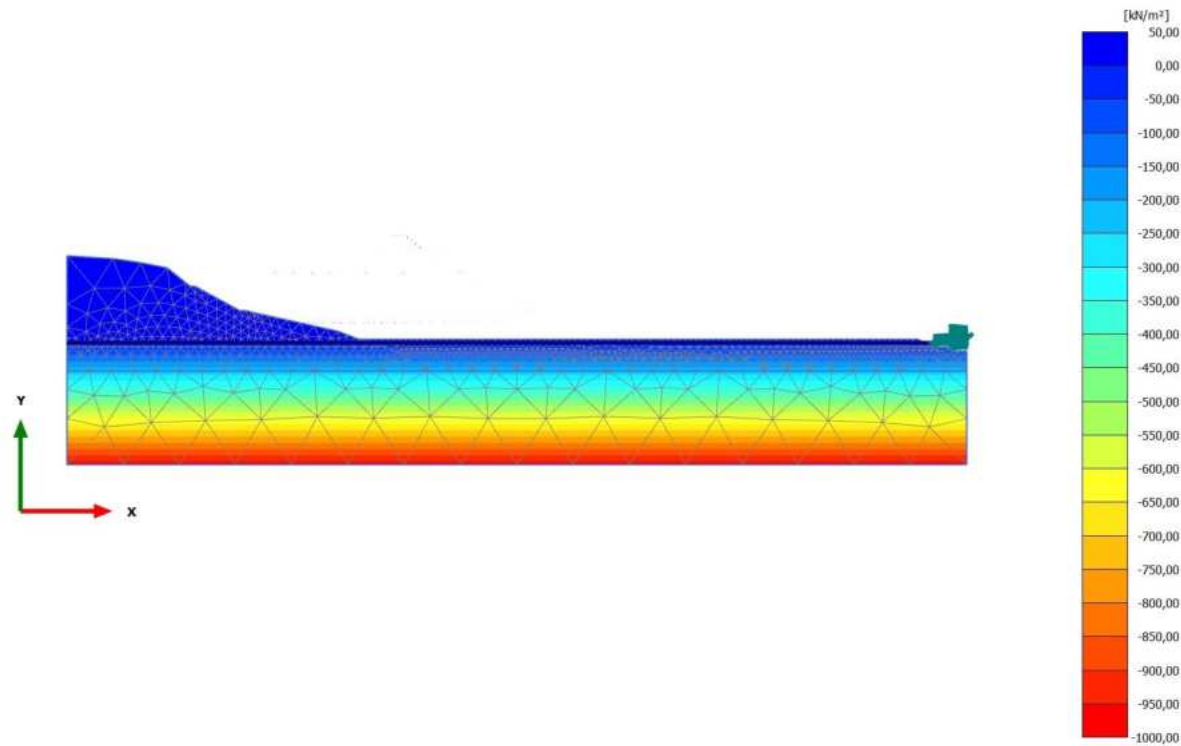


**Steady state pore pressures  $p_{\text{steady}}$  (scaled up 0,0200 times) (Pressure = negative)**

Maximum value = 0,000 kN/m<sup>2</sup> (Element 1 at Node 20261)

Minimum value = -978,6 kN/m<sup>2</sup> (Element 2398 at Node 3392)

2.2.1.1.8 Calculation results, Initial phase [InitialPhase] (0/171), Steady state pore pressures  $p_{\text{steady}}$

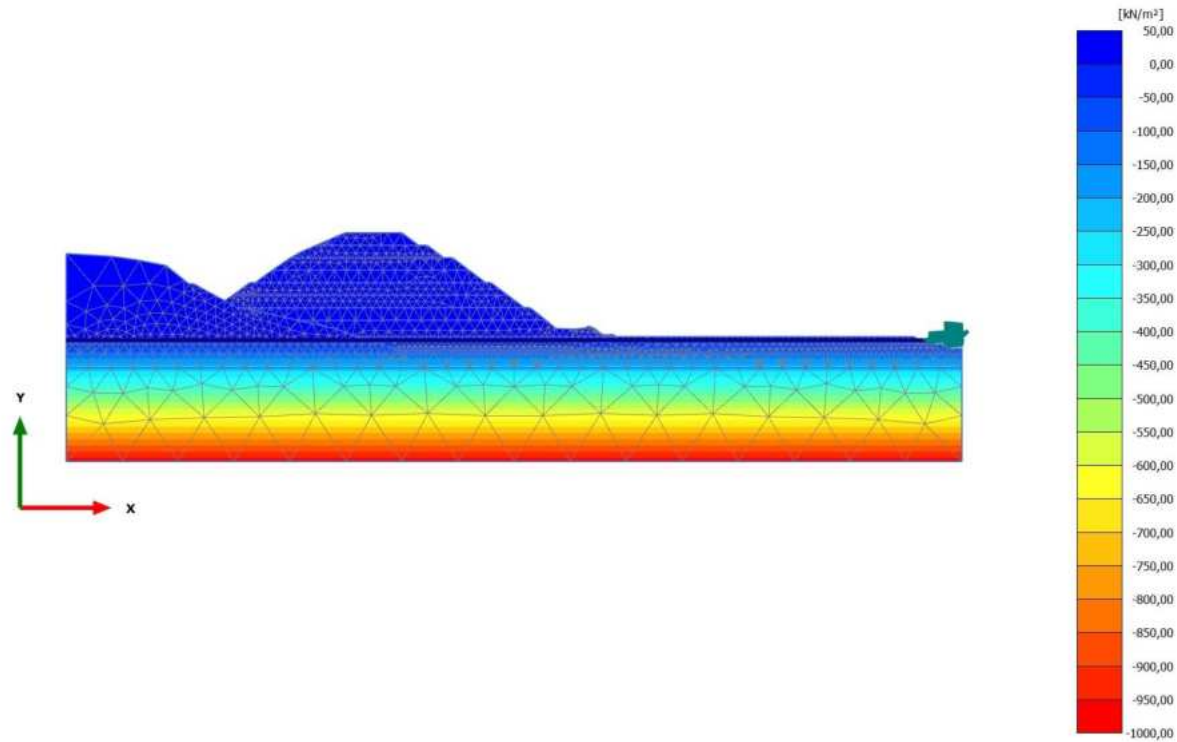


**Steady state pore pressures  $p_{\text{steady}}$  (scaled up 0,0200 times) (Pressure = negative)**

Maximum value = 0,000 kN/m<sup>2</sup> (Element 568 at Node 9027)

Minimum value = -972,7 kN/m<sup>2</sup> (Element 2398 at Node 3392)

2.2.1.1.9 Calculation results, Phase\_7 FoS seismic [Phase\_7] (1/271), Steady state pore pressures  $p_{\text{steady}}$



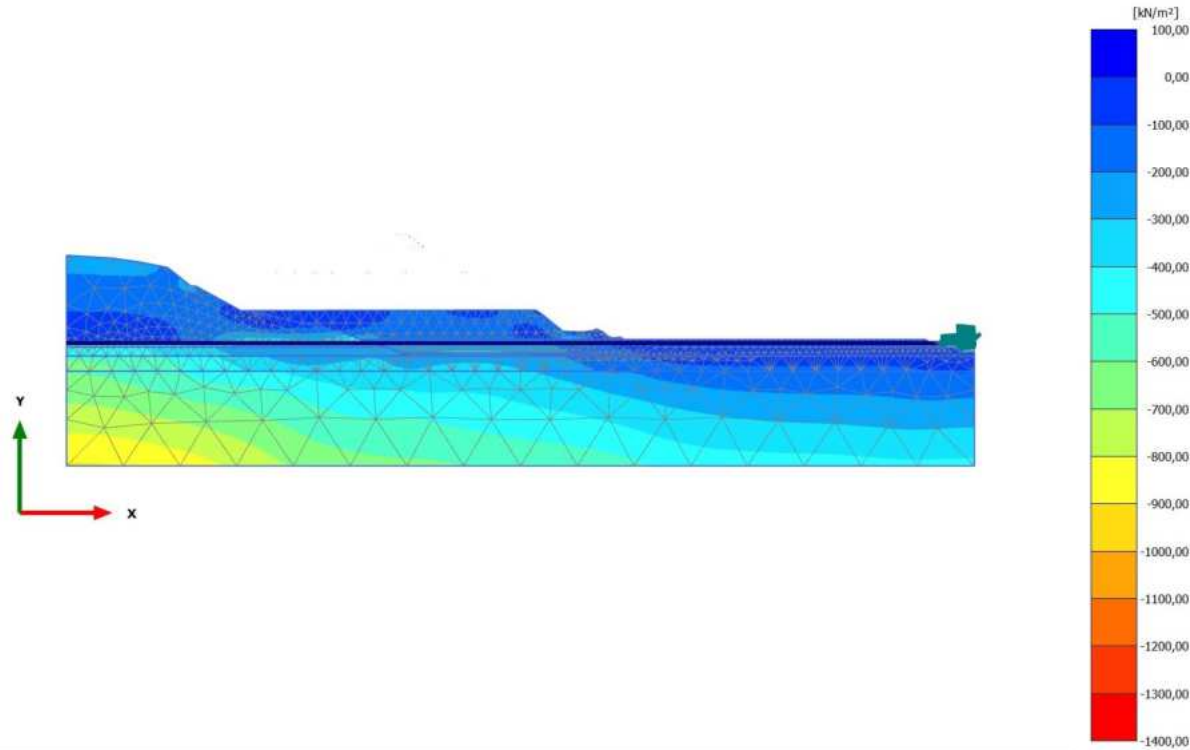
**Steady state pore pressures  $p_{\text{steady}}$  (scaled up 0,0200 times) (Pressure = negative)**

Maximum value = 0,000 kN/m<sup>2</sup> (Element 1 at Node 20261)

Minimum value = -978,6 kN/m<sup>2</sup> (Element 2398 at Node 3392)



2.2.2.1.1 Calculation results, Phase\_1 [Phase\_1] (8/4), Cartesian effective stress  $\sigma'_{xx}$

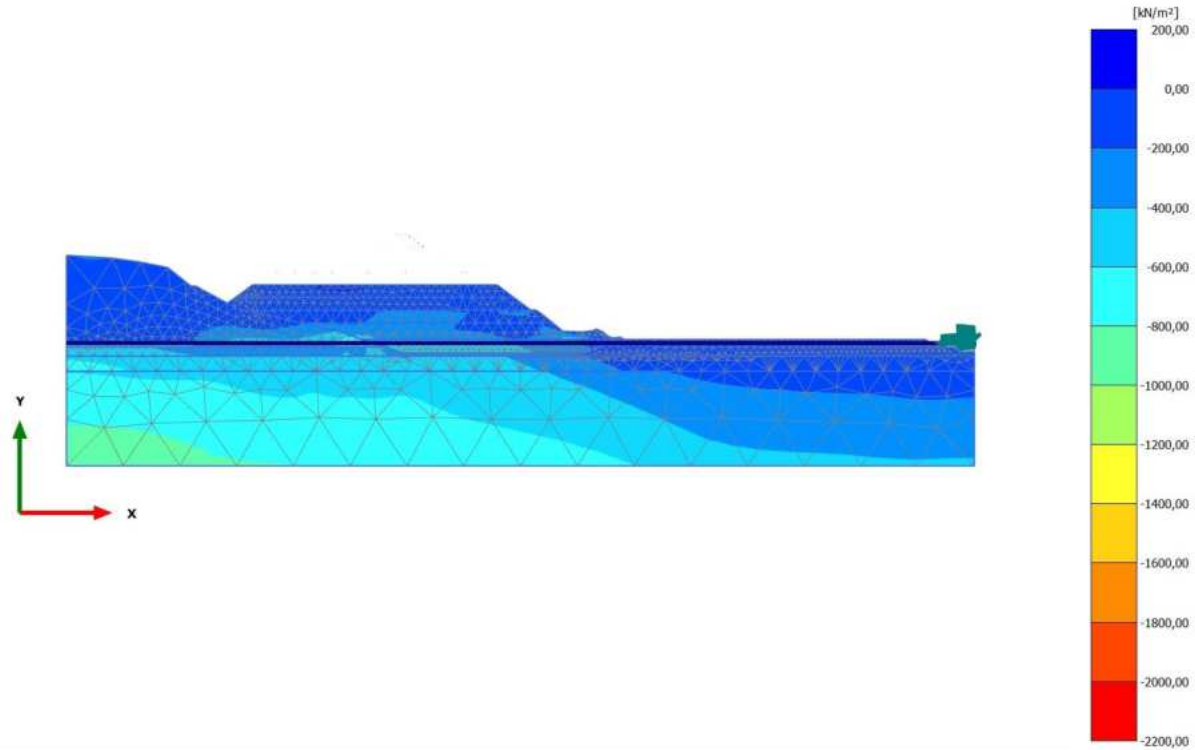


**Cartesian effective stress  $\sigma'_{xx}$  (scaled up 0,0200 times)**

Maximum value = 5,385 kN/m<sup>2</sup> (Element 1005 at Node 7298)

Minimum value = -1393 kN/m<sup>2</sup> (Element 831 at Node 15677)

2.2.2.1.2 Calculation results, Phase\_2 [Phase\_2] (9/8), Cartesian effective stress  $\sigma'_{xx}$

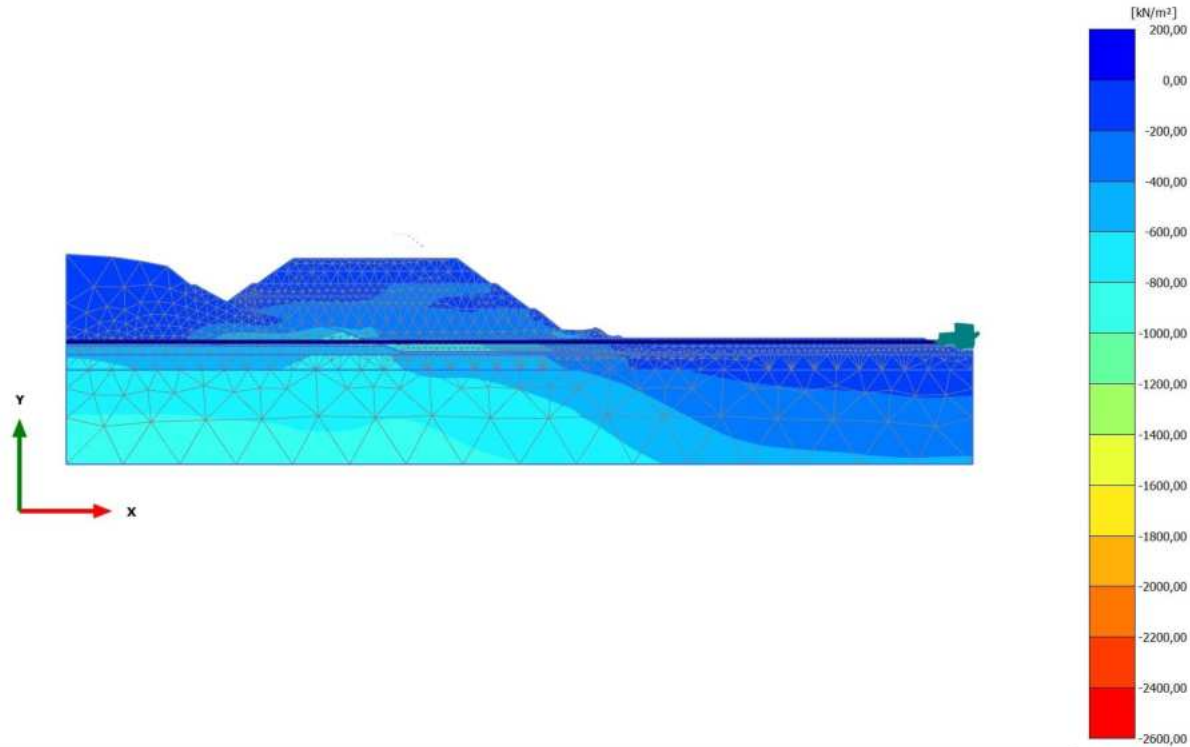


**Cartesian effective stress  $\sigma'_{xx}$  (scaled up 0,0100 times)**

Maximum value = 1,914 kN/m<sup>2</sup> (Element 649 at Node 11196)

Minimum value = -2104 kN/m<sup>2</sup> (Element 831 at Node 15677)

2.2.2.1.3 Calculation results, Phase\_3 [Phase\_3] (10/12), Cartesian effective stress  $\sigma'_{xx}$

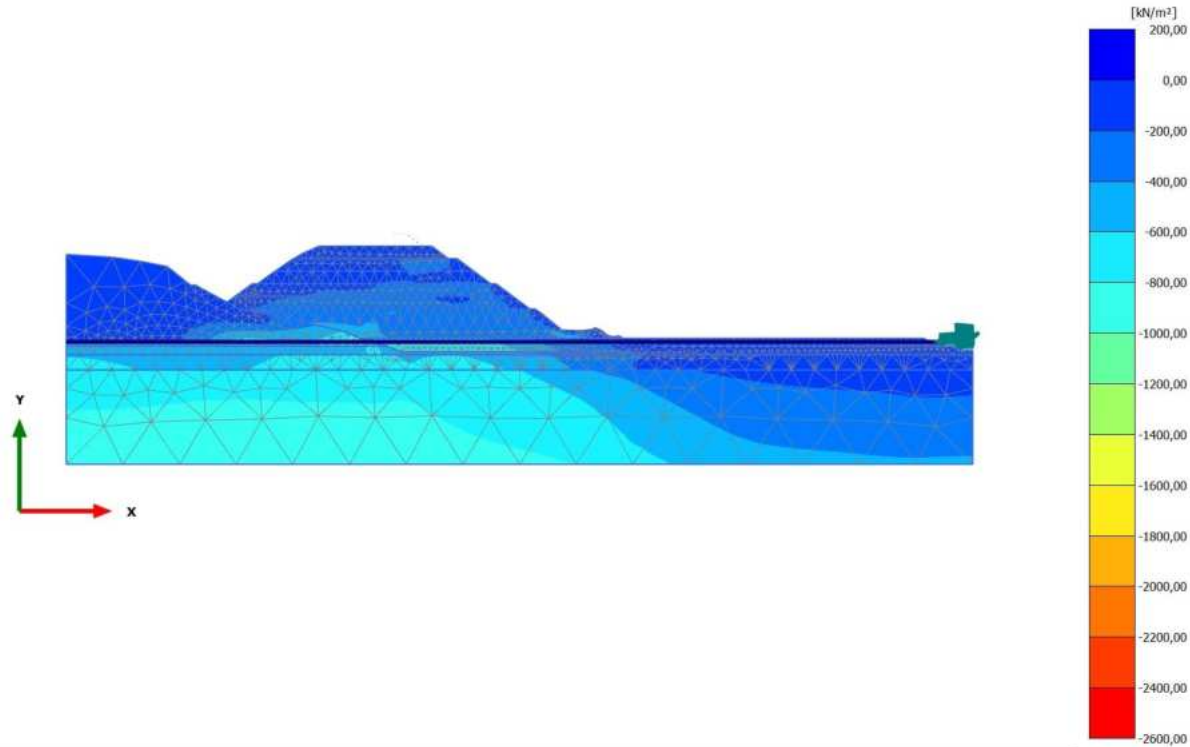


**Cartesian effective stress  $\sigma'_{xx}$  (scaled up  $5,00 \cdot 10^{-3}$  times)**

Maximum value = 12,99 kN/m<sup>2</sup> (Element 1005 at Node 7293)

Minimum value = -2579 kN/m<sup>2</sup> (Element 831 at Node 15677)

2.2.2.1.4 Calculation results, Phase\_4 [Phase\_4] (11/15), Cartesian effective stress  $\sigma'_{xx}$

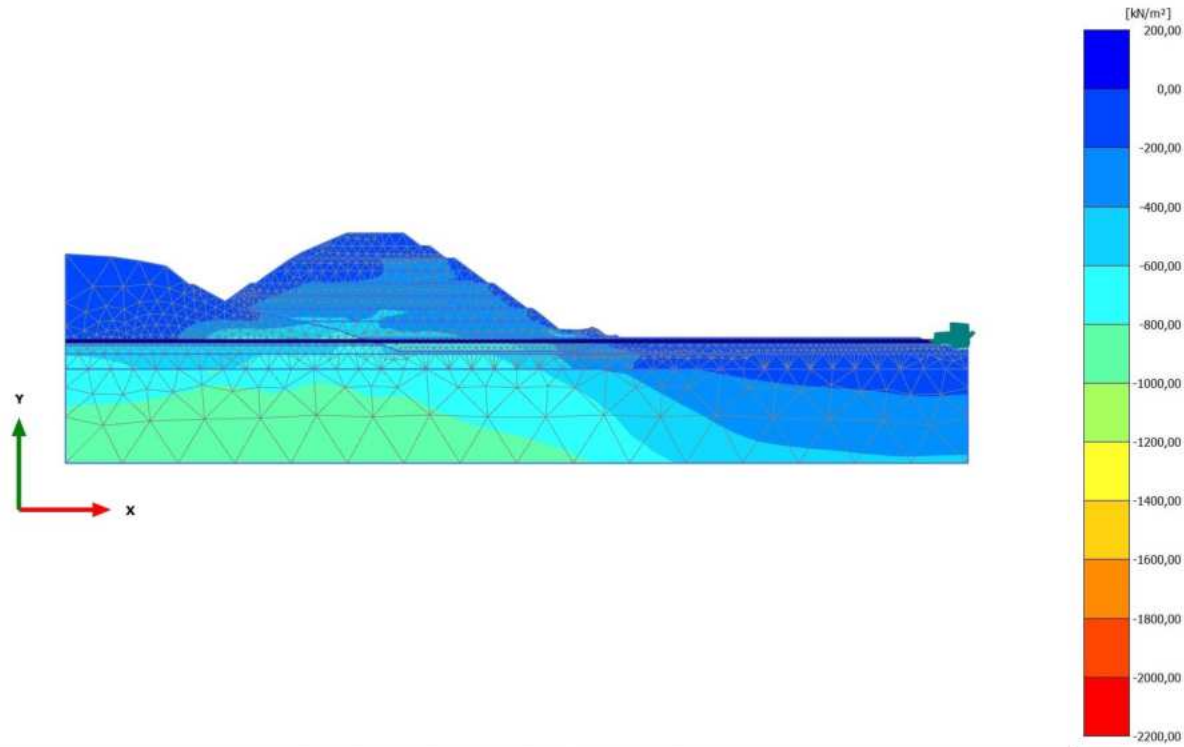


**Cartesian effective stress  $\sigma'_{xx}$  (scaled up  $5,00 \cdot 10^{-3}$  times)**

Maximum value = 29,91 kN/m<sup>2</sup> (Element 1005 at Node 7297)

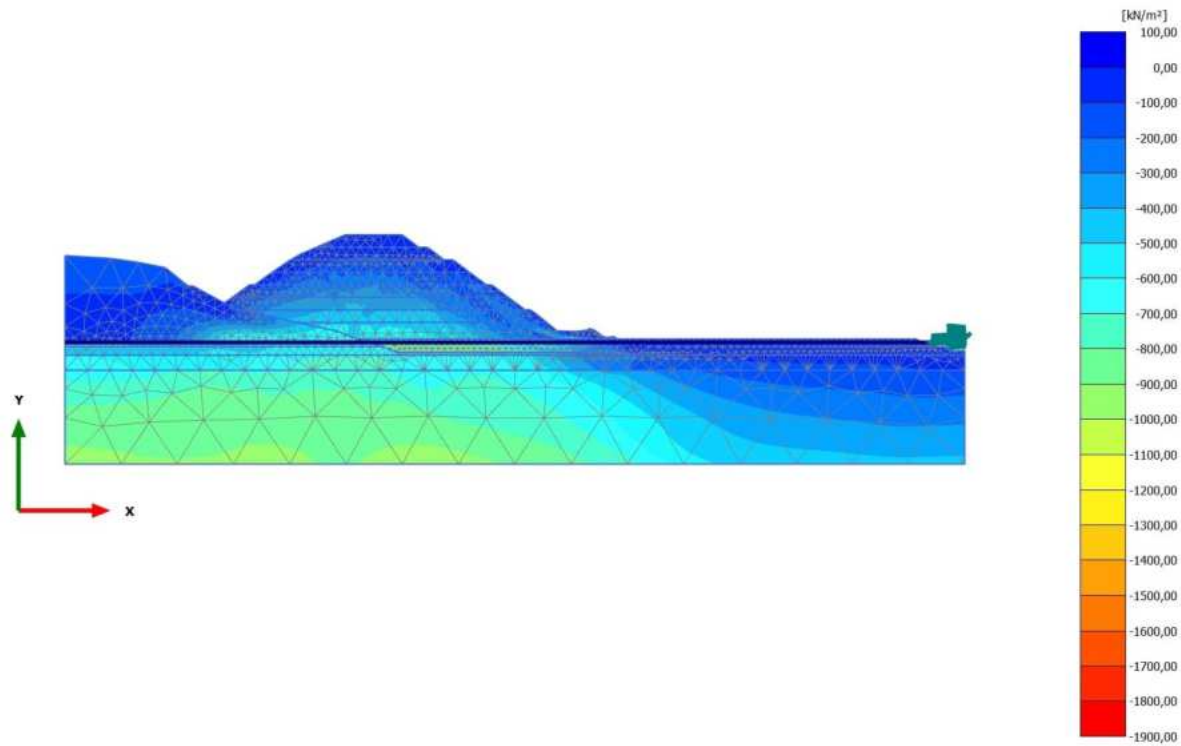
Minimum value = -2592 kN/m<sup>2</sup> (Element 831 at Node 15677)

2.2.2.1.5 Calculation results, Phase\_5\_static [Phase\_5] (12/19), Cartesian effective stress  $\sigma'_{xx}$



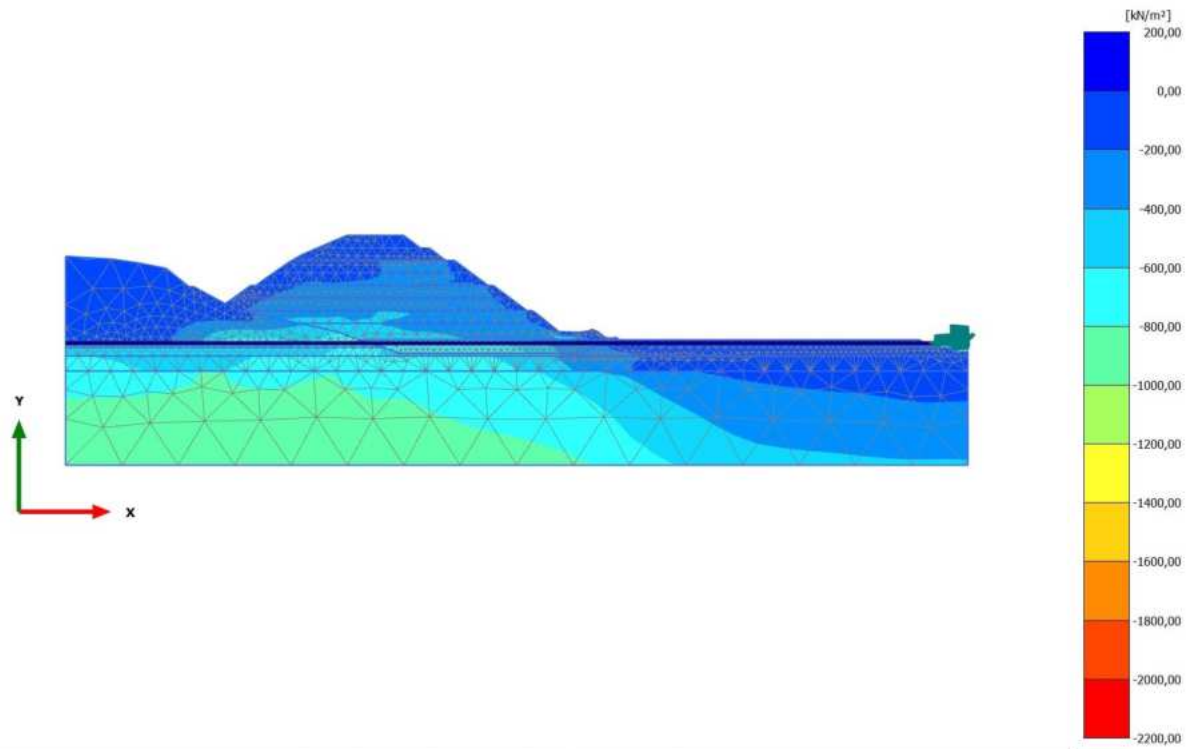
**Cartesian effective stress  $\sigma'_{xx}$  (scaled up 0,0100 times)**  
Maximum value = 29,38 kN/m<sup>2</sup> (Element 1005 at Node 7297)  
Minimum value = -2122 kN/m<sup>2</sup> (Element 831 at Node 15677)

2.2.2.1.6 Calculation results, Phase\_6 FoS static [Phase\_6] (13/119), Cartesian effective stress  $\sigma'_{xx}$



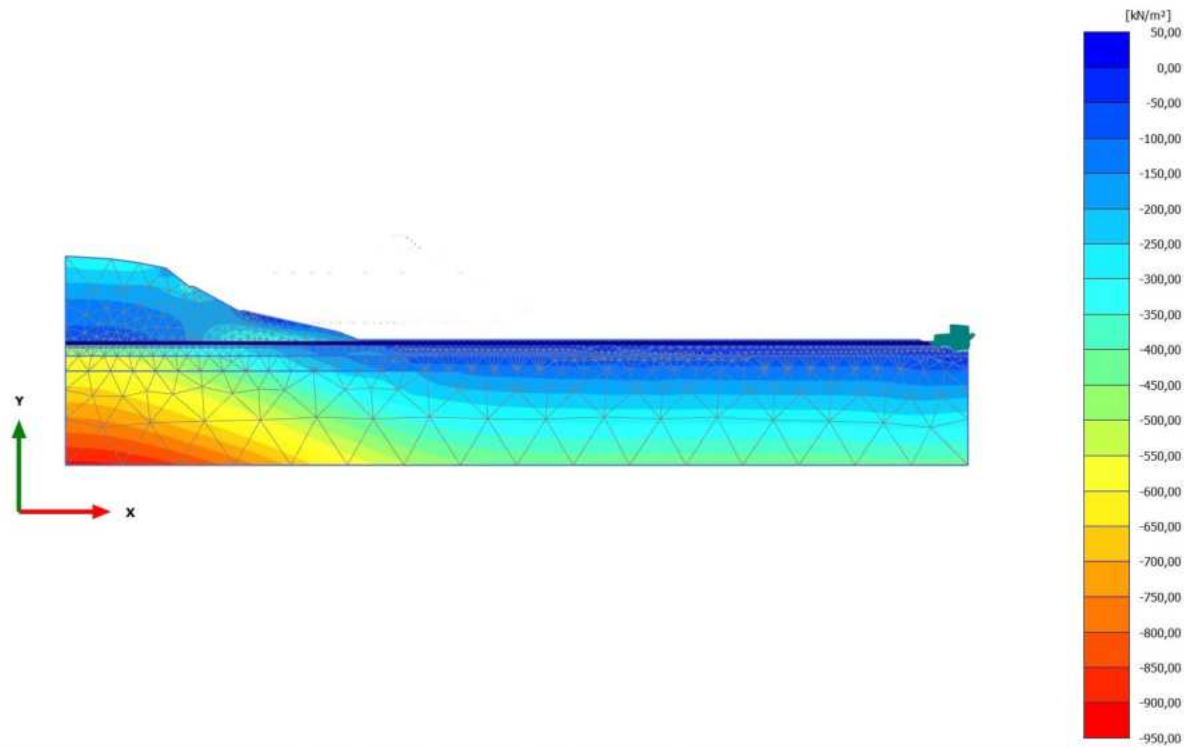
**Cartesian effective stress  $\sigma'_{xx}$  (scaled up 0,0100 times)**  
Maximum value = 31,74 kN/m<sup>2</sup> (Element 999 at Node 7567)  
Minimum value = -1844 kN/m<sup>2</sup> (Element 831 at Node 15677)

2.2.2.1.7 Calculation results, Phase\_8\_seismic [Phase\_8] (2/122), Cartesian effective stress  $\sigma'_{xx}$



**Cartesian effective stress  $\sigma'_{xx}$  (scaled up 0,0100 times)**  
Maximum value = 27,80 kN/m<sup>2</sup> (Element 1020 at Node 5107)  
Minimum value = -2030 kN/m<sup>2</sup> (Element 831 at Node 15677)

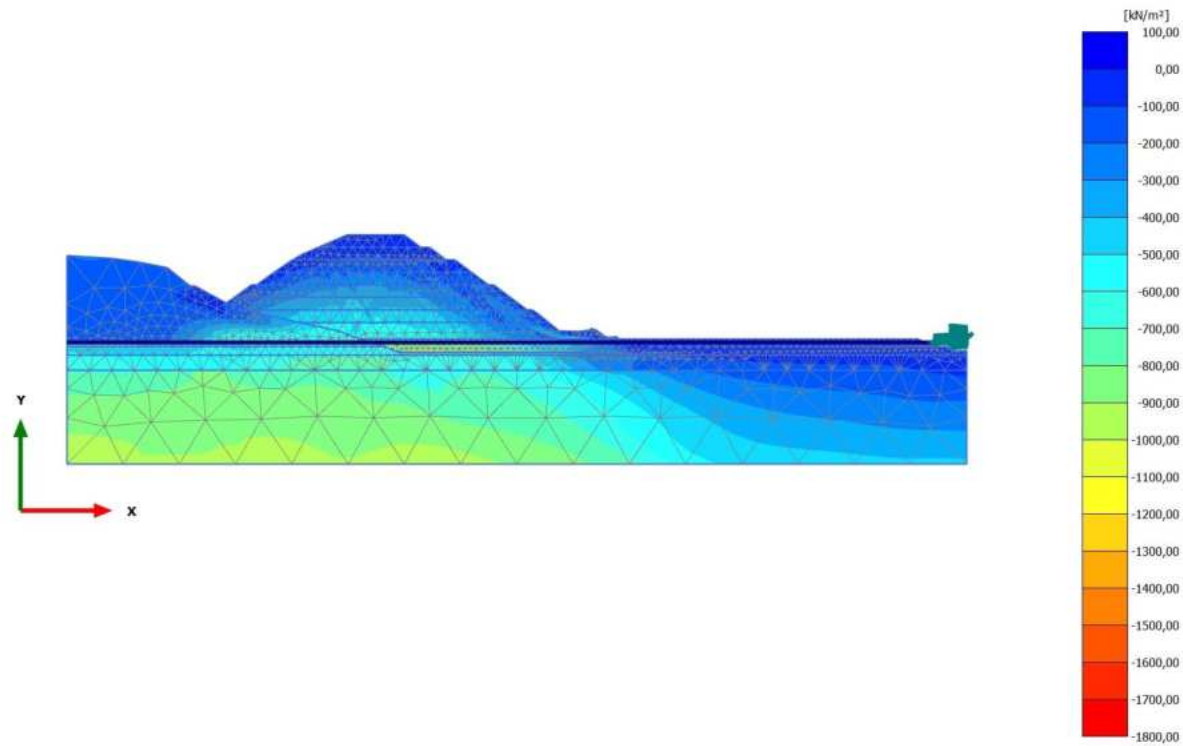
2.2.2.1.8 Calculation results, Initial phase [InitialPhase] (0/171), Cartesian effective stress  $\sigma'_{xx}$



**Cartesian effective stress  $\sigma'_{xx}$  (scaled up 0,0200 times)**  
Maximum value = 3,490 kN/m<sup>2</sup> (Element 675 at Node 14235)  
Minimum value = -915,7 kN/m<sup>2</sup> (Element 2399 at Node 8693)

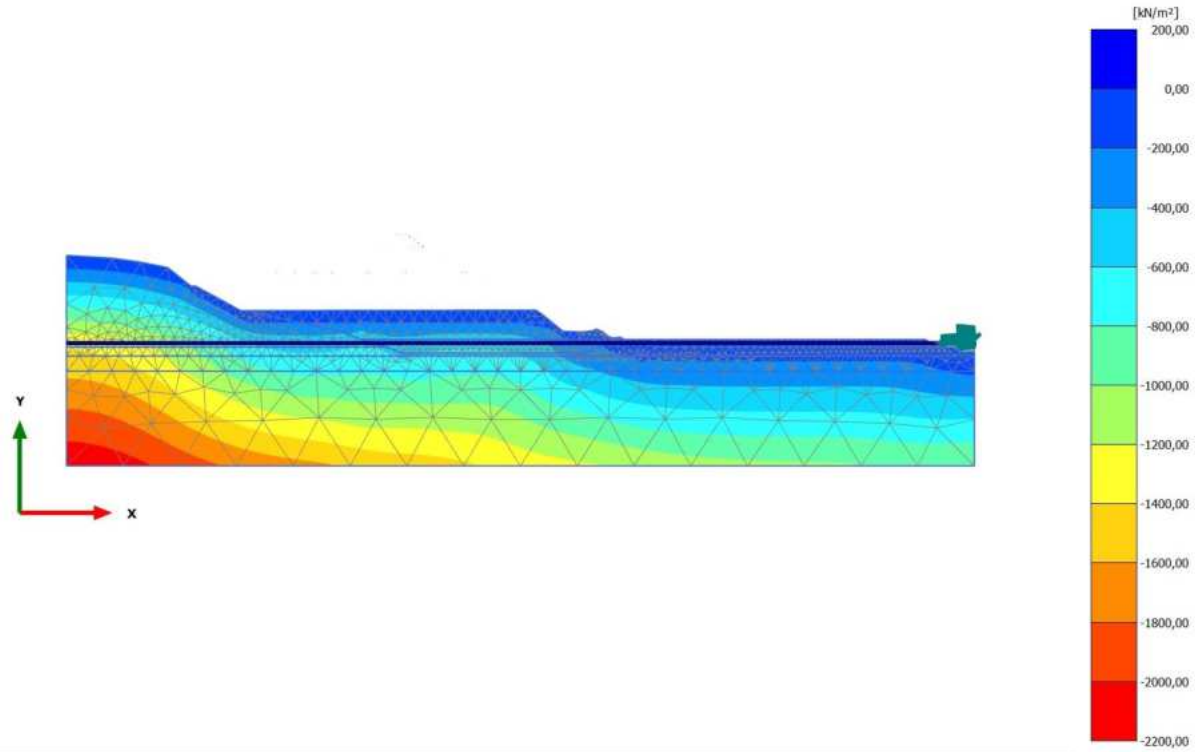


2.2.2.1.9 Calculation results, Phase\_7 FoS seismic [Phase\_7] (1/271), Cartesian effective stress  $\sigma'_{xx}$



**Cartesian effective stress  $\sigma'_{xx}$  (scaled up 0,0100 times)**  
Maximum value = 26,08 kN/m<sup>2</sup> (Element 999 at Node 7567)  
Minimum value = -1710 kN/m<sup>2</sup> (Element 831 at Node 15677)

2.2.2.2.1 Calculation results, Phase\_1 [Phase\_1] (8/4), Cartesian effective stress  $\sigma'_{yy}$

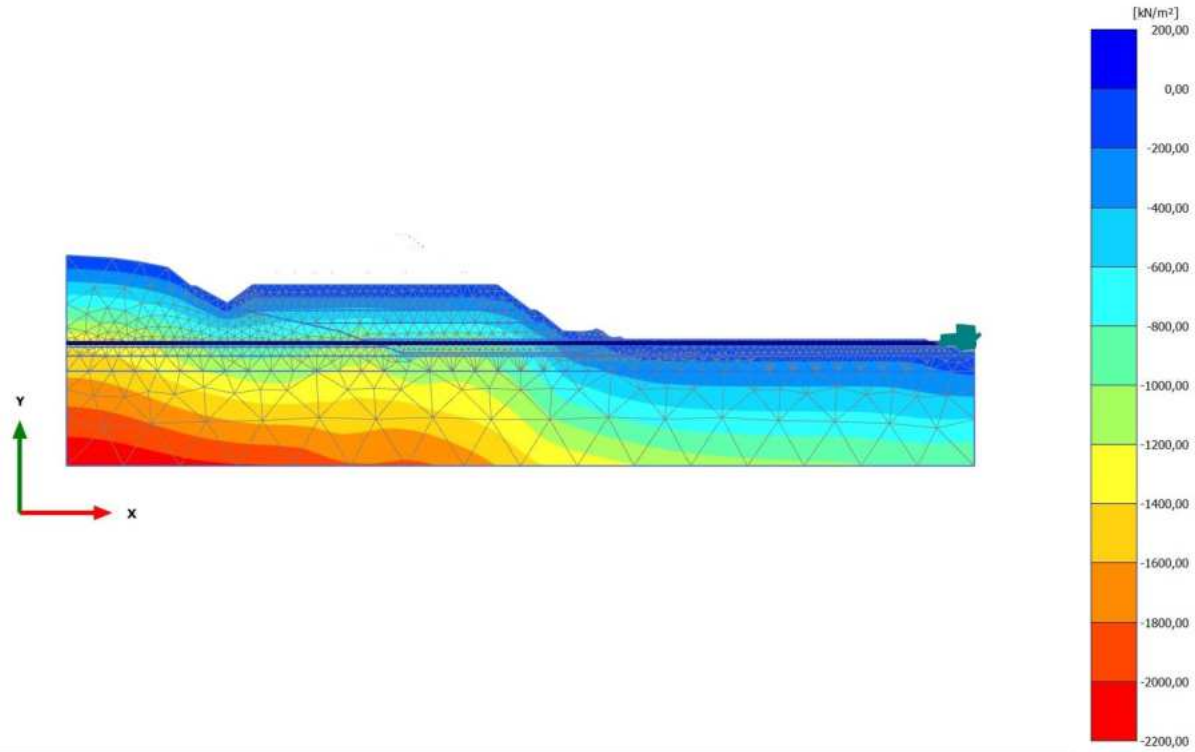


**Cartesian effective stress  $\sigma'_{yy}$  (scaled up 0,0100 times)**

Maximum value = 7,021 kN/m<sup>2</sup> (Element 1065 at Node 4807)

Minimum value = -2145 kN/m<sup>2</sup> (Element 2399 at Node 8693)

2.2.2.2.2 Calculation results, Phase\_2 [Phase\_2] (9/8), Cartesian effective stress  $\sigma'_{yy}$

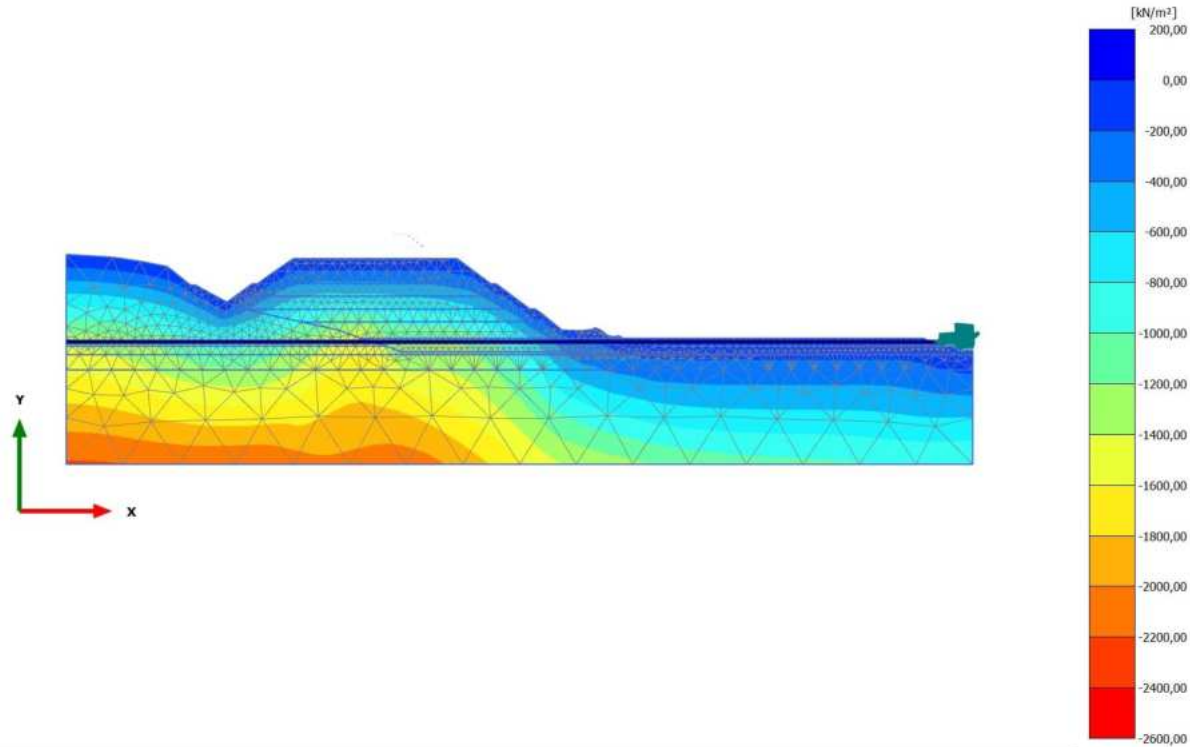


**Cartesian effective stress  $\sigma'_{yy}$  (scaled up 0,0100 times)**

Maximum value = 7,975 kN/m<sup>2</sup> (Element 495 at Node 11405)

Minimum value = -2187 kN/m<sup>2</sup> (Element 2399 at Node 8693)

2.2.2.2.3 Calculation results, Phase\_3 [Phase\_3] (10/12), Cartesian effective stress  $\sigma'_{yy}$

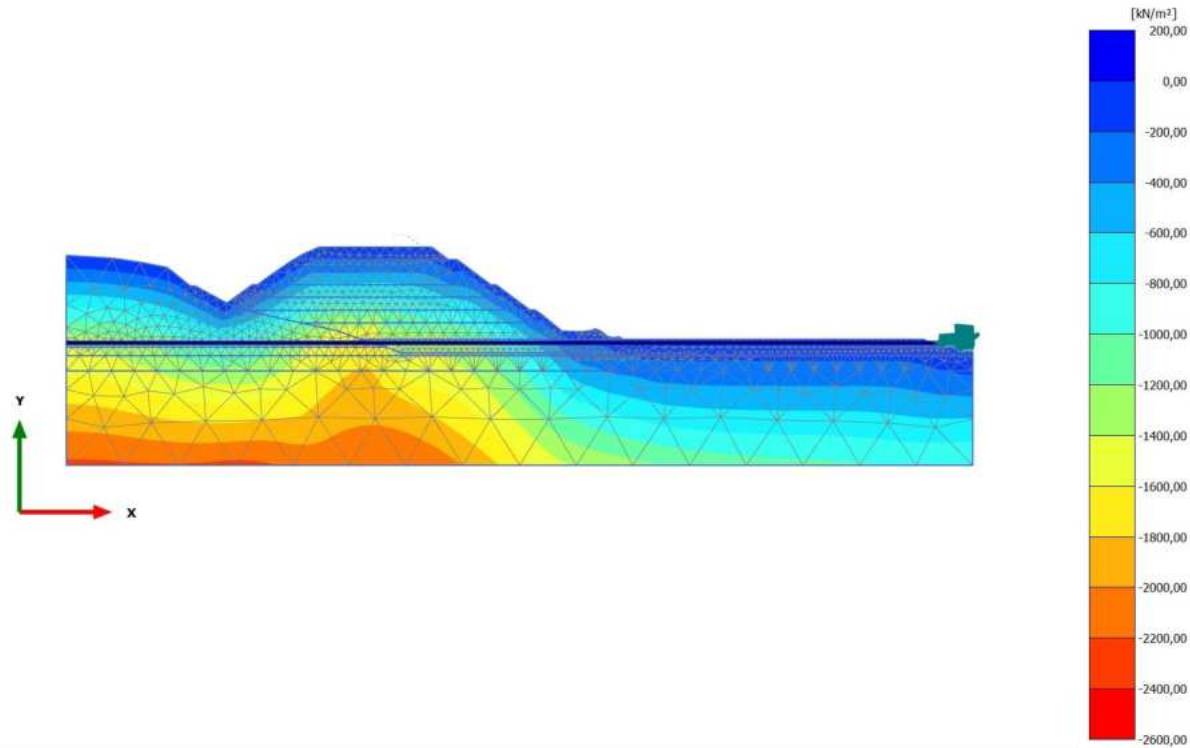


**Cartesian effective stress  $\sigma'_{yy}$  (scaled up  $5,00 \cdot 10^{-3}$  times)**

Maximum value = 10,33 kN/m<sup>2</sup> (Element 495 at Node 11405)

Minimum value = -2402 kN/m<sup>2</sup> (Element 829 at Node 16315)

2.2.2.2.4 Calculation results, Phase\_4 [Phase\_4] (11/15), Cartesian effective stress  $\sigma'_{yy}$

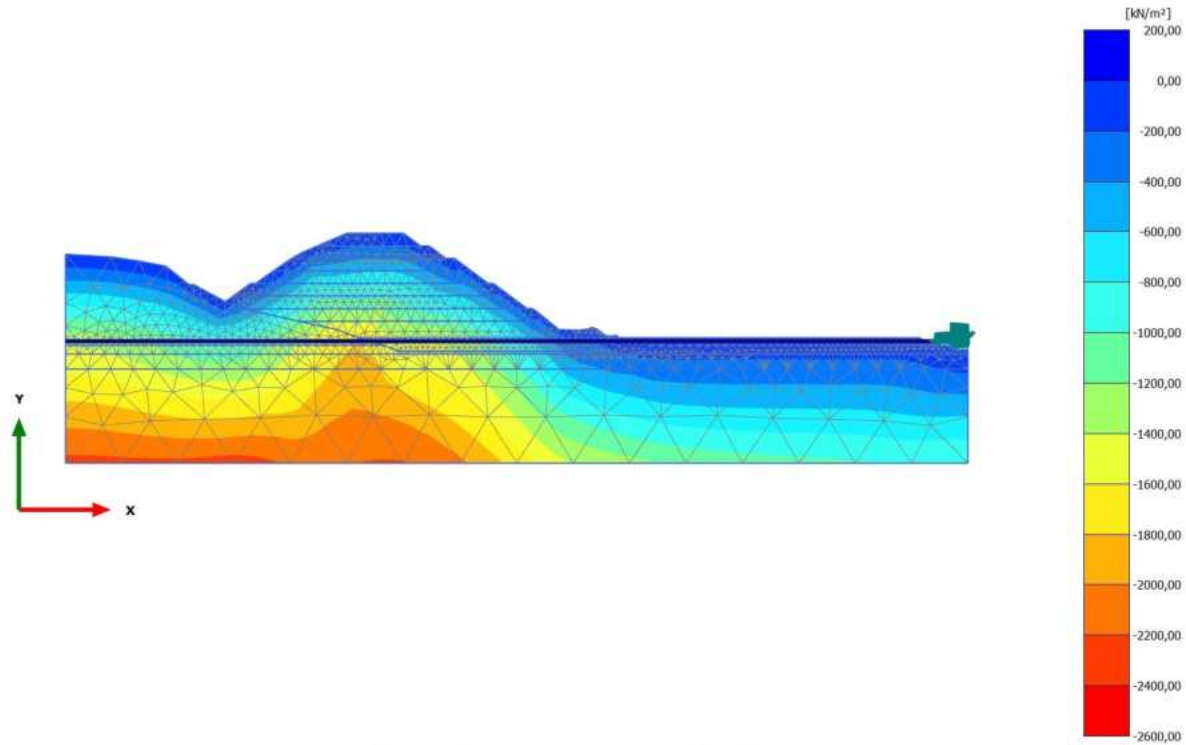


**Cartesian effective stress  $\sigma'_{yy}$  (scaled up  $5,00 \cdot 10^{-3}$  times)**

Maximum value = 7,389 kN/m<sup>2</sup> (Element 495 at Node 11405)

Minimum value = -2527 kN/m<sup>2</sup> (Element 829 at Node 16315)

2.2.2.2.5 Calculation results, Phase\_5\_static [Phase\_5] (12/19), Cartesian effective stress  $\sigma'_{yy}$

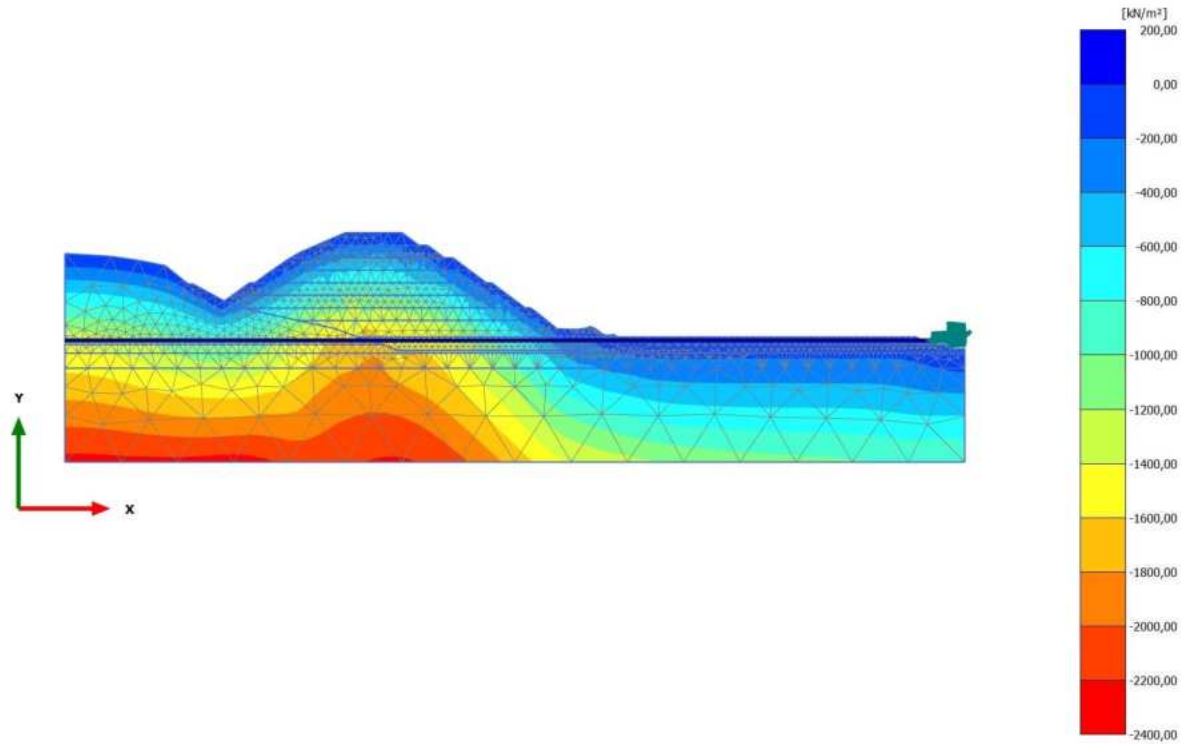


**Cartesian effective stress  $\sigma'_{yy}$  (scaled up  $5,00 \cdot 10^{-3}$  times)**

Maximum value = 9,624 kN/m<sup>2</sup> (Element 1043 at Node 4753)

Minimum value = -2407 kN/m<sup>2</sup> (Element 829 at Node 16315)

2.2.2.2.6 Calculation results, Phase\_6 FoS static [Phase\_6] (13/119), Cartesian effective stress  $\sigma'_{yy}$

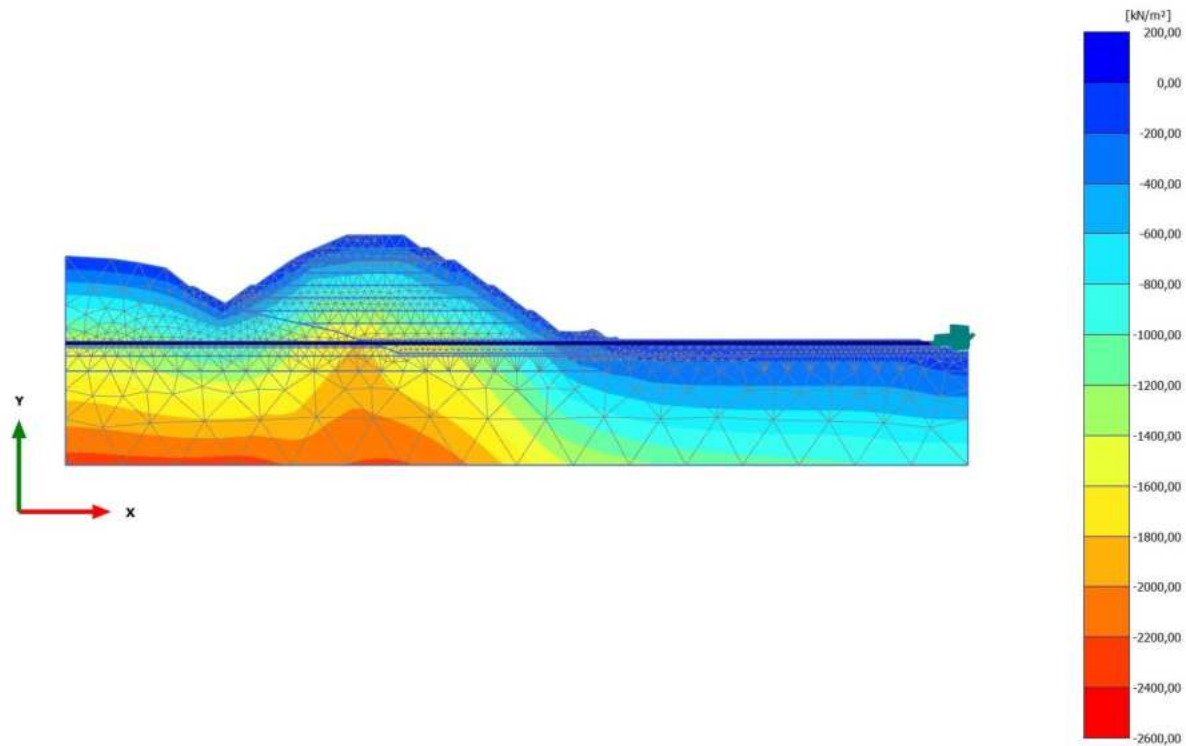


**Cartesian effective stress  $\sigma'_{yy}$  (scaled up  $5,00 \cdot 10^{-3}$  times)**

Maximum value = 26,18 kN/m<sup>2</sup> (Element 5 at Node 20569)

