

Regione EMILIA ROMAGNA

Provincia di MODENA

## Comune di Medolla

*DISCARICA PER RIFIUTI NON PERICOLOSI  
DI VIA CAMPANA NEL COMUNE DI MEDOLLA (MO)*

**Continuità di esercizio della discarica esistente  
sita nel Comune di Medolla**

**ISTANZA DI RILASCIO DEL P.A.U.R.**  
*(Provvedimento Autorizzatorio Unico Regionale)*

COMMITTENTE:

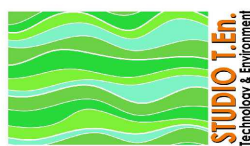


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Data: *Ottobre 2025*

Scala: /

Rif.

Titolo tavola

**RELAZIONE TECNICA  
ESPLICATIVA ARGINI  
- Allegato A del DGR 1373/2011 -**

EMISSIONE:

DATA:

SOSTITUISCE IL

SOSTITUITO DA

Descrizione

Tav n°

***S. 1***

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## 1) Premessa

La presente relazione riguarda le verifiche geotecniche sulla stabilità del corpo arginale della discarica di Medolla (MO).

Le verifiche sono state eseguite lungo le due sezioni tipo previste in progetto, utilizzando i parametri geotecnici del terreno in sito ed i dati sismici elaborati nelle relazioni specialistiche svolte in precedenza sul sito ed a cui si rimanda per i dettagli.

## 2) Normative di riferimento

Le verifiche eseguite si basano sul D.M. gennaio 2018 Norme Tecniche per le Costruzioni e successive integrazioni. Per la parte inerente i rinforzi, i riferimenti sono il manuale dell'ente federale americano gestore delle autostrade (FHWA NHI-00-043) ed il British Standard BS8006.

### 2.1) Approccio di calcolo

Sulla base delle NTC 2018, l'argine rientra tra le "opere di materiali sciolti" (par. 6.8. e 7.11.4). Pertanto, le verifiche sono state eseguite secondo la Combinazione 2 dell'Approccio 1 tenendo conto dei seguenti coefficienti parziali " $\gamma$ ":

Condizione	Grandezza di riferimento sulla quale applicare il coefficiente parziale	Coeff. parz. " $\gamma$ "	NTC 2018 Appr. 1 comb.2: A2+M2+R2	BS 8006
Statica	Tangente dell'angolo di resistenza al taglio " $\tan \phi'_k$ "	$\gamma_{\phi'}$	1.25	
	Coesione efficace " $c'_k$ "	$\gamma_{c'}$	1.25	
	Resistenza non drenata " $c_{uk}$ "	$\gamma_{cu}$	1.4	
	Peso dell'unità di volume " $\gamma_\gamma$ "	$\gamma_g$	1.0	
	Resistenza al pullout geogriglia	$\gamma_{Ra,p}$		1.3
	Carichi variabili favorevoli "Q"	$\gamma_{Qi}$	0.0	
	Carichi variabili sfavorevoli "Q"	$\gamma_{Qi}$	1.3	
	Stabilità globale	$\gamma_R$	1.1	
Sismica	Tangente dell'angolo di resistenza al taglio " $\tan \phi'_k$ "	$\gamma_{\phi'}$	1.0	
	Coesione efficace " $c'_k$ "	$\gamma_{c'}$	1.0	
	Resistenza non drenata " $c_{uk}$ "	$\gamma_{cu}$	1.0	
	Peso dell'unità di volume " $\gamma_\gamma$ "	$\gamma_g$	1.0	
	Resistenza al pullout geogriglia	$\gamma_{Ra,p}$		1.3
	Carichi variabili favorevoli	$\gamma_{Qi}$	1.0	
	Carichi variabili sfavorevoli	$\gamma_{Qi}$	1.0	
	Stabilità globale	$\gamma_R$	1.2	

Tab. 1

### 3) Modelli geotecnici di riferimento

Nel presente capitolo si riportano i modelli geotecnici adottati nelle diverse verifiche e le valutazioni sulla base delle quali sono stati definiti, in questa fase, i parametri meccanici di progetto in particolare per quanto concerne i rifiuti RSU.

#### 3.1) Modello sezione 1

Il modello adottato considera 12 unità geotecniche costituite dai terreni naturali presenti sul sedime, da quelli previsti per l'opera e dai rifiuti distinti per età come meglio specificato nel paragrafo successivo. Sono stati inseriti anche gli elementi di rinforzo del corpo arginale costituiti da geogriglie PET 110 kN/m di diversa lunghezza poste con una spaziatura di 60 cm.

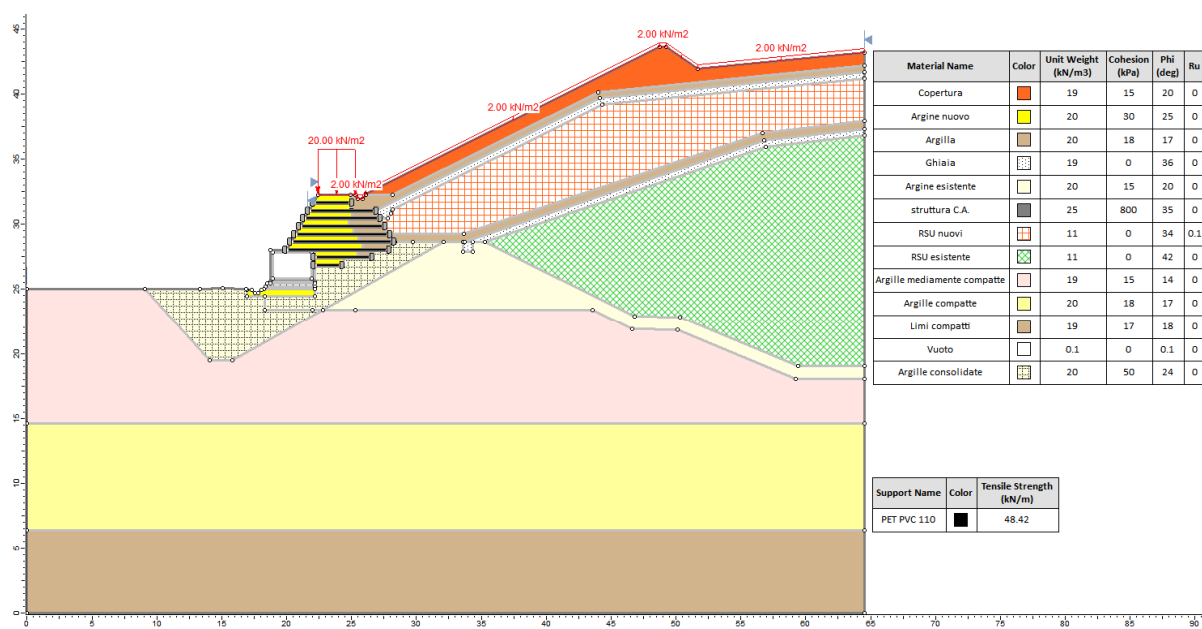


Fig. 1: geometria modello geotecnico sezione 1

### 3.2) Modello sezione 2

Il modello adottato considera 11 unità geotecniche costituite dai terreni naturali presenti sul sedime, da quelli previsti per l'opera e dai nuovi rifiuti come meglio specificato nel paragrafo successivo. Sono stati inseriti anche gli elementi di rinforzo del corpo arginale costituiti da geogriglie PET 110 kN/m di diversa lunghezza poste con una spaziatura prevalente di 60 cm.

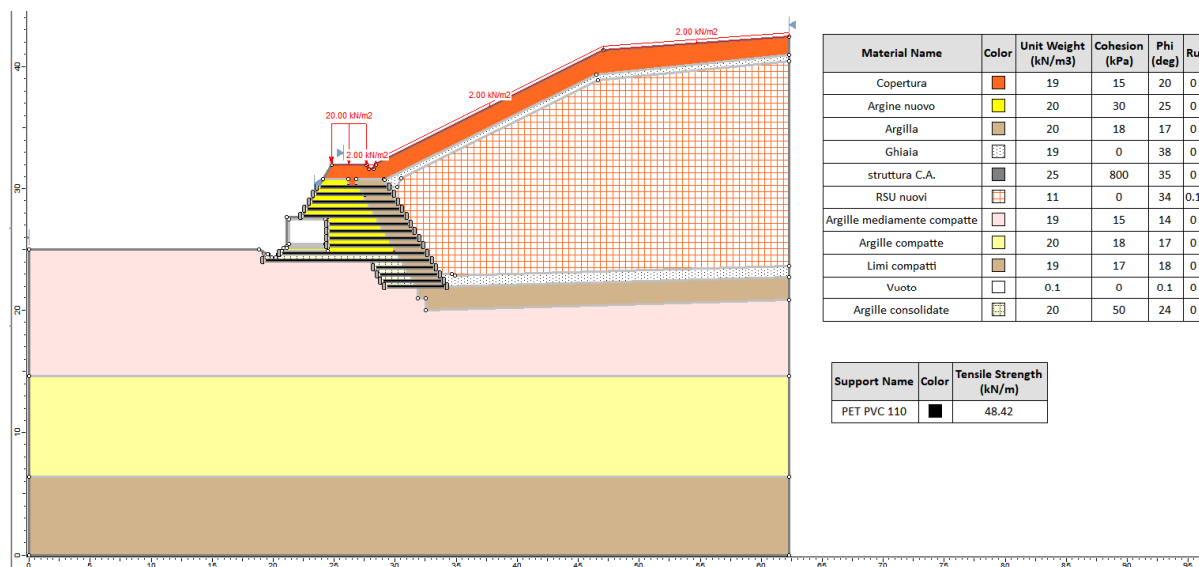


Fig. 2: geometria modello geotecnico sezione 2

### 3.3) Scelta della parametrizzazione meccanica di resistenza al taglio dei rifiuti RSU

Il modello considera sia i rifiuti esistenti che quelli previsti in progetto. Sulla base di tale premessa, per la definizione della parametrizzazione si è fatto riferimento agli studi eseguiti da Kockel & Jessberger ("Stability evaluation of municipal solid waste slopes"-1995) ed in particolare ai grafici da loro proposti che mettono in relazione la deformazione assiale ed il variare dell'attrito e della coesione (Fig. 2). Poiché le prove si riferiscono a rifiuti con diverso contenuto plastico, cautelativamente per tutte le valutazioni sono stati utilizzati i limiti inferiori trascurando il contributo coesivo.

