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Regional Engineer
TENCATE
materials that make a difference
TENCATE
Mirafi Road Show

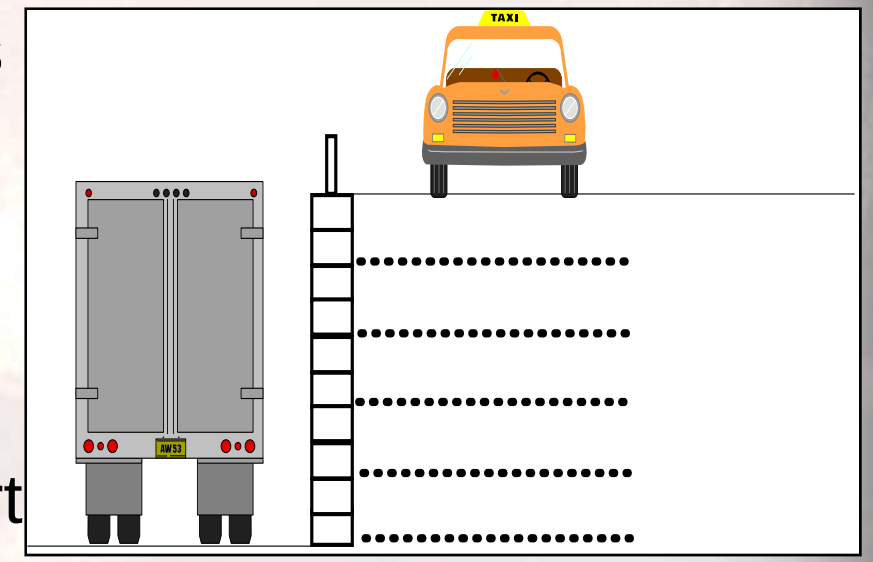
Mechanically Stabilized Earth

Mechanically Stabilized Earth (MSE)

- **Mechanically stabilized earth walls and slopes are constructed with** “reinforced soil” **and consist of horizontal soil reinforcing elements including such things as steel strips, steel or** polymeric grids**, and** geotextile sheets **and a *facing* to prevent erosion.**

Mechanically Stabilized Earth (MSE)

- Placement of horizontal reinforcing elements of this type significantly strengthens the soil and allows construction of **very steep slopes**. Even vertical walls can be constructed without support from a massive structural system at the face.



Mechanically Stabilized Earth: an old experience

Ziggurat :3300 years

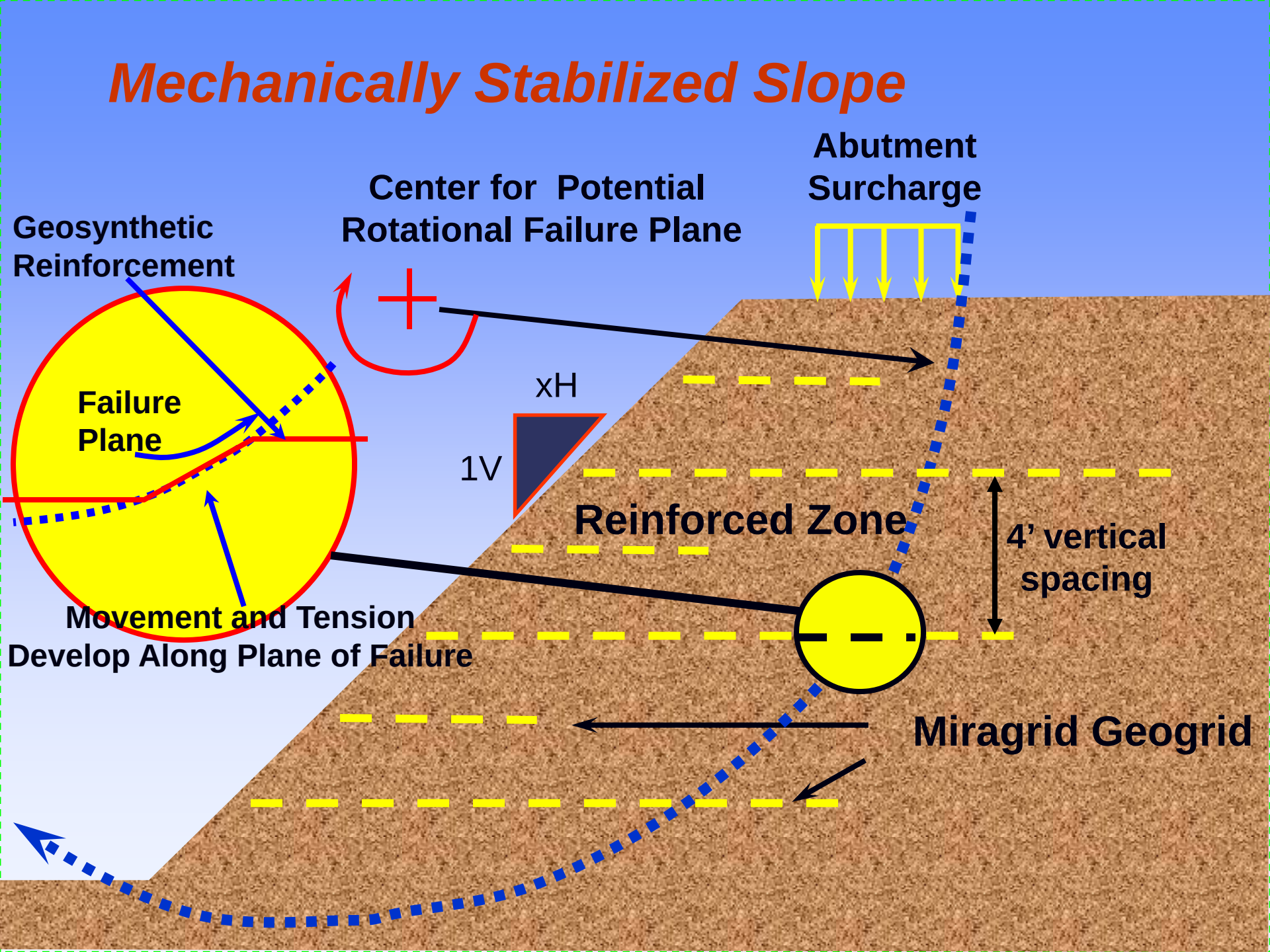
Clay reinforcement with straw

Mechanically Stabilized Earth: an old experience

1976 : Prapoutel, France

1970 : Rouen, France

Mechanically Stabilized Slope



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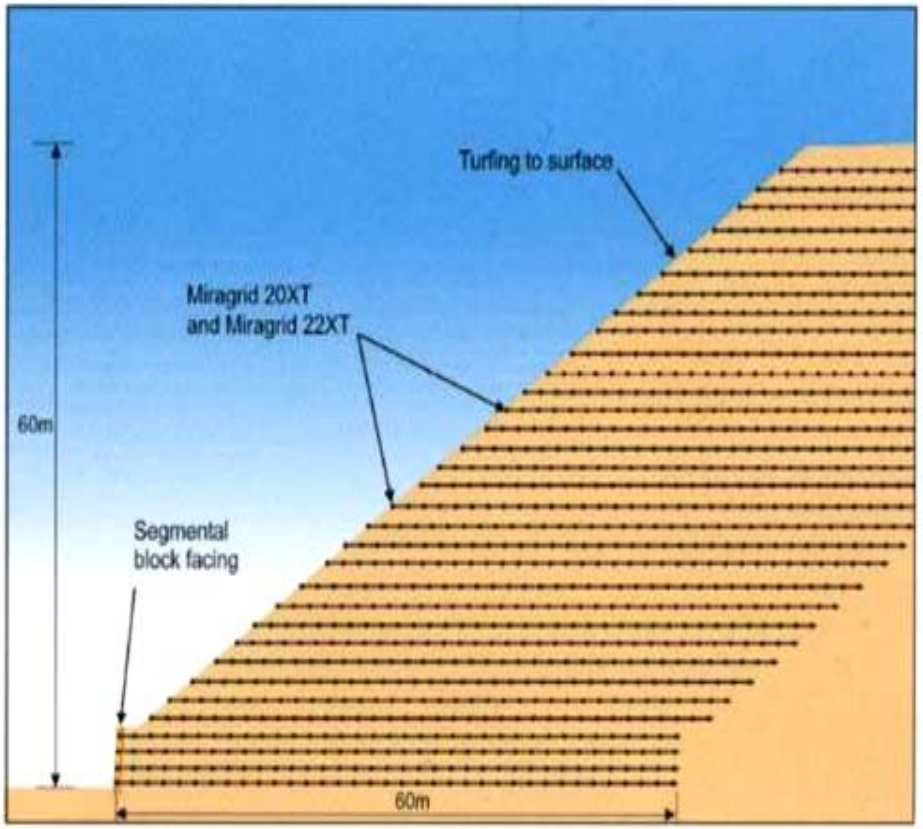
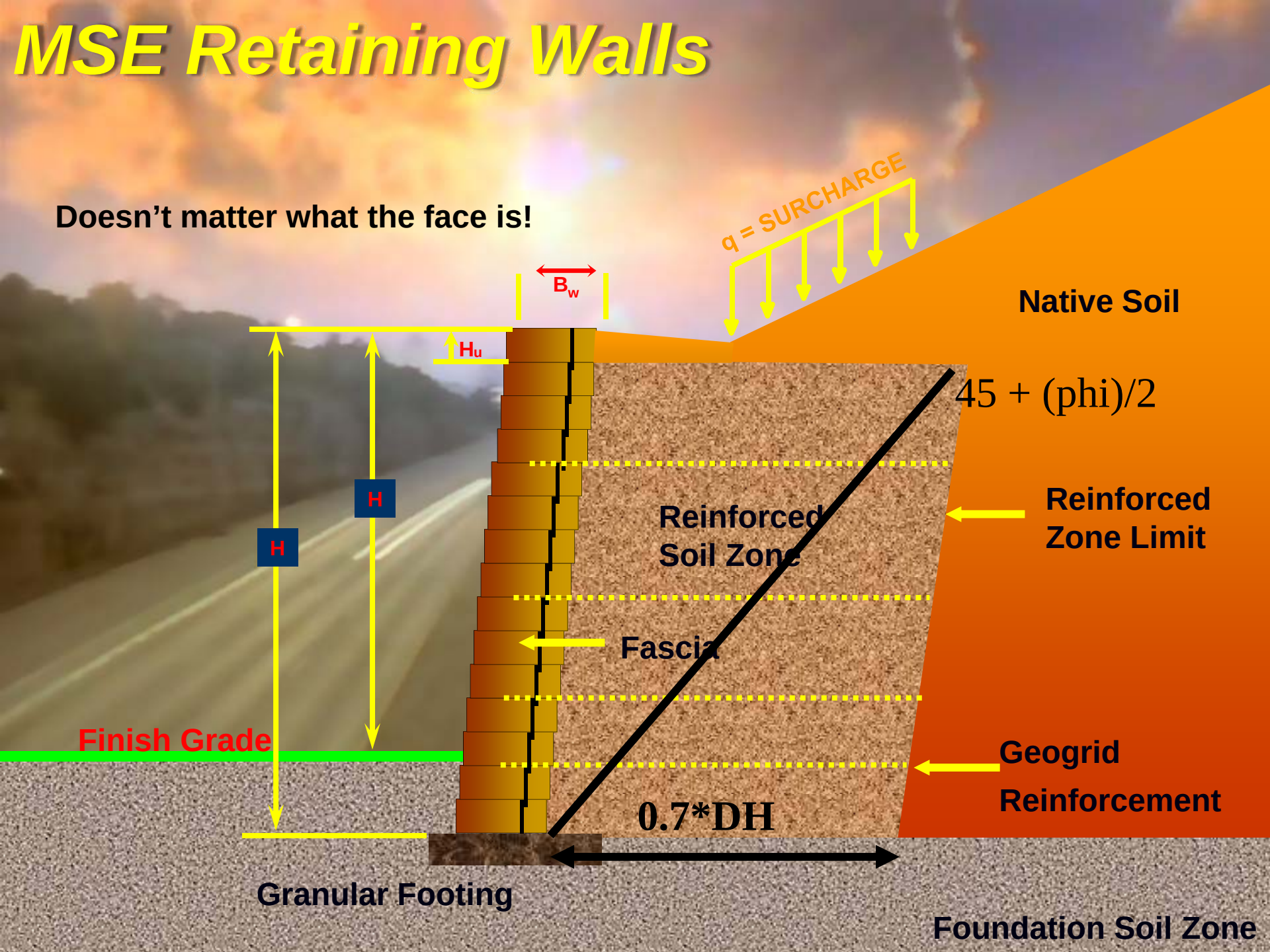
- **Laguna Beach Area, CA**

