PAVESTONE

QUIKRETE®
CEMENT & CONCRETE PRODUCTS™

Segmental Retaining Wall Presentation

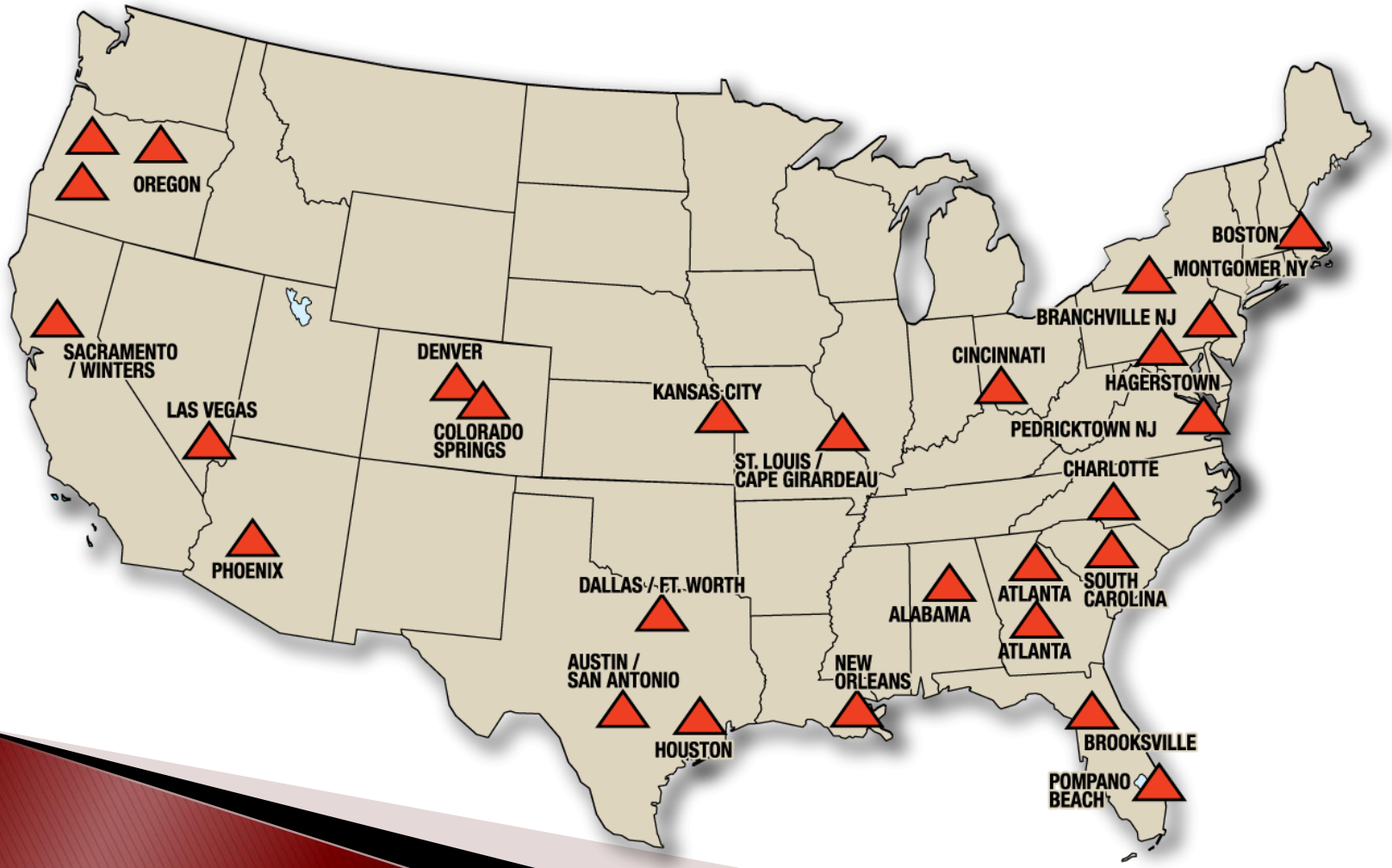
Presented by
Dave Hasness, PE

- Who We Are
- Products & General Applications
- Basic Design Concepts Using Geogrids for Reinforcement
- Colors and Textures
- Design Concepts Using Structural Backfill
- Closure