Si sono imposte pertanto le seguenti condizioni:

- RSU nuovi: rifiuto in progetto con usuale posa – deformazione considerata 10%
- RSU esistente: rifiuto esistente – deformazione media considerata 20%

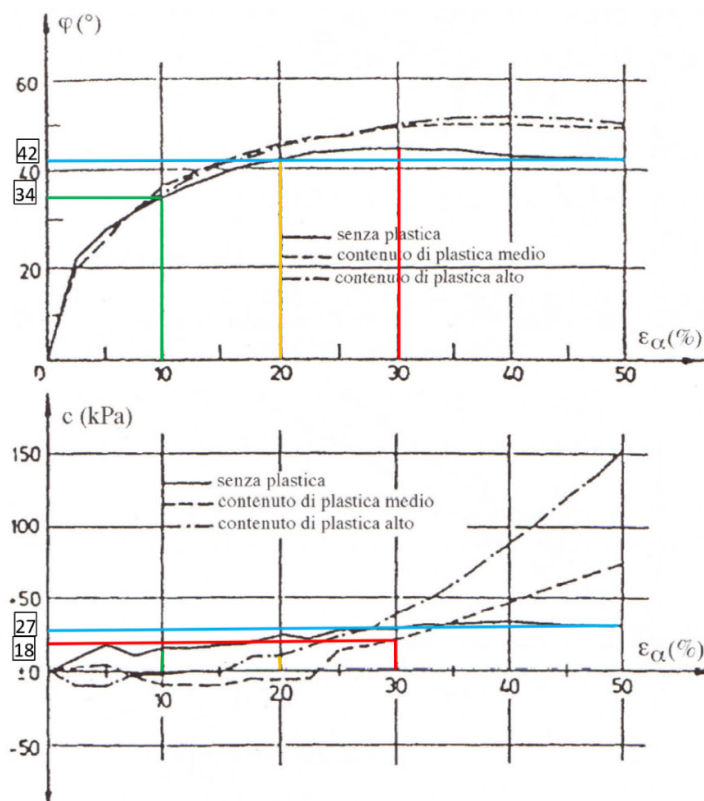


Fig. 3: valori della resistenza al taglio dei RSU in base alla deformazione assiale

Sulla base di quanto sopra sono stati definiti i parametri meccanici inerenti la resistenza al taglio sotto riportati.

“RSU nuovo”

Peso di volume $\gamma$	11.0 kN/m <sup>3</sup>
Angolo di attrito interno $\varphi'$	34°
Coesione efficace $c'$	0 kPa

“RSU esistente”

Peso di volume $\gamma$	11.0 kN/m <sup>3</sup>
Angolo di attrito interno $\varphi'$	42°
Coesione efficace $c'$	0 kPa

### 3.4) Falda e saturazione

Gli studi geologici sull’area indicano una falda profonda ininfluente per le opere in progetto. Al contempo, le acque superficiali richiederanno un adeguato ed attento sistema di gestione, onde evitare in modo assoluto che infiltrazioni e/o percolazioni possano penetrare nel corpo argine in particolare nella zona basale.

Per quanto concerne invece il nuovo corpo rifiuti, si è ritenuto opportuno adottare nelle calcolazioni la presenza di una saturazione parziale mediante l'utilizzo del coefficiente di pressione neutra  $r_u$  con un valore 0.1.

### **3.5) Sovraccarichi**

Per le diverse verifiche sono stati introdotti due carico variabile "Q":

- un carico da traffico di 20 kPa alla sommità dell'argine;
- un carico accidentale di 2 kPa sulle rimanenti zone.

Qualora l'azione del carico diventi favorevole, il software utilizzato ne trascura il contributo, in sintonia con la norma vigente.

### **3.6) Sismicità**

Per la definizione delle azioni sismiche di calcolo si è fatto riferimento ai coefficienti utilizzati nella relazione geologica del precedente studio pari a  $k_h=0.067$  e  $k_v= 0.0335$ .

#### 4) Teorie di calcolo e verifiche eseguite

In base alle NTC 2018 si è proceduto con le verifiche di stabilità nelle diverse condizioni. In particolare, le verifiche sono state eseguite per le seguenti condizioni:

- verifiche secondo superfici circolari;
- verifiche secondo spezzate al fine di ricercare potenziali meccanismi di tipo pseudo-traslato.

Non sono state eseguite verifiche per potenziali meccanismi di ribaltamento che, vista la tipologia di opera non rigida, risultano del tutto irrealistici.

Per ogni tipologia di verifica sono state analizzate sia le condizioni statiche che sismiche.

Le verifiche sono state eseguite con il software Slide 7.0 della Rocscience di Toronto (licenza 6050A).

Le teorie di calcolo adottate sono state quelle di Bishop, Spencer, GLE-Morgenstern-Price e Sarma. La scelta di operare con quattro diversi metodi di calcolo ha consentito di valutare la bontà dei singoli risultati ottenuti.

In considerazione dell'elevato numero di verifiche eseguite ed al contempo l'opportunità di rendere il presente documento di più facile e rapida lettura, si è ritenuto più utile indicare in dettaglio gli esiti delle sole verifiche più gravose, rimandando al contempo ai tabulati di calcolo allegati i relativi dettagli.



## 5) Geogriglie di rinforzo

Il progetto prevede l'inserimento nel corpo arginale di geogriglie di rinforzo. In base ad alcune verifiche preliminari, si è optato per l'utilizzo di geogriglie tessute in poliestere "PET" con resistenza ultima a trazione UTS 110 kN/m secondo lo schema sotto riportato.

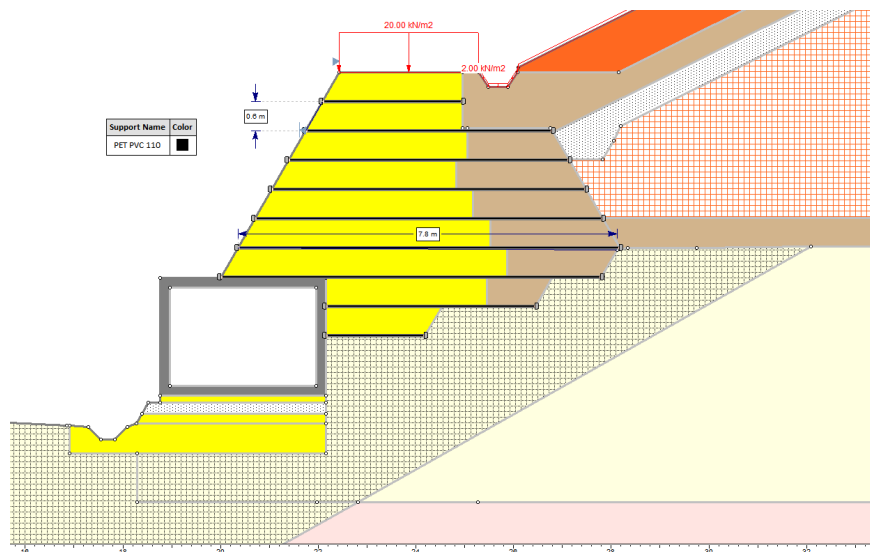


Fig. 4: schema rinforzi geogriglie sezione 1

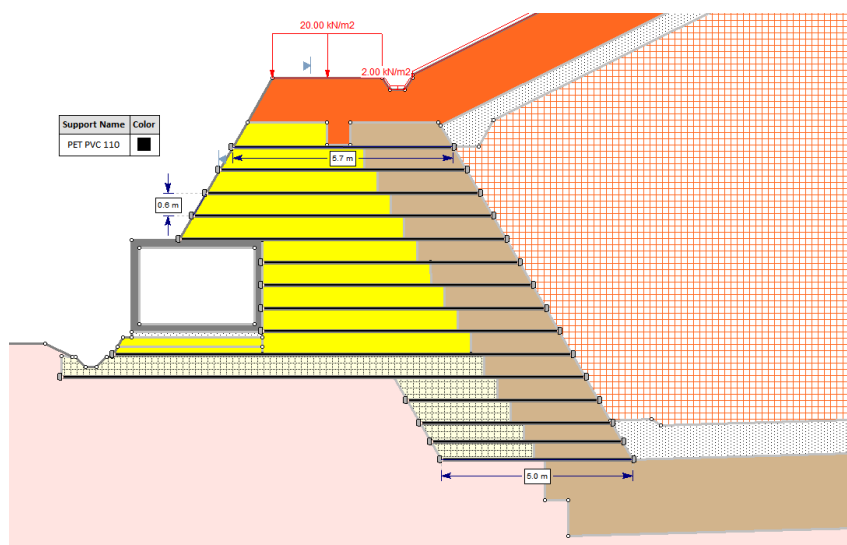


Fig. 5: schema rinforzi geogriglie sezione 2

Si è proceduto a definire le caratteristiche minime delle geogriglie sulla base di coefficienti di riduzione standard tipici per gran parte delle geogriglie presenti sul mercato.

Tipologia di rinforzo: geogriglie tessute in poliestere PET rivestite in PVC

<b>Geogriglia di rinforzo PET</b>	<b>110/30</b>
<b>Polimero rinforzo</b>	<b>PET</b>
<b>Polimero rivestimento</b>	<b>PVC</b>
<b>resistenza ultima a trazione longitudinale <math>T_{UTS}</math> (kN/m)</b>	<b><math>\geq 110</math></b>
<b>allungamento a carico UTS (%)</b>	<b><math>\leq 12.5</math></b>
<b>resistenza ultima a trazione trasversale <math>T_{UTS}</math> (kN/m)</b>	<b><math>\geq 30</math></b>
<b>allungamento a carico UTS (%)</b>	<b><math>\leq 12.5</math></b>
<b>interazione terreno-geogriglia per traslazione</b>	<b><math>\geq 0.80</math></b>
<b>interazione terreno-geogriglia allo sfilamento</b>	<b><math>\geq 0.80</math></b>
<b>coefficiente di riduzione per danneggiamento meccanico con sabbia ghiaiosa <math>RF_{ID}</math></b>	<b><math>\leq 1.12</math></b>
<b>coefficiente di riduzione durata dell'opera di 60 anni <math>RF_{creep}</math></b>	<b><math>\leq 1.56</math></b>
<b>coefficiente di riduzione per <math>8 \leq pH &lt; 9</math> <math>RF_D</math></b>	<b><math>\leq 1.30</math></b>

Tab. 2

Sulla base dei coefficienti di riduzione sopra indicati, è stata calcolata la resistenza minima adottabile per i singoli rinforzi secondo la classica formula proposta dal FHWA NHI-00-043:

$$T_{des} = T_{UTS} / (RF_{creep} \times RF_D \times RF_{ID})$$

Geogriglia PET 110/30

$$T_{des} = 48.42 \text{ kN/m}$$

## 6) Esiti delle verifiche

Nelle pagine a seguire vengono riportate graficamente le aree a diverso FS con indicazione dei valori minimi riscontrati, riportati in dettaglio nei tabulati di calcolo allegati. Tutte le verifiche eseguite hanno evidenziato per i quattro metodi adottati, valori di FS molto simili tra loro, a conferma dell'affidabilità dei calcoli eseguiti.

