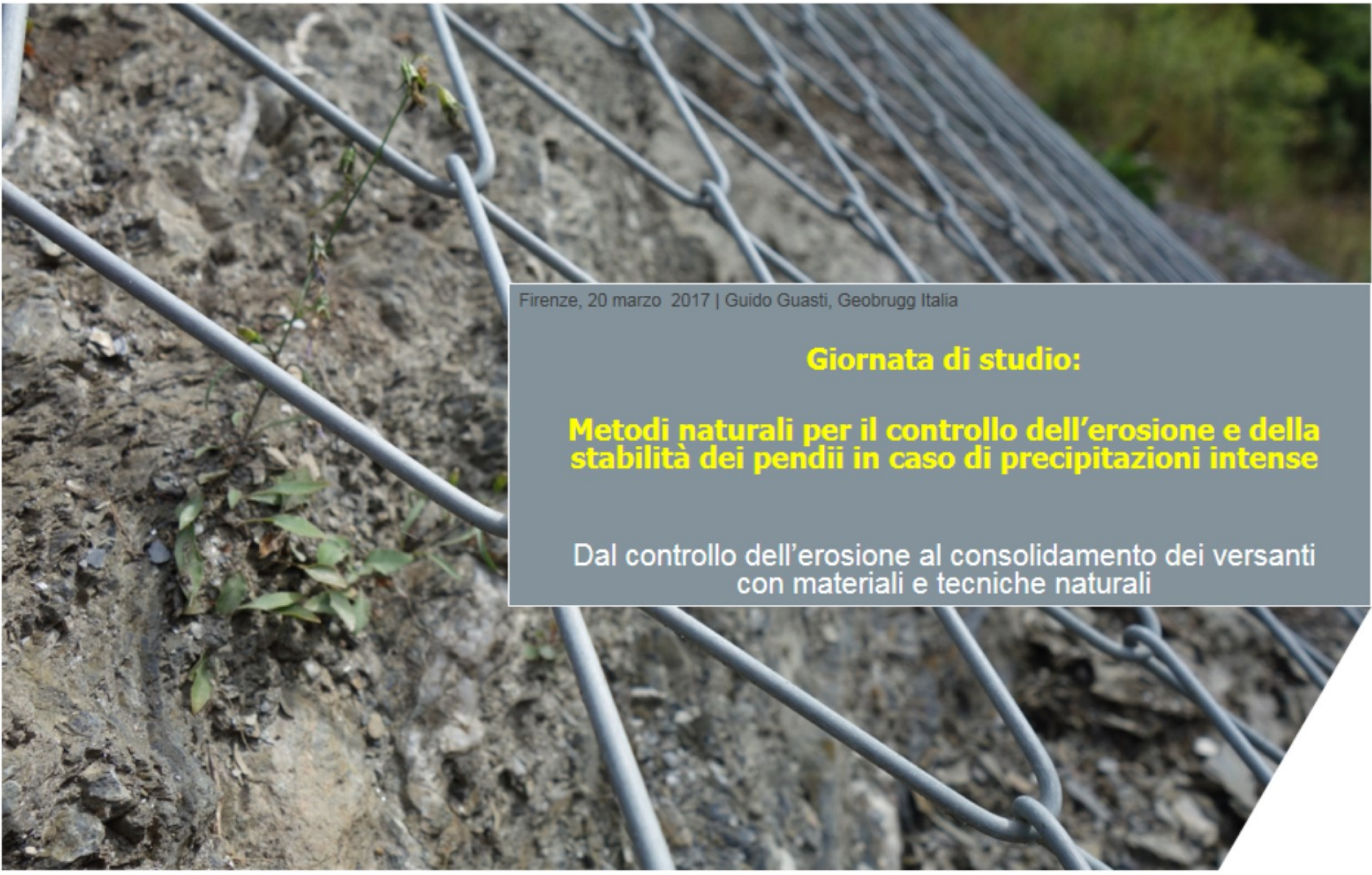




Firenze, 20 marzo 2017 | Guido Guasti, Geobrugg Italia

Giornata di studio:

Metodi naturali per il controllo dell'erosione e della stabilità dei pendii in caso di precipitazioni intense

Dal controllo dell'erosione al consolidamento dei versanti
con materiali e tecniche naturali



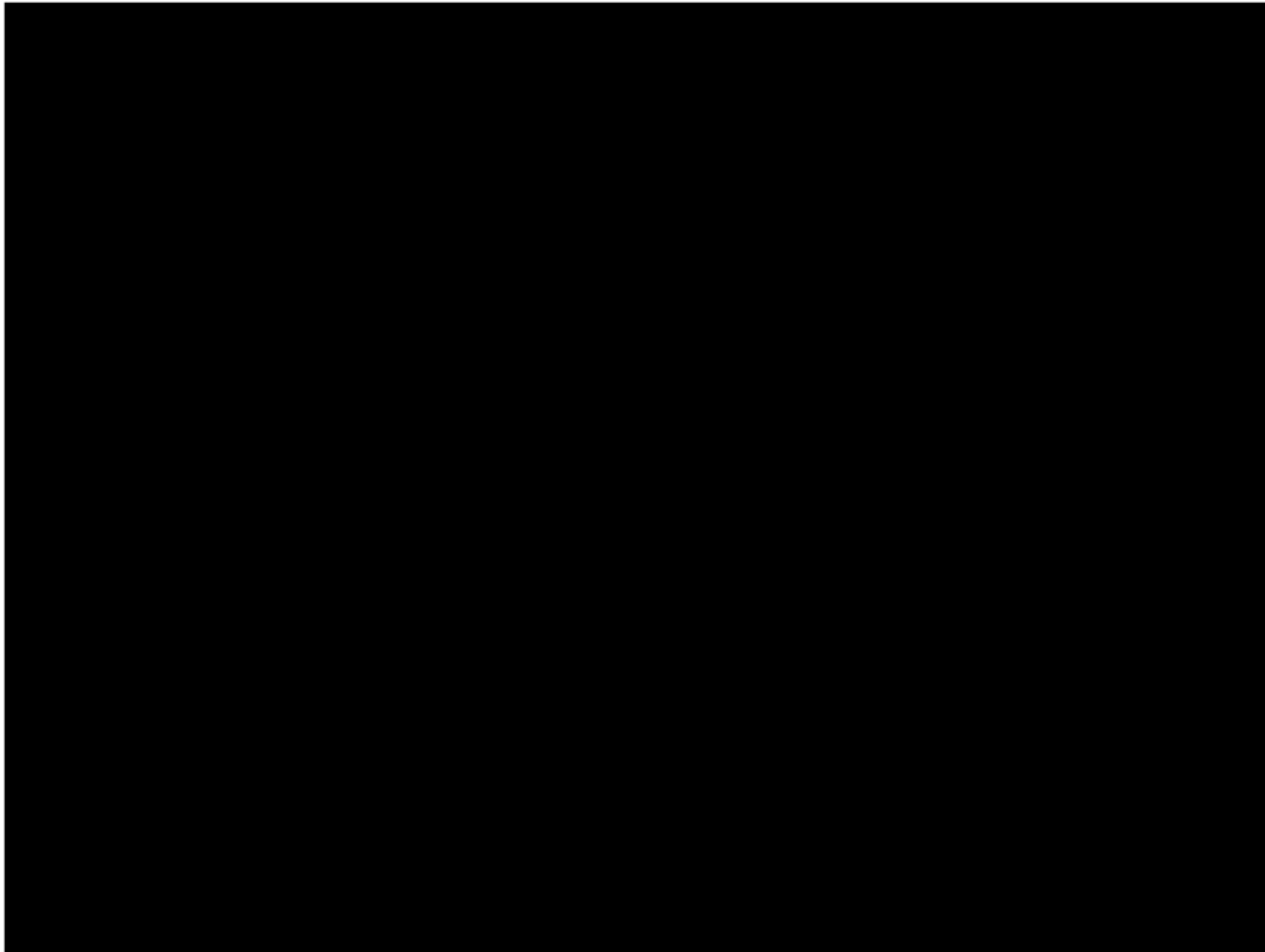
EROSIONE E STABILITA' DEI VERSANTI

Cosa fa Geobrugg

- ▶ Geobrugg è leader internazionale nella lavorazione del filo di acciaio ad alta resistenza (1770 N/mm^2) in applicazioni che spaziano dalla mitigazione dei rischi naturali, al controllo di aree soggette ad esplosioni e impatti di vario tipo.
- ▶ In sostanza laddove ci sono carichi permanenti o istantanei, l'uso del filo di acciaio ad alta resistenza assorbe e controlla energie, pressioni e forze
- ▶ ACCIAIO = MATERIALE NATURALE ?



Tanto per capire → 8'000 kJ (20t a 35m/s – 100 km/h)



Definizione di geosintetico (UNI EN ISO 10318)

Termine generico che descrive un prodotto, del quale almeno un componente è fatto di un polimero sintetico o naturale, sotto forma di foglio, striscia o struttura tridimensionale, utilizzato in contatto con il terreno e/o altri materiali in applicazioni geotecniche e di ingegneria civile.

(I.G.S. – International Geosynthetics Society)

Geotessili (nontessuti – tessuti)

Geogriglie

Georeti

Geostuoie - Biostuoie

Geocelle

Geotrisce

Geospaziatori

GSY con funzione barriera (P, C, B)

Geocomposito

TABELLA DI CLASSIFICAZIONE DEI GEOSINTETICI

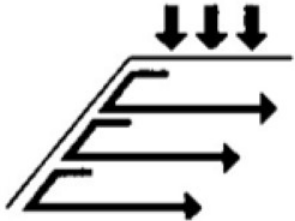
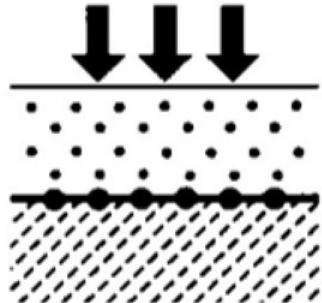
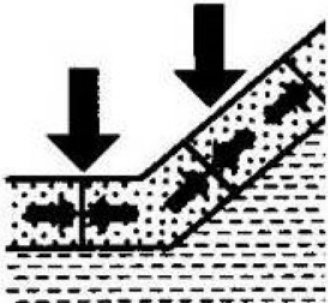
FUNZIONE	SIMBOLOGIA	SCOPO	PRODOTTI IDONEI
Rinforzo pendii		Fornire forze di trazione al terreno	Geogriglie mono-orientate; geotessili
Rinforzo terreni soffici		Incr. capacità portante; rid. cedimenti differenziali	Geogriglie bi-orientate, geotessili

TABELLA DI CLASSIFICAZIONE DEI GEOSINTETICI

FUNZIONE	SIMBOLOGIA	SCOPO	PRODOTTI IDONEI
Controllo erosione		Prevenire distacco e trasporto di terreno	Geostuoie, Geocelle, Biostuoie. Rip-rap: geotessili
Confinamento		Limitare il movimento laterale del terreno	Geocelle

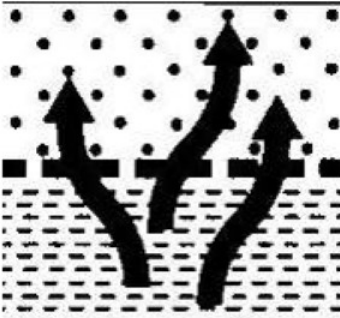
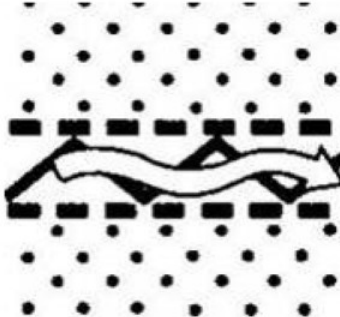
FUNZIONE	SIMBOLOGIA	SCOPO	PRODOTTI IDONEI
Filtrazione		Consentire il passaggio di fluidi e trattenere i solidi	Geotessili, geocompositi per il drenaggio
Drenaggio		Trasporto dei fluidi	Georeti, geocompositi per il drenaggio, geotessili.

TABELLA DI CLASSIFICAZIONE DEI GEOSINTETICI

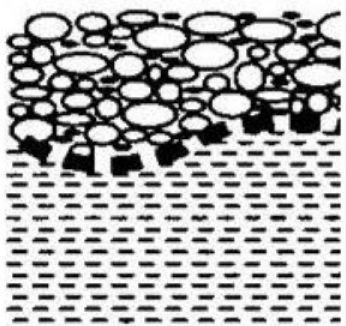
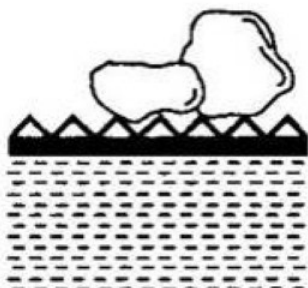
FUNZIONE	SIMBOLOGIA	SCOPO	PRODOTTI IDONEI
Separazione		Prevenire il mescolamento di materiali differenti	Geotessili, geocompositi
Impermeabilizzazione		Barriera	Geomembrane, Geocompositi

TABELLA DI CLASSIFICAZIONE DEI GEOSINTETICI

FUNZIONE	SIMBOLOGIA	SCOPO	PRODOTTI IDONEI
Protezione		Prevenire il danneggiamento a una struttura, o ad un altro geosintetico	Geotessili, georeti, geocompositi per il drenaggio

Geostuoie

Strutture costituite da una rete irregolare di filamenti, fibre, nastri o griglie, collegati termicamente o meccanicamente, aventi uno spessore di 10-20 mm. Caratterizzati da un indice dei vuoti assai elevato (mediamente superiore al 90%).

Biostuoie

Struttura costituita da una rete in materiali naturali, tessuti in filamenti o fibre, in uno o più strati collegati meccanicamente, di spessore limitato (10 mm).

GEOSINTETICI - EROSIONE

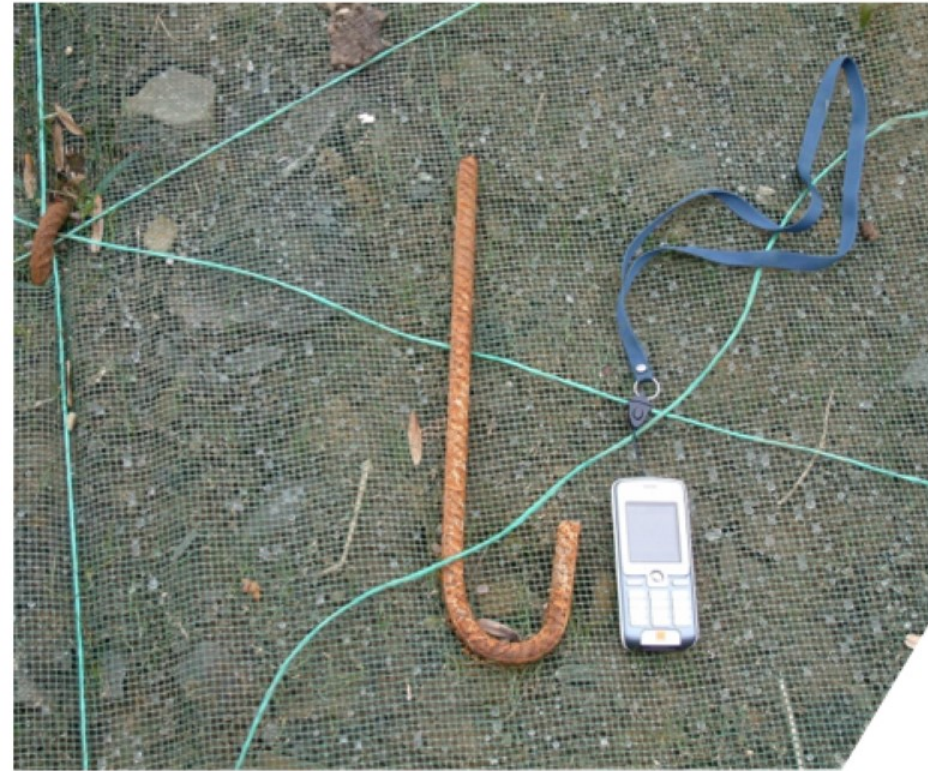
GEOSTUOIE



BIOSTUOIE



INSTABILITA' SUPERFICIALE



PROBLEMI DERIVANTI DA SATURAZIONE DEL MATERIALE



PROBLEMI DERIVANTI DA SATURAZIONE DEL MATERIALE



INSTABILITÀ DOVUTA A EROSIONE (?) AL PIEDE





CONSOLIDAMENTO DEI VERSANTI

Il termine CONSOLIDAMENTO viene talvolta mal impiegato. Non esistono materiali scadenti, ci sono scelte sbagliate. E' un errore standardizzare la soluzione o al limite suddividerla in «macroclassi».

- Frammenti visibili di dimensioni minori >> reti semplici
- Blocchi e fratture frequenti >> reti semplici con reticoli in fune
- Masse e discontinuità importanti >> reti a trefoli, reti robuste

Geobrugg ha introdotto nel settore dei consolidamenti il Sistema TECCO®, implementato con varianti per ottimizzare l'intervento sulla base di inquadramento di carattere geotecnico, per risolvere problemi complessi di stabilità superficiale, in abbinamento a ancoraggi in barra, autoperforanti e tiranti a trefolo, per versanti naturali e fronti di scavo.

Su terreni, viene poi ad essere indispensabile il controllo dell'erosione.

Caratteristiche



Positive

Rinverdimento
possibile

Inserimento
paesaggistico

Facile e veloce
installazione

Flessibilità a
sollecitazioni
sismiche

Ridotte
deformazioni

Dimensionamento
possibile

Su ogni
terreno/roccia

Negative

Necessità di
operatori qualificati

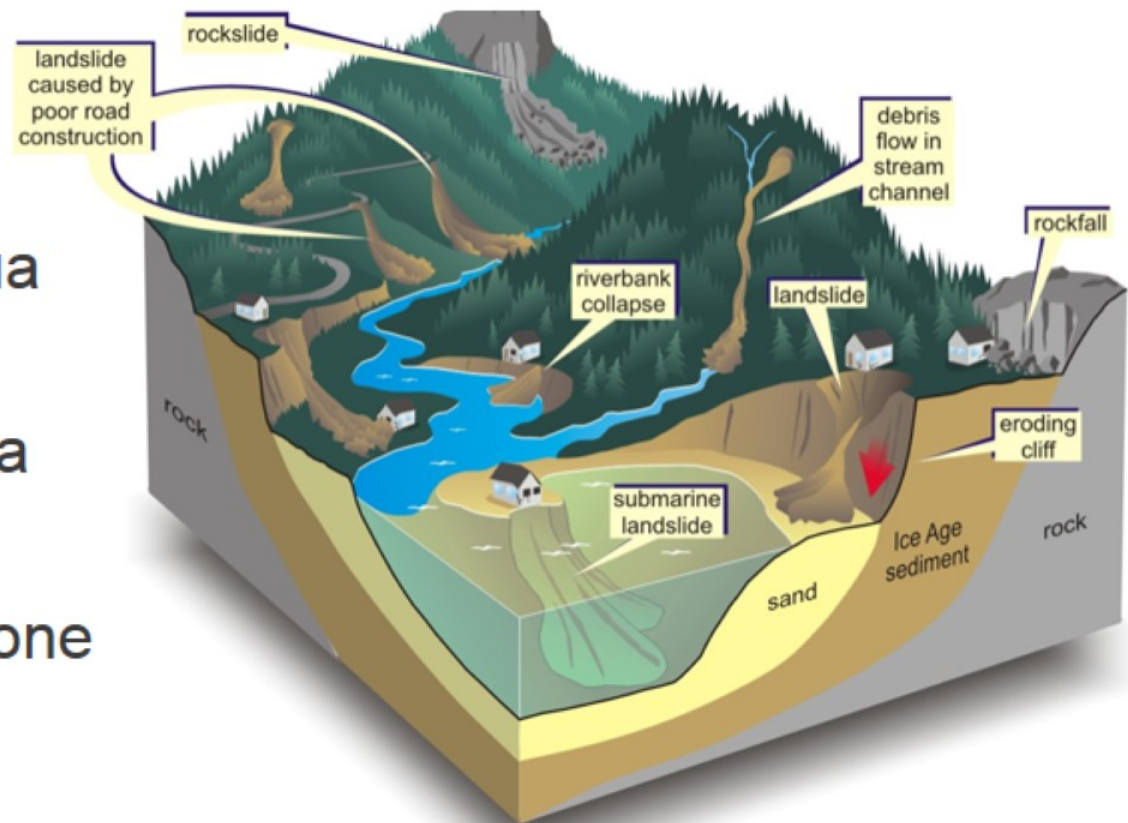
Spesso lavori in
corda

Grandi superfici da
trattare

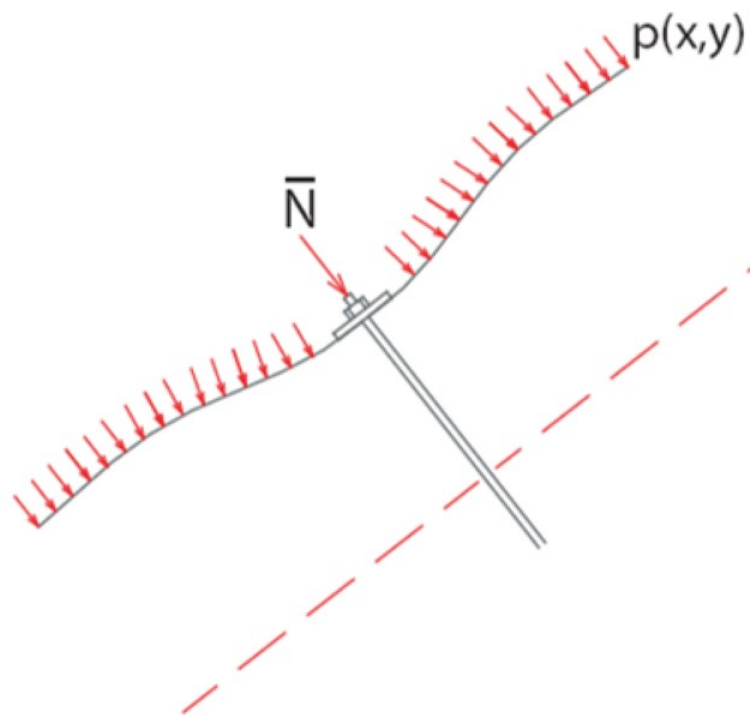
Particolare
attenzione nelle fasi
di installazione

Cause di innesco:

- ▶ Gravità (!)
- ▶ Influenza dell'acqua
- ▶ Eventi sismici
- ▶ Cambi di geometria
- ▶ Carichi artificiali
- ▶ Alterazione / erosione



COME LAVORA IL SISTEMA TECCO

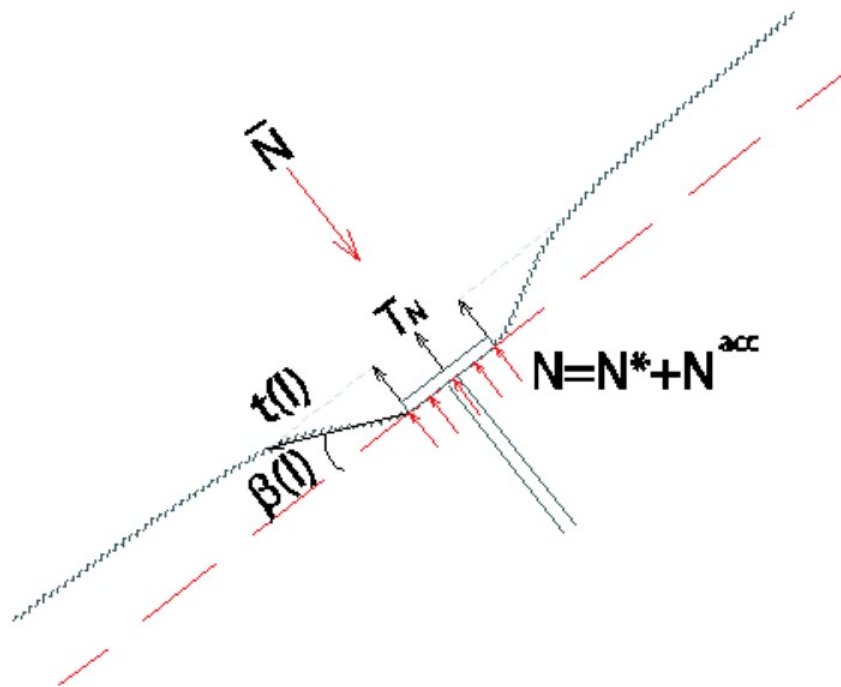


Il tensionamento dell'ancoraggio induce una deformazione nella rete, mettendola in tensione.

Visto il **comportamento membranale** della rete, questo si traduce in una pressione trasferita al terreno.