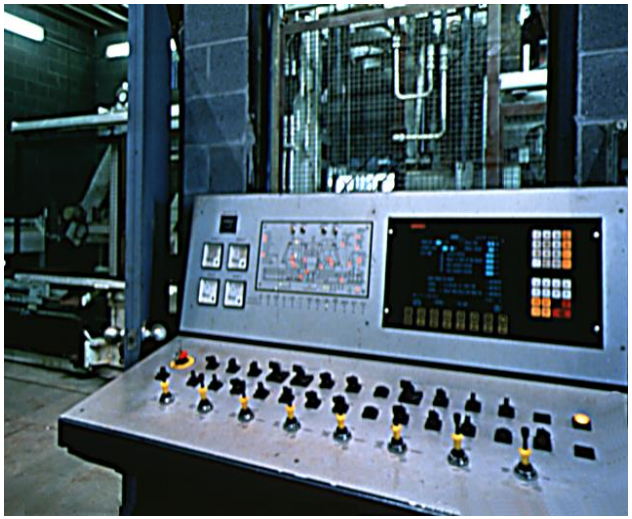
Private USA National Company

27 Manufacturing Plants

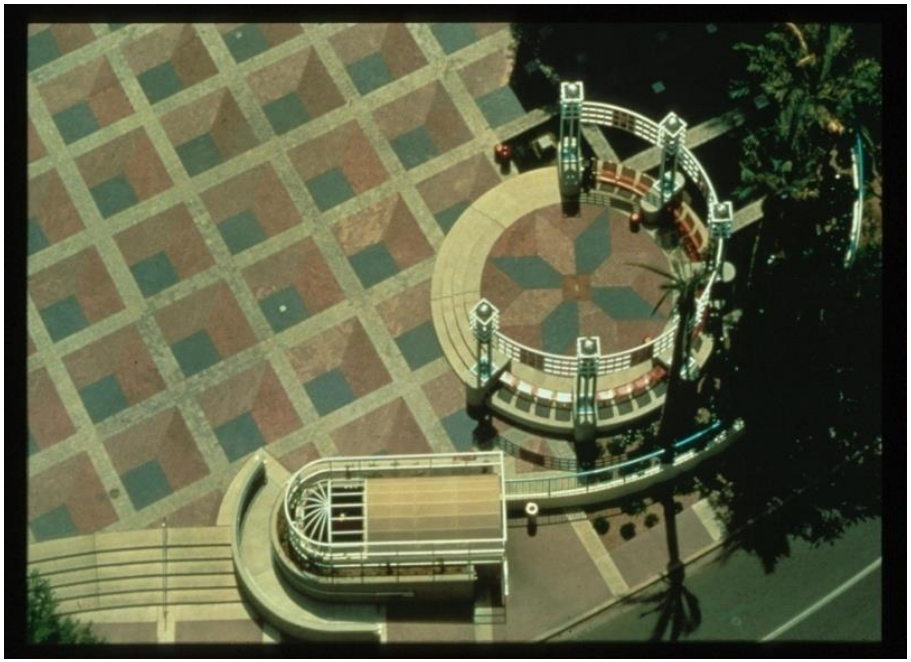
Servicing the US Market for 35 Years



Manufacturing



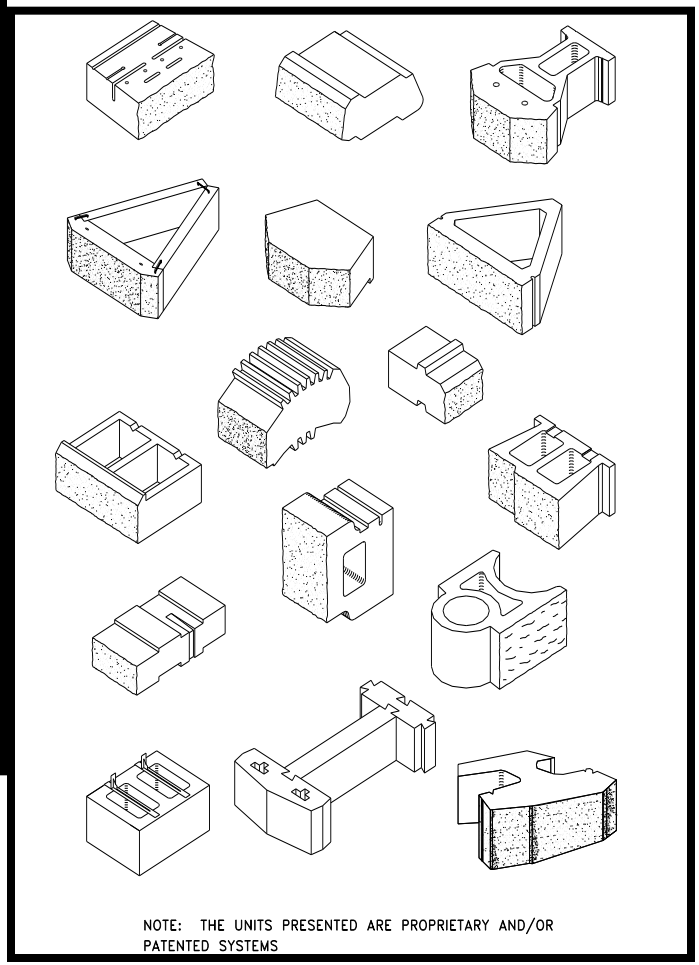
Segmental Paving Product Group



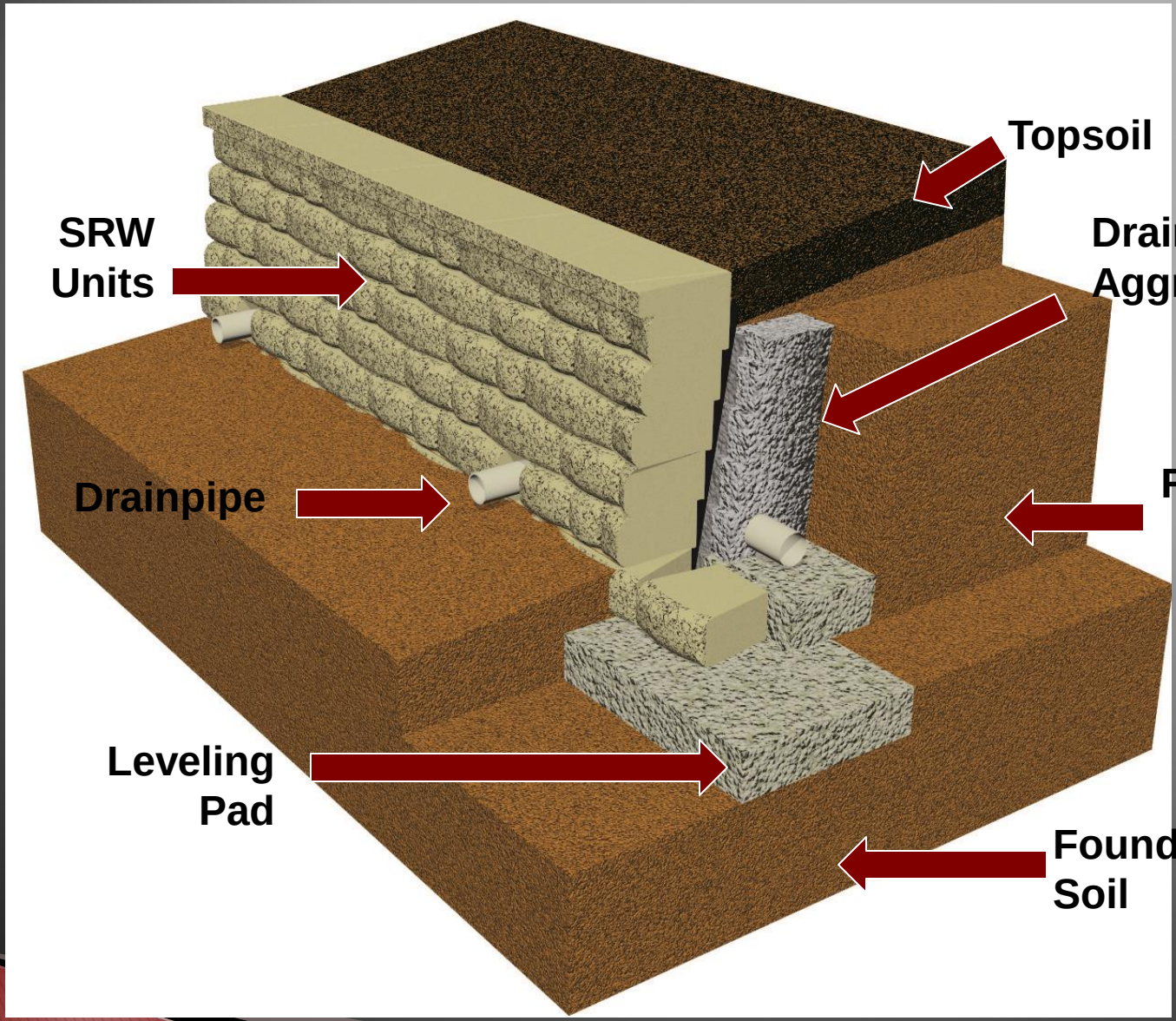
Gragg Park Complex – Houston, TX

Segmental Retaining Wall Product Group