### 6.1) Verifiche sezione 1

#### Verifiche in campo statico

La condizione più gravosa è emersa per superfici spezzate con un fattore di sicurezza pari a 1.12, valore superiore al minimo imposto dalla normativa di 1.10.

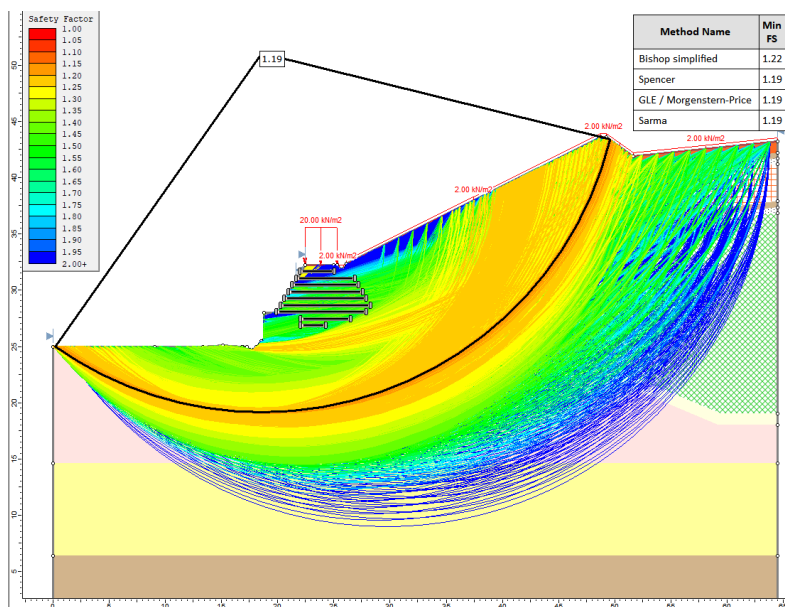


Fig. 6: verifica secondo superfici circolari

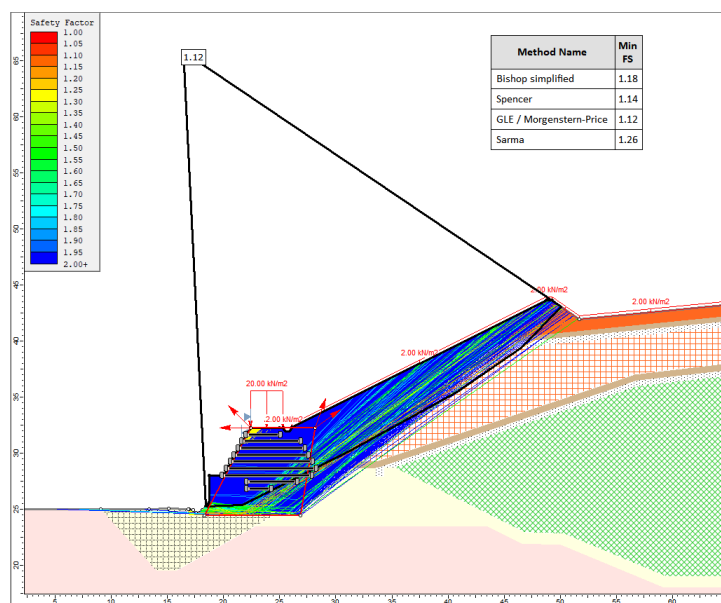


Fig. 7: verifica secondo spezzate lineari

## Verifiche in campo sismico

La condizione più gravosa è emersa in campo sismico per superfici circolari, con un fattore di sicurezza pari a 1.24, valore superiore al minimo imposto dalla normativa di 1.20.

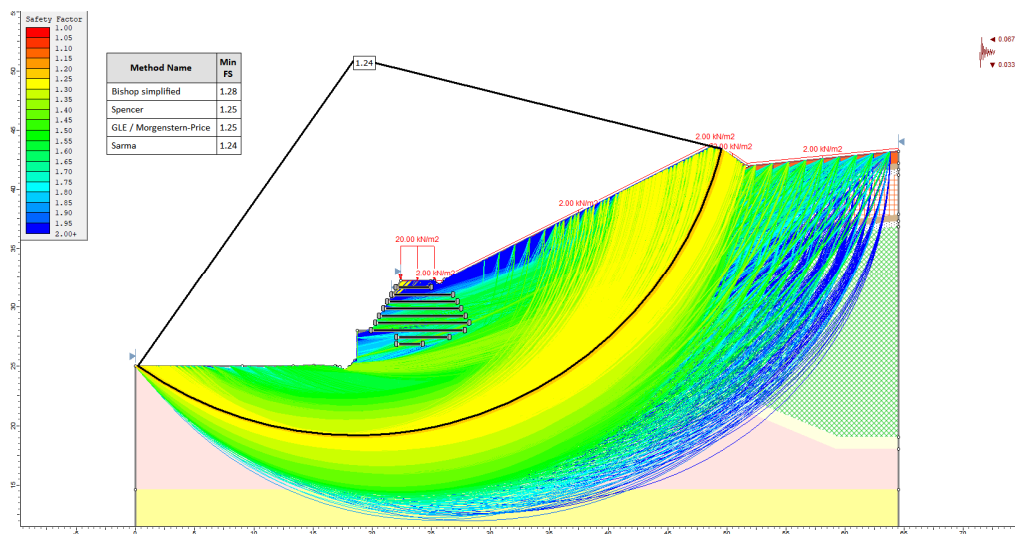


Fig. 8: verifica secondo superfici circolari in campo sismico

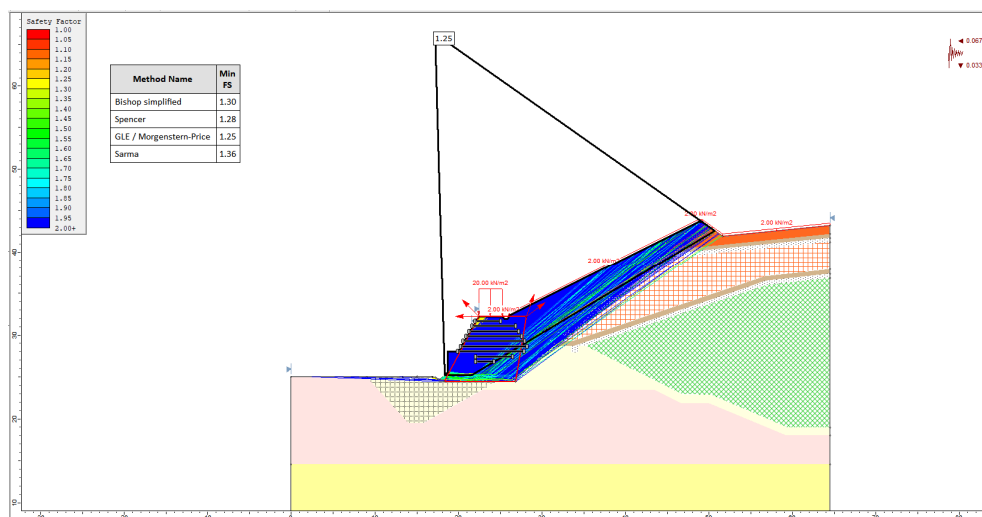


Fig. 9: verifica secondo spezzate lineari in campo sismico

## 6.1) Verifiche sezione 2

### Verifiche in campo statico

La condizione più gravosa è emersa per superfici circolari con un fattore di sicurezza pari a 1.23, valore superiore al minimo imposto dalla normativa di 1.10.

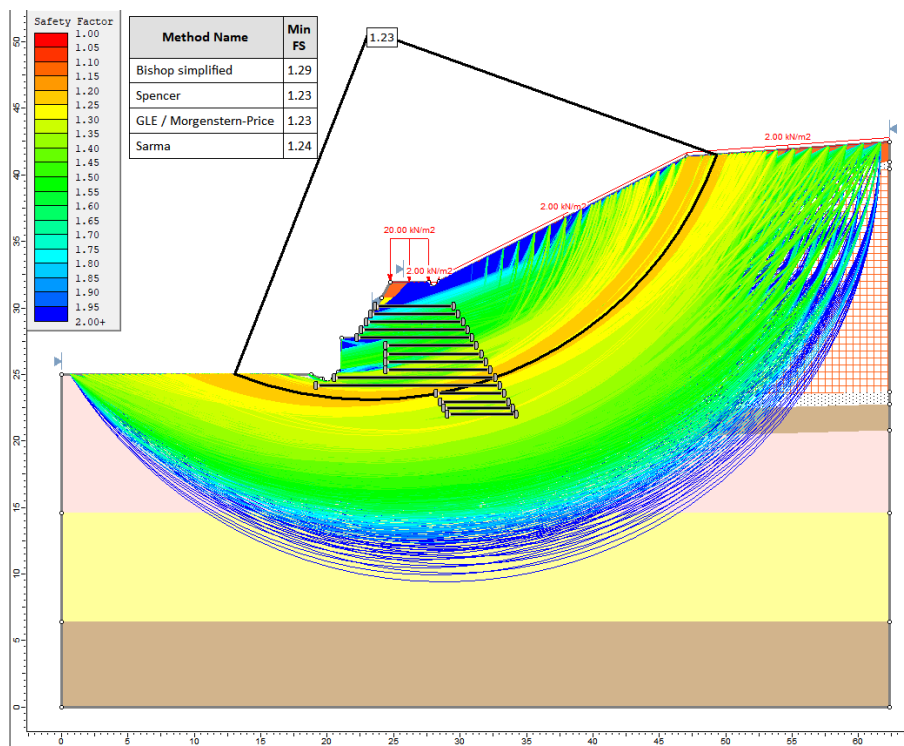


Fig. 10: verifica secondo superfici circolari

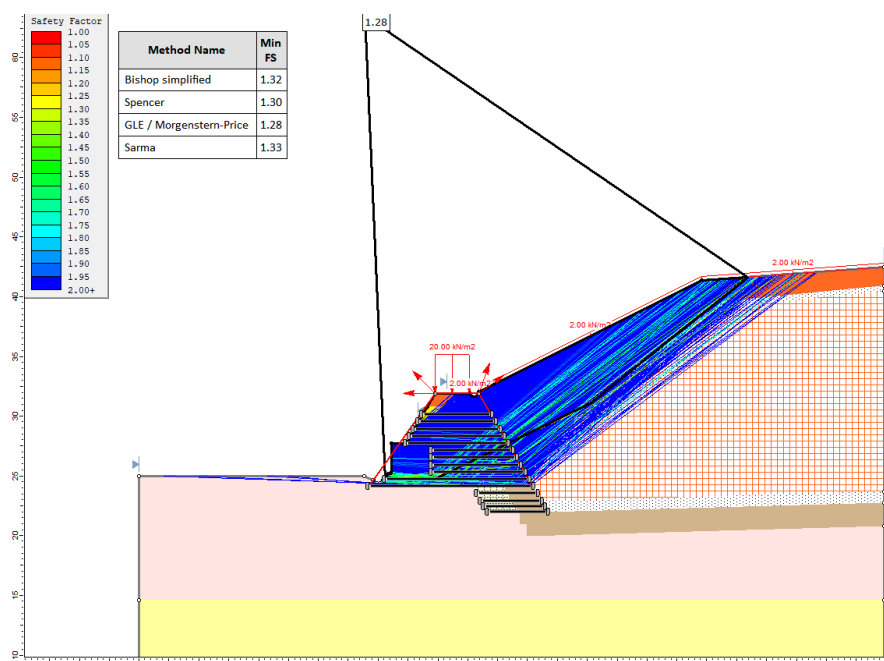


Fig. 11: verifica secondo spezzate lineari

## Verifiche in campo sismico

La condizione più gravosa è emersa in campo sismico per superfici circolari, con un fattore di sicurezza pari a 1.31, valore superiore al minimo imposto dalla normativa di 1.20.

