


Welcome 


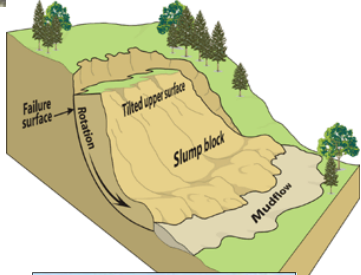
# The Full Scale Mechanics of Surficial Slope Stabilization

**Bob Lyne**  
Geobrugg North America, LLC  
Regional Manager – SE USA



Overview of content

1. Slope stabilization options
2. The anchored mesh system
3. Full scale testing
4. Results of full scale testing



2

## Slope Stabilization



Stability problems can occur as a result of

- Hillside water, saturation, water pressure in critical joints
- Stratification / joints unfavorably orientated
- Erosion
- Change of slope geometry
- Extraordinary effects (earthquake, etc.)
- External loads (traffic, etc.)
- Installed solutions, not properly designed for the conditions

3

## Stability problems: Soil slope failure



4

**Stability problems: Disadvantageous stratification**



5


**Stability problems: Stability problems downslope**




6



**Soft facing: Geotextiles**

**GEOBRUGG** 


- Facing has no static function
- No noteworthy force transmission possible







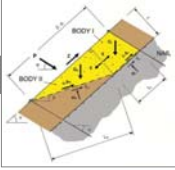
**Flexible Facing - Mild steel mesh**

**GEOBRUGG** 




**The anchored mesh system** 



1. High-tensile steel wire mesh 
2. System spike plates 
3. Anchors 
4. Dimensioning Concept 

11


**High tensile wire mesh** 

High-tensile steel wire: **> 256 ksi**

- 2mm wire → 1,200 lbs.
- 3mm wire → 2,800 lbs.
- 4mm wire → 4,900 lbs.

DTWM (3mm) → ~ 800 lbs.

**Extraordinary Load Transfer**



12

### The dimensioning concept (surficial instabilities)

**GEOBRUGG**

The dimensioning concept comprises two investigations

1. Investigation of local instabilities between single nails
2. Investigation of slope-parallel, superficial instabilities

13

### Small scale tests

**GEOBRUGG**

MESH  
CHAIN HOIST  
2000 mm  
FRAME  
SAND  
YELLOW MARKING STRING  
1500 mm  
WOODEN BEAM

**Anchored mesh system examples**

**GEOBRUGG**

Highway 101 – near Garberville, CA




The top section of the slide features a decorative banner with a close-up of a metal mesh system installed on a slope. Below this, the title "Anchored mesh system examples" is displayed in a black bar, followed by the "GEOBRUGG" logo. The main content is titled "Highway 101 – near Garberville, CA". It contains two photographs: the left one shows a steep, rocky embankment with a metal mesh system installed, and a road with orange traffic cones in the foreground; the right one shows a similar slope with the mesh system and some green vegetation growing on it.

**Anchored mesh system examples**

**GEOBRUGG**

Hana Highway – Maui, HI



The top section of the slide features a decorative banner with a close-up of a metal mesh system installed on a slope. Below this, the title "Anchored mesh system examples" is displayed in a black bar, followed by the "GEOBRUGG" logo. The main content is titled "Hana Highway – Maui, HI". It contains two photographs: the left one shows a steep, vegetated embankment with a metal mesh system installed, and a road with orange traffic cones in the foreground; the right one shows a similar slope with the mesh system and dense green vegetation growing on it.



**The anchored mesh system in comparison with shotcrete**





Nashville, TN -- parking lot behind a Walmart

17

This slide compares two erosion control methods. The top portion shows a close-up of a wire mesh system installed on a slope. The main image shows a parking lot area with a concrete curb and a gravel base. Behind the gravel, a large, smooth, grey concrete wall (shotcrete) is visible. To the left of the shotcrete wall, a green utility vehicle is parked. The background shows a grassy slope with trees.