Minimum value = -2288 kN/m<sup>2</sup> (Element 2386 at Node 8657)

2.2.2.2.7 Calculation results, Phase\_8\_seismic [Phase\_8] (2/122), Cartesian effective stress  $\sigma'_{yy}$



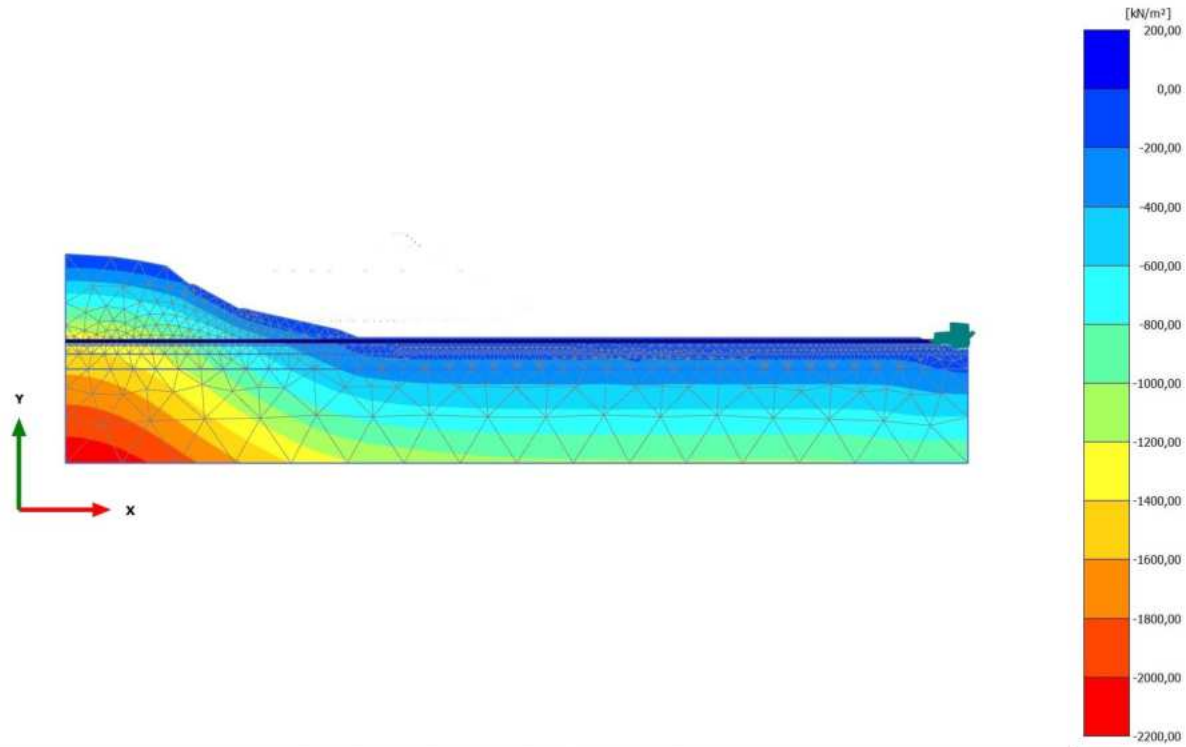
**Cartesian effective stress  $\sigma'_{yy}$  (scaled up  $5,00 \cdot 10^{-3}$  times)**

Maximum value = 7,498 kN/m<sup>2</sup> (Element 1043 at Node 4753)

Minimum value = -2412 kN/m<sup>2</sup> (Element 829 at Node 16315)



2.2.2.2.8 Calculation results, Initial phase [InitialPhase] (0/171), Cartesian effective stress  $\sigma'_{yy}$

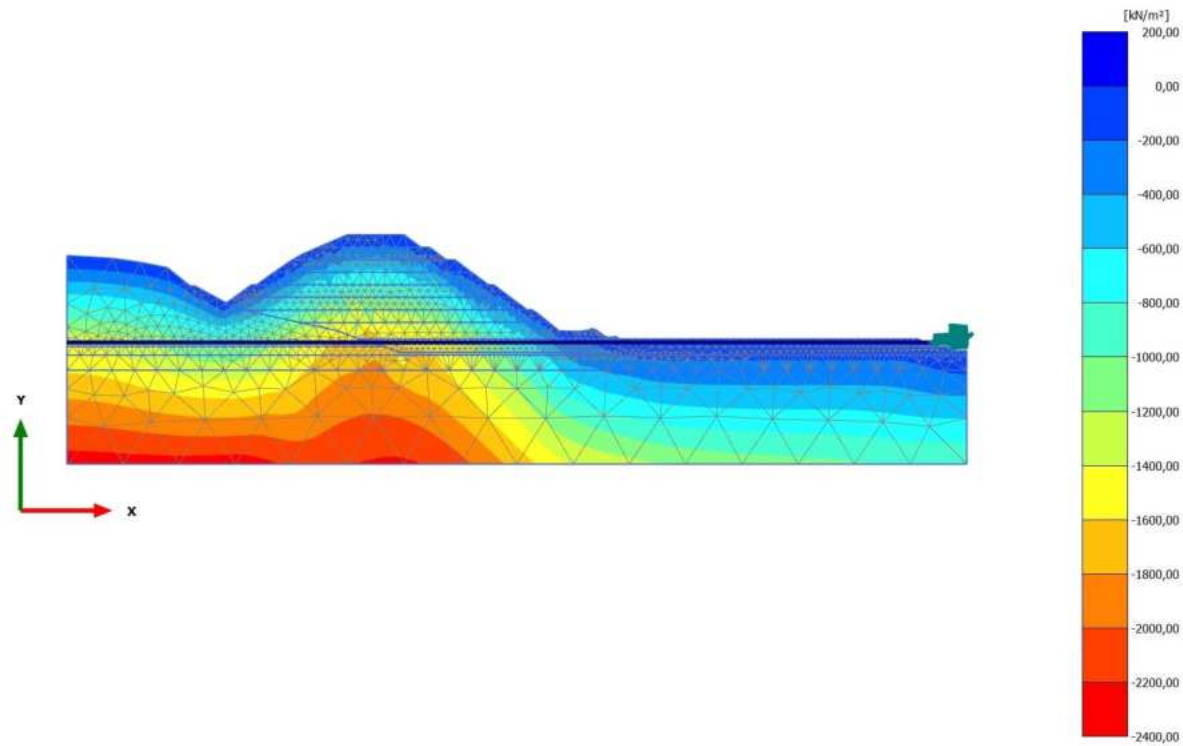


**Cartesian effective stress  $\sigma'_{yy}$  (scaled up 0,0100 times)**

Maximum value = 4,742 kN/m<sup>2</sup> (Element 568 at Node 8875)

Minimum value = -2156 kN/m<sup>2</sup> (Element 2399 at Node 8693)

2.2.2.2.9 Calculation results, Phase\_7 FoS seismic [Phase\_7] (1/271), Cartesian effective stress  $\sigma'_{yy}$

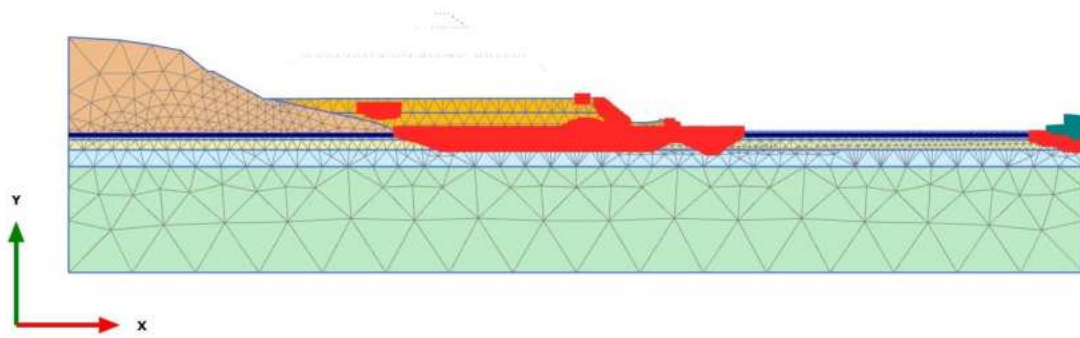


**Cartesian effective stress  $\sigma'_{yy}$  (scaled up  $5,00 \cdot 10^{-3}$  times)**

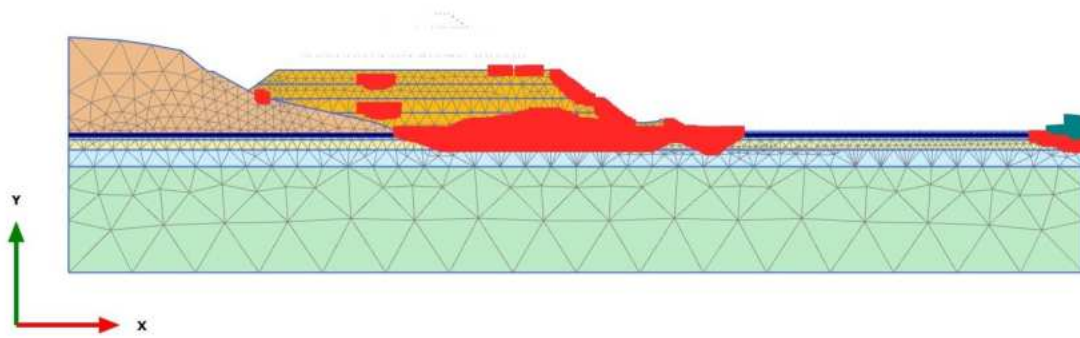
Maximum value = 16,76 kN/m<sup>2</sup> (Element 62 at Node 17953)

Minimum value = -2310 kN/m<sup>2</sup> (Element 2386 at Node 8657)

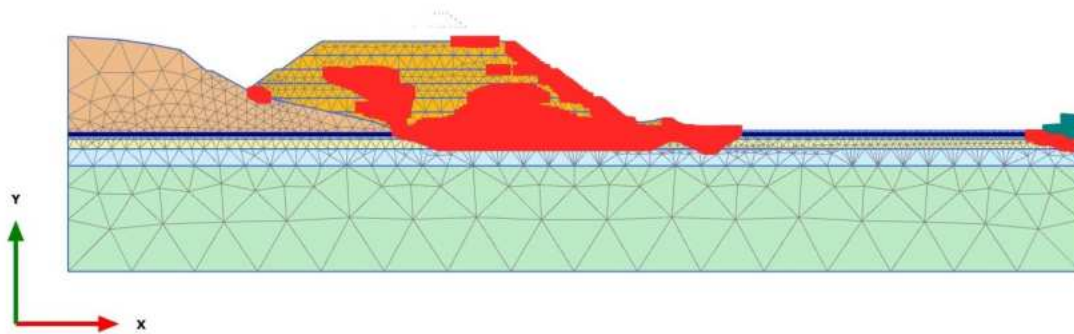
2.2.3.1.1 Calculation results, Phase\_1 [Phase\_1] (8/4), Plastic point history Failure



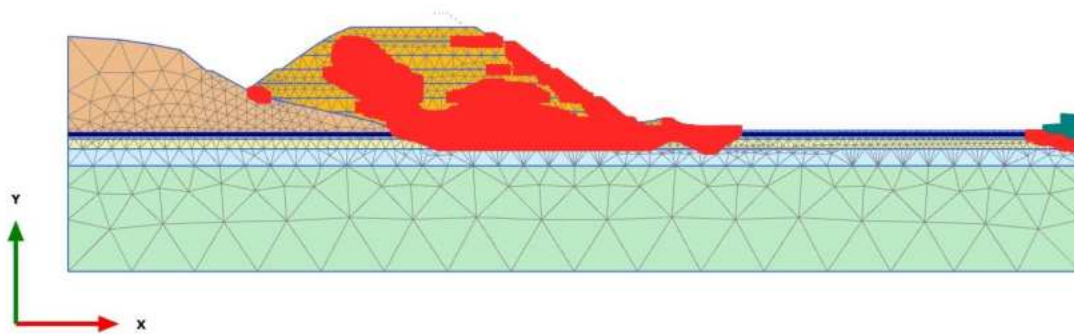
2.2.3.1.2 Calculation results, Phase\_2 [Phase\_2] (9/8), Plastic point history Failure



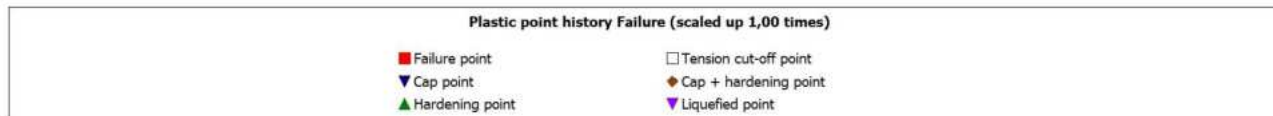
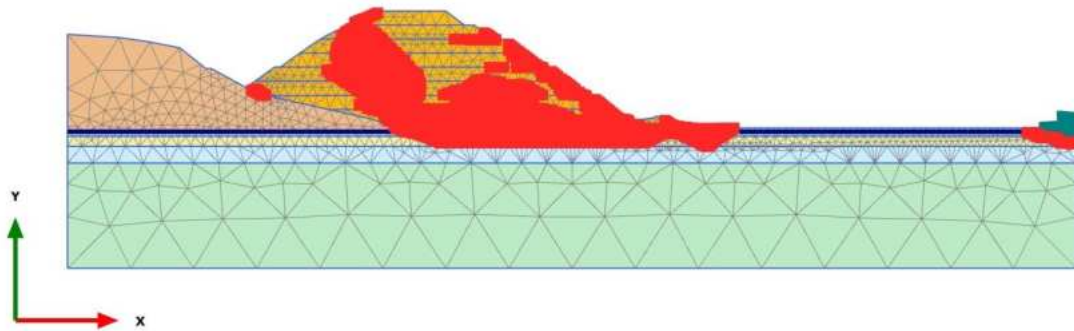
2.2.3.1.3 Calculation results, Phase\_3 [Phase\_3] (10/12), Plastic point history Failure



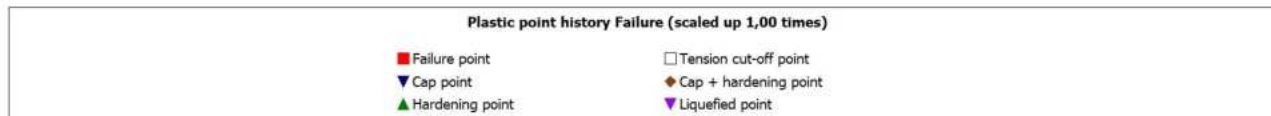
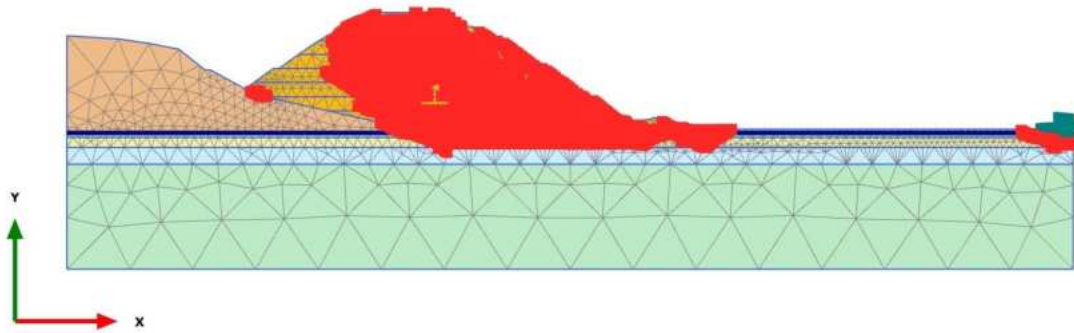
2.2.3.1.4 Calculation results, Phase\_4 [Phase\_4] (11/15), Plastic point history Failure



2.2.3.1.5 Calculation results, Phase\_5\_static [Phase\_5] (12/19), Plastic point history Failure

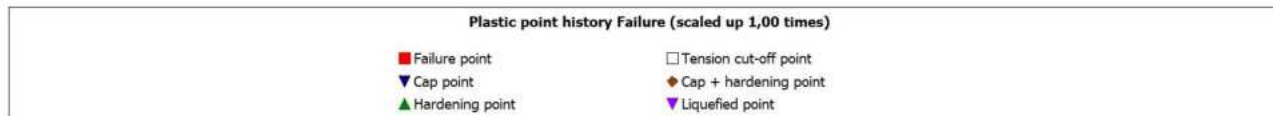
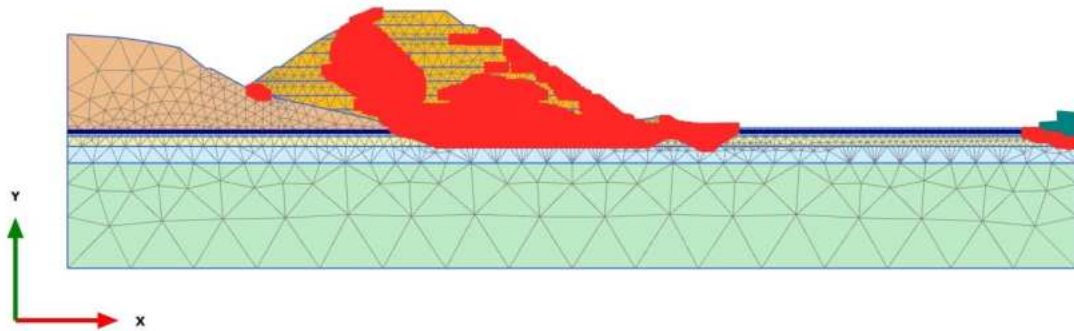


2.2.3.1.6 Calculation results, Phase\_6 FoS static [Phase\_6] (13/119), Plastic point history Failure

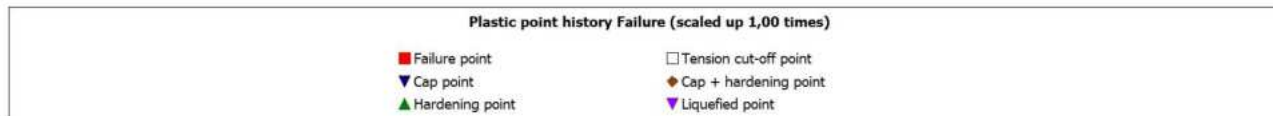
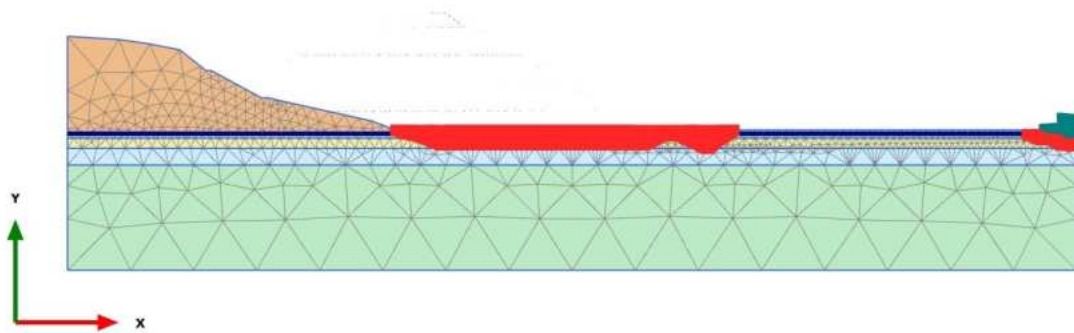




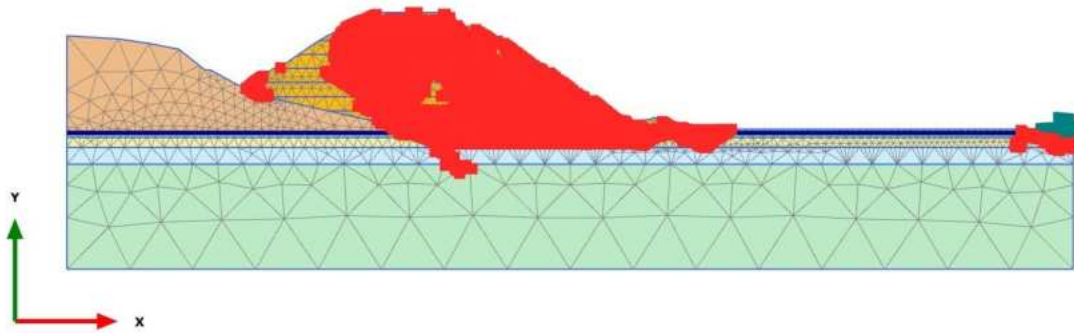
2.2.3.1.7 Calculation results, Phase\_8\_seismic [Phase\_8] (2/122), Plastic point history Failure



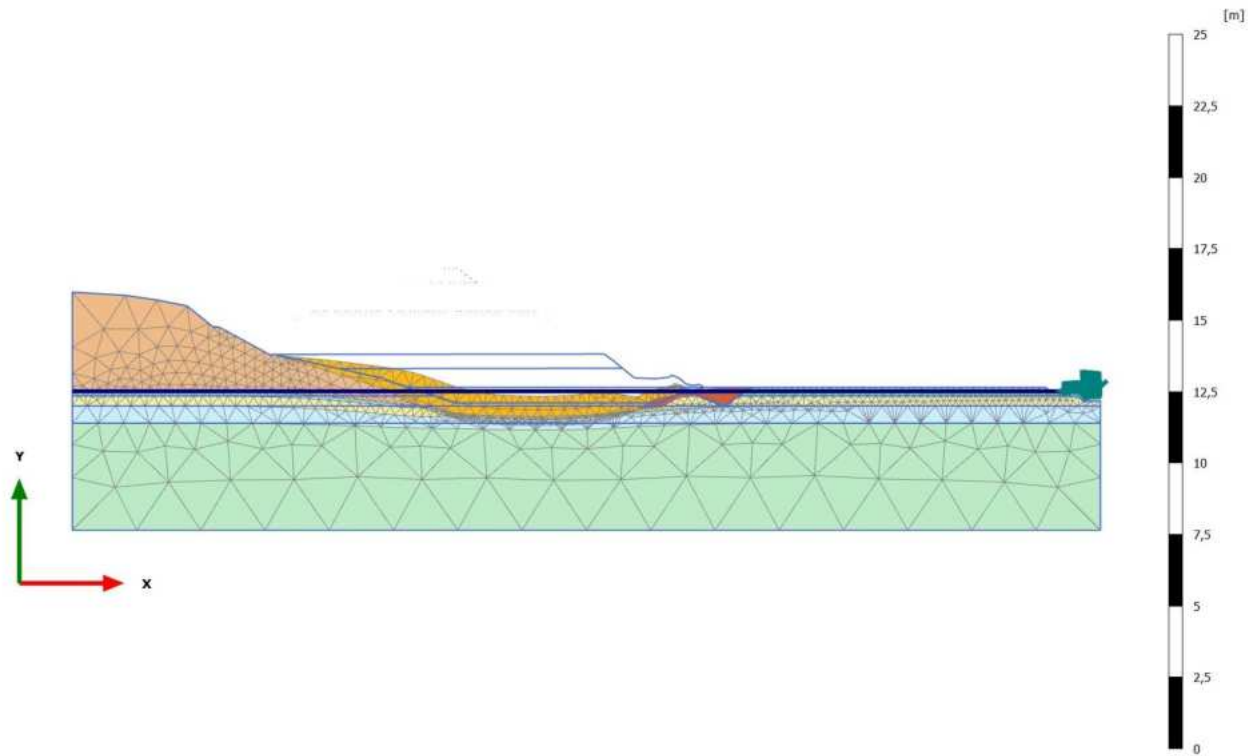
2.2.3.1.8 Calculation results, Initial phase [InitialPhase] (0/171), Plastic point history Failure



2.2.3.1.9 Calculation results, Phase\_7 FoS seismic [Phase\_7] (1/271), Plastic point history Failure

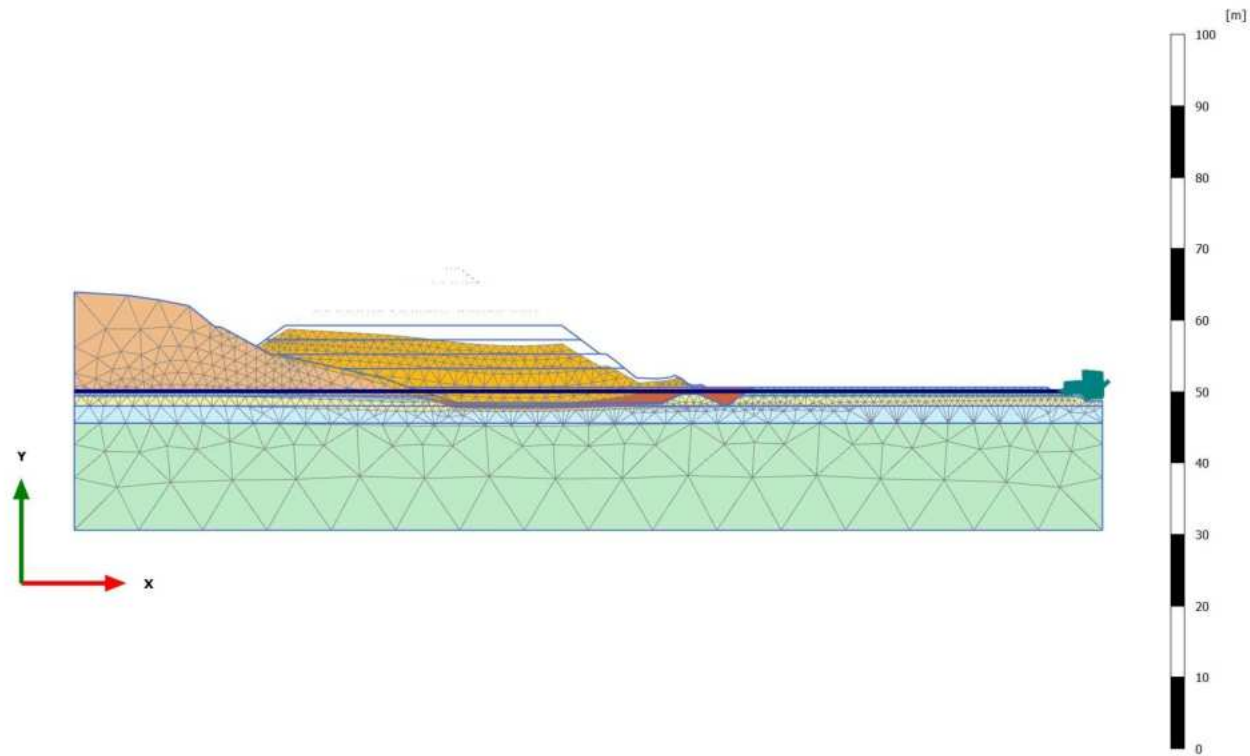


4.1.1 Calculation results, Phase\_1 [Phase\_1] (8/4), Deformed mesh |u|



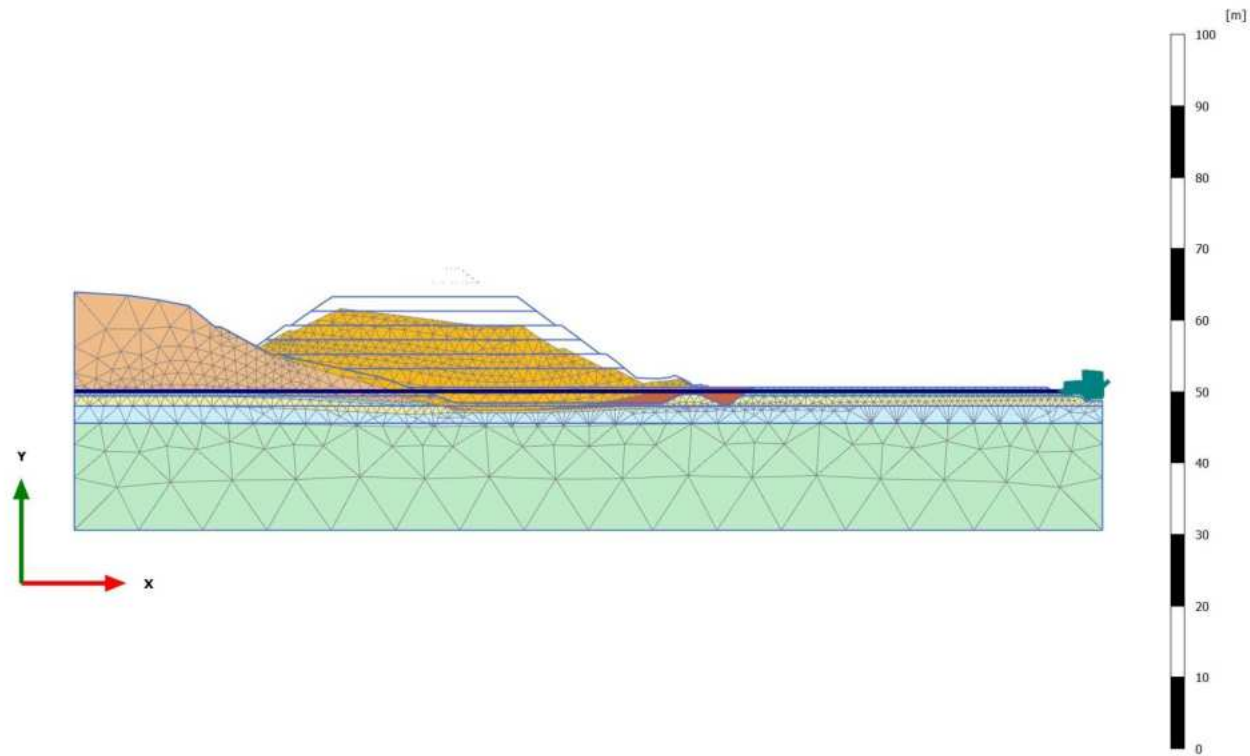
**Deformed mesh |u| (scaled up 20,0 times)**  
Maximum value = 1,476 m (Element 885 at Node 16406)

4.1.2 Calculation results, Phase\_2 [Phase\_2] (9/8), Deformed mesh |u|



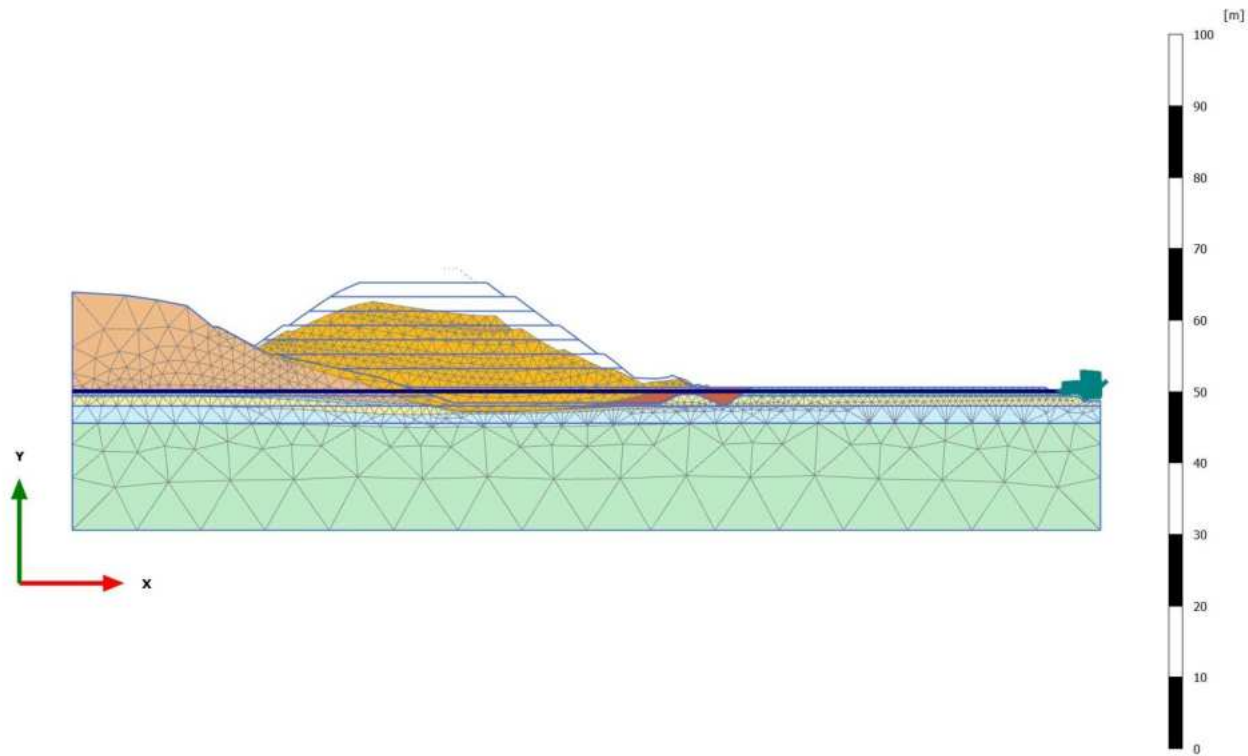
**Deformed mesh |u| (scaled up 5,00 times)**  
Maximum value = 2,888 m (Element 307 at Node 17417)

4.1.3 Calculation results, Phase\_3 [Phase\_3] (10/12), Deformed mesh |u|



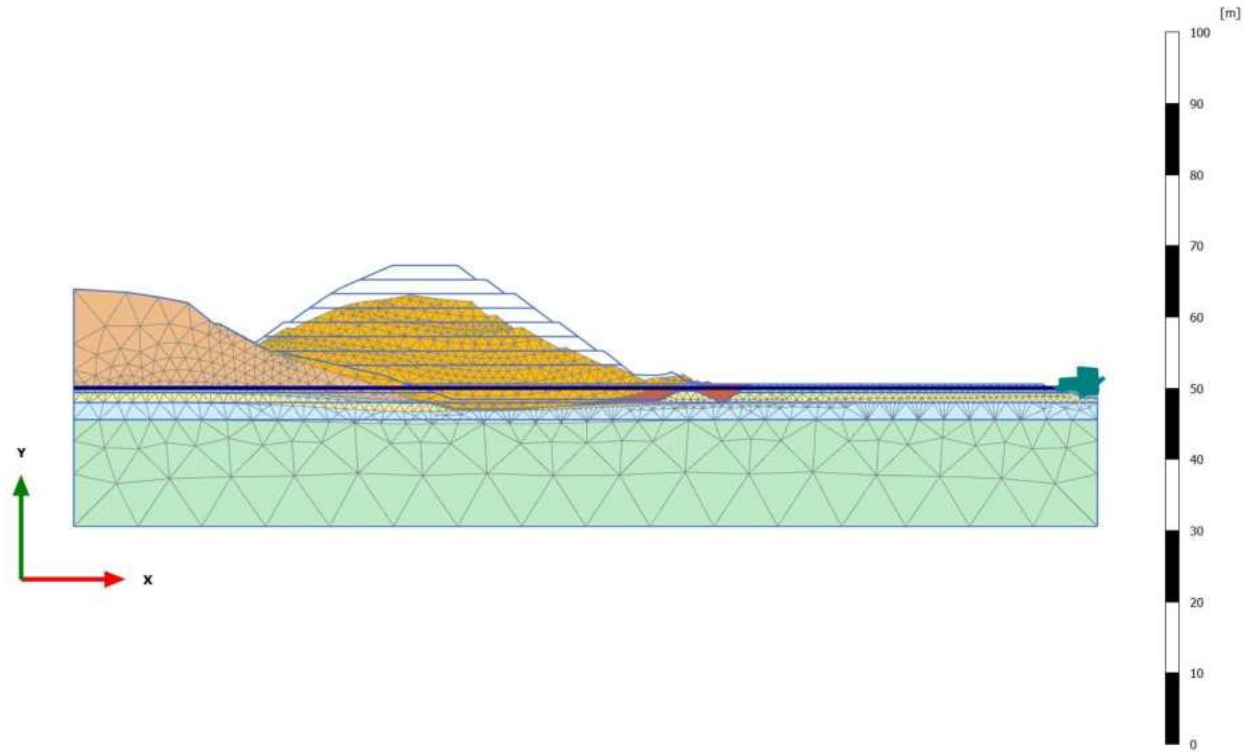
**Deformed mesh |u| (scaled up 5,00 times)**  
Maximum value = 4,273 m (Element 127 at Node 19189)

4.1.4 Calculation results, Phase\_4 [Phase\_4] (11/15), Deformed mesh |u|



**Deformed mesh |u| (scaled up 5,00 times)**  
Maximum value = 4,883 m (Element 154 at Node 19435)

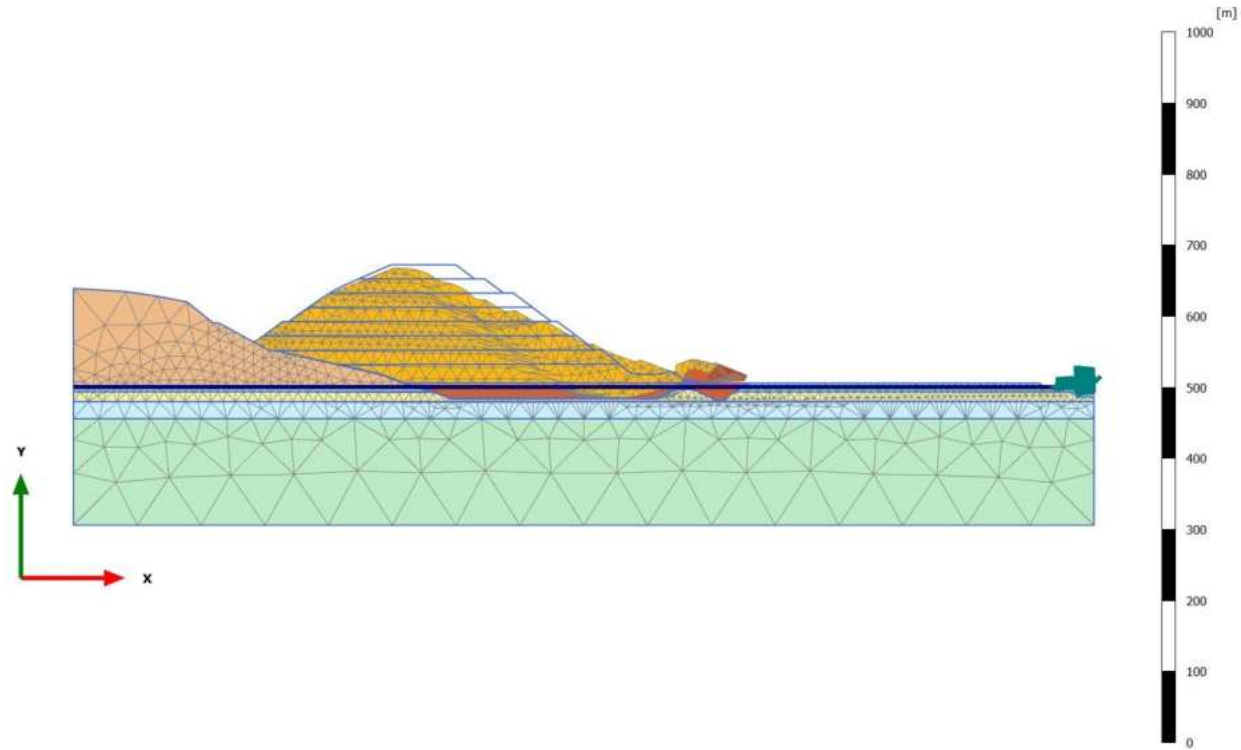
4.1.5 Calculation results, Phase\_5\_static [Phase\_5] (12/19), Deformed mesh |u|



**Deformed mesh |u| (scaled up 5,00 times)**  
Maximum value = 5,458 m (Element 1 at Node 20267)

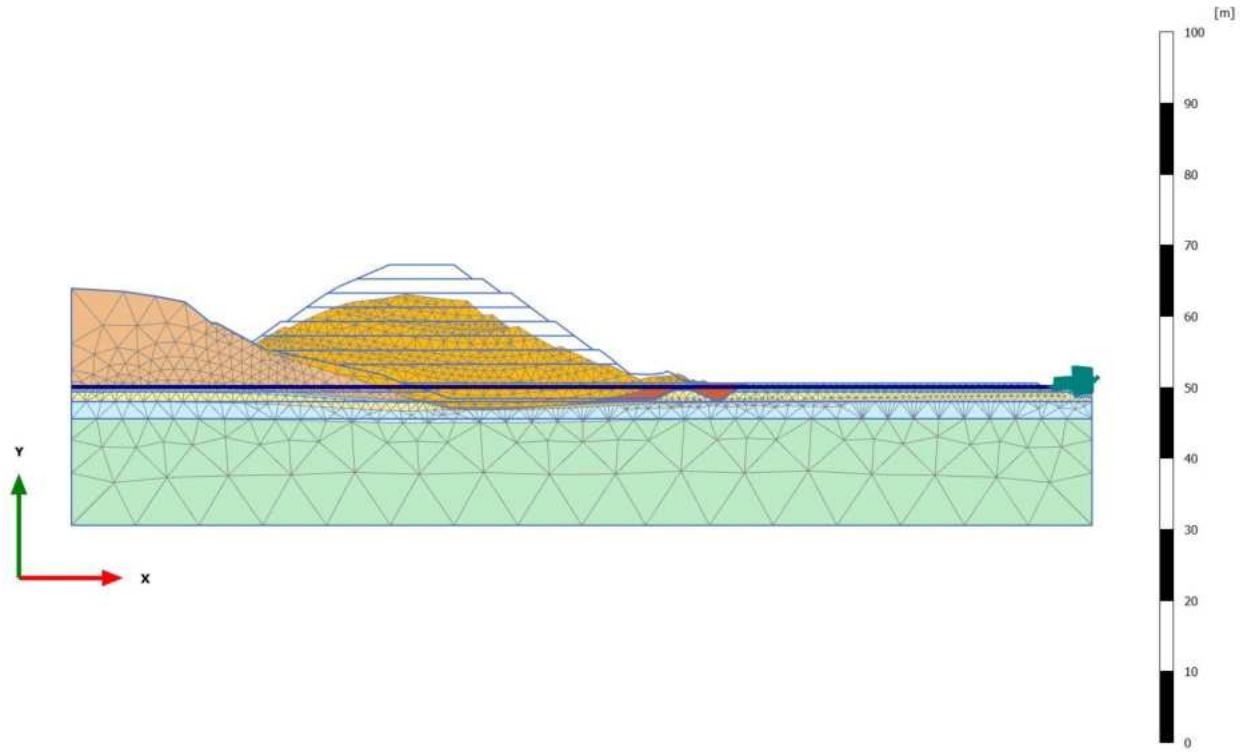


4.1.6 Calculation results, Phase\_6 FoS static [Phase\_6] (13/119), Deformed mesh |u|



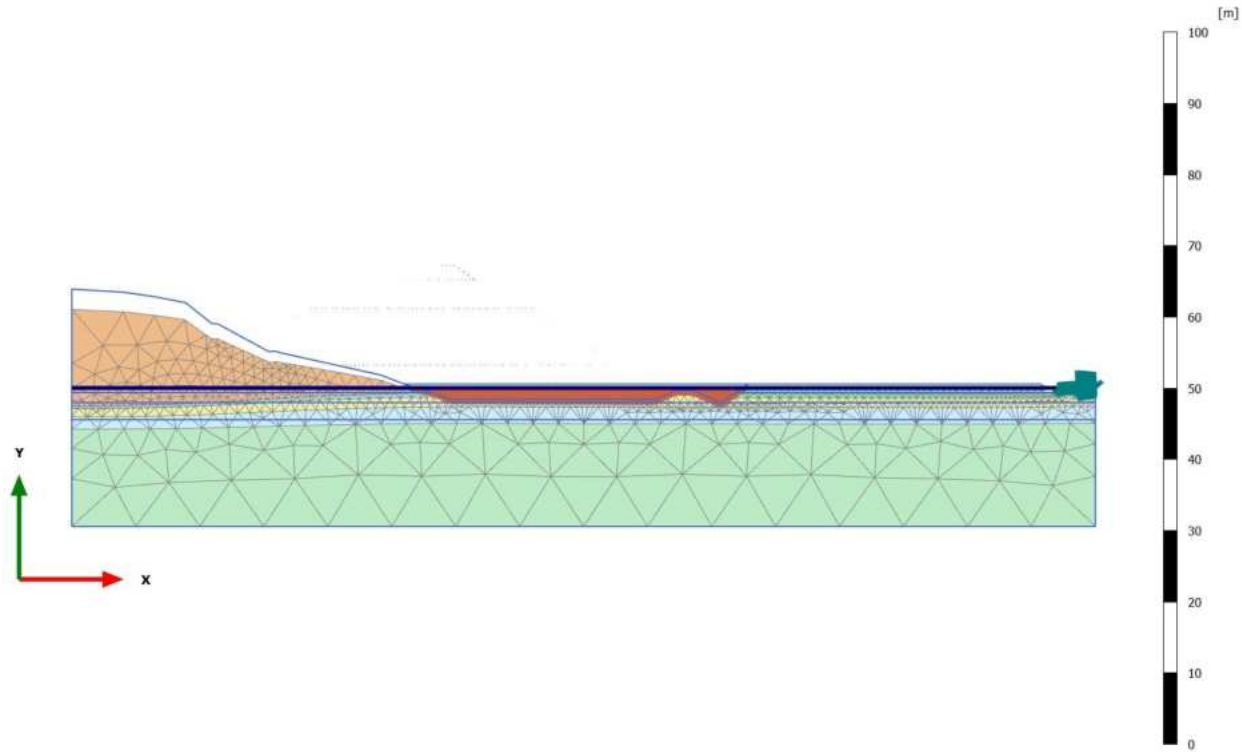
**Deformed mesh |u| (scaled up 0,500 times)**  
Maximum value = 69,70 m (Element 999 at Node 7573)

4.1.7 Calculation results, Phase\_8\_seismic [Phase\_8] (2/122), Deformed mesh |u|



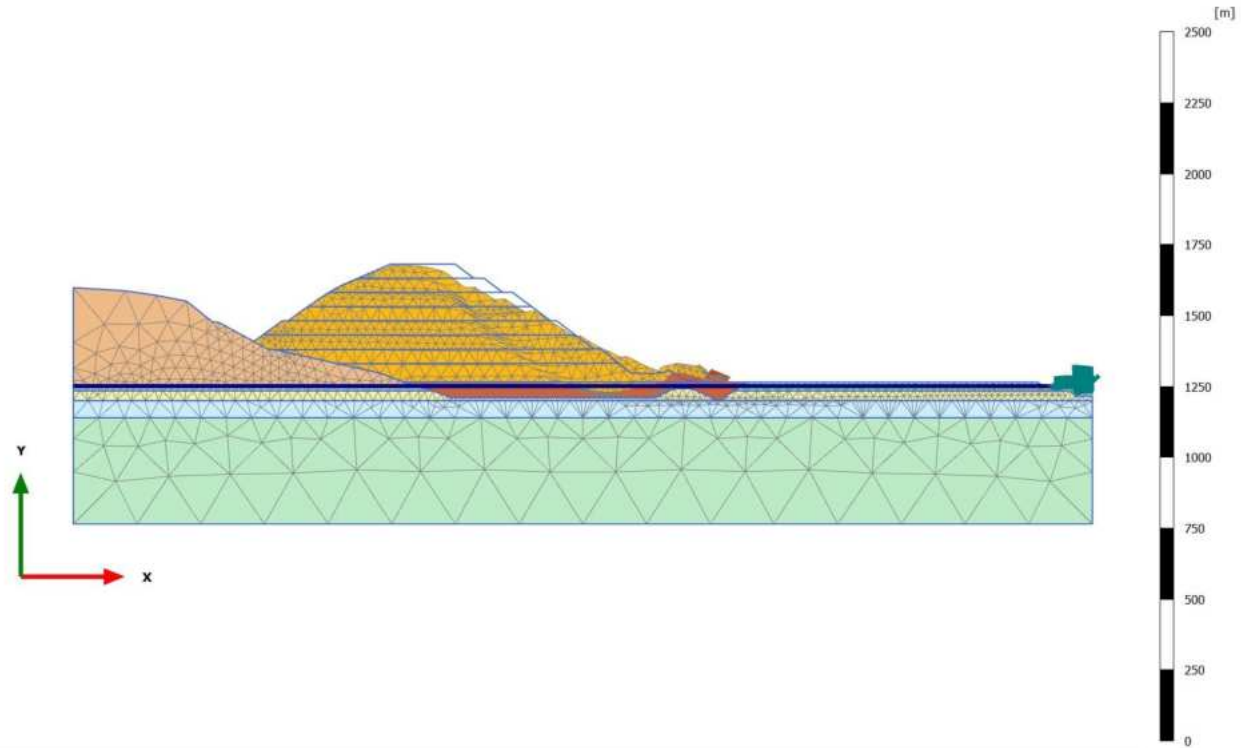
**Deformed mesh |u| (scaled up 5,00 times)**  
Maximum value = 5,436 m (Element 1 at Node 20267)

4.1.8 Calculation results, Initial phase [InitialPhase] (0/171), Deformed mesh |u|



**Deformed mesh |u| (scaled up 5,00 times)**  
Maximum value = 2,833 m (Element 569 at Node 8841)

4.1.9 Calculation results, Phase\_7 FoS seismic [Phase\_7] (1/271), Deformed mesh |u|



**Deformed mesh |u| (scaled up 0,200 times)**  
Maximum value = 115,7 m (Element 999 at Node 7573)

## ANHANG 10 – ERGEBNISSE DER SLIDE SLU – ABSCHNITT 2

## APPENDICE 10 – RISULTATI ANALISI SLIDE SLU – SEZIONE 2

SLIDE - An Interactive Slope Stability Program

Date Created: 16/11/2018, 18:41:47

Software Version: 9.023

### Table of Contents

Project Summary .....	3
General Settings .....	4
Design Standard .....	5
Analysis Options .....	6
Groundwater Analysis .....	7
Random Numbers .....	8
Surface Options .....	9
Seismic Loading .....	10
Materials .....	11
Global Minimums .....	13
Method: bishop simplified .....	13
Valid and Invalid Surfaces .....	14
Method: bishop simplified .....	14
Slice Data .....	15
Global Minimum Query (bishop simplified) - Safety Factor: 1.14041 .....	15
Interslice Data .....	16
Global Minimum Query (bishop simplified) - Safety Factor: 1.14041 .....	16
Entity Information .....	17
Water Table .....	17
External Boundary .....	17
Material Boundary .....	19

# Slide2 Analysis Information

## SLIDE - An Interactive Slope Stability Program

### Project Summary

---

Slide2 Modeler Version:	9.023
Compute Time:	00h:00m:00.391s
Date Created:	16/11/2018, 18:41:47

## General Settings

---

Units of Measurement:	Metric Units
Time Units:	days
Permeability Units:	meters/second
Data Output:	Standard
Failure Direction:	Left to Right

## Design Standard

Selected Type:	Eurocode 7 (User Defined)	
Name:	User Defined 1	
	Type	Partial Factor
Permanent Actions: Unfavourable	1	
Permanent Actions: Favourable	1	
Variable Actions: Unfavourable	1	
Variable Actions: Favourable	1	
Effective cohesion	1.25	
Coefficient of shearing resistance	1.25	
Undrained strength	1	
Weight density	1	
Shear strength (other models)	1	
Earth resistance	1	
Tensile and plate strength	1	
Shear strength	1	
Compressive strength	1	
Bond strength	1	
Seismic Coefficient	1	

## Analysis Options

---

Slices Type:	Vertical
	Analysis Methods Used
	Bishop simplified
Number of slices:	25
Tolerance:	0.005
Maximum number of iterations:	50
Check malpha < 0.2:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes



## Groundwater Analysis

---

Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [kN/m <sup>3</sup> ]:	9.81
Use negative pore pressure cutoff:	Yes
Maximum negative pore pressure [kPa]:	0
Advanced Groundwater Method:	None

## Random Numbers

---

Pseudo-random Seed:

10116

Random Number Generation Method:

Park and Miller v.3

## Surface Options

---

Surface Type:	Circular
Search Method:	Auto Refine Search
Divisions along slope:	10
Circles per division:	10
Number of iterations:	10
Divisions to use in next iteration:	50%
Composite Surfaces:	Disabled
Minimum Elevation:	Not Defined
Minimum Depth:	Not Defined
Minimum Area:	Not Defined
Minimum Weight:	Not Defined

## Seismic Loading

---

Advanced seismic analysis:	No
Staged pseudostatic analysis:	No

## Materials

A

Color	
Strength Type	Mohr-Coulomb
Unit Weight [kN/m <sup>3</sup> ]	21
Cohesion [kPa]	45
Friction Angle [deg]	37
Water Surface	Water Table
Hu Value	Automatically Calculated

Roccia

Color	
Strength Type	Mohr-Coulomb
Unit Weight [kN/m <sup>3</sup> ]	20
Cohesion [kPa]	400
Friction Angle [deg]	29.26
Water Surface	Water Table
Hu Value	Automatically Calculated

Strato 1

Color	
Strength Type	Mohr-Coulomb
Unit Weight [kN/m <sup>3</sup> ]	20
Cohesion [kPa]	5
Friction Angle [deg]	38
Water Surface	Water Table
Hu Value	Automatically Calculated

Strato 2

Color	
Strength Type	Mohr-Coulomb
Unit Weight [kN/m <sup>3</sup> ]	20
Cohesion [kPa]	0
Friction Angle [deg]	40
Water Surface	Water Table
Hu Value	Automatically Calculated

Strato 3



Color	
Strength Type	Mohr-Coulomb
Unit Weight [kN/m <sup>3</sup> ]	20
Cohesion [kPa]	0
Friction Angle [deg]	42
Water Surface	Water Table
Hu Value	Automatically Calculated

Strato 4

Color	
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Strength Type	Mohr-Coulomb
Unit Weight [kN/m <sup>3</sup> ]	20
Cohesion [kPa]	0

Friction Angle [deg]	36
Water Surface	Water Table
Hu Value	Automatically Calculated
Strato 5	
Color	
Strength Type	Mohr-Coulomb
Unit Weight [kN/m3]	20
Cohesion [kPa]	0
Friction Angle [deg]	36
Water Surface	Water Table
Hu Value	Automatically Calculated
F1	
Color	
Strength Type	Mohr-Coulomb
Unit Weight [kN/m3]	20
Cohesion [kPa]	0
Friction Angle [deg]	20
Water Surface	Water Table
Hu Value	1

# Global Minimums

---

Method: bishop simplified

---

	FS	1.140410
Center:	546.658, 731.206	
Radius:	121.380	
Left Slip Surface Endpoint:	428.349, 704.076	
Right Slip Surface Endpoint:	600.328, 622.336	
Resisting Moment:	5.8199e+06 kN-m	
Driving Moment:	5.10335e+06 kN-m	
Total Slice Area:	5247.66 m2	
Surface Horizontal Width:	171.979 m	
Surface Average Height:	30.5134 m	