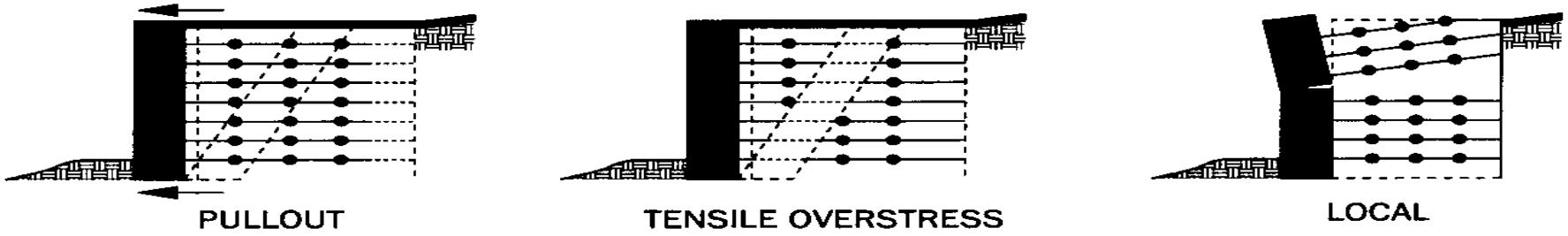


How Steep Can a MSE Slope Go?

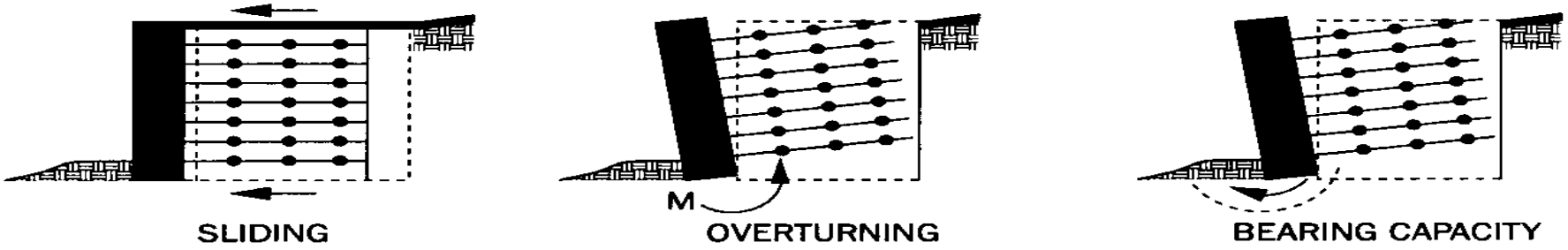
- **> 70 deg. is a retaining wall**

MSE Retaining Walls

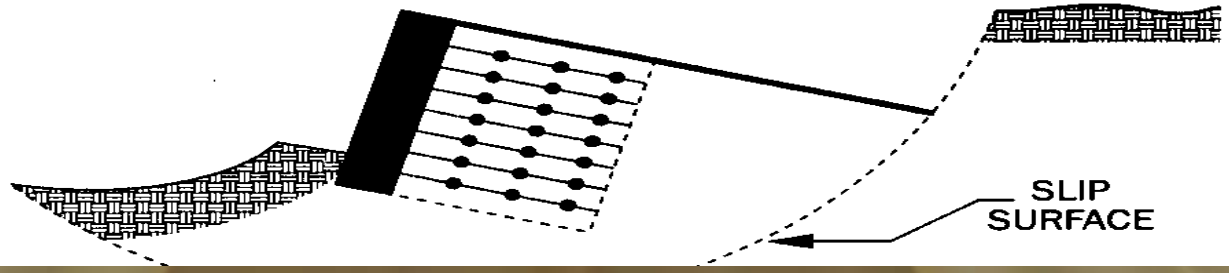




(A) Internal Stability

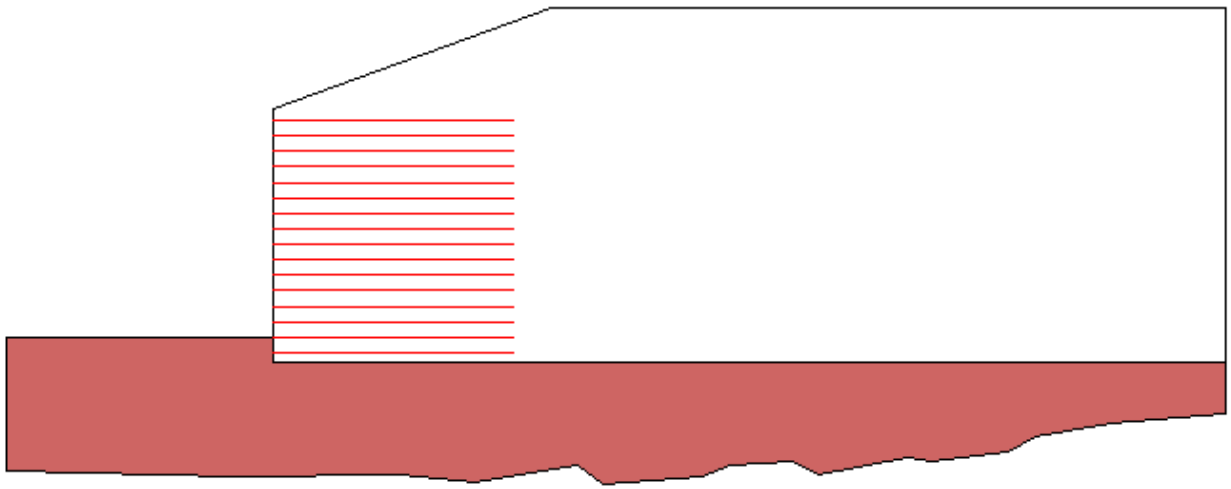


(B) External Stability



Typical MSE Wall

DESIGNED REINFORCEMENT LAYOUT:



SCALE:

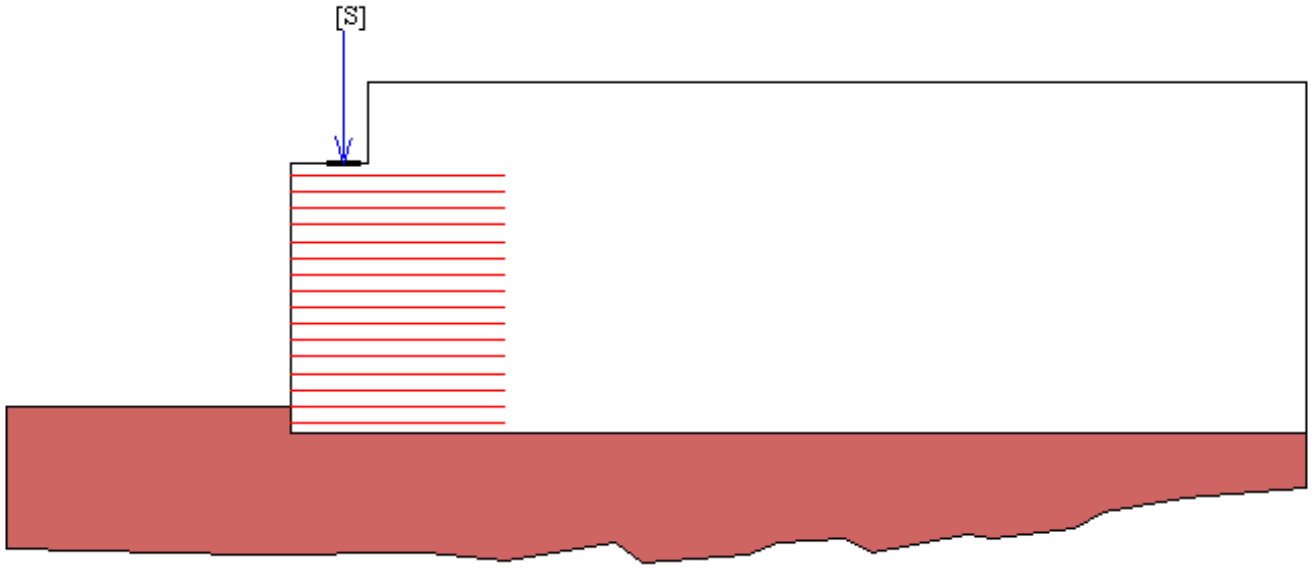
0 2 4 6 8 10 [ft]

Abutment's width, bf = 4.10 at distance from back of wall, cf = 0.66 [ft].
Footing's dimension: height, h' = 4.92, width, b = 0.66, and thickness, t = 1.64 [ft].
Dimensions of bridge bearing plate: height, fh = 0.33, width, fw = 1.64 [ft].