**Advantages of the anchored mesh system**





- cost effective solution
- natural appearance, allows revegetation
- a range of meshes and plates allow application to a wide variety of slope conditions
- provides effective static load transfer
- can be fully dimensioned with a design tool

18


This slide lists the advantages of the anchored mesh system. The main image shows a steep, rocky slope covered in a wire mesh system. The mesh is secured with metal anchors. The slope is partially covered with green vegetation. A paved road runs along the base of the slope. The background shows a forest of tall trees.

**Anchored mesh system achievements**




- **Public clients:** DOTs, FHWA, and others
- **Private clients:** Railroads, hydro facilities, mines, commercial, residential
- **Applications:** Soil, rock, erosion, temporary shoring
- > 6 million ft<sup>2</sup> installed in North America
- **The system has been very successful, but ...**



**Full scale testing**



**The Giant Sandbox!**




**Full scale testing**




***Test Program Details:***


- 40' (12m) x 33' (10m) x 4' (1.2m)
- Instrumented anchor bars
- Load cells in boundary ropes
- Multiple soil types – rounded gravel ( $\phi=33^\circ$ ), crushed gravel ( $\phi=38^\circ$ )
- Variable slope angle from  $0^\circ$  to  $85^\circ$
- Multiple meshes and anchor plates
- ***Laser scanning to measure displacement***



