

Nus, 10 Ottobre 2017 | Ing. Luca Dellarole,  
Ufficio Tecnico Geobrugg Italia

# Reti in acciaio per la prevenzione di frane in roccia e di versante: la progettazione di riferimento e i criteri di posa



Problematiche e situazioni della  
fase progettuale

Cosa Geobrugg propone per affrontare  
tali situazioni

Tipologie di sistemi

Metodi per la progettazione

Posa in opera

# ENTITÀ DEL DANNO



# ENTITÀ DEL DANNO



# ENTITÀ DEL DANNO?



# ENTITÀ DEL DANNO?



# ENTITÀ DEL DANNO





# DATI DI PARTENZA

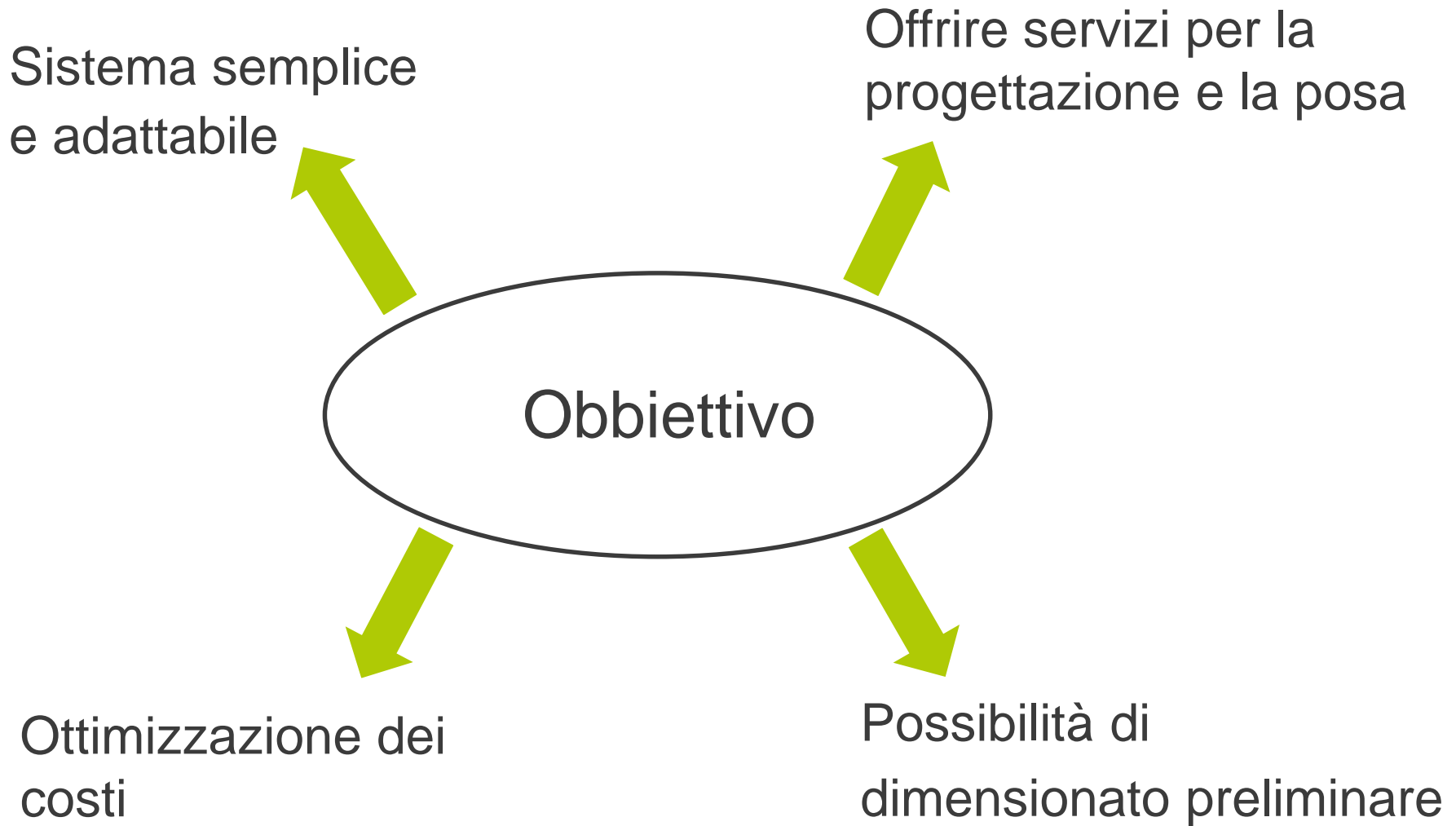


**Disponibilità economica  
del committente?**



**Tempo per la progettazione / realizzazione?**





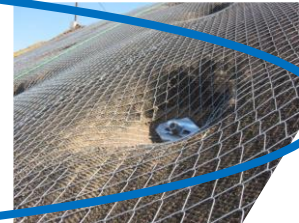
# TIPI DI RIVESTIMENTO

In accordo alla Norma EN 14490 (2010)

Hard facing



Flexible facing



Soft facing



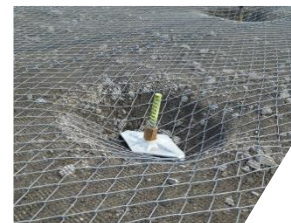


## SISTEMA TECCO®

**1** Rete in filo d'acciaio ad alta resistenza + connessioni



**2** Piastre cuspidate TECCO®



**3** Ancoraggi



SEMPLICI ELEMENTI CHE DEVONO LAVORARE BENE INSIEME

# Reti TECCO® in filo d'acciaio ad alta resistenza

Cosa si intende per alta resistenza?



$$f_y \geq 600 \text{ N/mm}^2$$

# CLASSI DI RESISTENZA

## **Norma UNI EN 10223-3:**

Fili e prodotti trafilati di acciaio per recinzioni e reti.



$f_t \geq 350-500 \text{ N/mm}^2$

vs

## **Norma UNI EN 10264-1:**

Filo d'acciaio e relativi prodotti. Filo d'acciaio per funi.



$f_t \geq 1180 - 2080 \text{ N/mm}^2$

# CLASSE DI RESISTENZA

## Un filo da 3 mm di diametro

Reti in acciaio standard

$f_t \geq 500 \text{ N/mm}^2$

**5** arrampicatori



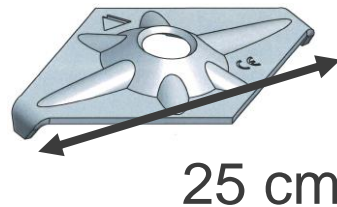
Reti GEOBRUGG

$f_t \geq 1770 \text{ N/mm}^2$

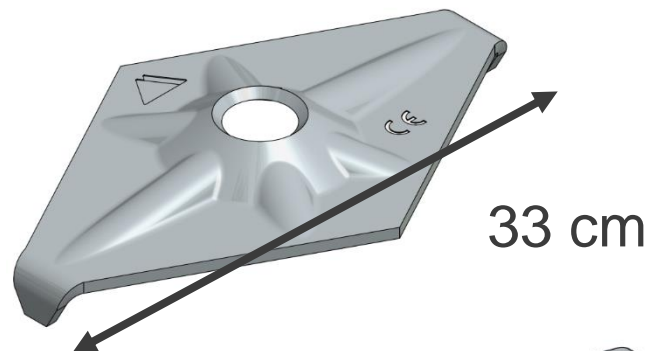
**18** arrampicatori



**Piastre P25/34**



**Piastre P33/40  
e P33/50**



**Piastra P66/50**



**4** tipi di rete

TECCO® G45/2  
TECCO® G65/3  
TECCO® G65/4  
SPIDER S3-130



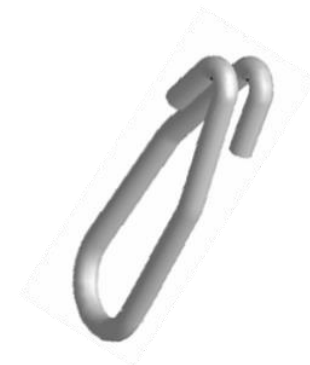
**3** tipi di piastre

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



**1** clip di  
connessione

T3



## 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 49228100  
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



# European Technical Approval ETA-13/0405

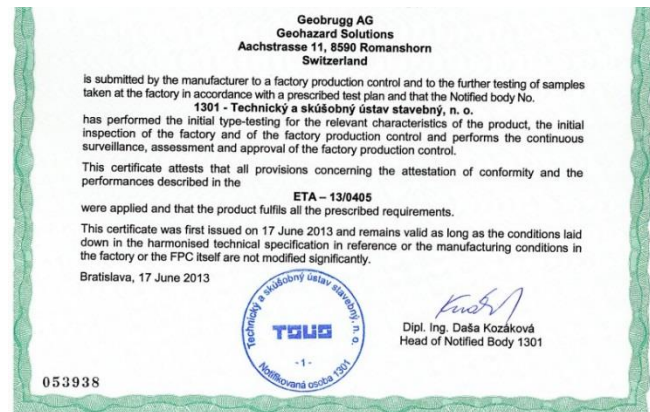
Validity from: 06. 05. 2013  
Platnosť od: 06. 05. 2013  
to: 05. 05. 2018  
do:

Manufacturing plant: Geobru AG  
Miesto výroby: Geohazard Solutions  
Aachstrasse 11  
CH-8590 Romanshorn  
Switzerland

This European Technical Approval contains: 16 pages including 2 annexes  
Toto európske technické osvedčenie obsahuje: 16 strán vrátane 2 príloh

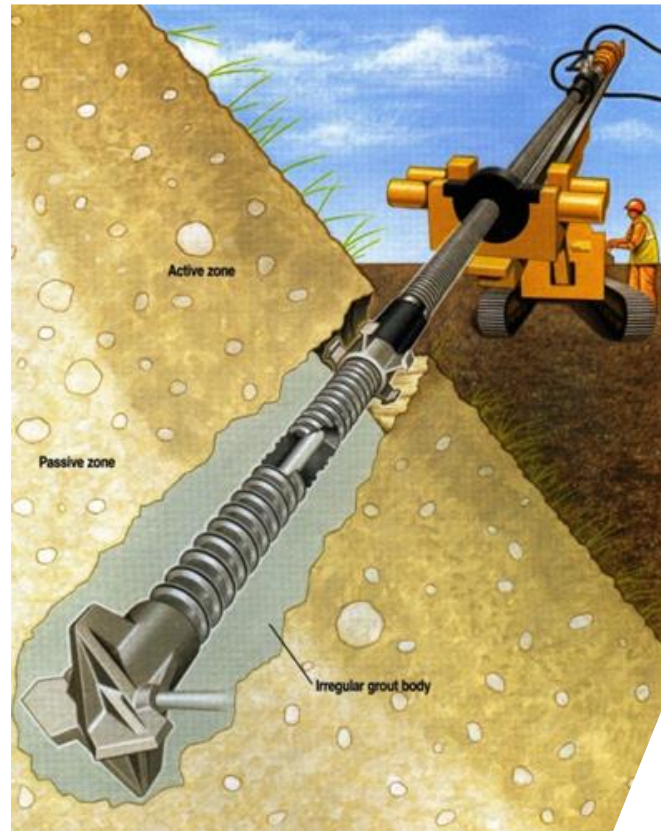


European Organisation for Technical Approvals  
Európska organizácia pre technické osvedčovanie



# ANCORAGGI

Barre d'acciaio filettate in fori per il rinforzo di terreni e rocce.