OTHER EXTERNAL LOAD(S)
[S] Vertical Dead Load, Pv-d = 3425.9 and Vertical Live Load, Pv-l = 3425.9 [lb/ft]. (Total of 6851.9 [lb/ft])
The distance from back of the wall is 3.3 [ft].

DESIGNED REINFORCEMENT LAYOUT:

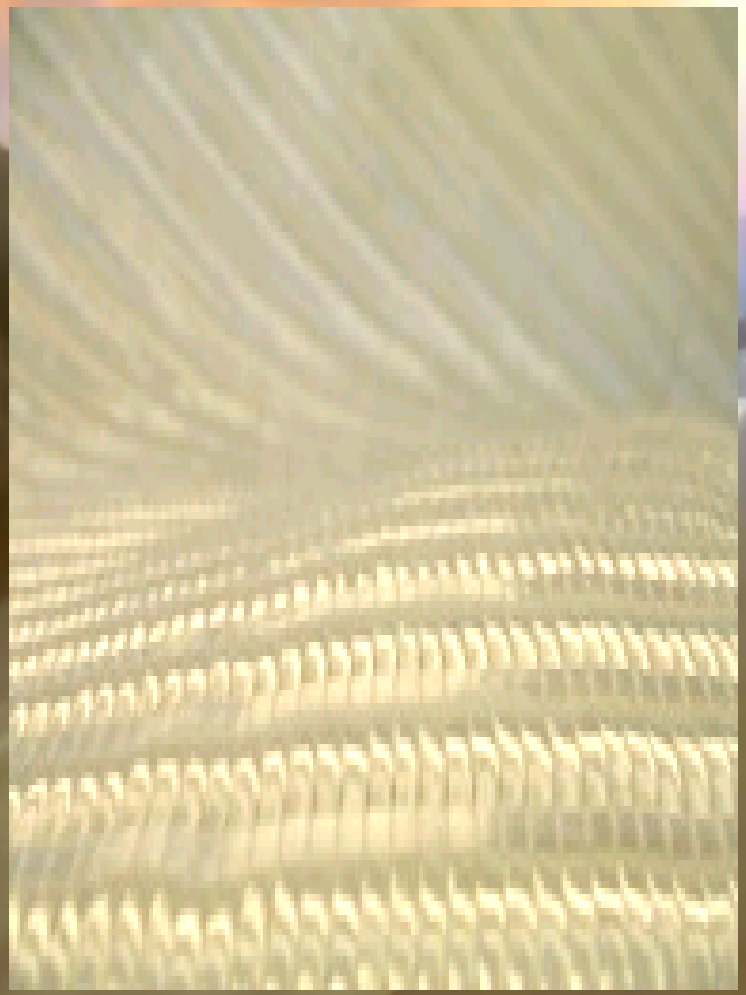
Typical MSE Bridge Abutment



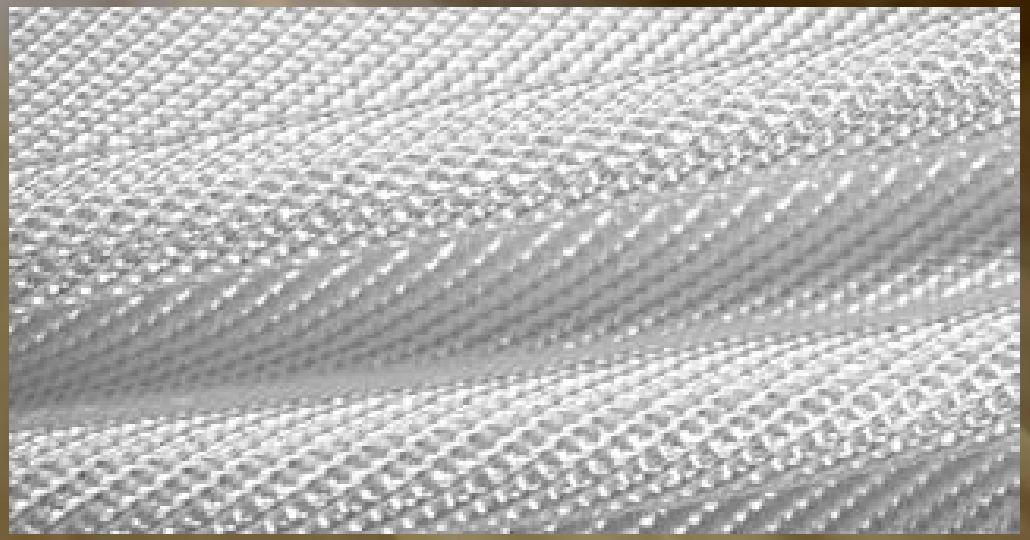
SCALE:

0 2 4 6 8 10 [ft]

PET / HS Woven Polyester



- Low creep behavior for long term structural stability and more economical design.
- Geotextile comprised of high tenacity polyester fibers.

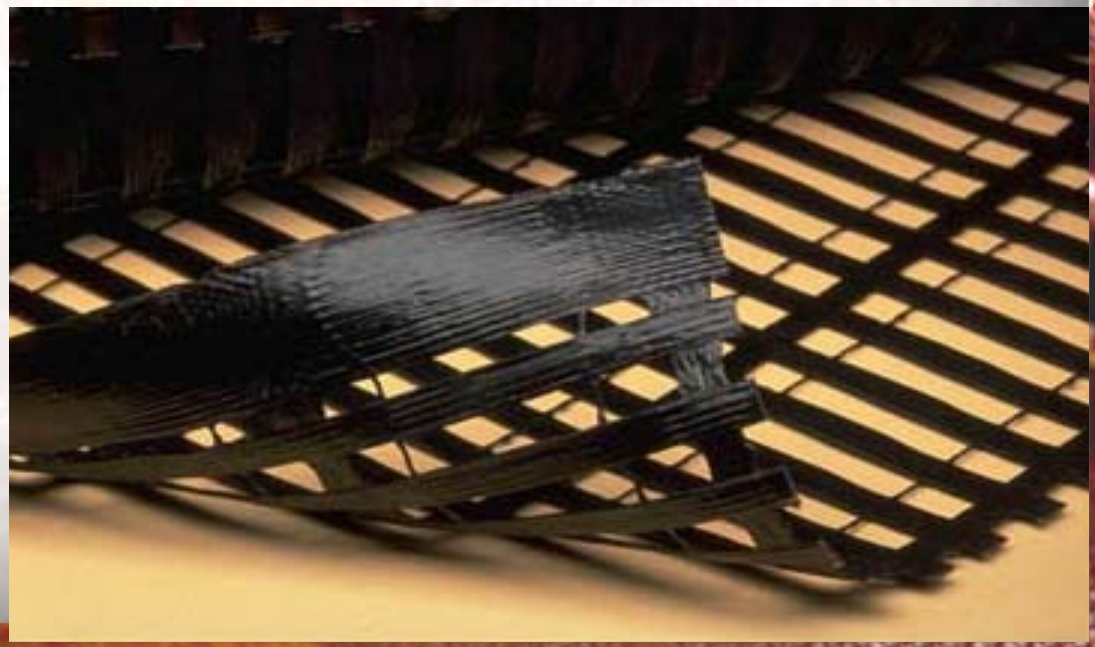


Polypropylene Geotextiles

- **For High Strength Short-Term Loading**
- **For Low Strength Long-Term Loading**