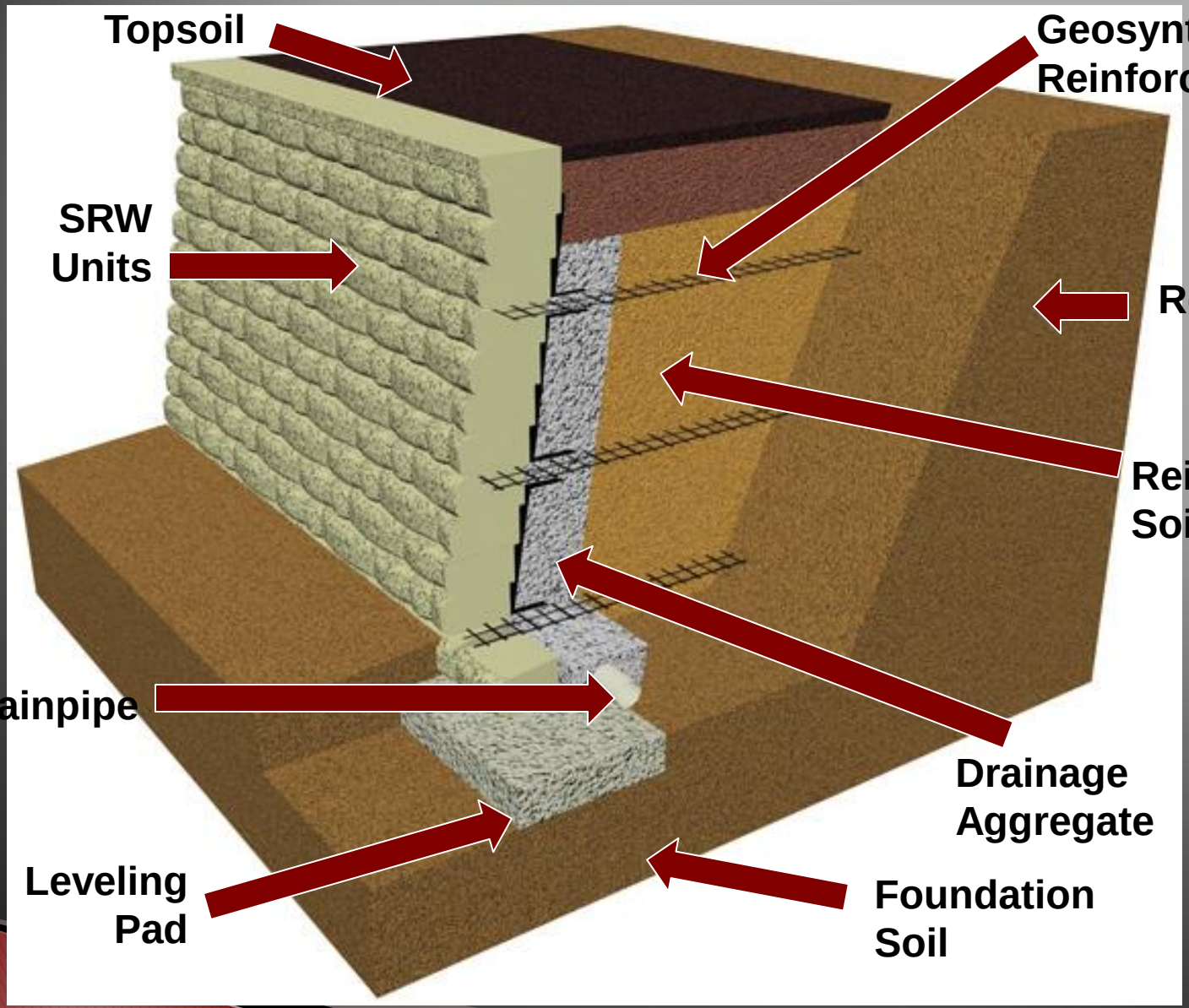
Components of an SRW



Gravity Wall Components

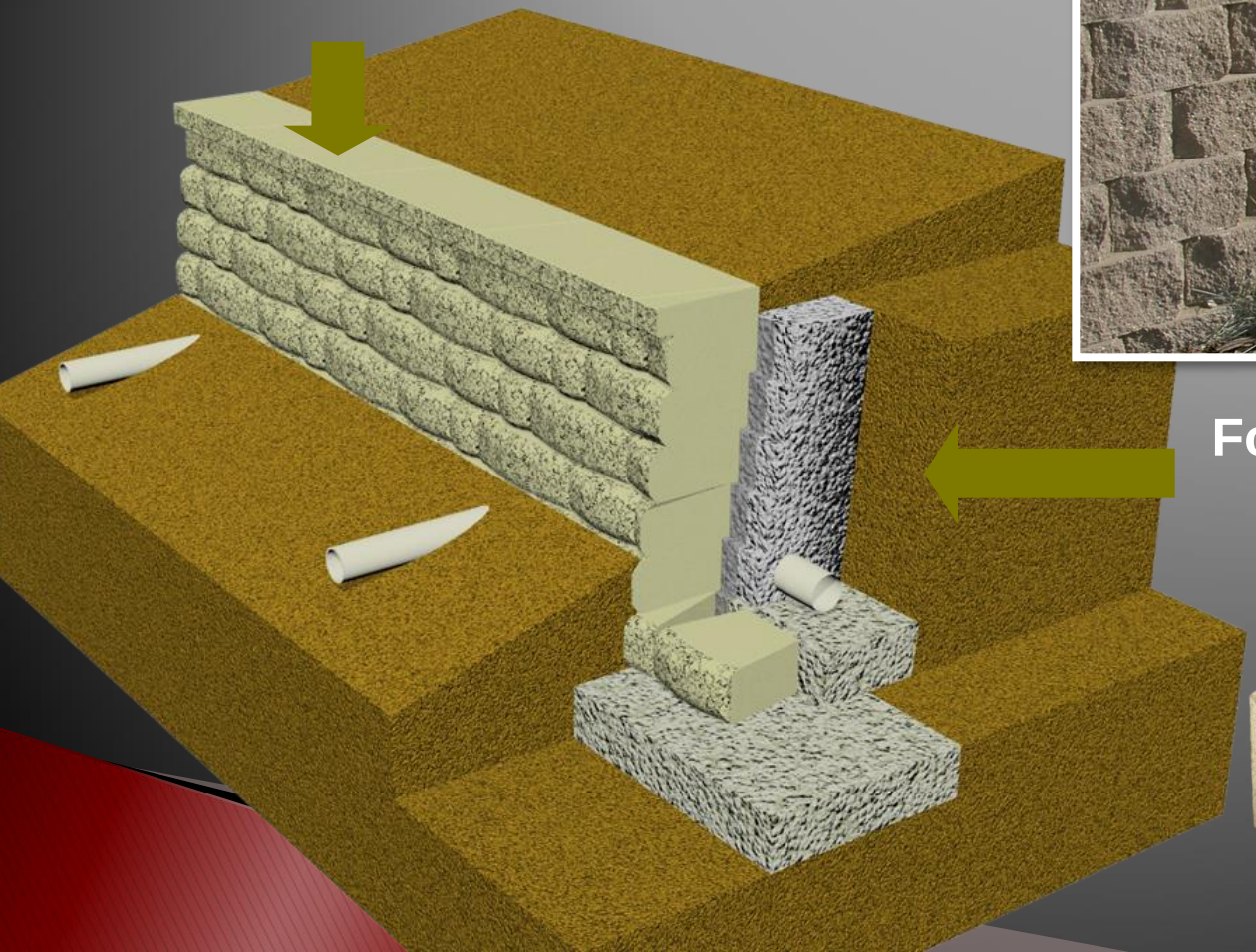


Reinforced Wall Components



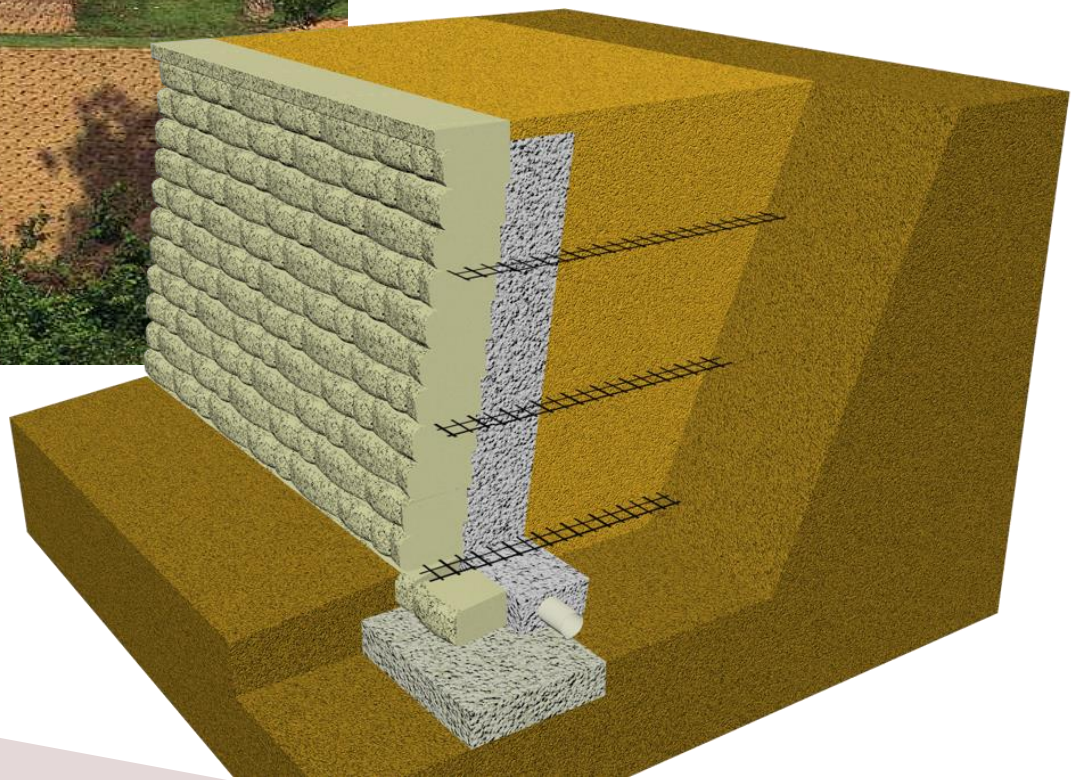
Gravity Wall

Weight of Block



Force Applied by Soil Wedge

Reinforced Retaining Wall



SRW Production

SRW Production

RETANI™ | TRUSTED BLOCK NEW NAME