Prodotti standard,  
diversi fornitori.



Siete voi a scegliere il  
più adatto!

# BARRE PIENE E CAVE

Barre piene

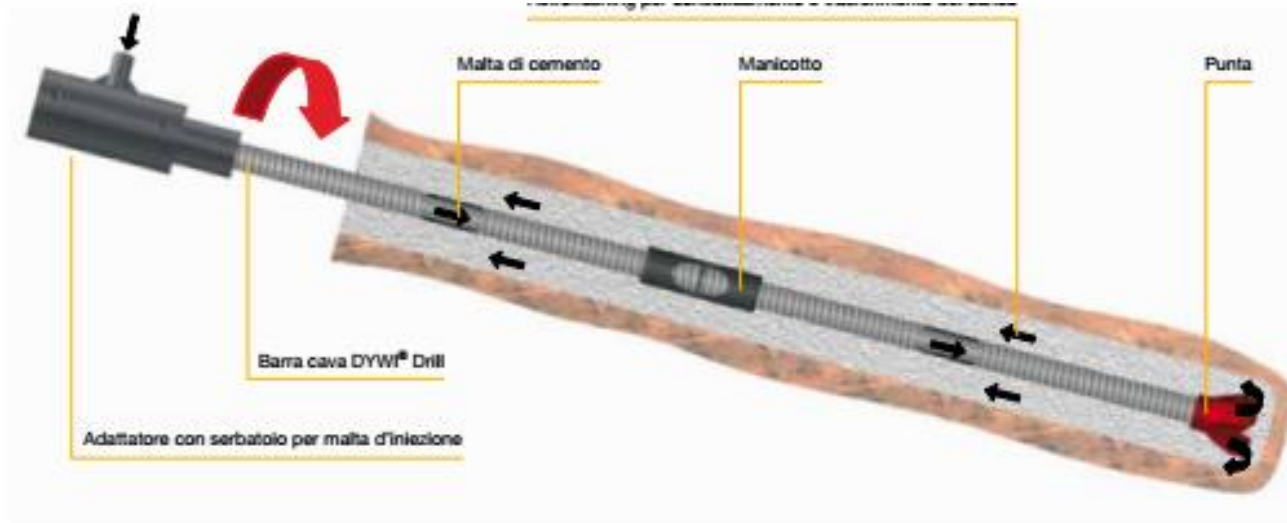
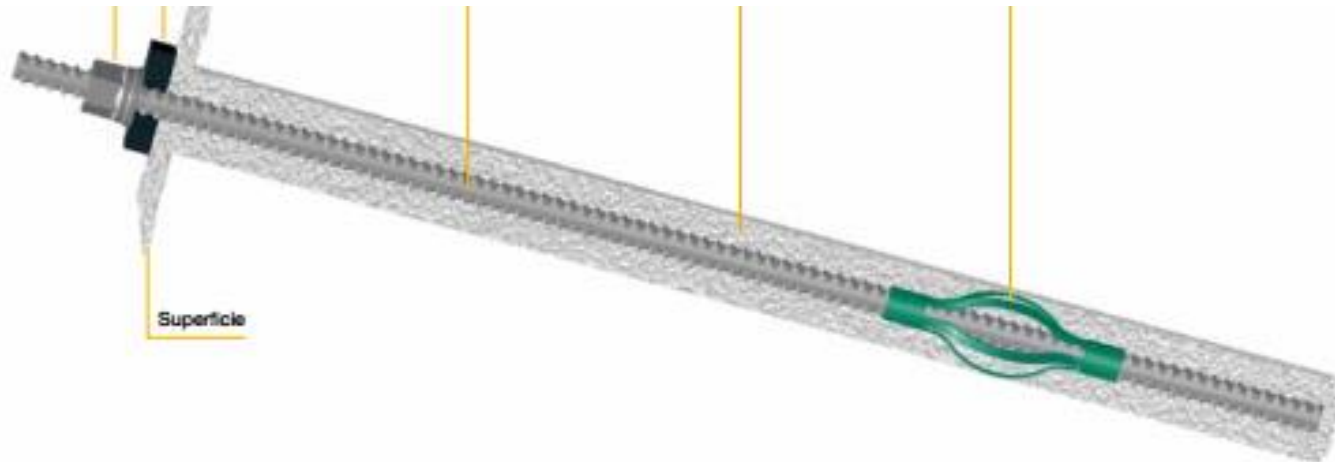


Barre cave,  
autoperforanti



Barre con diametro variabile tra i 24 mm e i 32 (40) mm

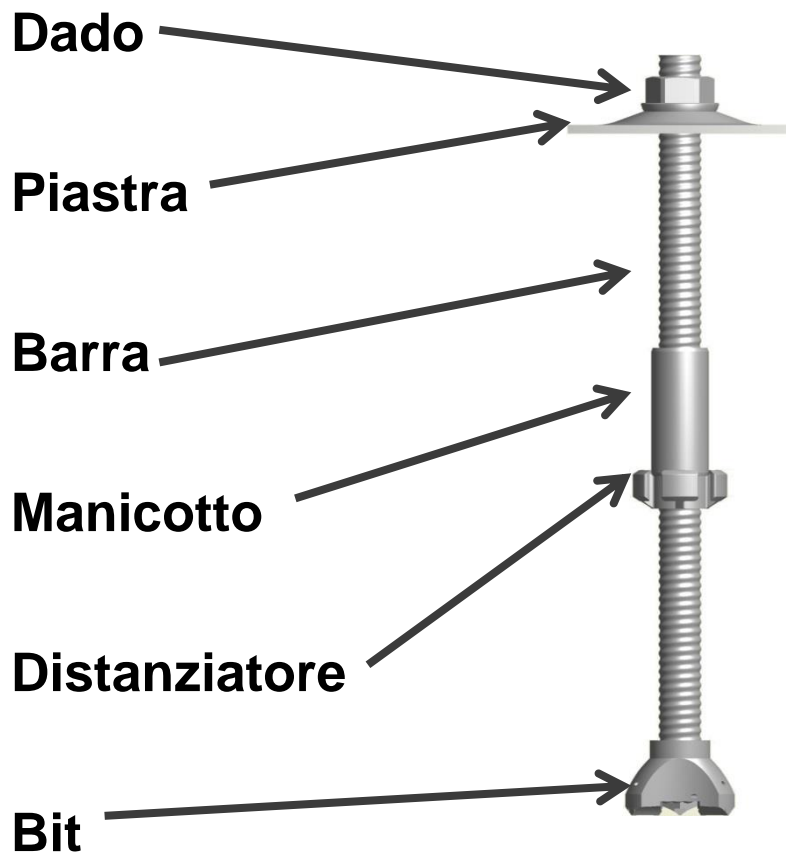
# BARRE PIENE E CAVE



Diametri di perforazione compresi tra 45 mm e i 110 mm.

# ANCORAGGI AUTOPERFORANTI

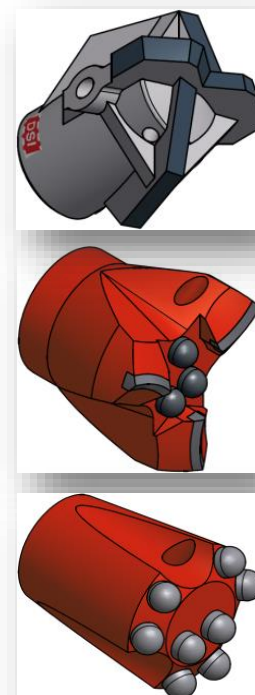
Esempio Dywidrill di Dywit (DSI – Dywidag)