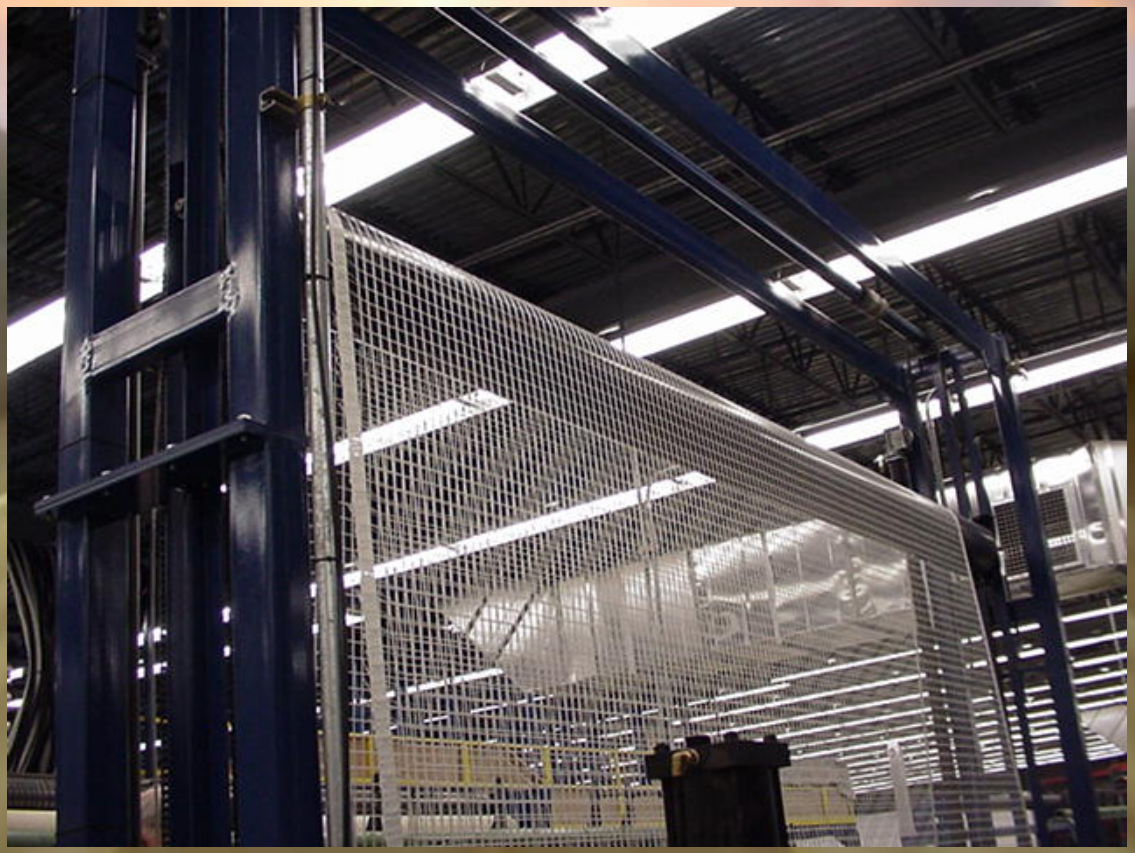
Geogrids

- **High Strength Polyester Coated Geogrid or HDPE Uniaxial grids for Long-Term Projects**
- **Polypropylene Biaxial for Short-Term Loading**



Polyester Yarn

Woven into Grid or Solid Pattern



Long Term Design Strength

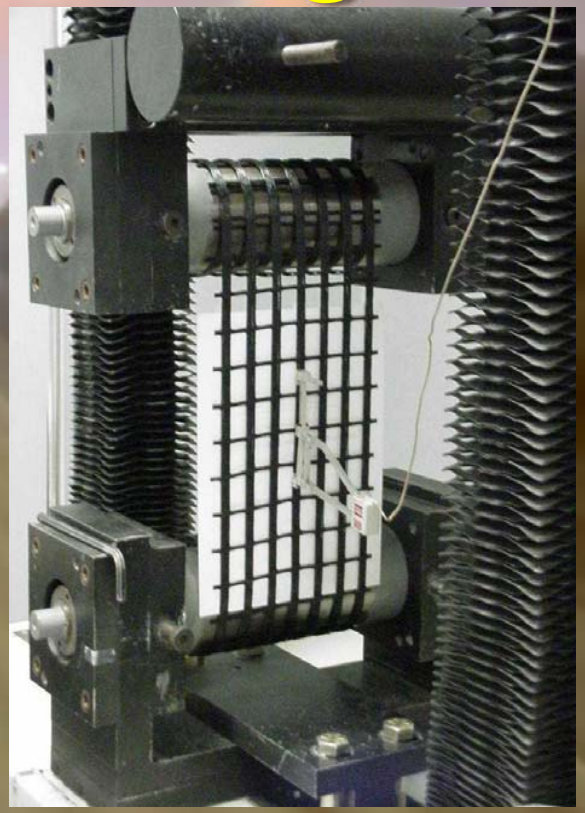
- Industry accepted method to determine the long term usable strength of a geogrid product
- Based on NCMA or AASHTO standard

$$\text{LTDS} = \frac{\text{Ultimate Wide Width Tensile Strength}}{RF_{ID} \times RF_{CR} \times RF_{D}}$$

LTDS ≈ 40% of Wide Width Tensile Strength (PET)

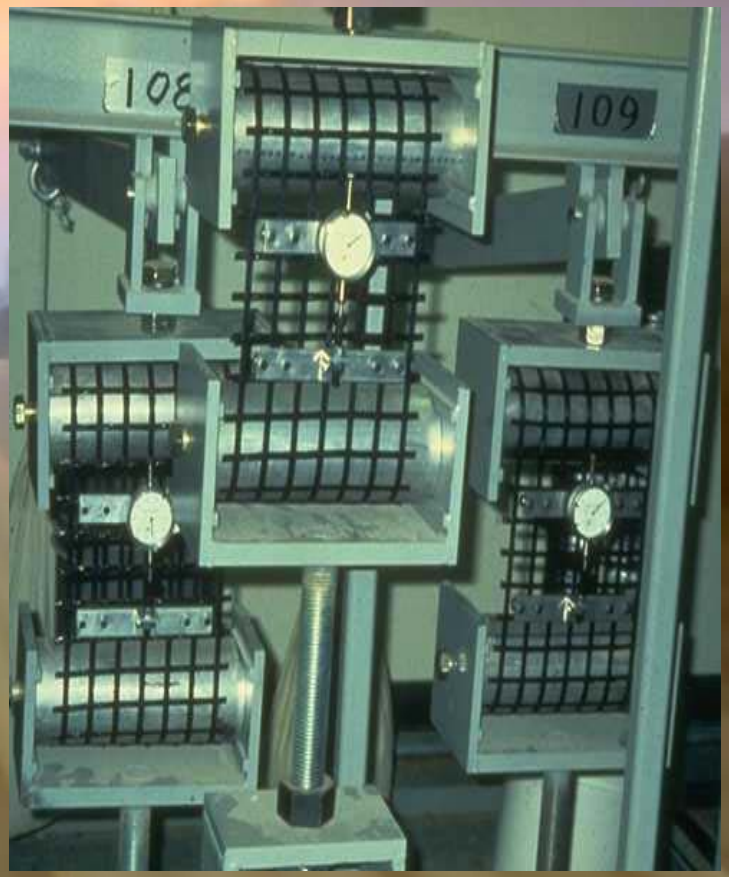
Wide Width Tensile Strength

- Measures the ultimate tensile strength of the geogrid
- Tested per ASTM D 6637 (8” specimen size)
- Reported in force / unit of measure (i.e., lbs/ft or kN/m)

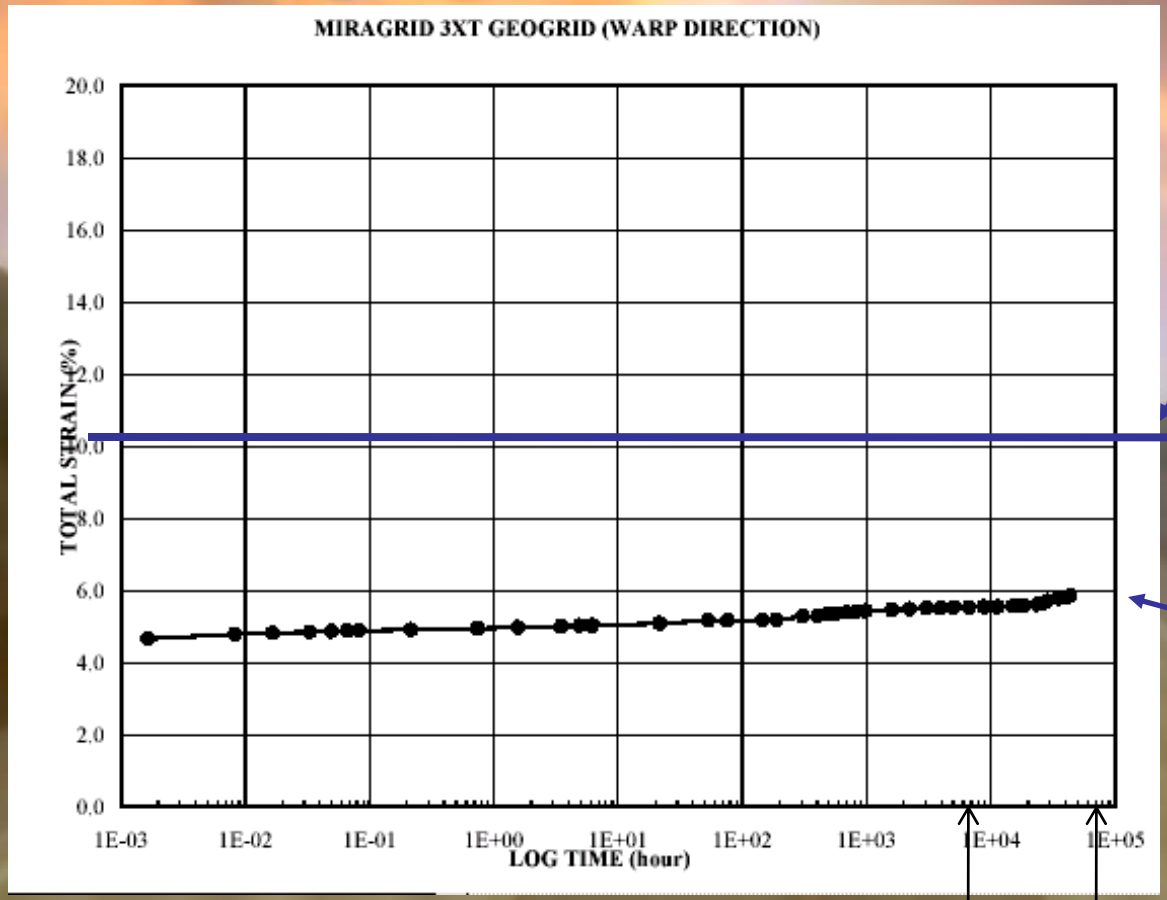


Creep Testing

- Measures the resistance of the geogrid to creep (sustained load)
- All polyester geogrids generally have the same creep resistance
- Polyester is much less susceptible to creep than polypropylene or polyethylene geogrids
- RF_{CR} is typically between 1.51 to 1.75 depending on polyester geogrid manufacturer
- 1.6 typical