La nascita di questo meccanismo è possibile grazie alle caratteristiche meccaniche della rete e all'**accoppiamento** di questa agli ancoraggi tramite la piastra.

Il comportamento ottimale si ha con rete flessibile e con elevate caratteristiche di resistenza.



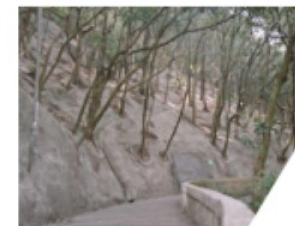
L'accoppiamento dell'azione di contenimento attivo della rete e dell'incremento di resistenza a taglio dato dalle barre e dall'azione trasmessa dalla rete porta ad un **incremento del fattore di sicurezza** del pendio.

In particolare nasce un fattore di accoppiamento che dipende dalle deformazioni impresse alla rete.

TIPI DI RIVESTIMENTO

Tipi in accordo alla Norma EN 14490 (2010)

Rivestimenti rigidi



Rivestimenti flessibili

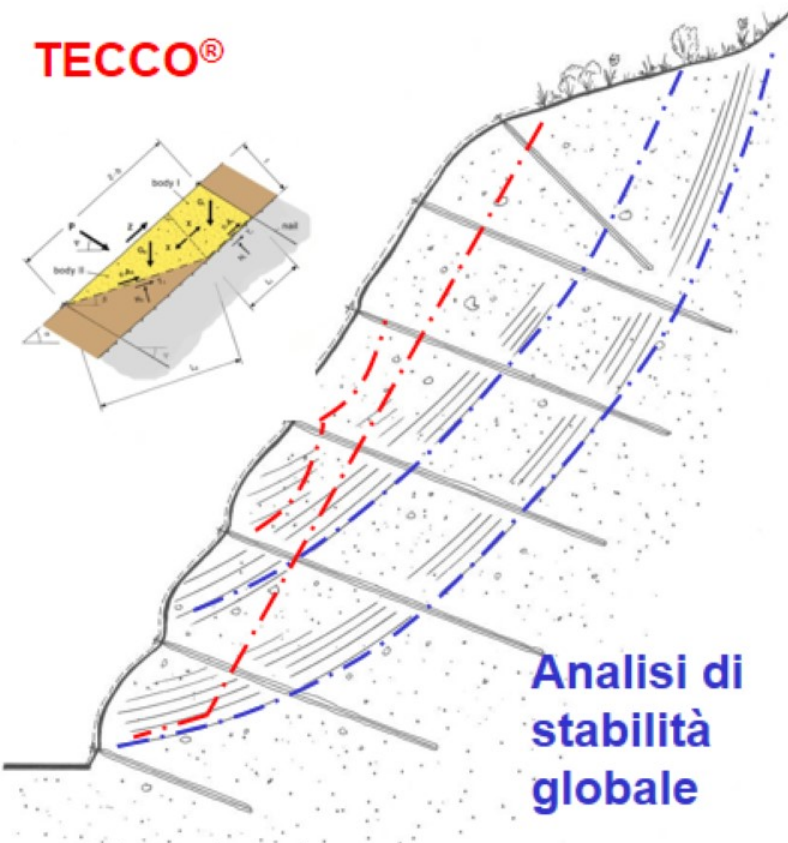


Rivestimenti leggeri

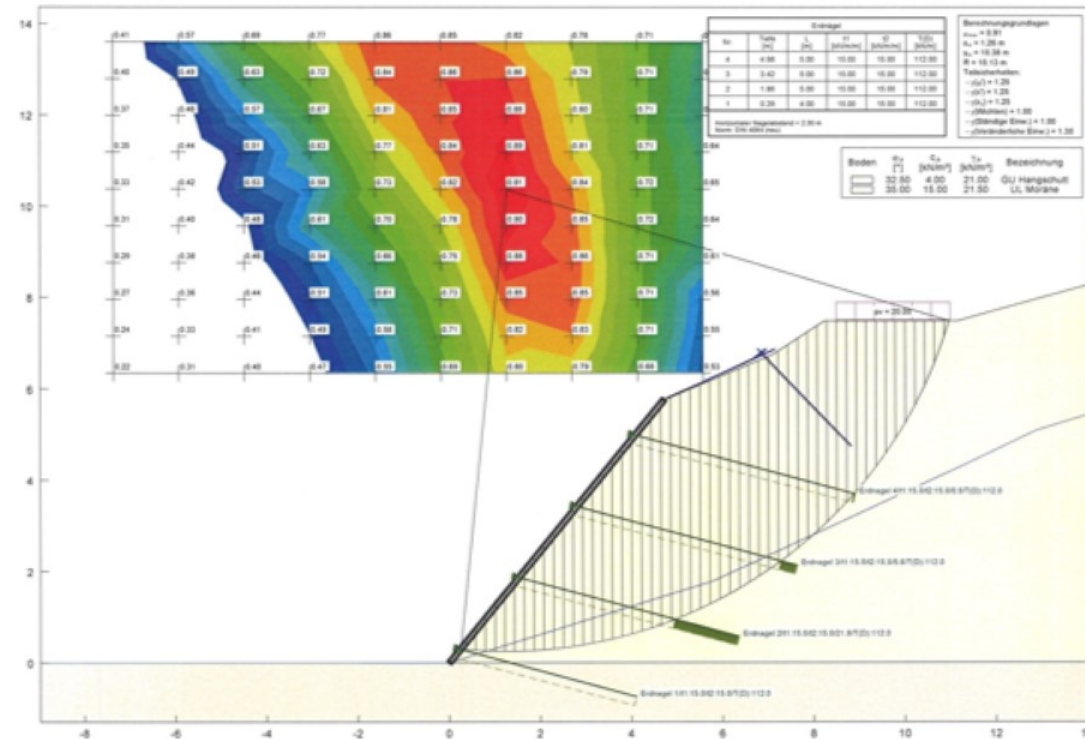


SUPERFICI PROFONDE

TECCO®



**Analisi di
stabilità
globale**

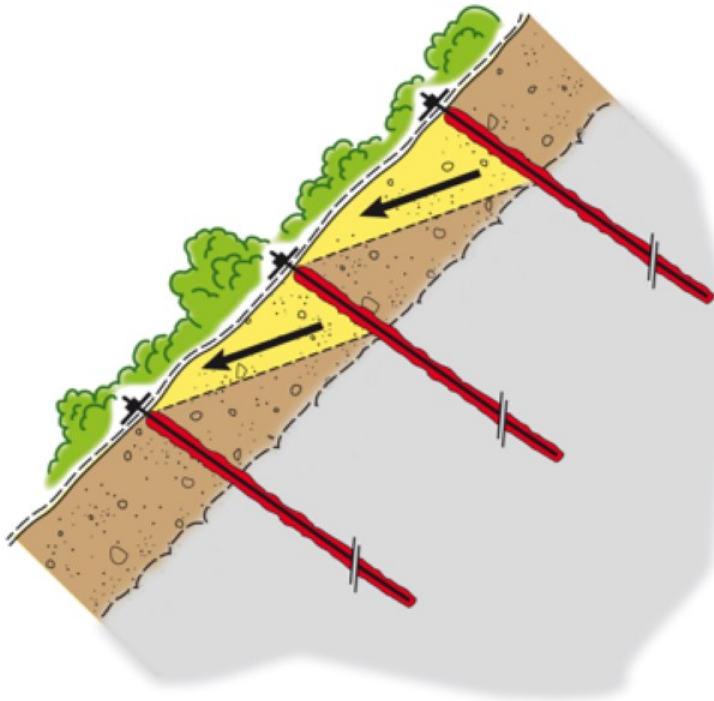




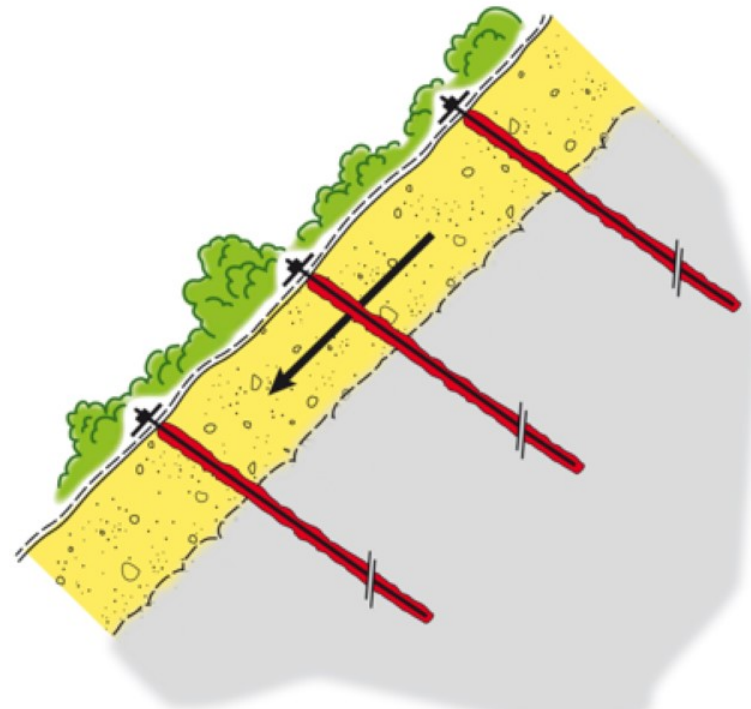
DIMENSIONAMENTO DEI SISTEMI FLESSIBILI

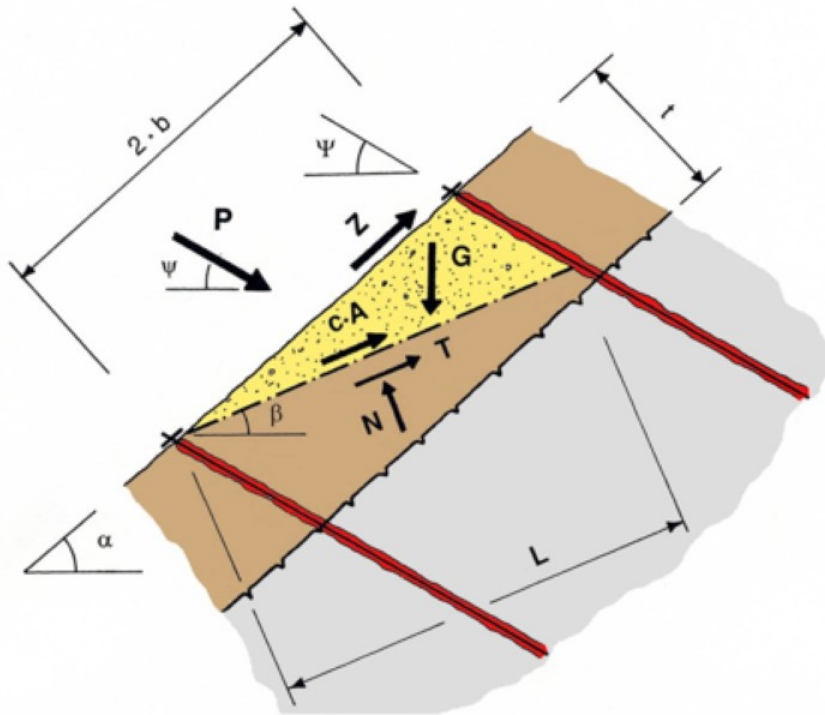
RUVOLUM® prevede la verifica di due modelli

1. La verifica di instabilità locali tra i singoli ancoraggi

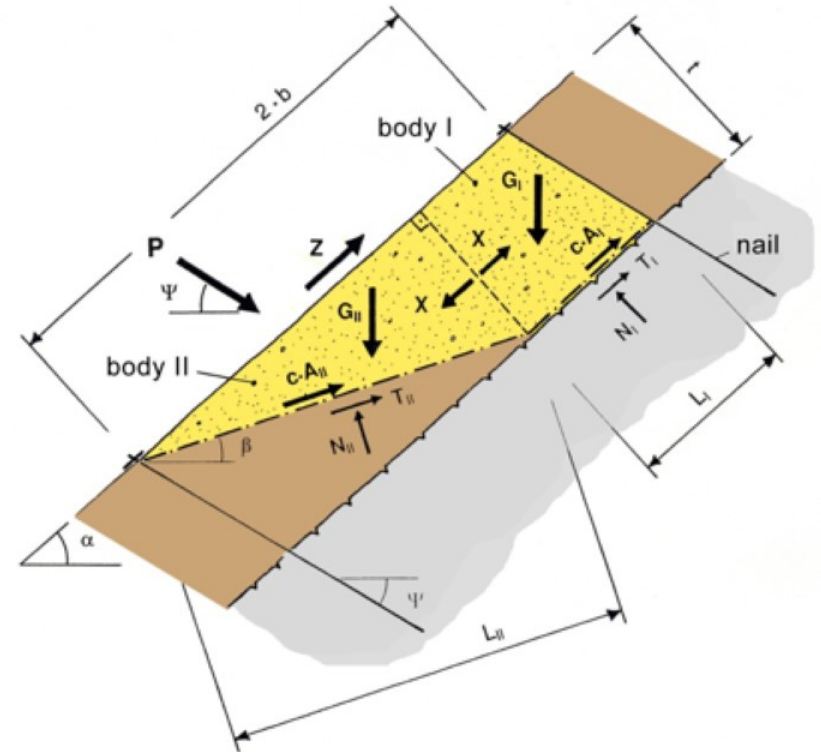


2. La verifica di instabilità di versante sul modello del pendio indefinito





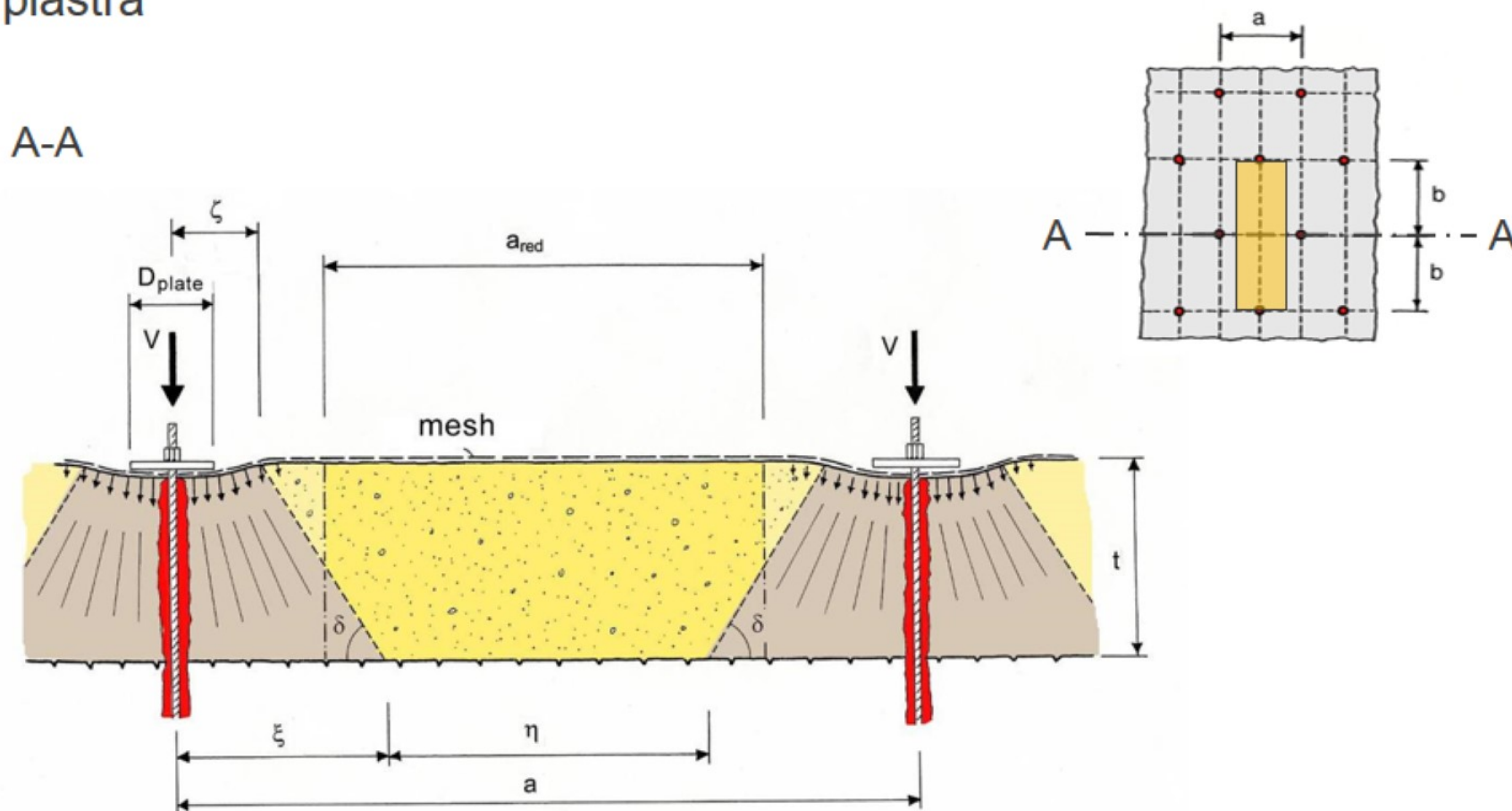
Modello con singolo concio



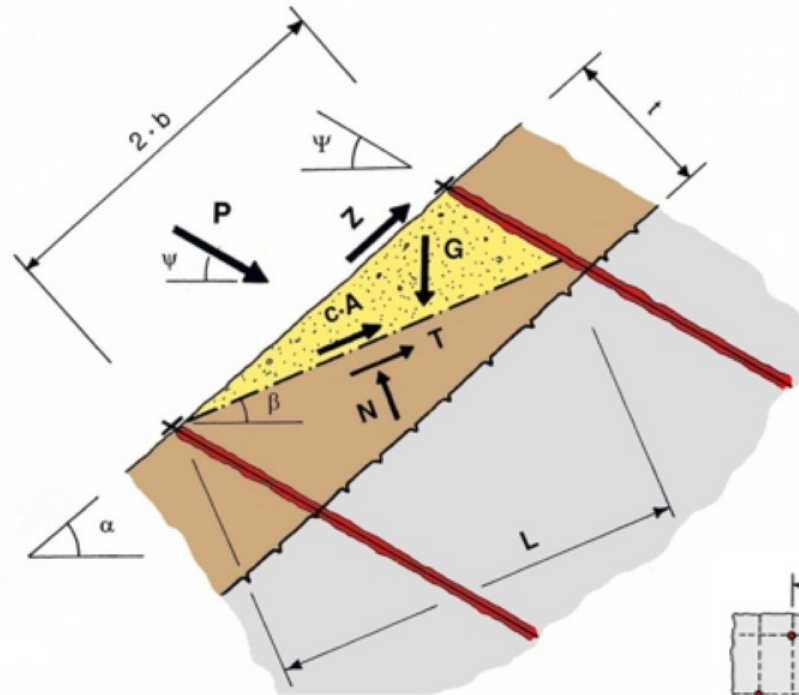
Modello con due conci

2 IL MODELLO RUVOLUM

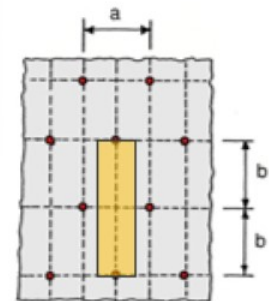
Si prende in considerazione la diffusione del carico impresso alla piastra



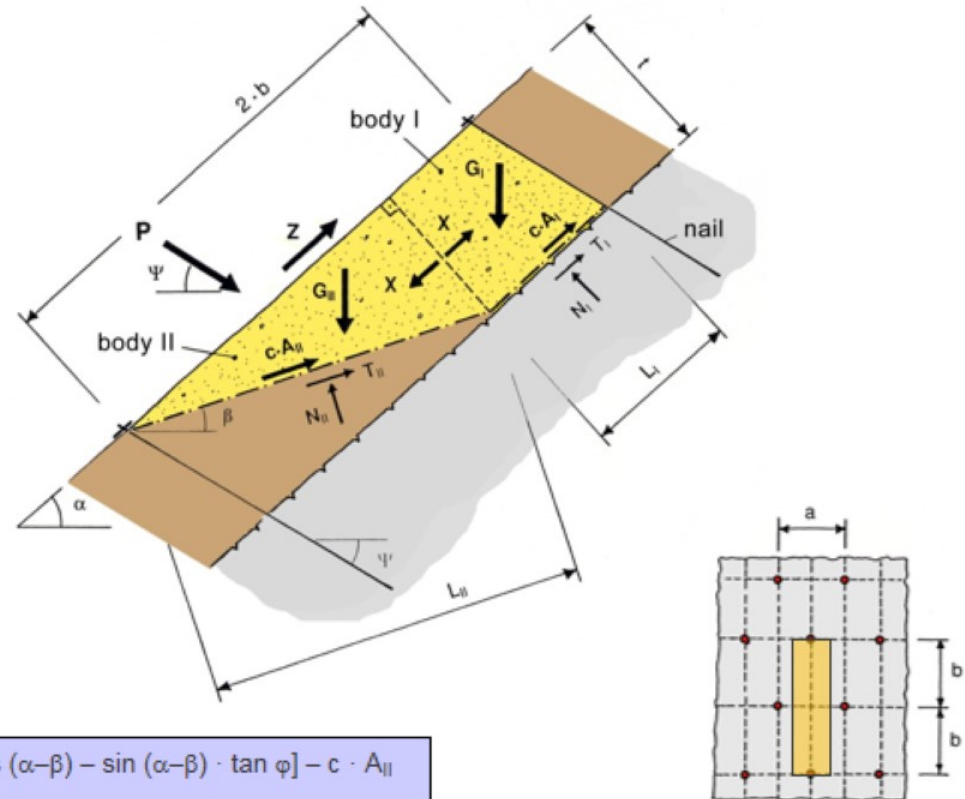
- Z = slope-parallel force
 P = stabilizing force
 G = dead weight of sliding body
 $c \cdot A$ = cohesion
 T, N = reaction forces
 α = inclination of the slope
 β = inclination of the sliding surface
 L = length of the sliding surface
 γ_{mod} = model uncertainty factor



$$P \text{ [kN]} = \frac{G \cdot [\gamma_{mod} \cdot \sin \beta - \cos \beta \cdot \tan \varphi] - Z \cdot [\gamma_{mod} \cdot \cos (\alpha - \beta) - \sin (\alpha - \beta) \cdot \tan \varphi] - c \cdot A}{\gamma_{mod} \cdot \cos (\beta + \Psi) + \sin (\beta + \Psi) \cdot \tan \varphi}$$



- Z = forza parallela al pendio
 P = forza stabilizzante
 G = peso proprio
 $c \cdot A$ = coesione
 T, N = forze resistenti
 α = inclinazione del versante
 β = inclinazione della superficie di scorrimento
 L = lunghezza del piano di scivolamento
 γ_{mod} = fattore di incertezza del modello
 X = azione di contatto



$$P \text{ [kN]} = \frac{G_{II} \cdot [\gamma_{mod} \cdot \sin \beta - \cos \beta \cdot \tan \varphi] + (X - Z) \cdot [\gamma_{mod} \cdot \cos (\alpha - \beta) - \sin (\alpha - \beta) \cdot \tan \varphi] - c \cdot A_{II}}{\gamma_{mod} \cdot \cos (\beta + \Psi) + \sin (\beta + \Psi) \cdot \tan \varphi}$$

$$X \text{ [kN]} = 1 / \gamma_{mod} \cdot \{ G_I \cdot (\gamma_{mod} \cdot \sin \alpha - \cos \alpha \cdot \tan \varphi) - c \cdot A_I \}$$