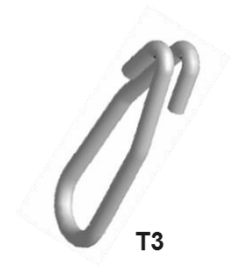
**Limi**

**Sabbie**

**Roccia**



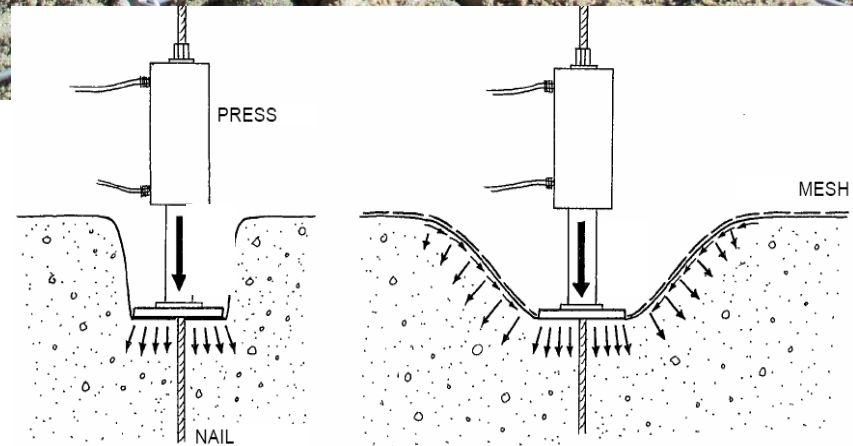
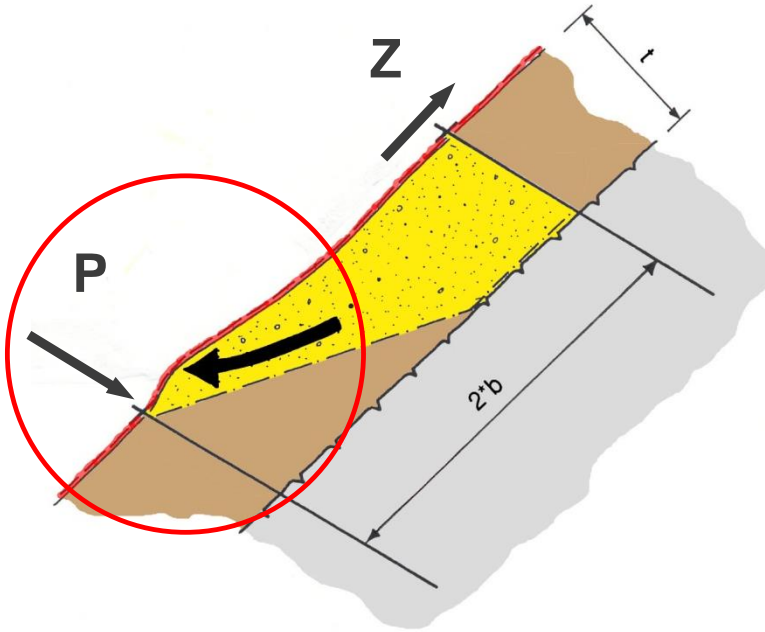
## Come caratterizziamo i componenti?



# PROVE DI LABORATORIO

## Resistenza contro la rottura al bordo superiore della piastra

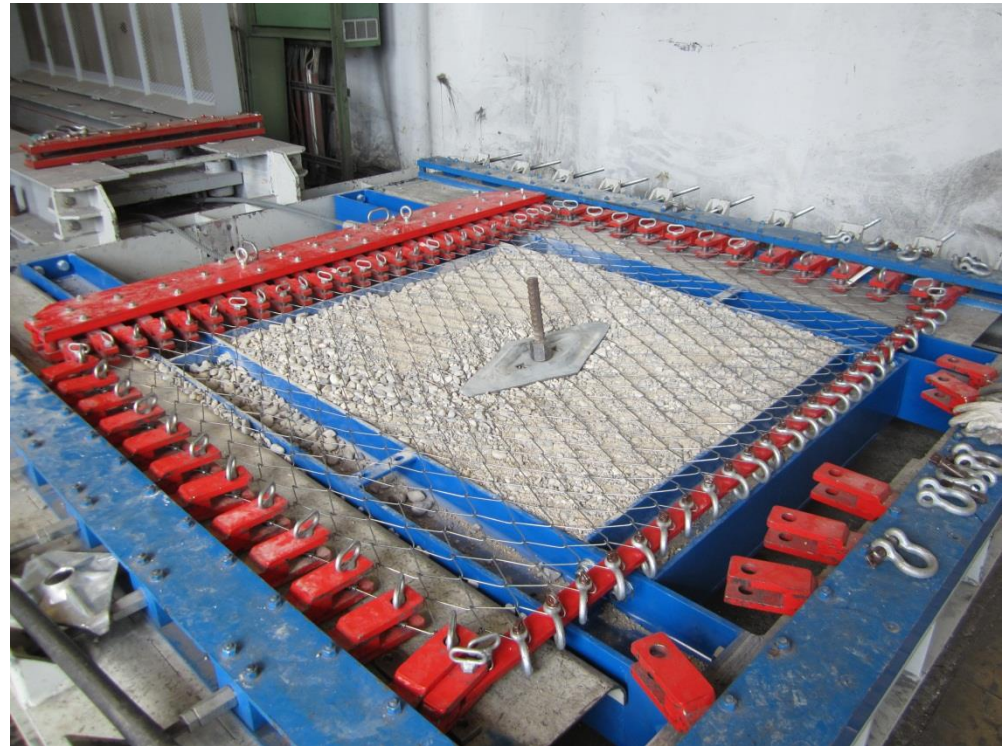
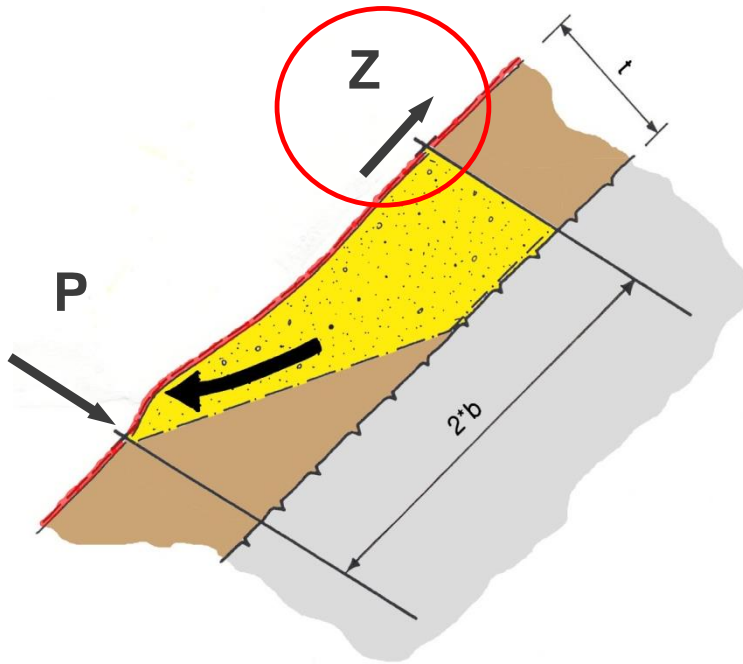
... come base per RUVOLUM®