Creep Testing



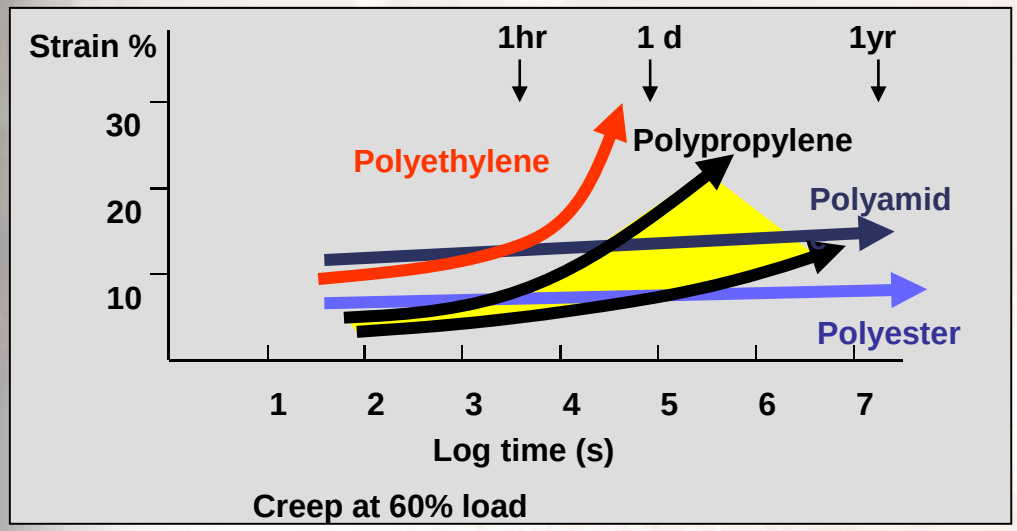
Limit total strain to be less than 10% after 75 years

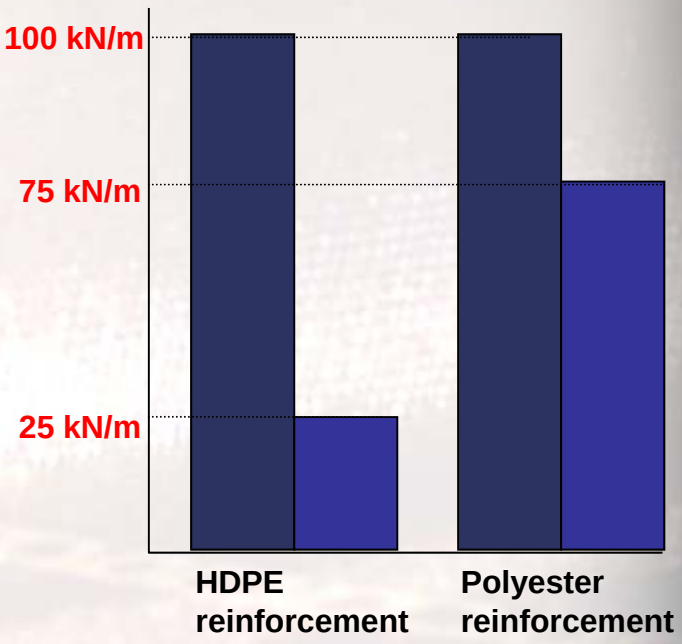
Set at percentage of the ultimate strength and record changes in strain level (creep strain rate). 62.5% of ultimate wide width

1 year **10 years**

Analysis of Different High Strength Geosynthetics

Creep comparison of HDPE and Polyester geogrids for Long Term Design Strength





Long term design strength (LTDS)

= Ult. Tensile strength / (fs_{creep}. fs_{mat}. fs_{env}. fs_{damage})

Back to MSE Navigation Slide

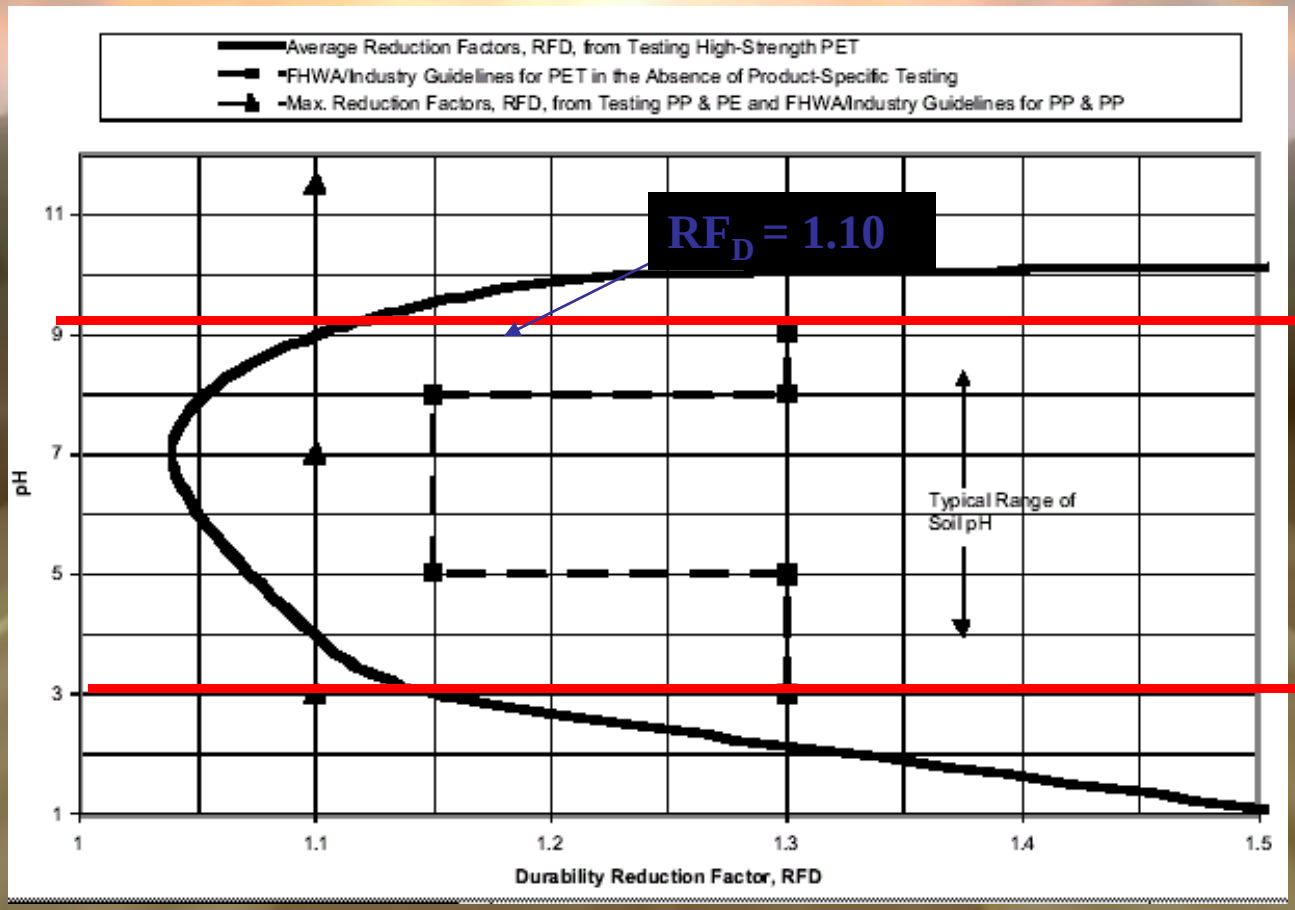
Installation Damage Testing

- Measures the installation damage effects on the geogrid
- In general, the lighter the geogrid, the lower the resistance to installation damage
- RF_{ID} is typically between 1.05 to 1.75 depending on soil type
- Most geogrid companies will report LTDS for three soil types
- Default soil type is sand

Durability Research (FHWA)

- Measured the resistance of the polyester yarns to degradation due to various pH ranges
- All polyester geogrids generally have the same resistance to chemical degradation if:
  - CEG < 30 (carboxyl end group)
  - Molecular weight > 25,000

Durability Testing (FHWA)



NHI Limits on Soil pH

Long Term Design Strength

- **Sample calculation, Miragrid 5XT in sand**
  Wide Width Tensile Strength = 4300 lbs/ft
  RF_{ID} = 1.05, RF_{CR} = 1.6
  RF_D = 1.10 (typical soil pH range)

$$LTDS = \frac{\text{Ultimate Wide Width Tensile Strength}}{RF_{ID} \times RF_{CR} \times RF_D}$$

LTDS = 4300 / (1.05 x 1.6 x 1.10) = 2327 lbs/ft

Geosynthetic Property *	Test Method	Unit	Polypropylene	HDPE	Polyester
Ultimate Tensile Strength	GRI-GG1	lbs./ft. (kN/m)	5,775(84.3)	2,657(38.8)	1,848(27.7)
Creep Reduction Factor	ASTM D5262		5	2.3	1.6
Biological/Chemical Reduction	FHWA		1.1	1.1	1.1
Installation Damage Reduction	ASTM D5818		1.05	1.05	1.05
Long Term Allowable Design Load	GRI GG4	lbs./ft. (kN/m)	1,000(15)	1,000(15)	1,000(15)