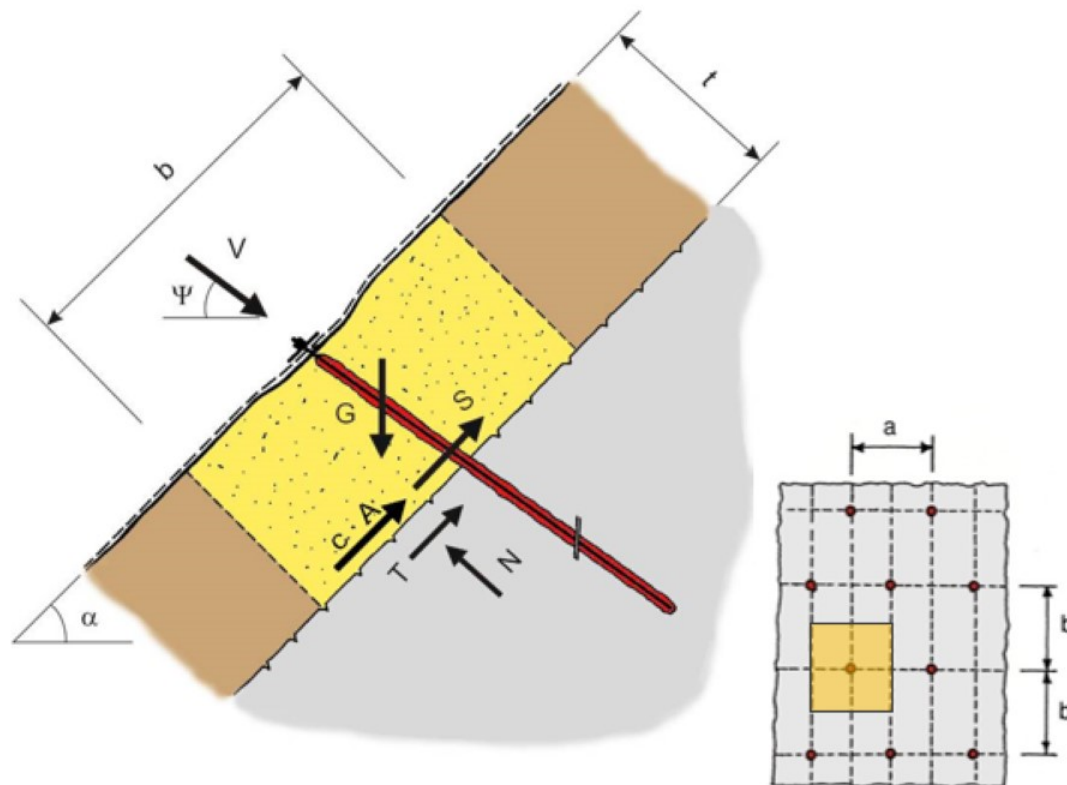
Verifica di instabilità superficiali parallele al versante

- Verifica degli ancoraggi al taglio
- Verifica della rete al punzonamento
- Verifica degli ancoraggi a carico combinato

Resistenze caratteristiche che devono essere note

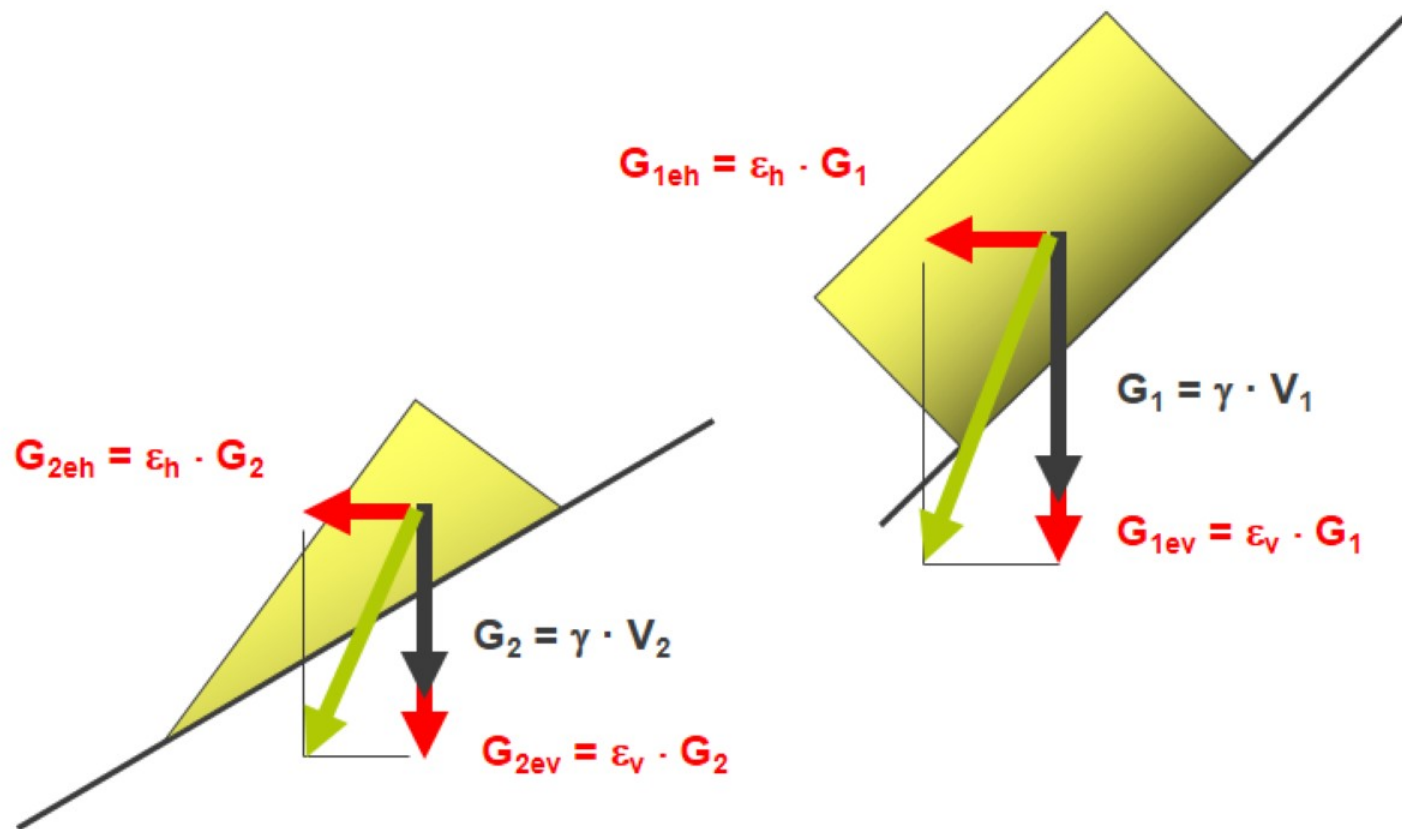
- D_R = resistenza al punzonamento della rete
- S_R = resistenza al taglio dell'ancoraggio
- T_R = resistenza a trazione dell'ancoraggio

- G = peso proprio
 S = azione di taglio
 V = pretensionamento
 $c \cdot A$ = coesione
 T, N = azioni di reazione
 α = inclinazione del pendio
 γ_{mod} = fattore di incertezza del modello



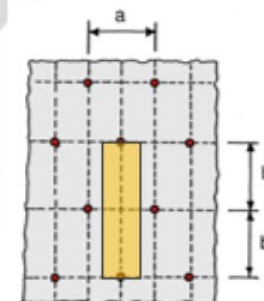
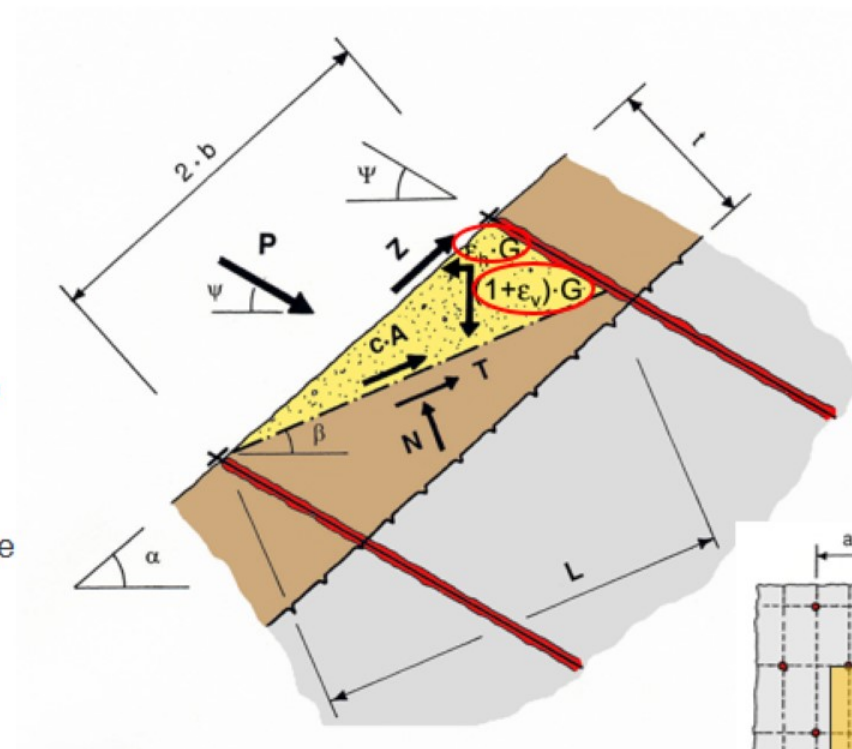
$$S \text{ [kN]} = G \cdot \sin\alpha - V \cdot \cos(\Psi+\alpha) - \frac{c \cdot A + [G \cdot \cos\alpha + V \cdot \sin(\Psi+\alpha)] \cdot \tan\varphi}{\gamma_{\text{mod}}}$$

Accelerazioni dovuti al sisma: Componenti



2 IL MODELLO RUVOLUMUM

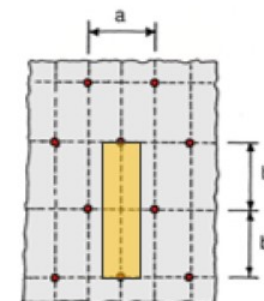
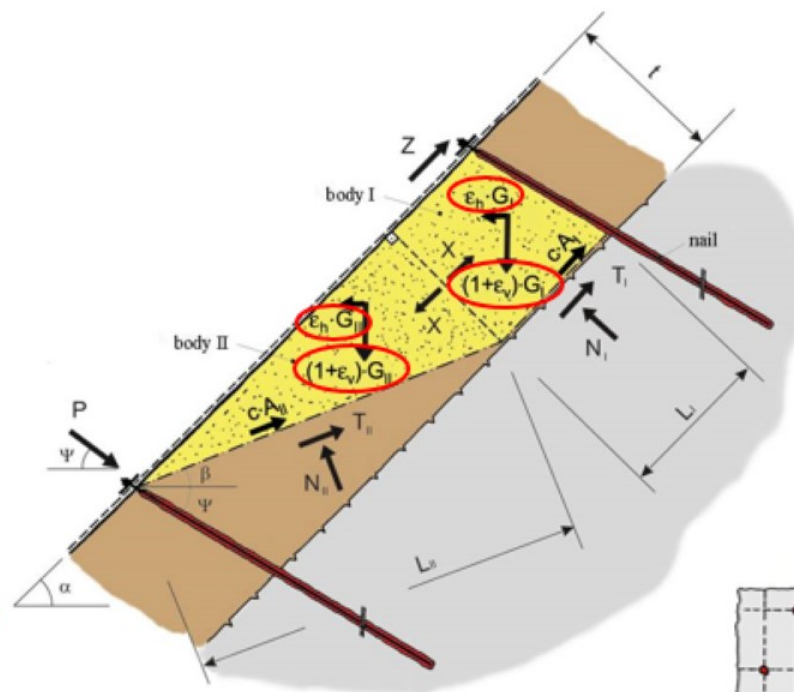
- Z = forza parallela al versante
 P = forza stabilizzante
 G = peso proprio
 $c \cdot A$ = coesione
 T, N = reazioni
 α = inclinazione del versante
 β = inclinazione del piano di scorrimento
 L = lunghezza del piano di scorrimento
 γ_{mod} = fattore di incertezza del modello
 ε_v = coefficiente di accelerazione verticale
 ε_h = coefficiente di accelerazione orizzontale



$$P \text{ [kN]} = \frac{(1+\varepsilon_v) \cdot G \cdot \sin \beta + \varepsilon_h \cdot G \cdot \cos \beta - Z \cdot \cos(\alpha - \beta) - \frac{[(1+\varepsilon_v) \cdot G \cdot \cos \beta - \varepsilon_h \cdot G \cdot \sin \beta - Z \cdot \sin(\alpha - \beta)] \cdot \tan \varphi + c \cdot A_c}{\gamma_{mod}}}{\cos(\Psi + \beta) + \sin(\Psi + \beta) \cdot \frac{\tan \varphi}{\gamma_{mod}}}$$

2 IL MODELLO RUVOLUMUM

- Z = forza parallela al versante
 P = forza stabilizzante
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 $c \cdot A$ = coesione
 T, N = reazioni
 α = inclinazione del versante
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 L = lunghezza del piano di scorrimento
 X = azioni di contatto
 γ_{mod} = fattore di incertezza del modello
 ε_v = coefficiente di accelerazione verticale
 ε_h = coefficiente di accelerazione orizzontale

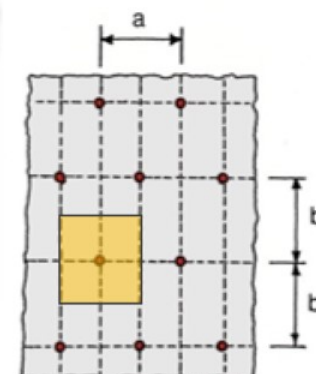
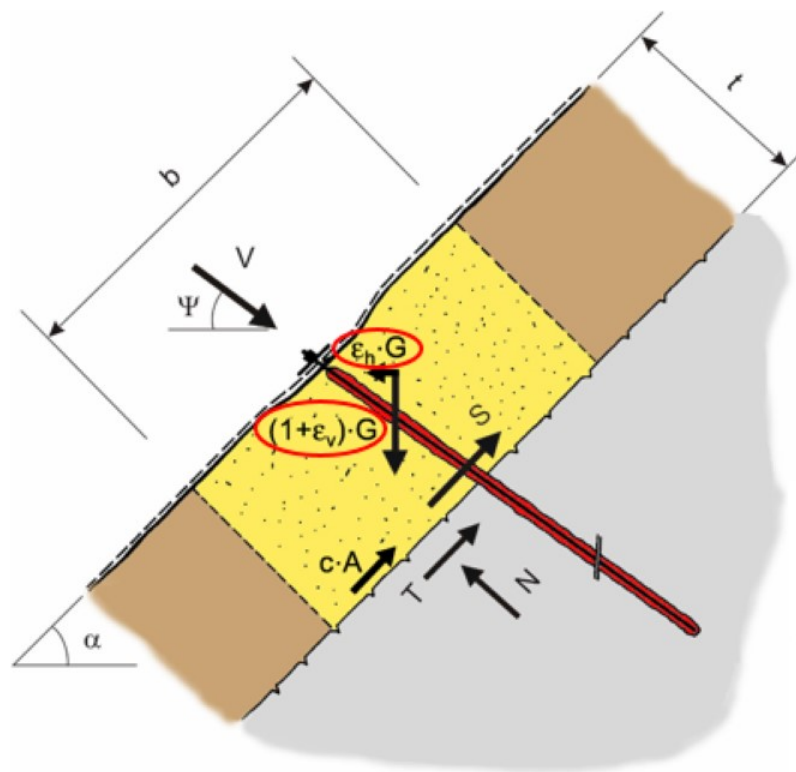


$$P \text{ [kN]} = \frac{(1+\varepsilon_v) \cdot G_{II} \sin \beta + \varepsilon_h \cdot G_{II} \cos \beta + X \cdot \cos(\alpha - \beta) - Z \cdot \cos(\alpha - \beta) - \frac{[(1+\varepsilon_v) \cdot G_{II} \cos \beta - \varepsilon_h \cdot G_{II} \sin \beta - Z \cdot \sin(\alpha - \beta) + X \cdot \sin(\alpha - \beta)] \cdot \tan \varphi + c \cdot A_{cI}}{\gamma_{mod}}}{\cos(\Psi + \beta) + \sin(\Psi + \beta) \cdot \frac{\tan \varphi}{\gamma_{mod}}}$$

$$X \text{ [kN]} = (1+\varepsilon_v) \cdot G_I \sin \alpha + \varepsilon_h \cdot G_I \cos \alpha - \frac{[(1+\varepsilon_v) \cdot G_I \cos \alpha - \varepsilon_h \cdot G_I \sin \alpha] \cdot \tan \varphi + c \cdot A_{cI}}{\gamma_{mod}}$$

2 IL MODELLO RUVOLUMUM

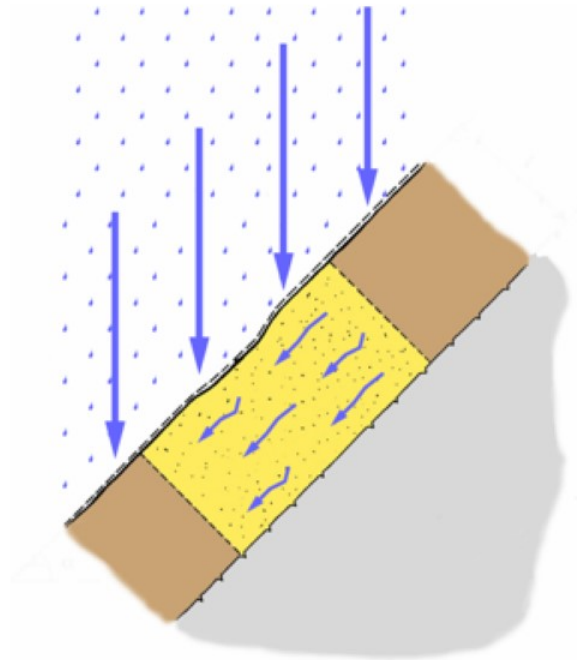
- G = peso proprio
 S = azione di taglio
 V = pretensionamento
 $c \cdot A$ = coesione
 T, N = azioni resistenti
 α = inclinazione del versante
 γ_{mod} = fattore di incertezza del modello
 ε_v = coefficiente di accelerazione verticale
 ε_h = coefficiente di accelerazione orizzontale



$$S \text{ [kN]} = (1+\varepsilon_v) \cdot G \cdot \sin \alpha + \varepsilon_h \cdot G \cdot \cos \alpha - V \cdot \cos(\Psi + \alpha) - \frac{[V \cdot \sin(\Psi + \alpha) + (1+\varepsilon_v) \cdot G \cdot \cos \alpha - \varepsilon_h \cdot G \cdot \sin \alpha] \cdot \tan \varphi}{\gamma_{mod}} + c \cdot A$$

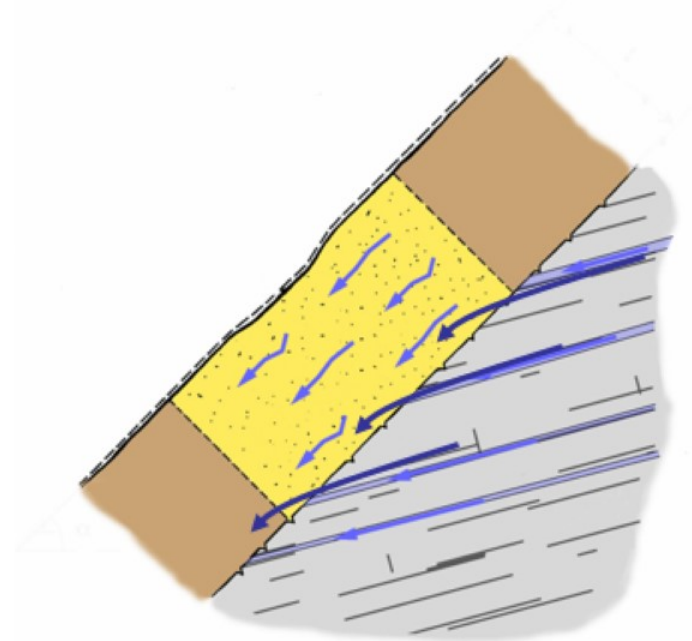
Precipitazioni intense

- Saturazione
- Flusso parallelo al versante



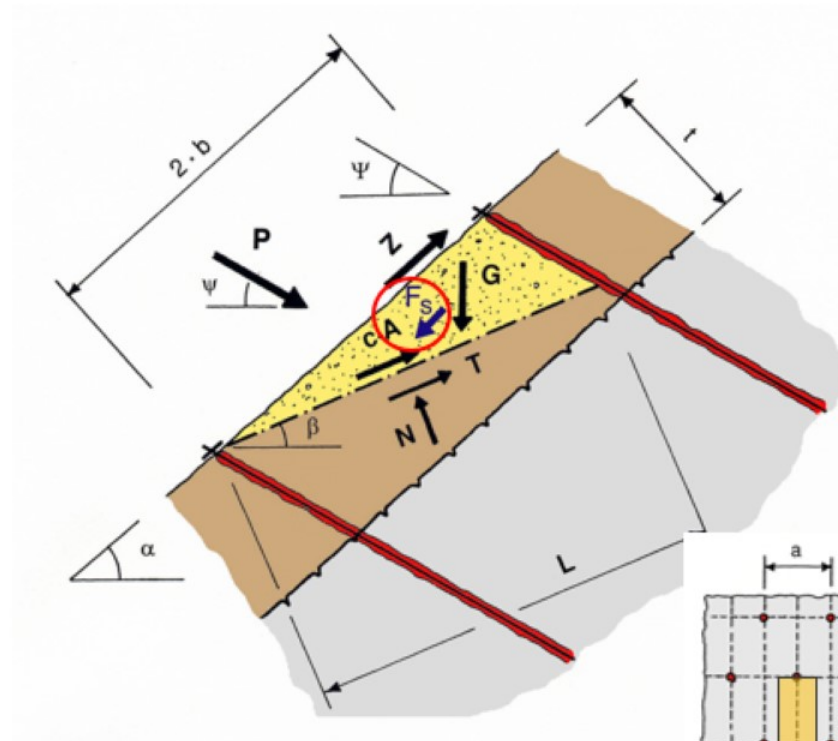
Acquifero superficiale

- Saturazione
- Flusso parallelo al versante



2 IL MODELLO RUVOLUM

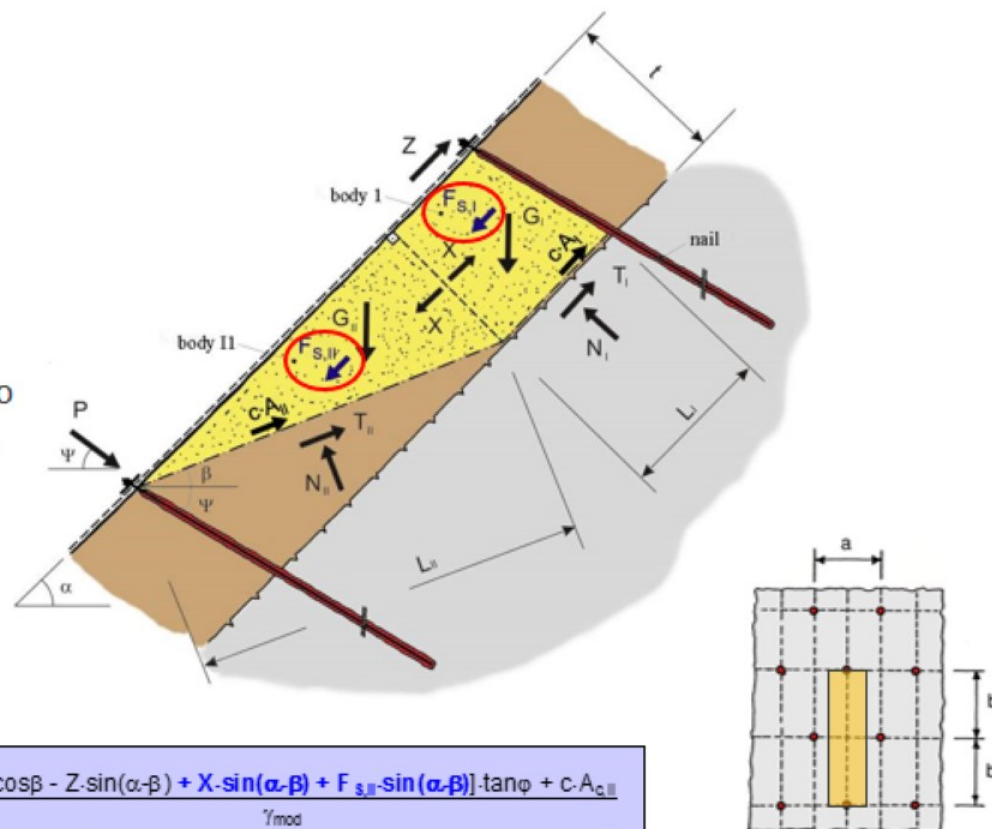
- Z = forza parallela al versante
 P = forza stabilizzante
 G = peso proprio
 $c \cdot A$ = coesione
 T, N = reazioni
 α = inclinazione del versante
 β = inclinazione del piano di scorrimento
 L = lunghezza del piano di scorrimento
 γ_{mod} = fattore di incertezza del modello
 F_s = risultante delle forze di flusso
 $(F_s = \gamma_w \cdot \sin \alpha \cdot \text{vol})$



$$P[kN] = \frac{F_s \cos(\alpha - \beta) + G \sin \beta - Z \cos(\alpha - \beta) - \frac{[G \cos \beta - Z \sin(\alpha - \beta) + F_s \sin(\alpha - \beta)] \cdot \tan \phi + c \cdot A_c}{\gamma_{mod}}}{\cos(\Psi + \beta) + \sin(\Psi + \beta) \cdot \frac{\tan \phi}{\gamma_{mod}}}$$