# PROVE DI LABORATORIO

## Resistenza alla trazione parallelamente al pendio

... come base per RUVOLUM®



# PROVE DI PERFORMANCE



# PROVE DI PERFORMANCE

**Caratteristiche materiale:** Ghiaia lavata 16/32 mm

**Non ha rotture improvvise**



**Non è influenzato  
da coesione**

**Ripetibilità dei test**

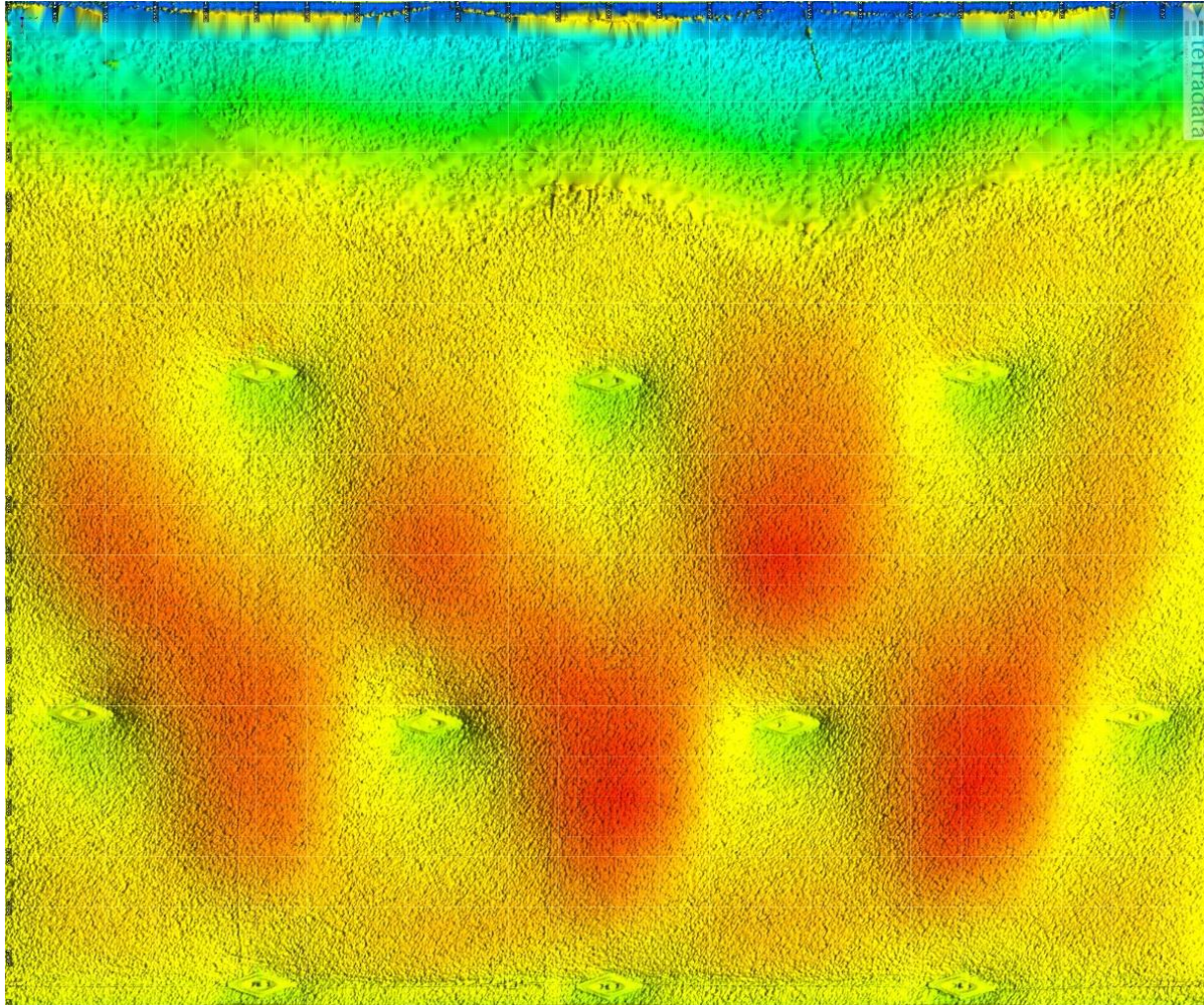
**Scenario “worst case”**

# PROVE DI PERFORMANCE

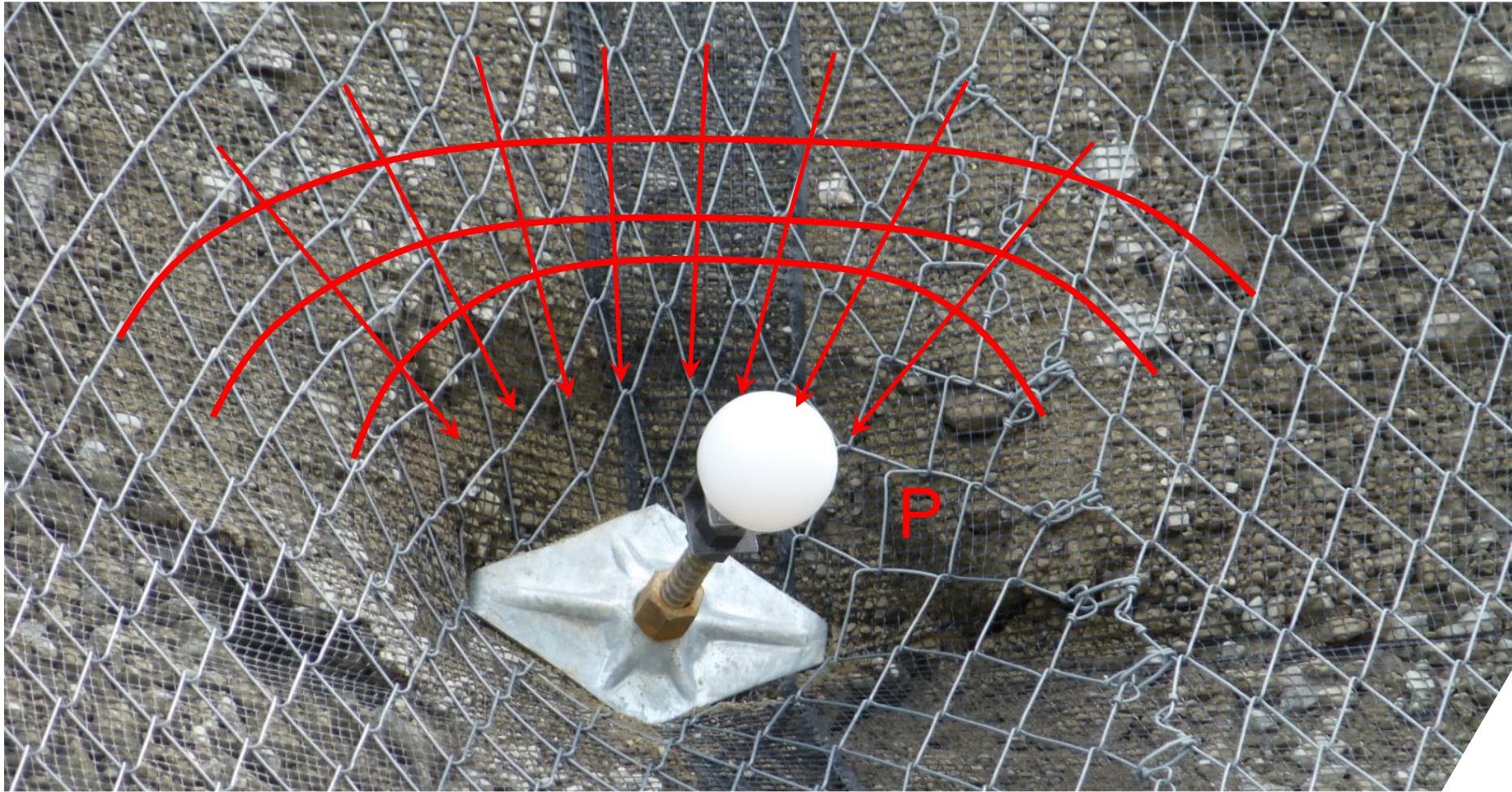


# RUVOLUM® VERIFICATO CON TEST IN GRANDE SCALE

# ANALISI DI MECCANISMI DI SCIVOLAMENTO REALI



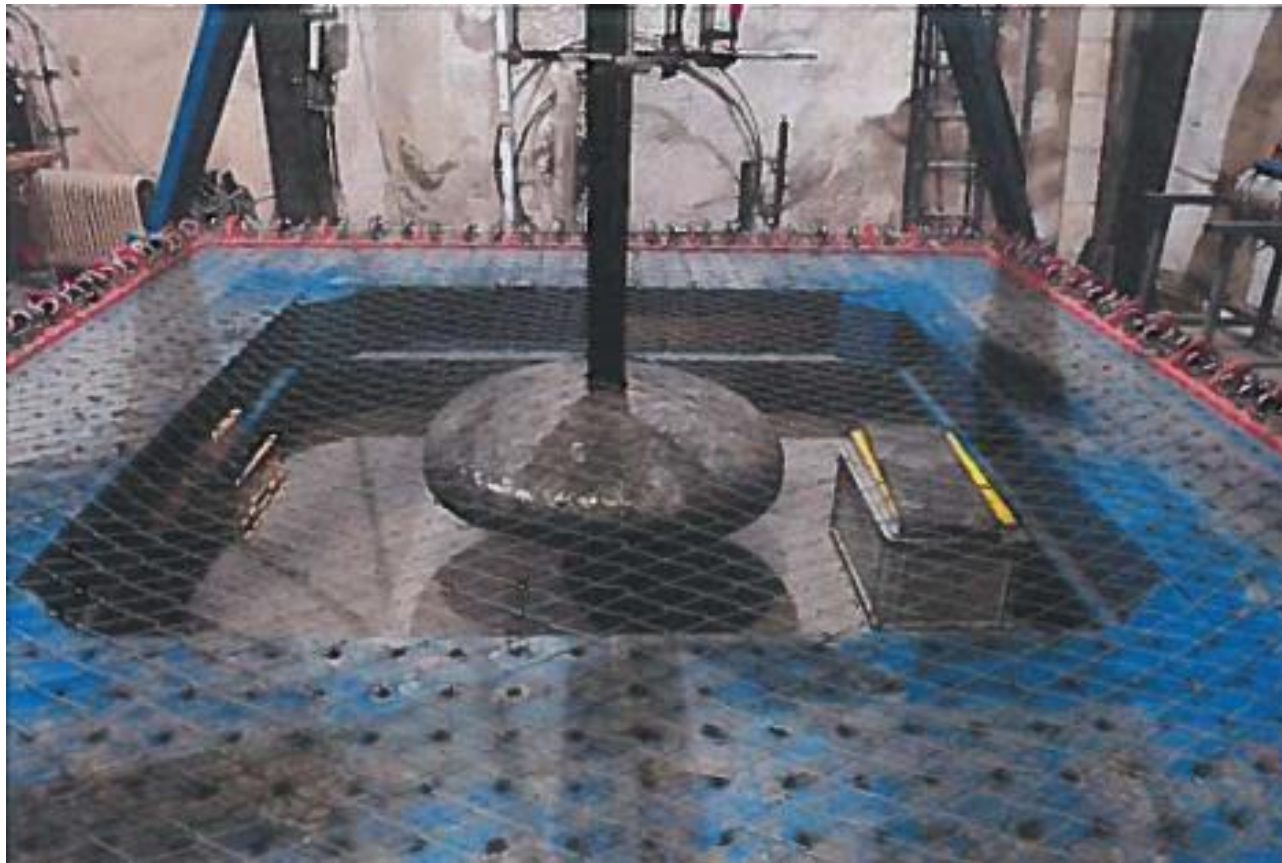
# PUNZONAMENTO

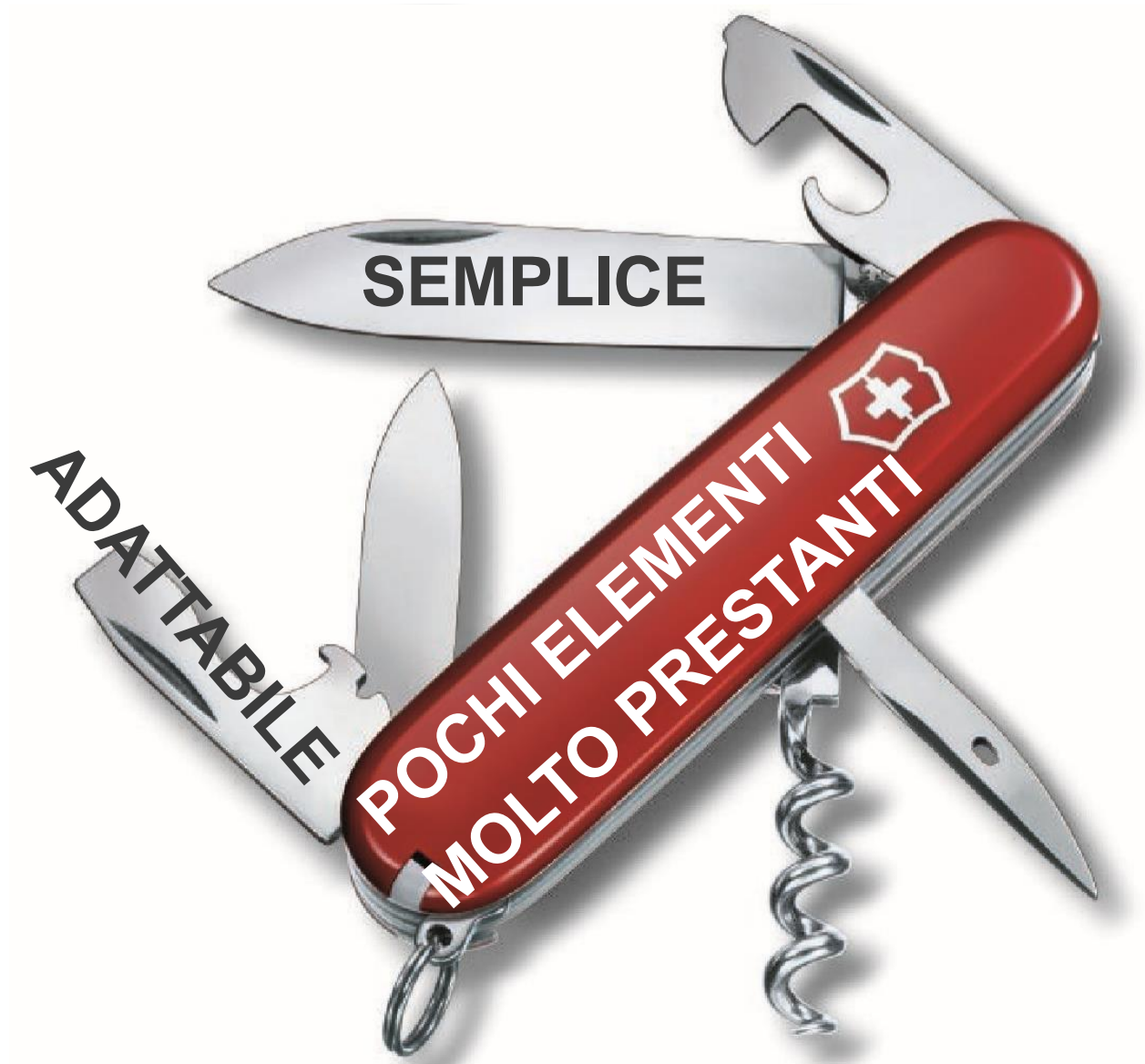


# TEST AL PUNZONAMENTO

Test del cupolone: norma UNI 11437

Prove su reti per rivestimento di versanti





## Sistema TECCO: 4 tipologie di reti



**45 mm**

**130 mm**

## Sistema TECCO: 4 tipologie di reti



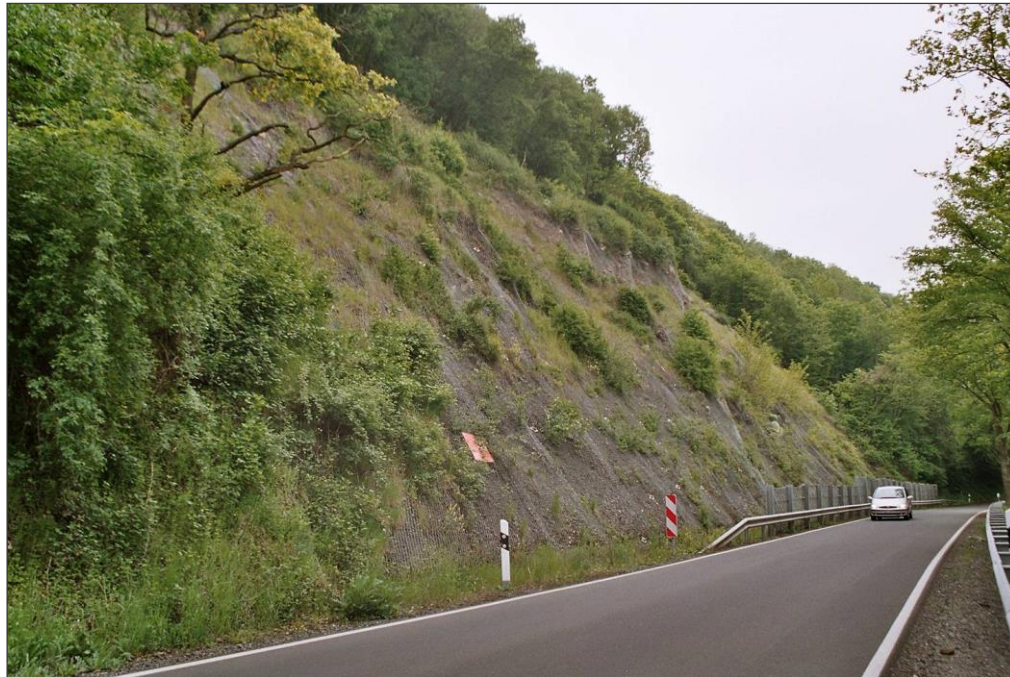
85 kN/m

2 mm

250 kN/m

4 mm

# ADATTABILE



# ADATTABILE



# ADATTABILE



# ADATTABILE

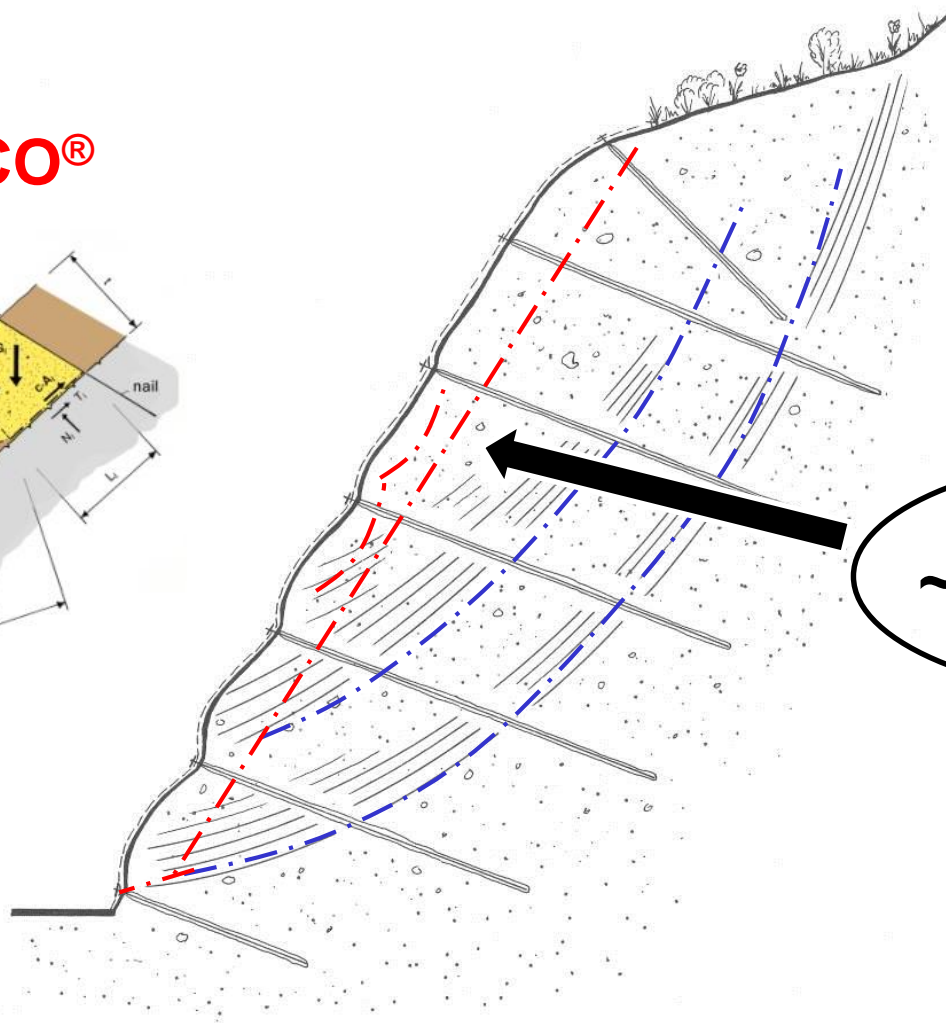