All Plastics Stretch

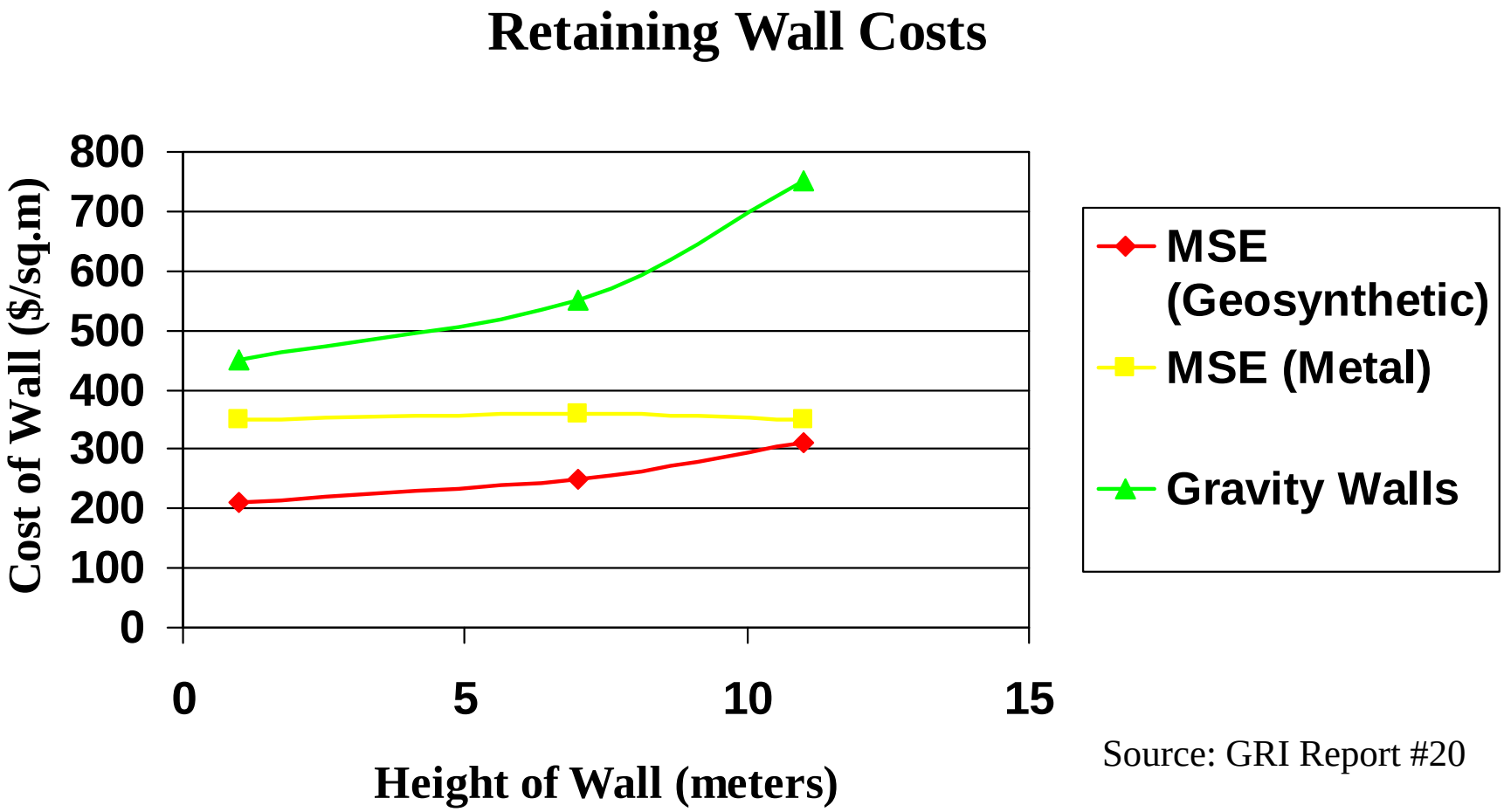
Some Plastics ***S T R E T C H*** more!

MSE Retaining Walls

- **Advantages**
  - **Aesthetics**
    - MSE Walls can be built with infinite types of facing
  - **Performance**
    - MSE Walls are flexible systems that can tolerate movement
  - **Economics**
    - One of the best values in earth retaining wall systems


3
4
5

Mechanically Stabilized Earth Walls

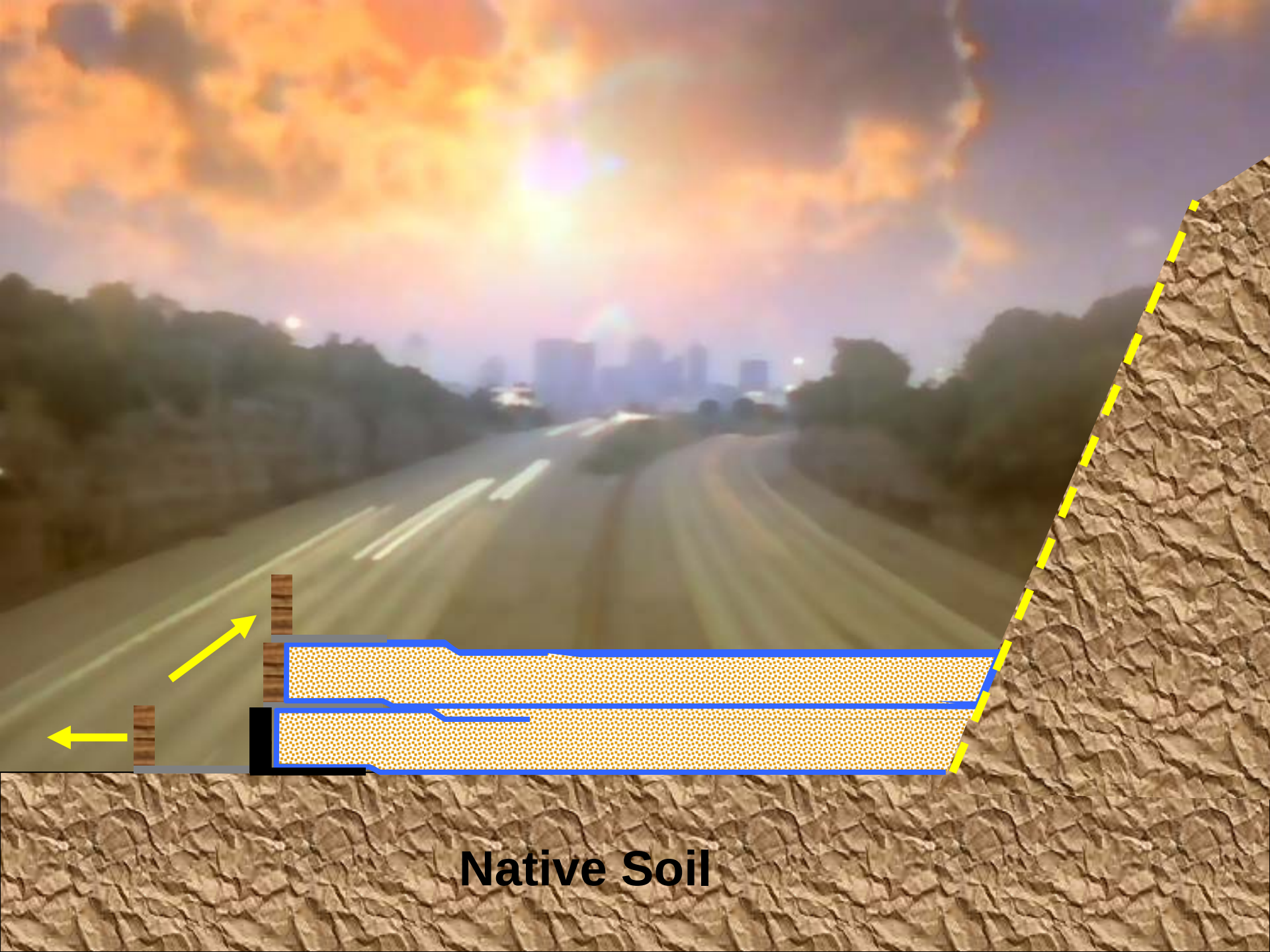


Source: GRI Report #20

3 Main Types of MSE Abutment Walls

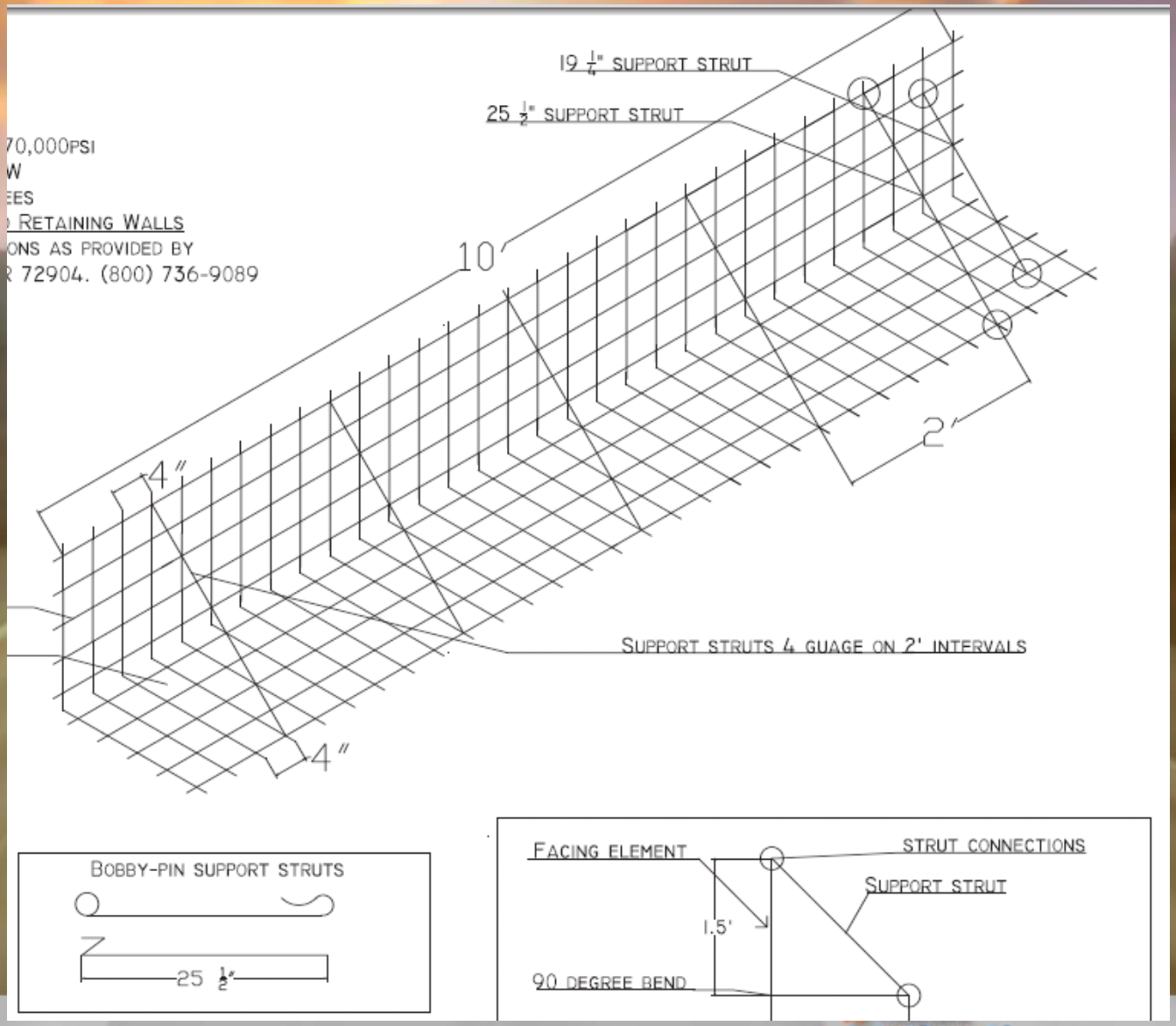
- **Traditional Fabric Faced (wood formed).**
- **Wire Basket Faced (Baskets left in place).**
- **Segmental Block Walls**