2 IL MODELLO RUVOLUMUM

- Z = forza parallela al versante
 P = forza stabilizzante
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 L = lunghezza del piano di scorrimento
 γ_{mod} = fattore di incertezza del modello
 X = forze di contatto
 F_s = risultante delle forze di flusso
 $(F_s = \gamma_w \cdot \sin \alpha \cdot vol)$

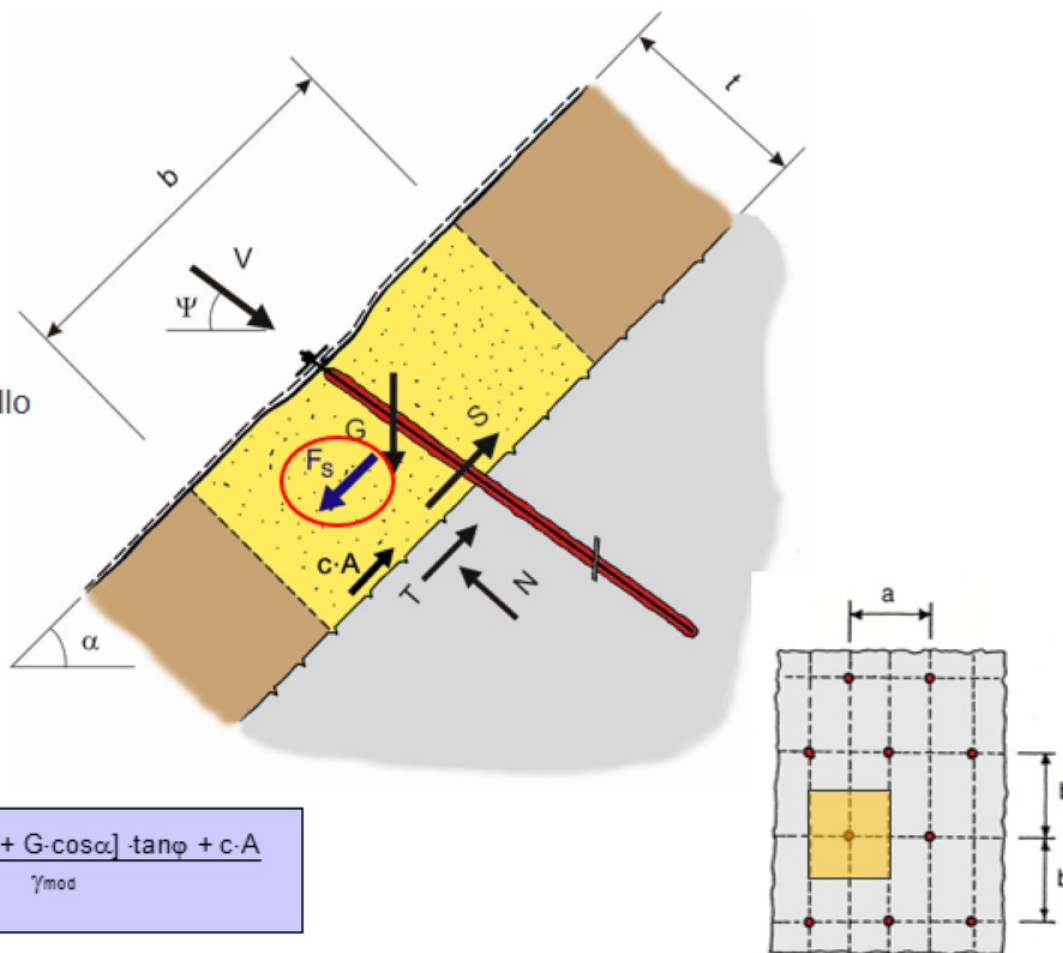


$$P \text{ [kN]} = \frac{G_{II} \cdot \sin \beta + X \cdot \cos(\alpha - \beta) + F_{s,II} \cdot \cos(\alpha - \beta) - Z \cdot \cos(\alpha - \beta) - \frac{[G_{II} \cdot \cos \beta - Z \cdot \sin(\alpha - \beta) + X \cdot \sin(\alpha - \beta) + F_{s,II} \cdot \sin(\alpha - \beta)] \cdot \tan \varphi + c \cdot A_{c,II}}{\gamma_{mod}}}{\cos(\psi + \beta) + \sin(\psi + \beta) \cdot \frac{\tan \varphi}{\gamma_{mod}}}$$

$$X \text{ [kN]} = F_{s,I} + G_I \cdot \sin \alpha - \frac{G_I \cdot \cos \alpha \cdot \tan \varphi + c \cdot A_{c,I}}{\gamma_{mod}}$$

2 IL MODELLO RUVOLUMUM

- G = peso proprio
 S = forza di taglio
 V = azione di pretensionamento
 $c \cdot A$ = coesione
 T, N = forze resistenti
 α = inclinazione del versante
 γ_{mod} = fattore di incertezza del modello
 F_s = risultante delle forze di flusso
 $(F_s = \gamma_w \cdot \sin \alpha \cdot vol)$



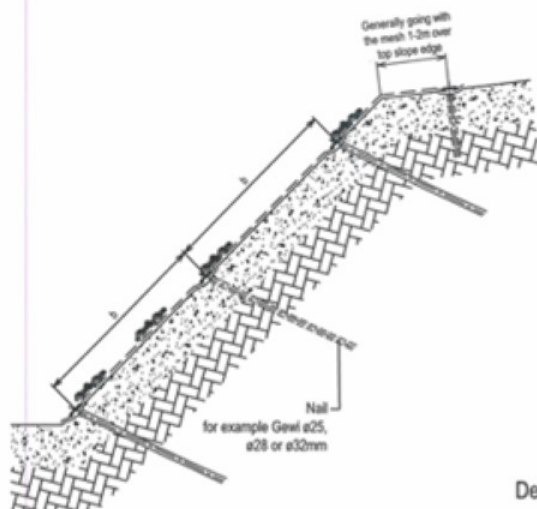
$$S \text{ [kN]} = G \cdot \sin \alpha - V \cdot \cos(\Psi + \alpha) + F_s - \frac{[V \cdot \sin(\Psi + \alpha) + G \cdot \cos \alpha] \cdot \tan \varphi + c \cdot A}{\gamma_{mod}}$$



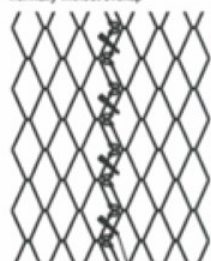
DESCRIZIONE DEL SISTEMA TECCO®

ELEMENTI DI BASE

Cross section A-A

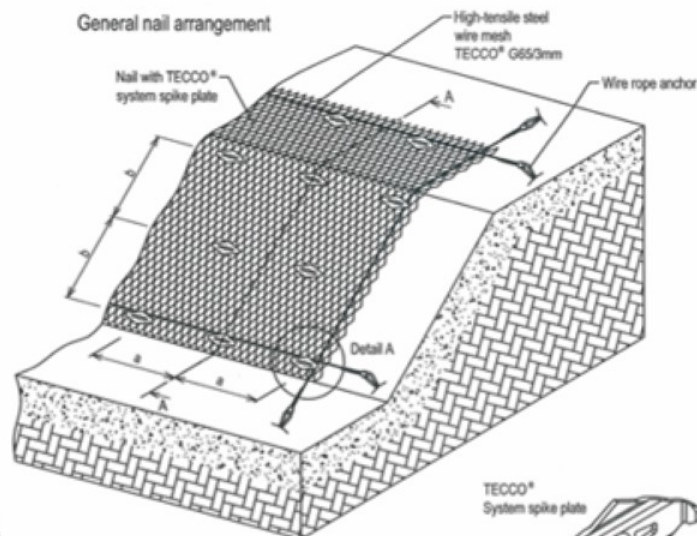


TECCO® mesh connection vertical normally without overlap

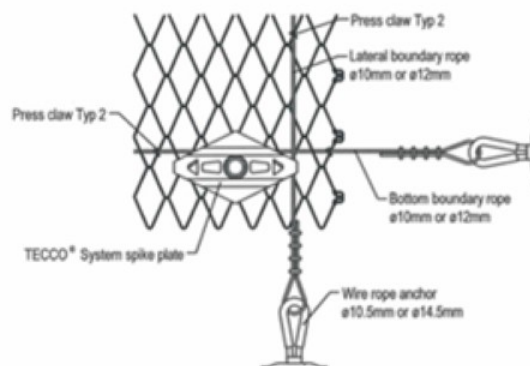


Connection clip T3
(1 Clip per mesh)

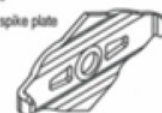
General nail arrangement



Detail A



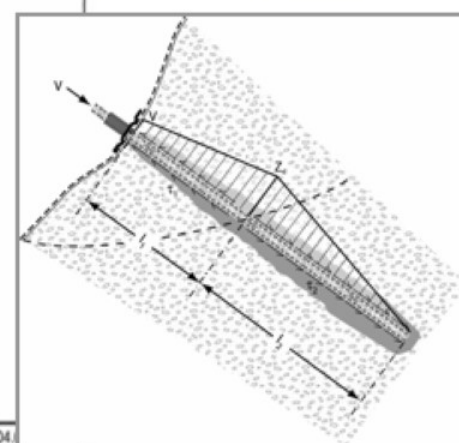
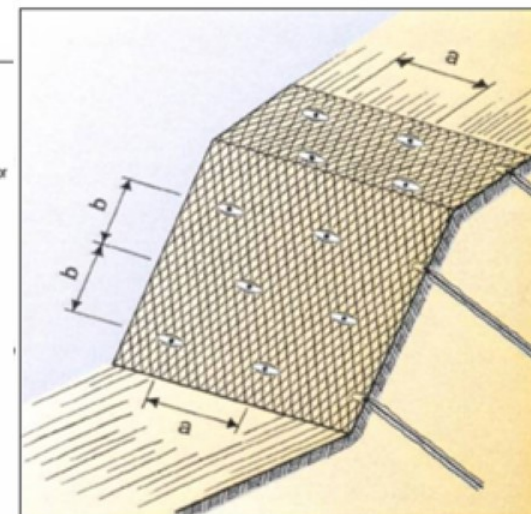
TECCO®
System spike plate



Connection clip T3



Press claw Typ 2



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This document will not be exchanged, when being modified.

modification: M.% substitute for: GE-1003e ed. 24.04.
replaced by:

TECCO®
System drawing

drawn	19.04.11	hb
checked	19.04.11	Ro
approved	19.04.11	HP

GEOBRUGG AG
CH-8590 Romanshorn



GE-1003e

Tre componenti

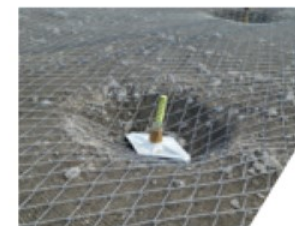
1 Rete in filo ad alta resistenza

TECCO® G45/2
TECCO® G65/3
TECCO® G65/4 } + clip di giunzione T3



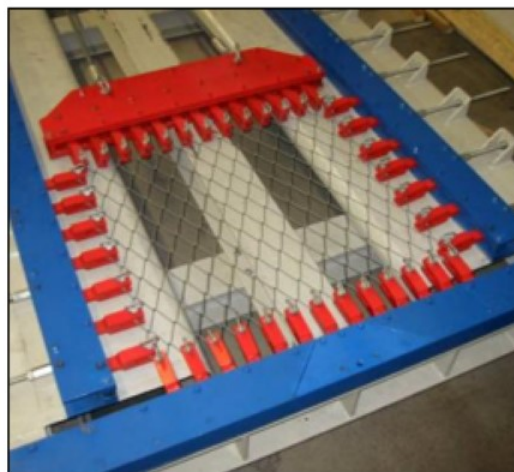
2 Piastre cuspidate TECCO®

P25
P33
P66



3 Ancoraggi (commerciali)





- Filo d'acciaio diametro: 3 mm
- Classe di resistenza acciaio: $> 1'770 \text{ N/mm}^2 \rightarrow 12.5 \text{ kN}$
- Rotolo dimensioni: 3.5 m x 30 m / 105 m²
- Peso: 1.65 kg/m² / 175 kg/roll
- Resistenza a trazione rete: 150 kN/m
- Apertura della maglia: 65 mm
- Anti-corrosione: GEOBRUGG SUPERCOATING®, 5% Al + 95% Zn
- Spessore rivestimento: $> 150 \text{ g/m}^2$

TECCO®
G65/3



Filo d'acciaio diametro: 4 mm

Classe di resistenza acciaio: $> 1'770 \text{ N/mm}^2 \rightarrow 22 \text{ kN}$

Rotolo dimensioni: 3.5 m x 20 m / 70 m²

Peso: 3,3 kg/m² / 231 kg/roll

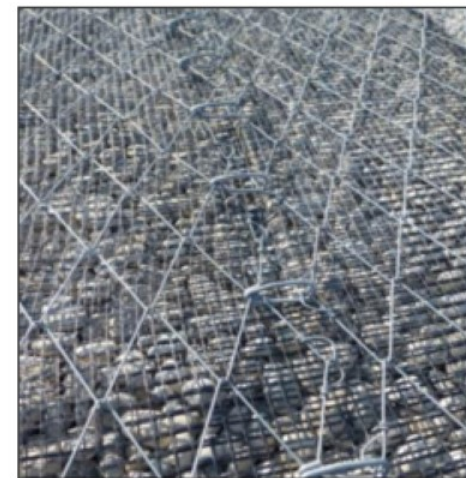
Resistenza a trazione rete: 250 kN/m

Apertura della maglia: 63 mm

Anti-corrosione: GEOBRUGG SUPERCOATING®, 5% Al + 95% Zn

Spessore rivestimento: $> 150 \text{ g/m}^2$

TECCO®
G65/4



- | | |
|-------------------------------|---|
| Filo d'acciaio diametro: | 2 mm |
| Classe di resistenza acciaio: | $> 1'770 \text{ N/mm}^2 \rightarrow 5.5 \text{ kN}$ |
| Rotolo dimensioni: | $3.5 \text{ m} \times 40 \text{ m} / 140 \text{ m}^2$ |
| Peso: | $0,74 \text{ kg/m}^2 / 104 \text{ kg/roll}$ |
| Resistenza a trazione rete: | 65 kN/m |
| Apertura della maglia: | 45 mm |
| Anti-corrosione: | GEOBRUGG ULTRACOATING®, 5% Al + 95% Zn + comp.sp. |
| Spessore rivestimento: | $> 115 \text{ g/m}^2$ |

TECCO®
G45/2

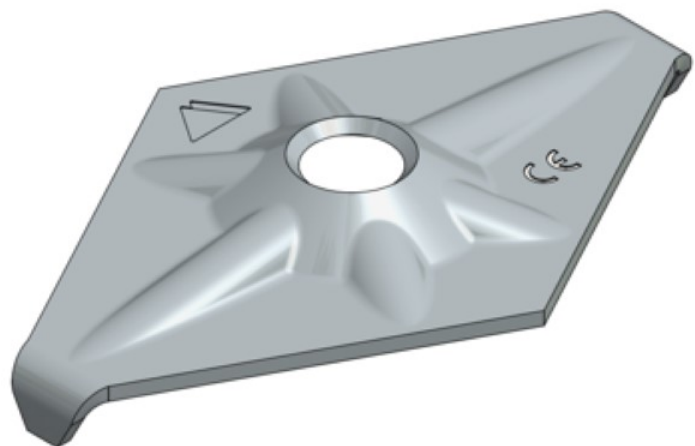


- | | |
|-------------------------------|--|
| Filo d'acciaio diametro: | 3 mm |
| Fune spiroidale diametro: | 6.5 mm |
| Classe di resistenza acciaio: | $> 1'770 \text{ N/mm}^2 \rightarrow 58.7 \text{ kN}$ |
| Rotolo dimensioni: | 3.5 m x 20 m / 70 m ² |
| Peso: | 2.60 kg/m ² / 182 kg/roll |
| Resistenza a trazione rete: | 220 kN/m |
| Apertura della maglia: | 143 mm |
| Anti-corrosione: | GEOBRUGG SUPERCOATING®, 5% Al + 95% Zn |
| Spessore rivestimento: | $> 150 \text{ g/m}^2$ |

SPIDER®
S3/130

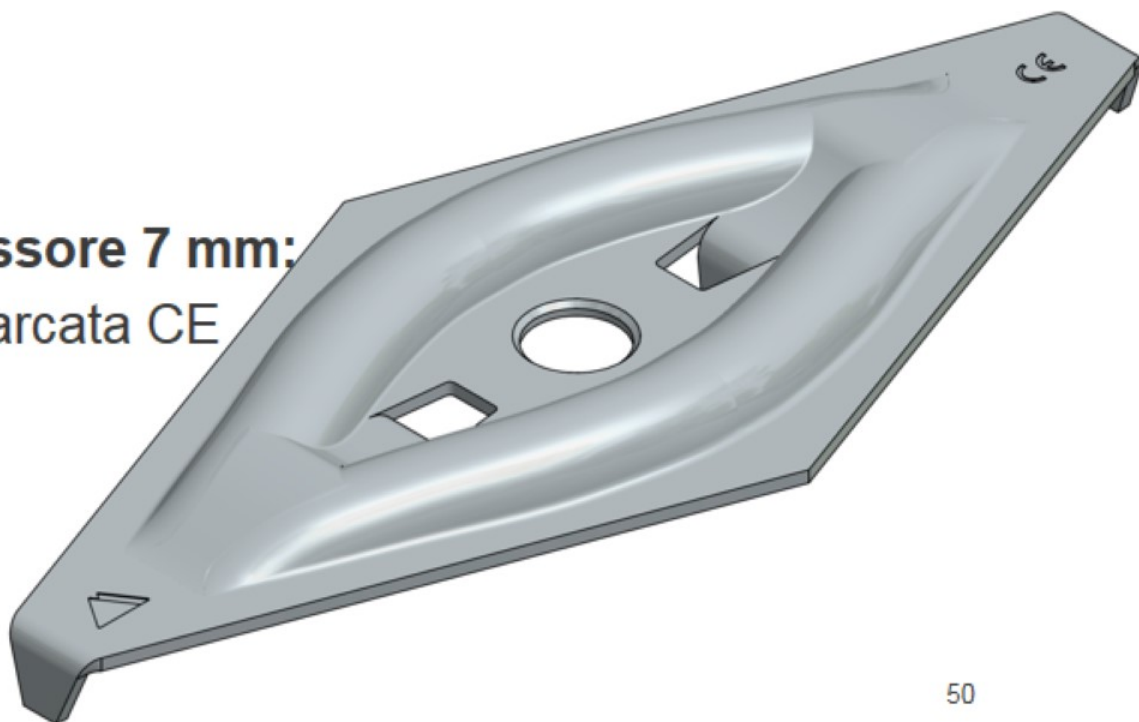
Nuove piastre P25/34, P33/40 e P33/50, spessore 7 mm:

Larghezza 25/33 cm, 1.7/2.2 kg, marcata CE



Nuova piastra P66/50, spessore 7 mm:

Larghezza 66 cm, 7.2 kg, marcata CE



- Primo produttore ad ottenere la marcatura CE su tutte le reti (TECCO e SPIDER)

Technický a skúšobný
ústav stavebný, n. o.

Študentská 3
821 04 Bratislava
Slovak Republic
Tel.: +421 2 40228100
Fax: +421 2 44453617
e-mail: eta@tsus.sk
Internet: www.tsus.sk



TSUS
TECHNICKÝ A SKÚŠOBNÝ ÚSTAV STAVEBNÝ
BUILDING TESTING AND RESEARCH INSTITUTE

ČLEN EOTA
EOTA MEMBER

European Technical Approval

ETA – 13/0405

(English translation prepared by TSUS – Original version in Slovak language)

Trade name: <i>Obchodný názov:</i>	High-Tensile Wire Mesh TECCO® G65/3
Holder of approval: <i>Držiteľ osvedčenia:</i>	Geobrugg AG Geohazard Solutions Aachstrasse 11 CH-8590 Romanshorn Switzerland
Generic type and use of construction product: <i>Typ a účel použitia stavebného výrobku:</i>	Steel mesh for retaining of unstable slopes <i>Oceťové sieťe na zachytávanie nestabilných svahov</i>
Validity <i>Platnosť:</i>	from: 06. 05. 2013 to: 06. 05. 2018
Manufacturing plant: <i>Miesto výroby:</i>	Geobrugg AG Geohazard Solutions Aachstrasse 11



European Technical Approval ETA-13/0405



European Organisation for Technical Approvals
Európska organizácia pre technické osvedčovanie



TECHNICKÝ A SKÚŠOBNÝ ÚSTAV STAVEBNÝ, n. o.
BUILDING TESTING AND RESEARCH INSTITUTE, Slovak Republic
Študentská 3, 821 04 Bratislava

EC CERTIFICATE OF CONFORMITY

1301 – CPD – 0899

In compliance with the Directive 89/106/EEC of the Council of European Communities of 21 December 1988 on the approximation of laws, regulations and administrative provisions of the Member States relating to the construction products (Construction Products Directive - CPD), amended by the Directive 93/68/EEC of the Council of European Communities of 22 July 1993, it has been stated that the construction product

Steel mesh for retaining of unstable slopes
High-Tensile Steel Wire Mesh TECCO® G65/3

is used to prevent and control the rolling and falling of rocks on slopes and to stabilize unstable slopes by covering them with either draps or nailed solutions. The products are designed, manufactured and installed in accordance with the ETA holder's concept and installation guide. A range of ambient temperature from - 20 °C to + 50 °C that covers the general situation met in different countries is fulfilled.

placed on the market by the manufacturer

**Geobrugg AG
Geohazard Solutions
Aachstrasse 11, 8590 Romanshorn
Switzerland**

and produced at the manufacturing plant

**Geobrugg AG
Geohazard Solutions
Aachstrasse 11, 8590 Romanshorn
Switzerland**

is submitted by the manufacturer to a factory production control and to the further testing of samples taken at the factory in accordance with a prescribed test plan and that the Notified body No.

1301 - Technický a skúšobný ústav stavebný, n. o.

has performed the initial type-testing for the relevant characteristics of the product, the initial inspection of the factory and of the factory production control and performs the continuous surveillance, assessment and approval of the factory production control.

This certificate attests that all provisions concerning the attestation of conformity and the performances described in the

ETA – 13/0405

were applied and that the product fulfils all the prescribed requirements.

This certificate was first issued on 17 June 2013 and remains valid as long as the conditions laid down in the harmonised technical specification in reference to the manufacturing conditions in the factory or the FPC itself are not modified significantly.