Rear Lip Locators

R612 3-Way

R812 3-Way

R612 Rockface Combo

No pins, no mortar, no misalignments.
Rear-lip technology makes installation quick, efficient and accurate.

RETANI™ | TRUSTED BLOCK NEW NAME

Top Locator Products

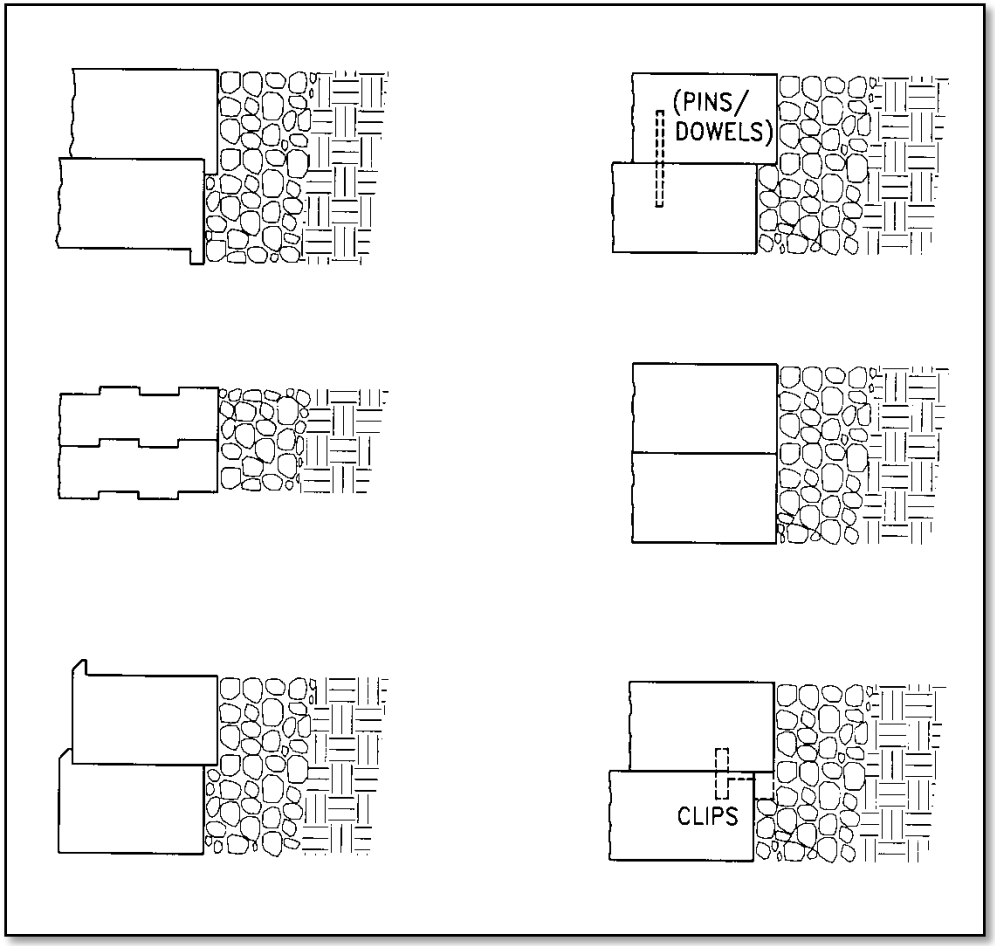
V811 Straight

V820 3-Way

Concrete locater used for alignment and reinforcement connection. Installation is fast, easy and efficient.

Facing Units: Proprietary Products

- Interlock and setback mechanisms
  - Concrete lips
  - Pins
  - Clips
  - Friction
  - Molded flange



Facing Units: Connection to Geogrid

- Typically Frictional Connection
- Unique Connection Curve for each block/Grid pair
- Only a few have mechanical Connections
- Usually much below working strength of grid