# Global Minimum Support Data

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No Supports Present

## Valid and Invalid Surfaces

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Method: bishop simplified

---

Number of Valid Surfaces:	3159
Number of Invalid Surfaces:	0

## Slice Data

Global Minimum Query (bishop simplified) - Safety Factor: 1.14041

Slice Number	Width [m]	Weight [kN]	Angle of Slice Base [deg]	Base Material	Base Cohesion [kPa]	Base Friction Angle [deg]	Shear Stress [kPa]	Shear Strength [kPa]	Base Normal Stress [kPa]	Pore Pressure [kPa]	Effective Normal Stress [kPa]	Base Vertical Stress [kPa]	Effective Vertical Stress [kPa]
1	6.80192	1444.09	-71.9077	A	36	31.0834	54.9485	62.6638	44.23	0	44.23	212.422	212.422
2	6.80192	3320.35	-63.1718	A	36	31.0834	141.654	161.544	208.254	0	208.254	488.339	488.339
3	6.80192	4344.86	-56.688	A	36	31.0834	204.694	233.435	327.507	0	327.507	638.982	638.982
4	6.80192	5505.96	-51.2007	A	36	31.0834	277.284	316.218	464.826	0	464.826	809.708	809.708
5	6.80192	6043.77	-46.3129	A	36	31.0834	322.765	368.084	550.863	0	550.863	888.77	888.77
6	6.80192	6311.79	-41.833	A	36	31.0834	354.476	404.248	610.852	0	610.852	928.158	928.158
7	6.80192	6939.17	-37.6499	A	36	31.0834	405.566	462.512	707.502	0	707.502	1020.39	1020.39
8	6.80192	7058.7	-33.692	A	36	31.0834	429.037	489.278	751.9	0	751.9	1037.95	1037.95
9	6.80192	6936.11	-29.9098	A	36	31.0834	437.629	499.076	768.154	0	768.154	1019.9	1019.9
10	6.80192	6729.78	-26.2669	A	36	31.0834	439.898	501.664	772.446	0	772.446	989.542	989.542
11	7.52774	7206.02	-22.5522	F1	0	16.2343	220.997	252.027	865.549	0	865.549	957.325	957.325
12	7.52774	7136.99	-18.7515	F1	0	16.2343	218.927	249.667	873.819	16.3768	857.443	948.142	931.765
13	7.52774	6595.31	-15.0349	F1	0	16.2343	200.074	228.166	822.429	38.8295	783.6	876.17	837.34
14	7.52774	5974.44	-11.3823	F1	0	16.2343	179.097	204.244	757.627	56.1805	701.446	793.682	737.501
15	7.52774	5336.48	-7.77621	F1	0	16.2343	157.969	180.149	687.352	68.656	618.696	708.924	640.268
16	7.52774	5002.24	-4.20099	F1	0	16.2343	147.394	168.09	653.688	76.4104	577.277	664.514	588.104
17	10.2472	5406.07	0	F1	0	16.2343	114.499	130.576	527.567	79.1226	448.444	527.567	448.444
18	6.45235	2471.85	3.9459	F1	0	16.2343	79.5695	90.7418	388.578	76.9395	311.639	383.09	306.15
19	6.45235	2153.07	7.00708	F1	0	16.2343	69.2779	79.0052	342.197	70.8665	271.331	333.682	262.816
20	6.45235	1996.72	10.0886	F1	0	16.2343	66.3618	75.6797	321.256	61.3455	259.911	309.449	248.103
21	6.45235	1844.82	13.1999	F1	0	16.2343	64.5332	73.5943	301.04	48.2914	252.749	285.904	237.613
22	6.45235	1769.49	16.3516	F1	0	16.2343	66.9701	76.3734	293.876	31.5826	262.293	274.227	242.644
23	6.45235	1385.31	19.5552	F1	0	16.2343	57.1774	65.2057	234.995	11.0552	223.94	214.685	203.63
24	6.45235	505.251	22.8239	F1	0	16.2343	22.3984	25.5434	87.725	0	87.725	78.2986	78.2986
25	3.37981	48.0315	25.3592	A	36	31.0834	52.1327	59.4526	38.9033	0	38.9033	14.1944	14.1944

## Interslice Data

Global Minimum Query (bishop simplified) - Safety Factor: 1.14041

Slice Number	X coordinate [m]	Y coordinate - Bottom [m]	Normal Force [kN]	Shear Force [kN]	Force Angle [deg]
1	428.349	704.076	0	0	0
2	435.151	683.256	547.369	0	0
3	441.953	669.807	2385.32	0	0
4	448.755	659.456	4383.73	0	0
5	455.557	650.996	6431.43	0	0
6	462.359	643.875	8160.22	0	0
7	469.161	637.787	9470.03	0	0
8	475.963	632.539	10426	0	0
9	482.765	628.004	10919.5	0	0
10	489.566	624.091	10950.5	0	0
11	496.368	620.734	10553.4	0	0
12	503.896	617.608	11596.7	0	0
13	511.424	615.053	12182.9	0	0

14	518.952	613.031	12340.7	0	0
15	526.479	611.515	12141.6	0	0
16	534.007	610.487	11659.8	0	0
17	541.535	609.934	10912.5	0	0
18	551.782	609.934	9740.01	0	0
19	558.234	610.379	9054.01	0	0
20	564.687	611.172	8335.92	0	0
21	571.139	612.321	7539.22	0	0
22	577.591	613.834	6667.53	0	0
23	584.044	615.727	5679.37	0	0
24	590.496	618.019	4772.12	0	0
25	596.948	620.734	4389.48	0	0
26	600.328	622.336	0	0	0

## Discharge Sections

---

## Entity Information

---

### Water Table

	X	Y
150		618
900		618

### External Boundary

	X	Y
461.174		688.076
453.219		694.076
446.156		694.076
432.817		704.076
415.55		704.076
410.273		704.076
406.154		704.076
401.047		704.076
396.103		704.076
391.434		704.076

387.418	704.076
385.446	703.223
381.277	701.461
368.133	695.765
364.234	694.076
359.124	691.862
353.54	689.436
349.648	687.548
343.792	684.076
341.013	682.428
328.899	674.076
323.401	670.284
314.977	664.076
310.689	664.076
306.758	661.178
301.708	657.506
298.442	655.163
296.971	654.076
295.313	652.851
290.499	649.508
265.639	663.027
261.527	663.141
243.261	677.78
221.846	681.968
199.673	685.173

163.025

687.401

163.025	617.683
163.025	614.683
163.025	607.683
163.025	595.683
163.025	520.734
883.257	520.734
883.257	595.683
883.257	607.683
883.257	611.215
871.403	610.663
868.175	614.297
857.341	614.683
852.521	617.683
851.96	618.032
848.524	618.028
844.639	620.734
689.364	620.734
639.238	620.734
605.437	620.734
602.256	622.695
601.53	622.676
600.218	622.305
599.431	622.249
597.879	622.162
597.114	622.151
596.621	622.148
595.445	622.229
593.94	623.059
593.199	623.082
592.8	623.126
589.985	625.759
589.298	626.016
588.106	627.101
586.169	627.911
583.013	629.224
581.231	627.886
572.752	626.834
571.587	626.818
568.284	626.892
562.751	627.073
556.738	627.363
552.789	630.576
548.455	634.1
544.039	637.692
541.814	639.576
535.512	644.076
531.292	644.076
522.573	650.576
517.878	654.076
510.5	659.576
504.499	664.076
500.267	664.076

492.232	670.076
486.876	674.076
480.18	679.076
473.503	684.076
466.487	684.076

Material Boundary

X	Y
163.025	617.683
405.547	617.683
396.735	620.734
380.175	627.103
349.828	633.816
310.926	642.422
306.159	643.753
301.413	643.574
290.499	649.508

Material Boundary

X	Y
639.238	620.734
634.622	617.683
852.521	617.683

Material Boundary

X	Y
163.025	614.683
416.848	614.683

Material Boundary

X	Y
634.622	617.683
630.084	614.683
857.341	614.683

Material Boundary

X	Y
630.084	614.683
619.623	607.683
883.257	607.683

Material Boundary

X	Y
163.025	607.683
618.16	607.683
616.47	608.705
614.473	609.765
609.65	611.884
600.053	616.229
587.784	616.335
574.521	609.934
429.885	609.934
416.848	614.683
411.793	616.524

Material Boundary

X	Y
163.025	595.683
883.257	595.683

Material Boundary

X	Y
618.16	607.683
619.623	607.683

Material Boundary

X	Y
396.735	620.734
605.437	620.734

Material Boundary

X	Y
306.159	643.753
531.292	644.076

Material Boundary

X	Y
314.977	664.076
500.267	664.076

Material Boundary

X	Y
343.792	684.076
466.487	684.076



Material Boundary

X	Y
364.234	694.076
446.156	694.076

Material Boundary

X	Y
349.828	633.816
548.455	634.1

Material Boundary

X	Y
296.971	654.076
517.878	654.076

Material Boundary

X	Y
328.899	674.076
486.876	674.076

Material Boundary

X	Y
405.547	617.683
411.793	616.524

## ANHANG 11 – ERGEBNISSE DER SLIDE SLV – ABSCHNITT 2

## APPENDICE 11 – RISULTATI ANALISI SLIDE SLV – SEZIONE 2

SLIDE - An Interactive Slope Stability Program

Date Created: 16/11/2018, 18:41:47

Software Version: 9.023

### Table of Contents

Project Summary .....	3
General Settings .....	4
Design Standard .....	5
Analysis Options .....	6
Groundwater Analysis .....	7
Random Numbers .....	8
Surface Options .....	9
Seismic Loading .....	10
Materials .....	11
Global Minimums .....	13
Method: bishop simplified .....	13
Valid and Invalid Surfaces .....	14
Method: bishop simplified .....	14
Slice Data .....	15
Global Minimum Query (bishop simplified) - Safety Factor: 1.10585 .....	15
Interslice Data .....	16
Global Minimum Query (bishop simplified) - Safety Factor: 1.10585 .....	16
Entity Information .....	17
Water Table .....	17
External Boundary .....	17
Material Boundary .....	19

# Slide2 Analysis Information

## SLIDE - An Interactive Slope Stability Program

### Project Summary

---

Slide2 Modeler Version:	9.023
Compute Time:	00h:00m:00.380s
Date Created:	16/11/2018, 18:41:47

## General Settings

---

Units of Measurement:	Metric Units
Time Units:	days
Permeability Units:	meters/second
Data Output:	Standard
Failure Direction:	Left to Right

## Design Standard

Selected Type:	Eurocode 7 (User Defined)	
Name:	User Defined 1	
	Type	Partial Factor
Permanent Actions: Unfavourable	1	
Permanent Actions: Favourable	1	
Variable Actions: Unfavourable	1	
Variable Actions: Favourable	1	
Effective cohesion	1.25	
Coefficient of shearing resistance	1.25	
Undrained strength	1	
Weight density	1	
Shear strength (other models)	1	
Earth resistance	1	
Tensile and plate strength	1	
Shear strength	1	
Compressive strength	1	
Bond strength	1	
Seismic Coefficient	1	

## Analysis Options

---

Slices Type:	Vertical
	Analysis Methods Used
	Bishop simplified
Number of slices:	25
Tolerance:	0.005
Maximum number of iterations:	50
Check malpha < 0.2:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

## Groundwater Analysis

---

Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [kN/m <sup>3</sup> ]:	9.81
Use negative pore pressure cutoff:	Yes
Maximum negative pore pressure [kPa]:	0
Advanced Groundwater Method:	None

## Random Numbers

---

Pseudo-random Seed:

10116

Random Number Generation Method:

Park and Miller v.3

## Surface Options

---

Surface Type:	Circular
Search Method:	Auto Refine Search
Divisions along slope:	10
Circles per division:	10
Number of iterations:	10
Divisions to use in next iteration:	50%
Composite Surfaces:	Disabled
Minimum Elevation:	Not Defined
Minimum Depth:	Not Defined
Minimum Area:	Not Defined
Minimum Weight:	Not Defined



## Seismic Loading

---

Advanced seismic analysis:	No
Staged pseudostatic analysis:	No
Seismic Load Coefficient (Horizontal):	0.013
Seismic Load Coefficient (Vertical):	0.0065

## Materials

A

Color	
Strength Type	Mohr-Coulomb
Unit Weight [kN/m3]	21
Cohesion [kPa]	45
Friction Angle [deg]	37
Water Surface	Water Table
Hu Value	Automatically Calculated

Roccia

Color	
Strength Type	Mohr-Coulomb
Unit Weight [kN/m3]	20
Cohesion [kPa]	400
Friction Angle [deg]	29.26
Water Surface	Water Table
Hu Value	Automatically Calculated

Strato 1

Color	
Strength Type	Mohr-Coulomb
Unit Weight [kN/m3]	20
Cohesion [kPa]	5
Friction Angle [deg]	38
Water Surface	Water Table
Hu Value	Automatically Calculated

Strato 2

Color	
Strength Type	Mohr-Coulomb
Unit Weight [kN/m3]	20
Cohesion [kPa]	0
Friction Angle [deg]	40
Water Surface	Water Table
Hu Value	Automatically Calculated

Strato 3



Color	
Strength Type	Mohr-Coulomb
Unit Weight [kN/m3]	20
Cohesion [kPa]	0
Friction Angle [deg]	42
Water Surface	Water Table
Hu Value	Automatically Calculated

Strato 4

Color	
-------	---

---

Strength Type	Mohr-Coulomb
Unit Weight [kN/m <sup>3</sup> ]	20
Cohesion [kPa]	0

Friction Angle [deg]	36
Water Surface	Water Table
Hu Value	Automatically Calculated
Strato 5	
Color	
Strength Type	Mohr-Coulomb
Unit Weight [kN/m3]	20
Cohesion [kPa]	0
Friction Angle [deg]	36
Water Surface	Water Table
Hu Value	Automatically Calculated
F1	
Color	
Strength Type	Mohr-Coulomb
Unit Weight [kN/m3]	20
Cohesion [kPa]	0
Friction Angle [deg]	20
Water Surface	Water Table
Hu Value	1

# Global Minimums

---

Method: bishop simplified

---

	FS	1.105850
Center:	546.658, 731.206	
Radius:	121.380	
Left Slip Surface Endpoint:	428.349, 704.076	
Right Slip Surface Endpoint:	600.328, 622.336	
Resisting Moment:	5.81317e+06 kN-m	
Driving Moment:	5.25674e+06 kN-m	
Total Slice Area:	5247.66 m2	
Surface Horizontal Width:	171.979 m	
Surface Average Height:	30.5134 m	

# Global Minimum Support Data

---

No Supports Present

## Valid and Invalid Surfaces

---

Method: bishop simplified

---

Number of Valid Surfaces:	3359
Number of Invalid Surfaces:	0

## Slice Data

Global Minimum Query (bishop simplified) - Safety Factor: 1.10585

Slice Number	Width [m]	Weight [kN]	Angle of Slice Base [deg]	Base Material	Base Cohesion [kPa]	Base Friction Angle [deg]	Shear Stress [kPa]	Shear Strength [kPa]	Base Normal Stress [kPa]	Pore Pressure [kPa]	Effective Normal Stress [kPa]	Base Vertical Stress [kPa]	Effective Vertical Stress [kPa]
1	6.80192	1444.09	-71.9077	A	36	31.0834	55.8644	61.7777	42.7602	0	42.7602	213.756	213.756
2	6.80192	3320.35	-63.1718	A	36	31.0834	144.597	159.903	205.531	0	205.531	491.436	491.436
3	6.80192	4344.86	-56.688	A	36	31.0834	209.403	231.568	324.41	0	324.41	643.05	643.05
4	6.80192	5505.96	-51.2007	A	36	31.0834	284.127	314.202	461.483	0	461.483	814.875	814.875
5	6.80192	6043.77	-46.3129	A	36	31.0834	331.16	366.213	547.759	0	547.759	894.455	894.455
6	6.80192	6311.79	-41.833	A	36	31.0834	364.1	402.64	608.185	0	608.185	934.105	934.105
7	6.80192	6939.17	-37.6499	A	36	31.0834	417.001	461.141	705.226	0	705.226	1026.94	1026.94
8	6.80192	7058.7	-33.692	A	36	31.0834	441.537	488.274	750.235	0	750.235	1044.61	1044.61
9	6.80192	6936.11	-29.9098	A	36	31.0834	450.763	498.476	767.159	0	767.159	1026.46	1026.46
10	6.80192	6729.78	-26.2669	A	36	31.0834	453.469	501.469	772.122	0	772.122	995.915	995.915
11	7.52774	7206.02	-22.5522	F1	0	16.2343	228.694	252.901	868.549	0	868.549	963.522	963.522
12	7.52774	7136.99	-18.7515	F1	0	16.2343	226.693	250.688	877.327	16.3768	860.95	954.285	937.908
13	7.52774	6595.31	-15.0349	F1	0	16.2343	207.31	229.254	826.167	38.8295	787.337	881.851	843.021
14	7.52774	5974.44	-11.3823	F1	0	16.2343	185.701	205.357	761.447	56.1805	705.266	798.831	742.65
15	7.52774	5336.48	-7.77621	F1	0	16.2343	163.904	181.253	691.143	68.656	622.487	713.525	644.869
16	7.52774	5002.24	-4.20099	F1	0	16.2343	153.028	169.226	657.591	76.4104	581.18	668.831	592.421
17	10.2472	5406.07	0	F1	0	16.2343	118.981	131.575	530.996	79.1226	451.873	530.996	451.873
18	6.45235	2471.85	3.9459	F1	0	16.2343	82.7704	91.5316	391.29	76.9395	314.351	385.581	308.641
19	6.45235	2153.07	7.00708	F1	0	16.2343	72.1062	79.7386	344.717	70.8665	273.85	335.854	264.988
20	6.45235	1996.72	10.0886	F1	0	16.2343	69.0942	76.4078	323.757	61.3455	262.412	311.464	250.118
21	6.45235	1844.82	13.1999	F1	0	16.2343	67.2054	74.3191	303.528	48.2914	255.237	287.766	239.474
22	6.45235	1769.49	16.3516	F1	0	16.2343	69.7484	77.1313	296.478	31.5826	264.896	276.014	244.432
23	6.45235	1385.31	19.5552	F1	0	16.2343	59.5556	65.8596	237.239	11.0552	226.184	216.085	205.03
24	6.45235	505.251	22.8239	F1	0	16.2343	23.3372	25.8074	88.6315	0	88.6315	78.81	78.81
25	3.37981	48.0315	25.3592	A	36	31.0834	54.4022	60.1607	40.0779	0	40.0779	14.2933	14.2933

## Interslice Data

Global Minimum Query (bishop simplified) - Safety Factor: 1.10585

Slice Number	X coordinate [m]	Y coordinate - Bottom [m]	Normal Force [kN]	Shear Force [kN]	Force Angle [deg]
1	428.349	704.076	0	0	0
2	435.151	683.256	529.207	0	0
3	441.953	669.807	2353.43	0	0
4	448.755	659.456	4343.86	0	0
5	455.557	650.996	6387.8	0	0
6	462.359	643.875	8115.36	0	0
7	469.161	637.787	9424.86	0	0
8	475.963	632.539	10380.6	0	0
9	482.765	628.004	10872.5	0	0
10	489.566	624.091	10899.6	0	0
11	496.368	620.734	10495.8	0	0
12	503.896	617.608	11583.8	0	0
13	511.424	615.053	12212.8	0	0

14	518.952	613.031	12409.1	0	0
15	526.479	611.515	12243.3	0	0
16	534.007	610.487	11789.9	0	0
17	541.535	609.934	11067	0	0
18	551.782	609.934	9918.57	0	0
19	558.234	610.379	9242.7	0	0
20	564.687	611.172	8532.24	0	0
21	571.139	612.321	7740.88	0	0
22	577.591	613.834	6872.06	0	0
23	584.044	615.727	5883.93	0	0
24	590.496	618.019	4974.1	0	0
25	596.948	620.734	4589.47	0	0
26	600.328	622.336	0	0	0

## Discharge Sections

---

## Entity Information

---

### Water Table

	X	Y
150		618
900		618

### External Boundary

	X	Y
461.174		688.076
453.219		694.076
446.156		694.076
432.817		704.076
415.55		704.076
410.273		704.076
406.154		704.076
401.047		704.076
396.103		704.076
391.434		704.076



387.418	704.076
385.446	703.223
381.277	701.461
368.133	695.765
364.234	694.076
359.124	691.862
353.54	689.436
349.648	687.548
343.792	684.076
341.013	682.428
328.899	674.076
323.401	670.284
314.977	664.076
310.689	664.076
306.758	661.178
301.708	657.506
298.442	655.163
296.971	654.076
295.313	652.851
290.499	649.508
265.639	663.027
261.527	663.141
243.261	677.78
221.846	681.968
199.673	685.173

163.025

687.401

163.025	617.683
163.025	614.683
163.025	607.683
163.025	595.683
163.025	520.734
883.257	520.734
883.257	595.683
883.257	607.683
883.257	611.215
871.403	610.663
868.175	614.297
857.341	614.683
852.521	617.683
851.96	618.032
848.524	618.028
844.639	620.734
689.364	620.734
639.238	620.734
605.437	620.734
602.256	622.695
601.53	622.676
600.218	622.305
599.431	622.249
597.879	622.162
597.114	622.151
596.621	622.148
595.445	622.229
593.94	623.059
593.199	623.082
592.8	623.126
589.985	625.759
589.298	626.016
588.106	627.101
586.169	627.911
583.013	629.224
581.231	627.886
572.752	626.834
571.587	626.818
568.284	626.892
562.751	627.073
556.738	627.363
552.789	630.576
548.455	634.1
544.039	637.692
541.814	639.576
535.512	644.076
531.292	644.076
522.573	650.576
517.878	654.076
510.5	659.576
504.499	664.076
500.267	664.076

492.232	670.076
486.876	674.076
480.18	679.076
473.503	684.076
466.487	684.076

Material Boundary

X	Y
163.025	617.683
405.547	617.683
396.735	620.734
380.175	627.103
349.828	633.816
310.926	642.422
306.159	643.753
301.413	643.574
290.499	649.508

Material Boundary

X	Y
639.238	620.734
634.622	617.683
852.521	617.683

Material Boundary

X	Y
163.025	614.683
416.848	614.683

Material Boundary

X	Y
634.622	617.683
630.084	614.683
857.341	614.683

Material Boundary

X	Y
630.084	614.683
619.623	607.683
883.257	607.683

Material Boundary

X	Y
163.025	607.683
618.16	607.683
616.47	608.705
614.473	609.765
609.65	611.884
600.053	616.229
587.784	616.335
574.521	609.934
429.885	609.934
416.848	614.683
411.793	616.524

Material Boundary

X	Y
163.025	595.683
883.257	595.683

Material Boundary

X	Y
618.16	607.683
619.623	607.683

Material Boundary

X	Y
396.735	620.734
605.437	620.734

Material Boundary

X	Y
306.159	643.753
531.292	644.076

Material Boundary

X	Y
314.977	664.076
500.267	664.076

Material Boundary

X	Y
343.792	684.076
466.487	684.076

Material Boundary

X	Y
364.234	694.076
446.156	694.076

Material Boundary

X	Y
349.828	633.816
548.455	634.1

Material Boundary

X	Y
296.971	654.076
517.878	654.076

Material Boundary

X	Y
328.899	674.076
486.876	674.076

Material Boundary

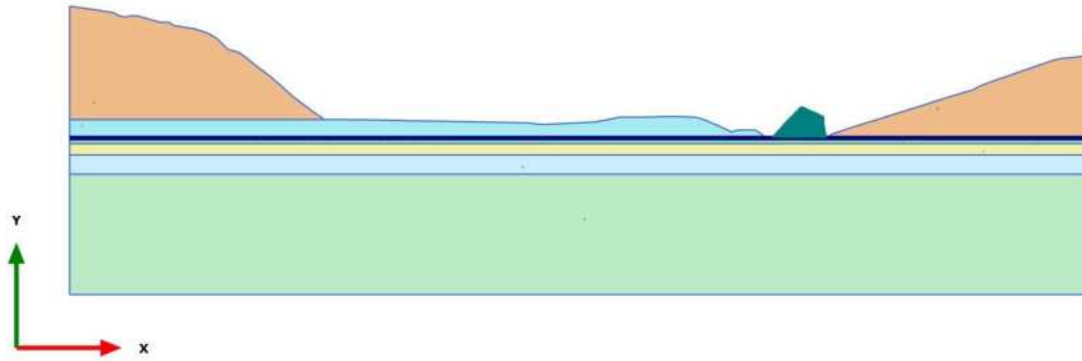
X	Y
405.547	617.683
411.793	616.524

**ANHANG 12 – ERGEBNISSE DER PLAXIS SLU/SLV – ABSCHNITT 3**

**APPENDICE 12 – RISULTATI ANALISI PLAXIS SLU/SLV – SEZIONE 3**

# PLAXIS Report

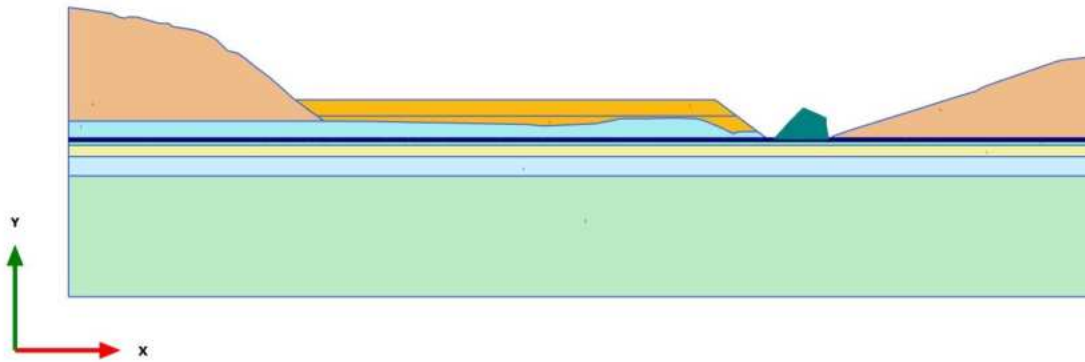
1.1.1.1 Calculation results, Initial phase [InitialPhase] (0/20), Materials plot



**Materials plot**

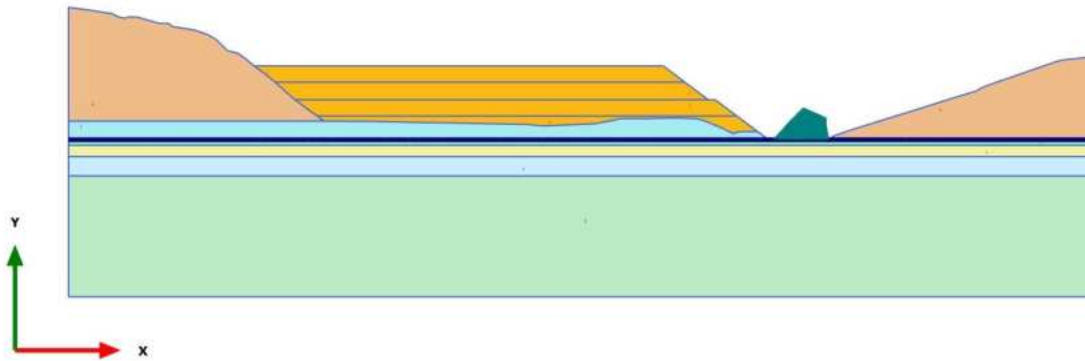


1.1.1.2 Calculation results, Phase\_1 [Phase\_1] (8/27), Materials plot



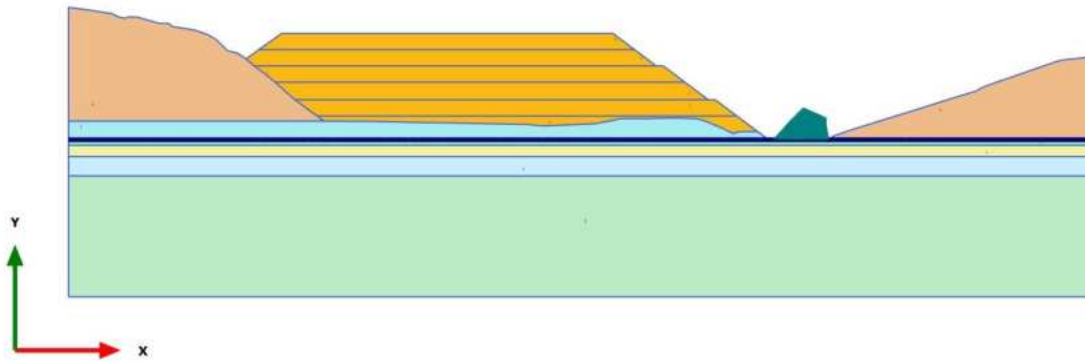
**Materials plot**

1.1.1.3 Calculation results, Phase\_2 [Phase\_2] (9/33), Materials plot



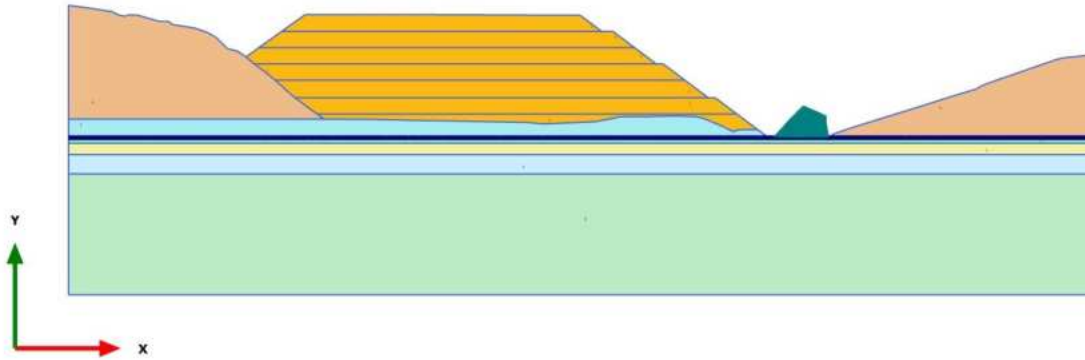
**Materials plot**

1.1.1.4 Calculation results, Phase\_3 [Phase\_3] (10/38), Materials plot



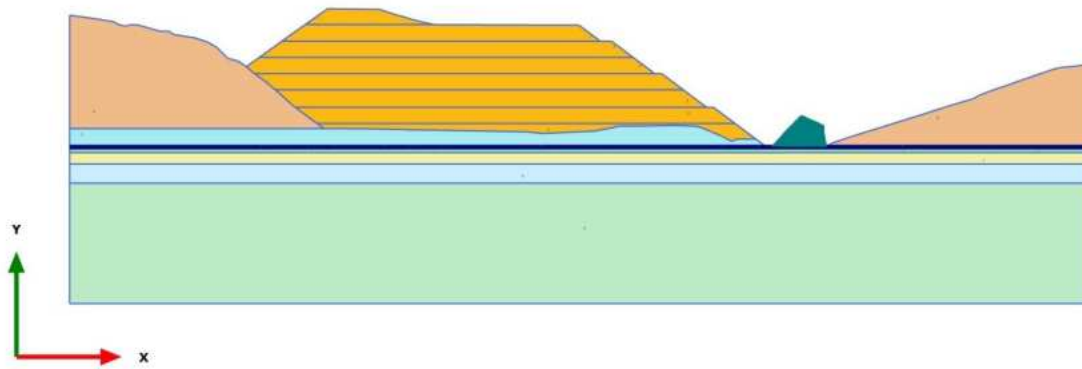
**Materials plot**

1.1.1.5 Calculation results, Phase\_4 [Phase\_4] (11/41), Materials plot



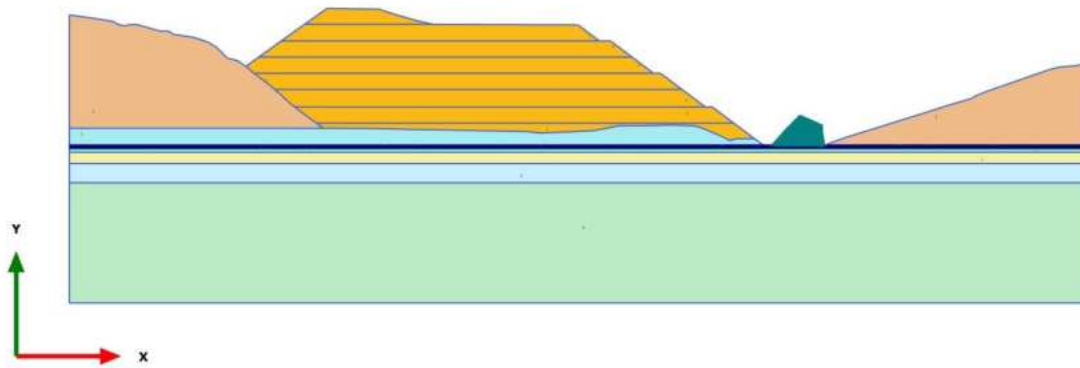
**Materials plot**

1.1.1.6 Calculation results, Phase\_5\_static [Phase\_5] (12/44), Materials plot



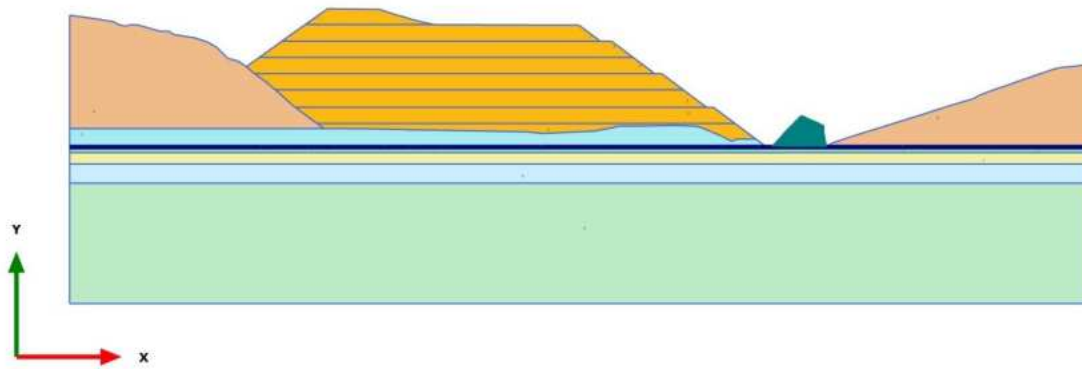
**Materials plot**

1.1.1.7 Calculation results, Phase\_6 FoS static [Phase\_6] (13/144), Materials plot



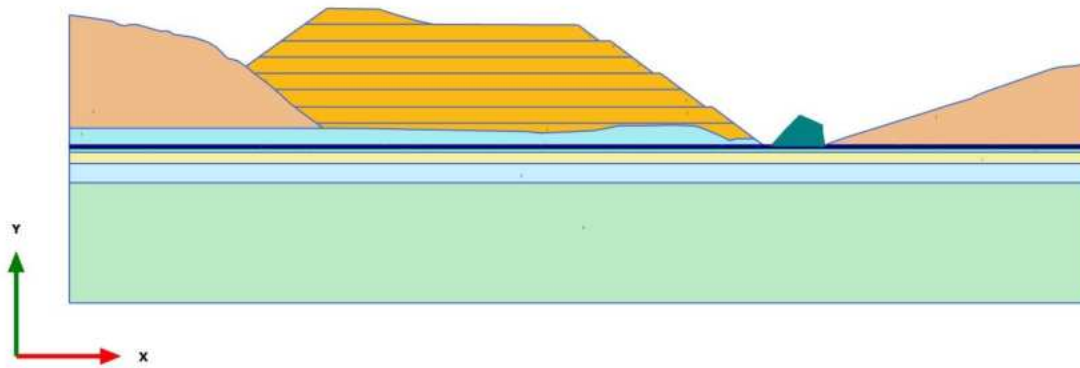
**Materials plot**

1.1.1.8 Calculation results, Phase\_8\_seismic [Phase\_8] (2/147), Materials plot



**Materials plot**






1.1.1.9 Calculation results, Phase\_7 FoS seismic [Phase\_7] (1/247), Materials plot



**Materials plot**



### 1.1.2.1.1 Materials - Soil and interfaces - Hardening soil





Identification		Strato 1	Strato 2	Strato 3	Strato 4	Strato 5
Identification number		1	2	3	4	5
Drainage type		Drained	Drained	Drained	Drained	Drained
Colour						
Comments						
$\gamma_{\text{unsat}}$	kN/m <sup>3</sup>	20,00	20,00	20,00	20,00	20,00
$\gamma_{\text{sat}}$	kN/m <sup>3</sup>	20,00	20,00	20,00	20,00	20,00
Dilatancy cut-off		No	No	No	No	No
$e_{\text{init}}$		0,5000	0,5000	0,5000	0,5000	0,5000
$e_{\text{min}}$		0,000	0,000	0,000	0,000	0,000
$e_{\text{max}}$		999,0	999,0	999,0	999,0	999,0
Rayleigh $\alpha$		0,000	0,000	0,000	0,000	0,000
Rayleigh $\beta$		0,000	0,000	0,000	0,000	0,000
$E_{50 \text{ ref}}$	kN/m <sup>2</sup>	25,00E3	40,00E3	50,00E3	30,00E3	70,00E3
$E_{\text{oed ref}}$	kN/m <sup>2</sup>	23,55E3	36,94E3	45,27E3	28,84E3	66,76E3
$E_{\text{ur ref}}$	kN/m <sup>2</sup>	75,00E3	120,0E3	150,0E3	90,00E3	210,0E3
power (m)		0,000	0,000	0,000	0,000	0,4000
Use alternatives		No	No	No	No	No
$C_c$		0,01465	9,339E-3	7,621E-3	0,01196	5,167E-3

Identification		Strato 1	Strato 2	Strato 3	Strato 4	Strato 5
$C_s$		4,140E-3	2,587E-3	2,070E-3	3,450E-3	1,479E-3
$e_{init}$		0,5000	0,5000	0,5000	0,5000	0,5000
$c_{ref}$	kN/m <sup>2</sup>	4,000	0,000	0,000	0,000	0,000
$\varphi$ (phi)	°	32,01	33,87	35,77	30,17	30,17
$\psi$ (psi)	°	0,000	0,000	0,000	0,000	0,000
Set to default values		No	No	No	No	No
$v_{ur}$		0,2000	0,2000	0,2000	0,2000	0,2000
$p_{ref}$	kN/m <sup>2</sup>	100,0	100,0	100,0	100,0	100,0
$K_{0nc}$		0,3943	0,3695	0,3449	0,4194	0,4217
$c_{inc}$	kN/m <sup>2</sup> /m	0,000	0,000	0,000	0,000	0,000
$y_{ref}$	m	0,000	0,000	0,000	0,000	608,0
$R_f$		0,9000	0,9000	0,9000	0,9000	0,9000
Tension cut-off		Yes	Yes	Yes	Yes	Yes
Tensile strength	kN/m <sup>2</sup>	0,000	0,000	0,000	0,000	0,000
Undrained behaviour		Standard	Standard	Standard	Standard	Standard
Skempton-B		0,9866	0,9866	0,9866	0,9866	0,9866
$v_u$		0,4950	0,4950	0,4950	0,4950	0,4950
$K_{w,ref} / n$	kN/m <sup>2</sup>	3,073E6	4,917E6	6,146E6	3,687E6	8,604E6
Stiffness		Standard	Standard	Standard	Standard	Standard

Strength		Rigid	Rigid	Rigid	Rigid	Rigid
$R_{inter}$		1,000	1,000	1,000	1,000	1,000
Consider gap closure		Yes	Yes	Yes	Yes	Yes
Identification		Strato 1	Strato 2	Strato 3	Strato 4	Strato 5
$\delta_{inter}$		0,000	0,000	0,000	0,000	0,000
Cross permeability		Impermeable	Impermeable	Impermeable	Impermeable	Impermeable
Drainage conductivity, dk	m <sup>3</sup> /day/m	0,000	0,000	0,000	0,000	0,000
R	m <sup>2</sup> K/kW	0,000	0,000	0,000	0,000	0,000
$K_0$ determination		Automatic	Automatic	Automatic	Automatic	Automatic
$K_{0,x} = K_{0,z}$		Yes	Yes	Yes	Yes	Yes
$K_{0,x}$		0,3943	0,3695	0,3449	0,4194	0,4217
$K_{0,z}$		0,3943	0,3695	0,3449	0,4194	0,4217
OCR		1,000	1,000	1,000	1,000	1,000
POP	kN/m <sup>2</sup>	0,000	0,000	0,000	0,000	0,000
Data set		Standard	Standard	Standard	Standard	Standard
Type		Coarse	Coarse	Coarse	Coarse	Coarse
< 2 $\mu$ m	%	10,00	10,00	10,00	10,00	10,00
2 $\mu$ m - 50 $\mu$ m	%	13,00	13,00	13,00	13,00	13,00
50 $\mu$ m - 2 mm	%	77,00	77,00	77,00	77,00	77,00
Use defaults		None	None	None	None	None

$k_x$	m/day	0,000	0,000	0,000	0,000	0,000
$k_y$	m/day	0,000	0,000	0,000	0,000	0,000
$-\psi_{\text{unsat}}$	m	10,00E3	10,00E3	10,00E3	10,00E3	10,00E3
$e_{\text{init}}$		0,5000	0,5000	0,5000	0,5000	0,5000
$S_s$	1/m	0,000	0,000	0,000	0,000	0,000
$c_k$		1000E12	1000E12	1000E12	1000E12	1000E12
Identification		Strato 1	Strato 2	Strato 3	Strato 4	Strato 5
$c_s$	kJ/t/K	0,000	0,000	0,000	0,000	0,000
$\lambda_s$	kW/m/K	0,000	0,000	0,000	0,000	0,000
$\rho_s$	t/m <sup>3</sup>	0,000	0,000	0,000	0,000	0,000
Solid thermal expansion		Volumetric	Volumetric	Volumetric	Volumetric	Volumetric
$\alpha_s$	1/K	0,000	0,000	0,000	0,000	0,000
$D_v$	m <sup>2</sup> /day	0,000	0,000	0,000	0,000	0,000
$f_{\text{TV}}$		0,000	0,000	0,000	0,000	0,000
Unfrozen water content		None	None	None	None	None

1.1.2.1.2 Materials - Soil and interfaces - Mohr-Coulomb

Identification		Rock	A	F1	GNEISS
Identification number		6	7	8	9
Drainage type		Drained	Drained	Drained	Drained
Colour					
Comments					
$\gamma_{\text{unsat}}$	kN/m <sup>3</sup>	20,00	21,00	20,00	20,00
$\gamma_{\text{sat}}$	kN/m <sup>3</sup>	20,00	21,00	20,00	20,00
Dilatancy cut-off		No	No	No	No
$e_{\text{init}}$		0,5000	0,5000	0,5000	0,5000
$e_{\text{min}}$		0,000	0,000	0,000	0,000
$e_{\text{max}}$		999,0	999,0	999,0	999,0
Rayleigh $\alpha$		0,000	0,000	0,000	0,000
Rayleigh $\beta$		0,000	0,000	0,000	0,000
E	kN/m <sup>2</sup>	100,0E3	30,00E3	5000	30,00E3
$\nu$ (nu)		0,3000	0,3000	0,3000	0,3000
G	kN/m <sup>2</sup>	38,46E3	11,54E3	1923	11,54E3
$E_{\text{oad}}$	kN/m <sup>2</sup>	134,6E3	40,38E3	6731	40,38E3

Identification		Rock	A	F1	GNEISS
$c_{ref}$	kN/m <sup>2</sup>	500,0	36,00	0,000	40,00
$\phi$ (phi)	°	35,00	31,08	20,00	36,00
$\psi$ (psi)	°	0,000	3,000	0,000	3,000
$V_s$	m/s	137,4	73,42	30,71	75,23
$V_p$	m/s	257,0	137,4	57,46	140,7
Set to default values		Yes	Yes	Yes	Yes
$E_{inc}$	kN/m <sup>2</sup> /m	0,000	0,000	0,000	0,000
$\gamma_{ref}$	m	0,000	0,000	0,000	0,000
$C_{inc}$	kN/m <sup>2</sup> /m	0,000	0,000	0,000	0,000
$\gamma_{ref}$	m	0,000	0,000	0,000	0,000
Tension cut-off		Yes	Yes	Yes	Yes
Tensile strength	kN/m <sup>2</sup>	0,000	0,000	0,000	0,000
Undrained behaviour		Standard	Standard	Standard	Standard
Skempton-B		0,9783	0,9783	0,9783	0,9783
$v_u$		0,4950	0,4950	0,4950	0,4950
$K_{w,ref} / n$	kN/m <sup>2</sup>	3,750E6	1,125E6	187,5E3	1,125E6
Stiffness		Standard	Standard	Standard	Standard

Strength		Rigid	Rigid	Rigid	Rigid
R <sub>inter</sub>		1,000	1,000	1,000	1,000
Identification		Rock	A	F1	GNEISS
Consider gap closure		Yes	Yes	Yes	Yes
$\delta_{inter}$		0,000	0,000	0,000	0,000
Cross permeability		Impermeable	Impermeable	Impermeable	Impermeable
Drainage conductivity, dk	m <sup>3</sup> /day/m	0,000	0,000	0,000	0,000
R	m <sup>2</sup> K/kW	0,000	0,000	0,000	0,000
K <sub>0</sub> determination		Automatic	Automatic	Automatic	Automatic
K <sub>0,x</sub> = K <sub>0,z</sub>		Yes	Yes	Yes	Yes
K <sub>0,x</sub>		0,4264	0,4837	0,6580	0,4122
K <sub>0,z</sub>		0,4264	0,4837	0,6580	0,4122
Data set		Standard	USDA	Standard	USDA
Model		Van Genuchten	Van Genuchten	Van Genuchten	Van Genuchten
Type		Coarse	Coarse	Coarse	Coarse
Type		Sand	Sand	Sand	Sand
< 2 μm	%	10,00	4,000	10,00	4,000
2 μm - 50 μm	%	13,00	4,000	13,00	4,000

50 $\mu\text{m}$ - 2 mm	%	77,00	92,00	77,00	92,00
Use defaults		None	None	None	None
$k_x$	m/day	0,000	0,000	0,000	0,000
$k_y$	m/day	0,000	0,000	0,000	0,000
Identification		Rock	A	F1	GNEISS
$-\psi_{\text{unsat}}$	m	10,00E3	10,00E3	10,00E3	10,00E3
$e_{\text{init}}$		0,5000	0,5000	0,5000	0,5000
$S_s$	1/m	0,000	0,000	0,000	0,000
$c_k$		1000E12	1000E12	1000E12	1000E12
$c_s$	kJ/t/K	0,000	0,000	0,000	0,000
$\lambda_s$	kW/m/K	0,000	0,000	0,000	0,000
$\rho_s$	t/m <sup>3</sup>	0,000	0,000	0,000	0,000
Solid thermal expansion		Volumetric	Volumetric	Volumetric	Volumetric
$\alpha_s$	1/K	0,000	0,000	0,000	0,000
$D_v$	m <sup>2</sup> /day	0,000	0,000	0,000	0,000
$f_{\text{TV}}$		0,000	0,000	0,000	0,000
Unfrozen water content		None	None	None	None



### 1.1.3.1 Calculation information

Calculation information				
Step info				
Phase	Initial phase [InitialPhase]			
Step	Initial			
Calculation mode	Classical mode			
Step type	Gravity loading			
Solver type	Picos			
Kernel type	64 bit			
Extrapolation factor	0,8634			
Relative stiffness	0,3201			
Design approach				
Index	1			
Name	DesignApproach_1			
Multipliers				
Soil weight			$\Sigma M_{\text{Weight}}$	1,000
Strength reduction factor	$M_{\text{sf}}$	0,000	$\Sigma M_{\text{sf}}$	1,000
Time	Increment	0,000	End time	0,000

Calculation information

Staged construction

Active proportion total area	$M_{Area}$	0,1843	$\Sigma M_{Area}$	0,8300
Active proportion of stage	$M_{Stage}$	0,2220	$\Sigma M_{Stage}$	1,000

Forces

$F_x$  0,000 kN/m

$F_y$  0,000 kN/m

Consolidation

Realised  $P_{Excess,Max}$  0,000 kN/m<sup>2</sup>

### 1.1.3.2 Calculation information

Calculation information				
Step info				
Phase	Phase_1 [Phase_1]			
Step	Initial			
Calculation mode	Classical mode			
Step type	Plastic			
Updated mesh	False			
Solver type	Picos			
Kernel type	64 bit			
Extrapolation factor	0,5299			
Relative stiffness	0,3197			
Design approach				
Index	1			
Name	DesignApproach_1			
Multipliers				
Soil weight			$\Sigma M_{\text{Weight}}$	1,000
Strength reduction factor	$M_{\text{sf}}$	0,000	$\Sigma M_{\text{sf}}$	1,000

Calculation information				
Time	Increment	0,000	End time	0,000
Staged construction				
Active proportion total area	$M_{Area}$	0,01035	$\Sigma M_{Area}$	0,8690
Active proportion of stage	$M_{Stage}$	0,1114	$\Sigma M_{Stage}$	1,000
Forces				
$F_x$	0,000 kN/m			
$F_y$	0,000 kN/m			
Consolidation				
Realised $P_{Excess,Max}$	0,000 kN/m <sup>2</sup>			

1.1.3.3 Calculation information

Calculation information				
Step info				
Phase	Phase_2 [Phase_2]			
Step	Initial			
Calculation mode	Classical mode			
Step type	Plastic			
Updated mesh	False			
Solver type	Picos			
Kernel type	64 bit			
Extrapolation factor	0,8627			
Relative stiffness	0,3544			
Design approach				
Index	1			
Name	DesignApproach_1			
Multipliers				
Soil weight			$\Sigma M_{\text{Weight}}$	1,000
Strength reduction factor	$M_{\text{sf}}$	0,000	$\Sigma M_{\text{sf}}$	1,000

Calculation information				
Time	Increment	0,000	End time	0,000
Staged construction				
Active proportion total area	$M_{Area}$	0,01951	$\Sigma M_{Area}$	0,9252
Active proportion of stage	$M_{Stage}$	0,1868	$\Sigma M_{Stage}$	1,000
Forces				
$F_x$	0,000 kN/m			
$F_y$	0,000 kN/m			
Consolidation				
Realised $P_{Excess,Max}$	0,000 kN/m <sup>2</sup>			

1.1.3.4 Calculation information

Calculation information				
Step info				
Phase	Phase_3 [Phase_3]			
Step	Initial			
Calculation mode	Classical mode			
Step type	Plastic			
Updated mesh	False			
Solver type	Picos			
Kernel type	64 bit			
Extrapolation factor	0,1803			
Relative stiffness	0,4064			
Design approach				
Index	1			
Name	DesignApproach_1			
Multipliers				
Soil weight			$\Sigma M_{\text{Weight}}$	1,000
Strength reduction factor	$M_{\text{sf}}$	0,000	$\Sigma M_{\text{sf}}$	1,000

Calculation information				
Time	Increment	0,000	End time	0,000
Staged construction				
Active proportion total area	$M_{Area}$	4,440E-3	$\Sigma M_{Area}$	0,9744
Active proportion of stage	$M_{Stage}$	0,05640	$\Sigma M_{Stage}$	1,000
Forces				
$F_x$	0,000 kN/m			
$F_y$	0,000 kN/m			
Consolidation				
Realised $P_{Excess,Max}$	0,000 kN/m <sup>2</sup>			



### 1.1.3.5 Calculation information

Calculation information				
Step info				
Phase	Phase_4 [Phase_4]			
Step	Initial			
Calculation mode	Classical mode			
Step type	Plastic			
Updated mesh	False			
Solver type	Picos			
Kernel type	64 bit			
Extrapolation factor	0,9476			
Relative stiffness	0,4383			
Design approach				
Index	1			
Name	DesignApproach_1			
Multipliers				
Soil weight			$\Sigma M_{\text{Weight}}$	1,000
Strength reduction factor	$M_{\text{sf}}$	0,000	$\Sigma M_{\text{sf}}$	1,000

Calculation information				
Time	Increment	0,000	End time	0,000
Staged construction				
Active proportion total area	$M_{Area}$	9,477E-3	$\Sigma M_{Area}$	0,9944
Active proportion of stage	$M_{Stage}$	0,3175	$\Sigma M_{Stage}$	1,000
Forces				
$F_x$	0,000 kN/m			
$F_y$	0,000 kN/m			
Consolidation				
Realised $P_{Excess,Max}$	0,000 kN/m <sup>2</sup>			

1.1.3.6 Calculation information

Calculation information				
Step info				
Phase	Phase_5_static [Phase_5]			
Step	Initial			
Calculation mode	Classical mode			
Step type	Plastic			
Updated mesh	False			
Solver type	Picos			
Kernel type	64 bit			
Extrapolation factor	0,3671			
Relative stiffness	0,4604			
Design approach				
Index	1			
Name	DesignApproach_1			
Multipliers				
Soil weight			$\Sigma M_{\text{Weight}}$	1,000
Strength reduction factor	$M_{\text{sf}}$	0,000	$\Sigma M_{\text{sf}}$	1,000

Calculation information				
Time	Increment	0,000	End time	0,000
Staged construction				
Active proportion total area	$M_{Area}$	1,023E-3	$\Sigma M_{Area}$	1,000
Active proportion of stage	$M_{Stage}$	0,1459	$\Sigma M_{Stage}$	1,000
Forces				
$F_x$	0,000 kN/m			
$F_y$	0,000 kN/m			
Consolidation				
Realised $P_{Excess,Max}$	0,000 kN/m <sup>2</sup>			

1.1.3.7 Calculation information

Calculation information				
Step info				
Phase	Phase_6 FoS static [Phase_6]			
Step	Initial			
Calculation mode	Classical mode			
Step type	Safety			
Updated mesh	False			
Solver type	Picos			
Kernel type	64 bit			
Extrapolation factor	1,000			
Relative stiffness	0,4728E-3			
Design approach				
Index	1			
Name	DesignApproach_1			
Multipliers				
Soil weight			$\Sigma M_{\text{Weight}}$	1,000
Strength reduction factor	$M_{sf}$	-0,4330E-3	$\Sigma M_{sf}$	1,106

Calculation information					
Time	Increment		0,000	End time	0,000
Staged construction					
Active proportion total area	$M_{Area}$		0,000	$\Sigma M_{Area}$	1,000
Active proportion of stage	$M_{Stage}$		0,000	$\Sigma M_{Stage}$	0,000
Forces					
$F_x$		0,000 kN/m			
$F_y$		0,000 kN/m			
Consolidation					
Realised $P_{Excess,Max}$		0,000 kN/m <sup>2</sup>			

1.1.3.8 Calculation information

Calculation information				
Step info				
Phase	Phase_8_seismic [Phase_8]			
Step	Initial			
Calculation mode	Classical mode			
Step type	Plastic			
Updated mesh	False			
Solver type	Picos			
Kernel type	64 bit			
Extrapolation factor	0,2251			
Relative stiffness	0,3675			
Design approach				
Index	1			
Name	DesignApproach_1			
Multipliers				
Soil weight			$\Sigma M_{Weight}$	1,000
Strength reduction factor	$M_{sf}$	0,000	$\Sigma M_{sf}$	1,000

Calculation information					
Time	Increment	0,000	End time	0,000	
Staged construction					
Active proportion total area	$M_{Area}$	0,000	$\Sigma M_{Area}$	1,000	
Active proportion of stage	$M_{Stage}$	0,08568	$\Sigma M_{Stage}$	1,000	
Forces					
$F_x$	0,000 kN/m				
$F_y$	0,000 kN/m				
Consolidation					
Realised $P_{Excess,Max}$	0,000 kN/m <sup>2</sup>				
Pseudo-static acceleration					
X	0,01300 g				
Y	6,000E-3 g				
1.1.3.9 Calculation information					
Calculation information					
Step info					
Phase	Phase_7 FoS seismic [Phase_7]				
Step	Initial				



Calculation mode	Classical mode			
Step type	Safety			
Updated mesh	False			
Solver type	Picos			
Kernel type	64 bit			
Extrapolation factor	1,000			
Relative stiffness	0,05464E-3			
Design approach				
Index	1			
Name	DesignApproach_1			
Multipliers				
Soil weight			$\Sigma M_{\text{Weight}}$	1,000
Strength reduction factor	$M_{\text{sf}}$	-1,253E-3	$\Sigma M_{\text{sf}}$	1,141
Calculation information				
Time	Increment	0,000	End time	0,000
Staged construction				
Active proportion total area	$M_{\text{Area}}$	0,000	$\Sigma M_{\text{Area}}$	1,000
Active proportion of stage	$M_{\text{Stage}}$	0,000	$\Sigma M_{\text{Stage}}$	0,000

## Forces

$F_x$	0,000 kN/m
-------	------------

$F_y$	0,000 kN/m
-------	------------

## Consolidation

Realised $P_{Excess,Max}$	0,000 kN/m <sup>2</sup>
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## Pseudo-static acceleration

X	0,01300 g
---	-----------

Y	6,000E-3 g
---	------------

### 1.1.4 Calculation information per phase

Identification	Phase	Start from	Calculation type	Loading input	Pore pressure	Time step [day]	First step	Last step	Log
Initial phase [InitialPhase]	0	N/A	Gravity loading	N/A	Phreatic	0,000	0	20	
Phase_1 [Phase_1]	8	0	Plastic	Staged construction	Phreatic	0,000	21	27	
Phase_2 [Phase_2]	9	8	Plastic	Staged construction	Phreatic	0,000	28	33	
Phase_3 [Phase_3]	10	9	Plastic	Staged construction	Phreatic	0,000	34	38	
Phase_4 [Phase_4]	11	10	Plastic	Staged construction	Phreatic	0,000	39	41	
Phase_5_static [Phase_5]	12	11	Plastic	Staged construction	Phreatic	0,000	42	44	
Phase_6 FoS static [Phase_6]	13	12	Safety	Incremental multipliers	Use pressures from previous phase	0,000	45	144	
Phase_8_seismic [Phase_8]	2	12	Plastic	Staged construction	Phreatic	0,000	145	147	
Phase_7 FoS seismic [Phase_7]	1	2	Safety	Incremental multipliers	Use pressures from previous phase	0,000	148	247	