Bratislava, 17 June 2013



Dipl. Ing. Daša Kozáková
Head of Notified Body 1301

053938

3 tipi di rete

TECCO® G45/2
TECCO® G65/3
TECCO® G65/4



3 tipi di piastre

P25/34
P33/40 + P33/50
P66/50



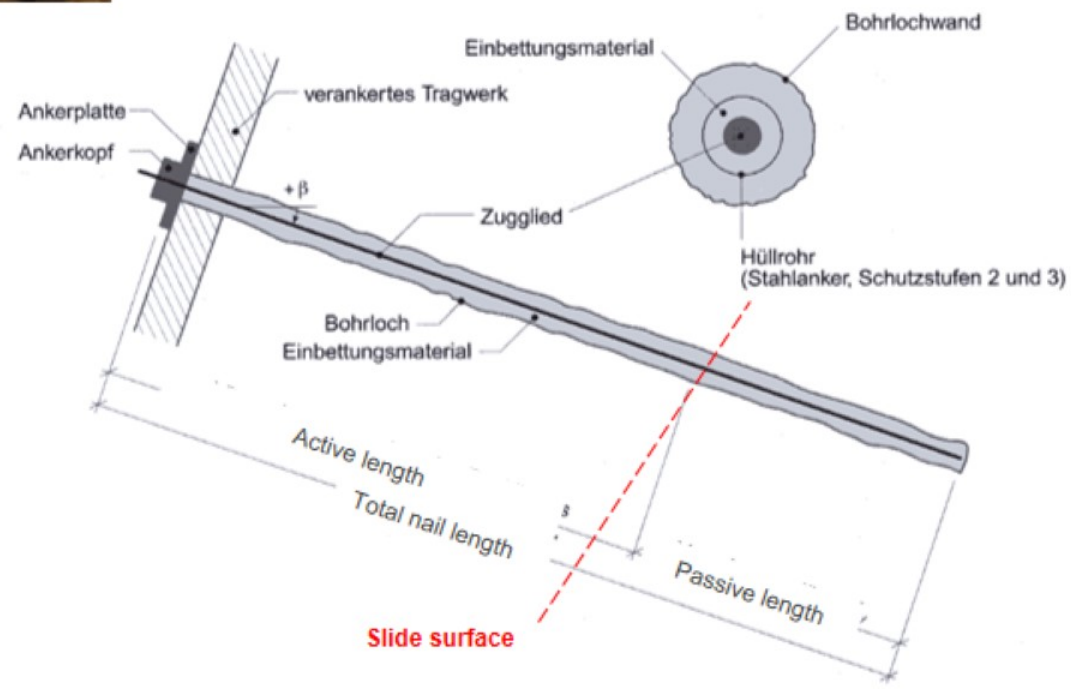
1 clip di
connessione

T3



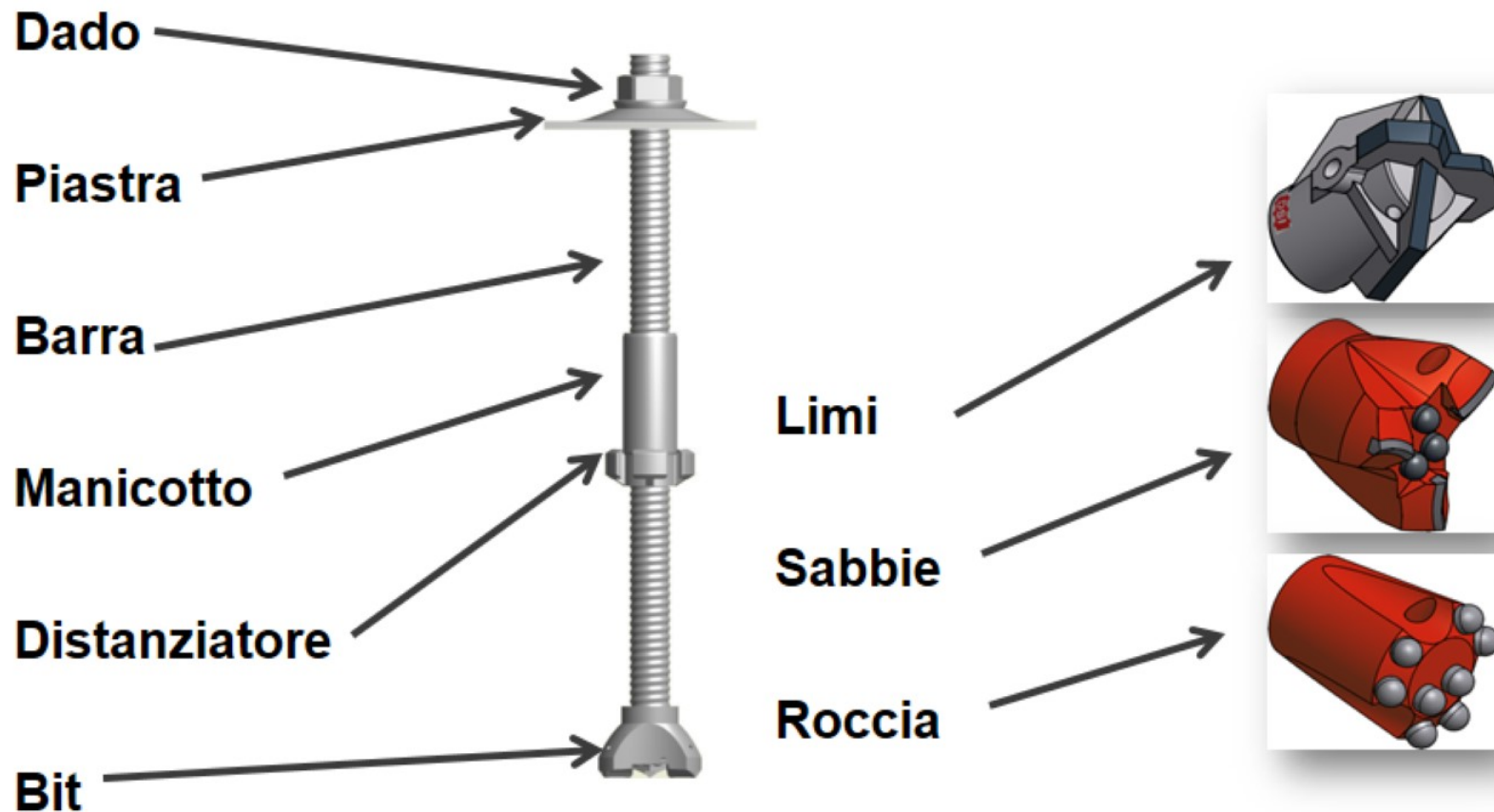
ANCORAGGI

Barre d'acciaio filettate (piene o cave) in fori per il rinforzo di terreni e rocce.



ANCORAGGI AUTOPERFORANTI

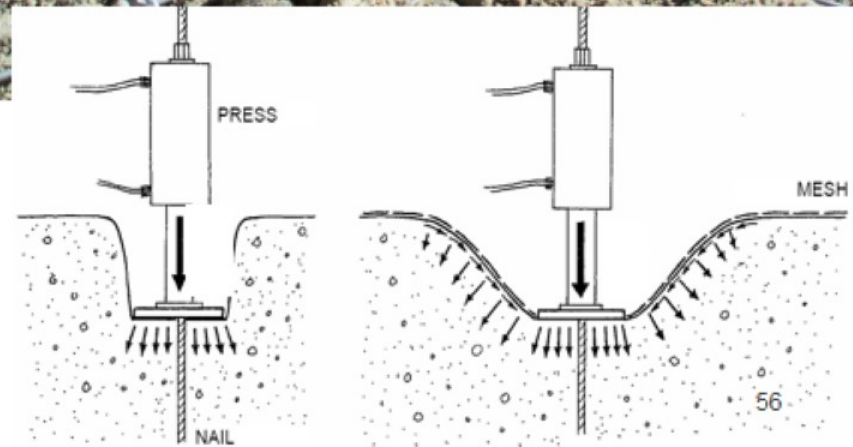
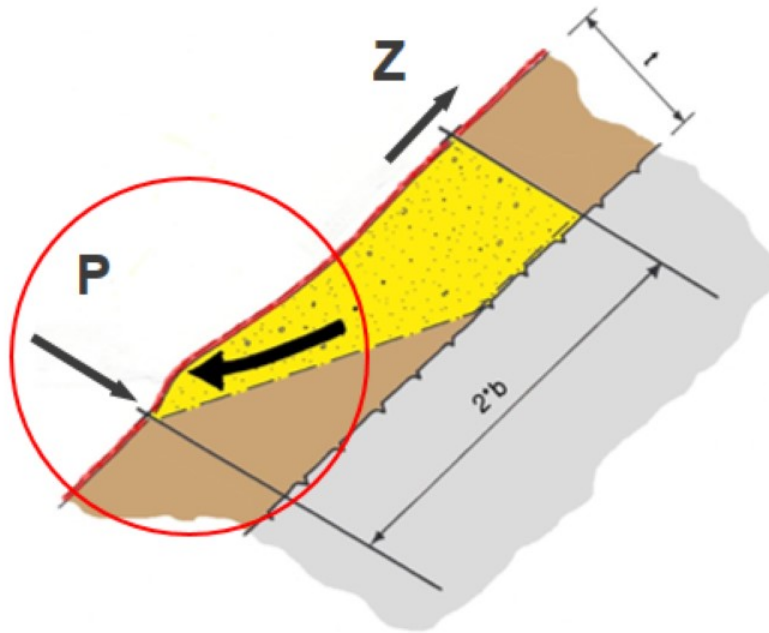
Esempio Dywidrill di Dywit (DSI – Dywidag)



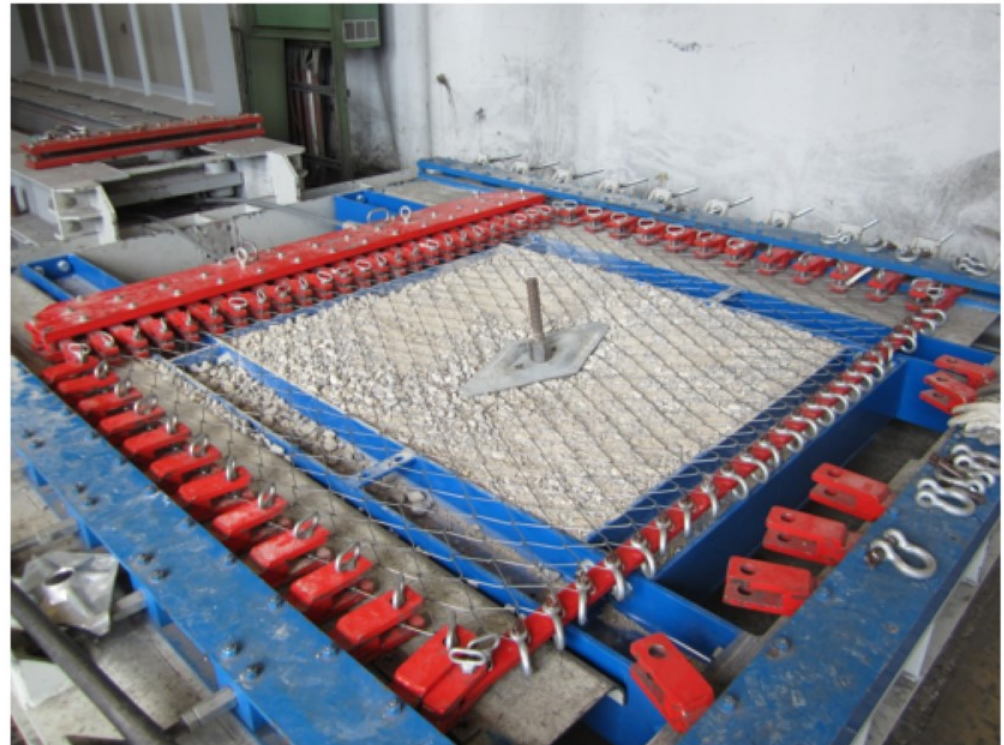
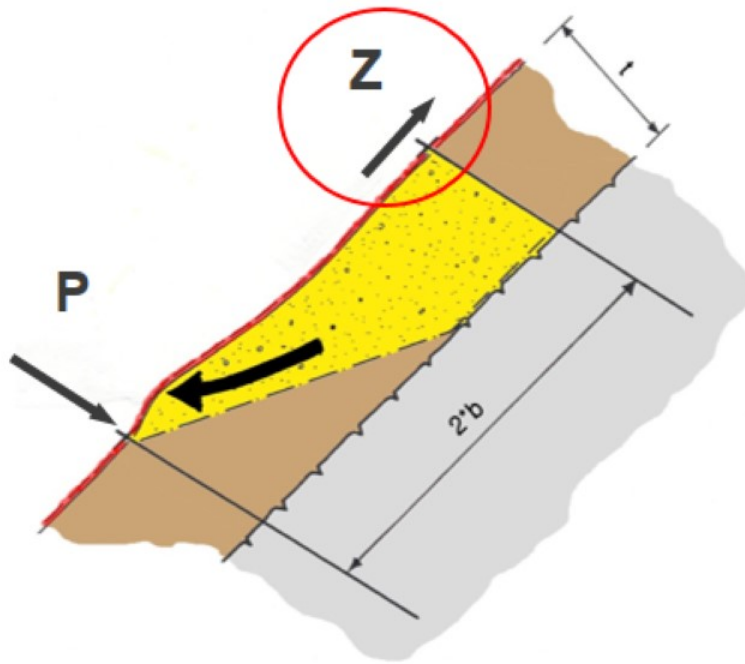


LE PROVE IN LARGA SCALA

Resistenza contro la rottura al bordo superiore della piastra ... come base per RUVOLUM®

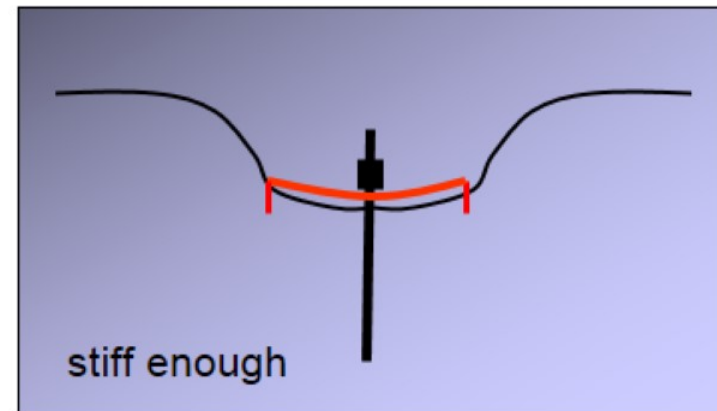
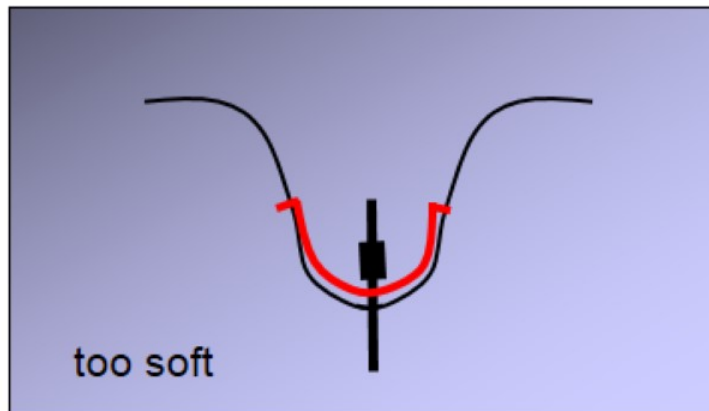


Resistenza alla trazione parallelamente al pendio ... come base per RUVOLUM®





E' fondamentale che la resistenza a flessione della piastra sia sufficientemente elevata per garantire le prestazioni richieste dal sistema TECCO®



PROVE DI LABORATORIO



Resistenza delle reti:

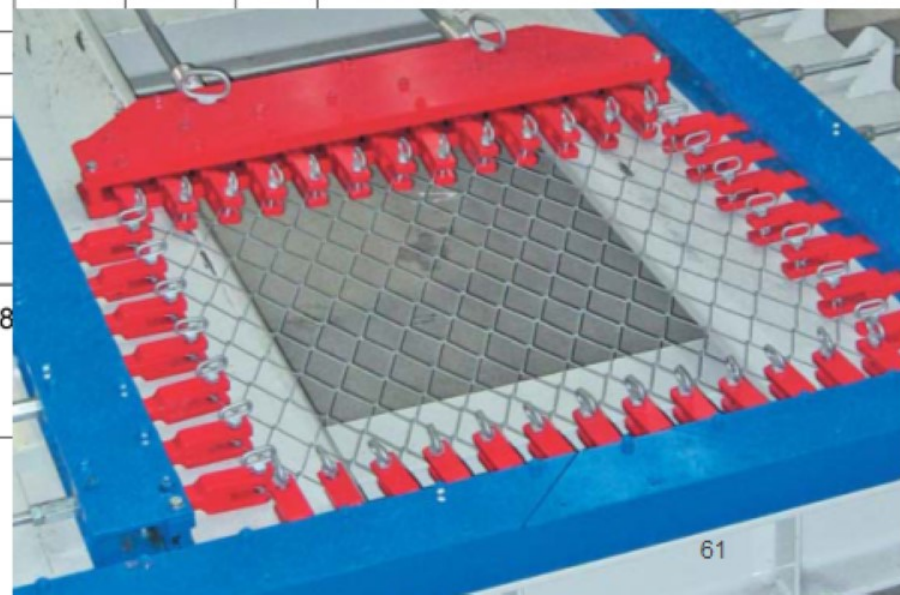
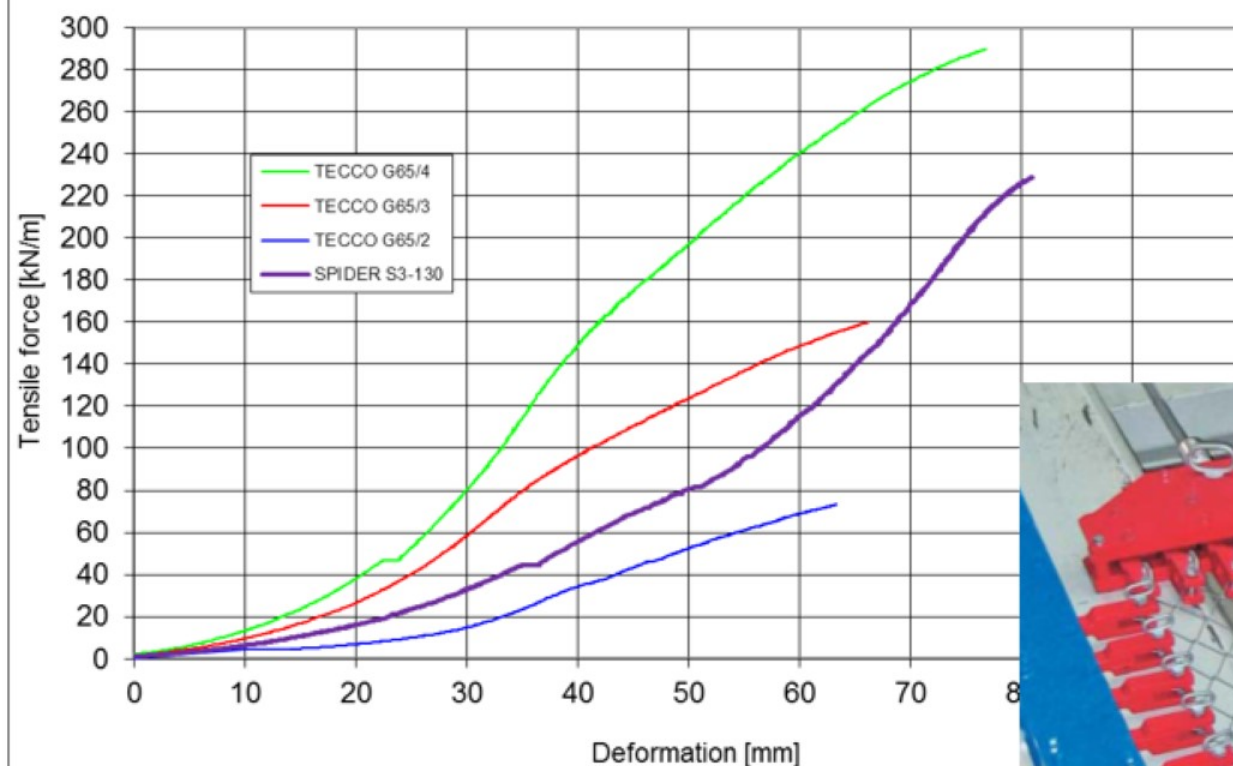
... come base per RUVOLUM®

Resistenza delle reti	TECCO® G65/2	TECCO® G65/3	TECCO® G65/4	SPIDER® S3- 130
Piastra	P33	P33 / P66	P33 / P66	P33 / P66
Taglio al bordo superiore della piastra P_R [kN]	40	90 / 120	140 / 185	115 / 150
Punzonamento della rete da parte della piastra $2 \times P_R$ [kN]	80	180 / 240	280 / 370	230 / 300
Capacità di trasmissione delle azioni parallelamente al pendio Z_R [kN]	10	30 / 45	50 / 75	45 / 70

parametri che possono essere ritrovati nelle verifiche

Test di resistenza a trazione per controllo qualità

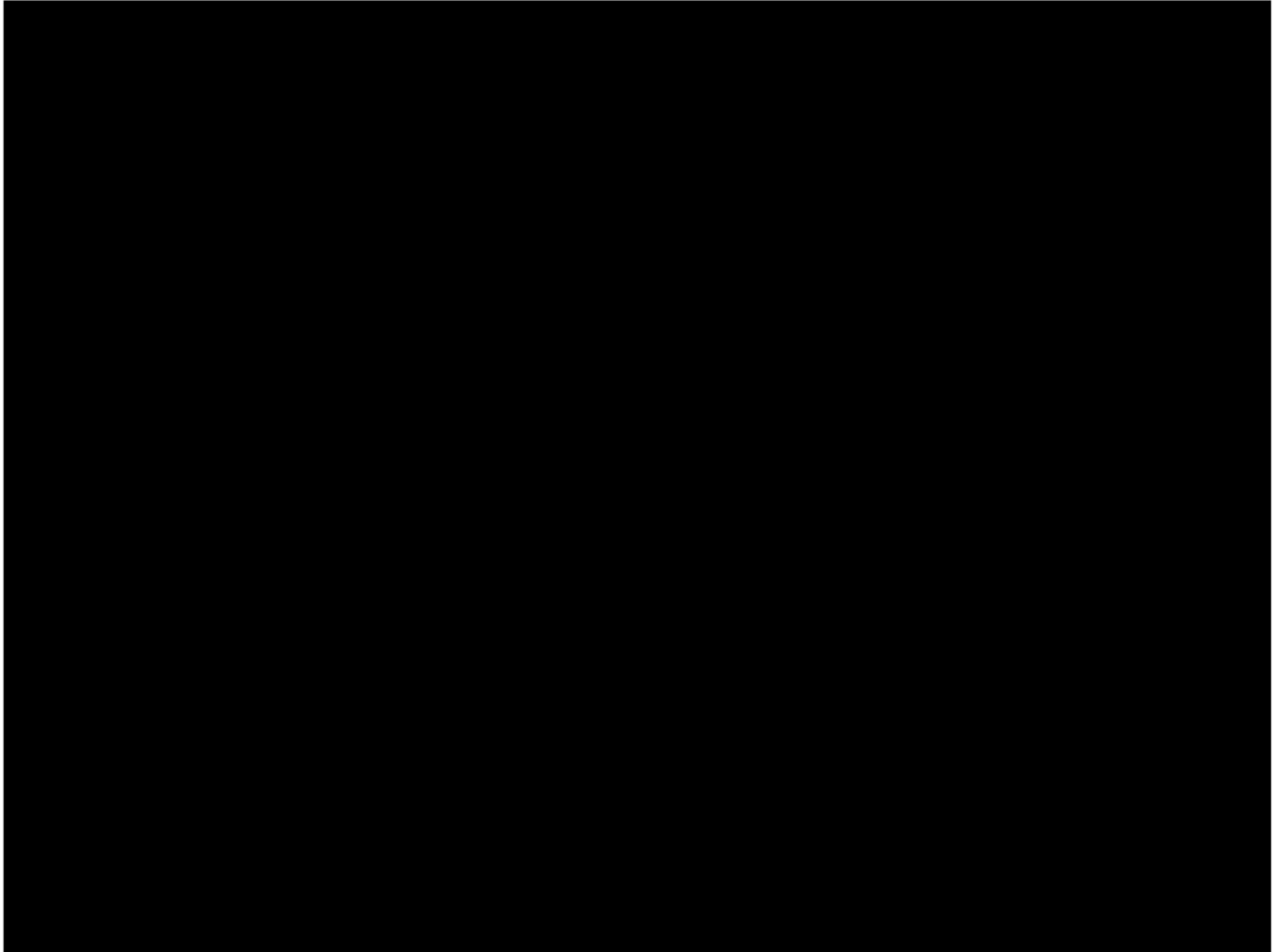
High-tensile steel wire meshes TECCO G65/2, G65/3 and G65/4 plus
SPIDER S3-130
Tensile tests in longitudinal direction



PROVE DI PERFORMANCE



PROVE DI PERFORMANCE



Condizioni al contorno:

Ghiaia lavata 16/32 mm
angolo di natural declivio = 33°

Vantaggi del materiale:

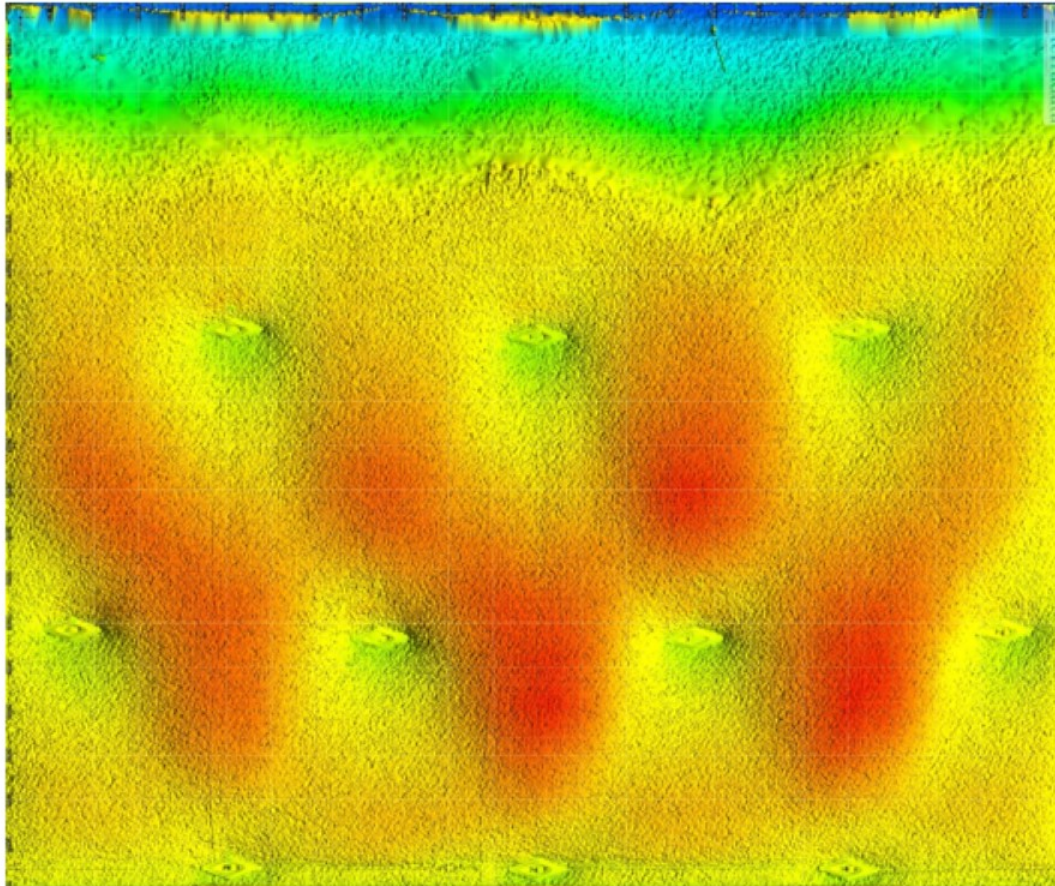
- Non ci sono rotture improvvise
- Non c'è influenza di altri parametri come la coesione
- Scenario “*worst case*” a causa del basso angolo di attrito
- Possibilità di ripetere i test in condizioni molto simili



PROVE DI PERFORMANCE



ANALISI DI MECCANISMI DI SCIVOLAMENTO REALI



Test # 12, 19.06.2013

TECCO G65/4 + P66

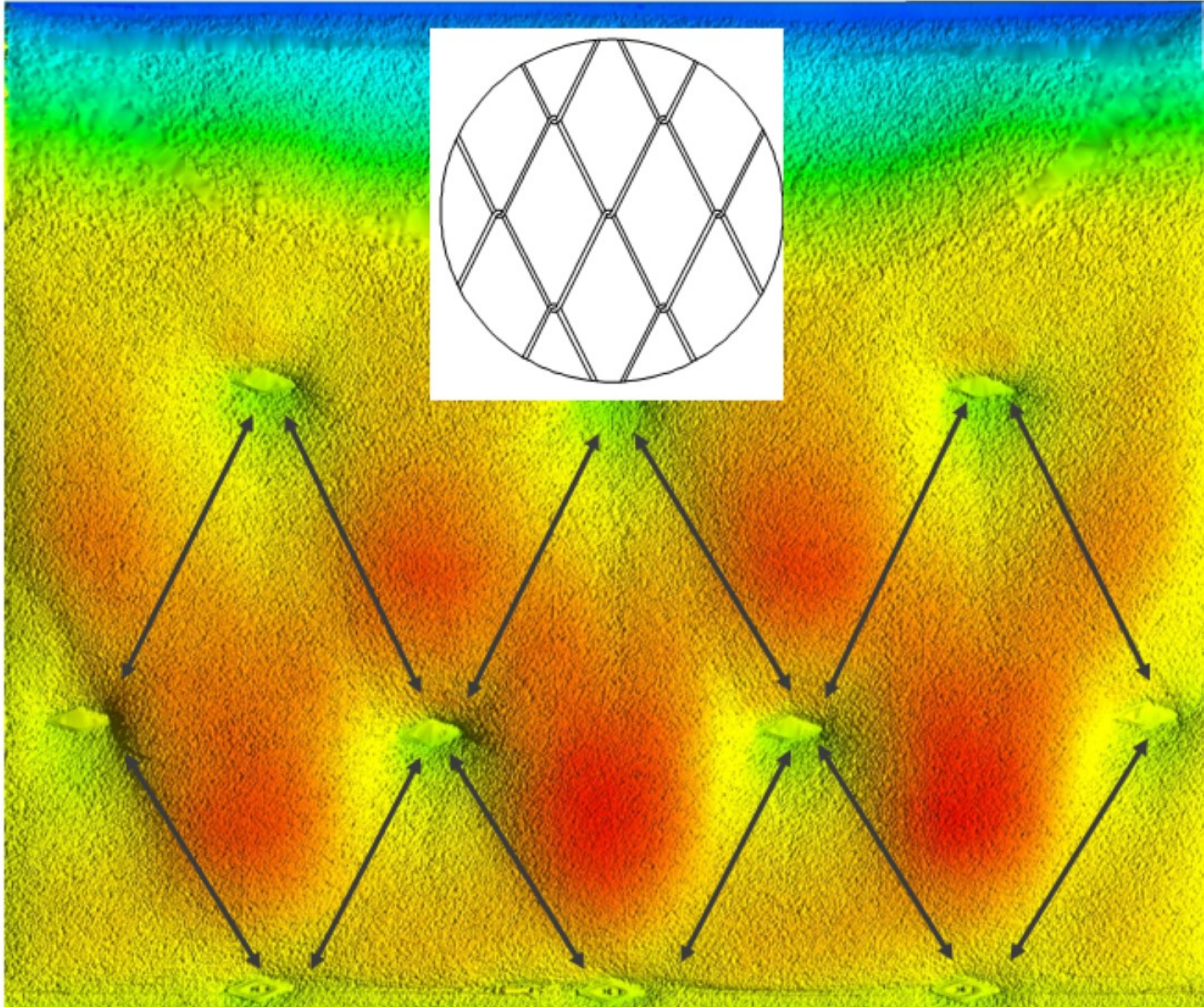
$a = b = 3.5 \text{ m}$

Ghiaia di fiume

Fuso 16...32 mm

$\alpha = 60^\circ$

ANALISI DI MECCANISMI DI SCIVOLAMENTO REALI



Test # 14, 03.07.2013, TECCO G65/3 + P66



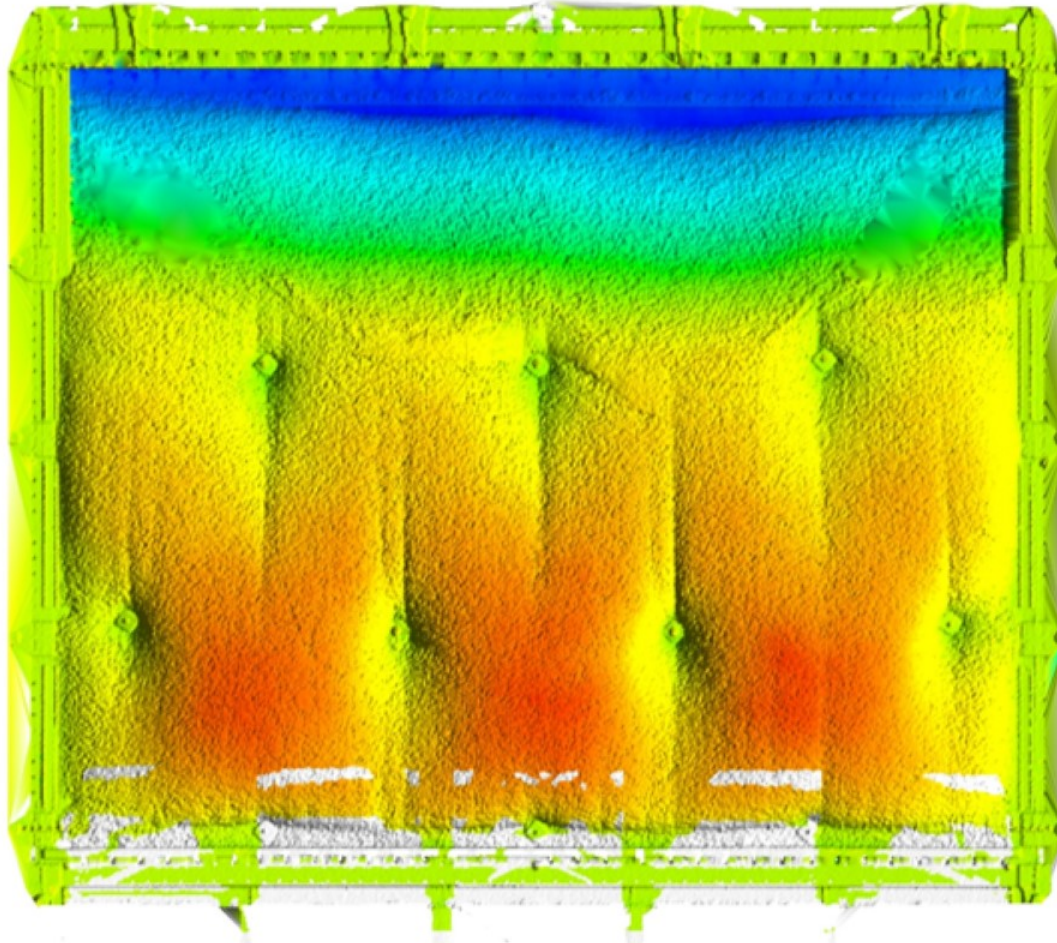
Test # 7, 20.03.2013, rete ibrida, $a = b = 3.5$ m
Ghiaia di fiume, fuso 16...32 mm

Rete Ibrid



Test # 7, 20.03.2013, rete ibrida, $a = b = 3.5$ m

Ghiaia di fiume, fuso 16...32 mm



Test # 7, 20.03.2013

Rete Ibrida

$a = b = 3.5 \text{ m}$

Ghiaia di fiume

Fuso 16...32 mm

ALTRI SISTEMI – MODELLI DIVERSI

Rete ibrida



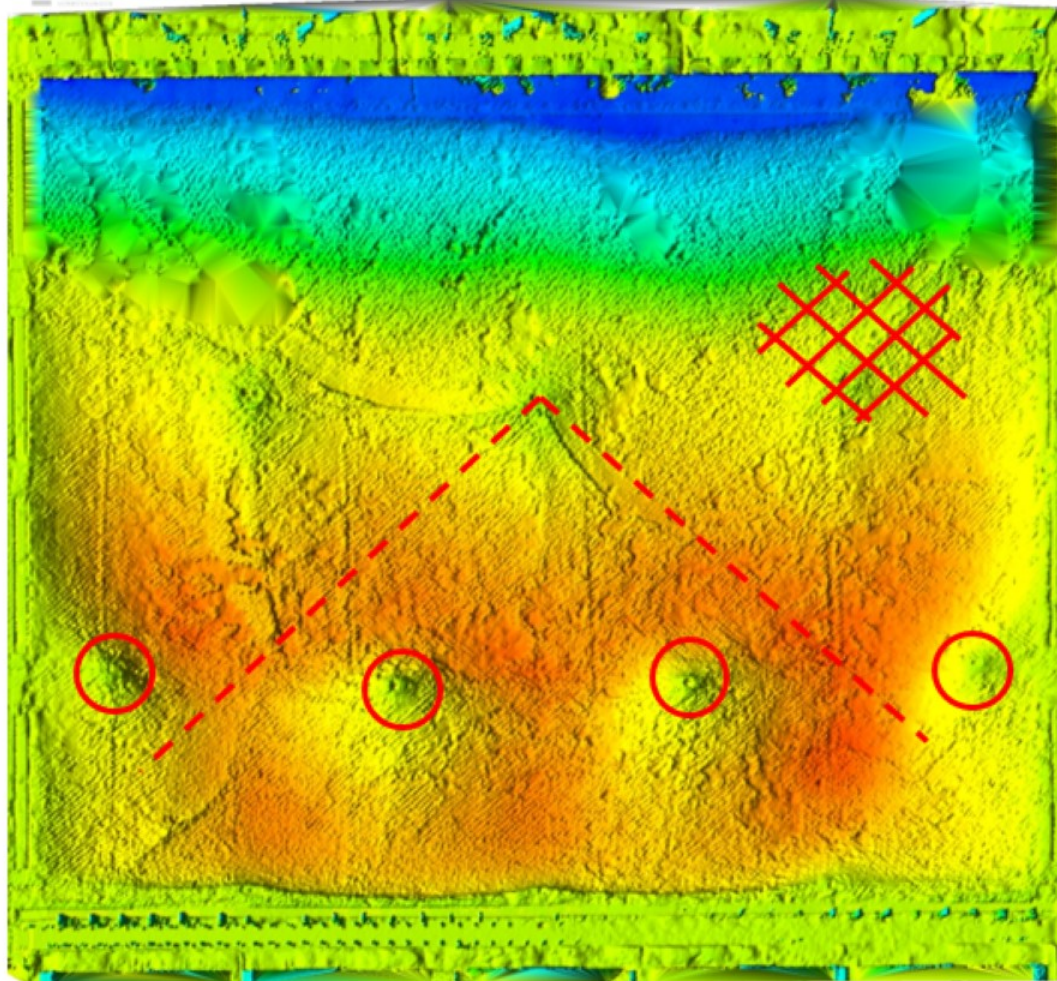
Rete in acciaio 550 N/mm² 50 x 50 x 4.6 mm





Test # 8, 26.03.2013, rete in acciaio 550 N/mm² , 50 x 50, 4.6 mm
a = b = 3.5 m, ghiaia di fiume, fuso 16...32 mm

terradata



Test # 8, 26.03.2013

Rete in acciaio 550 N/mm

50 x 50, 4.6 mm

$a = b = 3.5 \text{ m}$

Ghiaiai di fiume

Fuso 16...32 mm

ALTRI SISTEMI – MODELLI DIVERSI

Rete in acciaio 550 N/mm² 50 x 50 x 4.6 mm





IL MODELLO DI CALCOLO RUVOLUM

www.geobrugg.com/mygeobrugg

IL MODELLO DI CALCOLO RUVOLUM

Ruvolum® - The program to dimension the slope stabilization system TECCO®/ SPIDER®

Ruvolum Online Tool, Version 2014

Save

Load

Print

Full screen

Units

EN

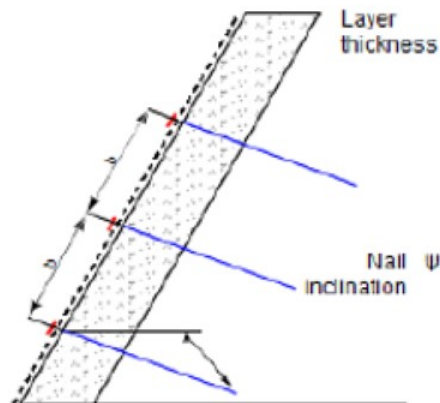


Project No.

Project Name

Date, Author

Cross-section:



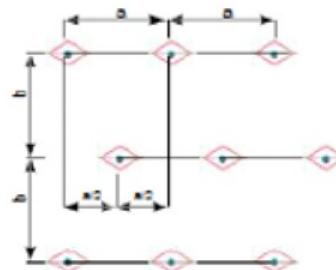
Layer thickness

$t = 1.00$ m

Nail inclination $\psi = 20.0$ degrees

Slope inclination $\alpha = 60.0$ degrees

View nail arrangement:



Mesh and spike plate type

TECCO® G65/3 + P33

About nailing

Variation a = b

Nail distance horizontal $a = 2.70$ m

Nail distance in line of slope $b = 2.70$ m

GEWI D = 28 mm

with rusting away

Dimensioning quantities

$\Phi_0 = 26.6$ degrees

$c_0 = 0.0$ kN/m²

$\gamma_s = 20.0$ kN/m³

Control:

Proofs of the mesh OK (0.73)

Proofs of the nails OK (0.95)

Friction angle ground (characteristic value)

$\Phi_k = 32.0$ degrees

Volume weight ground (characteristic value)

$\gamma_k = 20.0$ kN/m³

Load cases

Defaults

Safety factors

Nail types

Elements of the system

Proof of bearing safety

IL MODELLO DI CALCOLO RUVOLUM

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Ruvolum Online Tool, Version 2014

Save Load Print Full screen Units **EN**

Project No. 2013001
Project Name Winterthur
Date, Author 04.11.2013, D. Flum
Cross-section:

Layer thickness $t = 1.00$ m
Nail inclination $\psi = 20.0$ degrees
Slope inclination $\alpha = 60.0$ degrees

View nail array

EN
DE
ES
PL
PT
RO
RU
CN
FR

Mesh and spike plate type
TECCO® G65/3 + P33

About nailing
Variation a = b
Nail distance horizontal $a = 2.70$ m
Nail distance in line of slope $b = 2.70$ m
GEWI D = 28 mm
with rusting away

Dimensioning quantities
 $\Phi_c = 26.6$ degrees
 $c_0 = 0.0$ kN/m²
 $\gamma_0 = 20.0$ kN/m³

Control:
Proofs of the mesh OK
Proofs of the nails OK

Friction angle ground (characteristic value) $\Phi_k = 32.0$ degrees
Volume weight ground (characteristic value) $\gamma_k = 20.0$ kN/m³

Load cases Defaults Safety factors Nail types Elements of the system Proof of bearing safety

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Ruvolum® - The program to dimension the slope stabilization system TECCO®/ SPIDER®

Ruvolum Online Tool, Version 2014

Save Load Print Full screen Units

EN

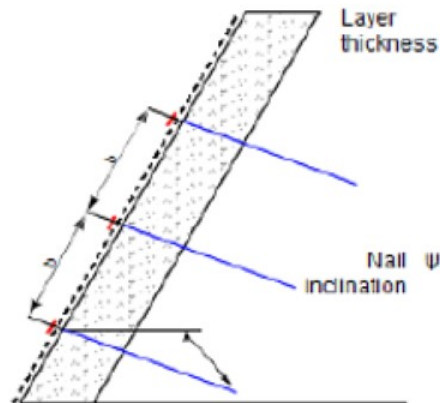


Project No. 12345-12345

Project Name Prova Sicilia

Date, Author Gennaio 2014 - G. Guasti

Cross-section:

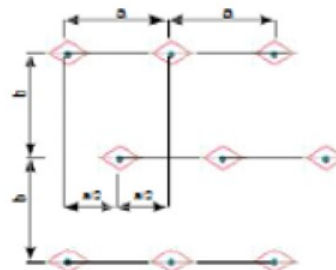


Layer thickness $t = 1.00$ m

Nail inclination $\psi = 20.0$ degrees

Slope inclination $\alpha = 60.0$ degrees

View nail arrangement:



Mesh and spike plate type

TECCO® G65/3 + P33

About nailing

Variation a = b

Nail distance horizontal $a = 2.70$ m

Nail distance in line of slope $b = 2.70$ m

GEWI D = 28 mm

with rusting away

Dimensioning quantities

$\Phi_0 = 26.6$ degrees

$c_0 = 0.0$ kN/m²

$\gamma_s = 20.0$ kN/m³

Control:

Proofs of the mesh OK (0.73)

Proofs of the nails OK (0.95)

Friction angle ground (characteristic value)

$\Phi_k = 32.0$ degrees

Volume weight ground (characteristic value)

$\gamma_k = 20.0$ kN/m³

Load cases

Defaults

Safety factors

Nail types

Elements of the system

Proof of bearing safety

IL MODELLO DI CALCOLO RUVOLUM

Ruvolum® - The program to dimension the slope stabilization system TECCO®/ SPIDER®

Ruvolum Online Tool, Version 2014

Save

Load

Print

Full screen

Units

EN

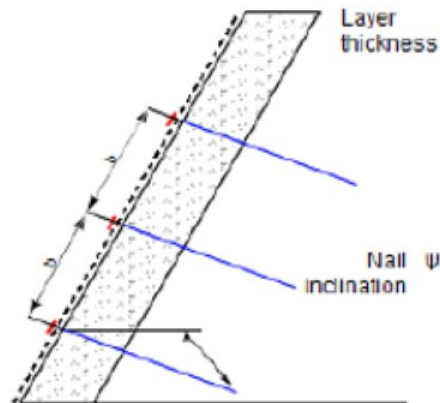


Project No. 12345-12345

Project Name Prova Sicilia

Date, Author Gennaio 2014 - G. Guasti

Cross-section:



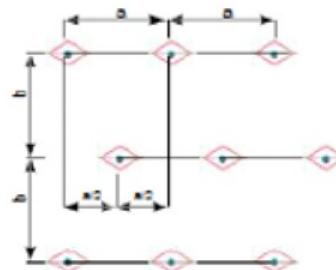
Layer thickness

$t = 1.00$ m

Nail $\psi = 20.0$ degrees

Slope inclination $\alpha = 60.0$ degrees

View nail arrangement:



Mesh and spike plate type

TECCO® G65/3 + P33

About nailing

Variation $a = b$

Nail distance horizontal $a = 2.70$ m

Nail distance in line of slope $b = 2.70$ m

GEWI D = 28 mm

with rusting away

Dimensioning quantities

$\Phi_0 = 26.6$ degrees

$c_0 = 0.0$ kN/m²

$\gamma_0 = 20.0$ kN/m³

Control:

Proofs of the mesh OK (0.73)

Proofs of the nails OK (0.95)

Friction angle ground (characteristic value)

$\Phi_k = 32.0$ degrees

Volume weight ground (characteristic value)

$\gamma_k = 20.0$ kN/m³

Load cases

Defaults

Safety factors

Nail types

Elements of the system

Proof of bearing safety

IL MODELLO DI CALCOLO RUVOLUM

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Ruvolum Online Tool, Version 2014

Save Load Print Full screen Units

EN

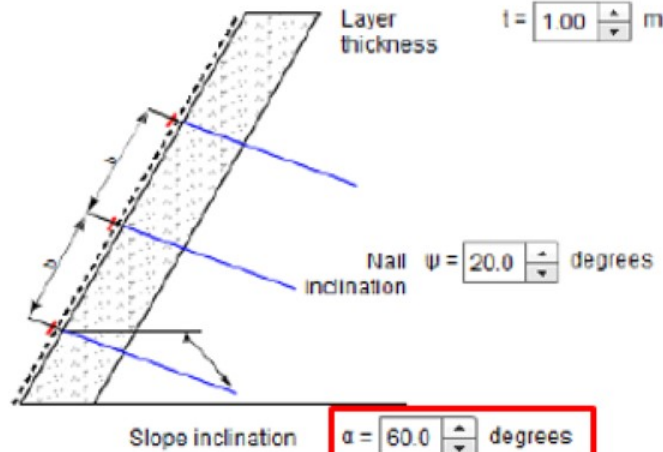


Project No. 12345-12345

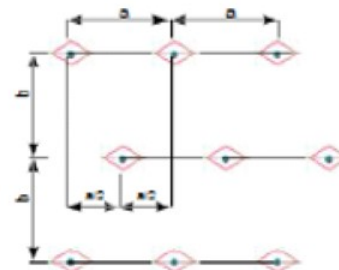
Project Name Prova Sicilia

Date, Author Gennaio 2014 - G. Guasti

Cross-section:



View nail arrangement:



Mesh and spike plate type

TECCO® G65/3 + P33

About nailing

Variation a = b

Nail distance horizontal $a = 2.70$ m

Nail distance in line of slope $b = 2.70$ m

GEWI D = 28 mm

with rusting away

Dimensioning quantities

$\Phi_0 = 26.6$ degrees

$c_0 = 0.0$ kN/m²

$\gamma_s = 20.0$ kN/m³

Control:

Proofs of the mesh OK (0.73)

Proofs of the nails OK (0.95)

Load cases

Defaults

Safety factors

Nail types

Elements of the system

Proof of bearing safety

IL MODELLO DI CALCOLO RUVOLUM

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Ruvolum Online Tool, Version 2014

Save Load Print Full screen Units

EN

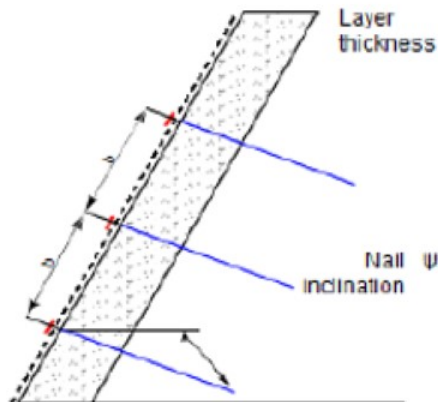


Project No. 12345-12345

Project Name Prova Sicilia

Date, Author Gennaio 2014 - G. Guasti

Cross-section:



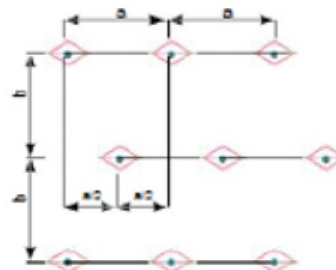
Layer thickness

$t = 1.00$ m

Nail $\psi = 20.0$ degrees

Slope inclination $\alpha = 60.0$ degrees

View nail arrangement:



Mesh and spike plate type

TECCO® G65/3 + P33

About nailing

Variation $a = b$

Nail distance horizontal $a = 2.70$ m

Nail distance in line of slope $b = 2.70$ m

GEWI D = 28 mm

with rusting away

Dimensioning quantities

$\Phi_0 = 26.6$ degrees

$c_0 = 0.0$ kN/m²

$\gamma_s = 20.0$ kN/m³

Control:

Proofs of the mesh OK (0.73)

Proofs of the nails OK (0.95)

Friction angle ground (characteristic value)

$\Phi_k = 32.0$ degrees

Volume weight ground (characteristic value)

$\gamma_k = 20.0$ kN/m³

Load cases

Defaults

Safety factors

Nail types

Elements of the system

Proof of bearing safety

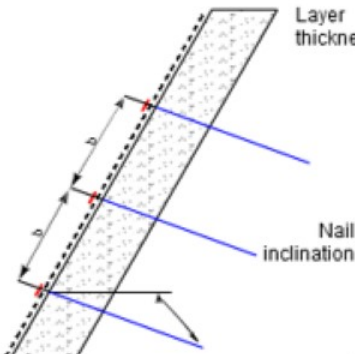
IL MODELLO DI CALCOLO RUVOLUM

Ruvolum® - The program to dimension the slope stabilization system TECCO®/ SPIDER®

Ruvolum Online Tool, Version 2014

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Project No. 2013001
Project Name Winterthur
Date, Author 04.11.2013, D. Flum
Cross-section:



Layer thickness
Nail inclination
Slope inclination $\alpha = 60.0$ degrees

Mesh and spike plate type

TECCO® G65/3 + P33

TECCO® G65/2 + P33
TECCO® G65/3 + P33
TECCO® G65/3 + P66
TECCO® G65/4 + P33
TECCO® G65/4 + P66
SPIDER® S3 - 130 + P33

Mesh and spike plate type
TECCO® G65/3 + P33

About nailing
Variation a = b
Nail distance horizontal a = 2.70 m
Nail distance in line of slope b = 2.70 m
GEWI D = 28 mm
with rusting away

Dimensioning quantities
 $\Phi_c = 26.6$ degrees
 $c_0 = 0.0$ kN/m²
 $\gamma_0 = 20.0$ kN/m³

Control:
Proofs of the mesh OK
Proofs of the nails OK

Friction angle ground (characteristic value) $\Phi_k = 32.0$ degrees
Volume weight ground (characteristic value) $\gamma_k = 20.0$ kN/m³

Load cases Defaults Safety factors Nail types Elements of the system Proof of bearing safety

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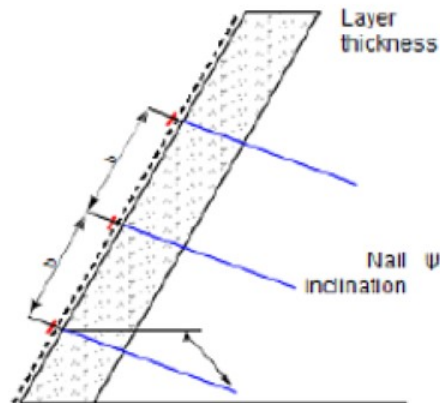


Project No. 12345-12345

Project Name Prova Sicilia

Date, Author Gennaio 2014 - G. Guasti

Cross-section:

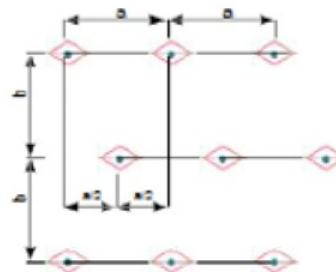


Layer thickness $t = 1.00$ m

Nail inclination $\psi = 20.0$ degrees

Slope inclination $\alpha = 60.0$ degrees

View nail arrangement:



Mesh and spike plate type

TECCO® G65/3 + P33

About nailing

Variation a = b

Nail distance horizontal $a = 2.70$ m

Nail distance in line of slope $b = 2.70$ m

GEWI D = 28 mm

with rusting away

Dimensioning quantities

$\Phi_0 = 26.6$ degrees

$c_0 = 0.0$ kN/m²

$\gamma_s = 20.0$ kN/m³

Control:

Proofs of the mesh OK (0.73)

Proofs of the nails OK (0.95)

Load cases

Defaults

Safety factors

Nail types

Elements of the system

Proof of bearing safety

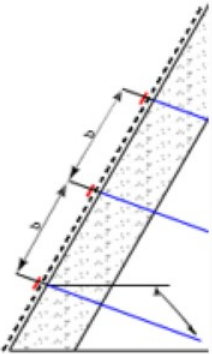
IL MODELLO DI CALCOLO RUVOLUM

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Project No. 201301
Project Name Winter
Date, Author 04.11.2
Cross-section:



Slope inclin

GEWI D = 28 mm
GEWI D = 25 mm
GEWI D = 28 mm
GEWI D = 32 mm
GEWI D = 40 mm
TITAN 30/11
TITAN 40/16

Friction angle ground (characteristic value) $\Phi_k = 32.0$ degrees
Volume weight ground (characteristic value) $\gamma_k = 20.0$ kN/m³

Mesh and spike plate type
TECCO® G65/3 + P33

About nailing
Variation a = b
Nail distance horizontal a = 2.70 m
Nail distance in line of slope b = 2.70 m
GEWI D = 28 mm
with rusting away

Dimensioning quantities
 $\Phi_c = 26.6$ degrees
 $c_0 = 0.0$ kN/m²
 $\gamma_0 = 20.0$ kN/m³

Control:
Proofs of the mesh OK
Proofs of the nails OK

Load cases Defaults Safety factors Nail types Elements of the system Proof of bearing safety

IL MODELLO DI CALCOLO RUVOLUM

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Ruvolum Online Tool, Version 2014

Save Load Print Full screen Units

EN

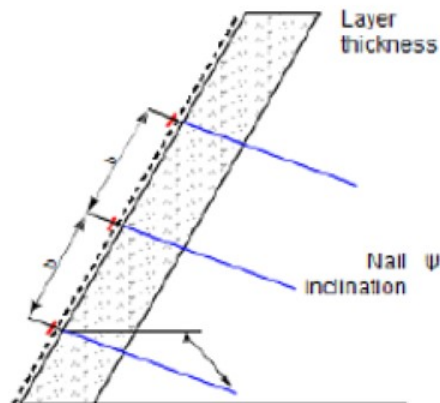


Project No. 12345-12345

Project Name Prova Sicilia

Date, Author Gennaio 2014 - G. Guasti

Cross-section:

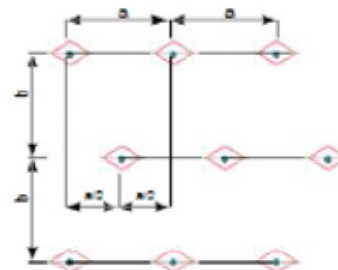


Layer thickness $t = 1.00$ m

Nail inclination $\psi = 20.0$ degrees

Slope inclination $\alpha = 60.0$ degrees

View nail arrangement:



Mesh and spike plate type

TECCO® G65/3 + P33

About nailing

Variation a = b

Nail distance horizontal $a = 2.70$ m

Nail distance in line of slope $b = 2.70$ m

GEWI D = 28 mm

with rusting away

Dimensioning quantities

$\Phi_0 = 26.6$ degrees

$c_0 = 0.0$ kN/m²

$\gamma_s = 20.0$ kN/m³

Control:

Proofs of the mesh OK (0.73)

Proofs of the nails OK (0.95)

Friction angle ground (characteristic value)

$\Phi_k = 32.0$ degrees

Volume weight ground (characteristic value)

$\gamma_k = 20.0$ kN/m³

Load cases

Defaults

Safety factors

Nail types

Elements of the system

Proof of bearing safety

IL MODELLO DI CALCOLO RUVOLUM

Ruvolum® The program to dimension the slope stabilization system TECCO®/ SPIDER®

Ruvolum Online Tool, Version 2014

Save

Load

Print

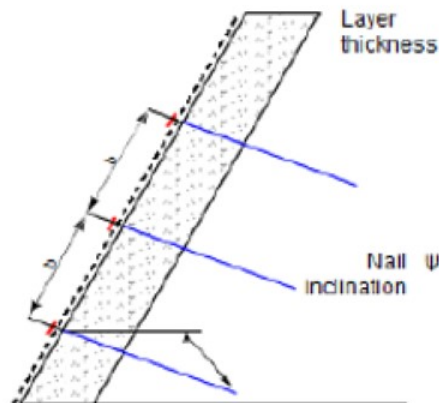
Full screen

Units

EN

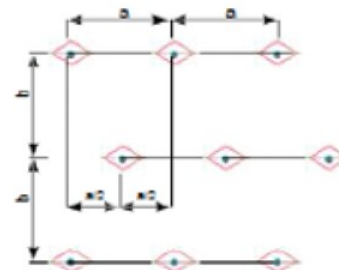
Project No.
Project Name
Date, Author

Cross-section:



Slope inclination $\alpha = 60.0$ degrees

View nail arrangement:



Mesh and spike plate type

TECCO® G55/3 + P33

About nailing

Variation a = b

Nail distance horizontal $a = 2.70$ m

Nail distance in line of slope $b = 2.70$ m

GEW D = 28 mm

with rusting away

Dimensioning quantities

$\Phi_0 = 26.6$ degrees

$c_0 = 0.0$ kN/m²

$\gamma_s = 20.0$ kN/m³

Control:

Proofs of the mesh OK (0.73)

Proofs of the nails OK (0.95)

Load cases

Defaults

Safety factors

Nail types

Elements of the system

Proof of bearing safety

IL MODELLO DI CALCOLO RUVOLUM

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Ruvolum Online Tool, Version 2014

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Project No. 2013001
Project Name Winterthur
Date, Author 04.11.2013, D. Flum
Cross-section: View nail arrangement:

Layer thickness $t = 1.00$ m

Mesh and spike plate type
TECCO® G65/3 + P33

About nailing
Variation a = b
Nail distance horizontal $a = 2.70$ m
Nail distance in line of slope $b = 2.70$ m

W D = 28 mm
rusting away

Dimensioning quantities
26.6 degrees
0.0 kN/m²
0.0 kN/m³

Control:
s of the mesh OK
s of the nails OK

Load cases

Earthquake:No

Coefficient of horizontal acceleration due to earthquake $\epsilon_h = 0.175$ [-]

Coefficient of vertical acceleration due to earthquake $\epsilon_v = 0.085$ [-]

Streaming pressure:No

Load cases Defaults Safety factors Nail types Elements of the system Proof of bearing safety

IL MODELLO DI CALCOLO RUVOLUM

Ruvolum® - The program to dimension the slope stabilization system TECCO®/ SPIDER®

Ruvolum Online Tool, Version 2014

Save Load Print Full screen Units EN

Project No. 2013001
Project Name Winterthur
Date, Author 04.11.2013, D. Flum
Cross-section: View nail arrangement

Layer t = 1.00 m

Defaults

Cohesion ground (characteristic value)	c_k	=	0.0	kN/m ²
Radius of pressure cone, top	ζ	=	0.15	m
Inclination of pressure cone to horizontal	δ	=	45.0	degrees
Slope-parallel force	Z_d	=	15.0	kN
Pretensioning force of the system	V	=	30.0	kN

Mesh and spike plate type
TECCO® G65/3 + P33

About nailing
Variation a = b
Nail distance horizontal a = 2.70 m
Nail distance in line of slope b = 2.70 m
GEWI D = 28 mm
with rusting away

Dimensioning quantities
 Φ_d = 26.6 degrees
 c_0 = 0.0 kN/m²
 γ_0 = 20.0 kN/m³

Control:
Proofs of the mesh OK
Proofs of the nails OK

Load cases Defaults Safety factors Nail types Elements of the system Proof of bearing safety

IL MODELLO DI CALCOLO RUVOLUM

Ruvolum® - The program to dimension the slope stabilization system TECCO®/ SPIDER®

Ruvolum Online Tool, Version 2014

Save Load Print Full screen Units EN

Project No. 2013001
Project Name Winterthur
Date, Author 04.11.2013, D. Flum
Cross-section: View nail arrangement

Layer thickness $t = 1.00$ m

Mesh and spike plate type
TECCO® G65/3 + P33

About nailing
Variation a = b
Nail distance horizontal a = 2.70 m
Nail distance in line of slope b = 2.70 m

Safety factors

Partial safety correction value for friction angle	$\gamma_\phi = 1.25$ [-]
Partial safety correction value for volume weight	$\gamma_Y = 1.00$ [-]
Partial safety correction value for cohesion	$\gamma_c = 1.25$ [-]
Model uncertainty correction value	$\gamma_{mod} = 1.10$ [-]

Load cases Defaults **Safety factors** Nail types Elements of the system Proof of bearing safety

IL MODELLO DI CALCOLO RUVOLUM

Nail types

Nail characteristics

Nail Type	Active / Non Active	D _E [mm]	D _I [mm]	Δ [mm]	f _y [N/mm ²]	f _t [N/mm ²]	G [kN/m]
GEWI D = 20 mm	☒	20	0	4	500	550	2.47
GEWI D = 25 mm	☒	25	0	4	500	550	3.85
GEWI D = 28 mm	☒	28	0	4	500	550	4.83
GEWI D = 32 mm	☒	32	0	4	500	550	6.31
GEWI D = 40 mm	☒	40	0	4	500	550	9.87
TITAN 30/11	☒	26.2	11	4	580	0	3.3

Remark: In contrast to the values D_E, D_I, Δ and f_y, which are necessary for the calculations, the values f_t and G are only for information and will not be used for the proofs of bearing safety.

Cross section areas and bearing resistances

Nail Type	A _e [mm ²]	A _{red} [mm ²]	T _R [kN]	T _{Red} [kN]	τ _y [N/mm ²]	S _R [kN]	S _{Red} [kN]
GEWI D = 20 mm	314	201	157	101	289	91	58
GEWI D = 25 mm	491	346	246	173	289	142	100
GEWI D = 28 mm	616	452	308	226	289	178	130
GEWI D = 32 mm	804	616	402	308	289	232	178
GEWI D = 40 mm	1257	1018	629	509	289	363	294
TITAN 30/11	420	271	258	169	335	149	98

Signification of the variables

D_E External diameter for static calculations
D_I Inner diameter
Δ Reduction of the external diameter regarding rusting away
f_y Yield point by tensile stress
f_t Tensile strength
G Weight of the steel bar per meter

A Cross section area without rusting away
A_{red} Cross section area with rusting away
T_R = f_y · A Bearing resistance of nail to tensile stress without rusting away
T_{Red} = f_y · A_{red} Bearing resistance of nail to tensile stress with rusting away
τ_y = f_y / 3^{0.5} Yield point by shear stress
S_R = τ_y · A Bearing resistance of nail to shear stress without rusting away
S_{Red} = τ_y · A_{red} Bearing resistance of nail to shear stress with rusting away

Load cases

Defaults

Safety factors

Nail types

Elements of the system

Proof of bearing safety

GEOBRUGG®
BRUGG

Mesh and spike plate type

TECCO® G65/3 + P33

About nailing

Variation a = b

Nail distance horizontal a = 2.70 m

Nail distance in line of slope b = 2.70 m

GEWI D = 28 mm

with rusting away

Dimensioning quantities

Φ_s = 26.6 degrees

c_s = 0.0 kN/m²

γ_s = 20.0 kN/m³

Control:

Proofs of the mesh OK

Proofs of the nails OK

IL MODELLO DI CALCOLO RUVOLUM

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Ruvolum Online Tool, Version 1.0.0

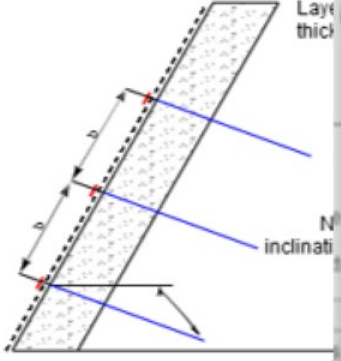
Save Load Print

Project No.

Project Name

Date, Author

Cross-section:



Slope inclination $\alpha =$

Friction angle ground (characteristic value) $\phi =$

Volume weight ground (characteristic value) $\gamma =$

Layer thickness $t =$

Nail inclination $\beta =$

Elements of the system

Applied mesh type

Applied spike plate

Bearing resistance of mesh to selective, slope parallel tensile stress Z_R [kN] =

Bearing resistance of mesh to pressure stress in nail direction D_R [kN] =

Bearing resistance of mesh against shearing-off in nail direction P_R [kN] =

Applied nail type

Taking into account rusting away

Bearing resistance of nail to tensile stress T_{Red} [kN] =

Bearing resistance of nail to shear stress S_{Red} [kN] =

Cross-section surface of the applied nail with / without rusting away A_{red} [mm²] =

OK OK

Load cases Defaults Safety factors Nail types **Elements of the system** Proof of bearing safety

Revolum Online Tool, Version 2.114

Save Load Print Fullscreen Exit

Proof of bearing safety

Investigation of local instabilities between single nails

Proof of the mesh against shearing-off at the upslope edge of the spike plate

Maximum stress on the mesh for shearing-off in nail direction at the upslope edge of the spike plate (dimensioning level) P_s [kN] = 44.0

Thickness of decisive sliding mechanism t_{sl} [m] = 0.85

Bearing resistance of the mesh against shearing-off in nail direction at the upslope edge of the spike plate (characteristic value) P_R [kN] = 90.0

Resistance correction value for shearing-off of the mesh γ_{PR} [-] = 1.5

Dimensioning value of the bearing resistance of the mesh against shearing-off $P_{n/\gamma_{PR}}$ [kN] = 60.0

Proof of bearing safety $P_s \leq P_{n/\gamma_{PR}}$ Fulfilled

Proof of the mesh to selective transmission of the force Z onto the nail

Slope parallel force taken into account in the equilibrium considerations Z_s [kN] = 15.0

Bearing resistance of the mesh to selective, slope-parallel tensile stress Z_R [kN] = 30.0

Resistance correction value for selective, slope-parallel transmission of the force Z γ_{ZR} [-] = 1.5

Dimensioning value of the bearing resistance of the mesh to tensile stress $Z_{n/\gamma_{ZR}}$ [kN] = 20.0

Proof of bearing safety $Z_s \leq Z_{n/\gamma_{ZR}}$ Fulfilled

Investigation of slope-parallel instabilities

Proof of the nail against sliding-off of a superficial layer parallel to the slope

Pretensioning force effectively applied on nail V [kN] = 30.0

Load factor for positive influence of pretension V_{II} [-] = 0.8

Dimensioning value of the applied pretensioning force by positive influence of V V_{II} [kN] = 24.0

Calculated required shear force at dimensioning level in function of V_{II} S_{II} [kN] = 78.2

Bearing resistance of the nail to shear stress S_{Rsd} [kN] = 130.0

Resistance correction value for shearing-off of the nail γ_{SR} [-] = 1.5

Dimensioning value of the bearing resistance of the nail to shear stress $S_{Rsd/\gamma_{SR}}$ [kN] = 86.7

Proof of bearing safety $S_{II} \leq S_{Rsd/\gamma_{SR}}$ Fulfilled

Proof of the mesh against puncturing

Pretensioning force effectively applied on nail V [kN] = 30.0

Load factor for negative influence of pretension V_{II} [-] = 1.5

Dimensioning value of the applied pretensioning force by negative influence of V V_{II} [kN] = 45.0

Bearing resistance of the mesh to pressure stress in nail direction D_R [kN] = 180.0

Resistance correction value for puncturing γ_{DR} [-] = 1.5

Dimensioning value of the bearing resistance of the mesh to pressure stress $D_{n/\gamma_{DR}}$ [kN] = 120.0

Proof of bearing safety $V_{II} \leq D_{n/\gamma_{DR}}$ Fulfilled

Mesh and spike plate type

TECCO® G65/G3 + P33

Spout nailing

Variation $a = b$

Nail distance horizontal $a = 2.70$ m

Nail distance in line of slope $b = 2.70$ m

Nail diameter $\phi = 28$ mm

Nail with rusting away

Dimensioning quantities

 $\alpha = 26.6$ degrees

 $\gamma = 0.0$ kN/m²
 $\gamma = 20.0$ kN/m³

Control:

Boards of the mesh OK (0.73)

Boards of the nails OK (0.95)

Proof of bearing safety

Proof of bearing safety

Resistance correction value for tensile stress γ_{TR} [-] = 1.5

Resistance correction value for shear stress γ_{SR} [-] = 1.5

Proof of bearing safety $[\gamma_{TR}/(T_{Rsd}/\gamma_{TR})]^2 + [S_{II}/(S_{Rsd}/\gamma_{SR})]^2 \leq 1.0$ 0.95 Fulfilled

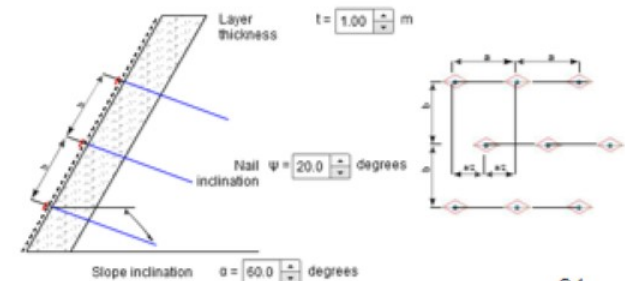
Proof of bearing safety $[\gamma_{TR}/(T_{Rsd}/\gamma_{TR})]^2 + [S_{II}/(S_{Rsd}/\gamma_{SR})]^2 \leq 1.0$ 0.95 Fulfilled

Minimal tensile strength in the nail for superficial instabilities

Dimensioning value of the static equivalent tensile force in the nail for determination of the nail length T_s [kN] = 156.4

Cross-section:

View nail arrangement:



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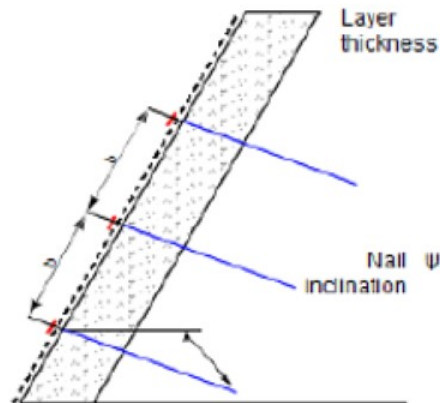


Project No. 12345-12345

Project Name Prova Sicilia

Date, Author Gennaio 2014 - G. Guasti

Cross-section:

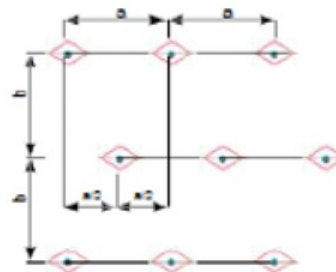


Layer thickness $t = 1.00$ m

Nail inclination $\psi = 20.0$ degrees

Slope inclination $\alpha = 60.0$ degrees

View nail arrangement:



Mesh and spike plate type

TECCO® G65/3 + P33

About nailing

Variation a = b

Nail distance horizontal $a = 2.70$ m

Nail distance in line of slope $b = 2.70$ m

GEWI D = 28 mm

with rusting away

Dimensioning quantities

$\Phi_d = 26.6$ degrees

$c_d = 0.0$ kN/m²

$\gamma_d = 20.0$ kN/m³

Control:

Proofs of the mesh OK (0.73)
Proofs of the nails OK (0.95)

Load cases

Defaults

Safety factors

Nail types

Elements of the system

Proof of bearing safety

IL MODELLO DI CALCOLO RUVOLUM

Ruvolum checklist

Dato che il dimensionamento dipende dai valori dei parametri geotecnici del pendio in frana, è stato elaborato un form per la raccolta dati, per standardizzare le informazioni necessarie

Il formulario include tutte le informazioni necessarie per la realizzazione del progetto, non solo quelle essenziali per il dimensionamento.