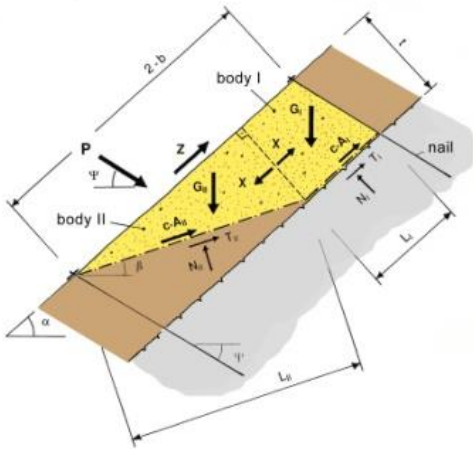


# ADATTABILE



# INSTABILITÀ SUPERFICIALE

**TECCO®**



**~ 2 m – 2.5 m**

**Fino a che profondità??**

# SOFTWARE RUVOLUM

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

## Ruvolum Online Tool, Version 2014

Save

Load

Print

Full screen

Units

EN

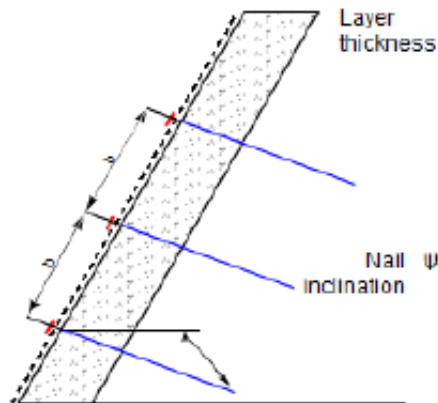


Project No. 12345-12345

Project Name Prova Sicilia

Date, Author Gennaio 2014 - G. Guasti

Cross-section:



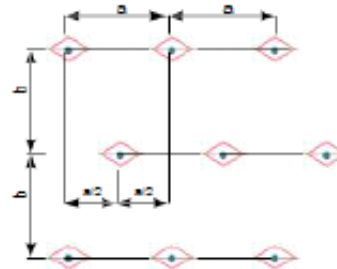
Layer thickness

$t = 1.00$  m

Nail inclination  $\psi = 20.0$  degrees

Slope inclination  $\alpha = 60.0$  degrees

View nail arrangement:



Friction angle ground (characteristic value)

$\Phi_k = 32.0$  degrees

Volume weight ground (characteristic value)

$\gamma_k = 20.0$  kN/m<sup>3</sup>

### 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/m<sup>2</sup>

$\gamma_s = 20.0$  kN/m<sup>3</sup>

### Control:

Proofs of the mesh OK (0.73)

Proofs of the nails OK (0.95)