1.1.5.1 Step info

Step	Phase Step type	Extrapolation factor	Relative stiffness [ $10^{-3}$ ]
20	0 Gravity loading	0,863	320,132
27	8 Plastic	0,530	319,650
33	9 Plastic	0,863	354,417
38	10 Plastic	0,180	406,431
41	11 Plastic	0,948	438,309
44	12 Plastic	0,367	460,448
144	13 Safety	1,000	0,473
147	2 Plastic	0,225	367,519
247	1 Safety	1,000	0,055

1.1.5.2 Multipliers

Step	Phase $\Sigma M_{DispX}$	$\Sigma M_{DispY}$	$\Sigma M_{Weight}$	$M_{sf}$	$\Sigma M_{sf}$
20	0 0,000	0,000	1,000	0,000	1,000
27	8 0,000	0,000	1,000	0,000	1,000
33	9 0,000	0,000	1,000	0,000	1,000
38	10 0,000	0,000	1,000	0,000	1,000
41	11 0,000	0,000	1,000	0,000	1,000
44	12 0,000	0,000	1,000	0,000	1,000
144	13 0,000	0,000	1,000	0,000	1,106
147	2 0,000	0,000	1,000	0,000	1,000
247	1 0,000	0,000	1,000	-0,001	1,141

### 1.1.5.3 Time

Step	Phase Time step [day]	End time [day]
20	0 0,000	0,000
27	8 0,000	0,000
33	9 0,000	0,000
38	10 0,000	0,000
41	11 0,000	0,000
44	12 0,000	0,000
144	13 0,000	0,000
147	2 0,000	0,000
247	1 0,000	0,000

1.1.5.4 Staged construction

Step	Phase M <sub>Area</sub>	ΣM <sub>Area</sub>	M <sub>Stage</sub>	ΣM <sub>Stage</sub>
20	0 1,000	0,830	0,222	1,000
27	8 0,420	0,869	0,111	1,000
33	9 0,538	0,925	0,187	1,000
38	10 0,625	0,974	0,056	1,000
41	11 0,670	0,994	0,318	1,000
44	12 0,795	1,000	0,146	1,000
144	13 -0,087	1,000	0,000	0,000
147	2 0,761	1,000	0,086	1,000
247	1 -0,252	1,000	0,000	0,000

#### 1.1.5.5 Forces

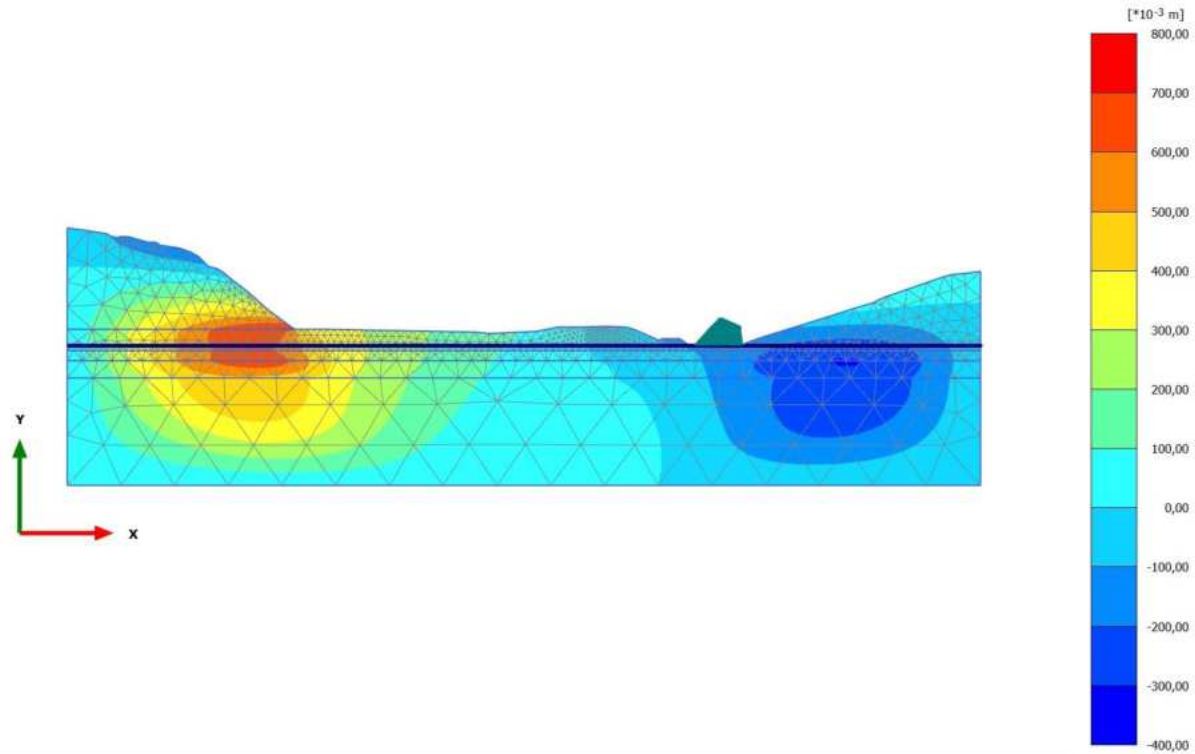
Step	Phase $F_x$ [kN/m]	$F_y$ [kN/m]
20	0 0,000	0,000
27	8 0,000	0,000
33	9 0,000	0,000
38	10 0,000	0,000
41	11 0,000	0,000
44	12 0,000	0,000
144	13 0,000	0,000
147	2 0,000	0,000
247	1 0,000	0,000

#### 1.1.5.6 Consolidation

Step	Phase Rel. P <sub>Max</sub> [kN/m <sup>2</sup> ]
20	0 0,000
27	8 0,000
33	9 0,000
38	10 0,000
41	11 0,000
44	12 0,000
144	13 0,000
147	2 0,000
247	1 0,000

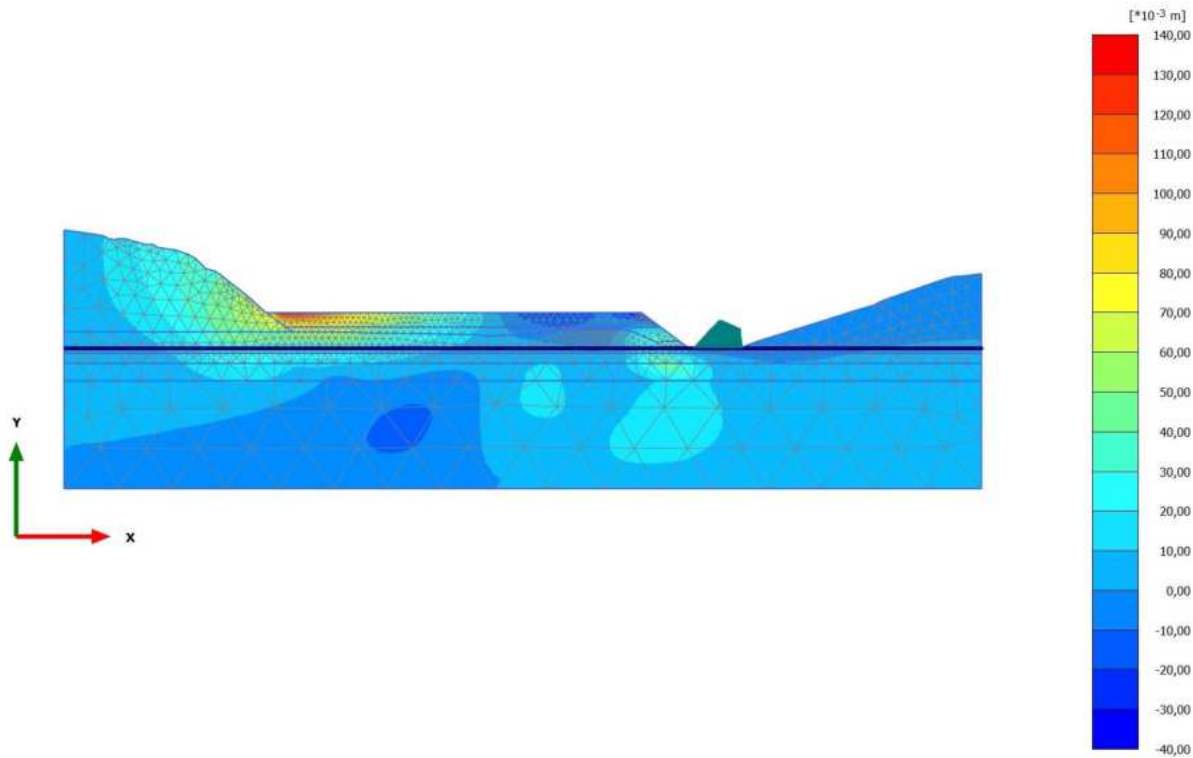


2.1.1.1.1 Calculation results, Initial phase [InitialPhase] (0/20), Total displacements  $u_x$



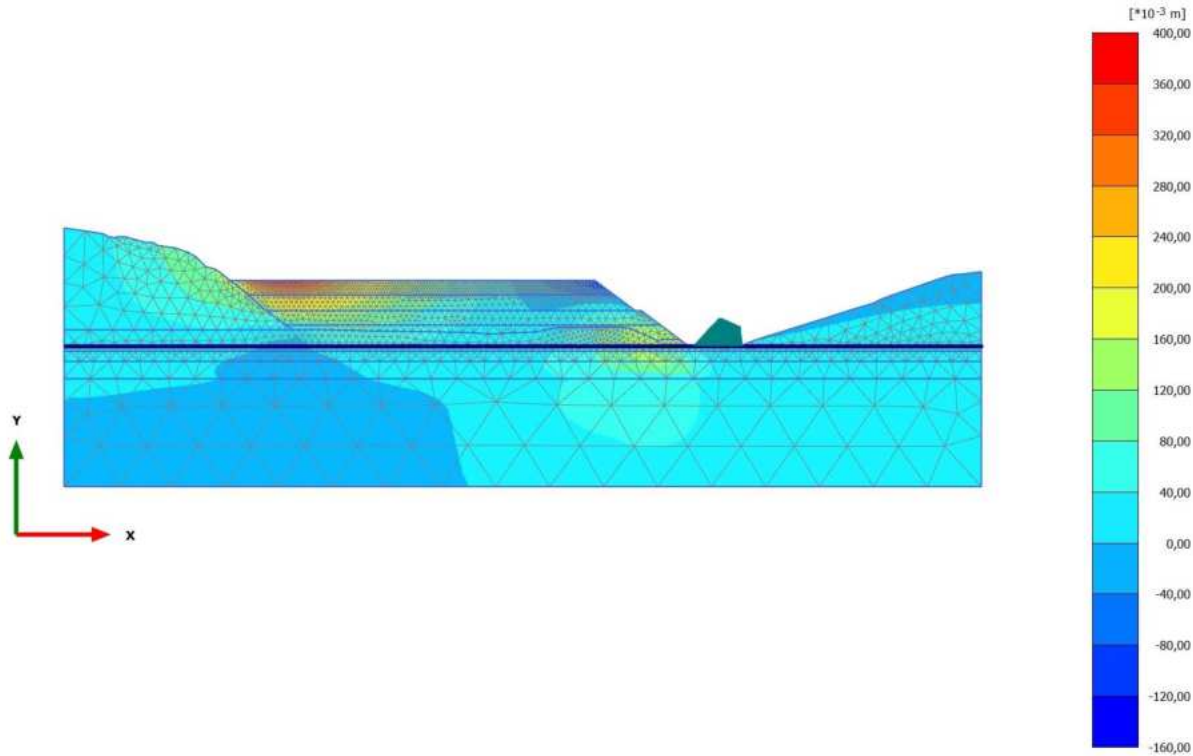
**Total displacements  $u_x$  (scaled up 20,0 times)**  
Maximum value = 0,7379 m (Element 4374 at Node 27833)  
Minimum value = -0,3055 m (Element 6511 at Node 43129)

2.1.1.1.2 Calculation results, Phase\_1 [Phase\_1] (8/27), Total displacements  $u_x$



**Total displacements  $u_x$  (scaled up 100 times)**  
Maximum value = 0,1376 m (Element 5189 at Node 23543)  
Minimum value = -0,03742 m (Element 5233 at Node 52483)

2.1.1.1.3 Calculation results, Phase\_2 [Phase\_2] (9/33), Total displacements  $u_x$

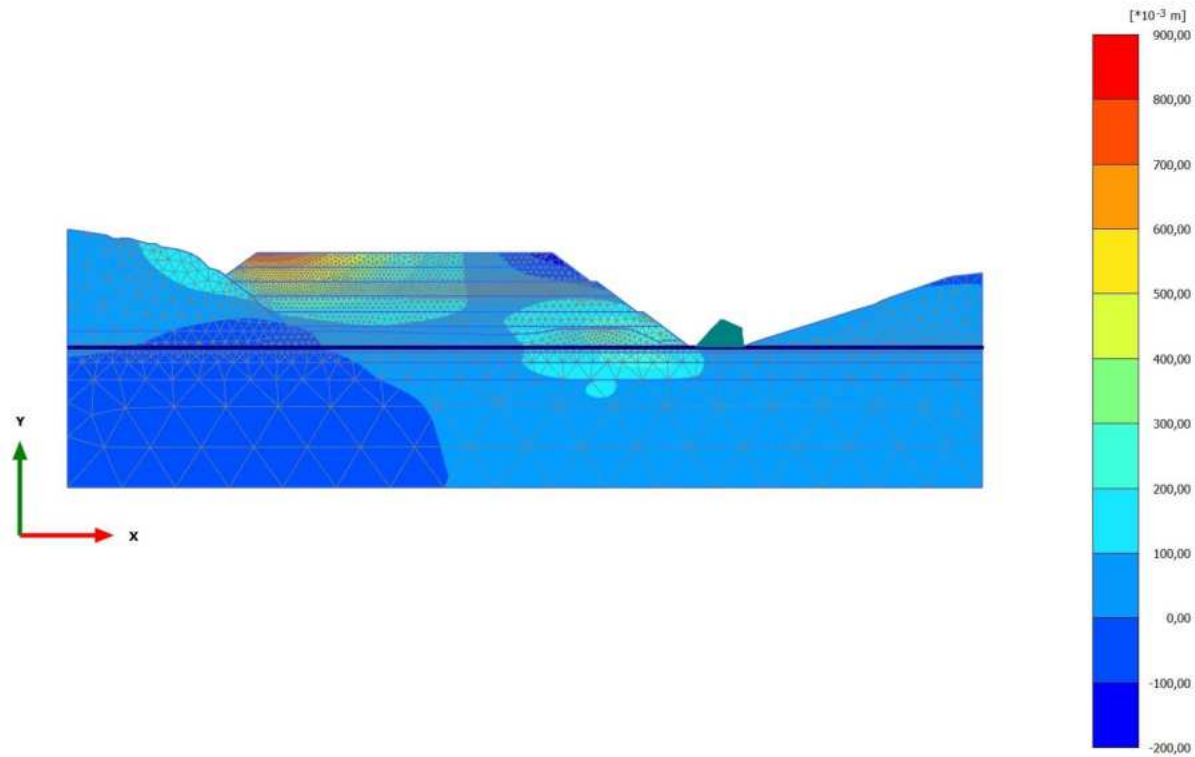


**Total displacements  $u_x$  (scaled up 50,0 times)**

Maximum value = 0,3974 m (Element 4166 at Node 12970)

Minimum value = -0,1259 m (Element 3076 at Node 56654)

2.1.1.1.4 Calculation results, Phase\_3 [Phase\_3] (10/38), Total displacements  $u_x$

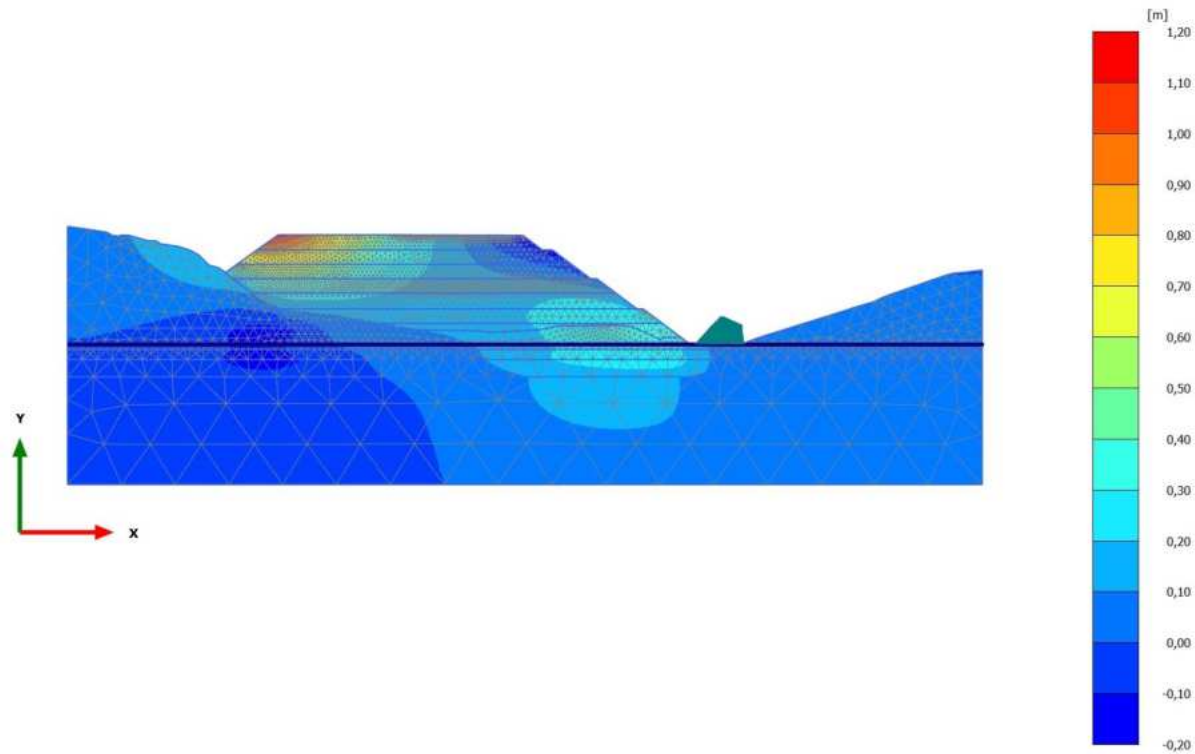


**Total displacements  $u_x$  (scaled up 20,0 times)**

Maximum value = 0,8699 m (Element 2297 at Node 7225)

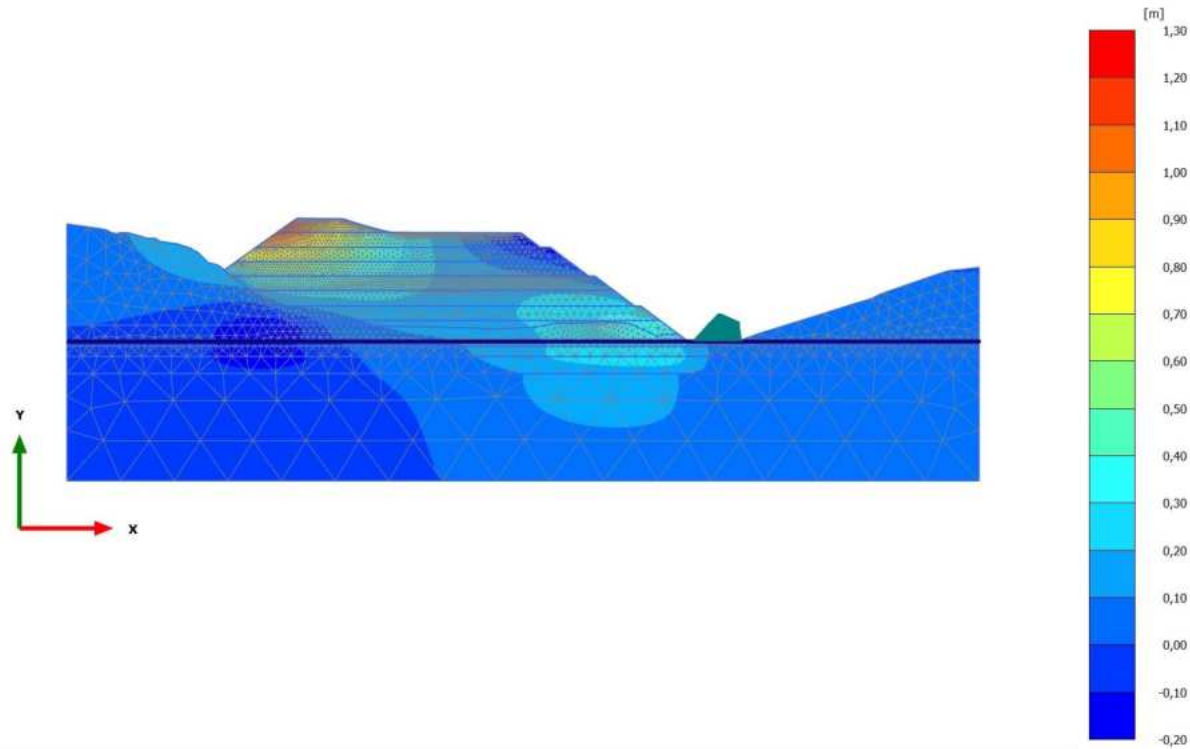
Minimum value = -0,1733 m (Element 1779 at Node 55353)

2.1.1.1.5 Calculation results, Phase\_4 [Phase\_4] (11/41), Total displacements  $u_x$



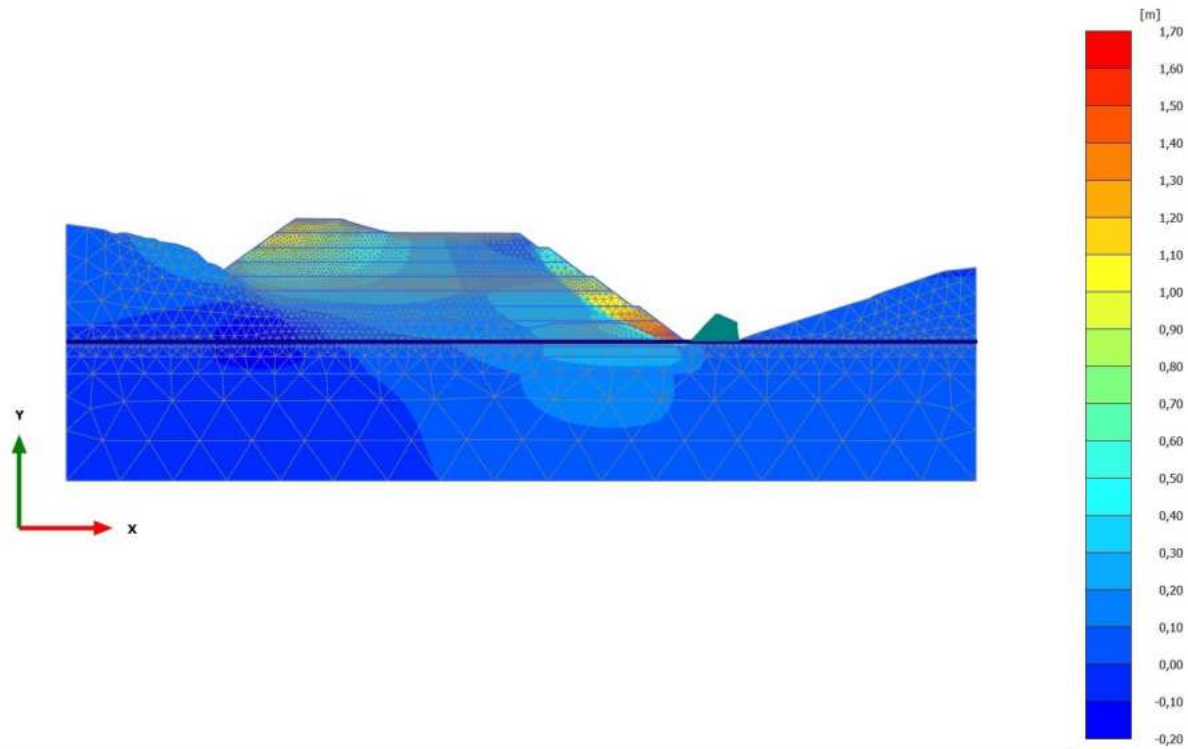
**Total displacements  $u_x$  (scaled up 20,0 times)**  
Maximum value = 1,160 m (Element 832 at Node 3481)  
Minimum value = -0,1794 m (Element 1779 at Node 55353)

2.1.1.1.6 Calculation results, Phase\_5\_static [Phase\_5] (12/44), Total displacements  $u_x$



**Total displacements  $u_x$  (scaled up 10,0 times)**  
Maximum value = 1,247 m (Element 364 at Node 381)  
Minimum value = -0,1724 m (Element 1779 at Node 55353)

2.1.1.1.7 Calculation results, Phase\_6 FoS static [Phase\_6] (13/144), Total displacements  $u_x$

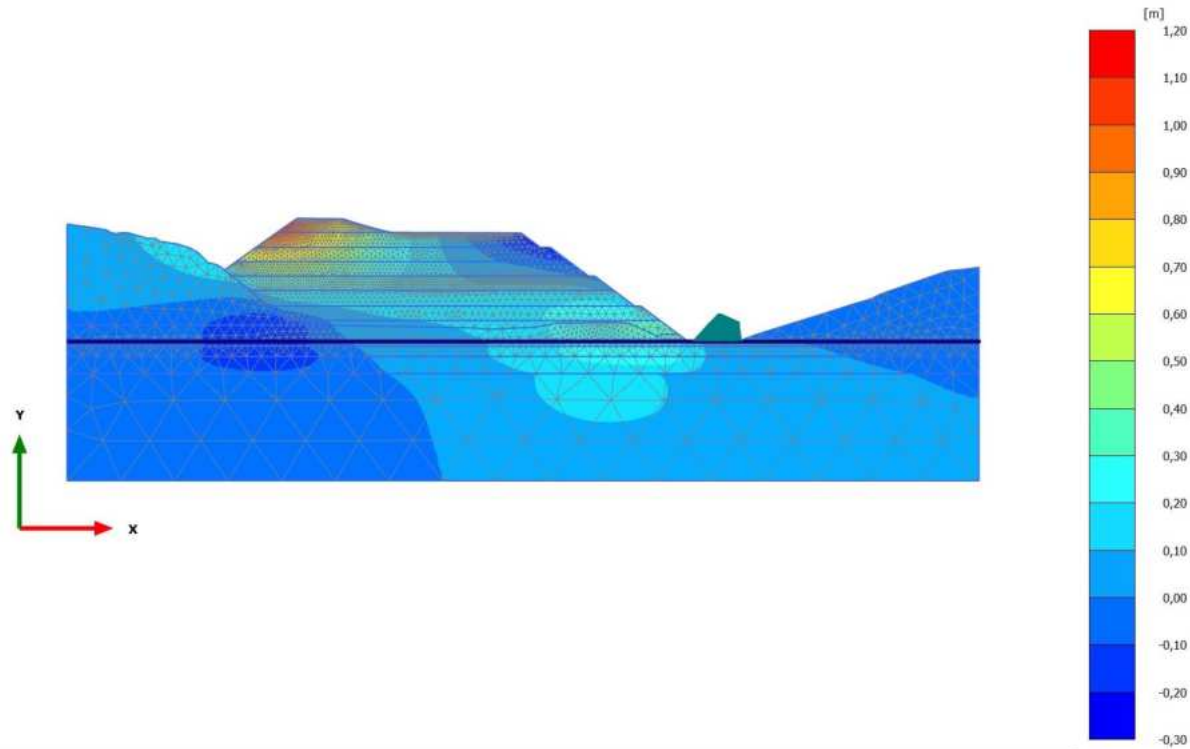


**Total displacements  $u_x$  (scaled up 10,0 times)**

Maximum value = 1,609 m (Element 5547 at Node 45301)

Minimum value = -0,1613 m (Element 5623 at Node 27752)

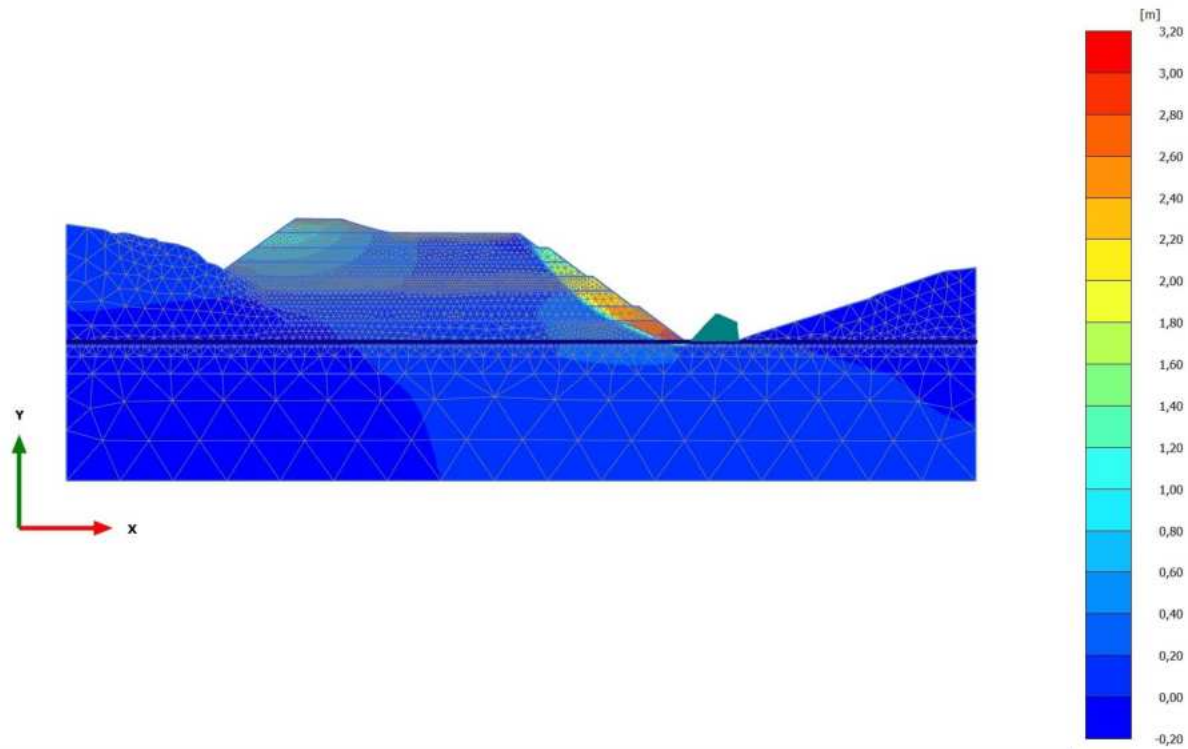
2.1.1.1.8 Calculation results, Phase\_8\_seismic [Phase\_8] (2/147), Total displacements  $u_x$



**Total displacements  $u_x$  (scaled up 10,0 times)**  
Maximum value = 1,178 m (Element 364 at Node 381)  
Minimum value = -0,2403 m (Element 1779 at Node 55353)

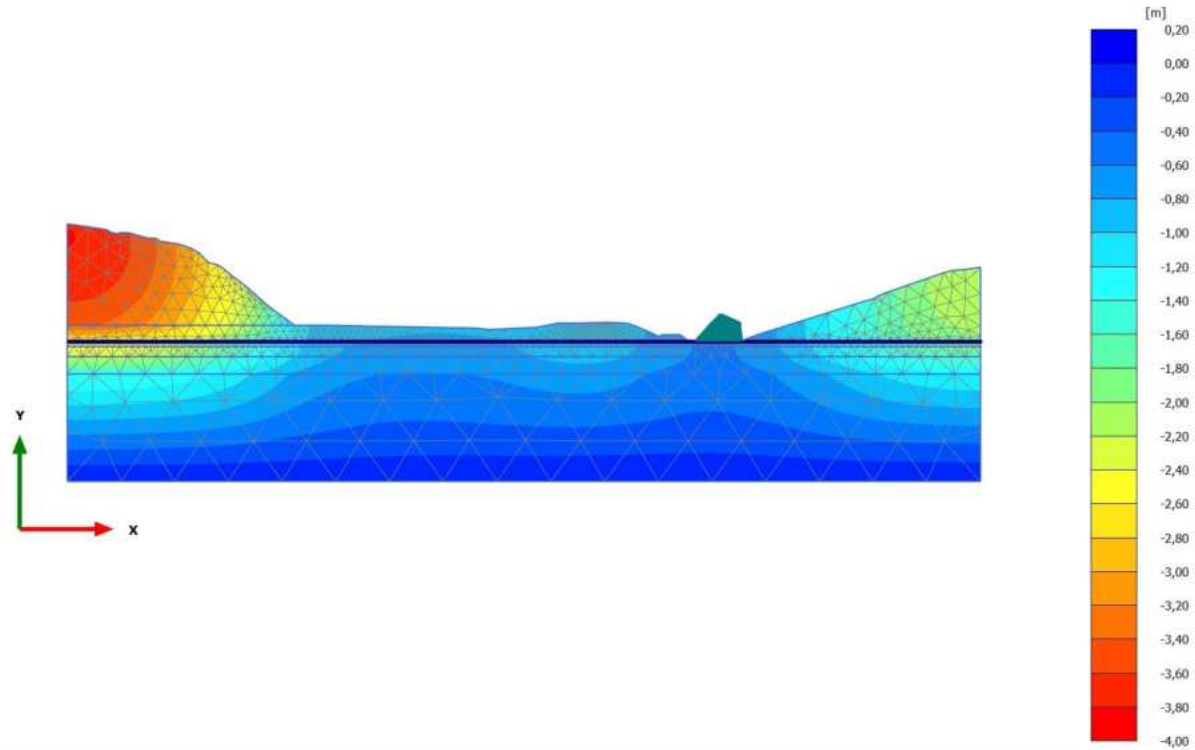


2.1.1.1.9 Calculation results, Phase\_7 FoS seismic [Phase\_7] (1/247), Total displacements  $u_x$



**Total displacements  $u_x$  (scaled up 5,00 times)**  
Maximum value = 3,091 m (Element 5936 at Node 44397)  
Minimum value = -0,1883 m (Element 5623 at Node 27753)

2.1.1.2.1 Calculation results, Initial phase [InitialPhase] (0/20), Total displacements  $u_y$

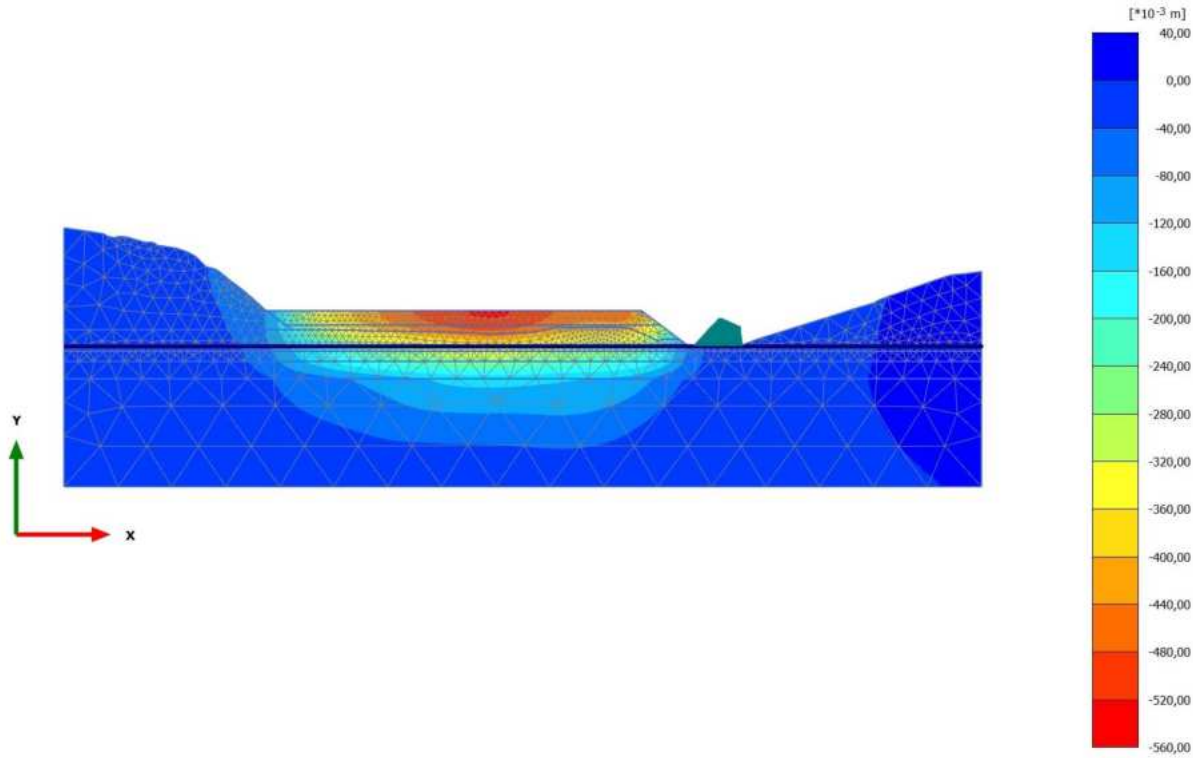


**Total displacements  $u_y$  (scaled up 5,00 times)**

Maximum value = 0,000 m (Element 6854 at Node 40221)

Minimum value = -3,804 m (Element 4219 at Node 21669)

2.1.1.2.2 Calculation results, Phase\_1 [Phase\_1] (8/27), Total displacements  $u_y$

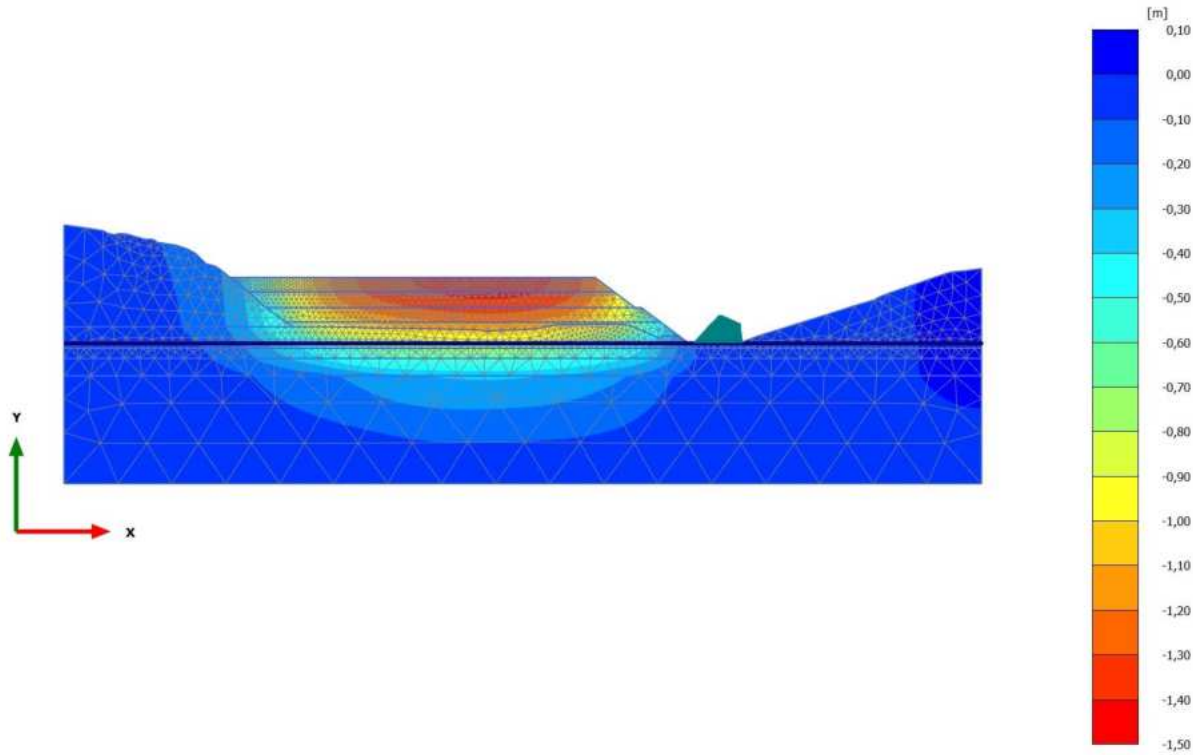


**Total displacements  $u_y$  (scaled up 50,0 times)**

Maximum value =  $0,9233 \cdot 10^{-3}$  m (Element 5379 at Node 40337)

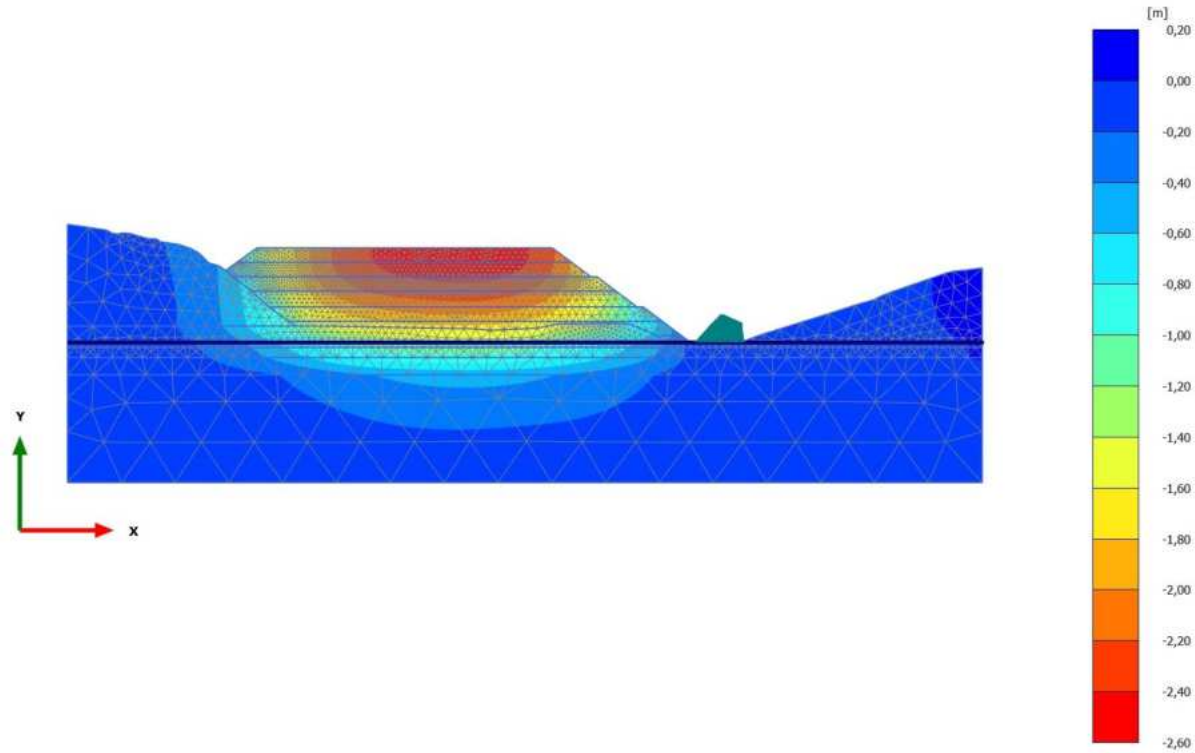
Minimum value = -0,5250 m (Element 4985 at Node 39841)

2.1.1.2.3 Calculation results, Phase\_2 [Phase\_2] (9/33), Total displacements  $u_y$



**Total displacements  $u_y$  (scaled up 10,0 times)**  
Maximum value =  $0,6844 \cdot 10^{-3}$  m (Element 5258 at Node 40389)  
Minimum value = -1,450 m (Element 3986 at Node 45703)

2.1.1.2.4 Calculation results, Phase\_3 [Phase\_3] (10/38), Total displacements  $u_y$

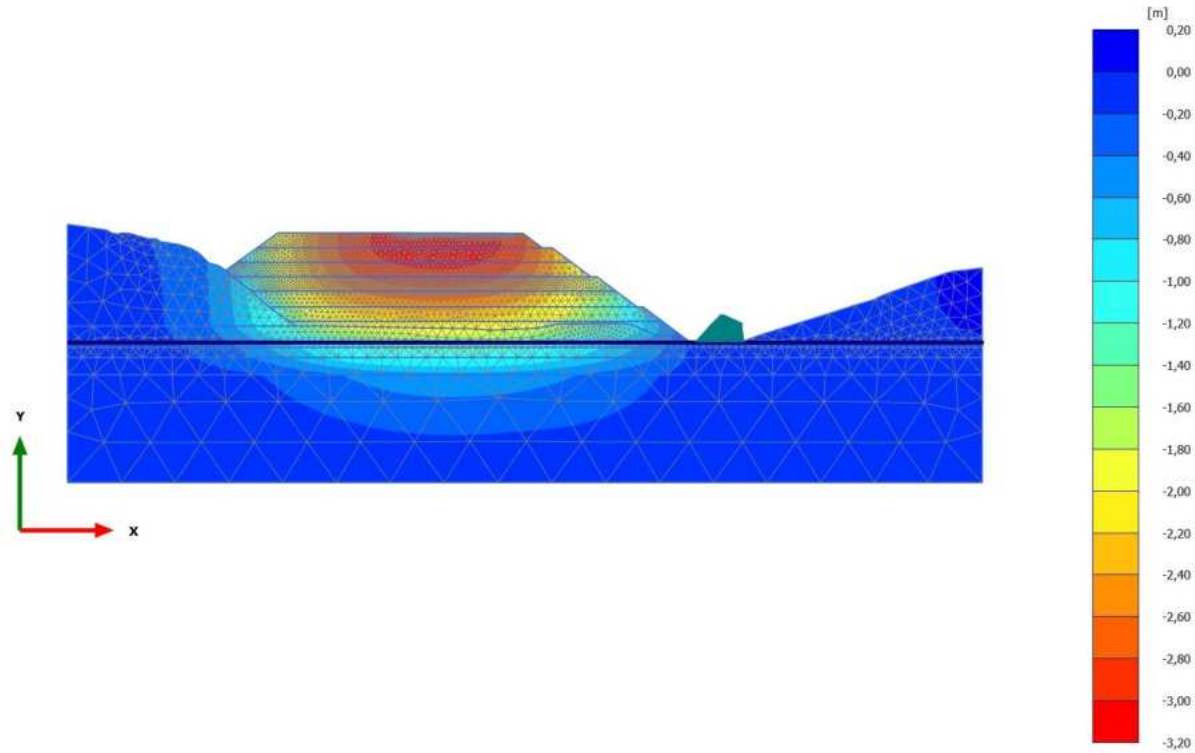


**Total displacements  $u_y$  (scaled up 5,00 times)**

Maximum value =  $0,5640 \cdot 10^{-3}$  m (Element 5251 at Node 40405)

Minimum value = -2,527 m (Element 1883 at Node 37317)

2.1.1.2.5 Calculation results, Phase\_4 [Phase\_4] (11/41), Total displacements  $u_y$

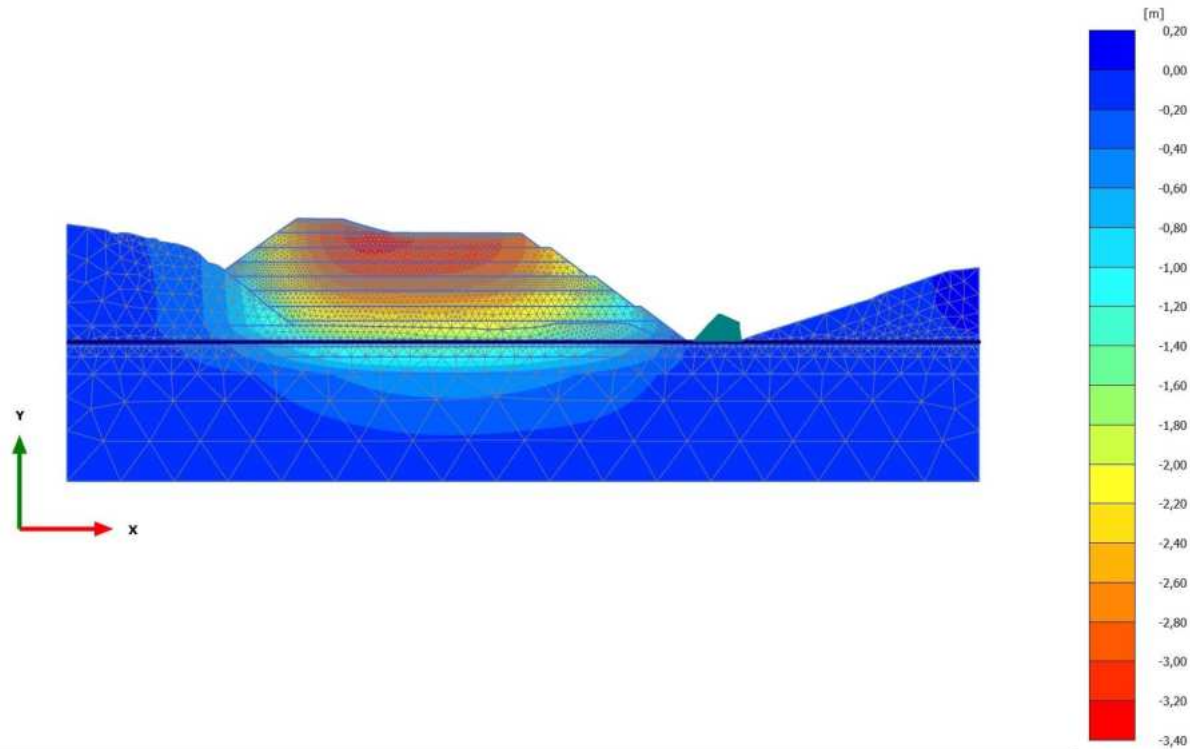


**Total displacements  $u_y$  (scaled up 5,00 times)**

Maximum value =  $0,5638 \cdot 10^{-3}$  m (Element 5251 at Node 40406)

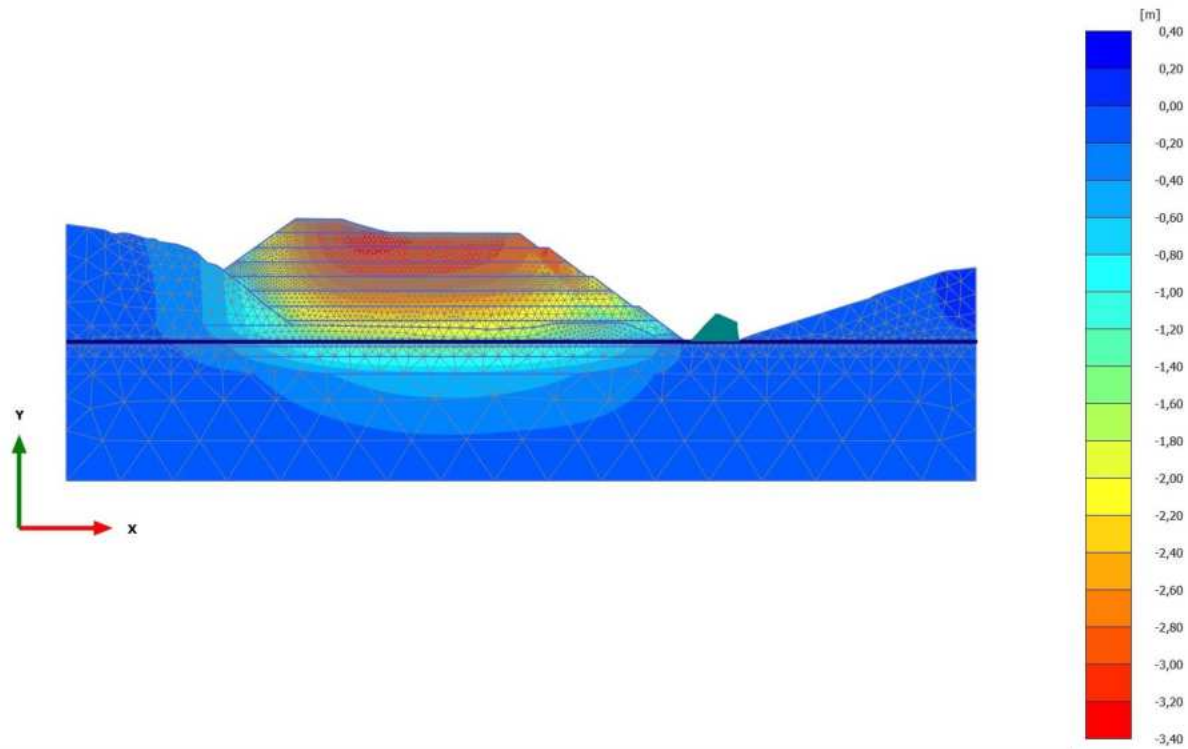
Minimum value = -3,129 m (Element 1047 at Node 29728)

2.1.1.2.6 Calculation results, Phase\_5\_static [Phase\_5] (12/44), Total displacements  $u_y$



**Total displacements  $u_y$  (scaled up 5,00 times)**  
Maximum value =  $0,5649 \cdot 10^{-3}$  m (Element 5251 at Node 40406)  
Minimum value = -3,246 m (Element 890 at Node 9208)

2.1.1.2.7 Calculation results, Phase\_6 FoS static [Phase\_6] (13/144), Total displacements  $u_y$



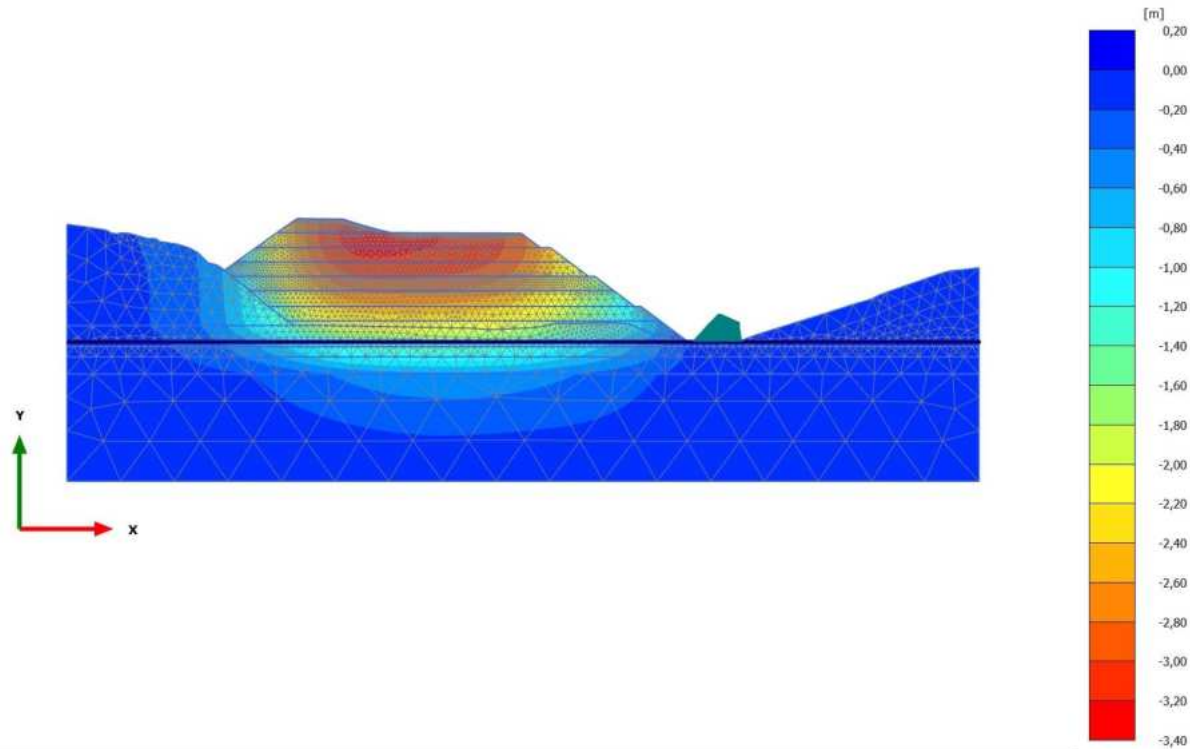
**Total displacements  $u_y$  (scaled up 5,00 times)**

Maximum value = 0,2595 m (Element 6117 at Node 43661)

Minimum value = -3,249 m (Element 890 at Node 9209)