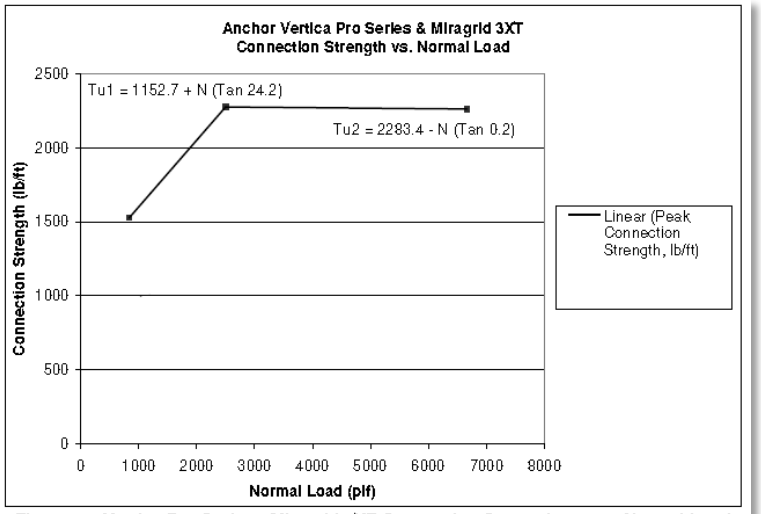
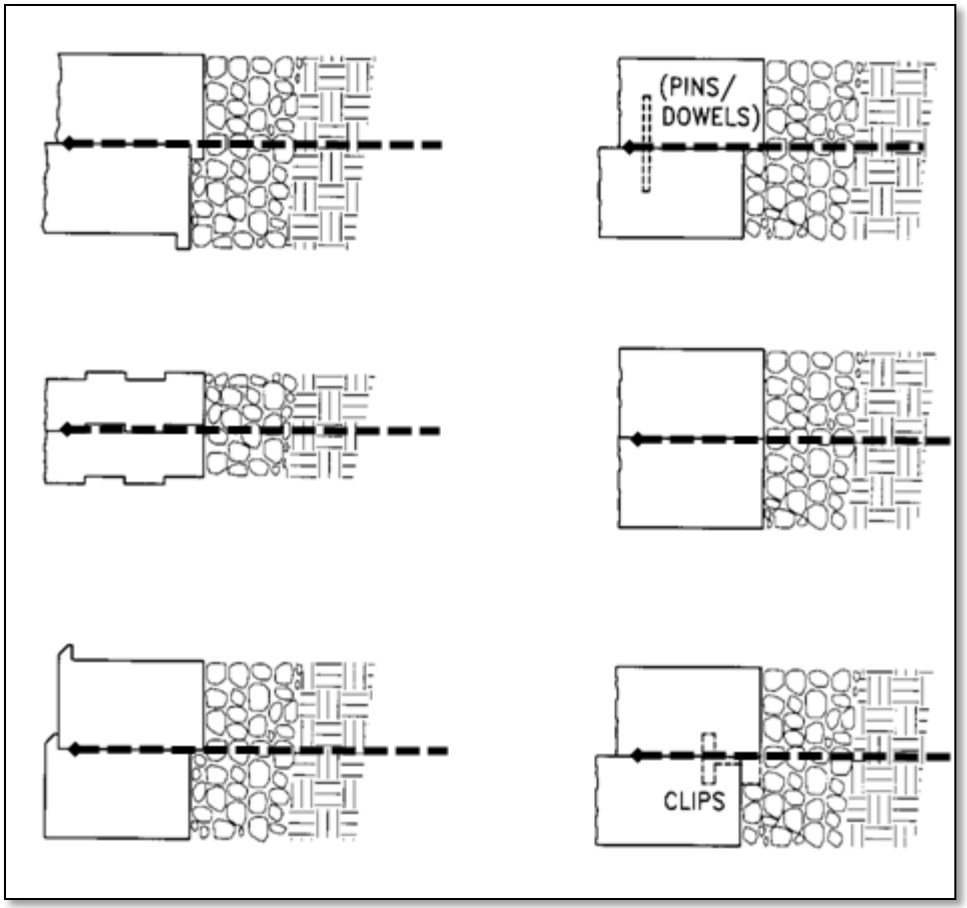


Figure 4 – Vertica Pro Series - Miragrid 3XT Connection Strength versus Normal Load



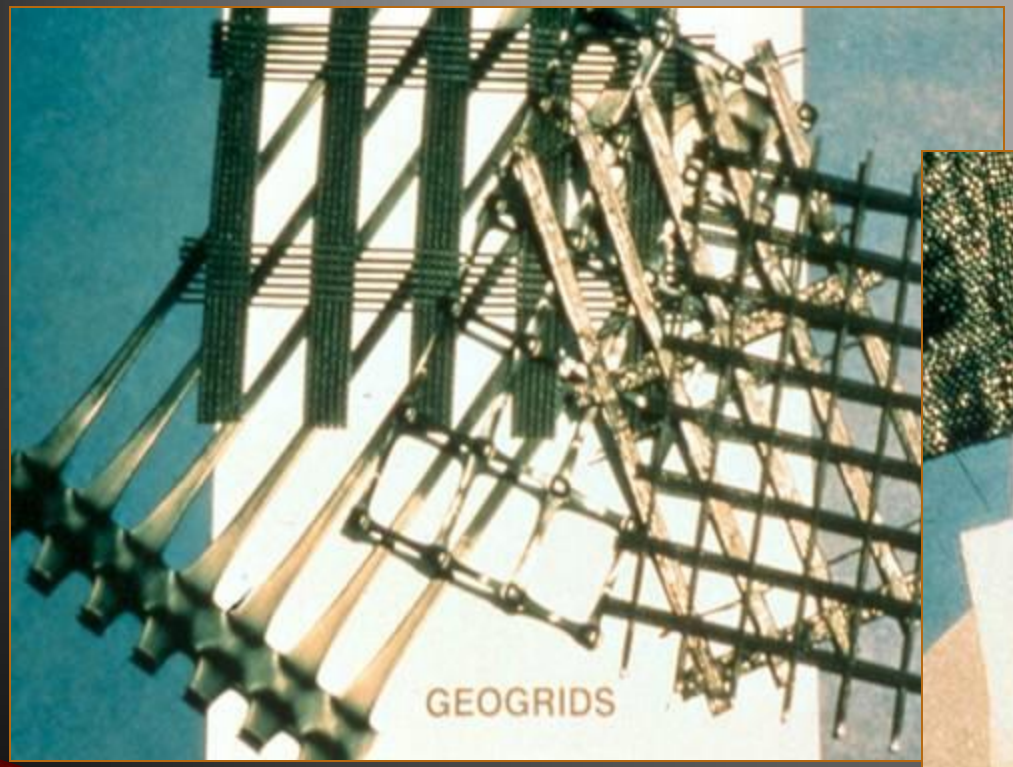
Natural Vegetation Reinforcement – Ziggurats in the Middle East