Traditional Wood Formed Fabric Wrapped Face Walls


Native Soil


Wooden Forms

Welded Wire Baskets

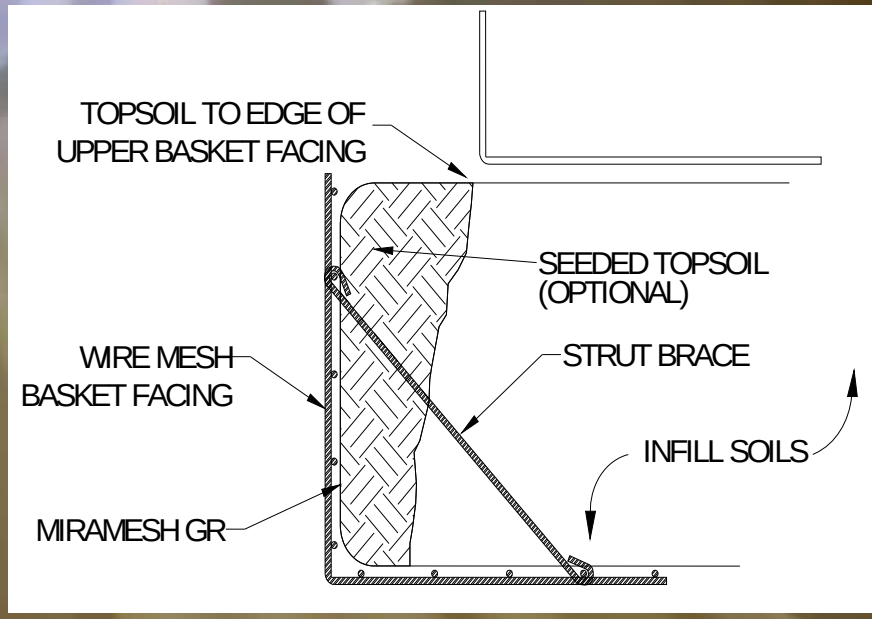


Facing Options

Wire Basket

Welded Wire Basket Bridge Abutment

- **Vegetated wall system**



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Welded Wire Basket Face

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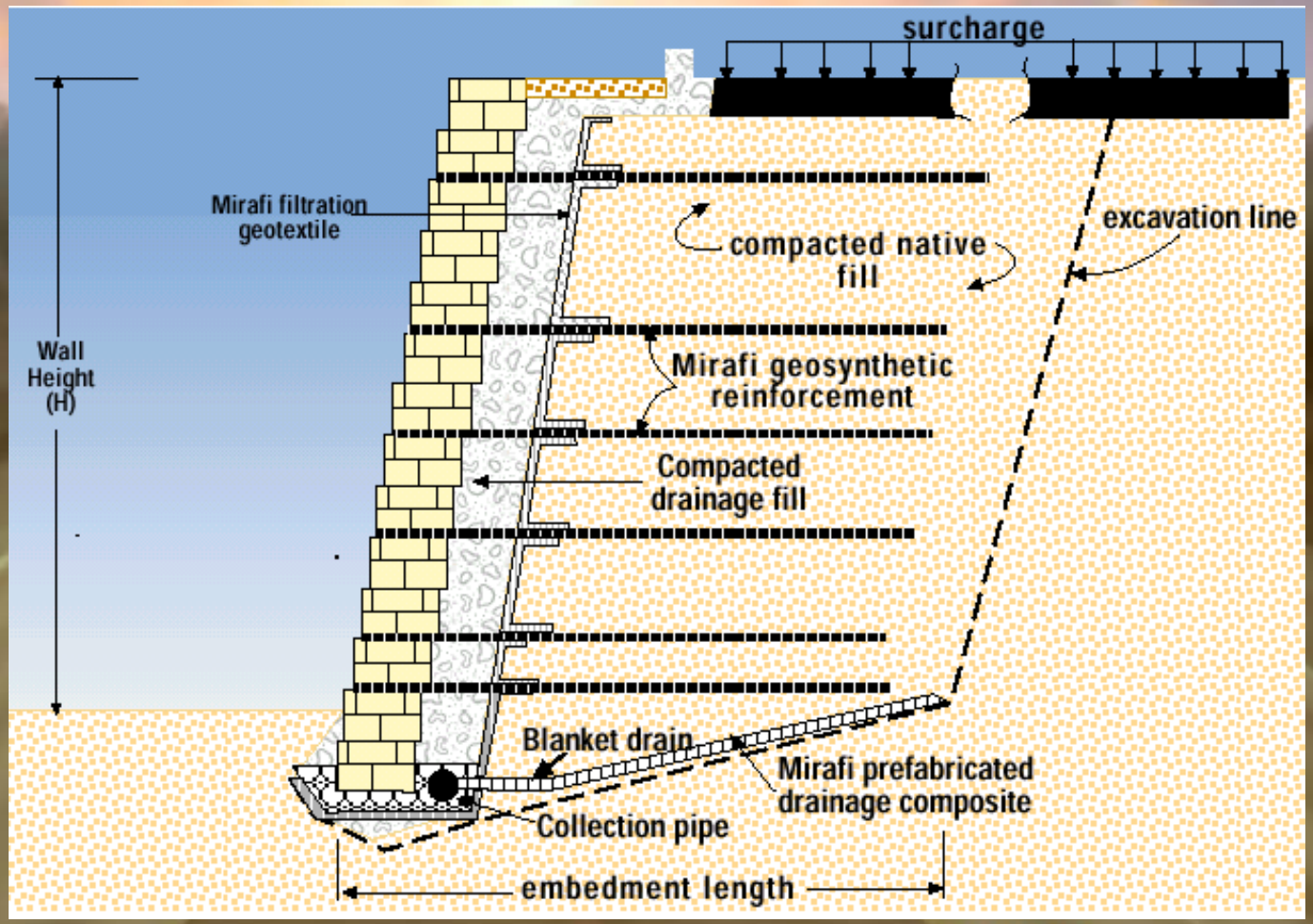
Segmental Block Retaining Walls/Abutments



Installation Issues

Installation Issues

Installation Issues

No reinforcement

Wrong orientation!