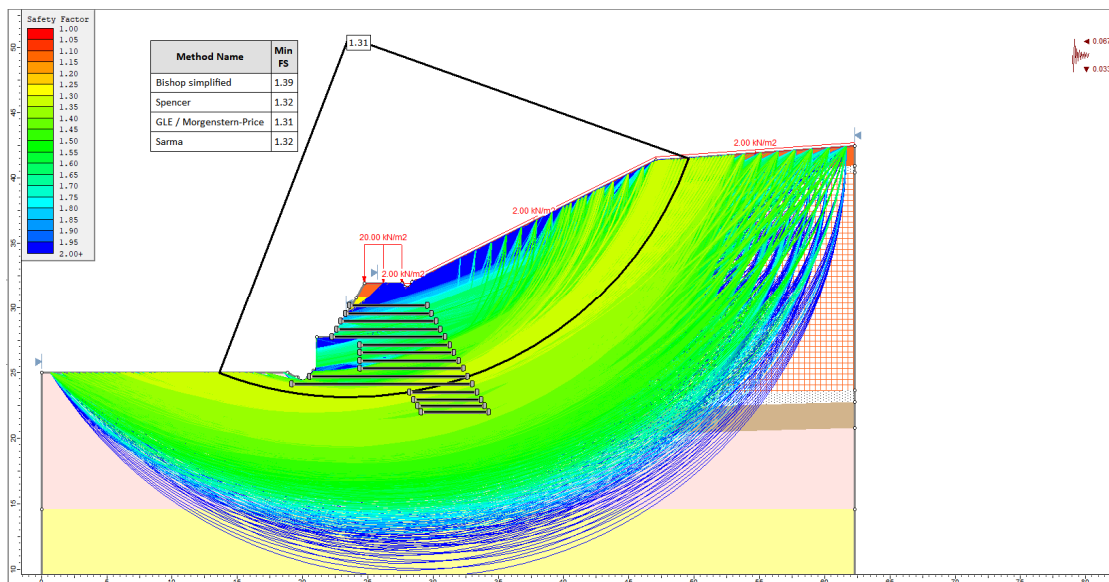


Fig. 12: verifica secondo superfici circolari in campo sismico

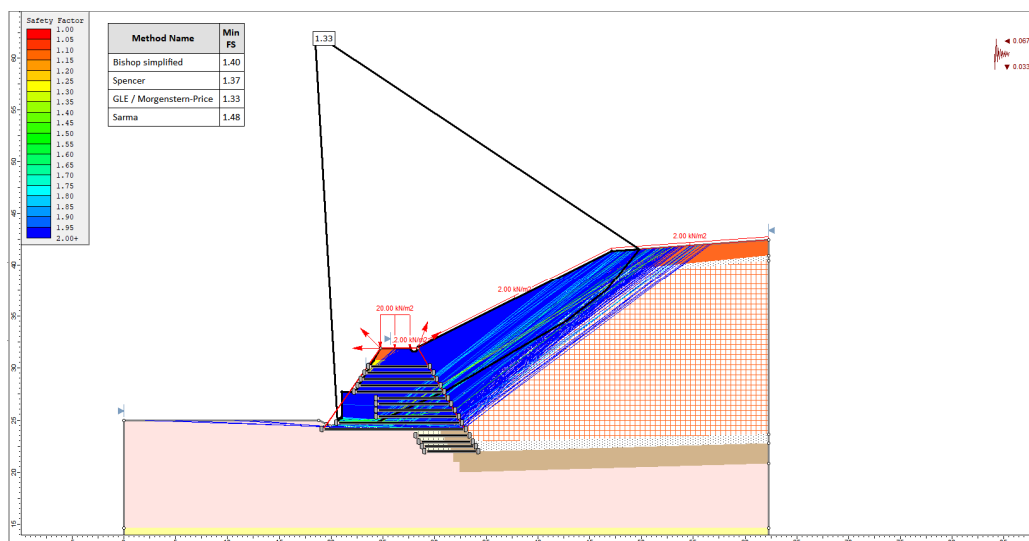


Fig. 13: verifica secondo spezzate lineari in campo sismico

## 6.2) Riassunto delle verifiche

Nel presente paragrafo vengono riassunti gli esiti delle verifiche svolte che in tutti i casi analizzati hanno fornito FS superiori ai minimi richiesti dalla normativa NTC 2018.

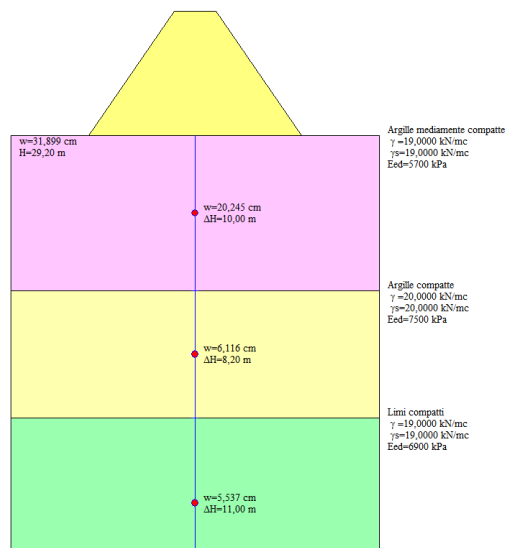
Sezione	Verifica	SS circolari	SS spezzate	FS minimo NTC 2018	Esito verifica
1	Statica	1.19	1.12	1.10	VERIFICATO
1	Sismica	1.24	1.25	1.20	VERIFICATO
2	Statica	1.23	1.28	1.10	VERIFICATO
2	Sismica	1.31	1.33	1.20	VERIFICATO

**Tab.2: schema riassuntivo dei minimi fattori di sicurezza ottenuti per le superfici di scivolamento SS analizzate per i diversi meccanismi di rottura**

## 7) Valutazione dei cedimenti attesi

Nella presente fase progettuale viene eseguita una stima preliminare dei cedimenti attesi alla base de nuovo rilevato.

Fondazione n° 1 - Metodo Edometrico



**Fig. 14: modello geotecnico di calcolo per la stima dei cedimenti con terra rinforzata inferiore**

La verifica seppur semplificata e quindi cautelativa, evidenzia un cedimento teorico massimo di circa 32 cm, valore accettabile per la tipologia di opera in terra, considerato che gli assestamenti si verificheranno buona parte in fase costruttiva. Prevedendo inoltre un'attività di preparazione del piano di posa con consolidamento, il valore reale sarà inferiore.



## 8) Conclusioni

La presente relazione riguarda le verifiche geotecniche del corpo arginale della discarica di Medolla (MO).

Tutte le verifiche eseguite hanno soddisfatto i minimi fattori di normativa NTC 2018.

Sono state effettuate anche delle valutazioni preliminari sull'entità dei cedimenti attesi. I calcoli effettuati hanno fornito cedimenti massimi di circa 32 cm, valori accettabili per l'opera in progetto.

## **Allegati (Tabulati di calcolo)**

## Slide Analysis Information

### Discarica di Medolla-verifica argini

#### Project Summary

---

File Name: Medolla-verifiche argine-sez01.slmd - Group 1 - Sez.01-valle-statica  
Slide Modeler Version: 7.038  
Project Title: Discarica di Medolla-verifica argini  
Analysis: sez.01-verifica di valle-SS circolari-statica  
Author: ing. Teneggi  
Company: Studio Ten  
Date Created: 31/10/2025

#### General Settings

---

Units of Measurement: Metric Units  
Time Units: days  
Permeability Units: meters/second  
Failure Direction: Right to Left  
Data Output: Standard  
Maximum Material Properties: 20  
Maximum Support Properties: 20

#### Design Standard

---

Selected Type: Eurocode 7 (User Defined)  
Name: NTC 2018 statica

Type	Partial Factor
Permanent Actions: Unfavourable	1
Permanent Actions: Favourable	1
Variable Actions: Unfavourable	1.3
Variable Actions: Favourable	0
Effective cohesion	1.25
Coefficient of shearing resistance	1.25
Undrained strength	1.4
Weight density	1
Shear strength (other models)	1.25
Earth resistance	1
Tensile and plate strength	1
Shear strength	1
Compressive strength	1
Bond strength	1.3
Seismic Coefficient	1

#### Analysis Options

---

Slices Type: Vertical

#### Analysis Methods Used

Bishop simplified  
 GLE/Morgenstern-Price with interslice force function (Half Sine)  
 Spencer  
 Sarma

Number of slices: 25  
 Tolerance: 0.005  
 Maximum number of iterations: 50  
 Initial trial value of FS: 1  
 Sarma Interslice Strength Option: Computed Average Value

## Seismic

Advanced seismic analysis: No  
 Staged pseudostatic analysis: No

## Loading

2 Distributed Loads present









#### Distributed Load 1






Distribution: Constant  
 Magnitude [kPa]: 20  
 Orientation: Vertical  
 Load Action: Variable

#### Distributed Load 2

Distribution: Constant  
 Magnitude [kPa]: 2  
 Orientation: Vertical  
 Load Action: Variable

## Material Properties

Property	Copertura	Argine nuovo	Argilla	Ghiaia	Argine esistente	struttura C.A.	RSU nuovi	RSU esistente
Color								
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [kN/m3]	19	20	20	19	20	25	11	11
Cohesion [kPa]	15	30	18	0	15	800	0	0
Friction Angle [deg]	20	25	17	36	20	35	34	42
Ru Value	0	0	0	0	0	0	0.1	0