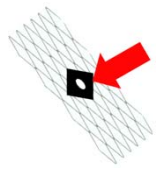

**Full scale testing**





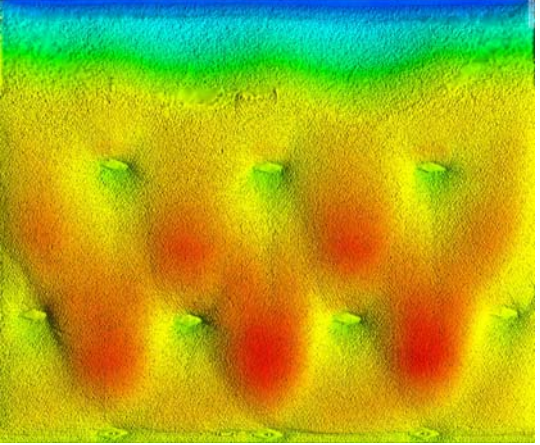
22

**Strength properties of mesh** 

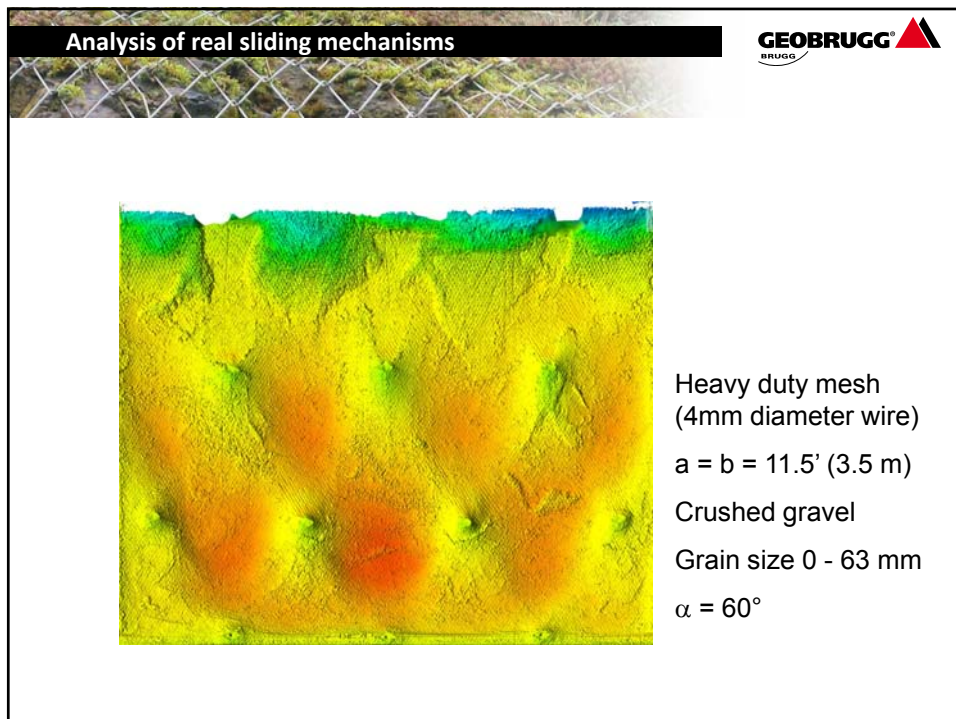
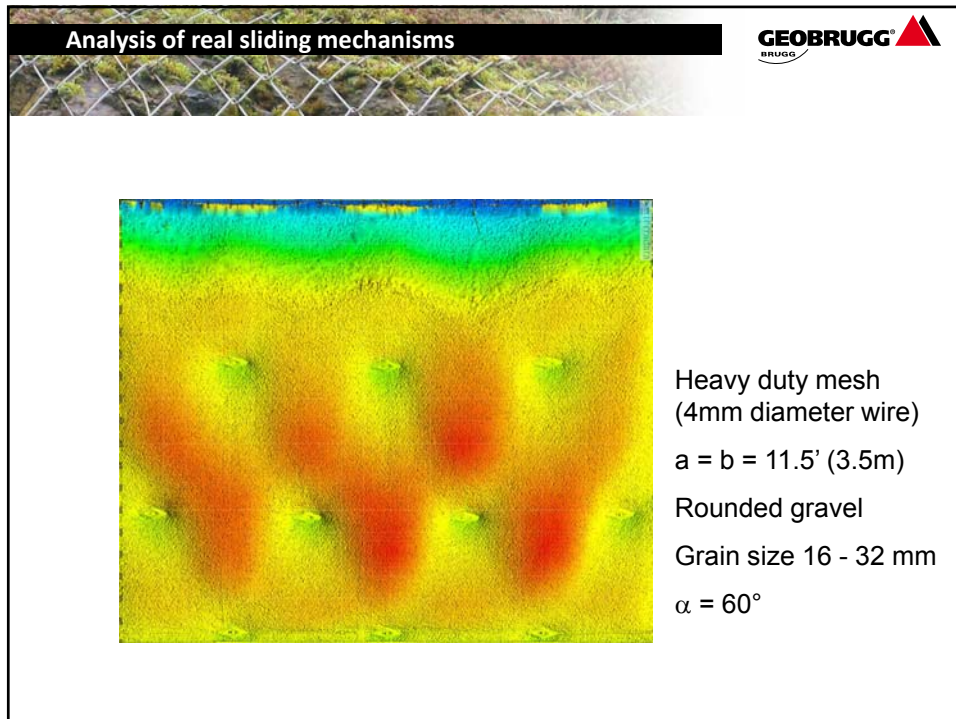


- Longitudinal 
- Transverse 
- Punching 
- Mesh-plate interaction 

**Analysis of real sliding mechanisms** 

Standard duty mesh  
(3mm diameter wire)  
 $a = b = 11.5'$  (3.5m)  
 Rounded gravel  
 Grain size 16 - 32 mm  
 $\alpha = 60^\circ$