Installation Issues

Poor Compaction

Incorrect reinforcement

Installation Issues

Incorrect drainage

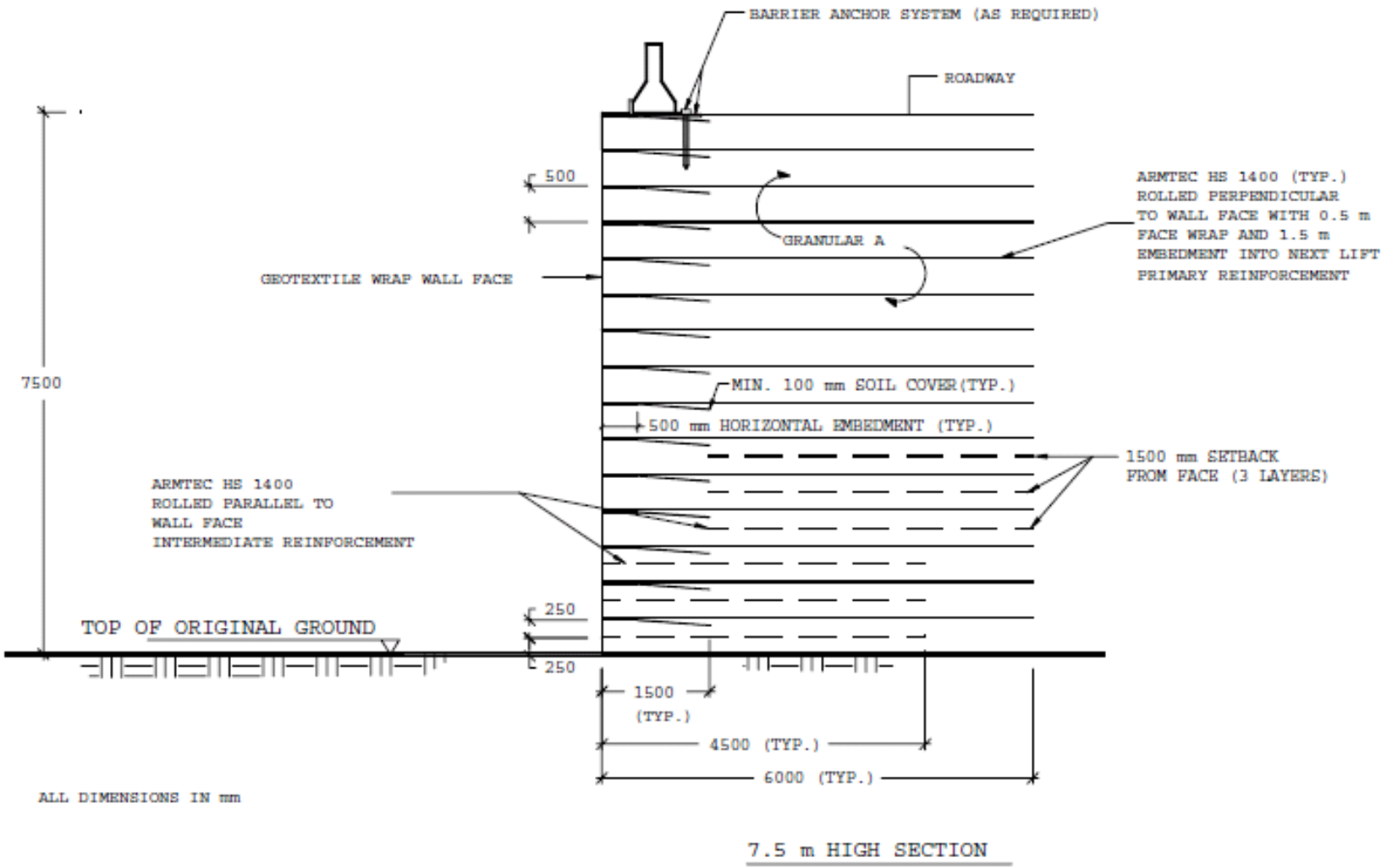
Reinforcement spacing

Installation Issues

Case Histories

Project: Bridge Construction

Location: Manitoba, Canada


BARRIER ANCHOR SYSTEM (AS REQUIRED)
ROADWAY
500
GRANULAR A
ARMTEC HS 1400 (TYP.)
ROLLED PERPENDICULAR
TO WALL FACE WITH 0.5 m
FACE WRAP AND 1.5 m
EMBEDMENT INTO NEXT LIFT
PRIMARY REINFORCEMENT
GEOTEXTILE WRAP WALL FACE
7500
MIN. 100 mm SOIL COVER(TYP.)
500 mm HORIZONTAL EMBEDMENT (TYP.)
1500 mm SETBACK
FROM FACE (3 LAYERS)
ARMTEC HS 1400
ROLLED PARALLEL TO
WALL FACE
INTERMEDIATE REINFORCEMENT
TOP OF ORIGINAL GROUND
250
250
1500
(TYP.)
4500 (TYP.)
6000 (TYP.)
ALL DIMENSIONS IN mm
7.5 m HIGH SECTION

Gabion Wall at bridge abutment. Fabric wrapped wall in background.

Metrolink - St. Louis, MO

- **Keystone with Mirafi Miragrid Geogrids**
- **30’ Max Height**

Case Histories

Project: Bridge Abutment

Location: Missouri, USA

Case Histories

Project: Airport Access Road

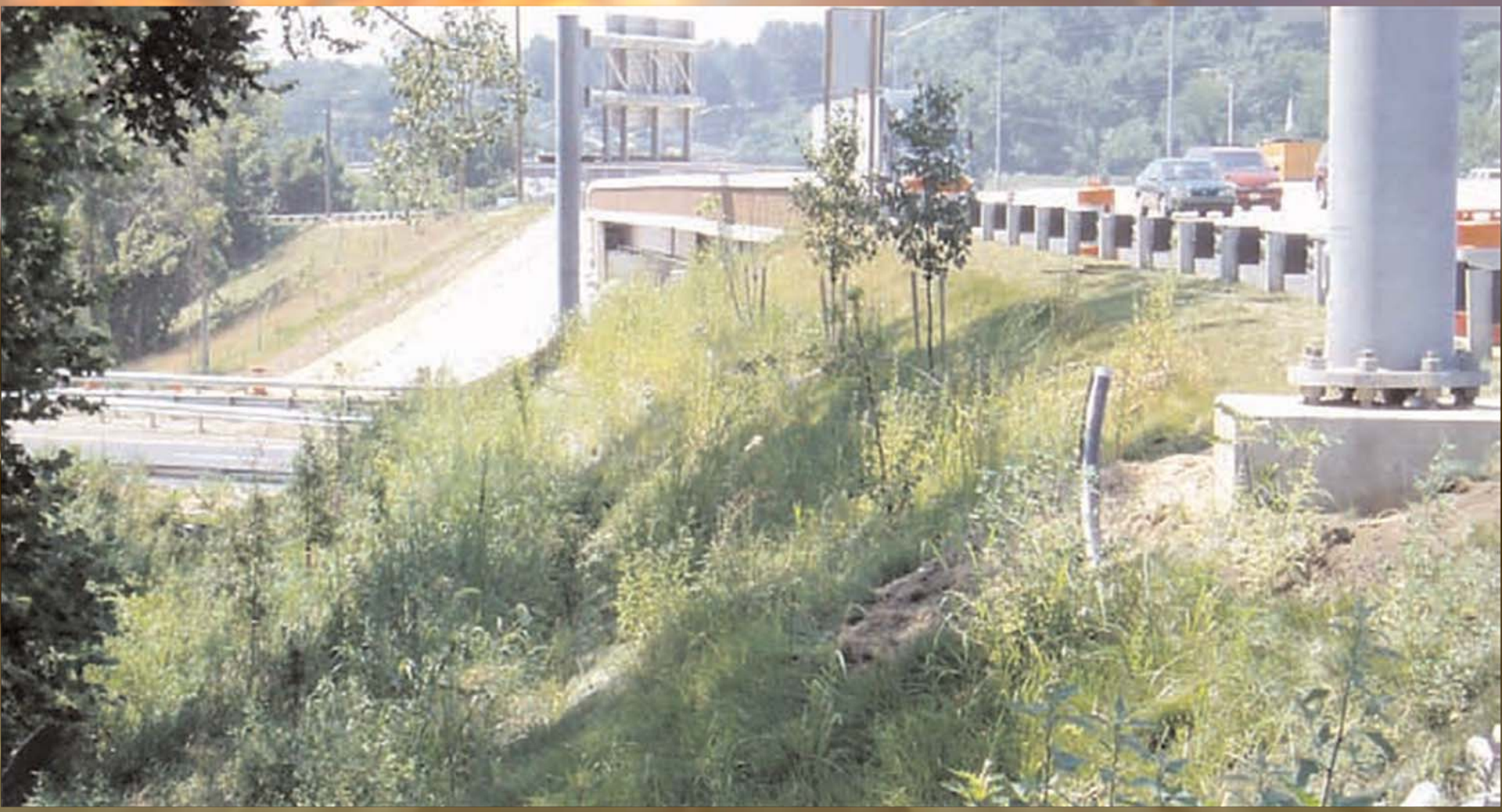
Location: Missouri, USA

Project:
CalTrans PGR Wall – 74’ Tall!

Location:
5/805 freeways San Diego,

afi Road Show

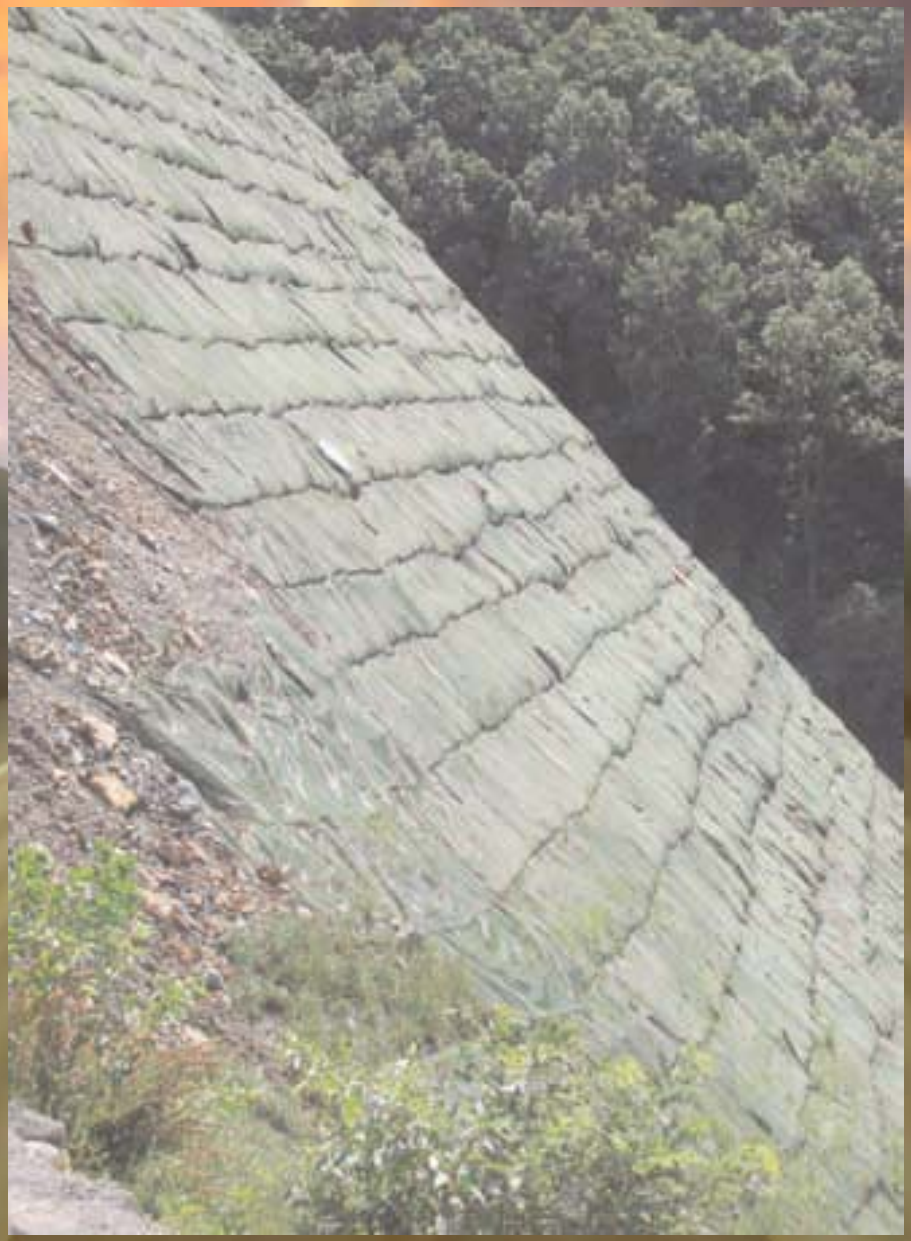
I695
MDSHA



Mission Viejo, CA
Bridge Abutment

Highest 1:1 mse slope in America
242’ high

Extension of Runway 5 at Yeager Airport in
Charleston, WV

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