Property	Argille mediamente compatte	Argille compatte	Limi compatti	Vuoto	Argille consolidate
Color					
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [kN/m3]	19	20	19	0.1	20
Cohesion [kPa]	15	18	17	0	50
Friction Angle [deg]	14	17	18	0.1	24
Ru Value	0	0	0	0	0

## Support Properties

### PET PVC 110

Support Type: GeoTextile  
Force Application: Passive  
Force Orientation: Tangent to Slip Surface  
Anchorage: Both Ends  
Shear Strength Model: Linear  
Use External Loads for Strength: yes  
Strip Coverage: 100 percent  
Tensile Strength: 48.42 kN/m

#### Pullout Strength Dependency:

Material	Adhesion (kPa)	Friction Angle (deg)
 Argine nuovo	0	19.6
 Argilla	32	23

## Global Minimums

### Method: bishop simplified

FS	1.216520
Center:	18.090, 43.001
Radius:	23.845
Left Slip Surface Endpoint:	2.451, 25.000
Right Slip Surface Endpoint:	41.763, 40.139
Resisting Moment:	44983 kN-m
Driving Moment:	36976.7 kN-m
Total Slice Area:	299.481 m2
Surface Horizontal Width:	39.3116 m
Surface Average Height:	7.61812 m

### Method: spencer

FS	1.190850
Center:	18.548, 43.679
Radius:	24.591
Left Slip Surface Endpoint:	2.553, 25.000
Right Slip Surface Endpoint:	42.962, 40.736
Resisting Moment:	47822.1 kN-m
Driving Moment:	40158 kN-m
Resisting Horizontal Force:	1628.9 kN
Driving Horizontal Force:	1367.85 kN
Total Slice Area:	318.396 m2
Surface Horizontal Width:	40.4094 m
Surface Average Height:	7.87927 m

### Method: gle/morgenstern-price

FS	1.193790
Center:	18.581, 51.080
Radius:	31.901
Left Slip Surface Endpoint:	0.210, 25.000
Right Slip Surface Endpoint:	49.547, 43.413
Resisting Moment:	80160.1 kN-m
Driving Moment:	67147.4 kN-m
Resisting Horizontal Force:	2108.41 kN
Driving Horizontal Force:	1766.14 kN
Total Slice Area:	409.086 m2
Surface Horizontal Width:	49.3366 m
Surface Average Height:	8.29174 m

### Method: sarma

FS	1.191880
Center:	17.978, 42.894
Radius:	23.758
Left Slip Surface Endpoint:	2.350, 25.000
Right Slip Surface Endpoint:	41.563, 40.039
Total Slice Area:	297.471 m2
Surface Horizontal Width:	39.2131 m
Surface Average Height:	7.586 m

## Slide Analysis Information

### Discarica di Medolla-verifica argini

#### Project Summary

File Name: Medolla-verifiche argine-sez01.slmd - Group 1 - Sez.01-valle-traslazione-statica  
Slide Modeler Version: 7.038  
Project Title: Discarica di Medolla-verifica argini  
Analysis: sez.01-verifica di valle-SS spezzate-statica  
Author: ing. Teneggi  
Company: Studio Ten  
Date Created: 31/10/2025

#### General Settings

Units of Measurement: Metric Units  
Time Units: days  
Permeability Units: meters/second  
Failure Direction: Right to Left  
Data Output: Standard  
Maximum Material Properties: 20  
Maximum Support Properties: 20

#### Design Standard

Selected Type: Eurocode 7 (User Defined)  
Name: NTC 2018 statica

Type	Partial Factor
Permanent Actions: Unfavourable	1
Permanent Actions: Favourable	1
Variable Actions: Unfavourable	1.3
Variable Actions: Favourable	0
Effective cohesion	1.25
Coefficient of shearing resistance	1.25
Undrained strength	1.4
Weight density	1
Shear strength (other models)	1.25
Earth resistance	1
Tensile and plate strength	1
Shear strength	1
Compressive strength	1
Bond strength	1.3
Seismic Coefficient	1

#### Analysis Options

Slices Type: Vertical

#### Analysis Methods Used

Bishop simplified  
 GLE/Morgenstern-Price with interslice force function (Half Sine)  
 Spencer  
 Sarma

Number of slices: 25  
 Tolerance: 0.005  
 Maximum number of iterations: 50  
 Initial trial value of FS: 1  
 Sarma Interslice Strength Option: Computed Average Value

## Seismic

Advanced seismic analysis: No  
 Staged pseudostatic analysis: No

## Loading

2 Distributed Loads present









#### Distributed Load 1

Distribution: Constant  
 Magnitude [kPa]: 20  
 Orientation: Vertical  
 Load Action: Variable






#### Distributed Load 2

Distribution: Constant  
 Magnitude [kPa]: 2  
 Orientation: Vertical  
 Load Action: Variable

## Material Properties

Property	Copertura	Argine nuovo	Argilla	Ghiaia	Argine esistente	struttura C.A.	RSU nuovi	RSU esistente
Color								
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [kN/m3]	19	20	20	19	20	25	11	11
Cohesion [kPa]	15	30	18	0	15	800	0	0
Friction Angle [deg]	20	25	17	36	20	35	34	42
Ru Value	0	0	0	0	0	0	0.1	0





Property	Argille mediamente compatte	Argille compatte	Limi compatti	Vuoto	Argille consolidate
Color					
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [kN/m3]	19	20	19	0.1	20
Cohesion [kPa]	15	18	17	0	50
Friction Angle [deg]	14	17	18	0.1	24
Ru Value	0	0	0	0	0

## Support Properties

### PET PVC 110

Support Type: GeoTextile  
 Force Application: Passive  
 Force Orientation: Tangent to Slip Surface  
 Anchorage: Both Ends  
 Shear Strength Model: Linear  
 Use External Loads for Strength: yes  
 Strip Coverage: 100 percent  
 Tensile Strength: 48.42 kN/m

#### Pullout Strength Dependency:

Material	Adhesion (kPa)	Friction Angle (deg)
 Argine nuovo	0	19.6
 Argilla	32	23

## Global Minimums

### Method: bishop simplified

FS	1.176160
Axis Location:	16.417, 65.821
Left Slip Surface Endpoint:	18.390, 25.239
Right Slip Surface Endpoint:	50.067, 43.050
Resisting Moment:	48106.2 kN-m
Driving Moment:	40901 kN-m
Passive Support Moment:	3729.59 kN-m
Total Slice Area:	130.176 m2
Surface Horizontal Width:	31.6764 m
Surface Average Height:	4.10955 m

### Method: spencer

FS	1.144390
Axis Location:	16.417, 65.821
Left Slip Surface Endpoint:	18.390, 25.239
Right Slip Surface Endpoint:	50.067, 43.050
Resisting Moment:	47624.9 kN-m
Driving Moment:	41615.8 kN-m
Resisting Horizontal Force:	1073.41 kN
Driving Horizontal Force:	937.973 kN
Passive Support Moment:	3729.59 kN-m
Passive Horizontal Support Force:	86.6019 kN
Total Slice Area:	130.176 m2
Surface Horizontal Width:	31.6764 m
Surface Average Height:	4.10955 m

### Method: gle/morgenstern-price

FS	1.124470
Axis Location:	16.417, 65.821
Left Slip Surface Endpoint:	18.390, 25.239
Right Slip Surface Endpoint:	50.067, 43.050
Resisting Moment:	47157.4 kN-m
Driving Moment:	41937.3 kN-m
Resisting Horizontal Force:	1061.69 kN
Driving Horizontal Force:	944.169 kN
Passive Support Moment:	3729.59 kN-m
Passive Horizontal Support Force:	86.6019 kN
Total Slice Area:	130.176 m2
Surface Horizontal Width:	31.6764 m
Surface Average Height:	4.10955 m

### Method: sarma

FS	1.260420
Axis Location:	16.023, 66.338
Left Slip Surface Endpoint:	17.834, 24.717
Right Slip Surface Endpoint:	50.406, 42.813
Total Slice Area:	131.347 m2
Surface Horizontal Width:	32.5729 m
Surface Average Height:	4.0324 m

## Global Minimum Coordinates

### Method: bishop simplified

X	Y
18.3904	25.2391
21.6871	25.3923
31.2484	30.177
40.8021	35.4637
46.5868	39.4105
50.0668	43.0504

### Method: spencer

--

X	Y
18.3904	25.2391
21.6871	25.3923
31.2484	30.177
40.8021	35.4637
46.5868	39.4105
50.0668	43.0504

### Method: gle/morgenstern-price

X	Y
18.3904	25.2391
21.6871	25.3923
31.2484	30.177
40.8021	35.4637
46.5868	39.4105
50.0668	43.0504

### Method: sarma

X	Y
17.8336	24.7165
22.1647	24.706
37.0295	33.4976
50.4065	42.8134

## Slide Analysis Information

### Discarica di Medolla-verifica argini

#### Project Summary

File Name: Medolla-verifiche argine-sez01.slmd - Group 2 - Sez.01-valle-sismica  
Slide Modeler Version: 7.038  
Project Title: Discarica di Medolla-verifica argini  
Analysis: sez.01-verifica di valle-SS circolari-sismica +kv  
Author: ing. Teneggi  
Company: Studio Ten  
Date Created: 31/10/2025

#### General Settings

Units of Measurement: Metric Units  
Time Units: days  
Permeability Units: meters/second  
Failure Direction: Right to Left  
Data Output: Standard  
Maximum Material Properties: 20  
Maximum Support Properties: 20

#### Design Standard

Selected Type: Eurocode 7 (User Defined)  
Name: NTC 2018 sismica

Type	Partial Factor
Permanent Actions: Unfavourable	1
Permanent Actions: Favourable	1
Variable Actions: Unfavourable	1
Variable Actions: Favourable	0
Effective cohesion	1
Coefficient of shearing resistance	1
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	1.3
Seismic Coefficient	1

#### Analysis Options

Slices Type: Vertical

#### Analysis Methods Used

Bishop simplified  
 GLE/Morgenstern-Price with interslice force function (Half Sine)  
 Spencer  
 Sarma

Number of slices: 25  
 Tolerance: 0.005  
 Maximum number of iterations: 50  
 Initial trial value of FS: 1  
 Sarma Interslice Strength Option: Computed Average Value

## Seismic

Advanced seismic analysis: No  
 Staged pseudostatic analysis: No

## Loading

Seismic Load Coefficient (Horizontal): 0.067  
 Seismic Load Coefficient (Vertical): 0.0335

2 Distributed Loads present









#### Distributed Load 1






Distribution: Constant  
 Magnitude [kPa]: 20  
 Orientation: Vertical  
 Load Action: Variable