2.1.1.2.8 Calculation results, Phase\_8\_seismic [Phase\_8] (2/147), Total displacements  $u_y$

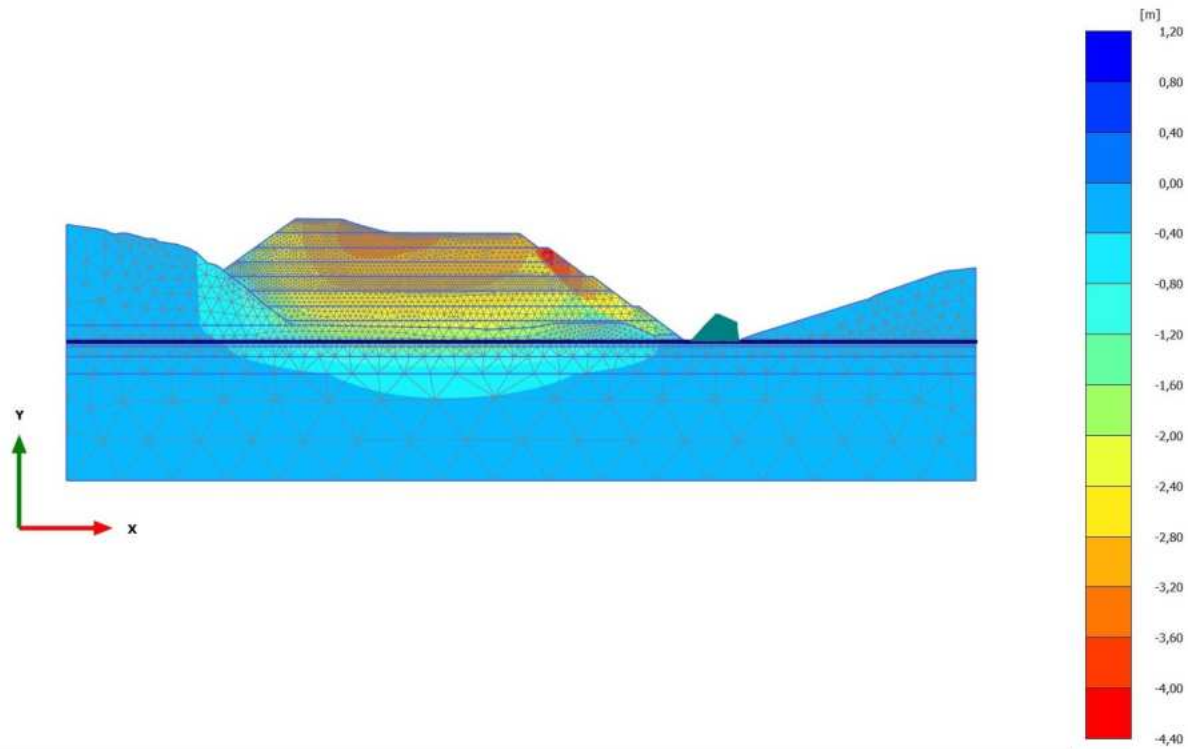


**Total displacements  $u_y$  (scaled up 5,00 times)**

Maximum value = 0,000 m (Element 6854 at Node 40221)

Minimum value = -3,271 m (Element 890 at Node 9209)

2.1.1.2.9 Calculation results, Phase\_7 FoS seismic [Phase\_7] (1/247), Total displacements  $u_y$

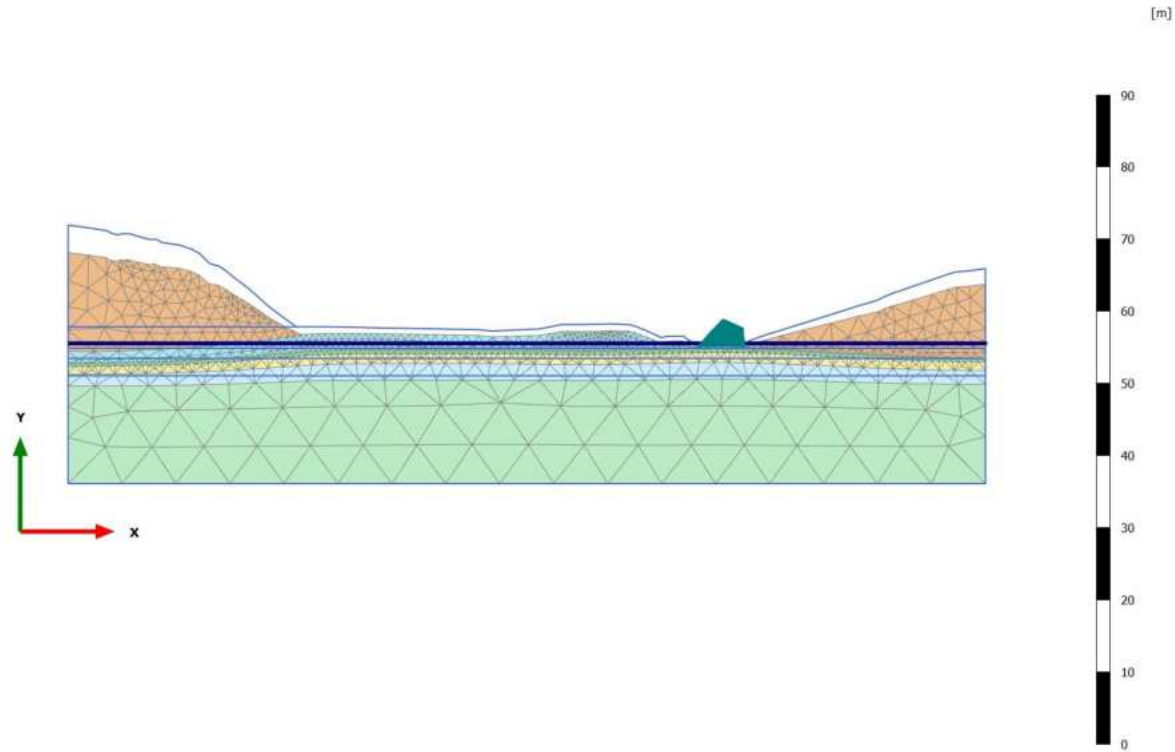


**Total displacements  $u_y$  (scaled up 5,00 times)**

Maximum value = 1,115 m (Element 6117 at Node 43661)

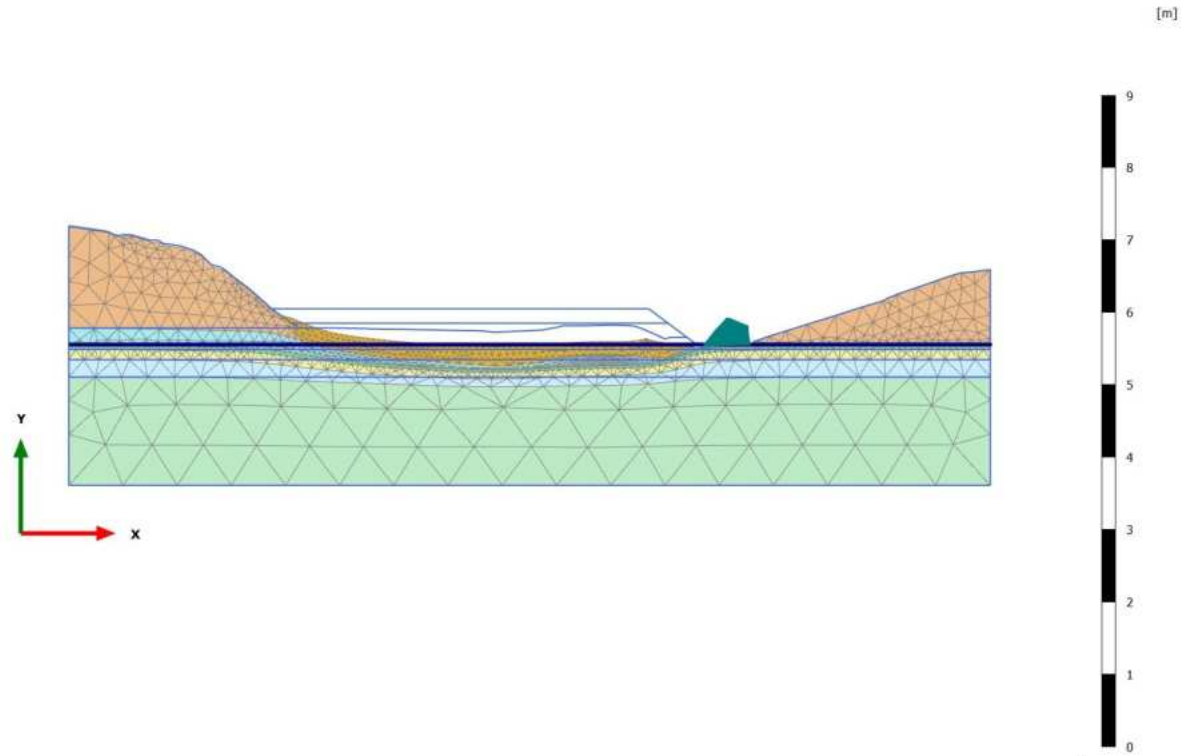
Minimum value = -4,136 m (Element 1788 at Node 55116)

2.1.2.1 Calculation results, Initial phase [InitialPhase] (0/20), Deformed mesh |u|



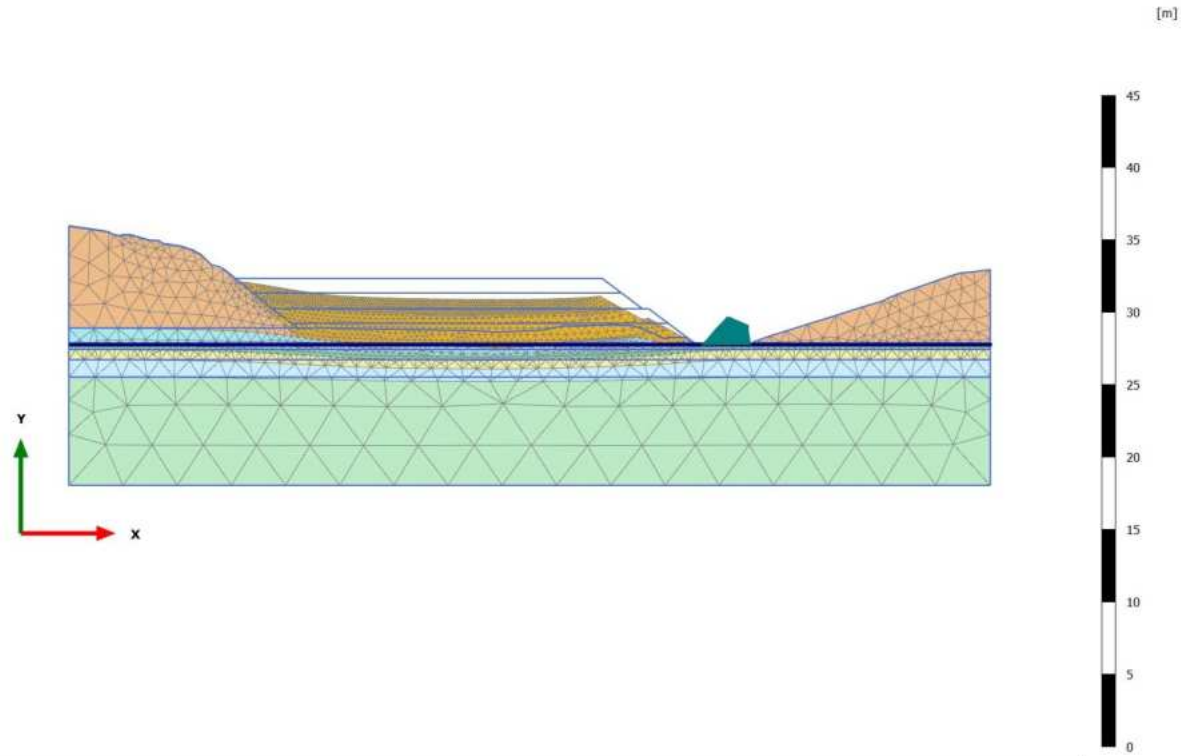
**Deformed mesh |u| (scaled up 5,00 times)**  
Maximum value = 3,804 m (Element 4219 at Node 21669)

2.1.2.2 Calculation results, Phase\_1 [Phase\_1] (8/27), Deformed mesh |u|



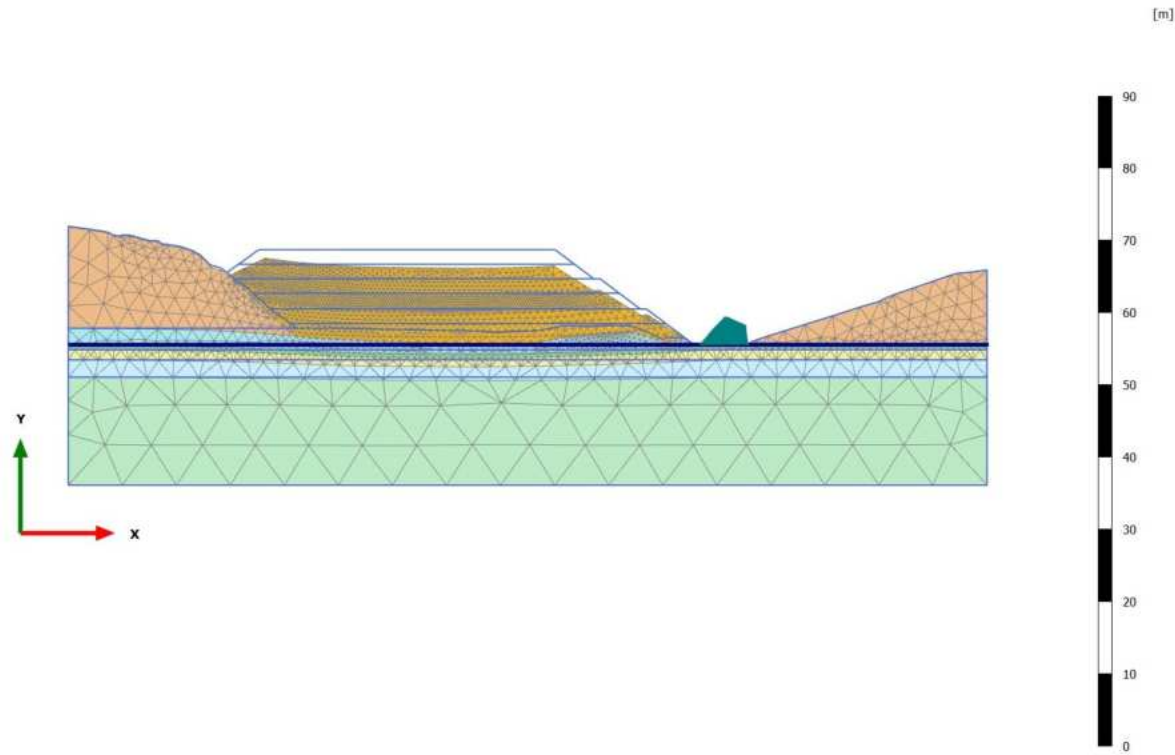
**Deformed mesh |u| (scaled up 50,0 times)**  
Maximum value = 0,5250 m (Element 4985 at Node 39841)

2.1.2.3 Calculation results, Phase\_2 [Phase\_2] (9/33), Deformed mesh [u]



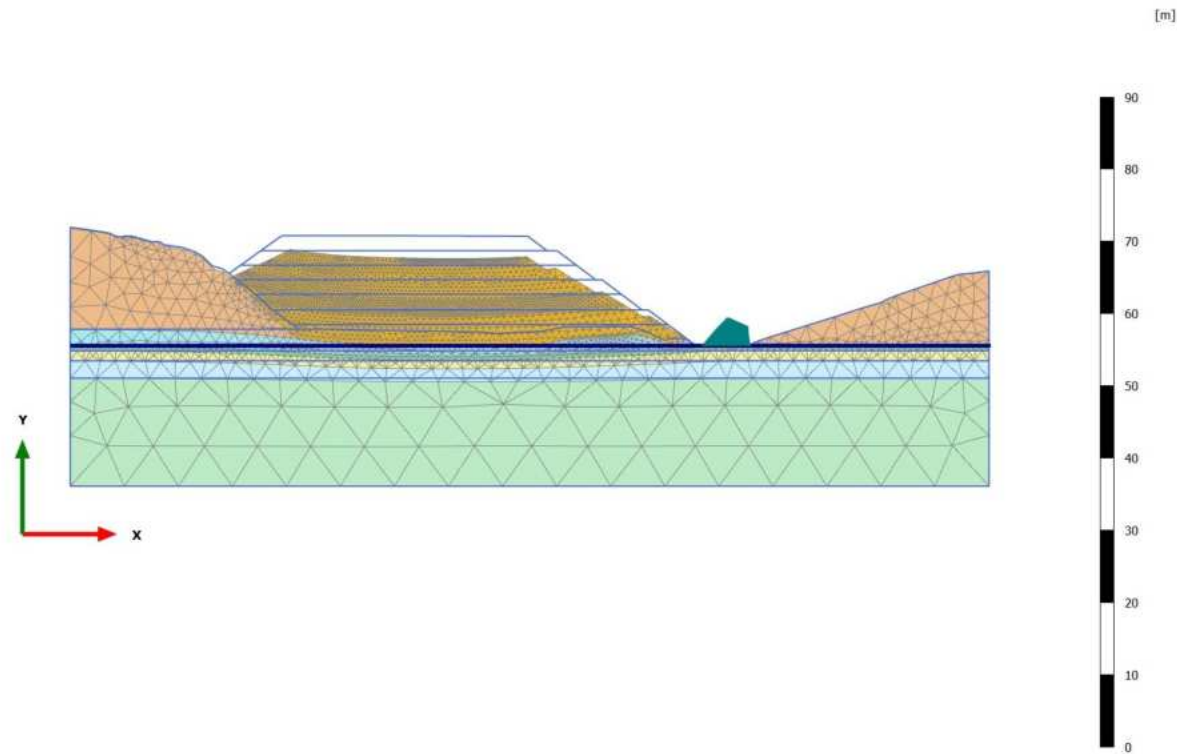
**Deformed mesh |u| (scaled up 10,0 times)**  
Maximum value = 1,450 m (Element 3991 at Node 45019)

2.1.2.4 Calculation results, Phase\_3 [Phase\_3] (10/38), Deformed mesh |u|



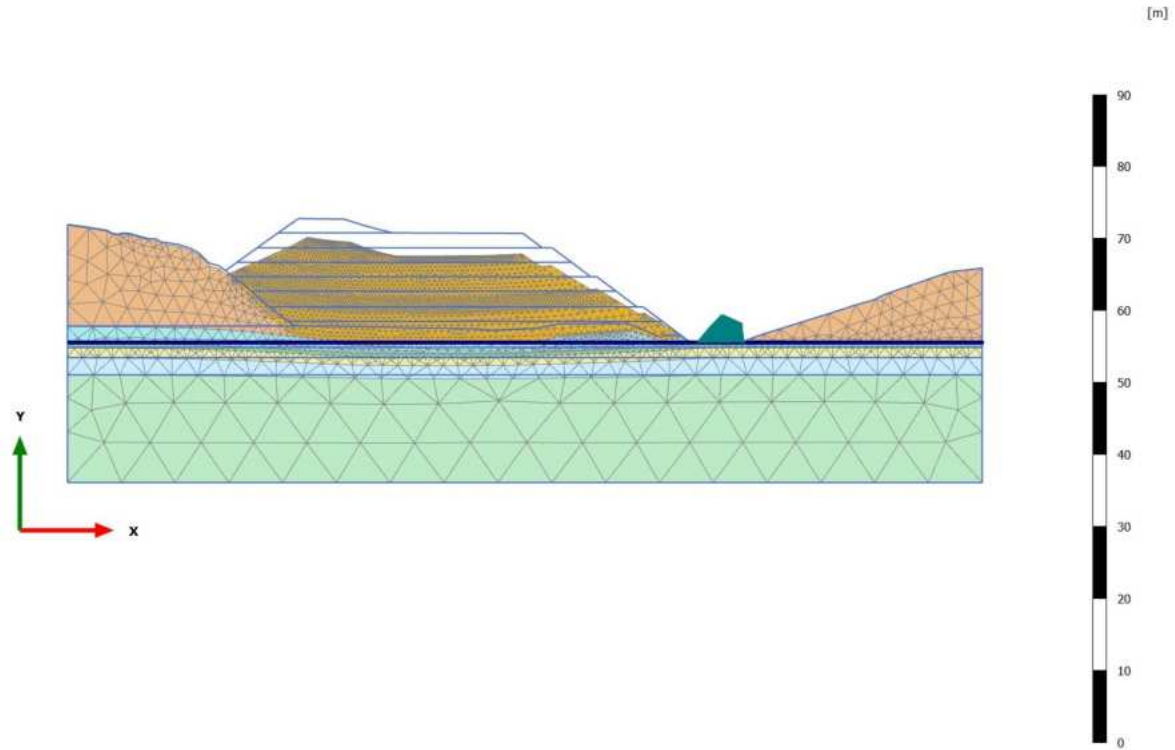
**Deformed mesh |u| (scaled up 5,00 times)**  
Maximum value = 2,530 m (Element 1883 at Node 37312)

2.1.2.5 Calculation results, Phase\_4 [Phase\_4] (11/41), Deformed mesh |u|



**Deformed mesh |u| (scaled up 5,00 times)**  
Maximum value = 3,135 m (Element 1100 at Node 27993)

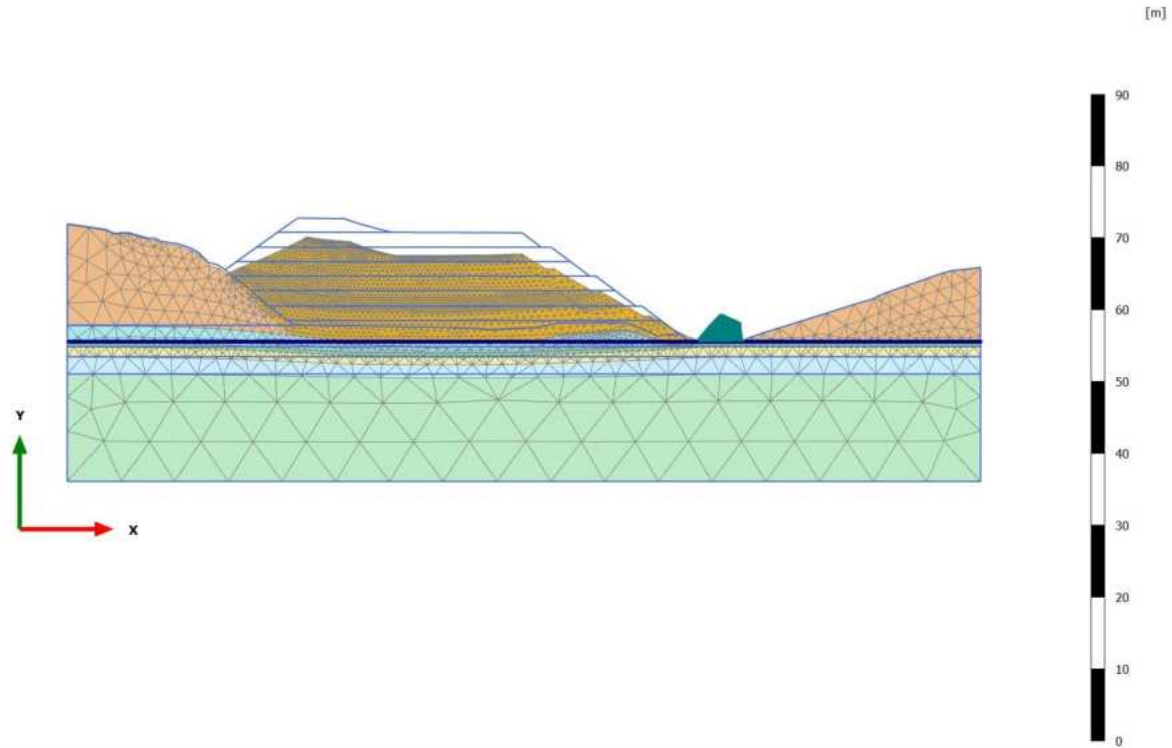
2.1.2.6 Calculation results, Phase\_5\_static [Phase\_5] (12/44), Deformed mesh |u|



**Deformed mesh |u| (scaled up 5,00 times)**  
Maximum value = 3,295 m (Element 233 at Node 5510)

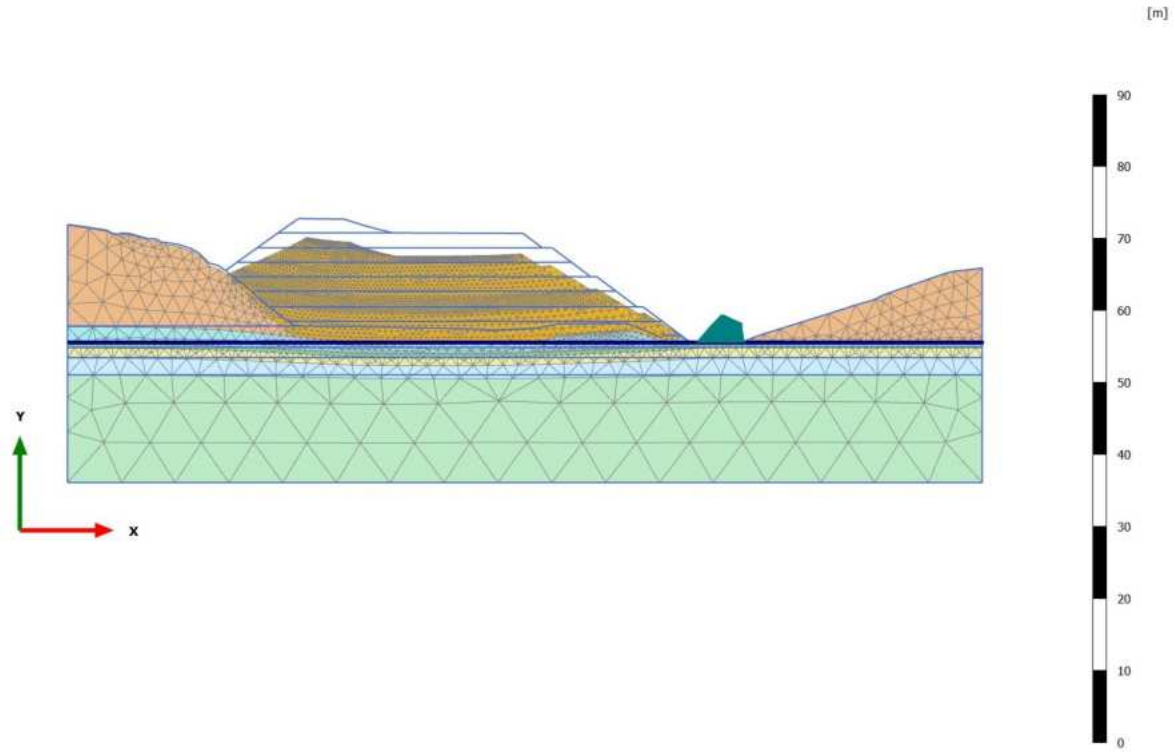


2.1.2.7 Calculation results, Phase\_6 FoS static [Phase\_6] (13/144), Deformed mesh |u|



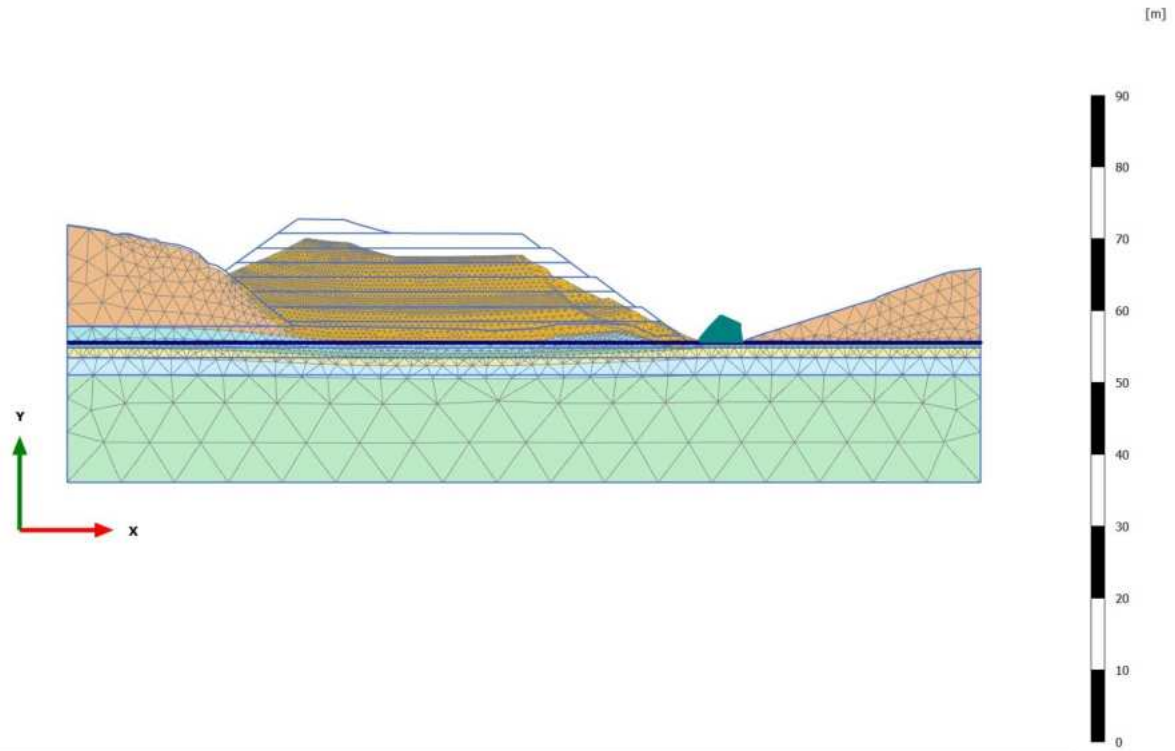
**Deformed mesh |u| (scaled up 5,00 times)**  
Maximum value = 3,302 m (Element 259 at Node 4918)

2.1.2.8 Calculation results, Phase\_8\_seismic [Phase\_8] (2/147), Deformed mesh |u|



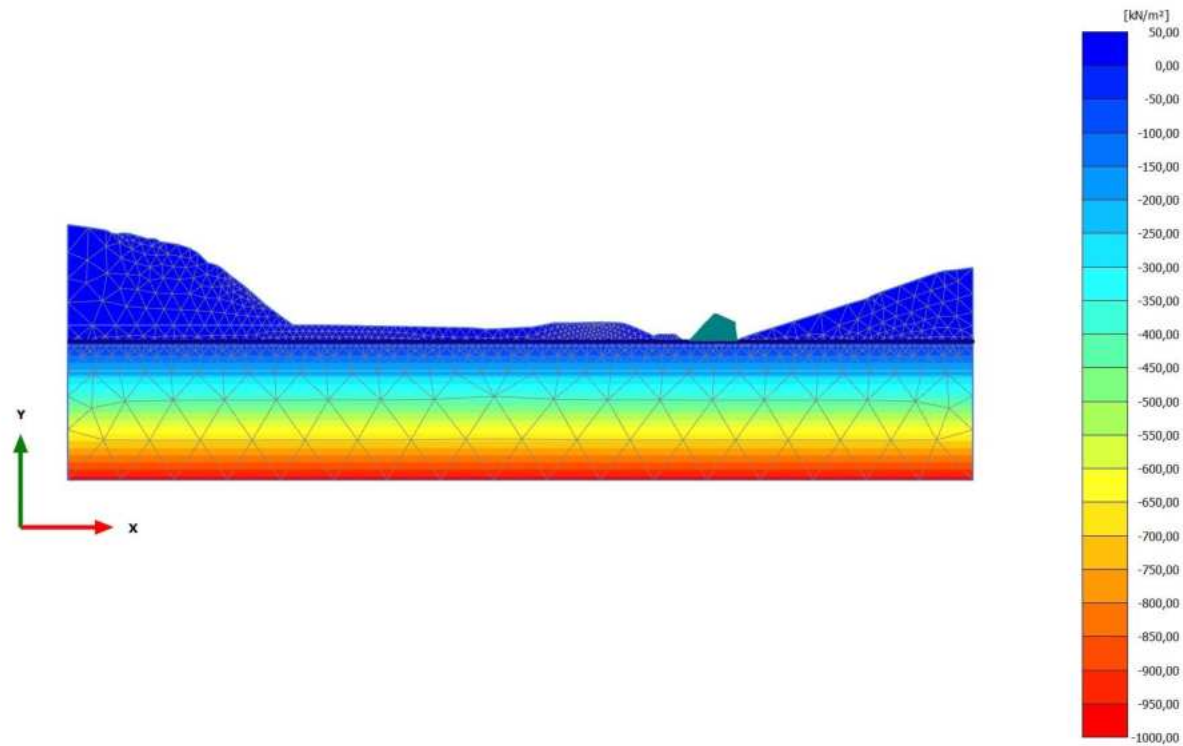
**Deformed mesh |u| (scaled up 5,00 times)**  
Maximum value = 3,306 m (Element 137 at Node 5991)

2.1.2.9 Calculation results, Phase\_7 FoS seismic [Phase\_7] (1/247), Deformed mesh |u|



**Deformed mesh |u| (scaled up 5,00 times)**  
Maximum value = 4,361 m (Element 1786 at Node 55112)

2.2.1.1.1 Calculation results, Initial phase [InitialPhase] (0/20), Steady state pore pressures  $p_{\text{steady}}$

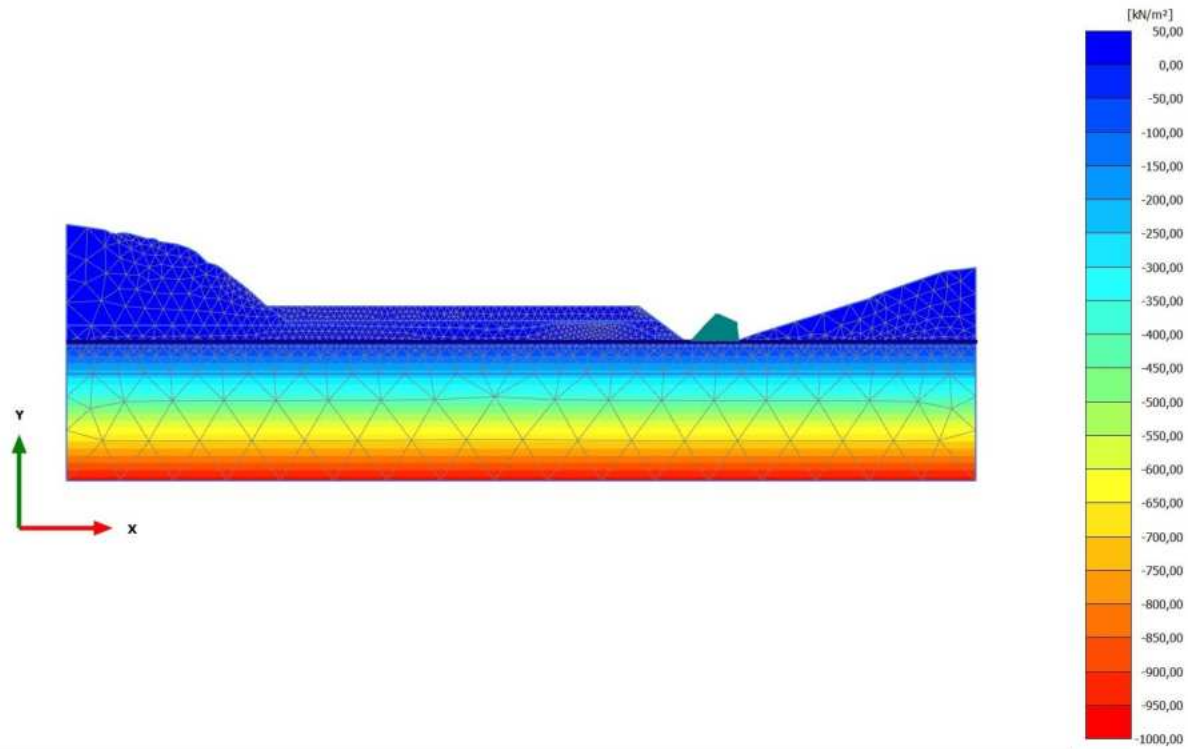


**Steady state pore pressures  $p_{\text{steady}}$  (scaled up 0,0200 times) (Pressure = negative)**

Maximum value = 0,000 kN/m<sup>2</sup> (Element 4218 at Node 21860)

Minimum value = -972,7 kN/m<sup>2</sup> (Element 6870 at Node 30709)

2.2.1.1.2 Calculation results, Phase\_1 [Phase\_1] (8/27), Steady state pore pressures  $p_{steady}$

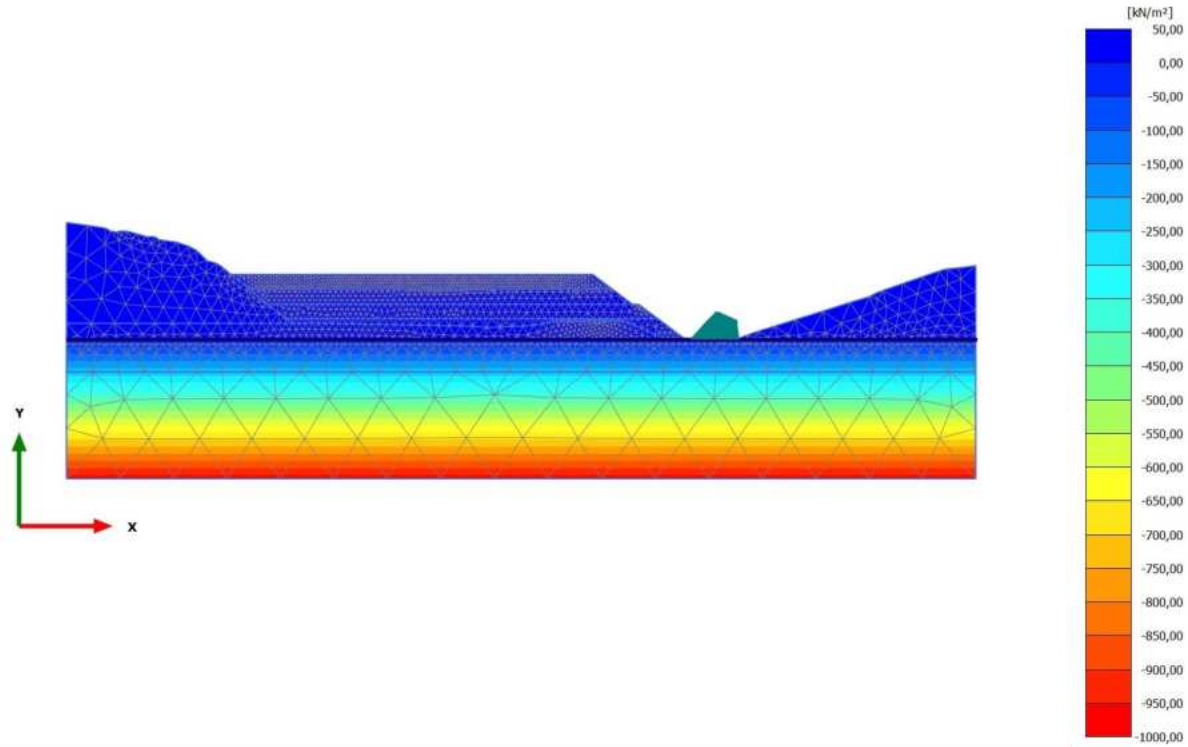


**Steady state pore pressures  $p_{steady}$  (scaled up 0,0200 times) (Pressure = negative)**

Maximum value = 0,000 kN/m<sup>2</sup> (Element 4218 at Node 21860)

Minimum value = -972,7 kN/m<sup>2</sup> (Element 6870 at Node 30709)

2.2.1.1.3 Calculation results, Phase\_2 [Phase\_2] (9/33), Steady state pore pressures  $p_{steady}$

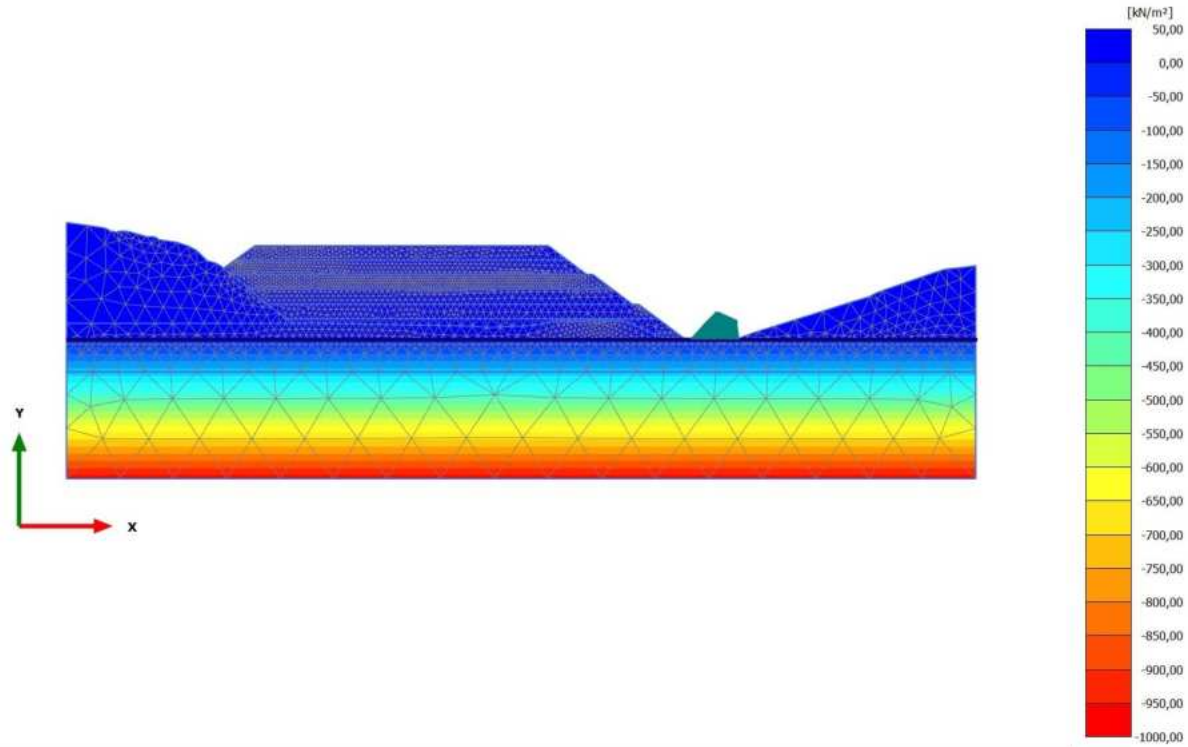


**Steady state pore pressures  $p_{steady}$  (scaled up 0,0200 times) (Pressure = negative)**

Maximum value = 0,000 kN/m<sup>2</sup> (Element 3072 at Node 20318)

Minimum value = -972,7 kN/m<sup>2</sup> (Element 6870 at Node 30709)

2.2.1.1.4 Calculation results, Phase\_3 [Phase\_3] (10/38), Steady state pore pressures  $p_{steady}$

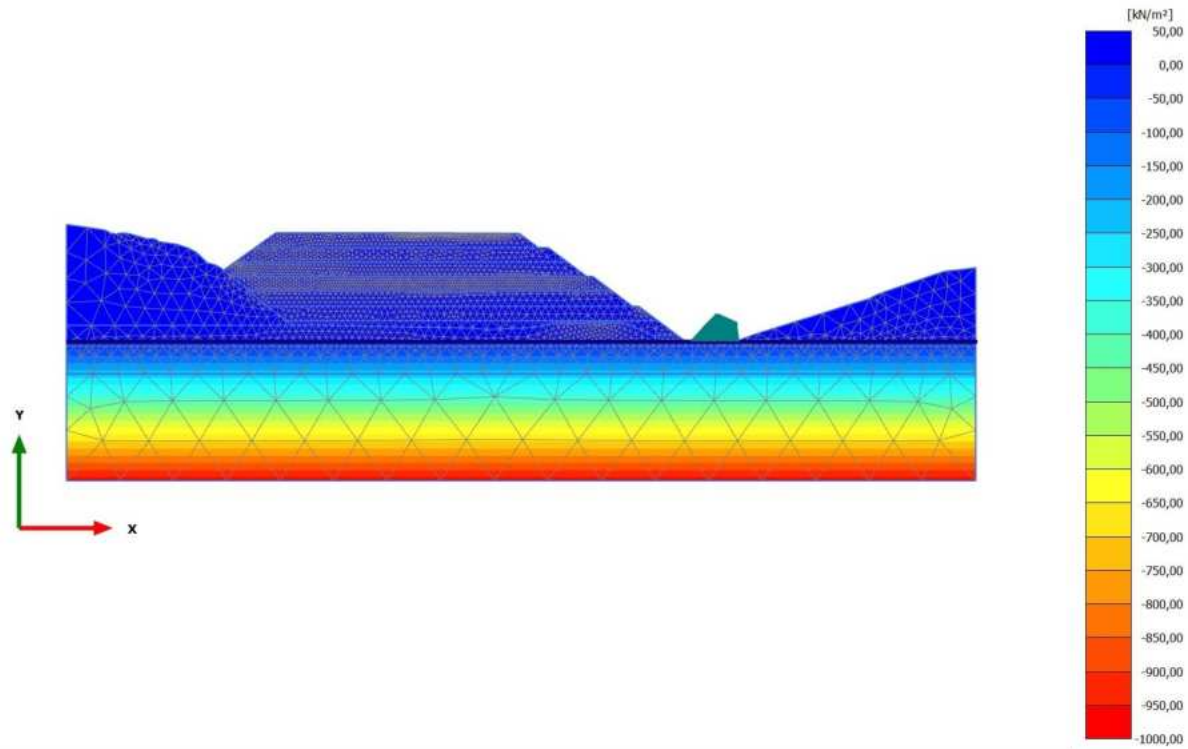


**Steady state pore pressures  $p_{steady}$  (scaled up 0,0200 times) (Pressure = negative)**

Maximum value = 0,000 kN/m<sup>2</sup> (Element 1779 at Node 55572)

Minimum value = -972,7 kN/m<sup>2</sup> (Element 6870 at Node 30709)

2.2.1.1.5 Calculation results, Phase\_4 [Phase\_4] (11/41), Steady state pore pressures  $p_{steady}$



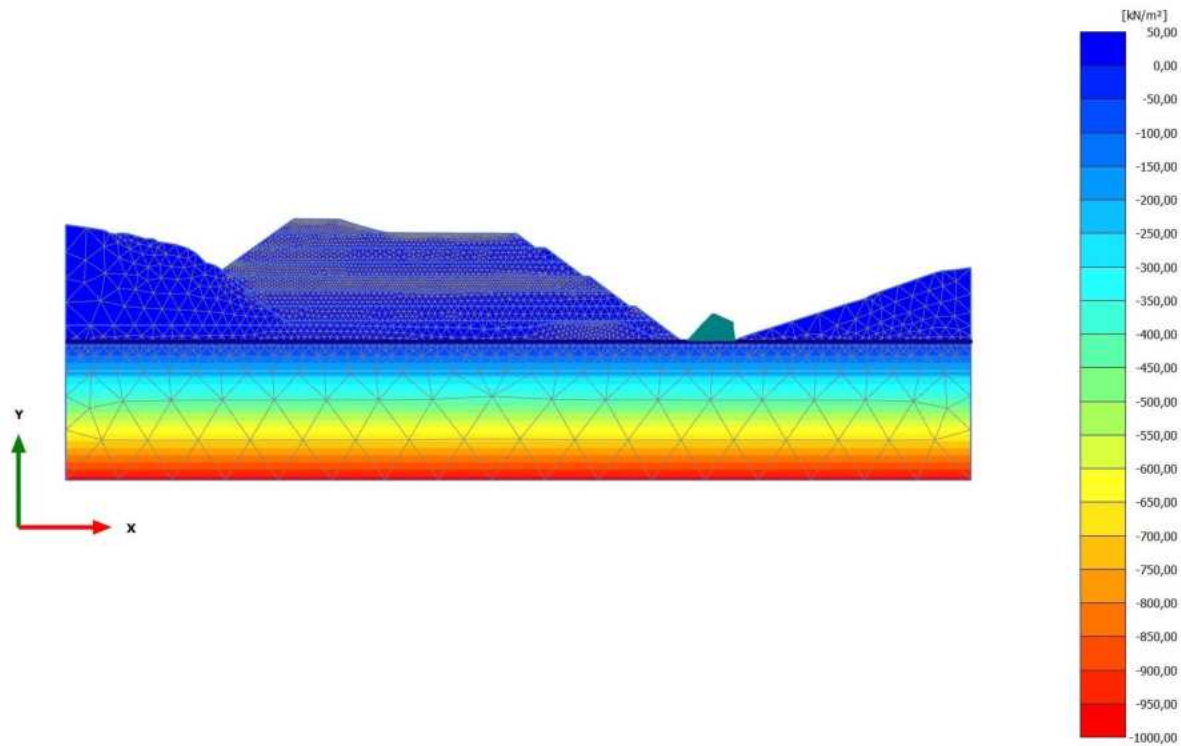
**Steady state pore pressures  $p_{steady}$  (scaled up 0,0200 times) (Pressure = negative)**

Maximum value = 0,000  $\text{kN/m}^2$  (Element 638 at Node 54386)

Minimum value = -972,7  $\text{kN/m}^2$  (Element 6870 at Node 30709)



2.2.1.1.6 Calculation results, Phase\_5\_static [Phase\_5] (12/44), Steady state pore pressures  $p_{\text{steady}}$

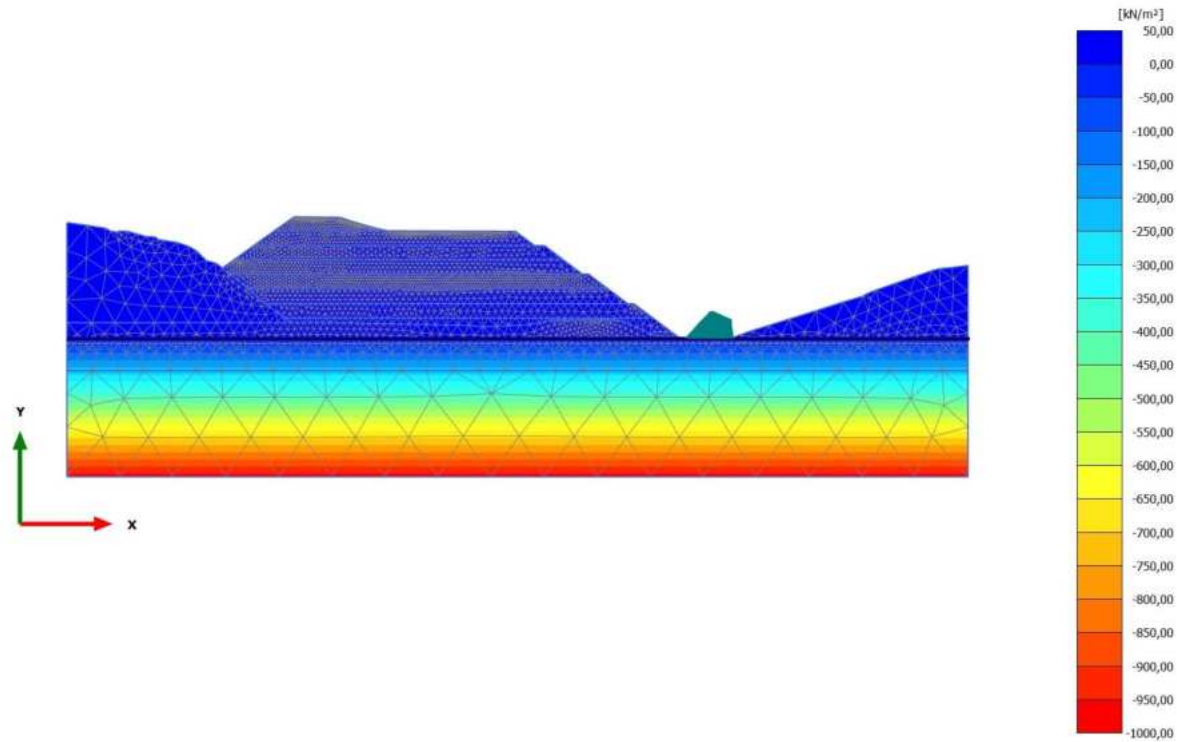


**Steady state pore pressures  $p_{\text{steady}}$  (scaled up 0,0200 times) (Pressure = negative)**

Maximum value = 0,000 kN/m<sup>2</sup> (Element 1 at Node 2873)

Minimum value = -972,7 kN/m<sup>2</sup> (Element 6870 at Node 30709)

2.2.1.1.7 Calculation results, Phase\_6 FoS static [Phase\_6] (13/144), Steady state pore pressures  $p_{\text{steady}}$

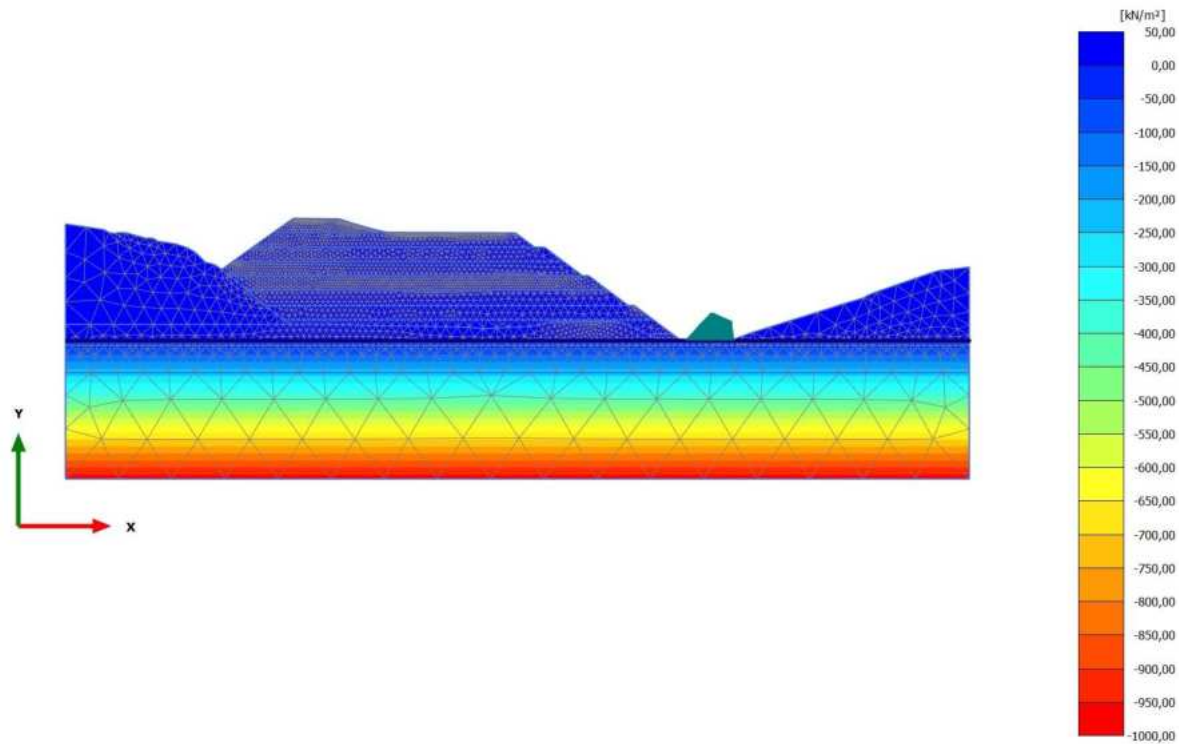


**Steady state pore pressures  $p_{\text{steady}}$  (scaled up 0,0200 times) (Pressure = negative)**

Maximum value = 0,000  $\text{kN/m}^2$  (Element 1 at Node 2873)

Minimum value = -972,7  $\text{kN/m}^2$  (Element 6870 at Node 30709)

2.2.1.1.8 Calculation results, Phase\_8\_seismic [Phase\_8] (2/147), Steady state pore pressures  $p_{\text{steady}}$

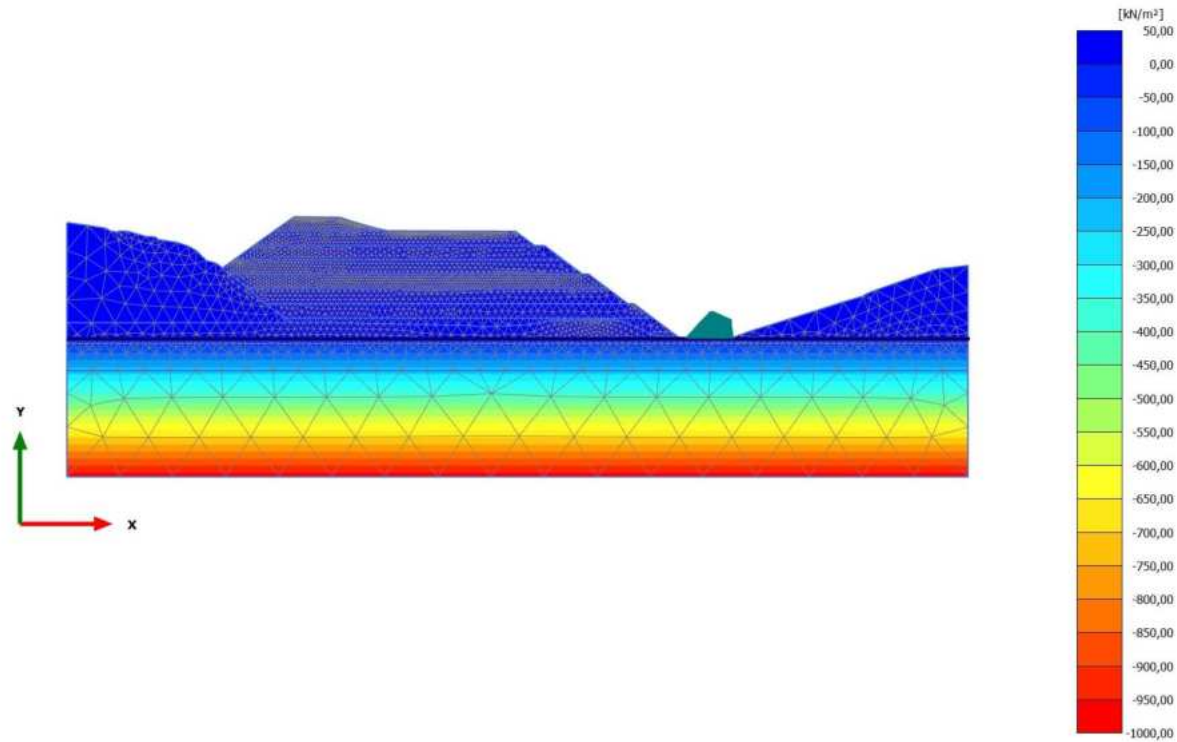


**Steady state pore pressures  $p_{\text{steady}}$  (scaled up 0,0200 times) (Pressure = negative)**

Maximum value = 0,000 kN/m<sup>2</sup> (Element 1 at Node 2873)