### What we learned from the Full-Scale Test

**GEOBRUGG**

- Dimensioning concept validated

Zone of Influence

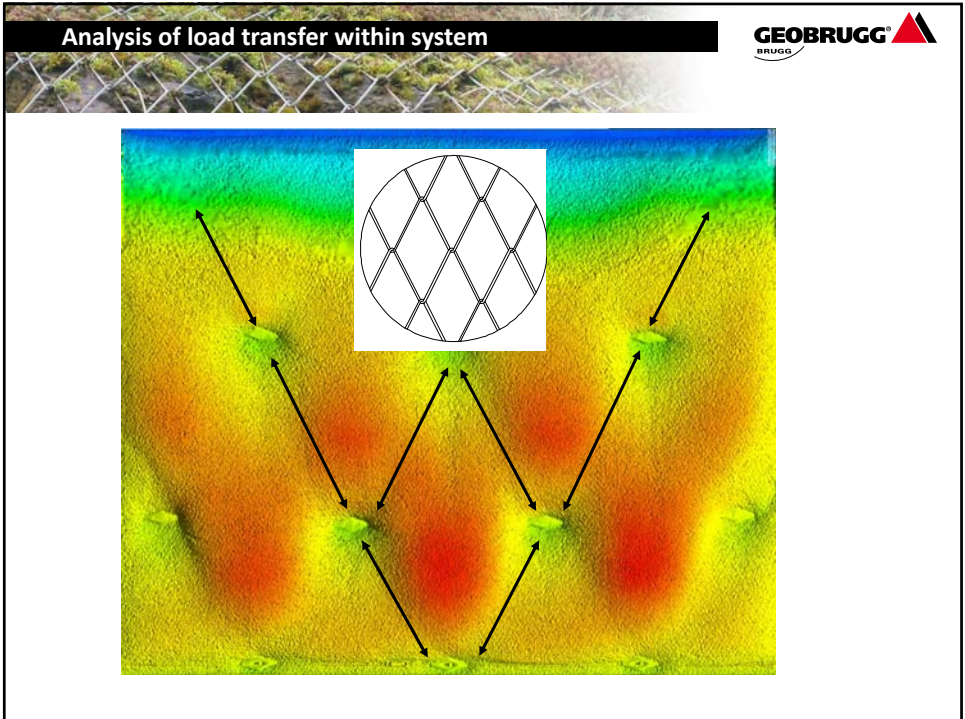
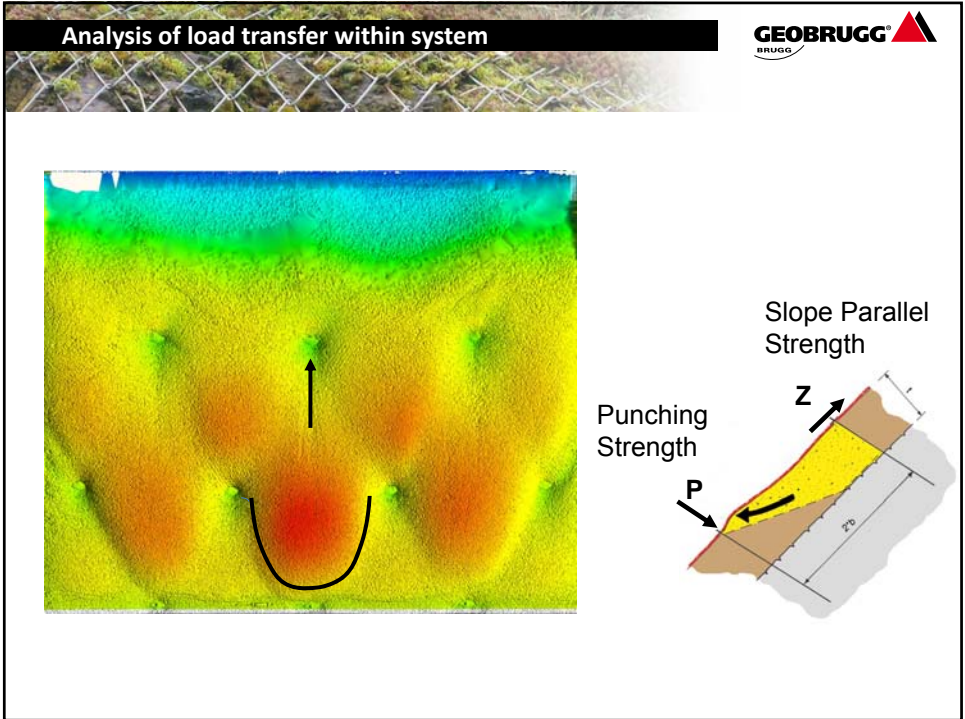
Without Zone of Lateral Influence