In the beginning...THE GREAT WALL OF CHINA

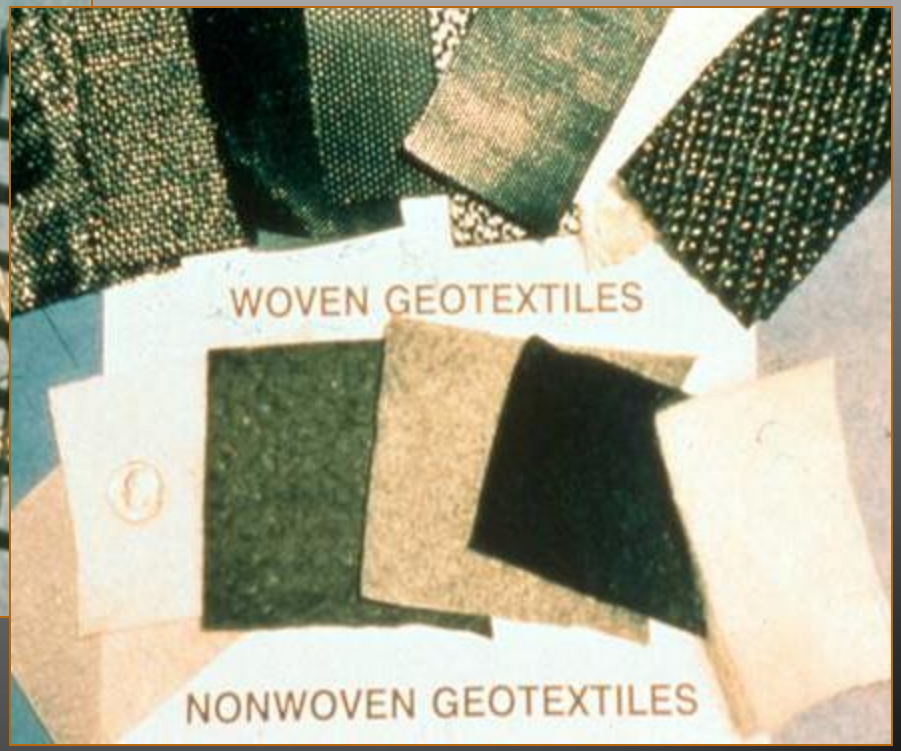
- From 206 BC, the Han Dynasty used reinforced soil to build large sections of the Great Wall of China
  - More than 300 miles long
  - Thin soil lifts
  - Tamarisk branches