Minimum value = -978,6 kN/m<sup>2</sup> (Element 6870 at Node 30709)

2.2.1.1.9 Calculation results, Phase\_7 FoS seismic [Phase\_7] (1/247), Steady state pore pressures  $p_{\text{steady}}$

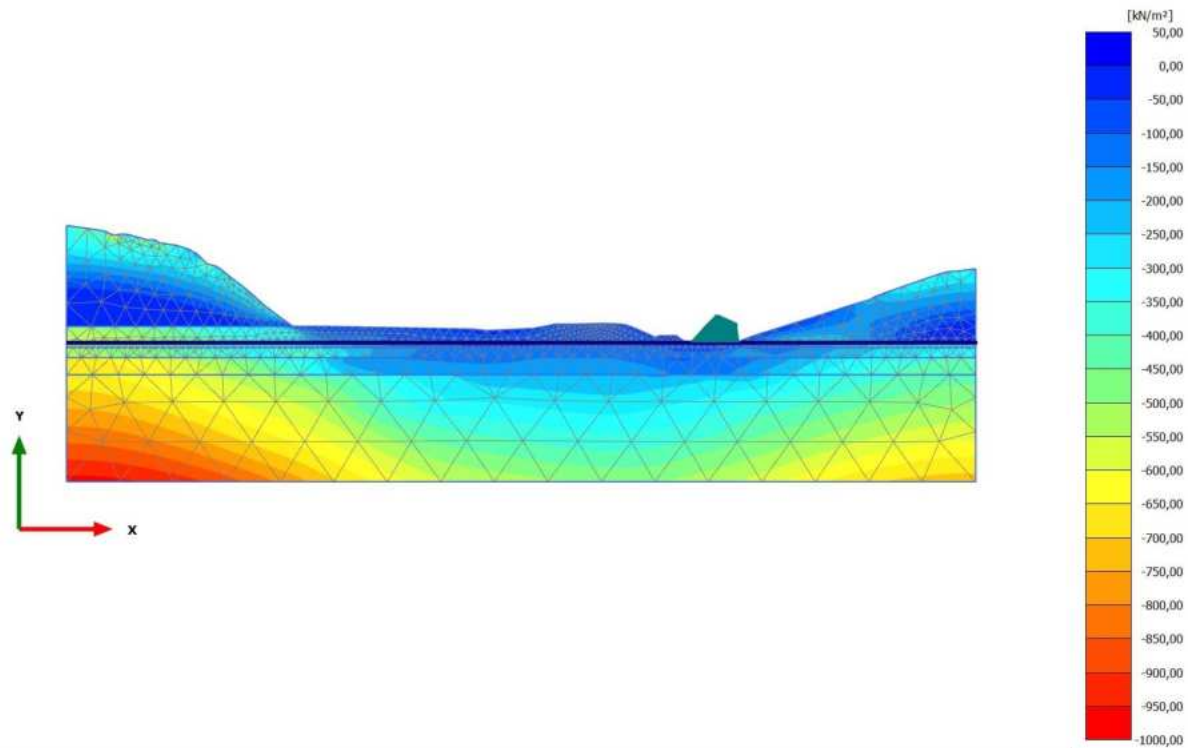


**Steady state pore pressures  $p_{\text{steady}}$  (scaled up 0,0200 times) (Pressure = negative)**

Maximum value = 0,000 kN/m<sup>2</sup> (Element 1 at Node 2873)

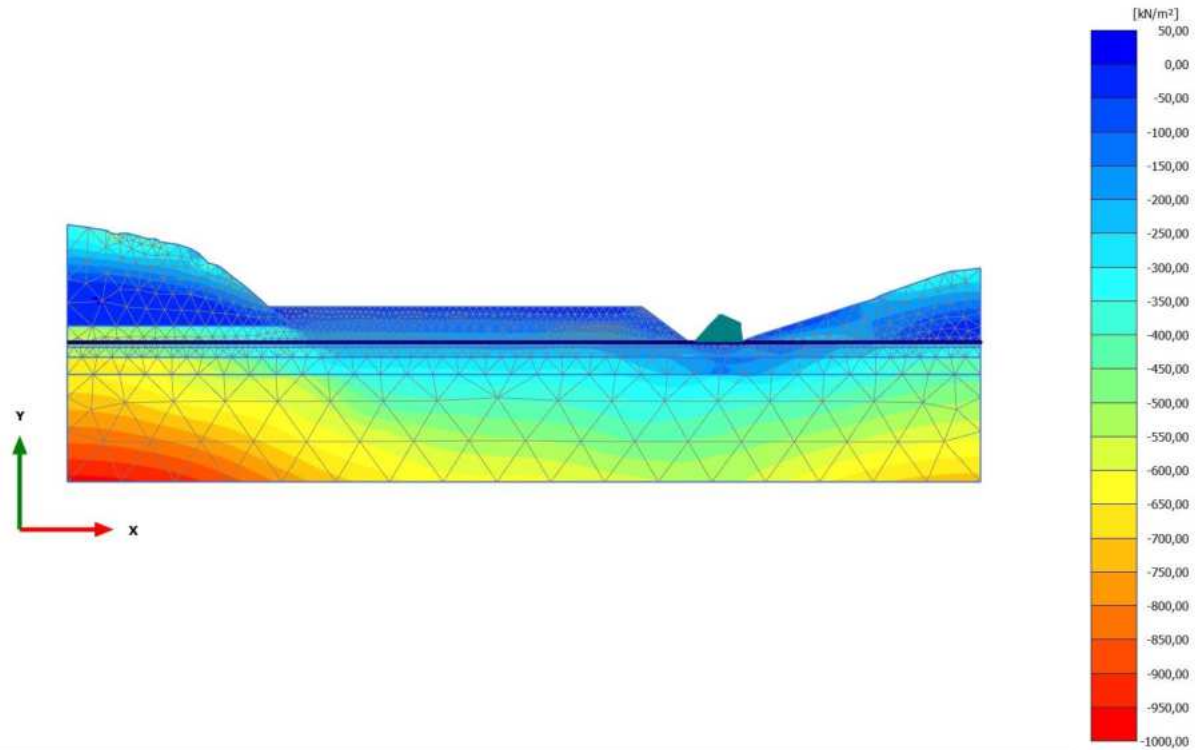
Minimum value = -978,6 kN/m<sup>2</sup> (Element 6870 at Node 30709)

2.2.2.1.1 Calculation results, Initial phase [InitialPhase] (0/20), Cartesian effective stress  $\sigma'_{xx}$



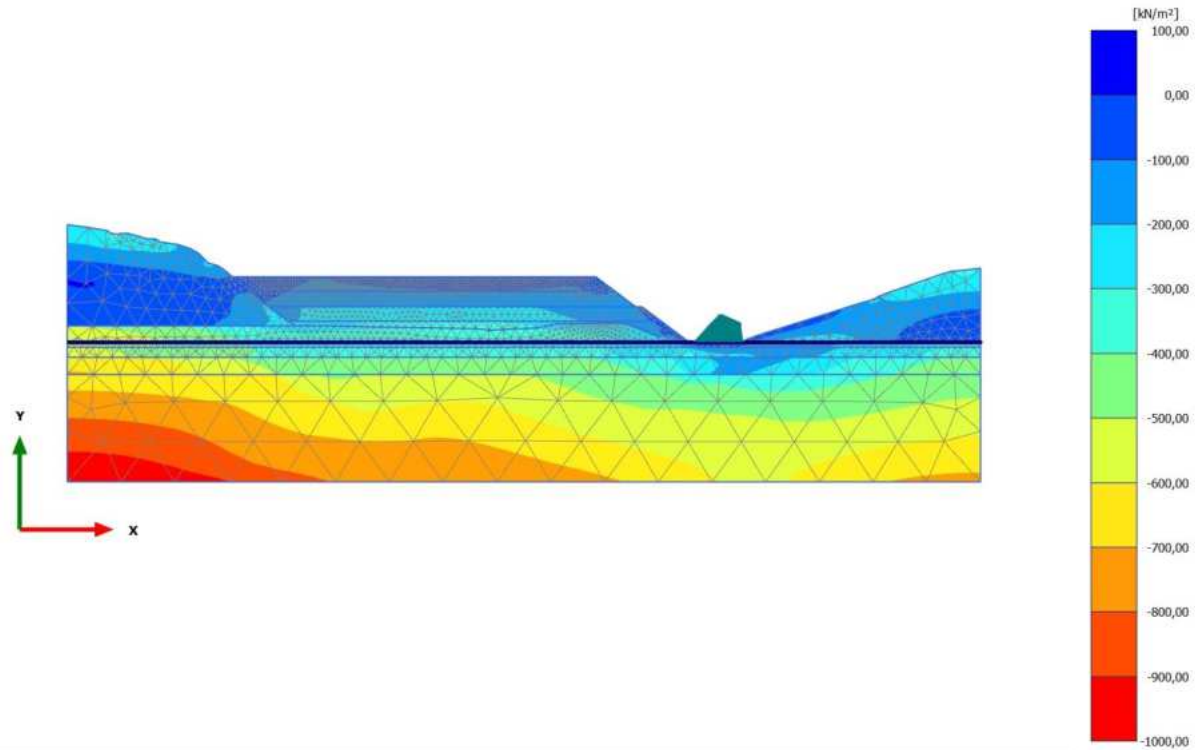
**Cartesian effective stress  $\sigma'_{xx}$  (scaled up 0,0200 times)**  
Maximum value = 7,281 kN/m<sup>2</sup> (Element 6490 at Node 43438)  
Minimum value = -971,4 kN/m<sup>2</sup> (Element 6870 at Node 30709)

2.2.2.1.2 Calculation results, Phase\_1 [Phase\_1] (8/27), Cartesian effective stress  $\sigma'_{xx}$



**Cartesian effective stress  $\sigma'_{xx}$  (scaled up 0,0200 times)**  
Maximum value = 14,45 kN/m<sup>2</sup> (Element 4323 at Node 21396)  
Minimum value = -971,5 kN/m<sup>2</sup> (Element 6870 at Node 30709)

2.2.2.1.3 Calculation results, Phase\_2 [Phase\_2] (9/33), Cartesian effective stress  $\sigma'_{xx}$

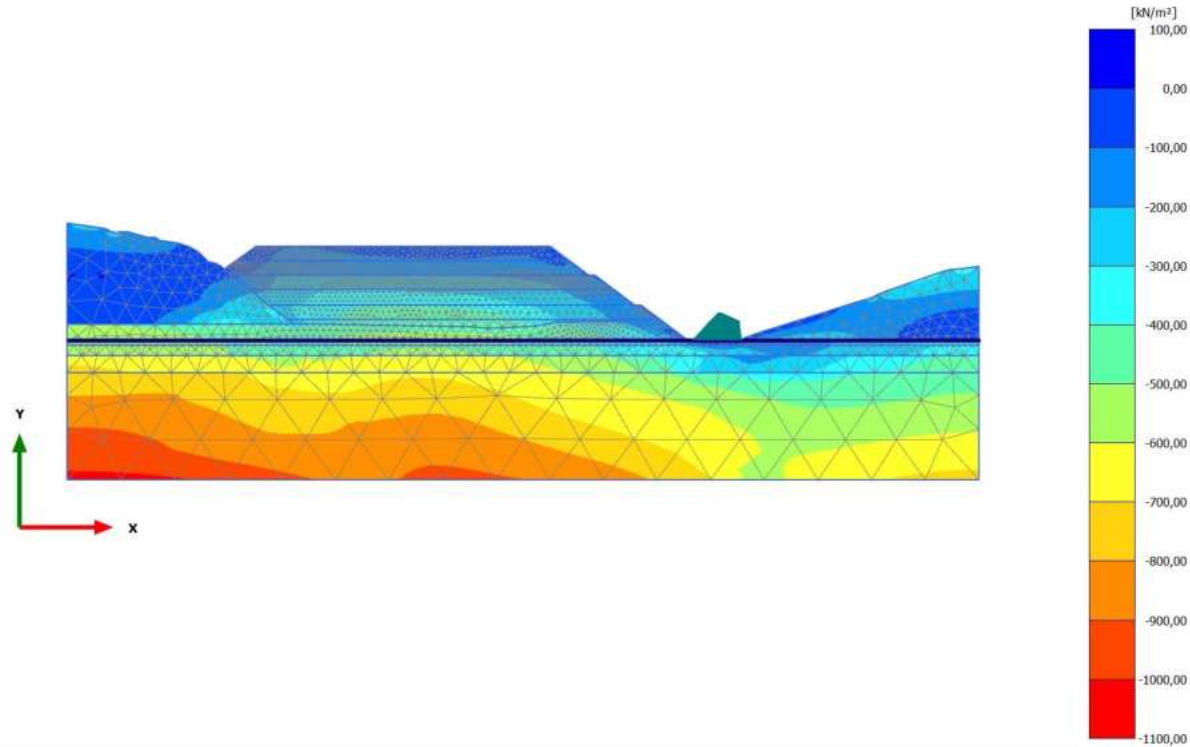


**Cartesian effective stress  $\sigma'_{xx}$  (scaled up 0,0200 times)**

Maximum value = 42,75 kN/m<sup>2</sup> (Element 4323 at Node 21396)

Minimum value = -979,4 kN/m<sup>2</sup> (Element 6870 at Node 30713)

2.2.2.1.4 Calculation results, Phase\_3 [Phase\_3] (10/38), Cartesian effective stress  $\sigma'_{xx}$



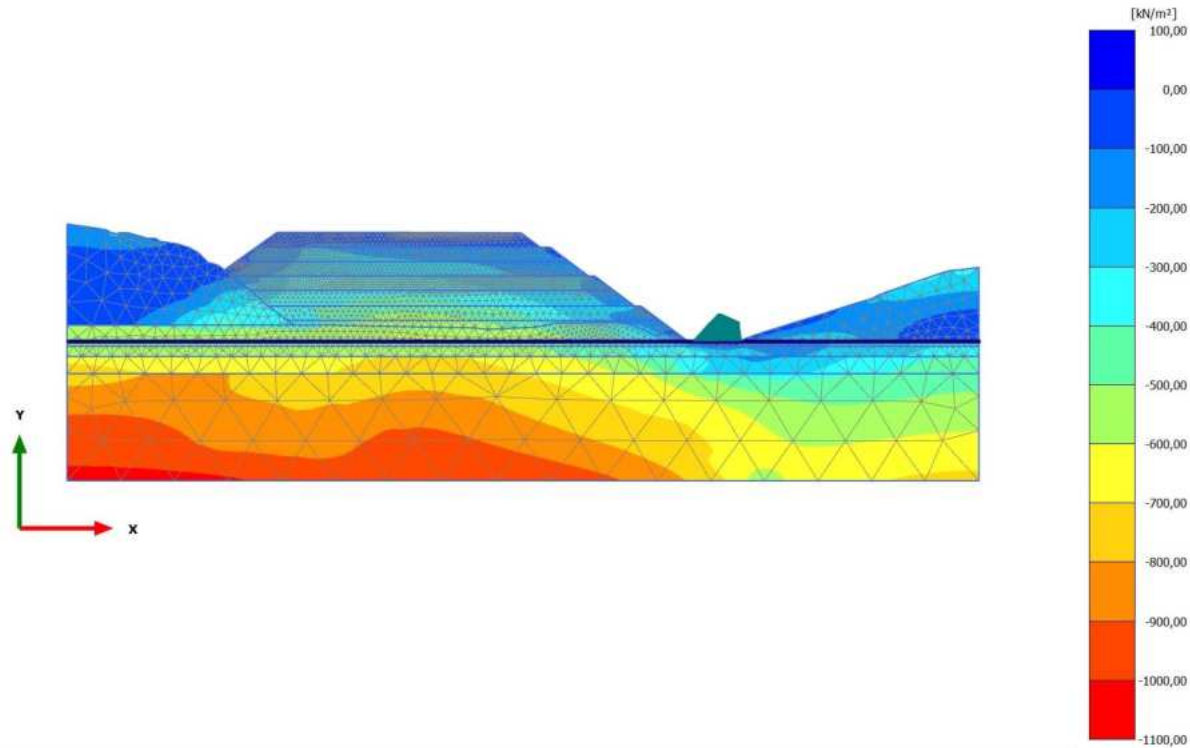
**Cartesian effective stress  $\sigma'_{xx}$  (scaled up 0,0200 times)**

Maximum value = 66,82 kN/m<sup>2</sup> (Element 4323 at Node 21396)

Minimum value = -1035 kN/m<sup>2</sup> (Element 6870 at Node 30709)

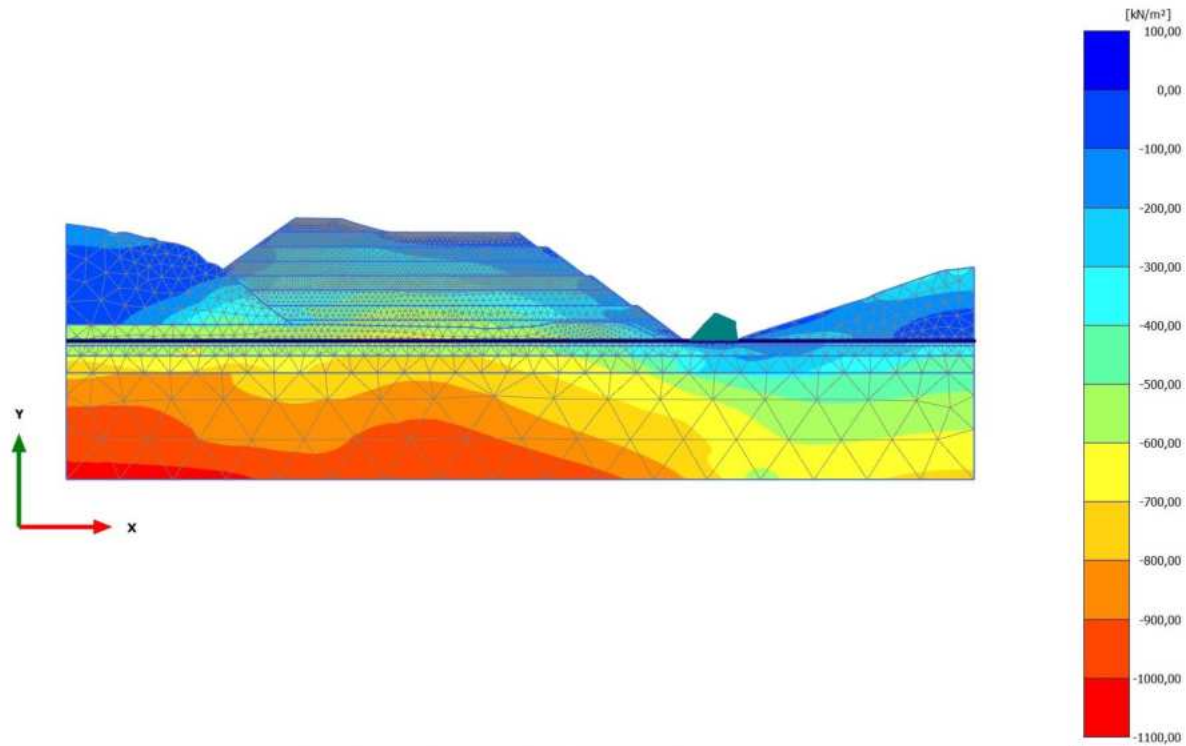


2.2.2.1.5 Calculation results, Phase\_4 [Phase\_4] (11/41), Cartesian effective stress  $\sigma'_{xx}$



**Cartesian effective stress  $\sigma'_{xx}$  (scaled up 0,0200 times)**  
Maximum value = 54,92 kN/m<sup>2</sup> (Element 4323 at Node 21396)  
Minimum value = -1058 kN/m<sup>2</sup> (Element 6870 at Node 30709)

2.2.2.1.6 Calculation results, Phase\_5\_static [Phase\_5] (12/44), Cartesian effective stress  $\sigma'_{xx}$

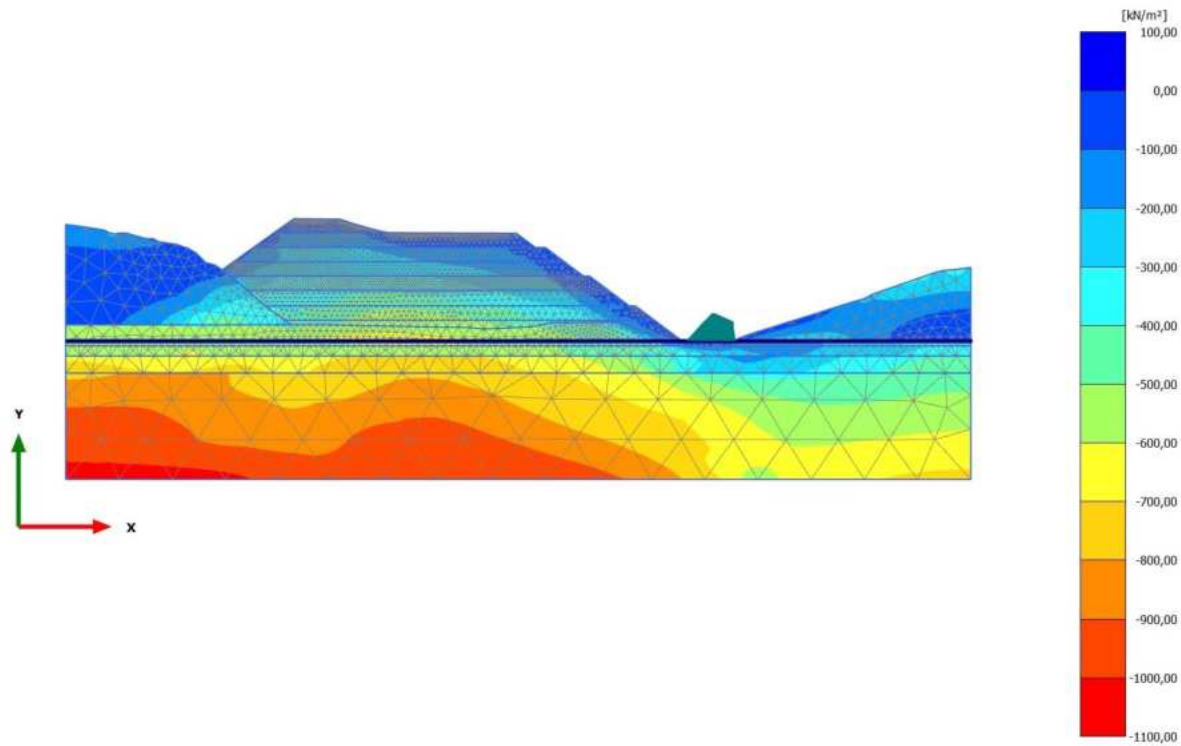


**Cartesian effective stress  $\sigma'_{xx}$  (scaled up 0,0200 times)**

Maximum value = 50,57 kN/m<sup>2</sup> (Element 4323 at Node 21396)

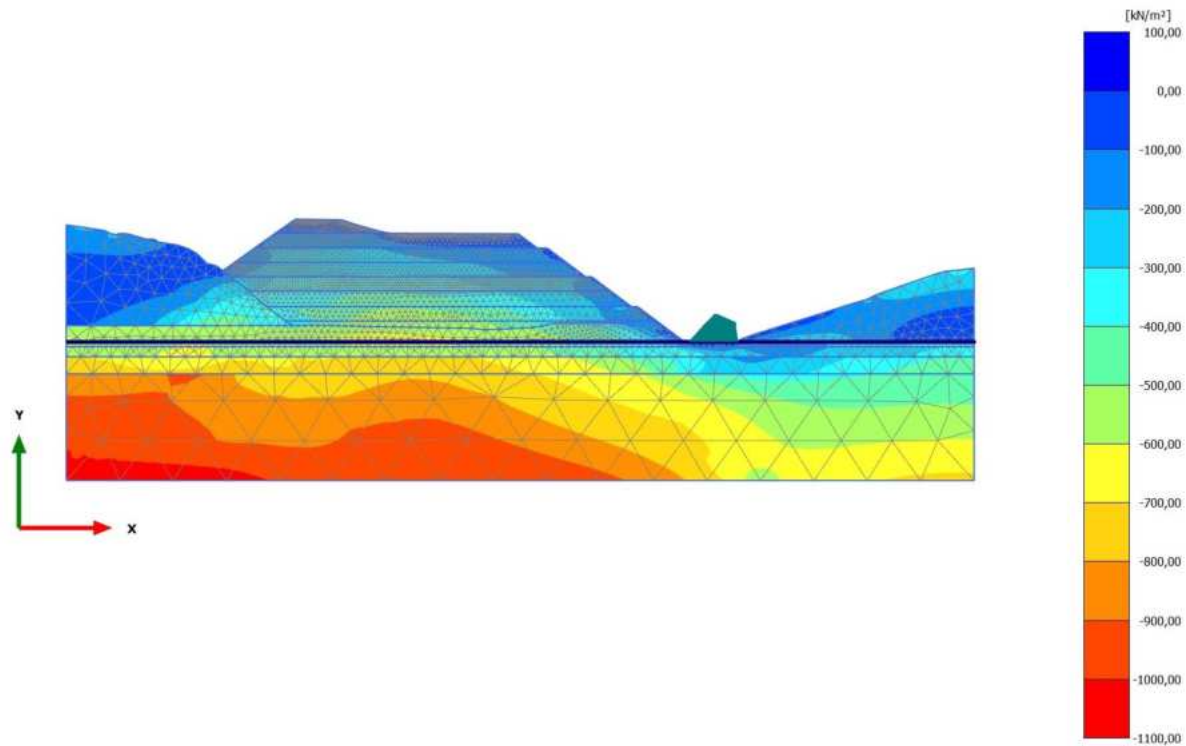
Minimum value = -1069 kN/m<sup>2</sup> (Element 6870 at Node 30709)

2.2.2.1.7 Calculation results, Phase\_6 FoS static [Phase\_6] (13/144), Cartesian effective stress  $\sigma'_{xx}$



**Cartesian effective stress  $\sigma'_{xx}$  (scaled up 0,0200 times)**  
Maximum value = 49,17 kN/m<sup>2</sup> (Element 4323 at Node 21396)  
Minimum value = -1070 kN/m<sup>2</sup> (Element 6870 at Node 30709)

2.2.2.1.8 Calculation results, Phase\_8\_seismic [Phase\_8] (2/147), Cartesian effective stress  $\sigma'_{xx}$

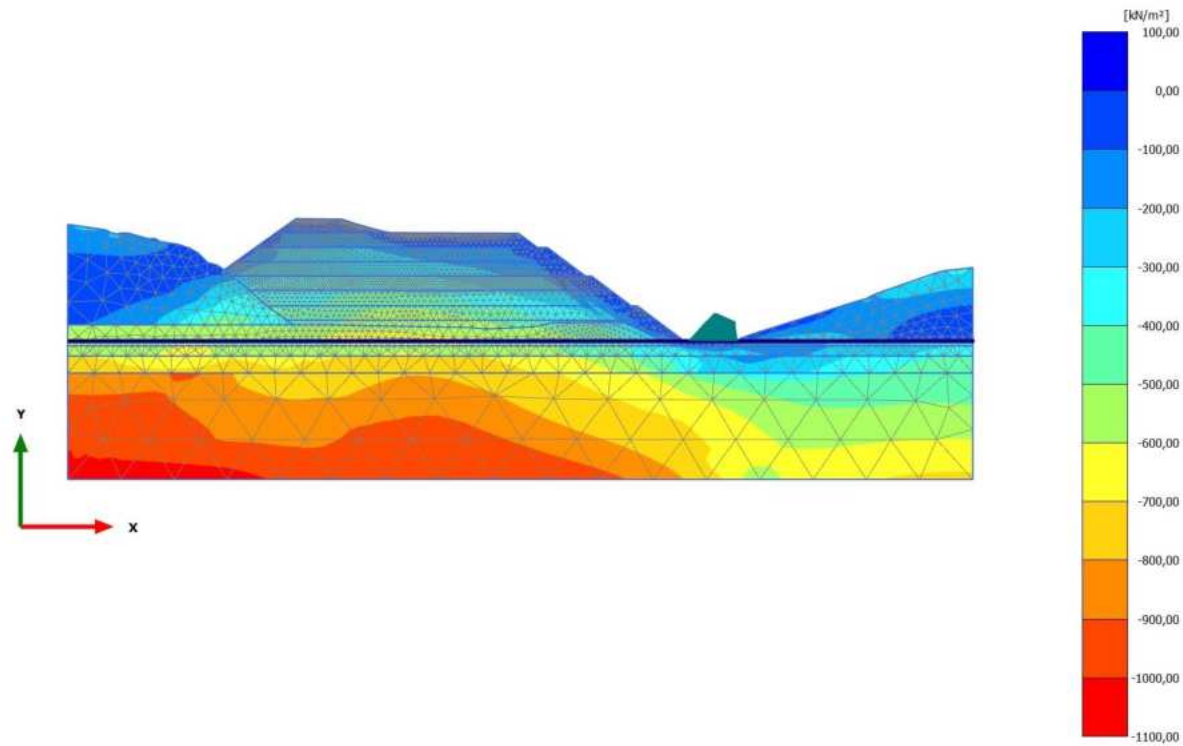


**Cartesian effective stress  $\sigma'_{xx}$  (scaled up 0,0200 times)**

Maximum value = 45,69 kN/m<sup>2</sup> (Element 4323 at Node 21396)

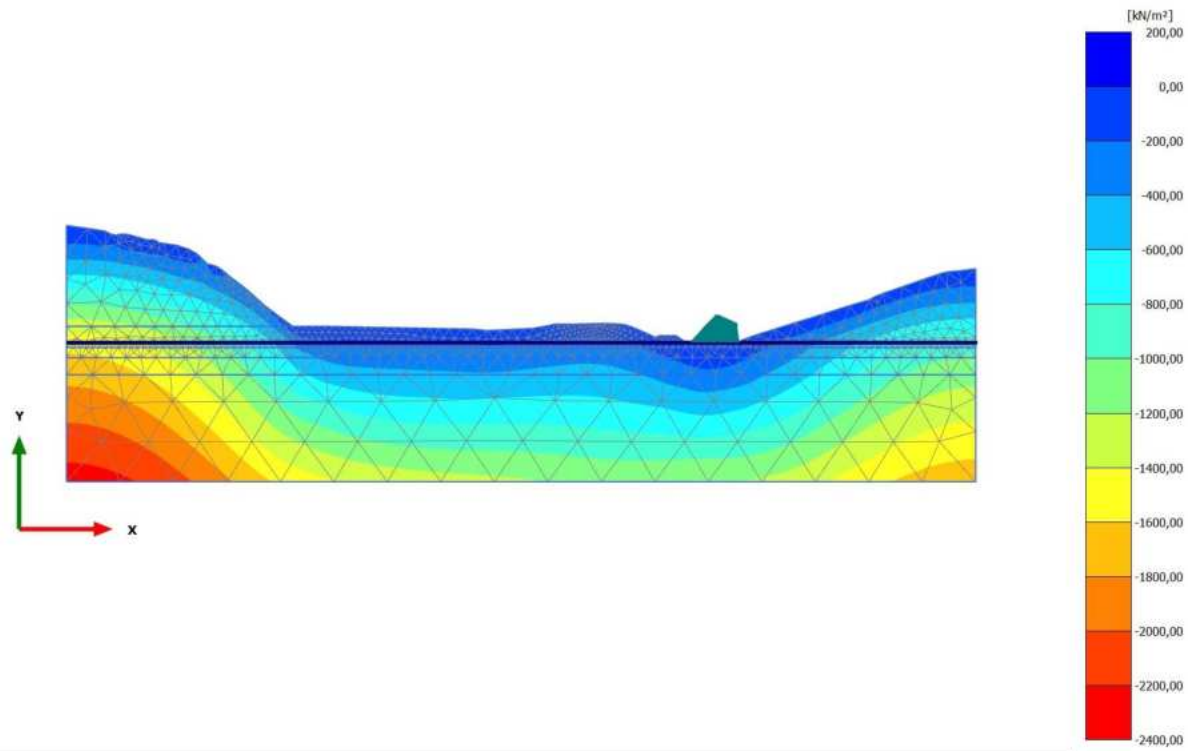
Minimum value = -1088 kN/m<sup>2</sup> (Element 6870 at Node 30709)

2.2.2.1.9 Calculation results, Phase\_7 FoS seismic [Phase\_7] (1/247), Cartesian effective stress  $\sigma'_{xx}$



**Cartesian effective stress  $\sigma'_{xx}$  (scaled up 0,0200 times)**  
Maximum value = 44,31 kN/m<sup>2</sup> (Element 4323 at Node 21396)  
Minimum value = -1089 kN/m<sup>2</sup> (Element 6870 at Node 30709)

2.2.2.2.1 Calculation results, Initial phase [InitialPhase] (0/20), Cartesian effective stress  $\sigma'_{yy}$

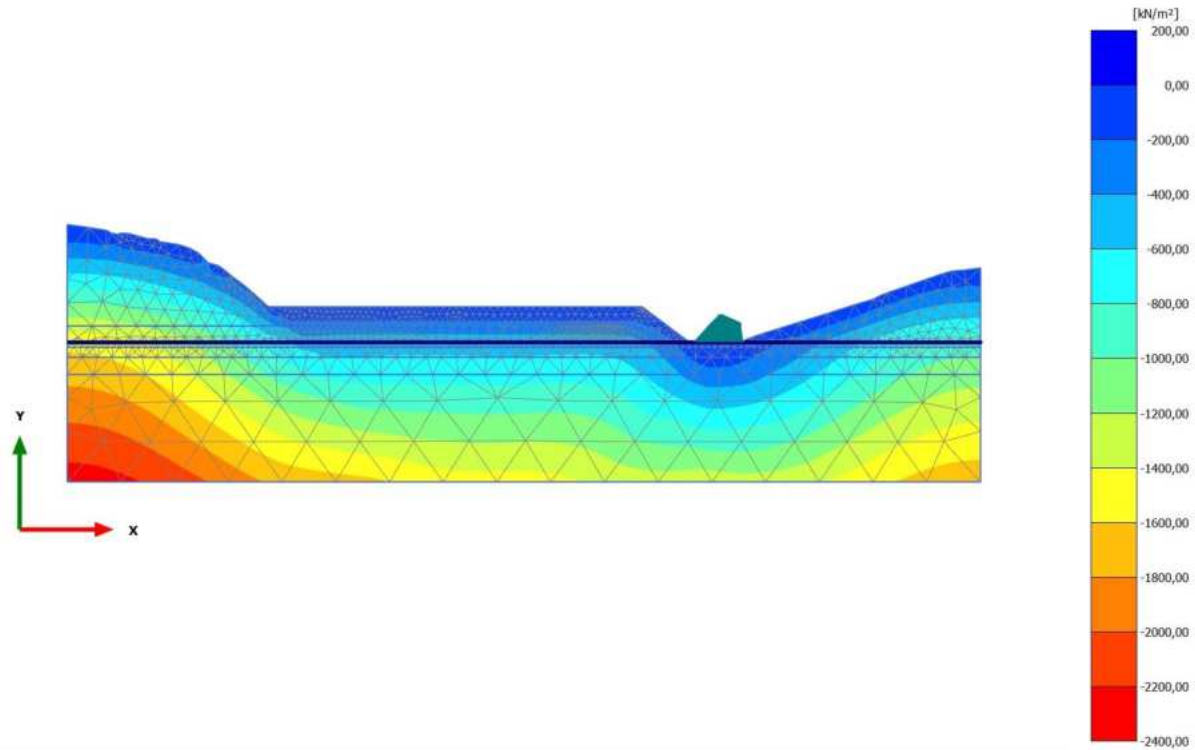


**Cartesian effective stress  $\sigma'_{yy}$  (scaled up  $5,00 \cdot 10^{-3}$  times)**

Maximum value = 8,198 kN/m<sup>2</sup> (Element 4219 at Node 21667)

Minimum value = -2293 kN/m<sup>2</sup> (Element 6870 at Node 30709)

2.2.2.2.2 Calculation results, Phase\_1 [Phase\_1] (8/27), Cartesian effective stress  $\sigma'_{yy}$

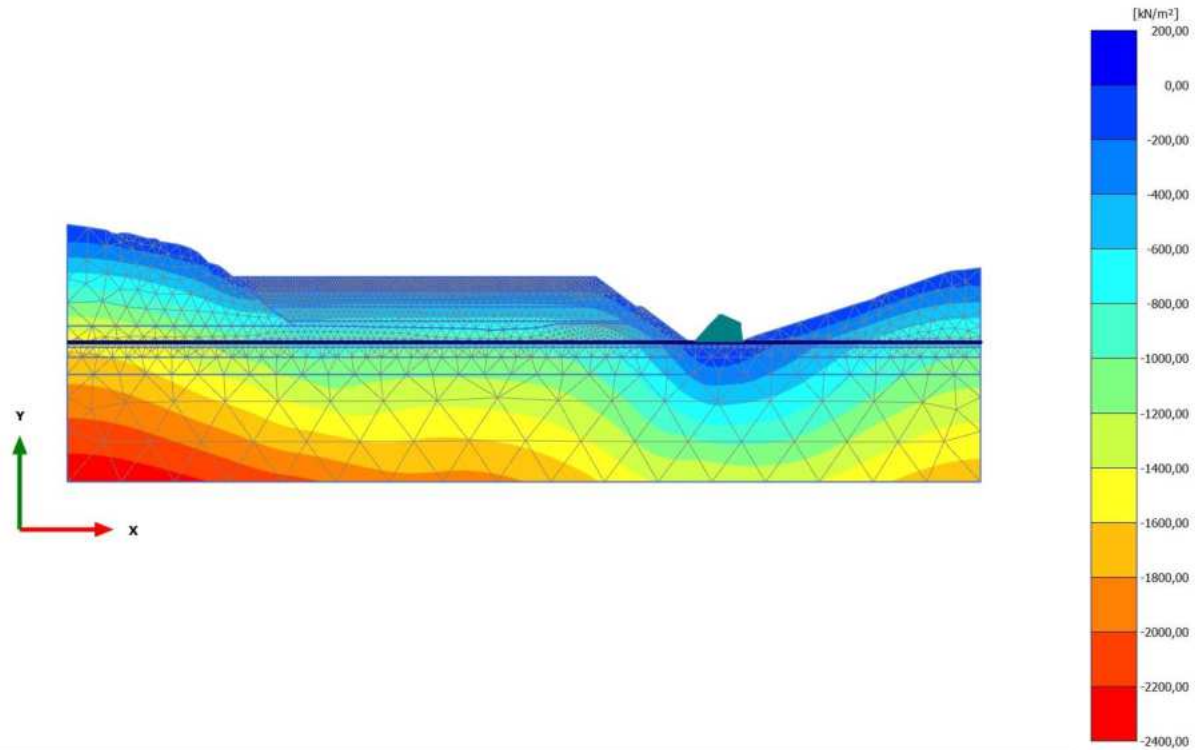


**Cartesian effective stress  $\sigma'_{yy}$  (scaled up  $5,00 \cdot 10^{-3}$  times)**

Maximum value = 7,568  $\text{kN/m}^2$  (Element 4219 at Node 21667)

Minimum value = -2295  $\text{kN/m}^2$  (Element 6870 at Node 30709)

2.2.2.2.3 Calculation results, Phase\_2 [Phase\_2] (9/33), Cartesian effective stress  $\sigma'_{yy}$



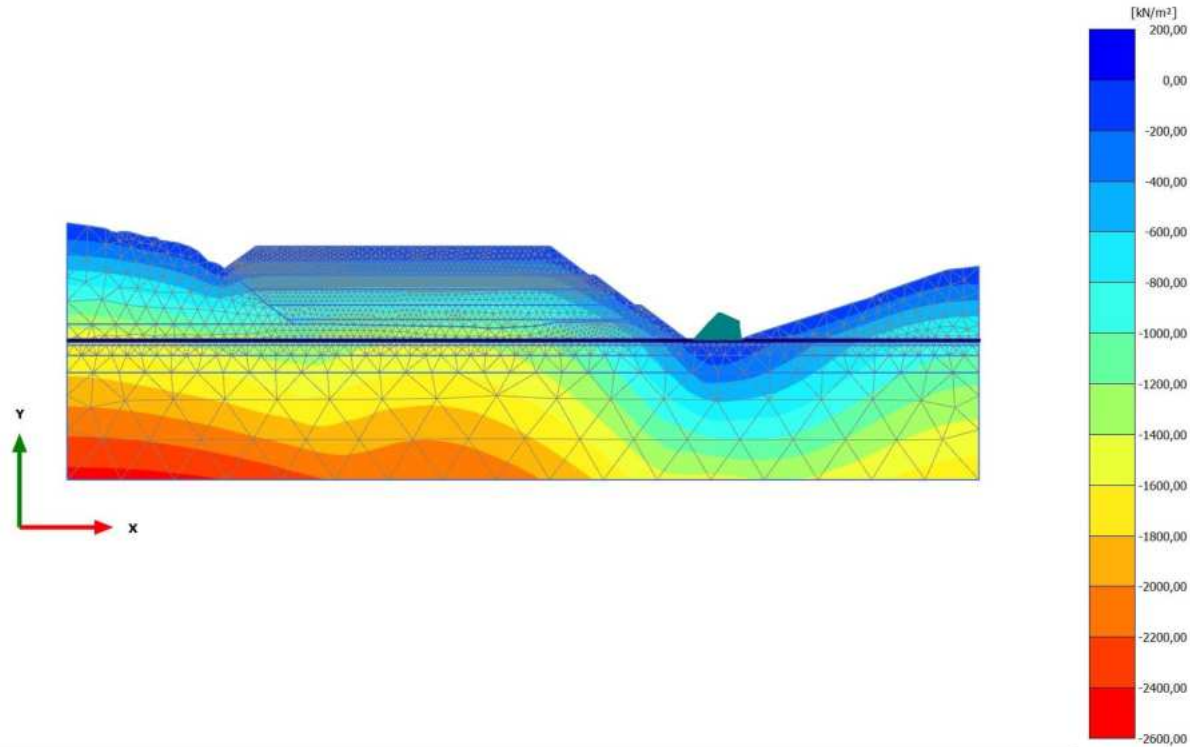
**Cartesian effective stress  $\sigma'_{yy}$  (scaled up  $5,00 \cdot 10^{-3}$  times)**

Maximum value = 6,899 kN/m<sup>2</sup> (Element 5251 at Node 40417)

Minimum value = -2356 kN/m<sup>2</sup> (Element 6870 at Node 30709)



2.2.2.2.4 Calculation results, Phase\_3 [Phase\_3] (10/38), Cartesian effective stress  $\sigma'_{yy}$

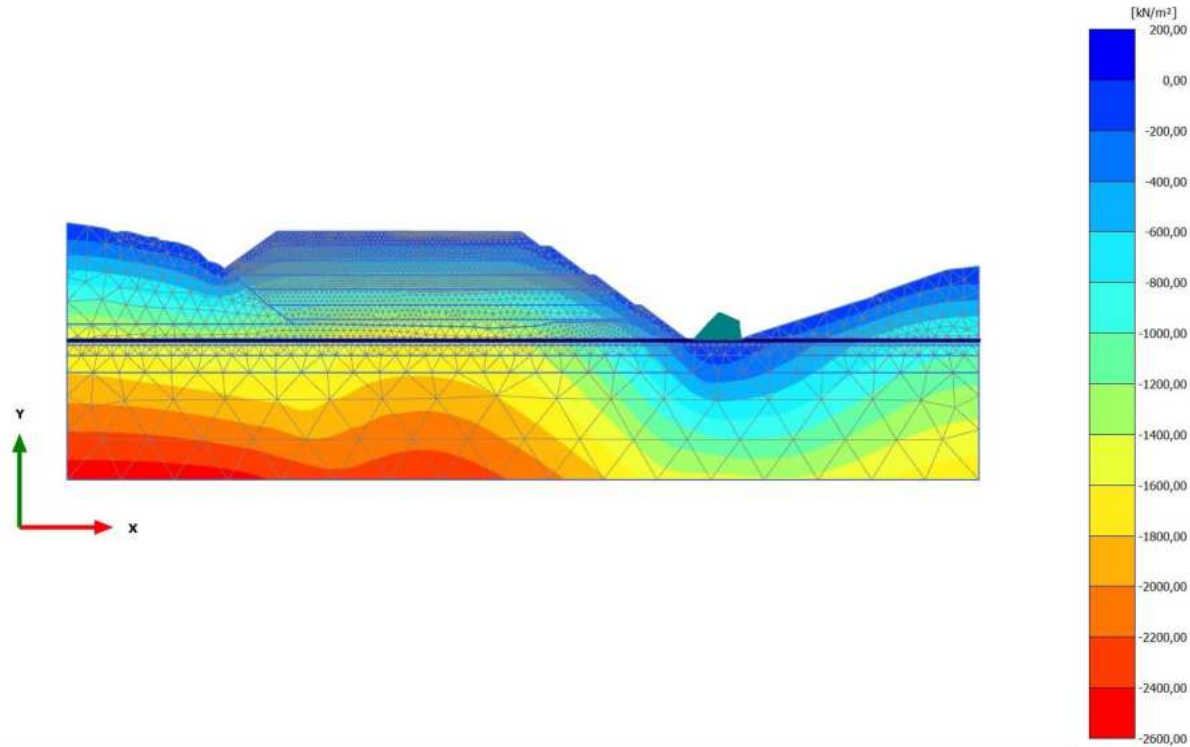


**Cartesian effective stress  $\sigma'_{yy}$  (scaled up  $5,00 \cdot 10^{-3}$  times)**

Maximum value = 6,908 kN/m<sup>2</sup> (Element 5251 at Node 40417)

Minimum value = -2483 kN/m<sup>2</sup> (Element 6870 at Node 30709)

2.2.2.2.5 Calculation results, Phase\_4 [Phase\_4] (11/41), Cartesian effective stress  $\sigma'_{yy}$

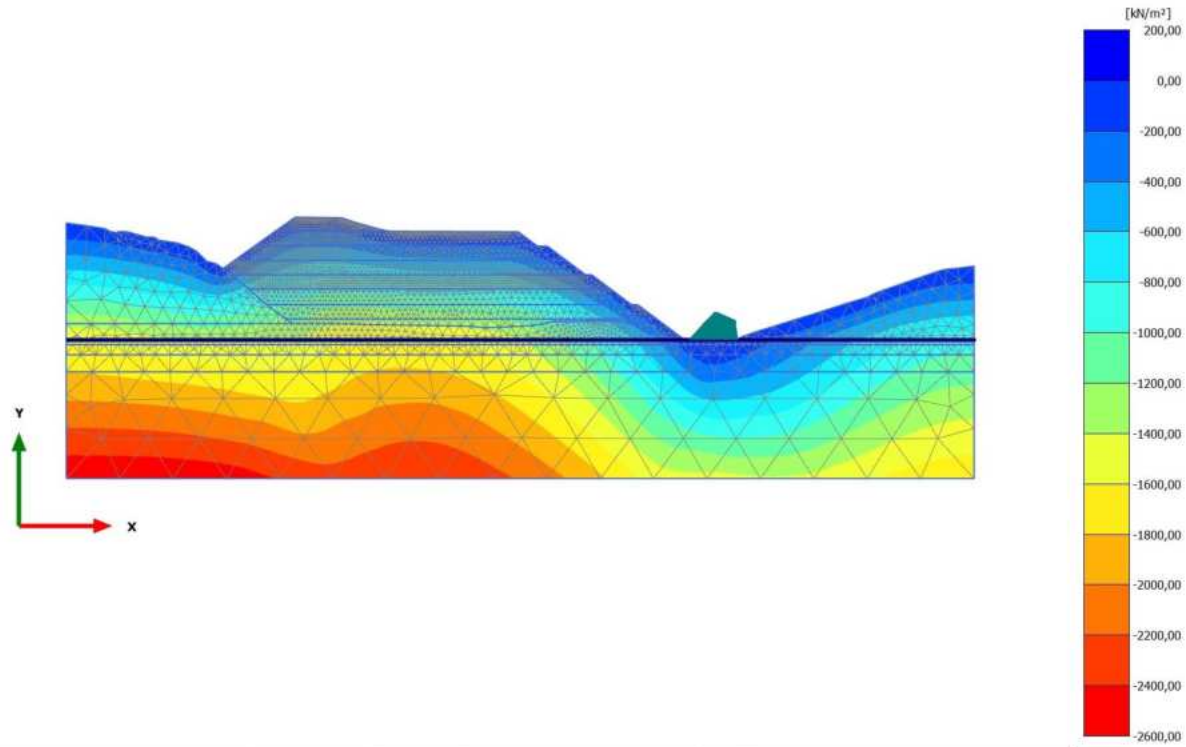


**Cartesian effective stress  $\sigma'_{yy}$  (scaled up  $5,00 \cdot 10^{-3}$  times)**

Maximum value = 6,915 kN/m<sup>2</sup> (Element 5251 at Node 40417)

Minimum value = -2538 kN/m<sup>2</sup> (Element 6870 at Node 30709)

2.2.2.2.6 Calculation results, Phase\_5\_static [Phase\_5] (12/44), Cartesian effective stress  $\sigma'_{yy}$

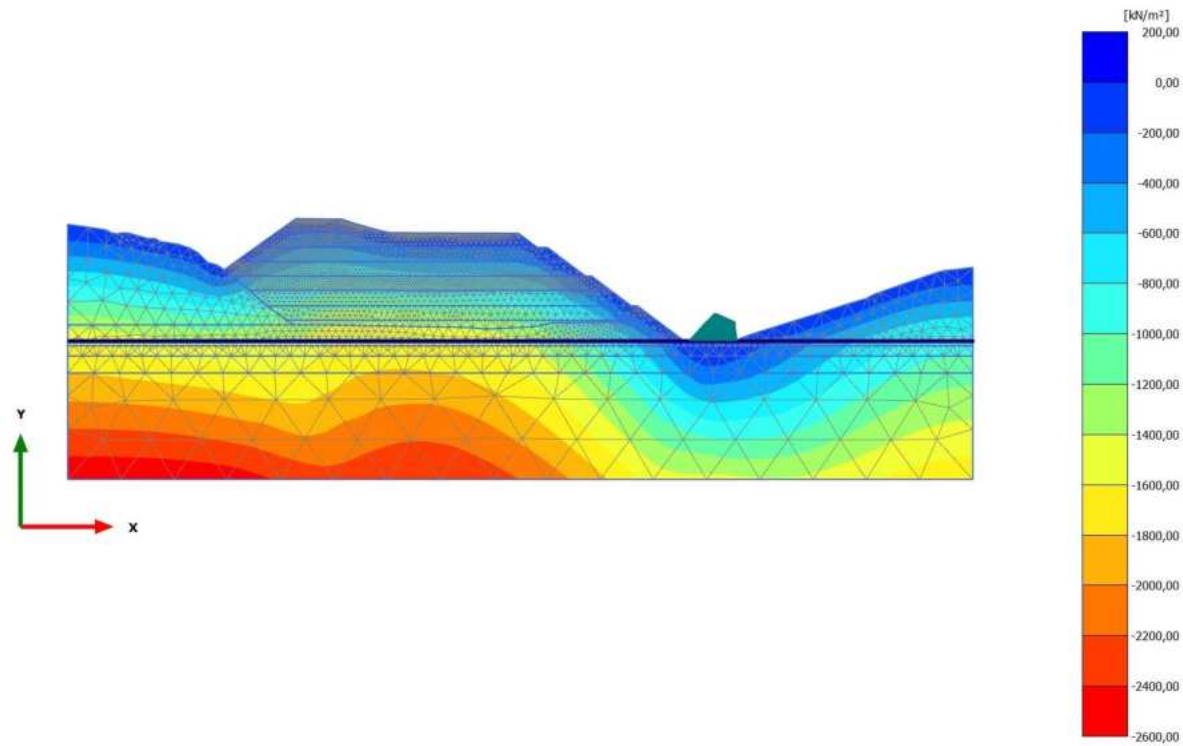


**Cartesian effective stress  $\sigma'_{yy}$  (scaled up  $5,00 \cdot 10^{-3}$  times)**

Maximum value = 6,914 kN/m<sup>2</sup> (Element 5251 at Node 40417)

Minimum value = -2566 kN/m<sup>2</sup> (Element 6870 at Node 30709)

2.2.2.2.7 Calculation results, Phase\_6 FoS static [Phase\_6] (13/144), Cartesian effective stress  $\sigma'_{yy}$

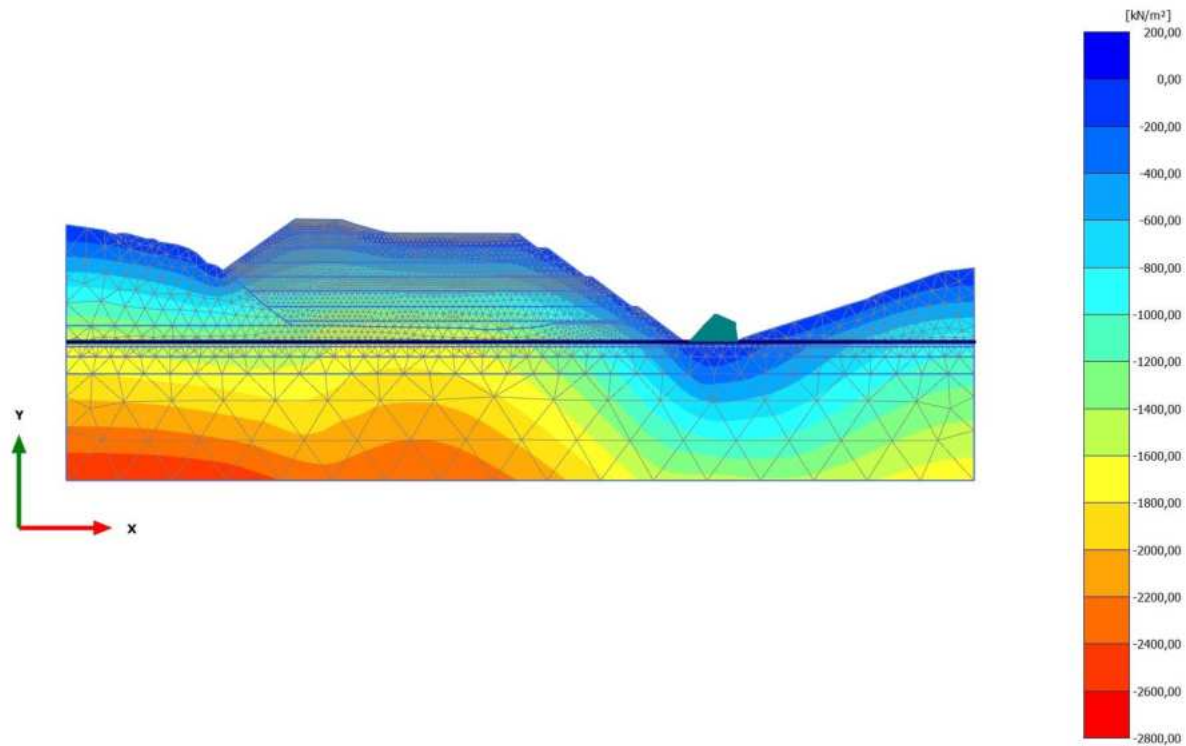


**Cartesian effective stress  $\sigma'_{yy}$  (scaled up  $5,00 \cdot 10^{-3}$  times)**

Maximum value = 7,675 kN/m<sup>2</sup> (Element 641 at Node 53401)

Minimum value = -2567 kN/m<sup>2</sup> (Element 6870 at Node 30709)