#### Distributed Load 2

Distribution: Constant  
 Magnitude [kPa]: 2  
 Orientation: Vertical  
 Load Action: Variable

## Material Properties

Property	Copertura	Argine nuovo	Argilla	Ghiaia	Argine esistente	struttura C.A.	RSU nuovi	RSU esistente
Color								
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [kN/m3]	19	20	20	19	20	25	11	11
Cohesion [kPa]	15	30	18	0	15	800	0	0
Friction Angle [deg]	20	25	17	36	20	35	34	42
Ru Value	0	0	0	0	0	0	0.1	0



Property	Argille mediamente compatte	Argille compatte	Limi compatti	Vuoto	Argille consolidate
Color					
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [kN/m3]	19	20	19	0.1	20
Cohesion [kPa]	15	18	17	0	50
Friction Angle [deg]	14	17	18	0.1	24
Ru Value	0	0	0	0	0

## Support Properties

### PET PVC 110

Support Type: GeoTextile  
Force Application: Passive  
Force Orientation: Tangent to Slip Surface  
Anchorage: Both Ends  
Shear Strength Model: Linear  
Use External Loads for Strength: yes  
Strip Coverage: 100 percent  
Tensile Strength: 48.42 kN/m

#### Pullout Strength Dependency:

Material	Adhesion (kPa)	Friction Angle (deg)
 Argine nuovo	0	19.6
 Argilla	32	23

## Global Minimums

Method: bishop simplified

FS	1.281590
Center:	18.383, 51.179
Radius:	31.971
Left Slip Surface Endpoint:	0.031, 25.000
Right Slip Surface Endpoint:	49.419, 43.502
Resisting Moment:	101596 kN-m
Driving Moment:	79273.1 kN-m
Total Slice Area:	404.874 m2
Surface Horizontal Width:	49.3876 m
Surface Average Height:	8.19788 m

#### Method: spencer

FS	1.252600
Center:	18.471, 51.135
Radius:	31.940
Left Slip Surface Endpoint:	0.111, 25.000
Right Slip Surface Endpoint:	49.475, 43.463
Resisting Moment:	99542.2 kN-m
Driving Moment:	79468.1 kN-m
Resisting Horizontal Force:	2636.87 kN
Driving Horizontal Force:	2105.11 kN
Total Slice Area:	406.722 m2
Surface Horizontal Width:	49.3643 m
Surface Average Height:	8.2392 m

#### Method: gle/morgenstern-price

FS	1.252940
Center:	18.471, 51.135
Radius:	31.940
Left Slip Surface Endpoint:	0.111, 25.000
Right Slip Surface Endpoint:	49.475, 43.463
Resisting Moment:	99568.7 kN-m
Driving Moment:	79468.1 kN-m
Resisting Horizontal Force:	2632.74 kN
Driving Horizontal Force:	2101.25 kN
Total Slice Area:	406.722 m2
Surface Horizontal Width:	49.3643 m
Surface Average Height:	8.2392 m

#### Method: sarma

FS	1.244690
Center:	18.592, 51.075
Radius:	31.899
Left Slip Surface Endpoint:	0.217, 25.000
Right Slip Surface Endpoint:	49.556, 43.407
Total Slice Area:	409.438 m2
Surface Horizontal Width:	49.339 m
Surface Average Height:	8.29846 m

## Slide Analysis Information

### Discarica di Medolla-verifica argini

#### Project Summary

File Name: Medolla-verifiche argine-sez01.slmd - Group 2 - Sez.01-valle-traslazione-sismica  
Slide Modeler Version: 7.038  
Project Title: Discarica di Medolla-verifica argini  
Analysis: sez.01-verifica di valle-SS spezzate-sismica +kv  
Author: ing. Teneggi  
Company: Studio Ten  
Date Created: 31/10/2025

#### General Settings

Units of Measurement: Metric Units  
Time Units: days  
Permeability Units: meters/second  
Failure Direction: Right to Left  
Data Output: Standard  
Maximum Material Properties: 20  
Maximum Support Properties: 20

#### Design Standard

Selected Type: Eurocode 7 (User Defined)  
Name: NTC 2018 sismica

Type	Partial Factor
Permanent Actions: Unfavourable	1
Permanent Actions: Favourable	1
Variable Actions: Unfavourable	1
Variable Actions: Favourable	0
Effective cohesion	1
Coefficient of shearing resistance	1
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	1.3
Seismic Coefficient	1

#### Analysis Options



Slices Type: Vertical

#### Analysis Methods Used

Bishop simplified  
 GLE/Morgenstern-Price with interslice force function (Half Sine)  
 Spencer  
 Sarma

Number of slices: 25  
 Tolerance: 0.005  
 Maximum number of iterations: 50  
 Initial trial value of FS: 1  
 Sarma Interslice Strength Option: Computed Average Value

## Seismic

Advanced seismic analysis: No  
 Staged pseudostatic analysis: No

## Loading

Seismic Load Coefficient (Horizontal): 0.067  
 Seismic Load Coefficient (Vertical): 0.0335

2 Distributed Loads present









#### Distributed Load 1






Distribution: Constant  
 Magnitude [kPa]: 20  
 Orientation: Vertical  
 Load Action: Variable

#### Distributed Load 2

Distribution: Constant  
 Magnitude [kPa]: 2  
 Orientation: Vertical  
 Load Action: Variable

## Material Properties

Property	Copertura	Argine nuovo	Argilla	Ghiaia	Argine esistente	struttura C.A.	RSU nuovi	RSU esistente
Color								
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [kN/m3]	19	20	20	19	20	25	11	11
Cohesion [kPa]	15	30	18	0	15	800	0	0
Friction Angle [deg]	20	25	17	36	20	35	34	42
Ru Value	0	0	0	0	0	0	0.1	0



Property	Argille mediamente compatte	Argille compatte	Limi compatti	Vuoto	Argille consolidate
Color					
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [kN/m3]	19	20	19	0.1	20
Cohesion [kPa]	15	18	17	0	50
Friction Angle [deg]	14	17	18	0.1	24
Ru Value	0	0	0	0	0

## Support Properties

### PET PVC 110

Support Type: GeoTextile  
Force Application: Passive  
Force Orientation: Tangent to Slip Surface  
Anchorage: Both Ends  
Shear Strength Model: Linear  
Use External Loads for Strength: yes  
Strip Coverage: 100 percent  
Tensile Strength: 48.42 kN/m

#### Pullout Strength Dependency:

Material	Adhesion (kPa)	Friction Angle (deg)
 Argine nuovo	0	19.6
 Argilla	32	23

## Global Minimums

Method: bishop simplified

FS	1.300470
Axis Location:	16.891, 66.078
Left Slip Surface Endpoint:	18.391, 25.240
Right Slip Surface Endpoint:	50.462, 42.775
Resisting Moment:	52333.5 kN-m
Driving Moment:	40242 kN-m
Passive Support Moment:	5424.08 kN-m
Total Slice Area:	107.1 m2
Surface Horizontal Width:	32.071 m
Surface Average Height:	3.33947 m

#### Method: spencer

FS	1.281650
Axis Location:	17.346, 66.326
Left Slip Surface Endpoint:	18.390, 25.239
Right Slip Surface Endpoint:	50.842, 42.509
Resisting Moment:	53832.8 kN-m
Driving Moment:	42002.9 kN-m
Resisting Horizontal Force:	1243.56 kN
Driving Horizontal Force:	970.284 kN
Passive Support Moment:	5449.37 kN-m
Passive Horizontal Support Force:	125.192 kN
Total Slice Area:	113.211 m2
Surface Horizontal Width:	32.4519 m
Surface Average Height:	3.48858 m

#### Method: gle/morgenstern-price

FS	1.246750
Axis Location:	17.210, 66.252
Left Slip Surface Endpoint:	18.391, 25.240
Right Slip Surface Endpoint:	50.728, 42.589
Resisting Moment:	52812.8 kN-m
Driving Moment:	42360.4 kN-m
Resisting Horizontal Force:	1216.57 kN
Driving Horizontal Force:	975.796 kN
Passive Support Moment:	5443.39 kN-m
Passive Horizontal Support Force:	124.837 kN
Total Slice Area:	112.047 m2
Surface Horizontal Width:	32.3373 m
Surface Average Height:	3.46495 m

#### Method: sarma

FS	1.363880
Axis Location:	17.309, 67.037
Left Slip Surface Endpoint:	17.834, 24.717
Right Slip Surface Endpoint:	51.480, 42.064
Total Slice Area:	177.345 m2
Surface Horizontal Width:	33.6464 m
Surface Average Height:	5.27085 m

#### Global Minimum Coordinates

### Method: bishop simplified

X	Y
18.3908	25.2397
21.5749	25.2398
50.4618	42.7748

### Method: spencer

X	Y
18.3902	25.2388
21.8994	25.4778
29.1351	29.7357
36.3708	33.9936
50.8422	42.5094

### Method: gle/morgenstern-price

X	Y
18.3907	25.2397
21.5716	25.2425
50.7281	42.589

### Method: sarma

X	Y
17.8336	24.7165
26.4548	24.7699
51.48	42.0643

## Slide Analysis Information

### Discarica di Medolla-verifica argini

#### Project Summary

File Name: Medolla-verifiche argine-sez02.slmd - Group 1 - Sez.02-valle-statica  
Slide Modeler Version: 7.038  
Project Title: Discarica di Medolla-verifica argini  
Analysis: sez.02-verifica di valle-SS circolari-statica  
Author: ing. Teneggi  
Company: Studio Ten  
Date Created: 31/10/2025

#### General Settings

Units of Measurement: Metric Units  
Time Units: days  
Permeability Units: meters/second  
Failure Direction: Right to Left  
Data Output: Standard  
Maximum Material Properties: 20  
Maximum Support Properties: 20

#### Design Standard

Selected Type: Eurocode 7 (User Defined)  
Name: NTC 2018 statica

Type	Partial Factor
Permanent Actions: Unfavourable	1
Permanent Actions: Favourable	1
Variable Actions: Unfavourable	1.3
Variable Actions: Favourable	0
Effective cohesion	1.25
Coefficient of shearing resistance	1.25
Undrained strength	1.4
Weight density	1
Shear strength (other models)	1.25
Earth resistance	1
Tensile and plate strength	1
Shear strength	1
Compressive strength	1
Bond strength	1.3
Seismic Coefficient	1

#### Analysis Options

Slices Type: Vertical

#### Analysis Methods Used

Bishop simplified  
 GLE/Morgenstern-Price with interslice force function (Half Sine)  
 Spencer  
 Sarma

Number of slices: 25  
 Tolerance: 0.005  
 Maximum number of iterations: 50  
 Initial trial value of FS: 1  
 Sarma Interslice Strength Option: Computed Average Value