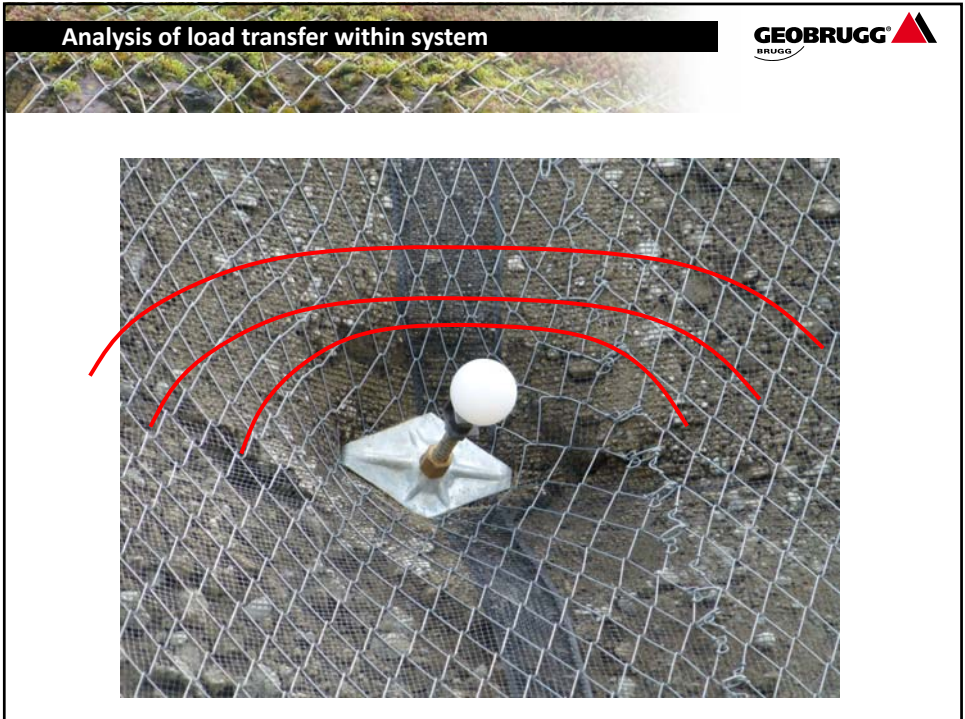
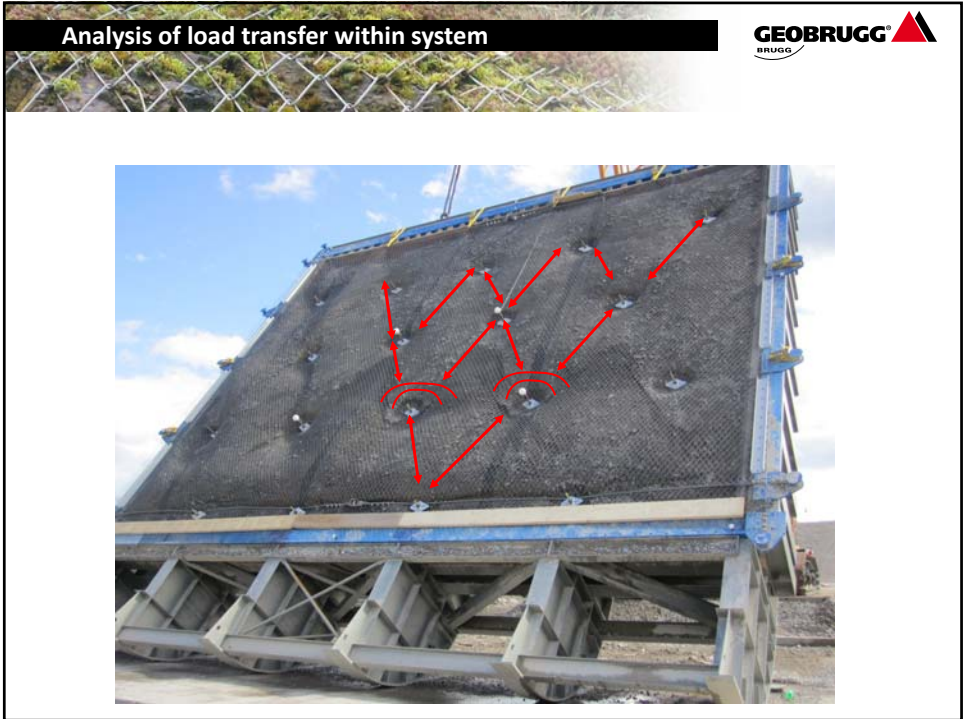
With Zone of Lateral Influence