2.2.2.2.8 Calculation results, Phase\_8\_seismic [Phase\_8] (2/147), Cartesian effective stress  $\sigma'_{yy}$

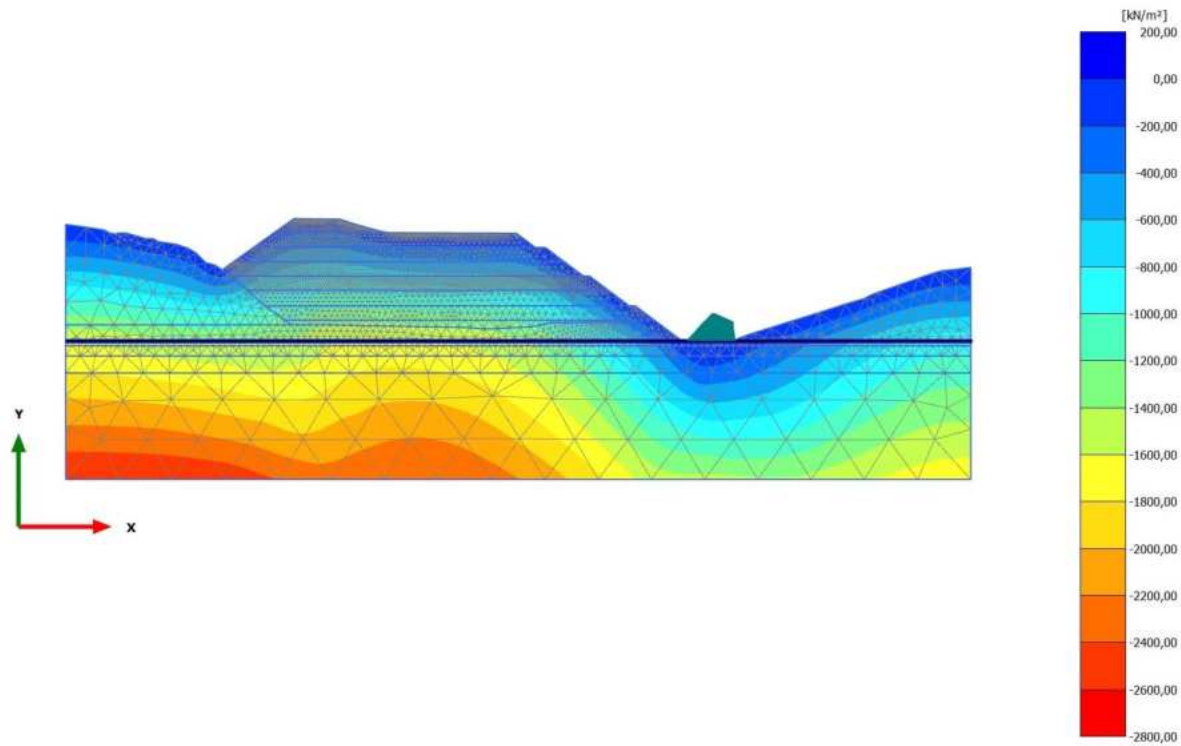


**Cartesian effective stress  $\sigma'_{yy}$  (scaled up  $5,00 \cdot 10^{-3}$  times)**

Maximum value = 6,761 kN/m<sup>2</sup> (Element 5251 at Node 40417)

Minimum value = -2609 kN/m<sup>2</sup> (Element 6870 at Node 30709)

2.2.2.2.9 Calculation results, Phase\_7 FoS seismic [Phase\_7] (1/247), Cartesian effective stress  $\sigma'_{yy}$

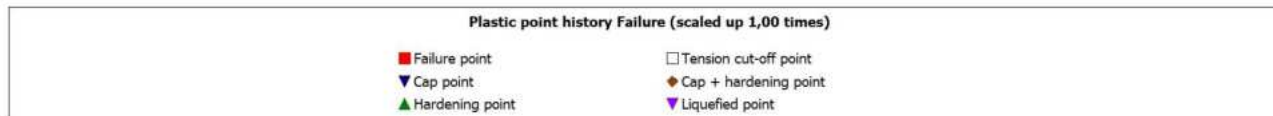
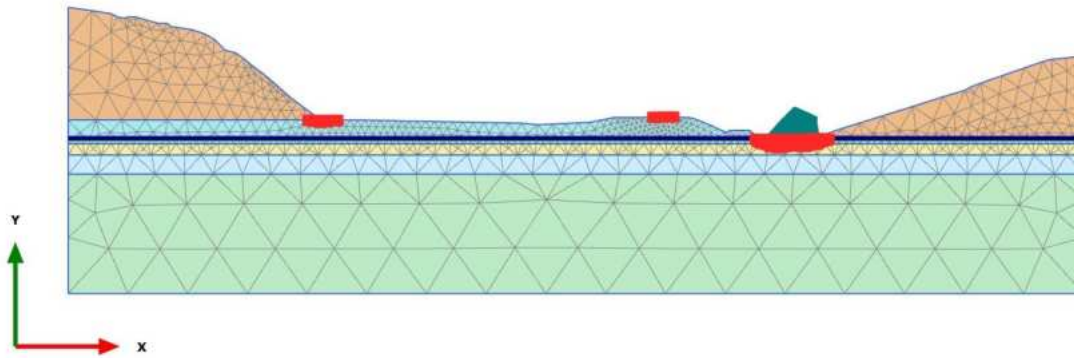


**Cartesian effective stress  $\sigma'_{yy}$  (scaled up  $5,00 \cdot 10^{-3}$  times)**

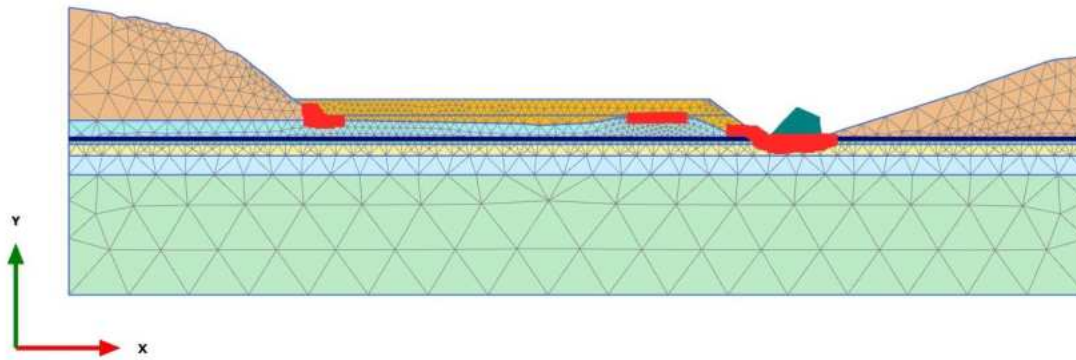
Maximum value = 13,15  $\text{kN/m}^2$  (Element 641 at Node 53401)

Minimum value = -2612  $\text{kN/m}^2$  (Element 6870 at Node 30709)

2.2.3.1.1 Calculation results, Initial phase [InitialPhase] (0/20), Plastic point history Failure

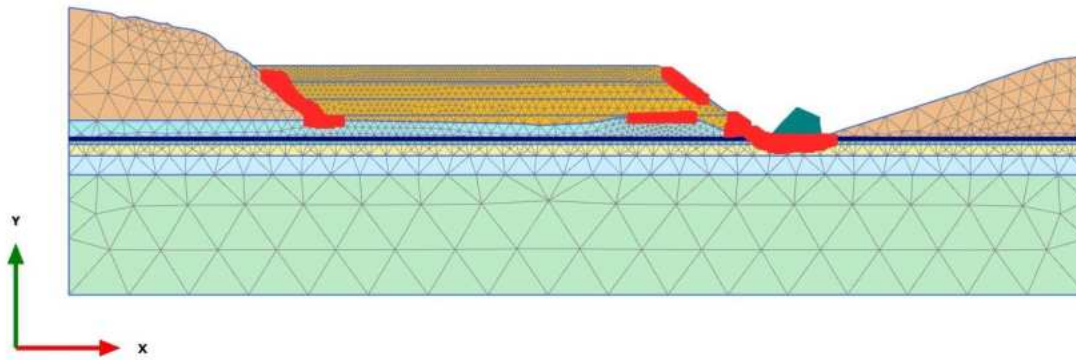


2.2.3.1.2 Calculation results, Phase\_1 [Phase\_1] (8/27), Plastic point history Failure

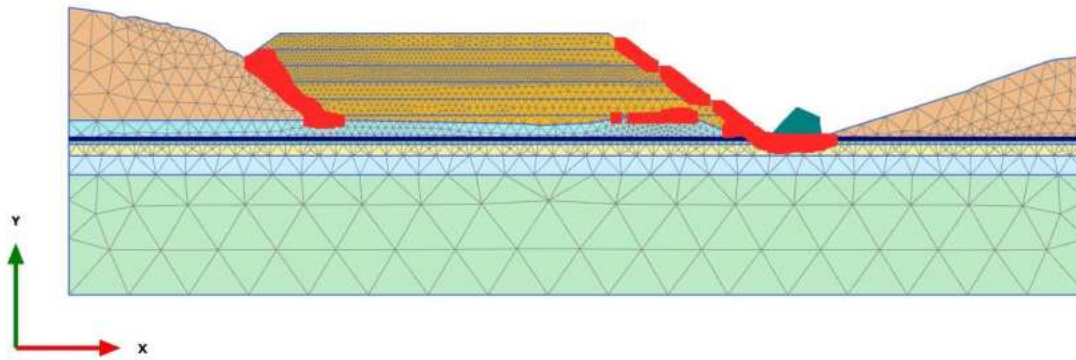




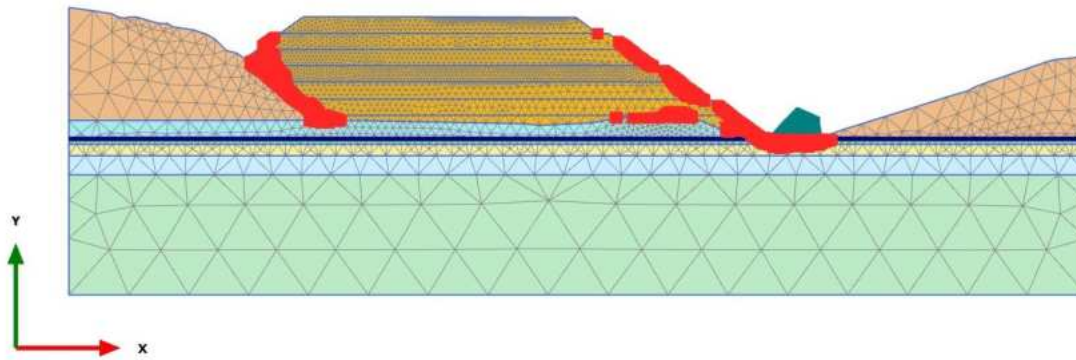
2.2.3.1.3 Calculation results, Phase\_2 [Phase\_2] (9/33), Plastic point history Failure



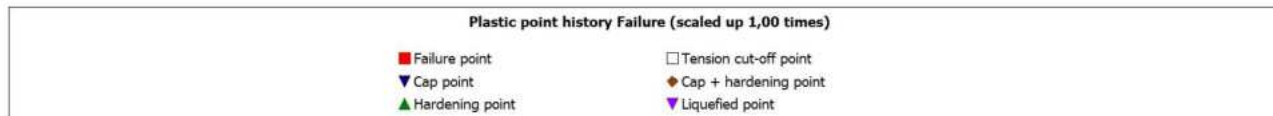
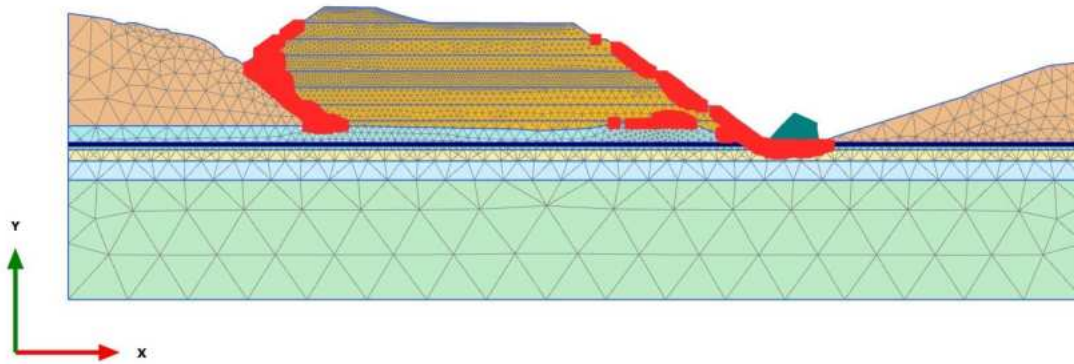
2.2.3.1.4 Calculation results, Phase\_3 [Phase\_3] (10/38), Plastic point history Failure



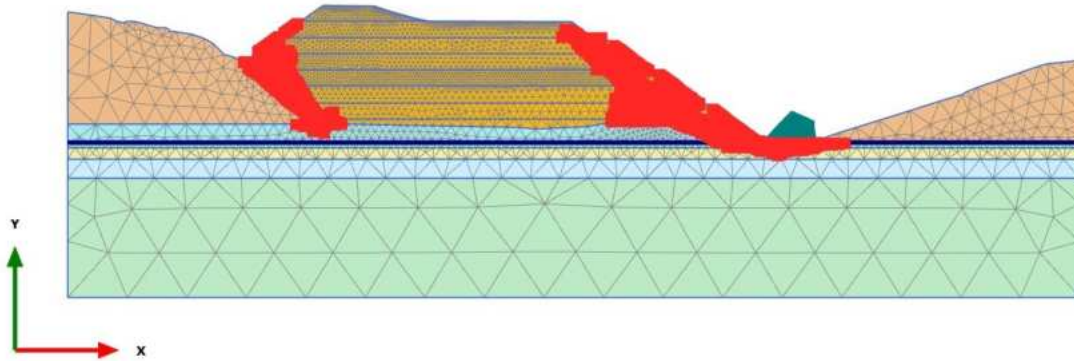
2.2.3.1.5 Calculation results, Phase\_4 [Phase\_4] (11/41), Plastic point history Failure



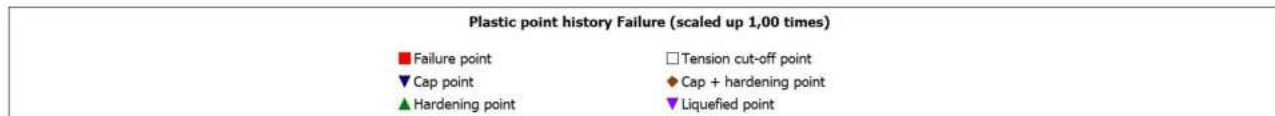
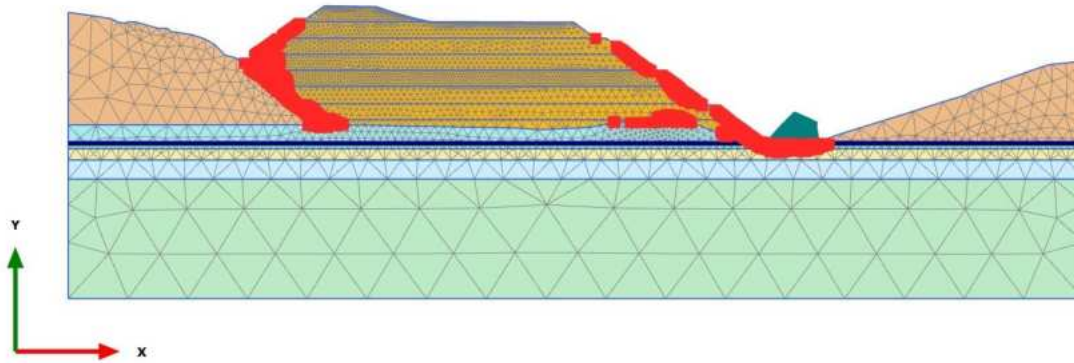
2.2.3.1.6 Calculation results, Phase\_5\_static [Phase\_5] (12/44), Plastic point history Failure



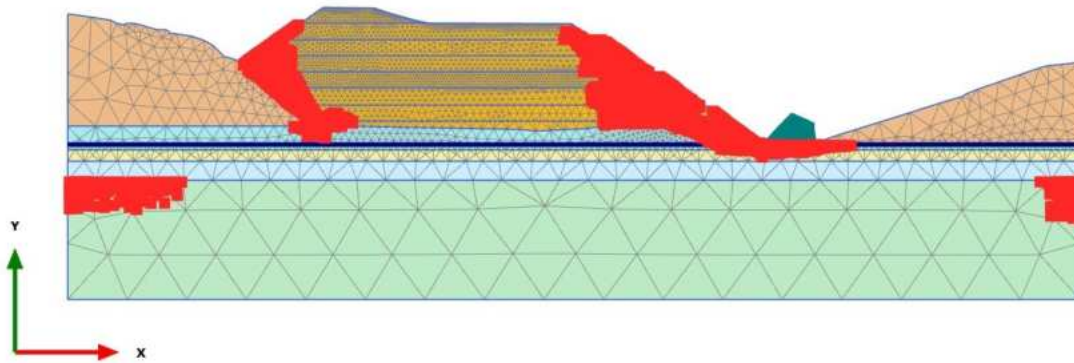
2.2.3.1.7 Calculation results, Phase\_6 FoS static [Phase\_6] (13/144), Plastic point history Failure



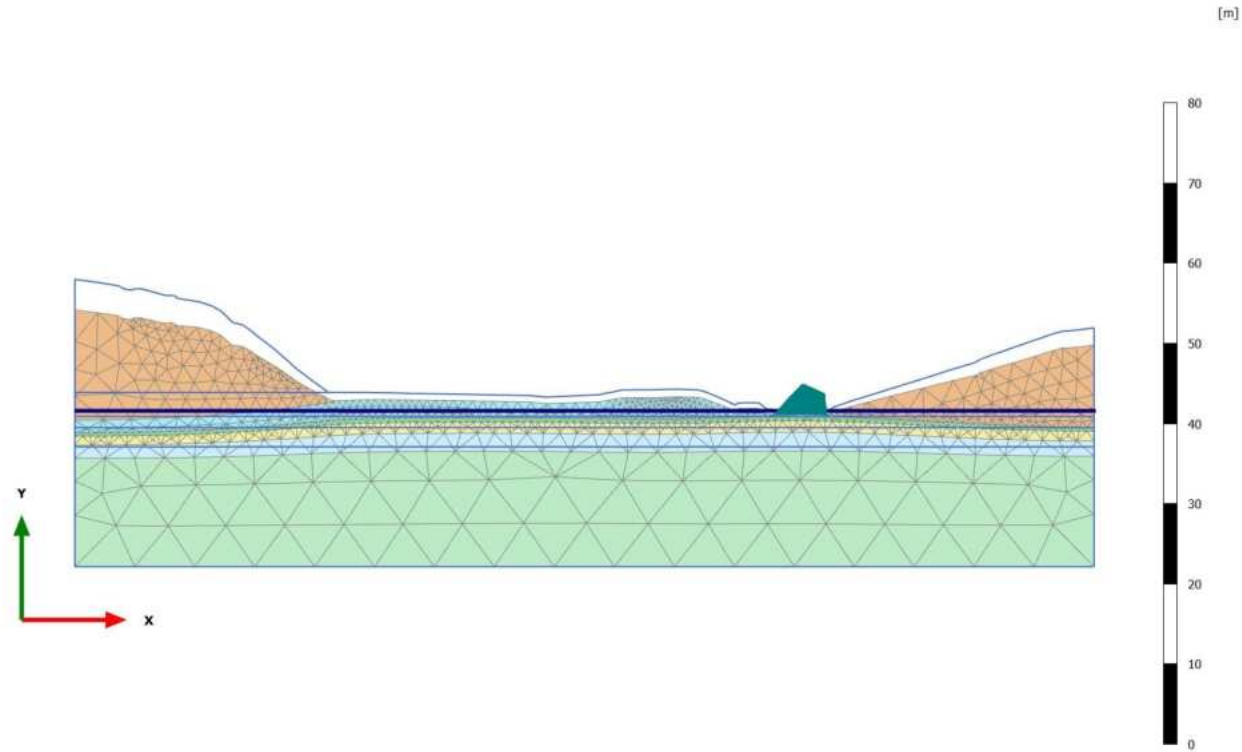
2.2.3.1.8 Calculation results, Phase\_8\_seismic [Phase\_8] (2/147), Plastic point history Failure



2.2.3.1.9 Calculation results, Phase\_7 FoS seismic [Phase\_7] (1/247), Plastic point history Failure



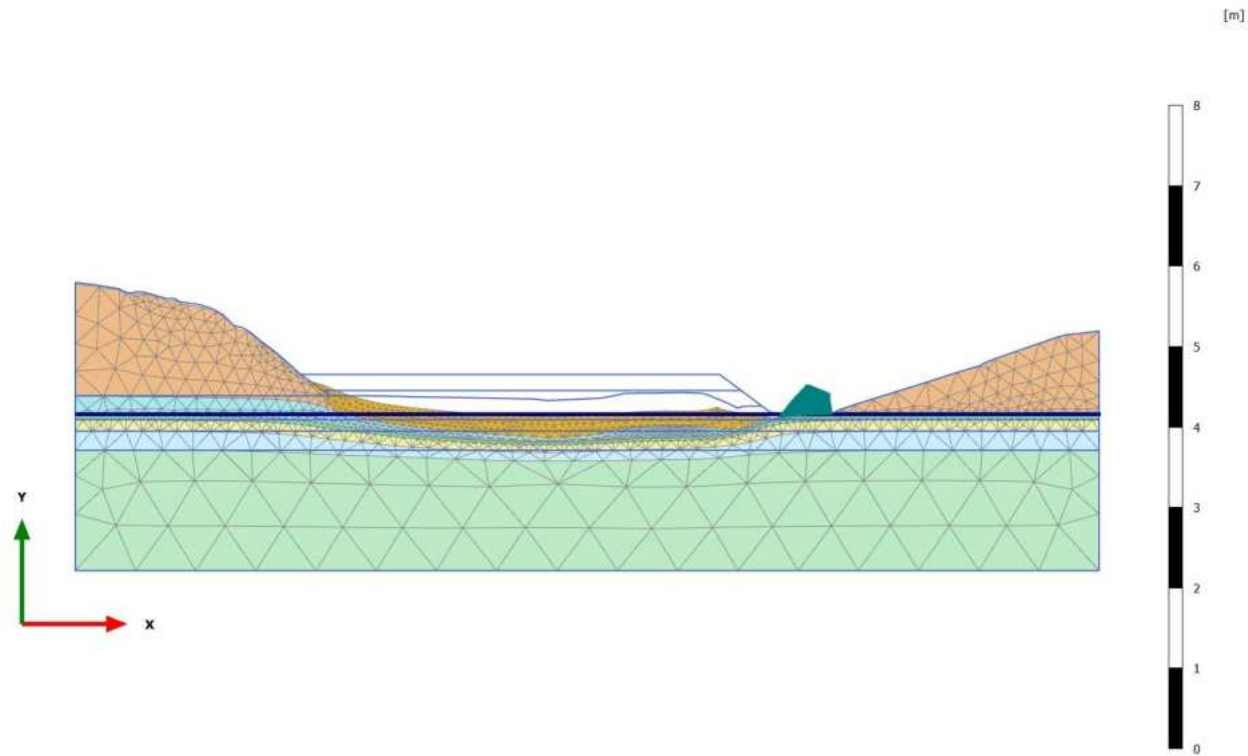
4.1.1 Calculation results, Initial phase [InitialPhase] (0/20), Deformed mesh |u|



**Deformed mesh |u| (scaled up 5,00 times)**  
Maximum value = 3,804 m (Element 4219 at Node 21669)

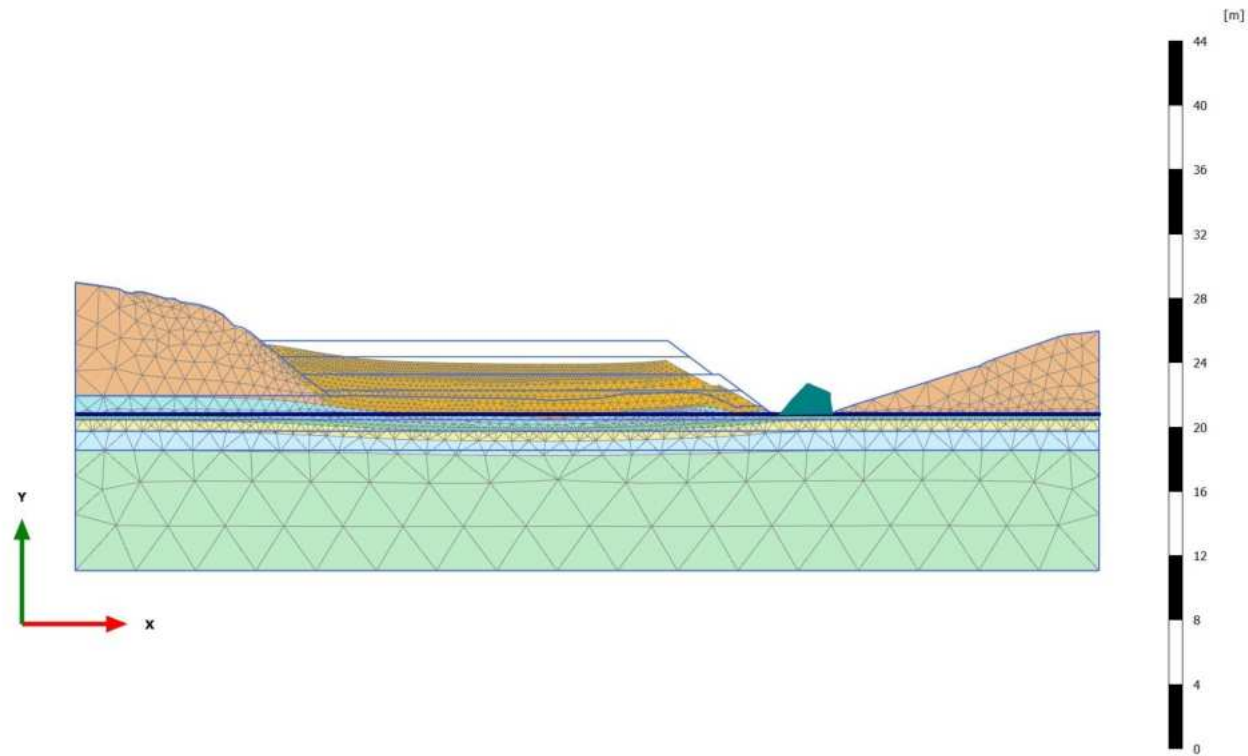


4.1.2 Calculation results, Phase\_1 [Phase\_1] (8/27), Deformed mesh |u|



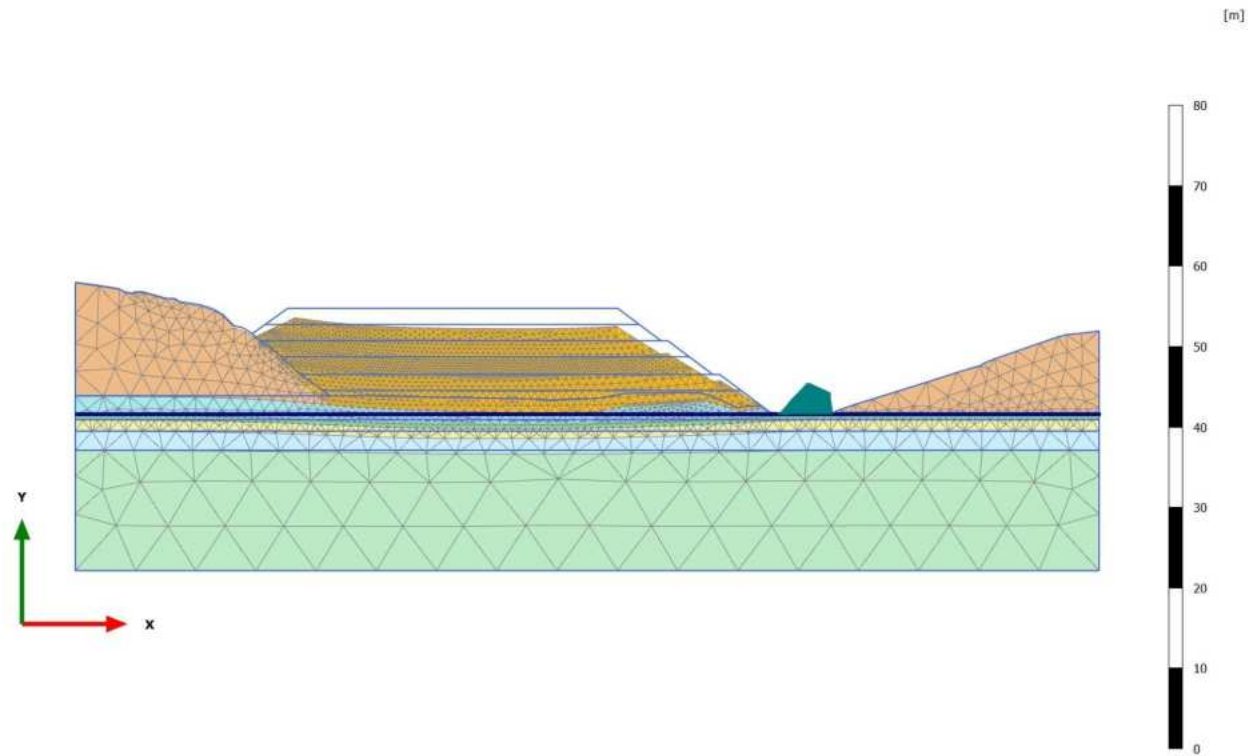
**Deformed mesh |u| (scaled up 50,0 times)**  
Maximum value = 0,5250 m (Element 4985 at Node 39841)

4.1.3 Calculation results, Phase\_2 [Phase\_2] (9/33), Deformed mesh |u|



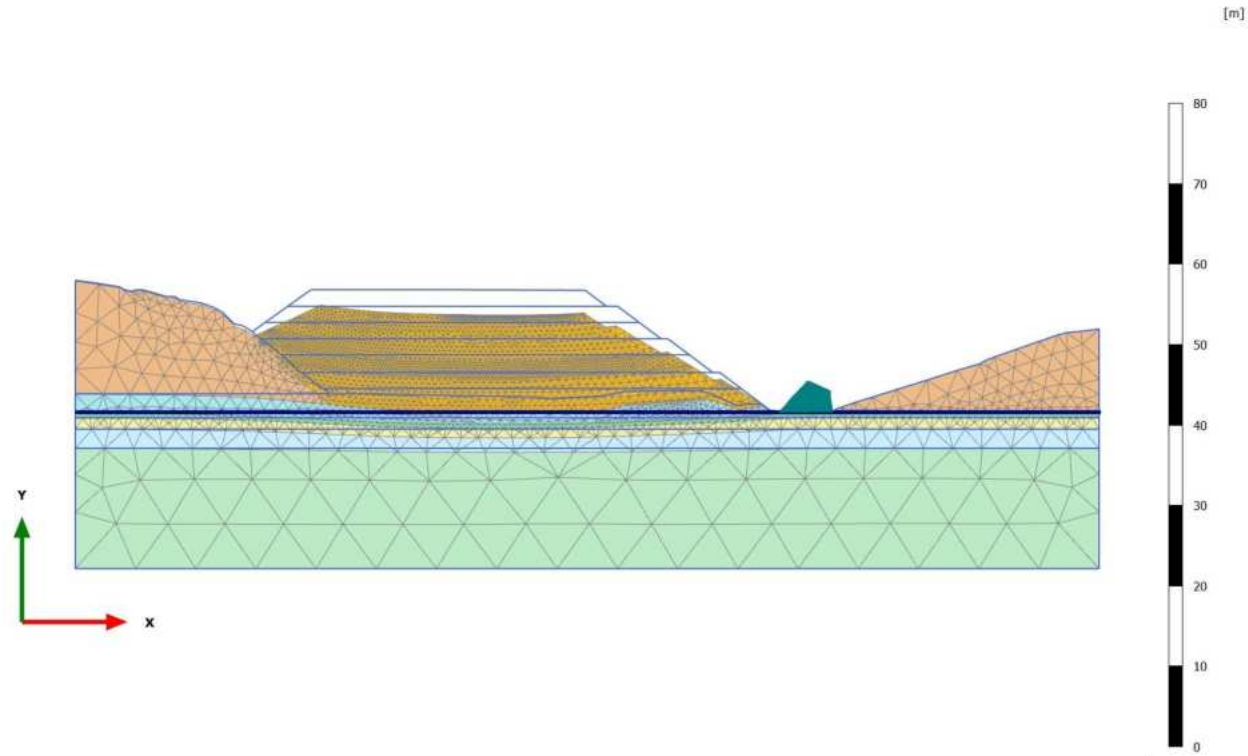
**Deformed mesh |u| (scaled up 10,0 times)**  
Maximum value = 1,450 m (Element 3991 at Node 45019)

4.1.4 Calculation results, Phase\_3 [Phase\_3] (10/38), Deformed mesh |u|



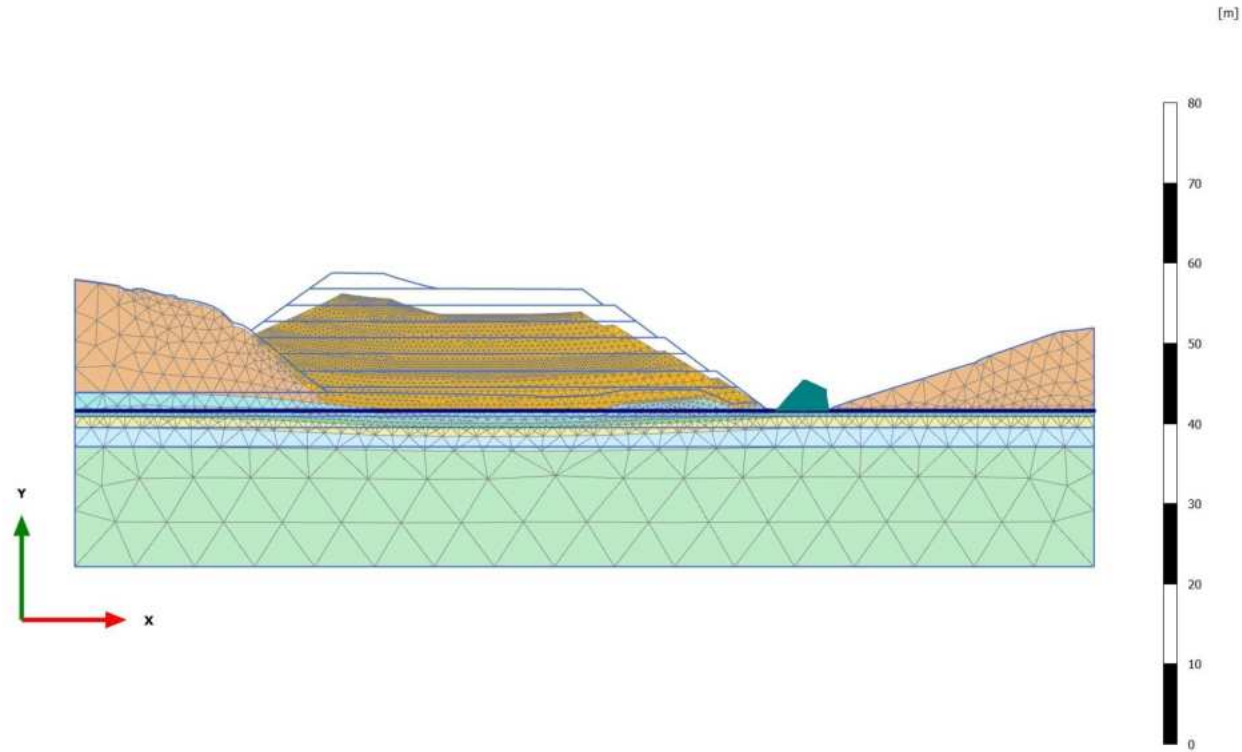
**Deformed mesh |u| (scaled up 5,00 times)**  
Maximum value = 2,530 m (Element 1883 at Node 37312)

4.1.5 Calculation results, Phase\_4 [Phase\_4] (11/41), Deformed mesh |u|



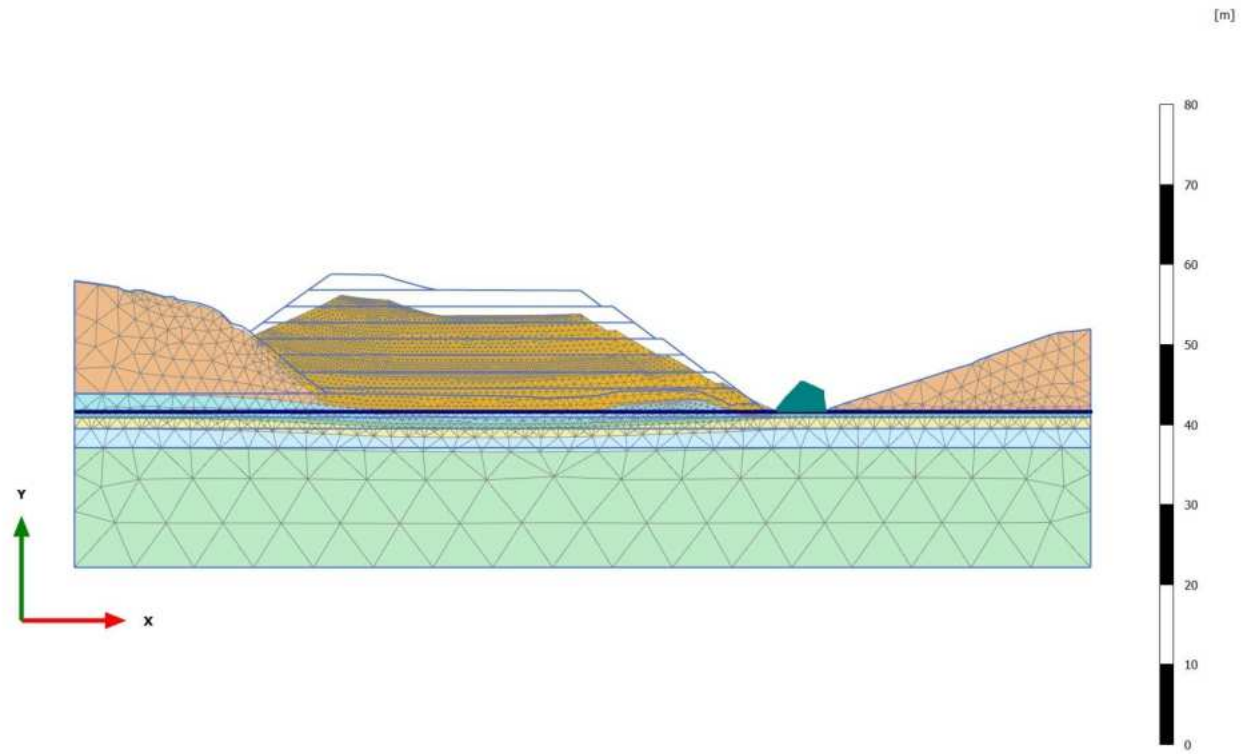
**Deformed mesh |u| (scaled up 5,00 times)**  
Maximum value = 3,135 m (Element 1100 at Node 27993)

4.1.6 Calculation results, Phase\_5\_static [Phase\_5] (12/44), Deformed mesh |u|



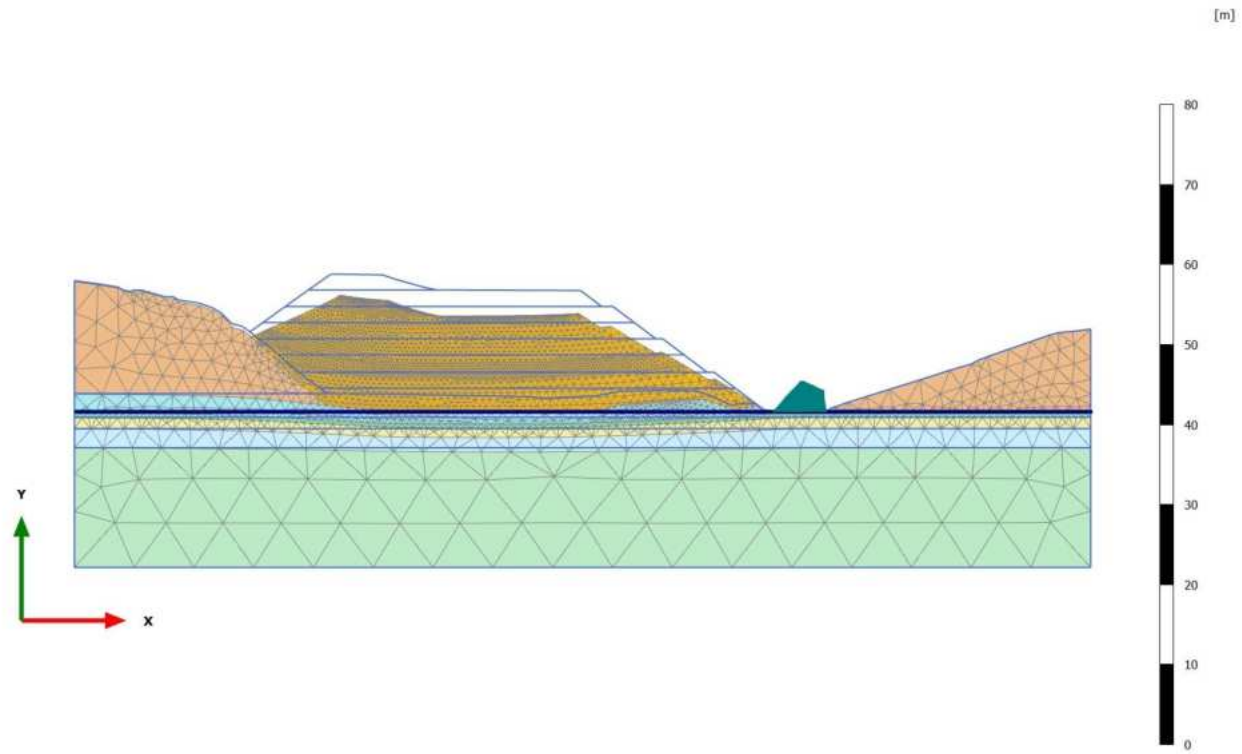
**Deformed mesh |u| (scaled up 5,00 times)**  
Maximum value = 3,295 m (Element 233 at Node 5510)

4.1.7 Calculation results, Phase\_6 FoS static [Phase\_6] (13/144), Deformed mesh |u|



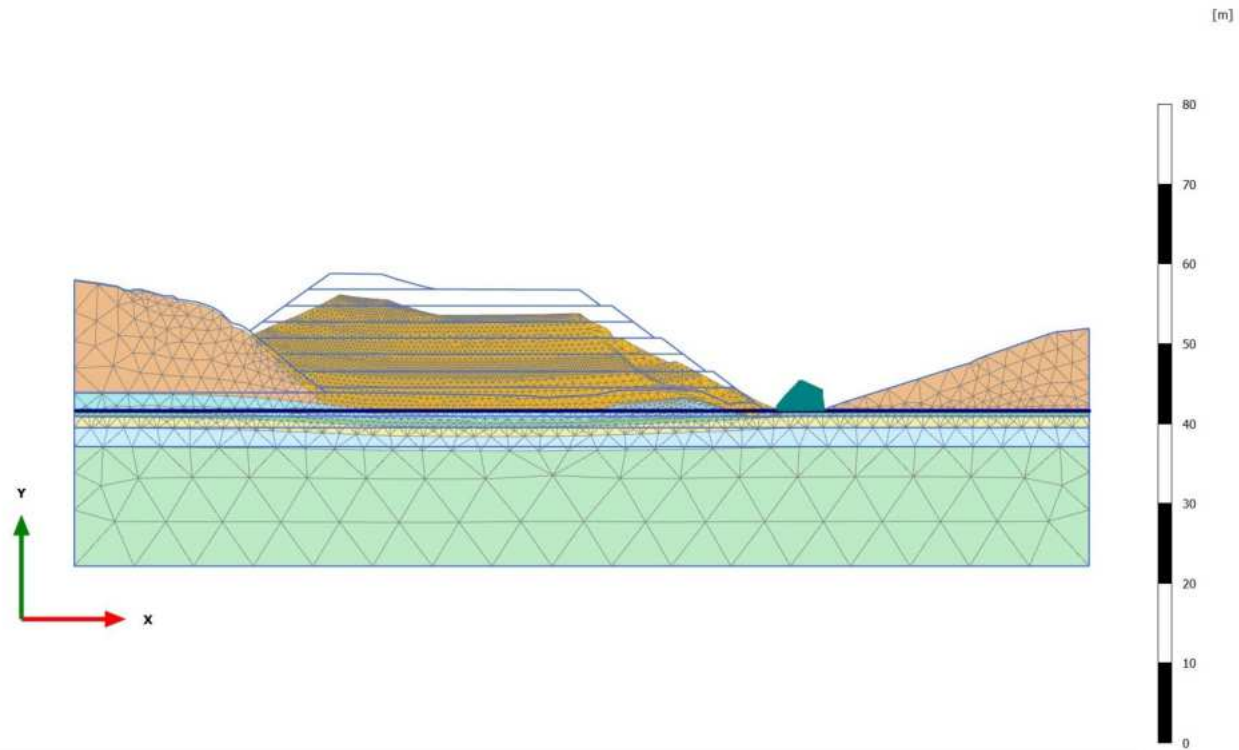
**Deformed mesh |u| (scaled up 5,00 times)**  
Maximum value = 3,302 m (Element 259 at Node 4918)

4.1.8 Calculation results, Phase\_8\_seismic [Phase\_8] (2/147), Deformed mesh |u|



**Deformed mesh |u| (scaled up 5,00 times)**  
Maximum value = 3,306 m (Element 137 at Node 5991)

4.1.9 Calculation results, Phase\_7 FoS seismic [Phase\_7] (1/247), Deformed mesh |u|



**Deformed mesh |u| (scaled up 5,00 times)**  
Maximum value = 4,361 m (Element 1786 at Node 55112)



## ANHANG 13 – ERGEBNISSE DER SLIDE SLU – ABSCHNITT 3

## APPENDICE 13 – RISULTATI ANALISI SLIDE SLU – SEZIONE 3

SLIDE - An Interactive Slope Stability Program

Date Created: 16/11/2018, 18:41:47

Software Version: 9.023

### Table of Contents

Project Summary .....	3
General Settings .....	4
Design Standard .....	5
Analysis Options .....	6
Groundwater Analysis .....	7
Random Numbers .....	8
Surface Options .....	9
Seismic Loading .....	10
Materials .....	11
Global Minimums .....	13
Method: bishop simplified .....	13
Valid and Invalid Surfaces .....	14
Method: bishop simplified .....	14
Slice Data .....	15
Global Minimum Query (bishop simplified) - Safety Factor: 1.2769 .....	15
Interslice Data .....	16
Global Minimum Query (bishop simplified) - Safety Factor: 1.2769 .....	16
Entity Information .....	17
Water Table .....	17
External Boundary .....	17
Material Boundary .....	19

# Slide2 Analysis Information

## SLIDE - An Interactive Slope Stability Program

### 15. PROJECT SUMMARY

---

Slide2 Modeler Version:	9.023
Compute Time:	00h:00m:00.358s
Date Created:	16/11/2018, 18:41:47

## 16. GENERAL SETTINGS

---

Units of Measurement:	Metric Units
Time Units:	days
Permeability Units:	meters/second
Data Output:	Standard
Failure Direction:	Left to Right

## 17. DESIGN STANDARD

Selected Type:	Eurocode 7 (User Defined)	
Name:	User Defined 1	
	<b>Type</b>	<b>Partial Factor</b>
Permanent Actions: Unfavourable	1	
Permanent Actions: Favourable	1	
Variable Actions: Unfavourable	1	
Variable Actions: Favourable	1	
Effective cohesion	1.25	
Coefficient of shearing resistance	1.25	
Undrained strength	1	
Weight density	1	
Shear strength (other models)	1	
Earth resistance	1	
Tensile and plate strength	1	
Shear strength	1	
Compressive strength	1	
Bond strength	1	
Seismic Coefficient	1	

## 18. ANALYSIS OPTIONS

---

Slices Type:	Vertical
<b>Analysis Methods Used</b>	
	Bishop simplified
Number of slices:	25
Tolerance:	0.005
Maximum number of iterations:	50
Check $m_{\alpha} < 0.2$ :	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

## 19. GROUNDWATER ANALYSIS

---

Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [kN/m <sup>3</sup> ]:	9.81
Use negative pore pressure cutoff:	Yes
Maximum negative pore pressure [kPa]:	0
Advanced Groundwater Method:	None

## 20. RANDOM NUMBERS

---

Pseudo-random Seed:

10116

Random Number Generation Method:

Park and Miller v.3

## 21. SURFACE OPTIONS

---

Surface Type:	Circular
Search Method:	Auto Refine Search
Divisions along slope:	10
Circles per division:	10
Number of iterations:	10
Divisions to use in next iteration:	50%
Composite Surfaces:	Disabled
Minimum Elevation:	Not Defined
Minimum Depth:	Not Defined
Minimum Area:	Not Defined
Minimum Weight:	Not Defined

## 22. SEISMIC LOADING

---

Advanced seismic analysis:	No
Staged pseudostatic analysis:	No



## 23. MATERIALS

**A**

Color	
Strength Type	Mohr-Coulomb
Unit Weight [kN/m3]	21
Cohesion [kPa]	45
Friction Angle [deg]	37
Water Surface	Water Table
Hu Value	Automatically Calculated

**Roccia**

Color	
Strength Type	Mohr-Coulomb
Unit Weight [kN/m3]	20
Cohesion [kPa]	400
Friction Angle [deg]	29.26
Water Surface	Water Table
Hu Value	Automatically Calculated

**Strato 1**

Color	
Strength Type	Mohr-Coulomb
Unit Weight [kN/m3]	20
Cohesion [kPa]	5
Friction Angle [deg]	38
Water Surface	Water Table
Hu Value	Automatically Calculated

**Strato 2**

Color	
Strength Type	Mohr-Coulomb
Unit Weight [kN/m3]	20
Cohesion [kPa]	0
Friction Angle [deg]	40
Water Surface	Water Table
Hu Value	Automatically Calculated

**Strato 3**


Color	
Strength Type	Mohr-Coulomb
Unit Weight [kN/m3]	20
Cohesion [kPa]	0
Friction Angle [deg]	42
Water Surface	Water Table
Hu Value	Automatically Calculated

**Strato 4**

Color	
-------	---

---

Strength Type	Mohr-Coulomb
Unit Weight [kN/m <sup>3</sup> ]	20
Cohesion [kPa]	0

Friction Angle [deg]	36
Water Surface	Water Table
Hu Value	Automatically Calculated
<b>Strato 5</b>	
Color	
Strength Type	Mohr-Coulomb
Unit Weight [kN/m3]	20
Cohesion [kPa]	0
Friction Angle [deg]	36
Water Surface	Water Table
Hu Value	Automatically Calculated

## 24. GLOBAL MINIMUMS

---

### 24.1 METHOD: BISHOP SIMPLIFIED

---

	<b>FS</b>	<b>1.276900</b>
Center:		608.270, 738.346
Radius:		121.190
Left Slip Surface Endpoint:		499.910, 684.076
Right Slip Surface Endpoint:		619.209, 617.650
Left Slope Intercept:		499.910 684.076
Right Slope Intercept:		619.209 618.000
Resisting Moment:		2.64366e+06 kN-m
Driving Moment:		2.07038e+06 kN-m
Total Slice Area:		1659.07 m <sup>2</sup>
Surface Horizontal Width:		119.299 m
Surface Average Height:		13.9069 m

# Global Minimum Support Data

---

No Supports Present

## 25. VALID AND INVALID SURFACES

---

### 25.1 METHOD: BISHOP SIMPLIFIED

---

Number of Valid Surfaces:	2693
Number of Invalid Surfaces:	0

## 26. SLICE DATA

## Global Minimum Query (bishop simplified) - Safety Factor: 1.2769

Slice Number	Width [m]	Weight [kN]	Angle of Slice Base [deg]	Base Material	Base Cohesion [kPa]	Base Friction Angle [deg]	Shear Stress [kPa]	Shear Strength [kPa]	Base Normal Stress [kPa]	Pore Pressure [kPa]	Effective Normal Stress [kPa]	Base Vertical Stress [kPa]	Effective Vertical Stress [kPa]
1	4.733	425.781	-61.0825	A	36	31.0834	38.1526	48.717	21.095	0	21.095	90.1584	90.1584
2	4.733	1114.71	-56.7283	A	36	31.0834	81.1587	103.632	112.188	0	112.188	235.873	235.873
3	4.733	1443.14	-52.8361	A	36	31.0834	106.196	135.602	165.22	0	165.22	305.311	305.311
4	4.733	1673.9	-49.2688	A	36	31.0834	126.181	161.12	207.549	0	207.549	354.086	354.086
5	4.733	1837.47	-45.9447	A	36	31.0834	142.263	181.655	241.615	0	241.615	388.647	388.647
6	4.733	1945.77	-42.8102	A	36	31.0834	154.784	197.644	268.137	0	268.137	411.52	411.52
7	4.733	2008.87	-39.8279	A	36	31.0834	164.135	209.584	287.943	0	287.943	424.831	424.831
8	4.733	2232.53	-36.9704	A	36	31.0834	185.244	236.538	332.654	0	332.654	472.095	472.095
9	4.733	2332.54	-34.2167	A	36	31.0834	197.604	252.321	358.834	0	358.834	493.21	493.21
10	4.733	2284.23	-31.5506	A	36	31.0834	198.629	253.63	361.006	0	361.006	482.968	482.968
11	4.733	2206.13	-28.9588	A	36	31.0834	196.948	251.483	357.445	0	357.445	466.429	466.429
12	5.14255	2272.29	-26.3236	Strato 1	4	32.0066	176.74	225.679	354.671	0	354.671	442.112	442.112
13	5.14255	2111.47	-23.64	Strato 1	4	32.0066	168.18	214.749	337.183	0	337.183	410.799	410.799
14	5.14255	2040.05	-21.0106	Strato 1	4	32.0066	166.163	212.174	333.065	0	333.065	396.884	396.884
15	5.14255	2055.47	-18.4268	Strato 1	4	32.0066	170.977	218.32	342.896	0	342.896	399.862	399.862
16	5.14255	1814.86	-15.8814	Strato 1	4	32.0066	154.433	197.196	309.099	0	309.099	353.036	353.036
17	5.14255	1533.52	-13.3678	Strato 1	4	32.0066	133.603	170.598	266.544	0	266.544	298.294	298.294
18	5.14255	1224.47	-10.8803	Strato 1	4	32.0066	109.417	139.715	217.133	0	217.133	238.165	238.165
19	5.14255	882.897	-8.41332	Strato 1	4	32.0066	81.3012	103.814	159.694	0	159.694	171.719	171.719
20	5.14255	507.886	-5.96203	Strato 1	4	32.0066	48.2403	61.5981	93.7379	1.58519	92.1527	98.7759	97.1907
21	5.00732	304.884	-3.55365	Strato 2	0	33.8726	28.0753	35.8493	59.149	5.74476	53.4043	60.8926	55.1478
22	5.00732	298.947	-1.18361	Strato 2	0	33.8726	27.0048	34.4824	59.1457	7.77751	51.3682	59.7037	51.9261
23	5.00732	78.9212	1.1844	Strato 2	0	33.8726	4.24325	5.41821	15.8486	7.77717	8.07146	15.7609	7.98373
24	5.00732	46.1104	3.55445	Strato 2	0	33.8726	1.88281	2.40416	9.3252	5.74374	3.58146	9.20825	3.46451
25	0.923317	3.93809	4.95956	Strato 1	4	32.0066	3.49607	4.46413	4.56767	3.8251	0.742565	4.26428	0.439185

## 27. INTERSLICE DATA

## Global Minimum Query (bishop simplified) - Safety Factor: 1.2769

Slice Number	X coordinate [m]	Y coordinate - Bottom [m]	Normal Force [kN]	e Shear Force [kN]	e Force Angle [deg]
1	499.91	684.076	0	0	0
2	504.643	675.508	0.676959	0	0
3	509.376	668.295	426.872	0	0
4	514.109	662.051	957.267	0	0
5	518.842	656.555	1502.58	0	0
6	523.575	651.663	2013.09	0	0
7	528.308	647.279	2458.2	0	0
8	533.041	643.331	2820.18	0	0
9	537.774	639.769	3131.09	0	0
10	542.507	636.55	3353.45	0	0
11	547.24	633.644	3465.17	0	0
12	551.973	631.025	3471.87	0	0
13	557.115	628.481	3467.95	0	0

14	562.258	626.23	3364.56	0	0
15	567.401	624.254	3170.36	0	0
16	572.543	622.541	2881.14	0	0
17	577.686	621.078	2541.47	0	0
18	582.828	619.856	2182.13	0	0
19	587.971	618.867	1835.69	0	0
20	593.113	618.107	1540.25	0	0
21	598.256	617.57	1343.23	0	0
22	603.263	617.259	1221.45	0	0
23	608.271	617.155	1092.73	0	0
24	613.278	617.259	1069.78	0	0
25	618.285	617.57	1057.06	0	0
26	619.209	617.65	0.600781	0	0

## Discharge Sections

### 28. ENTITY INFORMATION

#### 28.1 WATER TABLE

	X	Y
150		618
900		618

#### 28.2 EXTERNAL BOUNDARY

	X	Y
588.892		628.204
581.208		634.076
567.853		644.076
563.551		644.076
550.213		654.076
536.875		664.076
532.573		664.076
519.234		674.076
511.425		679.931