## Seismic

Advanced seismic analysis: No  
 Staged pseudostatic analysis: No

## Loading

2 Distributed Loads present









#### Distributed Load 1




Distribution: Constant  
 Magnitude [kPa]: 20  
 Orientation: Vertical  
 Load Action: Variable

#### Distributed Load 2

Distribution: Constant  
 Magnitude [kPa]: 2  
 Orientation: Vertical  
 Load Action: Variable

## Material Properties

Property	Copertura	Argine nuovo	Argilla	Ghiaia	struttura C.A.	RSU nuovi	Argille mediamente compatte	Argille compatte
Color								
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [kN/m3]	19	20	20	19	25	11	19	20
Cohesion [kPa]	15	30	18	0	800	0	15	18
Friction Angle [deg]	20	25	17	38	35	34	14	17
Ru Value	0	0	0	0	0	0.1	0	0



Property	Limi compatti	Vuoto	Argille consolidate
Color			
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [kN/m3]	19	0.1	20
Cohesion [kPa]	17	0	50
Friction Angle [deg]	18	0.1	24
Ru Value	0	0	0

## Support Properties

### PET PVC 110

Support Type: GeoTextile  
 Force Application: Passive  
 Force Orientation: Tangent to Slip Surface  
 Anchorage: Both Ends  
 Shear Strength Model: Linear  
 Use External Loads for Strength: yes  
 Strip Coverage: 100 percent  
 Tensile Strength: 48.42 kN/m

#### Pullout Strength Dependency:

Material	Adhesion (kPa)	Friction Angle (deg)
 Argine nuovo	0	19.6
 Argilla	32	23

## Global Minimums

### Method: bishop simplified

FS	1.292180
Center:	23.111, 50.848
Radius:	27.785
Left Slip Surface Endpoint:	12.917, 25.000
Right Slip Surface Endpoint:	49.273, 41.490
Resisting Moment:	45508.7 kN-m
Driving Moment:	35218.5 kN-m
Passive Support Moment:	1344.44 kN-m
Total Slice Area:	226.165 m2
Surface Horizontal Width:	36.3563 m
Surface Average Height:	6.22078 m

### Method: spencer

FS	1.233900
Center:	23.191, 50.819
Radius:	27.727
Left Slip Surface Endpoint:	13.083, 25.000
Right Slip Surface Endpoint:	49.302, 41.493
Resisting Moment:	43291.6 kN-m
Driving Moment:	35085.1 kN-m
Resisting Horizontal Force:	1376.04 kN
Driving Horizontal Force:	1115.2 kN
Passive Support Moment:	1341.61 kN-m
Passive Horizontal Support Force:	46.136 kN
Total Slice Area:	225.935 m2
Surface Horizontal Width:	36.2192 m
Surface Average Height:	6.23801 m

#### Method: gle/morgenstern-price

FS	1.225580
Center:	23.171, 50.826
Radius:	27.741
Left Slip Surface Endpoint:	13.042, 25.000
Right Slip Surface Endpoint:	49.295, 41.492
Resisting Moment:	43040.4 kN-m
Driving Moment:	35118.4 kN-m
Resisting Horizontal Force:	1363.49 kN
Driving Horizontal Force:	1112.53 kN
Passive Support Moment:	1342.31 kN-m
Passive Horizontal Support Force:	46.1275 kN
Total Slice Area:	225.996 m2
Surface Horizontal Width:	36.253 m
Surface Average Height:	6.23386 m

#### Method: sarma

FS	1.241440
Center:	23.283, 50.792
Radius:	27.672
Left Slip Surface Endpoint:	13.258, 25.000
Right Slip Surface Endpoint:	49.347, 41.496
Passive Support Moment:	1338.96 kN-m
Passive Horizontal Support Force:	46.1781 kN
Total Slice Area:	225.995 m2
Surface Horizontal Width:	36.0889 m
Surface Average Height:	6.26217 m



## Slide Analysis Information

### Discarica di Medolla-verifica argini

#### Project Summary

File Name: Medolla-verifiche argine-sez02.slmd - Group 1 - Sez.02-valle-traslazione-statica  
Slide Modeler Version: 7.038  
Project Title: Discarica di Medolla-verifica argini  
Analysis: sez.02-verifica di valle-SS spezzate-statica  
Author: ing. Teneggi  
Company: Studio Ten  
Date Created: 31/10/2025

#### General Settings

Units of Measurement: Metric Units  
Time Units: days  
Permeability Units: meters/second  
Failure Direction: Right to Left  
Data Output: Standard  
Maximum Material Properties: 20  
Maximum Support Properties: 20

#### Design Standard

Selected Type: Eurocode 7 (User Defined)  
Name: NTC 2018 statica

Type	Partial Factor
Permanent Actions: Unfavourable	1
Permanent Actions: Favourable	1
Variable Actions: Unfavourable	1.3
Variable Actions: Favourable	0
Effective cohesion	1.25
Coefficient of shearing resistance	1.25
Undrained strength	1.4
Weight density	1
Shear strength (other models)	1.25
Earth resistance	1
Tensile and plate strength	1
Shear strength	1
Compressive strength	1
Bond strength	1.3
Seismic Coefficient	1

#### Analysis Options

Slices Type: Vertical

#### Analysis Methods Used

Bishop simplified  
 GLE/Morgenstern-Price with interslice force function (Half Sine)  
 Spencer  
 Sarma

Number of slices: 25  
 Tolerance: 0.005  
 Maximum number of iterations: 50  
 Initial trial value of FS: 1  
 Sarma Interslice Strength Option: Computed Average Value

## Seismic

Advanced seismic analysis: No  
 Staged pseudostatic analysis: No

## Loading

2 Distributed Loads present









#### Distributed Load 1




Distribution: Constant  
 Magnitude [kPa]: 20  
 Orientation: Vertical  
 Load Action: Variable

#### Distributed Load 2

Distribution: Constant  
 Magnitude [kPa]: 2  
 Orientation: Vertical  
 Load Action: Variable

## Material Properties

Property	Copertura	Argine nuovo	Argilla	Ghiaia	struttura C.A.	RSU nuovi	Argille mediamente compatte	Argille compatte
Color								
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [kN/m3]	19	20	20	19	25	11	19	20
Cohesion [kPa]	15	30	18	0	800	0	15	18
Friction Angle [deg]	20	25	17	38	35	34	14	17
Ru Value	0	0	0	0	0	0.1	0	0



Property	Limi compatti	Vuoto	Argille consolidate
Color			
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [kN/m3]	19	0.1	20
Cohesion [kPa]	17	0	50
Friction Angle [deg]	18	0.1	24
Ru Value	0	0	0

## Support Properties

### PET PVC 110

Support Type: GeoTextile  
 Force Application: Passive  
 Force Orientation: Tangent to Slip Surface  
 Anchorage: Both Ends  
 Shear Strength Model: Linear  
 Use External Loads for Strength: yes  
 Strip Coverage: 100 percent  
 Tensile Strength: 48.42 kN/m

#### Pullout Strength Dependency:

Material	Adhesion (kPa)	Friction Angle (deg)
 Argine nuovo	0	19.6
 Argilla	32	23

## Global Minimums

### Method: bishop simplified

FS	1.323510
Axis Location:	18.840, 63.374
Left Slip Surface Endpoint:	20.604, 24.736
Right Slip Surface Endpoint:	50.809, 41.603
Resisting Moment:	50422.6 kN-m
Driving Moment:	38097.5 kN-m
Passive Support Moment:	7242.79 kN-m
Total Slice Area:	131.698 m2
Surface Horizontal Width:	30.2046 m
Surface Average Height:	4.36018 m

### Method: spencer

FS	1.298850
Axis Location:	18.840, 63.374
Left Slip Surface Endpoint:	20.604, 24.736
Right Slip Surface Endpoint:	50.809, 41.603
Resisting Moment:	49599.6 kN-m
Driving Moment:	38187.1 kN-m
Resisting Horizontal Force:	1177.74 kN
Driving Horizontal Force:	906.753 kN
Passive Support Moment:	7242.79 kN-m
Passive Horizontal Support Force:	175.863 kN
Total Slice Area:	131.698 m2
Surface Horizontal Width:	30.2046 m
Surface Average Height:	4.36018 m

### Method: gle/morgenstern-price

FS	1.279650
Axis Location:	18.880, 63.471
Left Slip Surface Endpoint:	20.604, 24.736
Right Slip Surface Endpoint:	50.903, 41.610
Resisting Moment:	50255.2 kN-m
Driving Moment:	39272.7 kN-m
Resisting Horizontal Force:	1187.38 kN
Driving Horizontal Force:	927.897 kN
Passive Support Moment:	7238.86 kN-m
Passive Horizontal Support Force:	174.17 kN
Total Slice Area:	134.949 m2
Surface Horizontal Width:	30.2982 m
Surface Average Height:	4.45403 m

### Method: sarma

FS	1.325910
Axis Location:	18.840, 63.374
Left Slip Surface Endpoint:	20.604, 24.736
Right Slip Surface Endpoint:	50.809, 41.603
Passive Support Moment:	7242.79 kN-m
Passive Horizontal Support Force:	175.863 kN
Total Slice Area:	131.698 m2
Surface Horizontal Width:	30.2046 m
Surface Average Height:	4.36018 m

## Global Minimum Coordinates

### Method: bishop simplified

X	Y
20.6044	24.7359
24.4841	24.794
36.0913	30.1494
50.809	41.6028

### Method: spencer

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X	Y
20.6044	24.7359
24.4841	24.794
36.0913	30.1494
50.809	41.6028

### Method: gle/morgenstern-price

X	Y
20.6044	24.7359
24.6903	24.7351
37.7738	31.0989
50.9026	41.6096

### Method: sarma

X	Y
20.6044	24.7359
24.4841	24.794
36.0913	30.1494
50.809	41.6028

## *Slide Analysis Information*

### *Discarica di Medolla-verifica argini*

#### *Project Summary*

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File Name: Medolla-verifiche argine-sez02.slmd - Group 2 - Sez.02-valle-sismica +kv  
Slide Modeler Version: 7.038  
Project Title: Discarica di Medolla-verifica argini  
Analysis: sez.02-verifica di valle-SS circolari-sismica  
Author: ing. Teneggi  
Company: Studio Ten  
Date Created: 31/10/2025

#### *General Settings*

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Units of Measurement: Metric Units  
Time Units: days  
Permeability Units: meters/second  
Failure Direction: Right to Left  
Data Output: Standard  
Maximum Material Properties: 20  
Maximum Support Properties: 20

#### *Design Standard*

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Selected Type: Eurocode 7 (User Defined)  
Name: NTC 2018 sismica