### Proof of lateral influence of pressure cones

**GEOBRUGG**


mesh










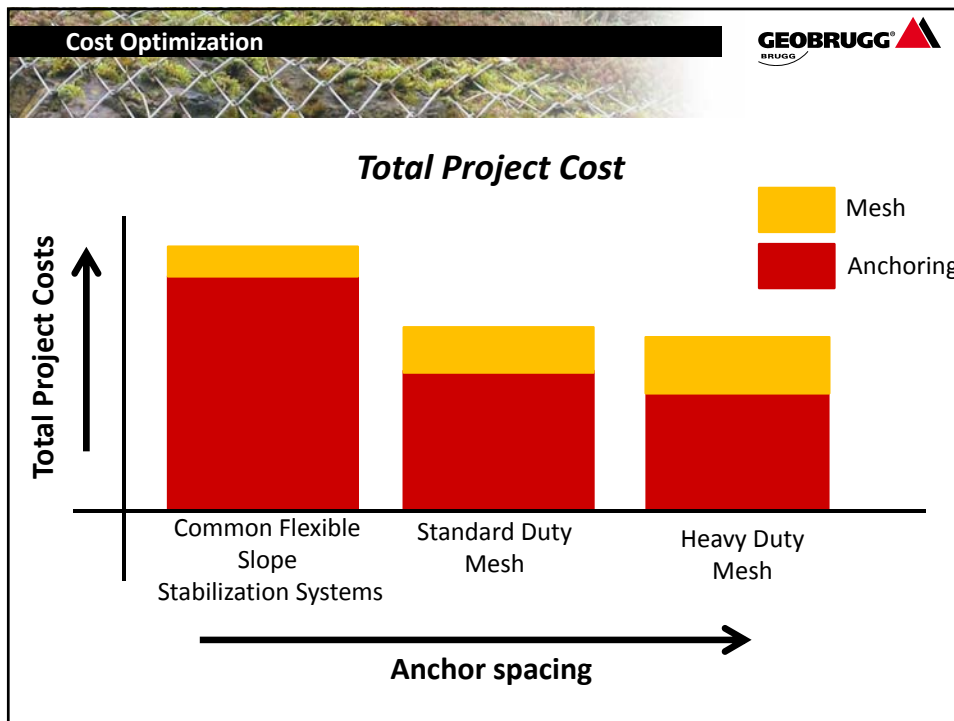
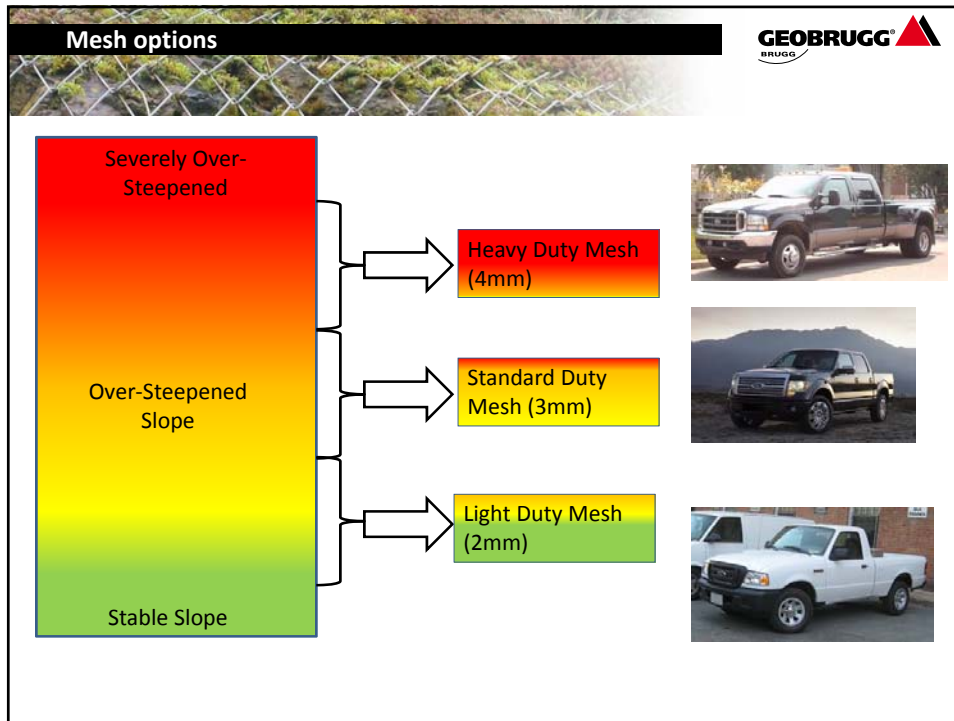
**Comparison of the different slope stabilization systems** **GEOBRUGG** 