Load cases

Defaults

Safety factors

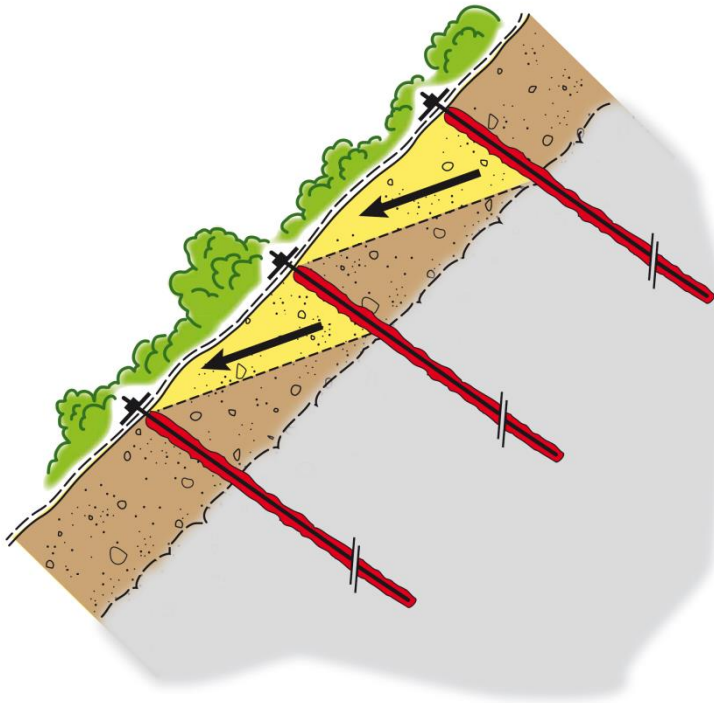
Nail types

Elements of the system

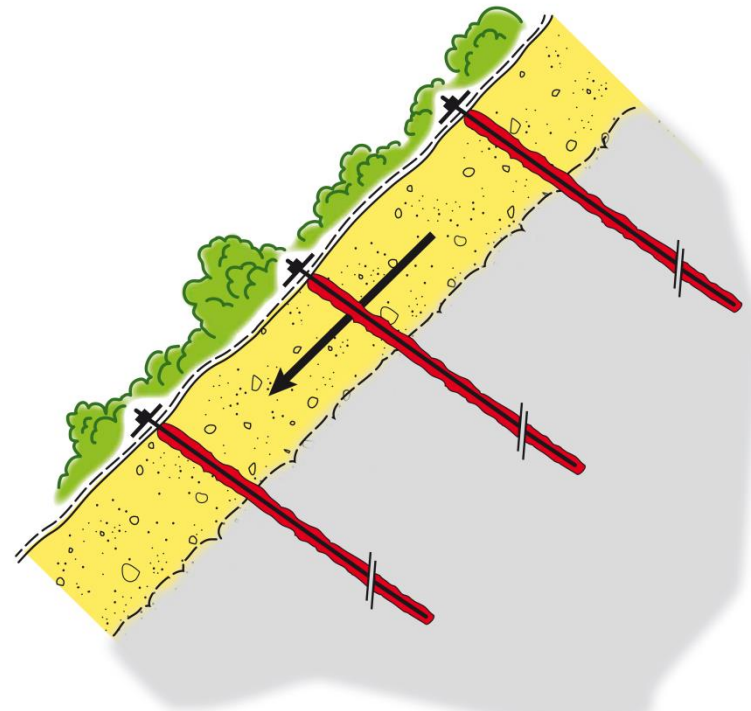
Proof of bearing safety

## **RUVOLUM® analisi di tipo attritivo-coesivo alla Mohr Coulomb**

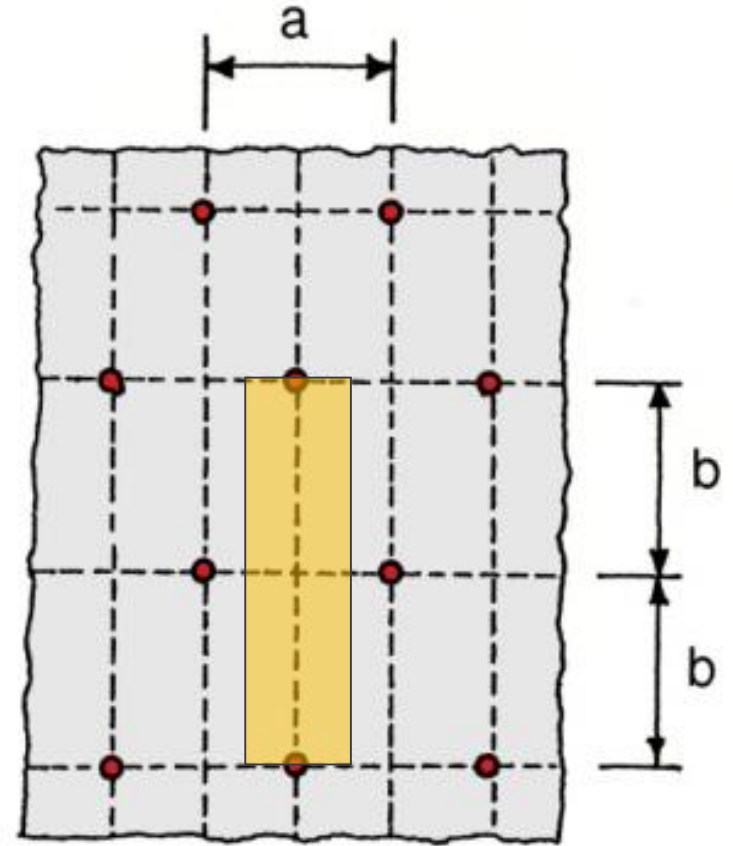
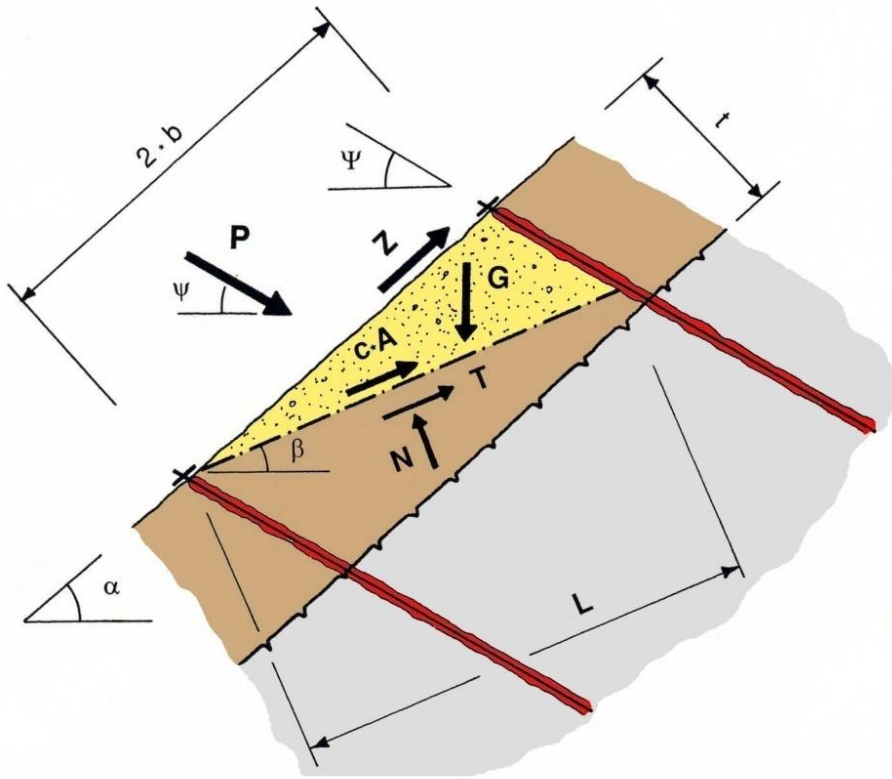
1. La verifica di instabilità locali tra i singoli ancoraggi



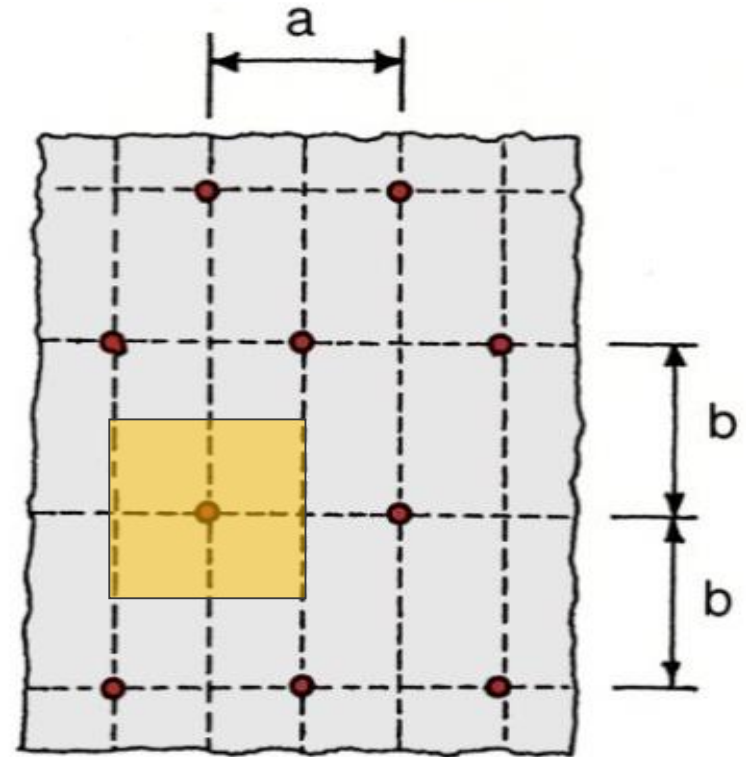
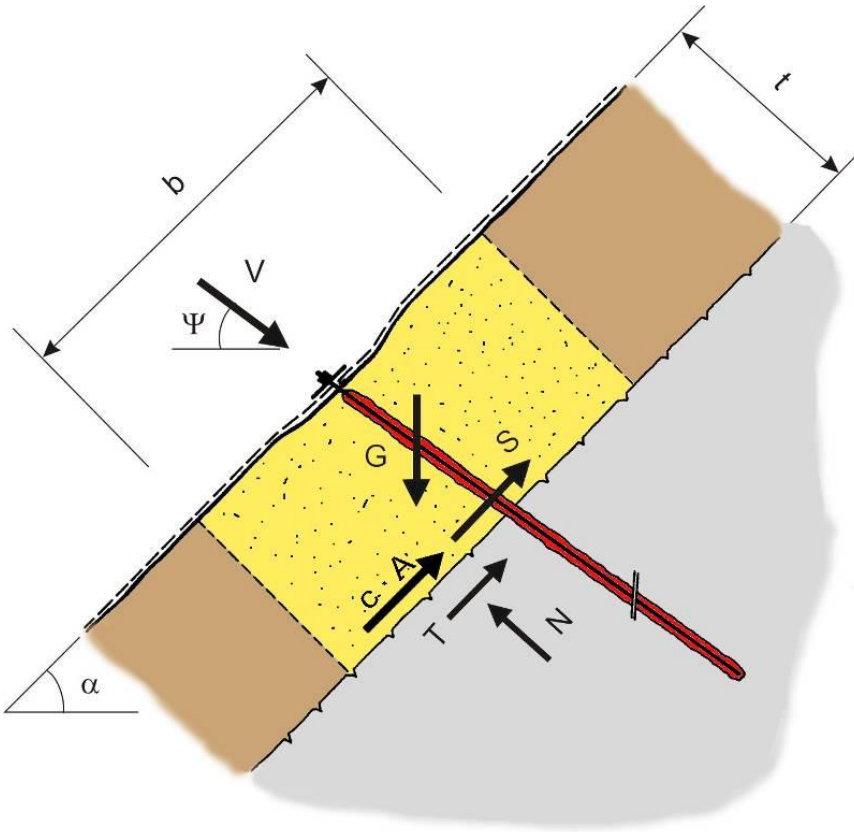
2. La verifica di instabilità di versante sul modello del pendio indefinito