Type	Partial Factor
Permanent Actions: Unfavourable	1
Permanent Actions: Favourable	1
Variable Actions: Unfavourable	1
Variable Actions: Favourable	0
Effective cohesion	1
Coefficient of shearing resistance	1
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	1.3
Seismic Coefficient	1

#### *Analysis Options*

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Slices Type: Vertical

#### Analysis Methods Used

Bishop simplified  
 GLE/Morgenstern-Price with interslice force function (Half Sine)  
 Spencer  
 Sarma

Number of slices: 25  
 Tolerance: 0.005  
 Maximum number of iterations: 50  
 Initial trial value of FS: 1  
 Sarma Interslice Strength Option: Computed Average Value

## Seismic

Advanced seismic analysis: No  
 Staged pseudostatic analysis: No

## Loading

Seismic Load Coefficient (Horizontal): 0.067  
 Seismic Load Coefficient (Vertical): 0.0335

2 Distributed Loads present









#### Distributed Load 1




Distribution: Constant  
 Magnitude [kPa]: 20  
 Orientation: Vertical  
 Load Action: Variable

#### Distributed Load 2

Distribution: Constant  
 Magnitude [kPa]: 2  
 Orientation: Vertical  
 Load Action: Variable

## Material Properties

Property	Copertura	Argine nuovo	Argilla	Ghiaia	struttura C.A.	RSU nuovi	Argille mediamente compatte	Argille compatte
Color								
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [kN/m3]	19	20	20	19	25	11	19	20
Cohesion [kPa]	15	30	18	0	800	0	15	18
Friction Angle [deg]	20	25	17	38	35	34	14	17
Ru Value	0	0	0	0	0	0.1	0	0



Property	Limi compatti	Vuoto	Argille consolidate
Color			
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [kN/m3]	19	0.1	20
Cohesion [kPa]	17	0	50
Friction Angle [deg]	18	0.1	24
Ru Value	0	0	0

## Support Properties

### PET PVC 110

Support Type: GeoTextile  
Force Application: Passive  
Force Orientation: Tangent to Slip Surface  
Anchorage: Both Ends  
Shear Strength Model: Linear  
Use External Loads for Strength: yes  
Strip Coverage: 100 percent  
Tensile Strength: 48.42 kN/m

#### Pullout Strength Dependency:

Material	Adhesion (kPa)	Friction Angle (deg)
 Argine nuovo	0	19.6
 Argilla	32	23

## Global Minimums

Method: bishop simplified



FS	1.386130
Center:	21.514, 50.563
Radius:	27.426
Left Slip Surface Endpoint:	11.578, 25.000
Right Slip Surface Endpoint:	47.346, 41.349
Resisting Moment:	51059.1 kN-m
Driving Moment:	36835.6 kN-m
Passive Support Moment:	2653.8 kN-m
Total Slice Area:	194.389 m2
Surface Horizontal Width:	35.768 m
Surface Average Height:	5.43471 m

#### Method: spencer

FS	1.320860
Center:	23.520, 50.770
Radius:	27.612
Left Slip Surface Endpoint:	13.605, 25.000
Right Slip Surface Endpoint:	49.533, 41.509
Resisting Moment:	53481.7 kN-m
Driving Moment:	40489.9 kN-m
Resisting Horizontal Force:	1714.14 kN
Driving Horizontal Force:	1297.74 kN
Passive Support Moment:	1336.03 kN-m
Passive Horizontal Support Force:	46.2919 kN
Total Slice Area:	228.04 m2
Surface Horizontal Width:	35.9282 m
Surface Average Height:	6.3471 m

#### Method: gle/morgenstern-price

FS	1.305880
Center:	23.520, 50.770
Radius:	27.612
Left Slip Surface Endpoint:	13.605, 25.000
Right Slip Surface Endpoint:	49.533, 41.509
Resisting Moment:	52874.9 kN-m
Driving Moment:	40489.9 kN-m
Resisting Horizontal Force:	1694.97 kN
Driving Horizontal Force:	1297.96 kN
Passive Support Moment:	1336.03 kN-m
Passive Horizontal Support Force:	46.2919 kN
Total Slice Area:	228.04 m2
Surface Horizontal Width:	35.9282 m
Surface Average Height:	6.3471 m

#### Method: sarma

FS	1.324620
Center:	23.555, 50.749
Radius:	27.572
Left Slip Surface Endpoint:	13.697, 25.000
Right Slip Surface Endpoint:	49.533, 41.509
Passive Support Moment:	1334.09 kN-m
Passive Horizontal Support Force:	46.3056 kN
Total Slice Area:	227.611 m2
Surface Horizontal Width:	35.8362 m
Surface Average Height:	6.35142 m

## Slide Analysis Information

### Discarica di Medolla-verifica argini

#### Project Summary

File Name: Medolla-verifiche argine-sez02.slmd - Group 2 - Sez.02-valle-traslazione-sismica +kv  
Slide Modeler Version: 7.038  
Project Title: Discarica di Medolla-verifica argini  
Analysis: sez.02-verifica di valle-SS spezzate-sismica  
Author: ing. Teneggi  
Company: Studio Ten  
Date Created: 31/10/2025

#### General Settings

Units of Measurement: Metric Units  
Time Units: days  
Permeability Units: meters/second  
Failure Direction: Right to Left  
Data Output: Standard  
Maximum Material Properties: 20  
Maximum Support Properties: 20

#### Design Standard

Selected Type: Eurocode 7 (User Defined)  
Name: NTC 2018 sismica

Type	Partial Factor
Permanent Actions: Unfavourable	1
Permanent Actions: Favourable	1
Variable Actions: Unfavourable	1
Variable Actions: Favourable	0
Effective cohesion	1
Coefficient of shearing resistance	1
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	1.3
Seismic Coefficient	1

#### Analysis Options

Slices Type: Vertical

#### Analysis Methods Used

Bishop simplified  
 GLE/Morgenstern-Price with interslice force function (Half Sine)  
 Spencer  
 Sarma

Number of slices: 25  
 Tolerance: 0.005  
 Maximum number of iterations: 50  
 Initial trial value of FS: 1  
 Sarma Interslice Strength Option: Computed Average Value

## Seismic

Advanced seismic analysis: No  
 Staged pseudostatic analysis: No

## Loading

Seismic Load Coefficient (Horizontal): 0.067  
 Seismic Load Coefficient (Vertical): 0.0335

2 Distributed Loads present









#### Distributed Load 1




Distribution: Constant  
 Magnitude [kPa]: 20  
 Orientation: Vertical  
 Load Action: Variable

#### Distributed Load 2

Distribution: Constant  
 Magnitude [kPa]: 2  
 Orientation: Vertical  
 Load Action: Variable

## Material Properties

Property	Copertura	Argine nuovo	Argilla	Ghiaia	struttura C.A.	RSU nuovi	Argille mediamente compatte	Argille compatte
Color								
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [kN/m3]	19	20	20	19	25	11	19	20
Cohesion [kPa]	15	30	18	0	800	0	15	18
Friction Angle [deg]	20	25	17	38	35	34	14	17
Ru Value	0	0	0	0	0	0.1	0	0



Property	Limi compatti	Vuoto	Argille consolidate
Color			
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [kN/m3]	19	0.1	20
Cohesion [kPa]	17	0	50
Friction Angle [deg]	18	0.1	24
Ru Value	0	0	0

## Support Properties

### PET PVC 110

Support Type: GeoTextile  
Force Application: Passive  
Force Orientation: Tangent to Slip Surface  
Anchorage: Both Ends  
Shear Strength Model: Linear  
Use External Loads for Strength: yes  
Strip Coverage: 100 percent  
Tensile Strength: 48.42 kN/m

#### Pullout Strength Dependency:

Material	Adhesion (kPa)	Friction Angle (deg)
 Argine nuovo	0	19.6
 Argilla	32	23

## Global Minimums

Method: bishop simplified

FS	1.402880
Axis Location:	18.417, 62.348
Left Slip Surface Endpoint:	20.604, 24.736
Right Slip Surface Endpoint:	49.820, 41.530
Resisting Moment:	59606.1 kN-m
Driving Moment:	42488.4 kN-m
Passive Support Moment:	7099.2 kN-m
Total Slice Area:	133.924 m2
Surface Horizontal Width:	29.2151 m
Surface Average Height:	4.58408 m

### Method: spencer

FS	1.368390
Axis Location:	18.417, 62.348
Left Slip Surface Endpoint:	20.604, 24.736
Right Slip Surface Endpoint:	49.820, 41.530
Resisting Moment:	58420.4 kN-m
Driving Moment:	42693 kN-m
Resisting Horizontal Force:	1410.46 kN
Driving Horizontal Force:	1030.75 kN
Passive Support Moment:	7099.2 kN-m
Passive Horizontal Support Force:	176.198 kN
Total Slice Area:	133.924 m2
Surface Horizontal Width:	29.2151 m
Surface Average Height:	4.58408 m

### Method: gle/morgenstern-price

FS	1.333960
Axis Location:	18.417, 62.348
Left Slip Surface Endpoint:	20.604, 24.736
Right Slip Surface Endpoint:	49.820, 41.530
Resisting Moment:	57973.9 kN-m
Driving Moment:	43459.8 kN-m
Resisting Horizontal Force:	1396.65 kN
Driving Horizontal Force:	1046.99 kN
Passive Support Moment:	7099.2 kN-m
Passive Horizontal Support Force:	176.198 kN
Total Slice Area:	133.924 m2
Surface Horizontal Width:	29.2151 m
Surface Average Height:	4.58408 m

### Method: sarma

FS	1.478500
Axis Location:	19.810, 65.730
Left Slip Surface Endpoint:	20.604, 24.736
Right Slip Surface Endpoint:	53.082, 41.769
Passive Support Moment:	9104.62 kN-m
Passive Horizontal Support Force:	208.042 kN
Total Slice Area:	122.286 m2
Surface Horizontal Width:	32.4778 m
Surface Average Height:	3.76522 m

## Global Minimum Coordinates

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### Method: bishop simplified

X	Y
20.6044	24.7359
24.2841	24.7347
31.2206	27.9003
42.8003	34.5699
46.6397	37.5975
49.8195	41.5304

### Method: spencer

X	Y
20.6044	24.7359
24.2841	24.7347
31.2206	27.9003
42.8003	34.5699
46.6397	37.5975
49.8195	41.5304

### Method: gle/morgenstern-price

X	Y
20.6044	24.7359
24.2841	24.7347
31.2206	27.9003
42.8003	34.5699
46.6397	37.5975
49.8195	41.5304

### Method: sarma

X	Y
20.6044	24.7359
24.4841	24.7488
53.0822	41.7691