Comparison

	Light Duty Mesh (2mm)	Standard Duty Mesh (3mm)		Heavy Duty Mesh (4mm)	
	Small spike plate	Small spike plate	Large spike plate	Small spike plate	Large spike plate
Friction angle [°]	33	33	33	33	33
Design level inclination [°]	42	51	55	56	60
Stabilized angle [°]	9	18	22	23	27

**Load Transfer and Stabilized Angle**






**Critical load transfer** **GEOBRUGG** 

---


**Load transfer in a surficial stabilization system**

Slope → Facing → Spike plate → Anchor → Stable subsoil



**The critical load transfer occurs at the Wire-Plate Interface**

37

**Strength properties of mesh** **GEOBRUGG** 

---

~~Not relevant to system performance:~~

➤ Longitudinal performance:

→ Evenly distributed loads do not occur on slopes

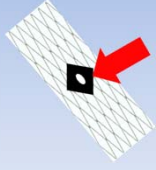
~~Not relevant to system performance:~~

➤ Transverse performance:


→ Gravity

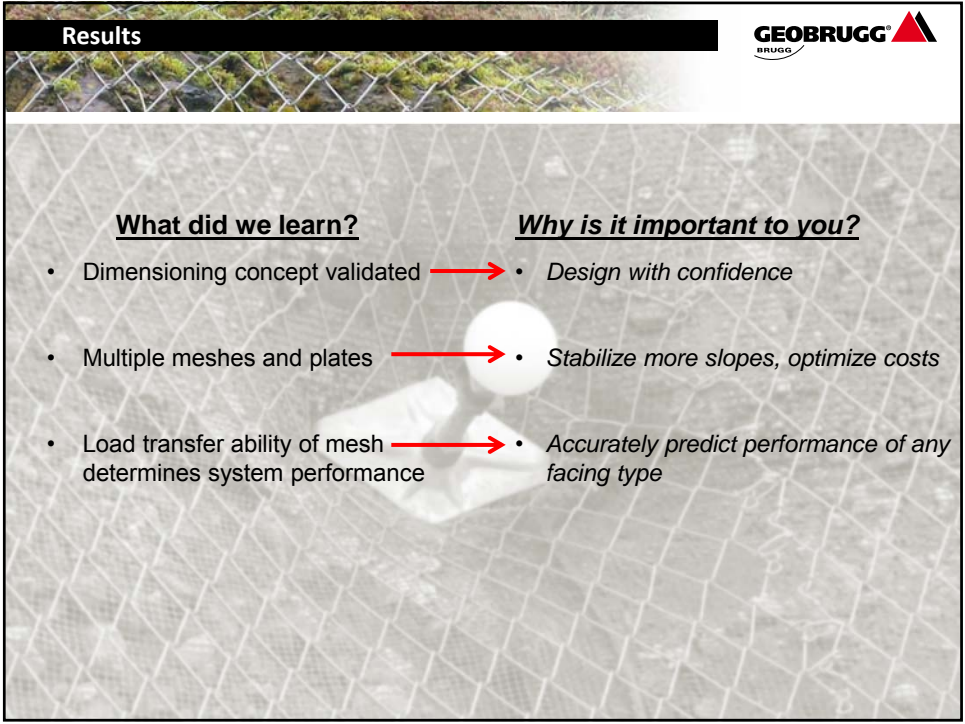
**The critical mesh characteristics for dimensioning and performance:**

➤ Punching



➤ Mesh-plate interaction





**Results**

**GEOBRUGG**

**What did we learn?**

- Dimensioning concept validated
- Multiple meshes and plates
- Load transfer ability of mesh determines system performance

**Why is it important to you?**

- *Design with confidence*
- *Stabilize more slopes, optimize costs*
- *Accurately predict performance of any facing type*