# DIMENSIONAMENTO - PRINCIPI



# DIMENSIONAMENTO - PRINCIPI



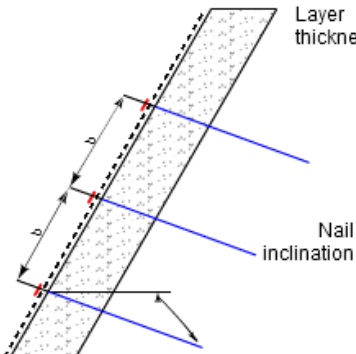
# IL MODELLO DI CALCOLO RUVOLUM

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:



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

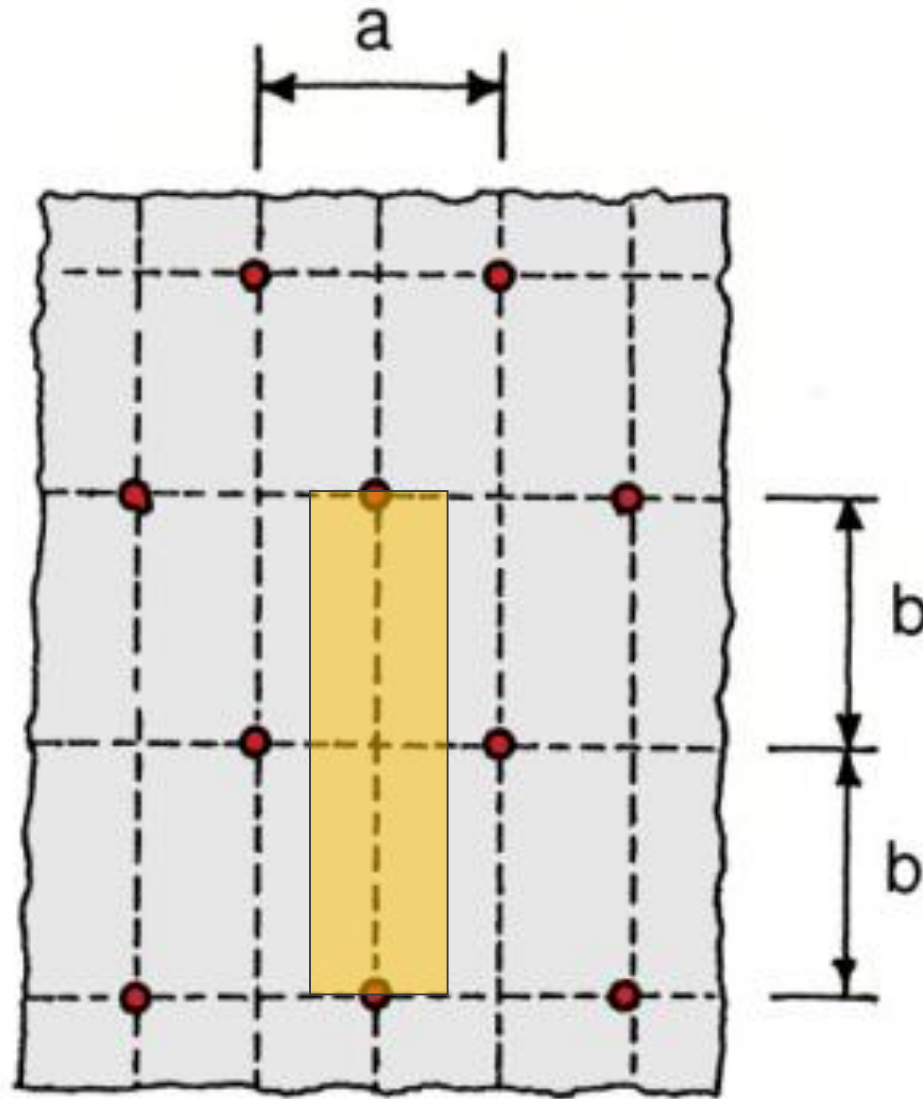
**Dimensioning quantities**  
 $\Phi_d = 26.6$  degrees  
 $c_d = 0.0$  kN/m<sup>2</sup>  
 $\gamma_d = 20.0$  kN/m<sup>3</sup>

**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/m<sup>3</sup>

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

# IL MODELLO DI CALCOLO RUVOLUM



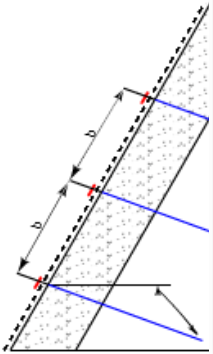
# IL MODELLO DI CALCOLO RUVOLUM

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. 20130  
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/m<sup>3</sup>

**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

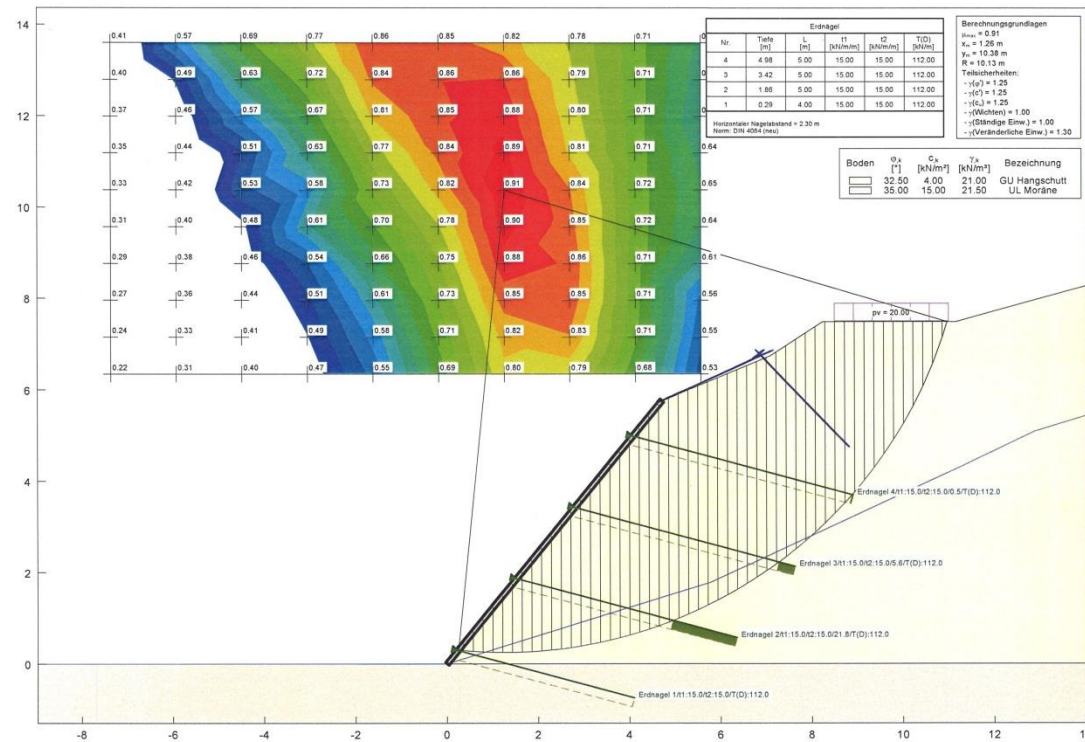
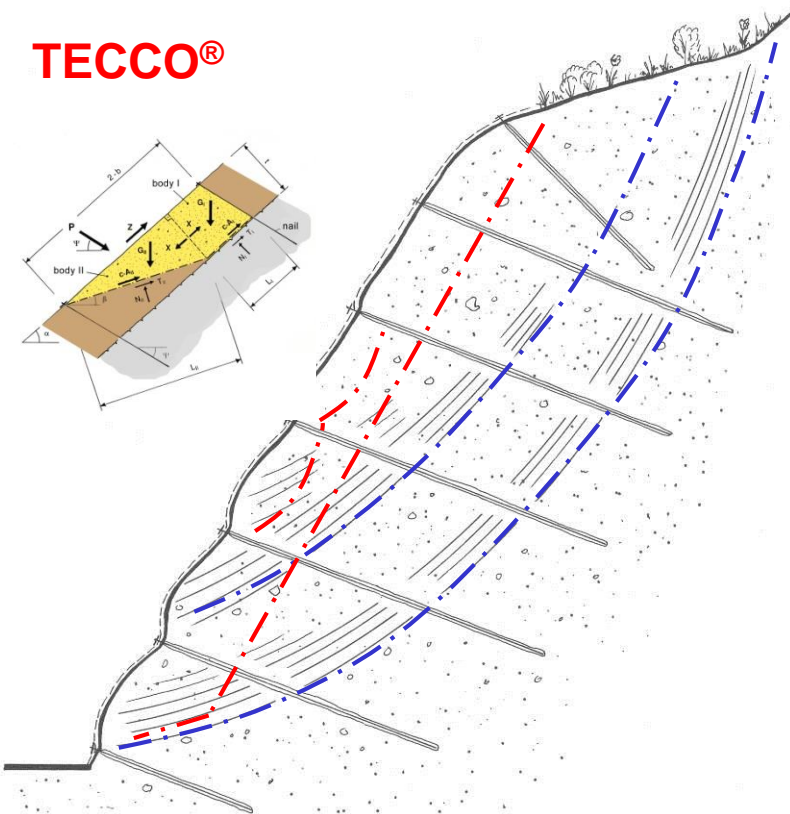
**Dimensioning quantities**  
 $\Phi_d = 26.6$  degrees  
 $c_d = 0.0$  kN/m<sup>2</sup>  
 $\gamma_d = 20.0$  kN/m<sup>3</sup>