505.896	684.076
498.893	684.076
493.275	688.288
484.57	694.076
484.03	694.076
477.495	694.076
474.061	694.076
467.018	694.076
464.092	694.076
456.542	694.076
454.123	694.076
451.374	694.076
450.84	694.076
445.639	694.076
444.144	694.076
436.171	694.076
434.145	694.076
431.973	694.076
424.168	694.076
421.208	694.076
414.258	694.076
409.885	694.076
404.452	694.076
398.017	694.076
394.778	694.076
385.252	694.076



384.194

694.076

376.09	694.076
367.005	694.076
356.117	697.977
348.554	700.954
345.124	702.316
341.027	704.076
333.717	704.076
331.768	704.076
323.795	704.076
317.881	699.848
309.815	694.076
295.835	684.076
288.061	678.543
285.773	676.896
281.858	674.076
277.235	670.745
273.26	667.882
268.038	671.492
261.605	673.139
254.783	680
248.92	683.267
240.758	686
227.706	688
225.009	690
219.437	690
205.281	694
199.776	694
198.375	693.175
193.874	694
190.253	696
177.678	698
163.025	700
163.025	629.5
163.025	617.567
163.025	614.567
163.025	607.567
163.025	595.567

163.025	520.734
800	520.734
800	595.567
800	607.567
800	614.567
800	617.571
800	669.745
788.562	668.248
779.808	667.509
774.305	666
762.733	662
748.786	657.179
735.074	652.44
728.921	650
725.517	648
711.827	644
693.082	638
673.746	632
659.261	627.488
647.965	624
636.524	620
634.642	618
631.651	617.752
618.822	617.647
608.828	618
605.988	620.817
605.018	620.598
598.661	620.369
595.397	622.986

28.3 MATERIAL BOUNDARY

X	Y
273.26	667.882
277.694	664.076
283.661	659.626
287.779	656.454

290.54	654.076
294.378	650.77
301.747	644.076
311.758	636.546
315.18	634.076
321.519	629.5
344.265	629.46
368.64	629
372.019	628.807
392.905	628.53
423.552	627.926
447.369	627.505
457.524	626.5
490.082	627.983
500.667	630
505.184	631
522.22	631.076
539.217	631.5
552.639	631
557.116	629.808
566.019	626.124
569.589	624.5
575.421	621.7
578.157	622.908
586.257	623
595.397	622.986

**Material Boundary**

X	Y
163.025	617.567
634.642	617.57
800	617.571

**Material Boundary**

X	Y
163.025	614.567
800	614.567

**Material Boundary**

X	Y
163.025	607.567
800	607.567

**Material Boundary**

X	Y
163.025	595.567
800	595.567

**Material Boundary**

X	Y
163.025	629.5
321.519	629.5

**Material Boundary**

X	Y
301.747	644.076
563.551	644.076

**Material Boundary**

X	Y
277.694	664.076
532.573	664.076

**Material Boundary**

X	Y
295.835	684.076
498.893	684.076

**Material Boundary**

X	Y
309.815	694.076
367.005	694.076

**Material Boundary**

X	Y
315.18	634.076
581.208	634.076

**Material Boundary**

X	Y
290.54	654.076
550.213	654.076

**Material Boundary**

X	Y
---	---

281.858	674.076
519.234	674.076

**Material Boundary**

	X	Y
634.642		617.57
634.642		618

## ANHANG 14 – ERGEBNISSE DER SLIDE SLV – ABSCHNITT 3

## APPENDICE 14 – RISULTATI ANALISI SLIDE SLV – SEZIONE 3

SLIDE - An Interactive Slope Stability Program

Date Created: 16/11/2018, 18:41:47

Software Version: 9.023

### Table of Contents

Project Summary .....	3
General Settings .....	4
Design Standard .....	5
Analysis Options .....	6
Groundwater Analysis .....	7
Random Numbers .....	8
Surface Options .....	9
Seismic Loading .....	10
Materials .....	11
Global Minimums .....	13
Method: bishop simplified .....	13
Valid and Invalid Surfaces .....	14
Method: bishop simplified .....	14
Slice Data .....	15
Global Minimum Query (bishop simplified) - Safety Factor: 1.2434 .....	15
Interslice Data .....	16
Global Minimum Query (bishop simplified) - Safety Factor: 1.2434 .....	16
Entity Information .....	17
Water Table .....	17
External Boundary .....	17
Material Boundary .....	19

# Slide2 Analysis Information

## SLIDE - An Interactive Slope Stability Program

### Project Summary

---

Slide2 Modeler Version:	9.023
Compute Time:	00h:00m:00.368s
Date Created:	16/11/2018, 18:41:47



## General Settings

Units of Measurement:	Metric Units
Time Units:	days
Permeability Units:	meters/second
Data Output:	Standard
Failure Direction:	Left to Right

## Design Standard

Selected Type:	Eurocode 7 (User Defined)	
Name:	User Defined 1	
	<b>Type</b>	<b>Partial Factor</b>
Permanent Actions: Unfavourable	1	
Permanent Actions: Favourable	1	
Variable Actions: Unfavourable	1	
Variable Actions: Favourable	1	
Effective cohesion	1.25	
Coefficient of shearing resistance	1.25	
Undrained strength	1	
Weight density	1	
Shear strength (other models)	1	
Earth resistance	1	
Tensile and plate strength	1	
Shear strength	1	
Compressive strength	1	
Bond strength	1	
Seismic Coefficient	1	

# Analysis Options

---

Slices Type:	Vertical
<b>Analysis Methods Used</b>	
	Bishop simplified
Number of slices:	25
Tolerance:	0.005
Maximum number of iterations:	50
Check $m_{\alpha} < 0.2$ :	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

## Groundwater Analysis

---

Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [kN/m <sup>3</sup> ]:	9.81
Use negative pore pressure cutoff:	Yes
Maximum negative pore pressure [kPa]:	0
Advanced Groundwater Method:	None

# Random Numbers

---

Pseudo-random Seed:

10116

Random Number Generation Method:

Park and Miller v.3

## Surface Options

---

Surface Type:	Circular
Search Method:	Auto Refine Search
Divisions along slope:	10
Circles per division:	10
Number of iterations:	10
Divisions to use in next iteration:	50%
Composite Surfaces:	Disabled
Minimum Elevation:	Not Defined
Minimum Depth:	Not Defined
Minimum Area:	Not Defined
Minimum Weight:	Not Defined

## Seismic Loading

---

Advanced seismic analysis:	No
Staged pseudostatic analysis:	No
Seismic Load Coefficient (Horizontal):	0.013
Seismic Load Coefficient (Vertical):	0.0065

# Materials

## A

Color	
Strength Type	Mohr-Coulomb
Unit Weight [kN/m <sup>3</sup> ]	21
Cohesion [kPa]	45
Friction Angle [deg]	37
Water Surface	Water Table
Hu Value	Automatically Calculated

## Roccia

Color	
Strength Type	Mohr-Coulomb
Unit Weight [kN/m <sup>3</sup> ]	20
Cohesion [kPa]	400
Friction Angle [deg]	29.26
Water Surface	Water Table
Hu Value	Automatically Calculated

## Strato 1

Color	
Strength Type	Mohr-Coulomb
Unit Weight [kN/m <sup>3</sup> ]	20
Cohesion [kPa]	5
Friction Angle [deg]	38
Water Surface	Water Table
Hu Value	Automatically Calculated

## Strato 2

Color	
Strength Type	Mohr-Coulomb
Unit Weight [kN/m <sup>3</sup> ]	20
Cohesion [kPa]	0
Friction Angle [deg]	40
Water Surface	Water Table
Hu Value	Automatically Calculated

## Strato 3

Color	
Strength Type	Mohr-Coulomb
Unit Weight [kN/m <sup>3</sup> ]	20
Cohesion [kPa]	0
Friction Angle [deg]	42
Water Surface	Water Table
Hu Value	Automatically Calculated


## Strato 4

Color	
-------	---

---

Strength Type	Mohr-Coulomb
Unit Weight [kN/m <sup>3</sup> ]	20
Cohesion [kPa]	0



Friction Angle [deg]	36
Water Surface	Water Table
Hu Value	Automatically Calculated
<b>Strato 5</b>	
Color	
Strength Type	Mohr-Coulomb
Unit Weight [kN/m3]	20
Cohesion [kPa]	0
Friction Angle [deg]	36
Water Surface	Water Table
Hu Value	Automatically Calculated

# Global Minimums

---

## 28.3.1 Method: bishop simplified

---

<b>FS</b>	<b>1.243400</b>
Center:	608.184, 738.717
Radius:	121.571
Left Slip Surface Endpoint:	499.584, 684.076
Right Slip Surface Endpoint:	619.247, 617.650
Left Slope Intercept:	499.584 684.076
Right Slope Intercept:	619.247 618.000
Resisting Moment:	2.67514e+06 kN-m
Driving Moment:	2.15148e+06 kN-m
Total Slice Area:	1675.74 m <sup>2</sup>
Surface Horizontal Width:	119.664 m
Surface Average Height:	14.0037 m

# Global Minimum Support Data

---

No Supports Present

## Valid and Invalid Surfaces

---

### 28.3.2 Method: bishop simplified

---

Number of Valid Surfaces:	2584
Number of Invalid Surfaces:	0

# Slice Data

## Global Minimum Query (bishop simplified) - Safety Factor: 1.2434

Slice Number	Width [m]	Weight [kN]	Angle of Slice Base [deg]	Base Material	Base Cohesion [kPa]	Base Friction Angle [deg]	Shear Stress [kPa]	Shear Strength [kPa]	Base Normal Stress [kPa]	Pore Pressure [kPa]	Effective Normal Stress [kPa]	Base Vertical Stress [kPa]	Effective Vertical Stress [kPa]
1	4.74326	425.929	-60.9858	A	36	31.0834	38.8709	48.3321	20.4565	0	20.4565	90.5405	90.5405
2	4.74326	1131.45	-56.6472	A	36	31.0834	83.7823	104.175	113.089	0	113.089	240.38	240.38
3	4.74326	1466.37	-52.7662	A	36	31.0834	109.876	136.62	166.908	0	166.908	311.488	311.488
4	4.74326	1696.75	-49.2075	A	36	31.0834	130.412	162.154	209.265	0	209.265	360.388	360.388
5	4.74326	1859.98	-45.8903	A	36	31.0834	146.97	182.742	243.416	0	243.416	395.026	395.026
6	4.74326	1967.92	-42.7617	A	36	31.0834	159.888	198.805	270.062	0	270.062	417.922	417.922
7	4.74326	2029.23	-39.7844	A	36	31.0834	169.461	210.708	289.806	0	289.806	430.917	430.917
8	4.74326	2238.64	-36.9313	A	36	31.0834	190.131	236.409	332.44	0	332.44	475.357	475.357
9	4.74326	2353.97	-34.1816	A	36	31.0834	204.084	253.758	361.219	0	361.219	499.819	499.819
10	4.74326	2305.06	-31.5191	A	36	31.0834	205.219	255.169	363.559	0	363.559	489.411	489.411
11	4.74326	2226.29	-28.9306	A	36	31.0834	203.566	253.114	360.149	0	360.149	472.665	472.665
12	5.14227	2288.23	-26.3015	Strato 1	4	32.0066	182.993	227.533	357.636	0	357.636	448.083	448.083
13	5.14227	2127.03	-23.627	Strato 1	4	32.0066	174.262	216.677	340.267	0	340.267	416.498	416.498
14	5.14227	2042.92	-21.0061	Strato 1	4	32.0066	171.24	212.92	334.258	0	334.258	400.012	400.012
15	5.14227	2068.99	-18.4306	Strato 1	4	32.0066	177.171	220.295	346.057	0	346.057	405.099	405.099
16	5.14227	1830.78	-15.8932	Strato 1	4	32.0066	160.436	199.486	312.764	0	312.764	358.445	358.445
17	5.14227	1549.9	-13.3875	Strato 1	4	32.0066	139.106	172.964	270.33	0	270.33	303.438	303.438
18	5.14227	1241.3	-10.9076	Strato 1	4	32.0066	114.301	142.122	220.984	0	220.984	243.011	243.011
19	5.14227	900.756	-8.44832	Strato 1	4	32.0066	85.4745	106.279	163.639	0	163.639	176.335	176.335
20	5.14227	525.85	-6.00464	Strato 1	4	32.0066	51.4533	63.977	97.5252	1.56638	95.9588	102.937	101.371
21	5.07214	310.357	-3.58843	Strato 2	0	33.8726	29.1441	36.2378	59.7628	5.77968	53.9831	61.5905	55.8108
22	5.07214	307.433	-1.19518	Strato 2	0	33.8726	28.3739	35.2801	60.4153	7.85893	52.5564	61.0073	53.1484
23	5.07214	81.8495	1.19598	Strato 2	0	33.8726	4.57506	5.68863	16.3329	7.85858	8.47432	16.2374	8.37881
24	5.07214	47.0478	3.58923	Strato 2	0	33.8726	1.97892	2.46059	9.44416	5.77865	3.66551	9.32003	3.54138
25	0.918688	3.90893	5.00421	Strato 1	4	32.0066	3.59444	4.46933	4.57442	3.82352	0.750897	4.25968	0.436158

# Interslice Data

## Global Minimum Query (bishop simplified) - Safety Factor: 1.2434

Slice Number	X coordinate [m]	Y coordinate - Bottom [m]	Normal Force [kN]	e Shear Force [kN]	e Force Angle [deg]
1	499.584	684.076	0	0	0
2	504.327	675.524	-3.47109	0	0
3	509.07	668.317	429.714	0	0
4	513.814	662.076	970.535	0	0
5	518.557	656.579	1525.67	0	0
6	523.3	651.686	2045.37	0	0
7	528.043	647.3	2498.89	0	0
8	532.787	643.35	2867.97	0	0
9	537.53	639.785	3182.57	0	0
10	542.273	636.563	3410.95	0	0
11	547.017	633.654	3527.27	0	0
12	551.76	631.033	3537.07	0	0
13	556.902	628.491	3536.95	0	0

14	562.044	626.242	3435.98	0	0
15	567.187	624.267	3243.99	0	0
16	572.329	622.553	2954.93	0	0
17	577.471	621.089	2613.54	0	0
18	582.613	619.865	2250.85	0	0
19	587.756	618.874	1899.55	0	0
20	592.898	618.111	1597.72	0	0
21	598.04	617.57	1393.32	0	0
22	603.112	617.252	1268.88	0	0
23	608.185	617.146	1135.68	0	0
24	613.257	617.252	1111.7	0	0
25	618.329	617.57	1098.7	0	0
26	619.247	617.65	0.599684	0	0

## Discharge Sections

## Entity Information

### Water Table

	X	Y
150		618
900		618

### External Boundary

	X	Y
588.892		628.204
581.208		634.076
567.853		644.076
563.551		644.076
550.213		654.076
536.875		664.076
532.573		664.076
519.234		674.076
511.425		679.931
505.896		684.076

498.893	684.076
493.275	688.288
484.57	694.076
484.03	694.076
477.495	694.076
474.061	694.076
467.018	694.076
464.092	694.076
456.542	694.076
454.123	694.076
451.374	694.076
450.84	694.076
445.639	694.076
444.144	694.076
436.171	694.076
434.145	694.076
431.973	694.076
424.168	694.076
421.208	694.076
414.258	694.076
409.885	694.076
404.452	694.076
398.017	694.076
394.778	694.076
385.252	694.076

384.194

694.076

376.09	694.076
367.005	694.076
356.117	697.977
348.554	700.954
345.124	702.316
341.027	704.076
333.717	704.076
331.768	704.076
323.795	704.076
317.881	699.848
309.815	694.076
295.835	684.076
288.061	678.543
285.773	676.896
281.858	674.076
277.235	670.745
273.26	667.882
268.038	671.492
261.605	673.139
254.783	680
248.92	683.267
240.758	686
227.706	688
225.009	690
219.437	690
205.281	694
199.776	694
198.375	693.175
193.874	694
190.253	696
177.678	698
163.025	700
163.025	629.5
163.025	617.567
163.025	614.567
163.025	607.567
163.025	595.567



163.025	520.734
800	520.734
800	595.567
800	607.567
800	614.567
800	617.571
800	669.745
788.562	668.248
779.808	667.509
774.305	666
762.733	662
748.786	657.179
735.074	652.44
728.921	650
725.517	648
711.827	644
693.082	638
673.746	632
659.261	627.488
647.965	624
636.524	620
634.642	618
631.651	617.752
618.822	617.647
608.828	618
605.988	620.817
605.018	620.598
598.661	620.369
595.397	622.986

**Material Boundary**

X	Y
273.26	667.882
277.694	664.076
283.661	659.626
287.779	656.454

290.54	654.076
294.378	650.77
301.747	644.076
311.758	636.546
315.18	634.076
321.519	629.5
344.265	629.46
368.64	629
372.019	628.807
392.905	628.53
423.552	627.926
447.369	627.505
457.524	626.5
490.082	627.983
500.667	630
505.184	631
522.22	631.076
539.217	631.5
552.639	631
557.116	629.808
566.019	626.124
569.589	624.5
575.421	621.7
578.157	622.908
586.257	623
595.397	622.986

**Material Boundary**

X	Y
163.025	617.567
634.642	617.57
800	617.571

**Material Boundary**

X	Y
163.025	614.567
800	614.567

**Material Boundary**

X	Y
163.025	607.567
800	607.567

**Material Boundary**

X	Y
163.025	595.567
800	595.567

**Material Boundary**

X	Y
163.025	629.5
321.519	629.5

**Material Boundary**

X	Y
301.747	644.076
563.551	644.076

**Material Boundary**

X	Y
277.694	664.076
532.573	664.076

**Material Boundary**

X	Y
295.835	684.076
498.893	684.076

**Material Boundary**

X	Y
309.815	694.076
367.005	694.076

**Material Boundary**

X	Y
315.18	634.076
581.208	634.076

**Material Boundary**

X	Y
290.54	654.076
550.213	654.076

**Material Boundary**

X	Y
---	---

281.858	674.076
519.234	674.076

**Material Boundary**

	X	Y
634.642		617.57
634.642		618

## ANHANG 15 – ERGEBNISSE DER SLIDE SLU „PIENA“ – ABSCHNITT 3

## APPENDICE 15 – RISULTATI ANALISI SLIDE SLU “PIENA” – SEZIONE 3

SLIDE - An Interactive Slope Stability Program

Date Created: 16/11/2018, 18:41:47

Software Version: 9.023

### Table of Contents

Project Summary .....	3
General Settings .....	4
Design Standard .....	5
Analysis Options .....	6
Groundwater Analysis .....	7
Random Numbers .....	8
Surface Options .....	9
Seismic Loading .....	10
Materials .....	11
Global Minimums .....	13
Method: bishop simplified .....	13
Valid and Invalid Surfaces .....	14
Method: bishop simplified .....	14
Slice Data .....	15
Global Minimum Query (bishop simplified) - Safety Factor: 1.2472 .....	15
Interslice Data .....	16
Global Minimum Query (bishop simplified) - Safety Factor: 1.2472 .....	16
Entity Information .....	17
Water Table .....	17
External Boundary .....	17
Material Boundary .....	19

# Slide2 Analysis Information

## SLIDE - An Interactive Slope Stability Program

### Project Summary

---

Slide2 Modeler Version:	9.023
Compute Time:	00h:00m:00.363s
Date Created:	16/11/2018, 18:41:47

## General Settings

Units of Measurement:	Metric Units
Time Units:	days
Permeability Units:	meters/second
Data Output:	Standard
Failure Direction:	Left to Right

## Design Standard

Selected Type:	Eurocode 7 (User Defined)	
Name:	User Defined 1	
	<b>Type</b>	<b>Partial Factor</b>
Permanent Actions: Unfavourable	1	
Permanent Actions: Favourable	1	
Variable Actions: Unfavourable	1	
Variable Actions: Favourable	1	
Effective cohesion	1.25	
Coefficient of shearing resistance	1.25	
Undrained strength	1	
Weight density	1	
Shear strength (other models)	1	
Earth resistance	1	
Tensile and plate strength	1	
Shear strength	1	
Compressive strength	1	
Bond strength	1	
Seismic Coefficient	1	

# Analysis Options

---

Slices Type:	Vertical
<b>Analysis Methods Used</b>	
	Bishop simplified
Number of slices:	25
Tolerance:	0.005
Maximum number of iterations:	50
Check $m_{\alpha} < 0.2$ :	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes



## Groundwater Analysis

---

Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [kN/m <sup>3</sup> ]:	9.81
Use negative pore pressure cutoff:	Yes
Maximum negative pore pressure [kPa]:	0
Advanced Groundwater Method:	None

# Random Numbers

---

Pseudo-random Seed:

10116

Random Number Generation Method:

Park and Miller v.3

## Surface Options

---

Surface Type:	Circular
Search Method:	Auto Refine Search
Divisions along slope:	10
Circles per division:	10
Number of iterations:	10
Divisions to use in next iteration:	50%
Composite Surfaces:	Disabled
Minimum Elevation:	Not Defined
Minimum Depth:	Not Defined
Minimum Area:	Not Defined
Minimum Weight:	Not Defined

## Seismic Loading

---

Advanced seismic analysis: No


Staged pseudostatic analysis: No

# Materials

## A

Color	
Strength Type	Mohr-Coulomb
Unit Weight [kN/m <sup>3</sup> ]	21
Cohesion [kPa]	45
Friction Angle [deg]	37
Water Surface	Water Table
Hu Value	Automatically Calculated

## Roccia

Color	
Strength Type	Mohr-Coulomb
Unit Weight [kN/m <sup>3</sup> ]	20
Cohesion [kPa]	400
Friction Angle [deg]	29.26
Water Surface	Water Table
Hu Value	Automatically Calculated

## Strato 1

Color	
Strength Type	Mohr-Coulomb
Unit Weight [kN/m <sup>3</sup> ]	20
Cohesion [kPa]	5
Friction Angle [deg]	38
Water Surface	Water Table
Hu Value	Automatically Calculated

## Strato 2

Color	
Strength Type	Mohr-Coulomb
Unit Weight [kN/m <sup>3</sup> ]	20
Cohesion [kPa]	0
Friction Angle [deg]	40
Water Surface	Water Table
Hu Value	Automatically Calculated

## Strato 3


Color	
Strength Type	Mohr-Coulomb
Unit Weight [kN/m <sup>3</sup> ]	20
Cohesion [kPa]	0
Friction Angle [deg]	42
Water Surface	Water Table
Hu Value	Automatically Calculated

## Strato 4

Color	
-------	---

---

Strength Type	Mohr-Coulomb
Unit Weight [kN/m <sup>3</sup> ]	20
Cohesion [kPa]	0

Friction Angle [deg]	36
Water Surface	Water Table
Hu Value	Automatically Calculated
<b>Strato 5</b>	
Color	
Strength Type	Mohr-Coulomb
Unit Weight [kN/m3]	20
Cohesion [kPa]	0
Friction Angle [deg]	36
Water Surface	Water Table
Hu Value	Automatically Calculated

# Global Minimums

---

## 28.3.3 Method: bishop simplified

---

	<b>FS</b>	<b>1.247200</b>
Center:		608.695, 736.231
Radius:		119.667
Left Slip Surface Endpoint:		500.993, 684.076
Right Slip Surface Endpoint:		625.131, 617.699
Left Slope Intercept:		500.993 684.076
Right Slope Intercept:		625.131 622.000
Resisting Moment:		2.52069e+06 kN-m
Driving Moment:		2.02108e+06 kN-m
Total Slice Area:		1749.51 m <sup>2</sup>
Surface Horizontal Width:		124.139 m
Surface Average Height:		14.0932 m



# Global Minimum Support Data

---

No Supports Present

## Valid and Invalid Surfaces

---

### 28.3.4 Method: bishop simplified

---

Number of Valid Surfaces:	2900
Number of Invalid Surfaces:	0

# Slice Data

## Global Minimum Query (bishop simplified) - Safety Factor: 1.2472

Slice Number	Width [m]	Weight [kN]	Angle of Slice Base [deg]	Base Material	Base Cohesion [kPa]	Base Friction Angle [deg]	Shear Stress [kPa]	Shear Strength [kPa]	Base Normal Stress [kPa]	Pore Pressure [kPa]	Effective Normal Stress [kPa]	Base Vertical Stress [kPa]	Effective Vertical Stress [kPa]
1	5.06567	498.319	-61.6099	A	36	31.0834	40.3849	50.368	23.8337	0	23.8337	98.5547	98.5547
2	5.06567	1194.5	-56.8408	A	36	31.0834	82.1881	102.505	110.318	0	110.318	236.11	236.11
3	5.06567	1555.61	-52.6249	A	36	31.0834	108.69	135.558	165.148	0	165.148	307.437	307.437
4	5.06567	1811.96	-48.7858	A	36	31.0834	130.124	162.291	209.492	0	209.492	358.058	358.058
5	5.06567	1987.13	-45.2229	A	36	31.0834	147.026	183.371	244.461	0	244.461	392.636	392.636
6	5.06567	2096.18	-41.8721	A	36	31.0834	159.808	199.313	270.904	0	270.904	414.152	414.152
7	5.06567	2267.95	-38.6894	A	36	31.0834	176.943	220.683	306.352	0	306.352	448.057	448.057
8	5.06567	2496.13	-35.6431	A	36	31.0834	198.432	247.485	350.812	0	350.812	493.101	493.101
9	5.06567	2459.77	-32.7093	A	36	31.0834	201.252	251.001	356.644	0	356.644	485.892	485.892
10	5.06567	2383.54	-29.8693	A	36	31.0834	200.716	250.333	355.536	0	355.536	470.81	470.81
11	5.19605	2324.41	-27.0735	Strato 1	4	32.0066	181.111	225.882	354.994	0	354.994	447.568	447.568
12	5.19605	2168.17	-24.3113	Strato 1	4	32.0066	173.205	216.021	339.219	0	339.219	417.465	417.465
13	5.19605	2090.17	-21.6081	Strato 1	4	32.0066	170.949	213.207	334.717	0	334.717	402.429	402.429
14	5.19605	2118.99	-18.9547	Strato 1	4	32.0066	177.161	220.955	347.113	0	347.113	407.957	407.957
15	5.19605	1879.97	-16.3429	Strato 1	4	32.0066	158.487	197.665	315.448	5.59914	309.849	361.922	356.323
16	5.19605	1597.21	-13.7657	Strato 1	4	32.0066	131.471	163.971	275.26	19.3166	255.943	307.469	288.152
17	5.19605	1285.34	-11.2167	Strato 1	4	32.0066	101.746	126.897	227.241	30.6148	196.627	247.418	216.803
18	5.19605	939.396	-8.68995	Strato 1	4	32.0066	68.7304	85.7206	170.311	39.5644	130.747	180.816	141.252
19	5.15952	568.651	-6.18897	Strato 2	0	33.8726	32.5564	40.6044	106.692	46.2041	60.4882	110.223	64.0186
20	5.15952	451.111	-3.70859	Strato 2	0	33.8726	19.1636	23.9008	86.1936	50.5888	35.6048	87.4358	36.847
21	5.15952	451.099	-1.23517	Strato 2	0	33.8726	18.4392	22.9974	87.0338	52.7749	34.2589	87.4314	34.6565
22	5.15952	340.376	1.23595	Strato 2	0	33.8726	7.1857	8.96201	66.1251	52.7745	13.3506	65.97	13.1955
23	5.15952	307.713	3.70938	Strato 2	0	33.8726	5.04781	6.29563	59.9663	50.5878	9.37853	59.6391	9.05127
24	5.15952	258.338	6.18976	Strato 2	0	33.8726	2.21048	2.75691	50.3093	46.2024	4.10691	50.0696	3.86718
25	0.956401	41.5493	7.6633	Strato 1	4	32.0066	3.7699	4.70182	43.9493	42.8265	1.12284	43.4421	0.615591

# Interslice Data

## Global Minimum Query (bishop simplified) - Safety Factor: 1.2472

Slice Number	X coordinate [m]	Y coordinate - Bottom [m]	Normal Force [kN]	e Shear Force [kN]	e Force Angle [deg]
1	500.993	684.076	0	0	0
2	506.058	674.703	19.3089	0	0
3	511.124	666.95	459.315	0	0
4	516.19	660.318	1005.27	0	0
5	521.255	654.535	1559.33	0	0
6	526.321	649.429	2064.4	0	0
7	531.387	644.889	2486.95	0	0
8	536.452	640.832	2835.64	0	0
9	541.518	637.199	3107.21	0	0
10	546.584	633.946	3250.49	0	0
11	551.649	631.037	3270.57	0	0
12	556.845	628.381	3274.66	0	0
13	562.041	626.034	3173.14	0	0

14	567.238	623.975	2975.94	0	0
15	572.434	622.191	2677.1	0	0
16	577.63	620.667	2336.25	0	0
17	582.826	619.394	2005.19	0	0
18	588.022	618.364	1711.96	0	0
19	593.218	617.57	1490.96	0	0
20	598.377	617.01	1373.43	0	0
21	603.537	616.676	1302.9	0	0
22	608.696	616.565	1154.62	0	0
23	613.856	616.676	1098.11	0	0
24	619.015	617.01	1044.8	0	0
25	624.175	617.57	1007.07	0	0
26	625.131	617.699	90.7513	0	0

## Discharge Sections

## Entity Information

### Water Table

	X	Y
150		622
900		622

### External Boundary

	X	Y
588.892		628.204
581.208		634.076
567.853		644.076
563.551		644.076
550.213		654.076
536.875		664.076
532.573		664.076
519.234		674.076
511.425		679.931
505.896		684.076

498.893	684.076
493.275	688.288
484.57	694.076
484.03	694.076
477.495	694.076
474.061	694.076
467.018	694.076
464.092	694.076
456.542	694.076
454.123	694.076
451.374	694.076
450.84	694.076
445.639	694.076
444.144	694.076
436.171	694.076
434.145	694.076
431.973	694.076
424.168	694.076
421.208	694.076
414.258	694.076
409.885	694.076
404.452	694.076
398.017	694.076
394.778	694.076
385.252	694.076

384.194

694.076

376.09	694.076
367.005	694.076
356.117	697.977
348.554	700.954
345.124	702.316
341.027	704.076
333.717	704.076
331.768	704.076
323.795	704.076
317.881	699.848
309.815	694.076
295.835	684.076
288.061	678.543
285.773	676.896
281.858	674.076
277.235	670.745
273.26	667.882
268.038	671.492
261.605	673.139
254.783	680
248.92	683.267
240.758	686
227.706	688
225.009	690
219.437	690
205.281	694
199.776	694
198.375	693.175
193.874	694
190.253	696
177.678	698
163.025	700
163.025	629.5
163.025	617.567
163.025	614.567
163.025	607.567
163.025	595.567

163.025	520.734
800	520.734
800	595.567
800	607.567
800	614.567
800	617.571
800	669.745
788.562	668.248
779.808	667.509
774.305	666
762.733	662
748.786	657.179
735.074	652.44
728.921	650
725.517	648
711.827	644
693.082	638
673.746	632
659.261	627.488
647.965	624
636.524	620
634.642	618
631.651	617.752
618.822	617.647
608.828	618
605.988	620.817
605.018	620.598
598.661	620.369
595.397	622.986

**Material Boundary**

	X	Y
273.26	667.882	
277.694	664.076	
283.661	659.626	
287.779	656.454	

290.54	654.076
294.378	650.77
301.747	644.076
311.758	636.546
315.18	634.076
321.519	629.5
344.265	629.46
368.64	629
372.019	628.807
392.905	628.53
423.552	627.926
447.369	627.505
457.524	626.5
490.082	627.983
500.667	630
505.184	631
522.22	631.076
539.217	631.5
552.639	631
557.116	629.808
566.019	626.124
569.589	624.5
575.421	621.7
578.157	622.908
586.257	623
595.397	622.986

**Material Boundary**

X	Y
163.025	617.567
634.642	617.57
800	617.571

**Material Boundary**

X	Y
163.025	614.567
800	614.567

**Material Boundary**



X	Y
163.025	607.567
800	607.567

**Material Boundary**

X	Y
163.025	595.567
800	595.567

**Material Boundary**

X	Y
163.025	629.5
321.519	629.5

**Material Boundary**

X	Y
301.747	644.076
563.551	644.076

**Material Boundary**

X	Y
277.694	664.076
532.573	664.076

**Material Boundary**

X	Y
295.835	684.076
498.893	684.076

**Material Boundary**

X	Y
309.815	694.076
367.005	694.076

**Material Boundary**

X	Y
315.18	634.076
581.208	634.076

**Material Boundary**

X	Y
290.54	654.076
550.213	654.076

**Material Boundary**

X	Y
---	---

281.858	674.076
519.234	674.076

**Material Boundary**

	X	Y
634.642		617.57
634.642		618

**ANHANG 16 – ERGEBNISSE DER SLIDE SLU „SVASO RAPIDO“ – ABSCHNITT 3**  
**APPENDICE 16 – RISULTATI ANALISI SLIDE SLU “SVASO RAPIDO” – SEZIONE 3**

SLIDE - An Interactive Slope Stability Program  
Date Created: 16/11/2018, 18:41:47  
Software Version: 9.023

## **Table of Contents**

Project Summary .....	3
General Settings .....	4
Design Standard .....	5
Analysis Options .....	6
Groundwater Analysis .....	7
Random Numbers .....	8
Surface Options .....	9
Seismic Loading .....	10
Materials .....	11
Global Minimums .....	14
Method: bishop simplified .....	14
Valid and Invalid Surfaces .....	15
Method: bishop simplified .....	15
Slice Data .....	16
Global Minimum Query (bishop simplified) - Safety Factor: 1.26769 .....	16
Interslice Data .....	17
Global Minimum Query (bishop simplified) - Safety Factor: 1.26769 .....	17
Entity Information .....	18
Piezoline .....	18
External Boundary .....	20
Material Boundary .....	22

# Slide2 Analysis Information

## SLIDE - An Interactive Slope Stability Program

### Project Summary

---

Slide2 Modeler Version:	9.023
Compute Time:	00h:00m:00.408s
Date Created:	16/11/2018, 18:41:47

## General Settings

Units of Measurement:	Metric Units
Time Units:	days
Permeability Units:	meters/second
Data Output:	Standard
Failure Direction:	Left to Right

## Design Standard

Selected Type:	Eurocode 7 (User Defined)	
Name:	User Defined 1	
	<b>Type</b>	<b>Partial Factor</b>
Permanent Actions: Unfavourable	1	
Permanent Actions: Favourable	1	
Variable Actions: Unfavourable	1	
Variable Actions: Favourable	1	
Effective cohesion	1.25	
Coefficient of shearing resistance	1.25	
Undrained strength	1	
Weight density	1	
Shear strength (other models)	1	
Earth resistance	1	
Tensile and plate strength	1	
Shear strength	1	
Compressive strength	1	
Bond strength	1	
Seismic Coefficient	1	

# Analysis Options

---

Slices Type:	Vertical
<b>Analysis Methods Used</b>	
	Bishop simplified
Number of slices:	25
Tolerance:	0.005
Maximum number of iterations:	50
Check $m_{\alpha} < 0.2$ :	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

## Groundwater Analysis

---

Groundwater Method:	Steady State FEA
Pore Fluid Unit Weight [kN/m <sup>3</sup> ]:	9.81
Tolerance:	1e-06
Maximum number of iterations:	500
Use negative pore pressure cutoff:	No
Advanced Groundwater Method:	None
Mesh Element Type:	3 noded triangles
Number of Elements:	1897
Number of Nodes:	1074

# Random Numbers

---

Pseudo-random Seed:

10116

Random Number Generation Method:

Park and Miller v.3



## Surface Options

---

Surface Type:	Circular
Search Method:	Auto Refine Search
Divisions along slope:	10
Circles per division:	10
Number of iterations:	10
Divisions to use in next iteration:	50%
Composite Surfaces:	Disabled
Minimum Elevation:	Not Defined
Minimum Depth:	Not Defined
Minimum Area:	Not Defined
Minimum Weight:	Not Defined


## Seismic Loading

---


Advanced seismic analysis:	No
Staged pseudostatic analysis:	No

# Materials


## A

Color	
Strength Type	Mohr-Coulomb
Unit Weight [kN/m <sup>3</sup> ]	21
Cohesion [kPa]	45
Friction Angle [deg]	37
Unsaturated Shear Strength Angle [deg]	0
Air Entry Value [kPa]	0
Ks [meters/second]	0.0005
K2/K1	1
K Angle [deg]	0
Groundwater Model	van Genuchten
GW Model Properties	Alpha: 0n: 2.68m: 0.626866
Unsat. Shear Strength Phi b [deg]	0
Unsat. Shear Strength Air Entry Value [kPa]	0

## Roccia


Color	
Strength Type	Mohr-Coulomb
Unit Weight [kN/m <sup>3</sup> ]	20
Cohesion [kPa]	400
Friction Angle [deg]	29.26
Unsaturated Shear Strength Angle [deg]	0
Air Entry Value [kPa]	0
Ks [meters/second]	3.91e-05
K2/K1	1
K Angle [deg]	0
Groundwater Model	van Genuchten
GW Model Properties	Alpha: 0n: 2.68m: 0.626866
Unsat. Shear Strength Phi b [deg]	0
Unsat. Shear Strength Air Entry Value [kPa]	0

## Strato 1


Color	
Strength Type	Mohr-Coulomb
Unit Weight [kN/m <sup>3</sup> ]	20
Cohesion [kPa]	5
Friction Angle [deg]	38
Unsaturated Shear Strength Angle [deg]	0
Air Entry Value [kPa]	0
Ks [meters/second]	3.91e-05
K2/K1	1
K Angle [deg]	0
Groundwater Model	van Genuchten
GW Model Properties	Alpha: 0n: 2.68m: 0.626866
Unsat. Shear Strength Phi b [deg]	0
Unsat. Shear Strength Air Entry Value [kPa]	0

**Strato 2**


---




Color	
Strength Type	Mohr-Coulomb
Unit Weight [kN/m3]	20
Cohesion [kPa]	0
Friction Angle [deg]	40
Unsaturated Shear Strength Angle [deg]	0
Air Entry Value [kPa]	0
Ks [meters/second]	3.91e-05
K2/K1	1
K Angle [deg]	0
Groundwater Model	van Genuchten
GW Model Properties	Alpha: 0n: 2.68m: 0.626866
Unsat. Shear Strength Phi b [deg]	0
Unsat. Shear Strength Air Entry Value [kPa]	0


### Strato 3




Color	
Strength Type	Mohr-Coulomb
Unit Weight [kN/m3]	20
Cohesion [kPa]	0
Friction Angle [deg]	42
Unsaturated Shear Strength Angle [deg]	0
Air Entry Value [kPa]	0
Ks [meters/second]	3.91e-05
K2/K1	1
K Angle [deg]	0
Groundwater Model	van Genuchten
GW Model Properties	Alpha: 0n: 2.68m: 0.626866
Unsat. Shear Strength Phi b [deg]	0
Unsat. Shear Strength Air Entry Value [kPa]	0

### Strato 4

Color	
Strength Type	Mohr-Coulomb
Unit Weight [kN/m3]	20
Cohesion [kPa]	0
Friction Angle [deg]	36
Unsaturated Shear Strength Angle [deg]	0
Air Entry Value [kPa]	0
Ks [meters/second]	3.91e-05
K2/K1	1

 	<b>DETAILPLANUNG / PROGETTO DI DETTAGLIO</b> Nachweis der Standfestigkeit und Setzungsberechnung Hinterrigger/ Verifica di stabilità e assestamenti Hinterrigger		
	Project	Document ID <b>KTB_B0130_51058</b>	




K Angle [deg]	0
Groundwater Model	van Genuchten
GW Model Properties	Alpha: 0n: 2.68m: 0.626866
Unsat. Shear Strength Phi b [deg]	0
Unsat. Shear Strength Air Entry Value [kPa]	0
<b>Strato 5</b>	
Color	
Strength Type	Mohr-Coulomb
Unit Weight [kN/m3]	20
Cohesion [kPa]	0
Friction Angle [deg]	36
Unsaturated Shear Strength Angle [deg]	0
Air Entry Value [kPa]	0
Ks [meters/second]	3.91e-05
K2/K1	1
K Angle [deg]	0
Groundwater Model	van Genuchten
GW Model Properties	Alpha: 0n: 2.68m: 0.626866
Unsat. Shear Strength Phi b [deg]	0
Unsat. Shear Strength Air Entry Value [kPa]	0

 	<b>DETAILPLANUNG / PROGETTO DI DETTAGLIO</b> Nachweis der Standfestigkeit und Setzungsberechnung Hinterrigger/ Verifica di stabilità e assestamenti Hinterrigger		
	Project	Document ID <b>KTB_B0130_51058</b>	

# Global Minimums

## 28.3.5 Method: bishop simplified

	<b>FS</b>	<b>1.267690</b>
Center:	608.234, 737.961	
Radius:	120.863	
Left Slip Surface Endpoint:	500.048, 684.076	
Right Slip Surface Endpoint:	619.825, 617.655	
Left Slope Intercept:	500.048 684.076	
Right Slope Intercept:	619.825 618.000	
Resisting Moment:	2.61717e+06 kN-m	
Driving Moment:	2.06452e+06 kN-m	
Total Slice Area:	1660.01 m <sup>2</sup>	
Surface Horizontal Width:	119.777 m	
Surface Average Height:	13.8592 m	

 	<b>DETAILPLANUNG / PROGETTO DI DETTAGLIO</b> Nachweis der Standfestigkeit und Setzungsberechnung Hinterrigger/ Verifica di stabilità e assestamenti Hinterrigger		
	Project	Document ID <b>KTB_B0130_51058</b>	

## Global Minimum Support Data

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No Supports Present

## Valid and Invalid Surfaces

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### 28.3.6 Method: bishop simplified

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Number of Valid Surfaces:	2111
Number of Invalid Surfaces:	0



Project	Document ID KTB_B0130_51058	Version 00	Technical report
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## Slice Data



### Global Minimum Query (bishop simplified) - Safety Factor: 1.26769

Slice Number	Width [m]	Weight [kN]	Angle of Slice Base [deg]	Base Material	Base Cohesion [kPa]	Base Friction Angle [deg]	Shear Stress [kPa]	Shear Strength [kPa]	Base Normal Stress [kPa]	Pore Pressure [kPa]	Effective Normal Stress [kPa]	Base Vertical Stress [kPa]	Effective Vertical Stress [kPa]
1	4.71421	424.508	-61.2027	A	36	31.0834	38.2341	48.469	20.6836	-585.735	20.6836	90.2388	90.2388
2	4.71421	1105.22	-56.8392	A	36	31.0834	81.0563	102.754	110.732	-508.415	110.732	234.784	234.784
3	4.71421	1431.59	-52.9414	A	36	31.0834	106.148	134.562	163.496	-442.563	163.496	304.059	304.059
4	4.71421	1662.67	-49.3706	A	36	31.0834	126.306	160.117	205.885	-385.152	205.885	353.096	353.096
5	4.71421	1826.77	-46.0443	A	36	31.0834	142.556	180.717	240.057	-334.394	240.057	387.906	387.906
6	4.71421	1935.8	-42.9085	A	36	31.0834	155.238	196.794	266.725	-289.088	266.725	411.024	411.024
7	4.71421	1999.87	-39.9255	A	36	31.0834	164.748	208.849	286.724	-248.423	286.724	424.599	424.599
8	4.71421	2223.76	-37.0678	A	36	31.0834	186.062	235.869	331.545	-211.788	331.545	472.098	472.098
9	4.71421	2324.69	-34.3143	A	36	31.0834	198.613	251.78	357.937	-178.732	357.937	493.494	493.494
10	4.71421	2277.89	-31.6486	A	36	31.0834	199.781	253.261	360.394	-148.912	360.394	483.534	483.534
11	4.71421	2201.48	-29.0574	A	36	31.0834	198.237	251.303	357.145	-122.045	357.145	467.29	467.29
12	5.07357	2248.54	-26.4359	Strato 1	4	32.0066	178.122	225.803	354.87	-97.1562	354.87	443.429	443.429
13	5.07357	2093.25	-23.7785	Strato 1	4	32.0066	169.792	215.243	337.974	-74.1756	337.974	412.785	412.785
14	5.07357	2012.34	-21.1745	Strato 1	4	32.0066	166.92	211.603	332.15	-53.8982	332.15	396.809	396.809
15	5.07357	2044.04	-18.6157	Strato 1	4	32.0066	173.12	219.463	344.724	-36.1943	344.724	403.039	403.039
16	5.07357	1815.13	-16.0949	Strato 1	4	32.0066	157.24	199.331	312.515	-20.8241	312.515	357.885	357.885
17	5.07357	1543.93	-13.6058	Strato 1	4	32.0066	136.901	173.548	271.265	-8.40643	271.265	304.4	304.4
18	5.07357	1245.89	-11.1426	Strato 1	4	32.0066	112.479	142.589	223.471	1.73891	221.732	245.626	243.887
19	5.07357	917.672	-8.70019	Strato 1	4	32.0066	81.6512	103.508	168.413	9.20625	159.206	180.907	171.701
20	5.07357	554.62	-6.27361	Strato 1	4	32.0066	47.7257	60.5014	104.083	13.685	90.3982	109.33	95.645
21	5.33431	333.634	-3.79644	Strato 2	0	33.8726	24.4139	30.9492	60.9293	14.8245	46.1048	62.5494	47.7249
22	5.33431	327.401	-1.26439	Strato 2	0	33.8726	25.2397	31.9961	60.8208	13.1564	47.6644	61.3778	48.2214
23	5.33431	89.3758	1.26518	Strato 2	0	33.8726	4.18249	5.3021	16.847	8.94852	7.8985	16.7546	7.80613
24	5.33431	50.5424	3.79724	Strato 2	0	33.8726	1.84581	2.33992	9.59712	6.11136	3.48576	9.47461	3.36325
25	0.921028	3.86547	5.28374	Strato 1	4	32.0066	3.50125	4.43849	4.51982	3.81826	0.701563	4.19602	0.377765

## Interslice Data


### Global Minimum Query (bishop simplified) - Safety Factor: 1.26769

Slice Number	X coordinate [m]	Y coordinate - Bottom [m]	Normal Force [kN]	Shear Force [kN]	Force Angle [deg]
1	500.048	684.076	0	0	0
2	504.762	675.5	-2.36684	0	0
3	509.477	668.285	415.476	0	0

	<b>DETAILPLANUNG / PROGETTO DI DETTAGLIO</b> Nachweis der Standfestigkeit und Setzungsberechnung Hinterrigger/ Verifica di stabilità e assestamenti Hinterrigger			
	Project	Document ID <b>KTB_B0130_51058</b>	Version <b>00</b>	

4	514.191	662.042	937.092	0	0
5	518.905	656.548	1474.52	0	0
6	523.619	651.658	1978.02	0	0
7	528.333	647.276	2416.99	0	0
8	533.048	643.331	2773.66	0	0
9	537.762	639.77	3079.6	0	0
10	542.476	636.552	3297.53	0	0
11	547.19	633.647	3405.49	0	0
12	551.905	631.027	3408.99	0	0
13	556.978	628.505	3402.91	0	0
14	562.052	626.269	3299.34	0	0
15	567.125	624.304	3107.55	0	0
16	572.199	622.595	2820.75	0	0
17	577.272	621.131	2482.66	0	0
18	582.346	619.903	2123.09	0	0
19	587.42	618.904	1777.29	0	0
20	592.493	618.128	1494.92	0	0
21	597.567	617.57	1311.49	0	0
22	602.901	617.216	1203.18	0	0
23	608.235	617.098	1076.08	0	0
24	613.57	617.216	1051.7	0	0
25	618.904	617.57	1038.02	0	0
26	619.825	617.655	0.583539	0	0




## Discharge Sections

 	<b>DETAILPLANUNG / PROGETTO DI DETTAGLIO</b> Nachweis der Standfestigkeit und Setzungsberechnung Hinterrigger/ Verifica di stabilità e assestamenti Hinterrigger		
	Project	Document ID <b>KTB_B0130_51058</b>	




## Entity Information

### Piezoline

X	Y
163.025	621.971
164.121	621.968
167.4	621.955
168.585	621.948
169.792	621.939
174.817	621.907
179.598	621.874
187.565	621.813
193.079	621.771
203.22	621.687
208.565	621.641
218.878	621.547
224.032	621.494
234.541	621.387
237.68	621.35
248.438	621.23
251.843	621.186
262.872	621.057
267.429	620.996
278.705	620.869
283.016	620.813




 	<b>DETAILPLANUNG / PROGETTO DI DETTAGLIO</b> Nachweis der Standfestigkeit und Setzungsberechnung Hinterrigger/ Verifica di stabilità e assestamenti Hinterrigger		
	Project	Document ID <b>KTB_B0130_51058</b>	

294.515	620.7
297.956	620.663
300.088	620.644
309.988	620.564
311.412	620.552
312.574	620.543
320.66	620.493
321.93	620.484
324.162	620.48
332.294	620.446
335.582	620.44
346.108	620.405
349.056	620.399
358.406	620.372
359.511	620.37
361.71	620.365
367.212	620.35
369.713	620.344
374.787	620.33

 	<b>DETAILPLANUNG / PROGETTO DI DETTAGLIO</b> Nachweis der Standfestigkeit und Setzungsberechnung Hinterrigger/ Verifica di stabilità e assestamenti Hinterrigger		 <b>Technical report</b>
	Project	Document ID <b>KTB_B0130_51058</b>	

377.106




620.325

 	<b>DETAILPLANUNG / PROGETTO DI DETTAGLIO</b> Nachweis der Standfestigkeit und Setzungsberechnung Hinterrigger/ Verifica di stabilità e assestamenti Hinterrigger		
	Project	Document ID <b>KTB_B0130_51058</b>	

384.767	620.306
388.053	620.299
398.998	620.273
402.823	620.265
416.138	620.233
419.999	620.225
430.865	620.199
434.12	620.192
442.732	620.171
445.583	620.165
453.138	620.147
455.841	620.142
463.444	620.123
466.331	620.117
475.099	620.094
478.57	620.086
487.442	620.06
489.746	620.055
491.032	620.051
494.918	620.038
499.88	620.022
504.626	620.004
508.043	619.992
510.108	619.985
518.403	619.952
520.729	619.944

 	<b>DETAILPLANUNG / PROGETTO DI DETTAGLIO</b> Nachweis der Standfestigkeit und Setzungsberechnung Hinterrigger/ Verifica di stabilità e assestamenti Hinterrigger		
	Project	Document ID <b>KTB_B0130_51058</b>	

522.191	619.939
533.914	619.887
535.336	619.882
545.371	619.831
546.63	619.825
548.454	619.817
554.272	619.784
555.777	619.777
557.839	619.768
562.383	619.742
564.654	619.734
567.481	619.718
569.342	619.711
570.554	619.711
572.832	619.701
573.313	619.698
575.337	619.689
575.736	619.686
577.634	619.666
580.156	619.636
581.517	619.627
583.24	619.614
586.799	619.556
588.532	619.54
592.266	619.437
593.762	619.412

 	<b>DETAILPLANUNG / PROGETTO DI DETTAGLIO</b> Nachweis der Standfestigkeit und Setzungsberechnung Hinterrigger/ Verifica di stabilità e assestamenti Hinterrigger		
	Project	Document ID <b>KTB_B0130_51058</b>	

596.796	619.247
598.105	619.112
599.94	618.979
601.69	618.806
603.317	618.678
604.289	618.602
605.34	618.512
606.08	618.457
606.778	618.392
608.296	618.168
608.828	618
608.828	618
608.828	618

**External Boundary**

X	Y
588.892	628.204
581.208	634.076
567.853	644.076
563.551	644.076
550.213	654.076
536.875	664.076
532.573	664.076
519.234	674.076
511.425	679.931
505.896	684.076






Project

Document ID  
**KTB\_B0130\_51058**

Version  
**00**

**Technical report**

498.893	684.076
493.275	688.288
484.57	694.076
484.03	694.076
477.495	694.076
474.061	694.076
467.018	694.076
464.092	694.076
456.542	694.076
454.123	694.076
451.374	694.076
450.84	694.076
445.639	694.076
444.144	694.076
436.171	694.076
434.145	694.076
431.973	694.076
424.168	694.076
421.208	694.076
414.258	694.076
409.885	694.076
404.452	694.076
398.017	694.076
394.778	694.076
385.252	694.076



 	<b>DETAILPLANUNG / PROGETTO DI DETTAGLIO</b> Nachweis der Standfestigkeit und Setzungsberechnung Hinterrigger/ Verifica di stabilità e assestamenti Hinterrigger		 <b>Technical report</b>
	Project	Document ID <b>KTB_B0130_51058</b>	

| 384.194

694.076

376.09




694.076

 	<b>DETAILPLANUNG / PROGETTO DI DETTAGLIO</b> Nachweis der Standfestigkeit und Setzungsberechnung Hinterrigger/ Verifica di stabilità e assestamenti Hinterrigger		
	Project	Document ID <b>KTB_B0130_51058</b>	

367.005	694.076
356.117	697.977
348.554	700.954
345.124	702.316
341.027	704.076
333.717	704.076
331.768	704.076
323.795	704.076
317.881	699.848
309.815	694.076
295.835	684.076
288.061	678.543
285.773	676.896
281.858	674.076
277.235	670.745
273.26	667.882
268.038	671.492
261.605	673.139
254.783	680
248.92	683.267
240.758	686
227.706	688
225.009	690
219.437	690
205.281	694
199.776	694

Project	Document ID <b>KTB_B0130_51058</b>	Version <b>00</b>	<b>Technical report</b>
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198.375	693.175
193.874	694
190.253	696
177.678	698
163.025	700
163.025	629.5
163.025	617.567
163.025	614.567
163.025	607.567
163.025	595.567
163.025	520.734
800	520.734
800	595.567
800	607.567
800	614.567
800	617.571
800	669.745
788.562	668.248
779.808	667.509
774.305	666
762.733	662
748.786	657.179
735.074	652.44
728.921	650
725.517	648
711.827	644

 	<b>DETAILPLANUNG / PROGETTO DI DETTAGLIO</b> Nachweis der Standfestigkeit und Setzungsberechnung Hinterrigger/ Verifica di stabilità e assestamenti Hinterrigger		
	Project	Document ID <b>KTB_B0130_51058</b>	

693.082	638
673.746	632
659.261	627.488
647.965	624
636.524	620
634.642	618
631.651	617.752
618.822	617.647
608.828	618
605.988	620.817
605.018	620.598
598.661	620.369
595.397	622.986

### **Material Boundary**



X	Y
273.26	667.882
277.694	664.076
283.661	659.626
287.779	656.454
290.54	654.076
294.378	650.77
301.747	644.076
311.758	636.546
315.18	634.076
321.519	629.5

 	<b>DETAILPLANUNG / PROGETTO DI DETTAGLIO</b> Nachweis der Standfestigkeit und Setzungsberechnung Hinterrigger/ Verifica di stabilità e assestamenti Hinterrigger		
	Project	Document ID <b>KTB_B0130_51058</b>	

344.265	629.46
368.64	629
372.019	628.807
392.905	628.53
423.552	627.926
447.369	627.505
457.524	626.5
490.082	627.983
500.667	630
505.184	631
522.22	631.076
539.217	631.5
552.639	631
557.116	629.808
566.019	626.124
569.589	624.5
575.421	621.7
578.157	622.908
586.257	623
595.397	622.986

**Material Boundary**

X	Y
163.025	617.567
634.642	617.57
800	617.571

	<b>DETAILPLANUNG / PROGETTO DI DETTAGLIO</b> Nachweis der Standfestigkeit und Setzungsberechnung Hinterrigger/ Verifica di stabilità e assestamenti Hinterrigger		
	Project	Document ID <b>KTB_B0130_51058</b>	

**Material Boundary**

	X	Y
163.025		614.567
800		614.567

**Material Boundary**

	X	Y
163.025		607.567
800		607.567

**Material Boundary**

	X	Y
163.025		595.567
800		595.567

**Material Boundary**

	X	Y
163.025		629.5
321.519		629.5

**Material Boundary**

	X	Y
301.747		644.076
563.551		644.076




**Material Boundary**

	X	Y
277.694		664.076
532.573		664.076

**Material Boundary**

	X	Y



 	<b>DETAILPLANUNG / PROGETTO DI DETTAGLIO</b> Nachweis der Standfestigkeit und Setzungsberechnung Hinterrigger/ Verifica di stabilità e assestamenti Hinterrigger		
	Project	Document ID <b>KTB_B0130_51058</b>	

295.835	684.076
498.893	684.076

**Material Boundary**

	<b>X</b>	<b>Y</b>
309.815		694.076
367.005		694.076

**Material Boundary**

	<b>X</b>	<b>Y</b>
315.18		634.076
581.208		634.076

**Material Boundary**

	<b>X</b>	<b>Y</b>
290.54		654.076
550.213		654.076

**Material Boundary**

	<b>X</b>	<b>Y</b>
281.858		674.076
519.234		674.076

**Material Boundary**

	<b>X</b>	<b>Y</b>
634.642		617.57
634.642		618