The Slope and Rock Stabilization System TECCO® / SPIDER® Checklist for Projects

Signs and symbols:
appropriate, relevant, existing;
not appropriate, irrelevant, not existing

Project:

Subsoil: Soil ☐
Terminology / classification ☐
Deposit density or consistency ☐
Terminology / classification ☐
Deposit density or consistency ☐
Rock ☐
Terminology ☐
Terminology ☐
Superficial weathered / loosened ☐
Medium to strongly fissured ☐
C: ☐ D: ☐

Geotechnical parameters: γ_s [kN/m³] c_k [kN/m²] ϕ_k [°]

	γ_s [kN/m ³]	c_k [kN/m ²]	ϕ_k [°]
A			
B			
C			
D			

Problem: Rock fall ☐
Erosion ☐
Superficial instabilities up to a depth of max. $z = 1.0 - 1.5$ m ☐
Possible sliding mechanisms with deep-seated sliding surfaces ☐
Ice formation ☐

Geometry / exposition: Total area to be stabilized
Maximum slope height
Length
Slope inclination actual state α_{act} °
Slope inclination after stabilizing α_{st} °
Altitude
Exposition (N, NE, E, SE, S, SW, W, NW)
Slope existing ☐
Location of the slope to be stabilized: up slope ☐
Location of the slope to be stabilized: down slope ☐

Water: Haildrainage ☐
Water along stratification or joint systems ☐
Springs ☐
Water flowing over the area to be stabilized ☐
Drainage measures required ☐

Active vegetation: Not required ☐
Required ☐
Adequate erosion control planned ☐

Stabilization measure: System TECCO® / SPIDER® ☐
- High tensile steel wire mesh ☐
- System slope plane ☐
- Adequate nailing ☐

Nailing: Preferred nail type: 1st choice
Preferred nail type: 2nd choice
Corrosion protection ☐
Considered nail distance horizontal $a =$
Considered nail distance in line of slope $b =$
Nail length $L =$

Load cases for the investigation of superficial instabilities: Screening pressure to be considered ☐
Accelerations due to earthquake to be considered ☐
Coefficient of horiz. acceleration due to earthquake $a_h =$
Coefficient of vertical acceleration due to earthquake $a_v =$

Documents: The following documents ought to be provided for an assessment ☐
Detailed cross-section (full-scale) including information about stratification and joints (in rock) and possible sliding mechanisms ☐
Situation (including the location of the cross-sections) ☐
Description of the subsoil ☐
Photographs ☐
Way of providing this information

Address:
Phone
Mobile
Fax
E-mail
Date & Signature

Client:
Phone
Mobile
Fax
E-mail

Project Engineer / Geology, Geotechnics:
Phone
Mobile
Fax
E-mail

Address of the system manufacturer: Geobrugg AG
Geotazard Solutions
Jachetstrasse 11
CH - 6260 Romanshorn, Switzerland
Phone: +41 71 666 61 22
Fax: +41 71 666 61 20
E-mail: info@geobrugg.com
Homepage: www.geobrugg.com

Remarks / Further documents:

IL MODELLO DI CALCOLO RUVOLUM

Ruvolum checklist

Il modello geotecnico cui Ruvolum® fa riferimento è il modello **Mohr – Coulomb**, quindi un terreno coesivo – attritivo.

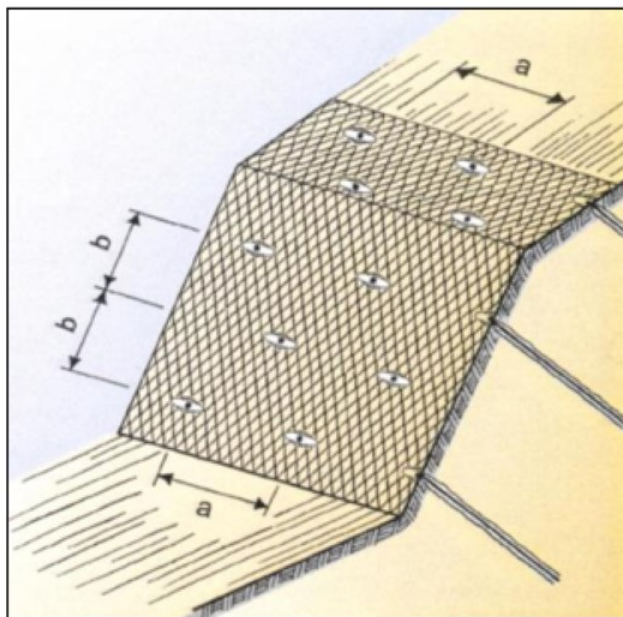
Quindi, è necessario avere dati solidi rispetto ai seguenti parametri:

1. Angolo di resistenza a taglio ϕ'
2. Coesione c , anche se abbiamo visto che è spesso posta pari a zero
3. Peso di volume γ
4. Spessore potenzialmente instabile t
5. Inclinazione del pendio α



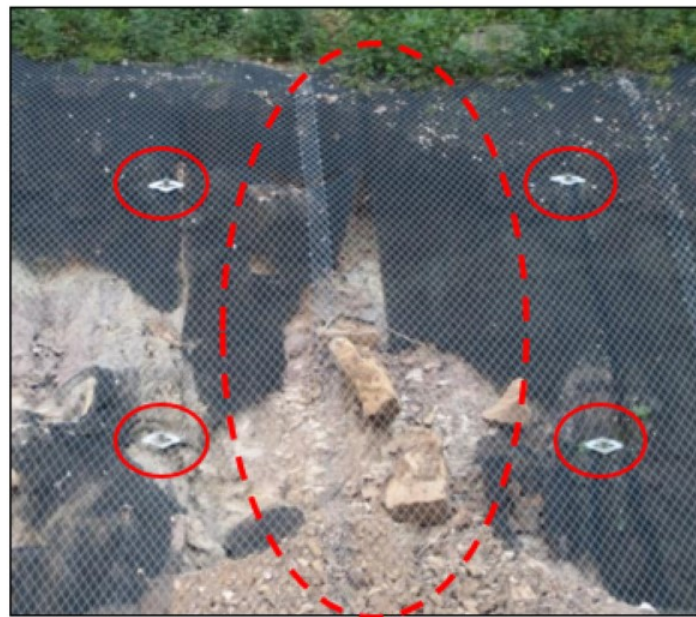
LA CORRETTA POSA IN OPERA

E' importante traslare le file di ancoraggi di un semi-interasse orizzontale



a = interasse orizzontale

b = interasse verticale



Da evitare!!

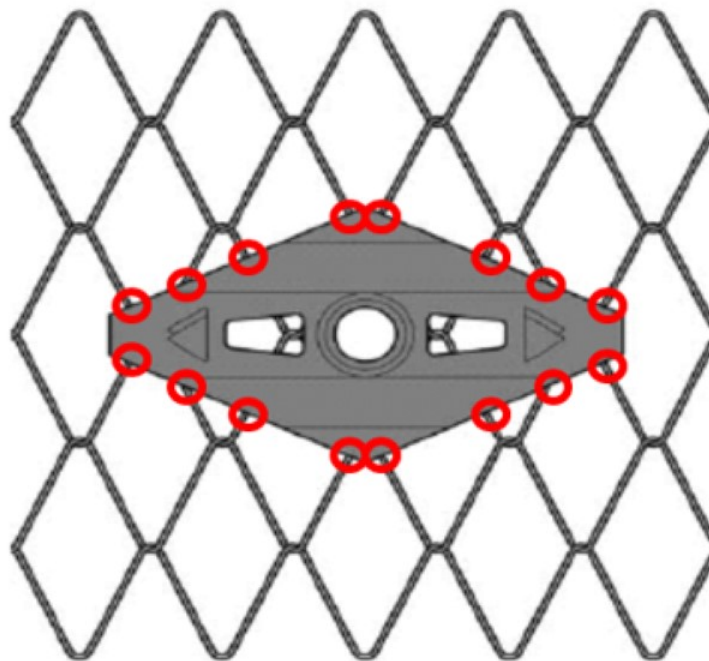
**Ancoraggi non sfalsati =
porzioni di versante senza
soluzione di continuità!!**

LA CORRETTA POSA IN OPERA

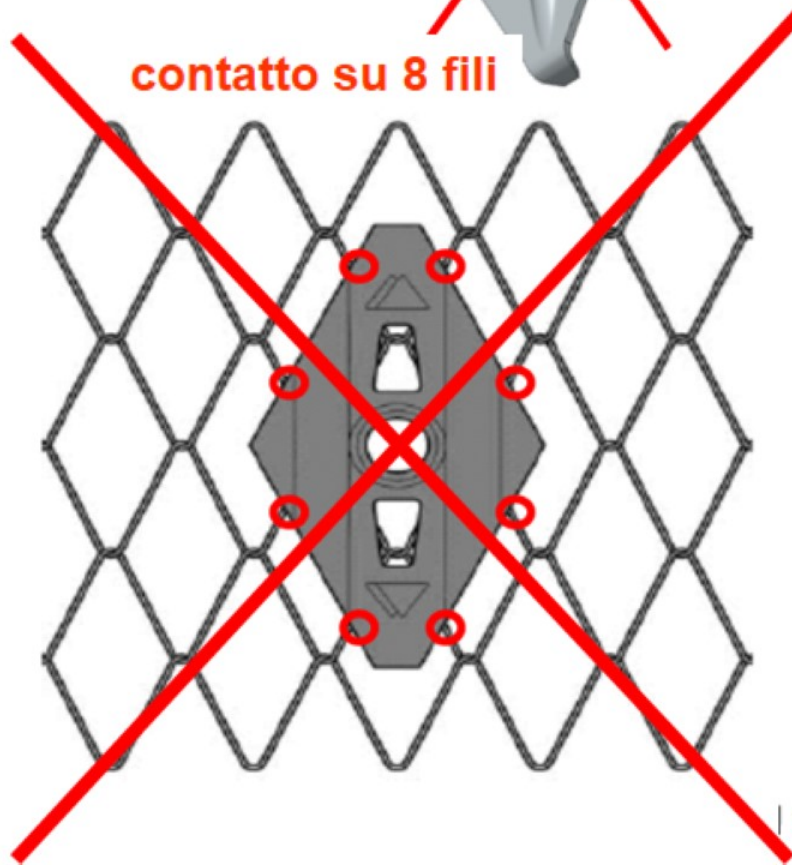
E' importante curare la posizione delle piastre!



contatto su 16 fili



contatto su 8 fili



Messa in tensione della rete



E' importante che laddove possibile (trincee) gli ancoraggi vengano realizzati in nicchie ricavate allo scopo, al fine di porre in tensione la rete nelle adiacenze dell'ancoraggio.

Messa in tensione della rete

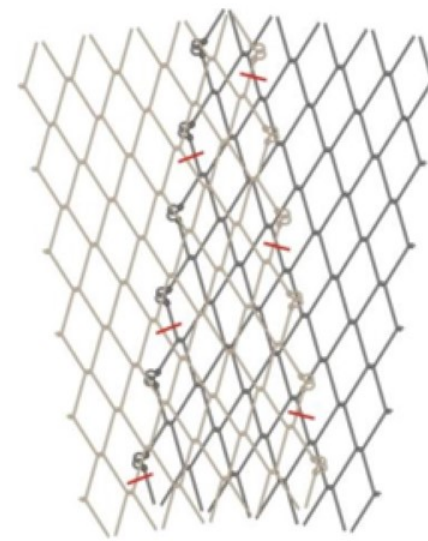
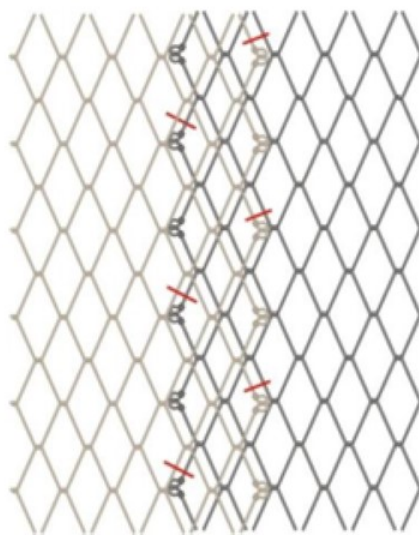
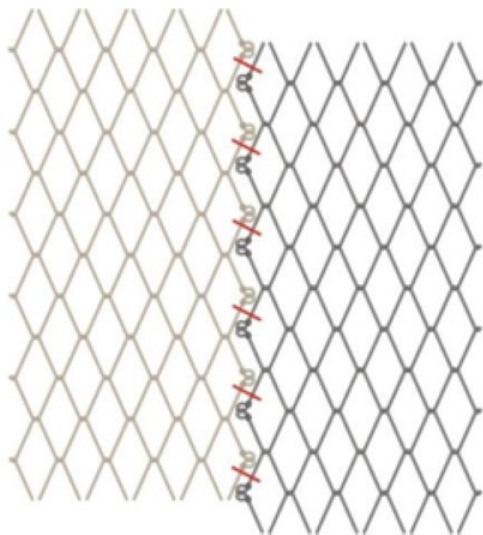


Laddove non sia possibile, gli ancoraggi devono essere realizzati in concavità naturali, per poi porre in tensione la rete per effetto del serraggio del dado dell'ancoraggio.

LA CORRETTA POSA IN OPERA

E' importante curare la giunzione tra i teli!

TECCO® G65/2 e G65/3: 1 clip per maglia



LA CORRETTA POSA IN OPERA





PERCHE SCEGLIERE
IL SISTEMA TECCO®

No.	elemento	vantaggio	beneficio
1	<u>Acciaio ad alta resistenza min. 1770 [MPa]</u>	Pretensionamento possibile e raccomandato	Ogni rilascio iniziale del versante viene contrastato; successive deformazioni sono per lo più impedito.
2	<u>Tre elementi armonizzati</u>	Ottima trasmissione delle forze, elevata resistenza ai carichi	100% sicuro, controllato e confermato, testato in scala 1:1, soluzione dimensionabile.
3	<u>Struttura a maglia romboidale libera</u>	Ottima trasmissione delle forze lungo la rete fino agli ancoraggi.	Rigidità equilibrata; sagoma ottimizzata per trasmissione delle forze con deformazioni minime; resistente ai sismi
4	<u>Leggero e versatile</u>	Rapporto resistenza/peso ineguagliabile.	Minimo impatto ambientale e estetico; facile trasporto e posa. Abbinabile a geosintetici. Rinverdibile.
5	<u>Protezione contro la corrosione</u>	Lunga vita tecnologica	Bassi costi di manutenzione. Protezione di lunga durata (stato dell'arte).
6	<u>Nodi ritorti</u>	Effetto membrana: non perde resistenza alle giunzioni	Sovrapposizioni non necessarie, risparmio di materiale tra fornito e installato
7	<u>T3 Clips</u>	Trasmissione delle forze senza discontinuità, installazione senza attrezzi.	Massima sicurezza, minimizzazione dell'errore, velocità di installazione.

Richieste standard, buona qualità

- Inclinazione del pendio non eccessiva
- Resistenza a punzonamento standard
- Applicazione standard per terreni e rocce alterate

→ **TECCO® G65/2**

Richieste da standard a elevate

- Versanti più ripidi
- Richiesta di una maggiore resistenza a punzonamento
- Applicazioni speciali

→ **TECCO® G65/3**

Richieste da elevate a molto elevate

- Inclinazioni estreme
- Richiesta di un alto valore di resistenza a punzonamento
- Richiesta di un alto valore di resistenza a taglio

→ **TECCO® G65/4**

→ **SPIDER® S3-130**

CONCLUSIONI

3 tipi di rete

TECCO® G65/2
TECCO® G65/3
TECCO® G65/4



2 tipi di piastra

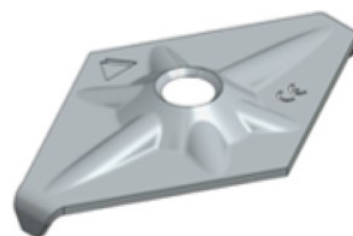
P33/40
P33/50
P66



1 clip di giunzione
compatibile
T3



3

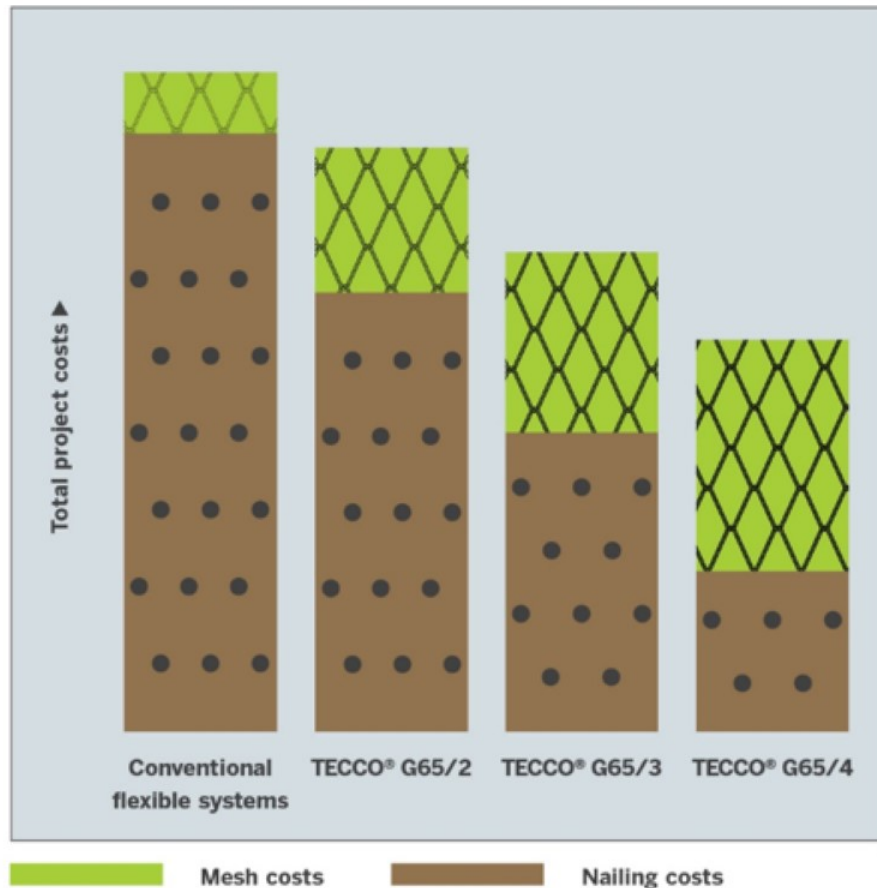


2



1

CONCLUSIONI



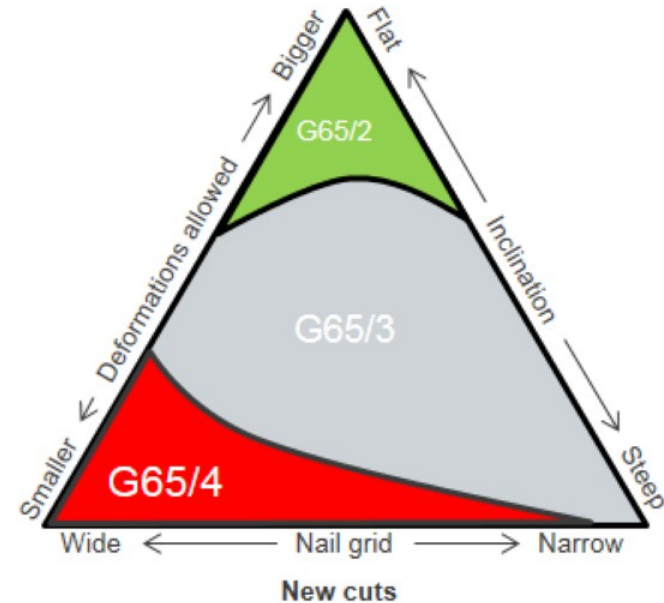
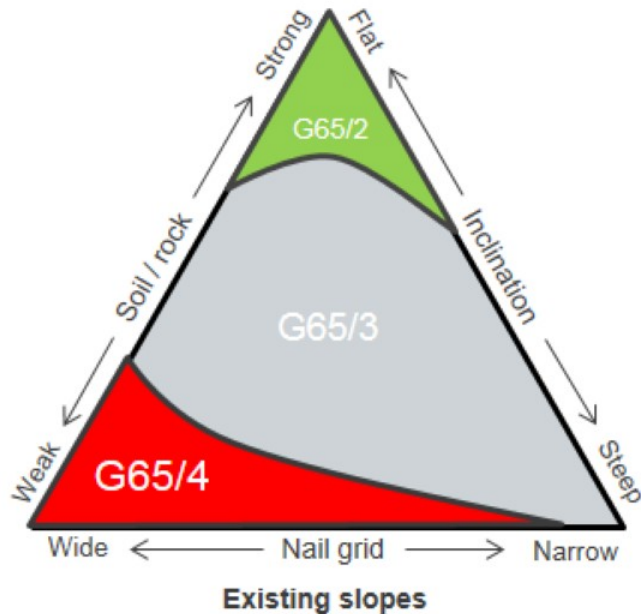
Progettato per la stabilizzazione dei versanti da subito.

Ottimizzare la soluzione alle necessità (e disponibilità).



L'aumentare della resistenza della rete incide sul numero di ancoraggi (che si riducono), e infine sui costi complessivi

Individuare la corretta soluzione per ogni versante



Per ogni versante instabile, esiste una soluzione possibile e sostenibile

- Con le nuove tipologie di rete e di piastre è possibile scegliere la soluzione più adeguata e economicamente conveniente per ogni progetto
- Tutte le reti e le piastre sono testate in vera grandezza e in laboratorio, e dispongono di marcatura CE
- Il nuovo RUVOLUM® include tutti i sistemi
- Il parametro fondamentale non è la resistenza a trazione ma la resistenza a punzonamento e la resistenza alle azioni parallele al versante (capacità di trasferire i carichi)

Lunga durata



Tecco System³ – Acciaio INOX

Lunga durata

TECHNICAL DATA SHEET

High-tensile steel wire mesh TECCO® G65/3 STAINLESS

TECCO® high-performance steel wire mesh

Mesh shape:	rhomboid
Diagonal:	$x \cdot y = 83 \cdot 143 \text{ mm (+/- 3\%)}$
Mesh width:	$D_1 = 65 \text{ mm (+/- 3\%)}$
Angle of mesh:	$\alpha = 45 \text{ degrees}$
Total height of mesh:	$h_{tot} = 11.0 \text{ mm (+/- 1 mm)}$
Clearance of mesh:	$h_1 = 5.0 \text{ mm (+/- 1 mm)}$
No. of meshes longitudinal:	$n_1 = 7 \text{ pcs/m}$
No. of meshes transversal:	$n_2 = 12 \text{ pcs/m}$

Load capacity

Tensile strength of mesh:	$Z_m = 140 \text{ kN/m}^2$
Bearing resistance against puncturing:	$D_k = 170 \text{ kN (*)}$
Bearing resistance against shearing-off:	$P_k = 85 \text{ kN (*)}$
Bearing resistance against slope-parallel tensile stress:	$Z_k = 25 \text{ kN (*)}$
Elongation longitudinal with a	

TECCO® steel wire

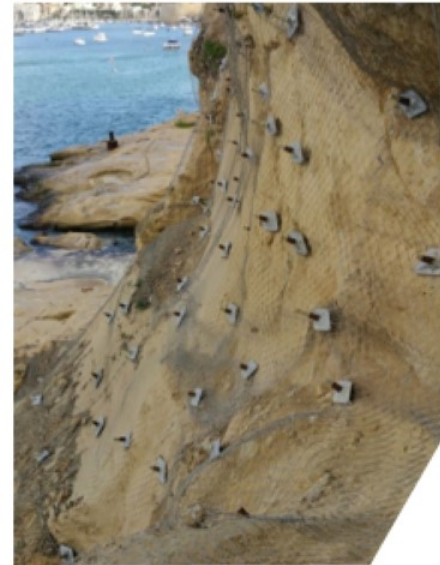
Wire diameter:	$d = 3.0 \text{ mm}$
Tensile strength:	$f_t \approx 1'650 \text{ N/mm}^2$
Material:	high-tensile steel wire
Tensile resistance of a wire:	$Z_w = 11.6 \text{ kN}$

TECCO® corrosion protection

Stainless steel (INOX):	1.4462 (AISI 316)
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TECCO® mesh standard roll

Roll width:	$b_{roll} = 3.5 \text{ m}$
Roll length:	$l_{roll} = 30 \text{ m}$
Total surface per roll:	$A_{roll} = 105 \text{ m}^2$
Weight per m ² :	$g = 1.65 \text{ kg/m}^2$
Weight per mesh roll:	$G_{roll} = 175 \text{ kg}$



Tecco System³ – Acciaio INOX



ESEMPI E CONCLUSIONI

CASTEL SAN NICCOLO' (AR)

Tecco G65/3 e Geostuoia



Tecco G65/3 e localmente biostuoia in Juta



SANTA MARIA HOE' (LC)

Tecco G65/3 e Prati Armati



ROCCASCALEGNA (TE)

Tecco G65/3 Color



Abbiamo una domanda in sospeso

Il consolidamento con il Sistema TECCO® è un intervento naturale?

- ▶ Certamente non al 100%
- ▶ Come peraltro non lo sono al 100% i geosintetici
- ▶ Ma può essere efficacemente abbinato a tecniche «bio»
- ▶ Esigenze di sicurezza ne impongono l'uso

Non esistono materiali scadenti o poco performanti,
esistono scelte inadeguate (o problemi sottovalutati)