**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

# INSTABILITÀ SUPERFICIALI E PROFONDE

**TECCO®**



COMBINAZIONE TRA INTERVENTI INSTABILITÀ PROFONDA E INTERVENTI INSTABILITÀ SUPERFICIALE

# INSTABILITÀ SUPERFICIALI E PROFONDE

Monte Rosa, Cali



Descrizione	
Altezza pendio:	70 [m]
Pendenze:	Fino a 60 [deg]
Area totale:	8000 [m <sup>2</sup> ]
Rete utilizzata:	G65/3 + P33
Ancoraggi:	• Gewi 32
Lunghezza e griglia ancoraggi:	• 4, 6, 10 [m] • 2.0 x 2.5 [m]

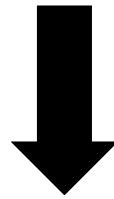
# ALTRI ASPETTI



# ALTRI ASPETTI



**Che ulteriore aspetto dovete considerare?**



**CORROSIONE AMBIENTALE!**



## Come fate a determinare la vita utile?

### UNI EN10223

Site Environment level <sup>a</sup> (in accordance with EN ISO 9223:2012, Table 1)	Plastic coating material	Coating <sup>*</sup>	Class <sup>b, c</sup> (EN 10244-2)	Assumed working life of the product (year) <sup>f</sup>
Very High aggressive: (C5) <sup>d</sup> Wet conditions  Temperate and subtropical zone, atmospheric environment with very high pollution and/or important effect of chlorides, e.g. industrial areas, coastal areas, shelter positions at coastline	Polyvinyl chloride (PVC)	Zn95%/Al5% alloy <sup>*</sup>	A	120 <sup>*</sup>
Extreme aggressive: (CX) <sup>d</sup>  Subtropical and tropical zone (very high time of wetness), atmospheric environment with very high pollution SO <sub>2</sub> (higher than 250 µg/m <sup>3</sup> ) including accompanying and production ones and/or strong effect of chlorides, e.g. extreme industrial areas, coastal and off shore areas, occasionally contact with salt spray	Polyvinyl chloride (PVC)	Zn95%/Al5% alloy <sup>*</sup>	A	> 50 <sup>*</sup>

# INOX



**Ambienti  
molto aggressivi**



**TECCO INOX**

# SINERGIA

## VOI, PROGETTISTI

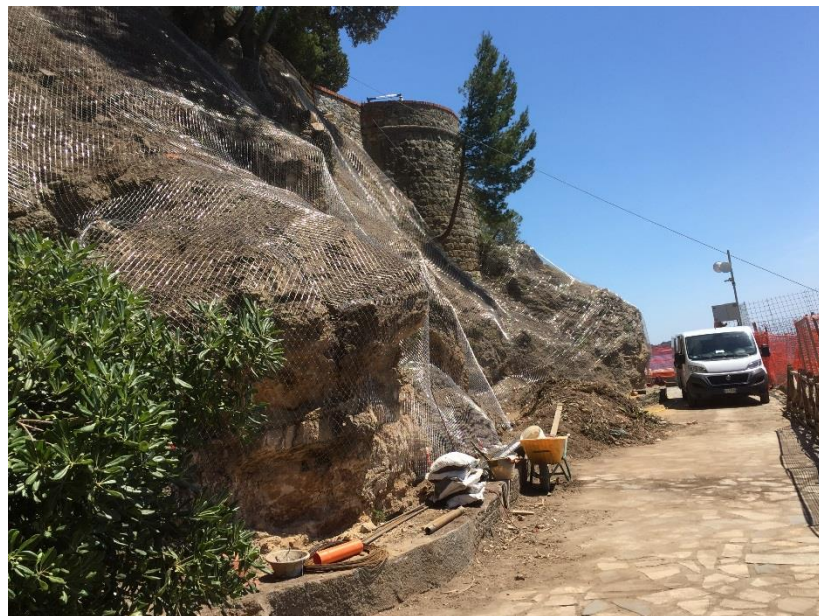
IMPRESE

FORNITORI



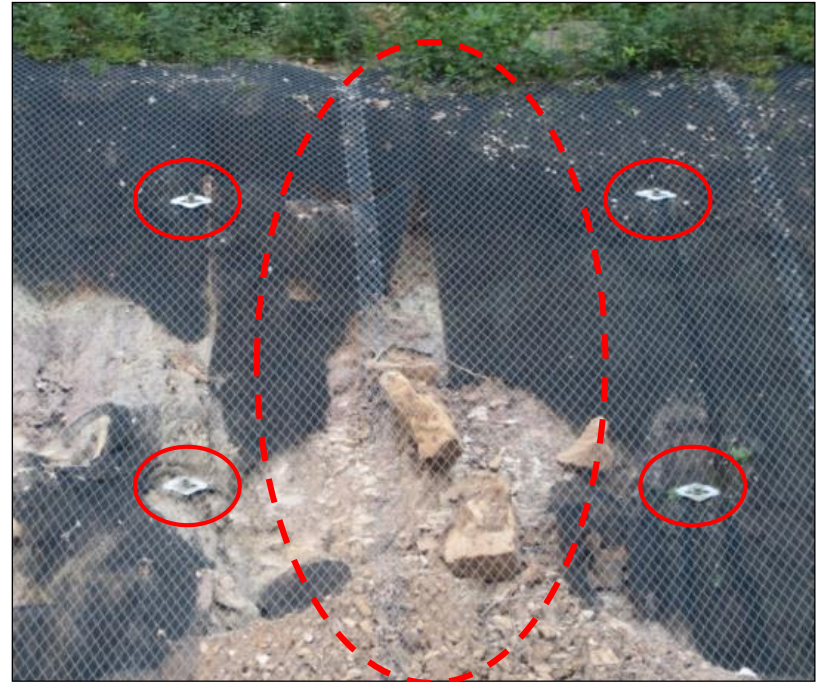
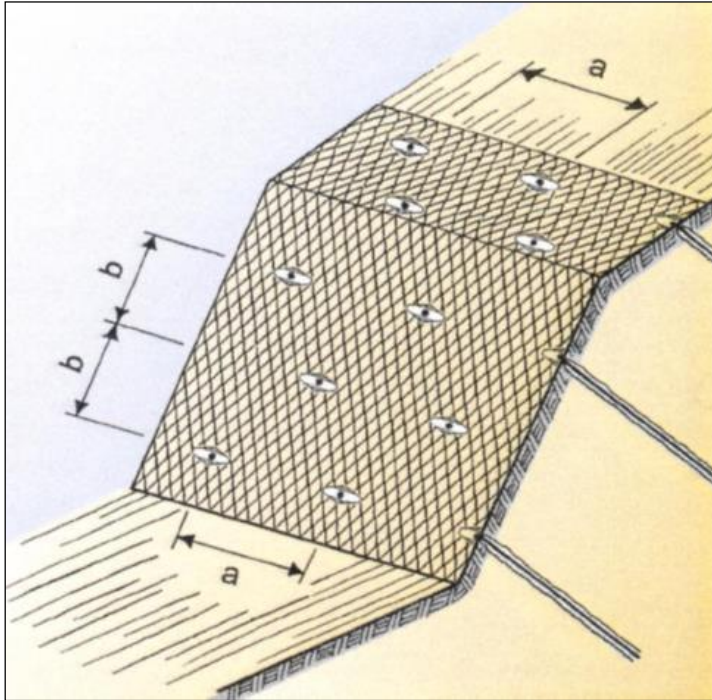
OTTIMIZZAZIONE DELLE FASI PROGETTUALI, DI  
FORNITURA E DI POSA

# SOPRALLUOGHI



# LA CORRETTA POSA IN OPERA

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



**Da evitare!!**

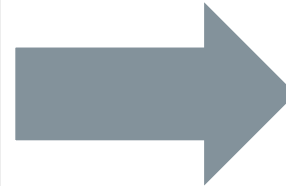
# LA CORRETTA POSA IN OPERA



# PROTOCOLLO DI VERIFICA


*CHECKLIST*

<input checked="" type="checkbox"/>	_____
<input checked="" type="checkbox"/>	_____
<input checked="" type="checkbox"/>	_____
<input checked="" type="checkbox"/>	_____
<input checked="" type="checkbox"/>	_____
<input checked="" type="checkbox"/>	_____
<input checked="" type="checkbox"/>	_____





Verifica corretto  
montaggio

# ONLINE TOOL

← → ↻  Sicuro | https://www.geobrug.com/index\_en.html

**GEOBRUGG®**  
BRUGG  
Safety is our nature  
A company of the BRUGG Group

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Dimensioning Tools

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[more](#)

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# A PIÙ TARDI PER LA SECONDA PRESENTAZIONE....

## INTANTO, DOMANDE?