Geosynthetic Soil Reinforcement

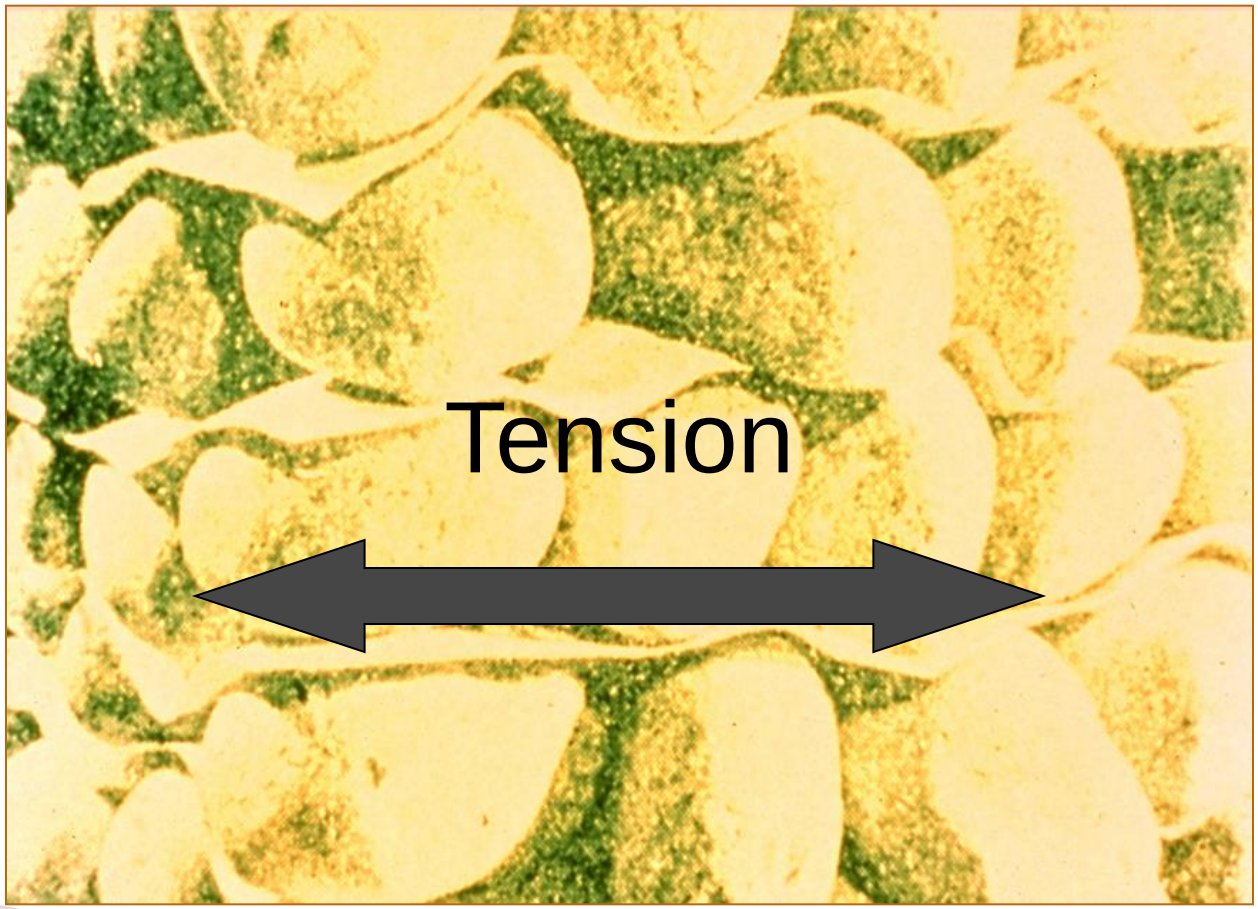
Geogrid



Geotextiles



Using Geosynthetic Reinforcement



Soil Without/With Reinforcement

Traditional Commercial Products for Constructing SRWs

R612 3-Way

R612 Rockface Combo

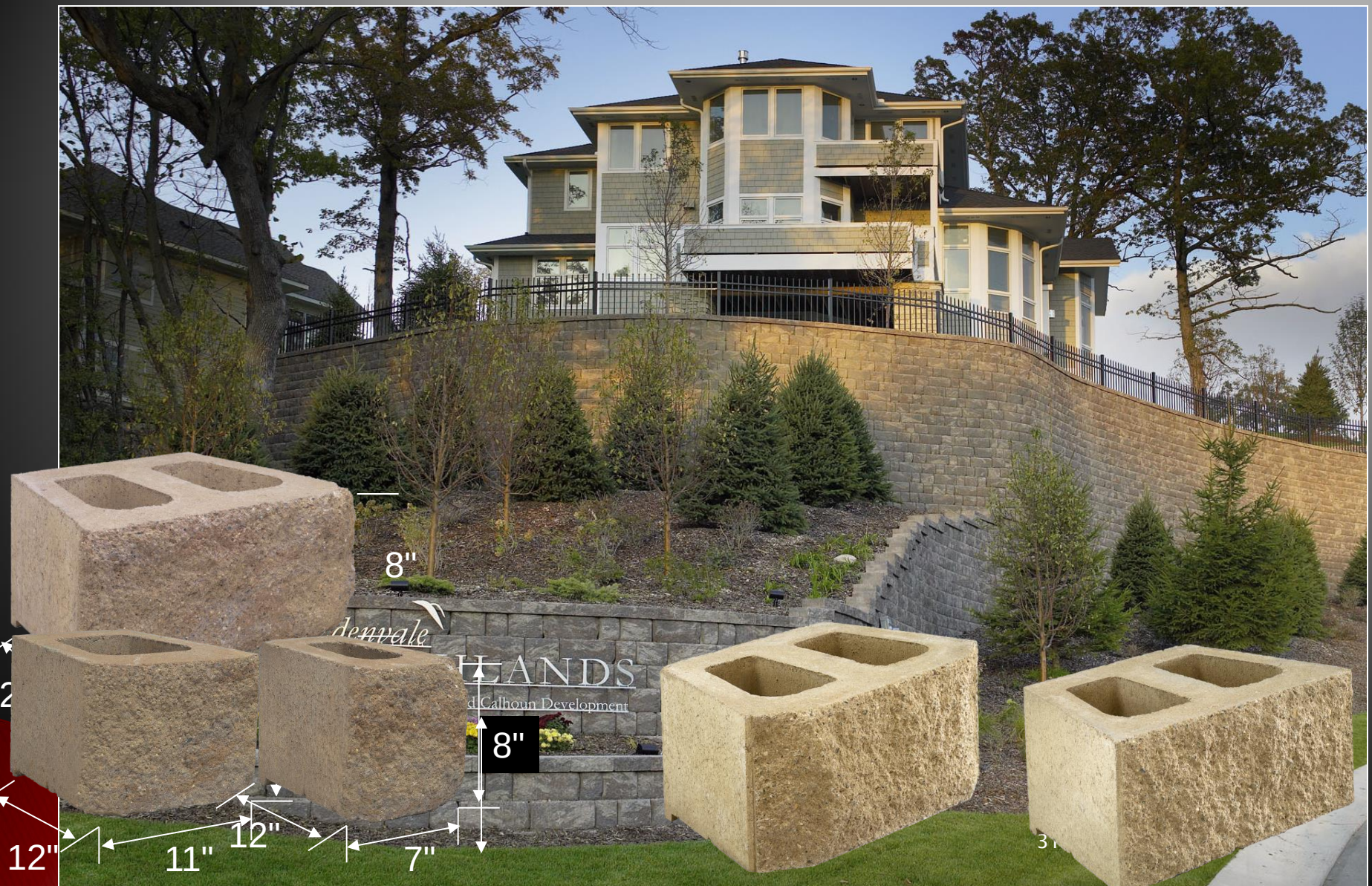
R812 3-Way

V811 Straight

V820 3-Way

R612 Rockface Combo Retaining Walls

R812 Rockface Combo/ R812 3-Way & Straight



Wall Specification Data

ASTM 1372

Max Absorption	13-15 pcf
Density	125 lb/ft³
Freeze Thaw	ASTM C 1262
Dimensional Tolerance	± 1/8"

Wall Specification Data

ASTM 1372

Min Compressive Strength 3000 psi

Geosynthetic Soil Reinforcement

- Installation Considerations
  - Roll widths
  - Strength direction
- Structural Considerations
  - Embedment
  - Spacing
  - Interaction
  - Connection

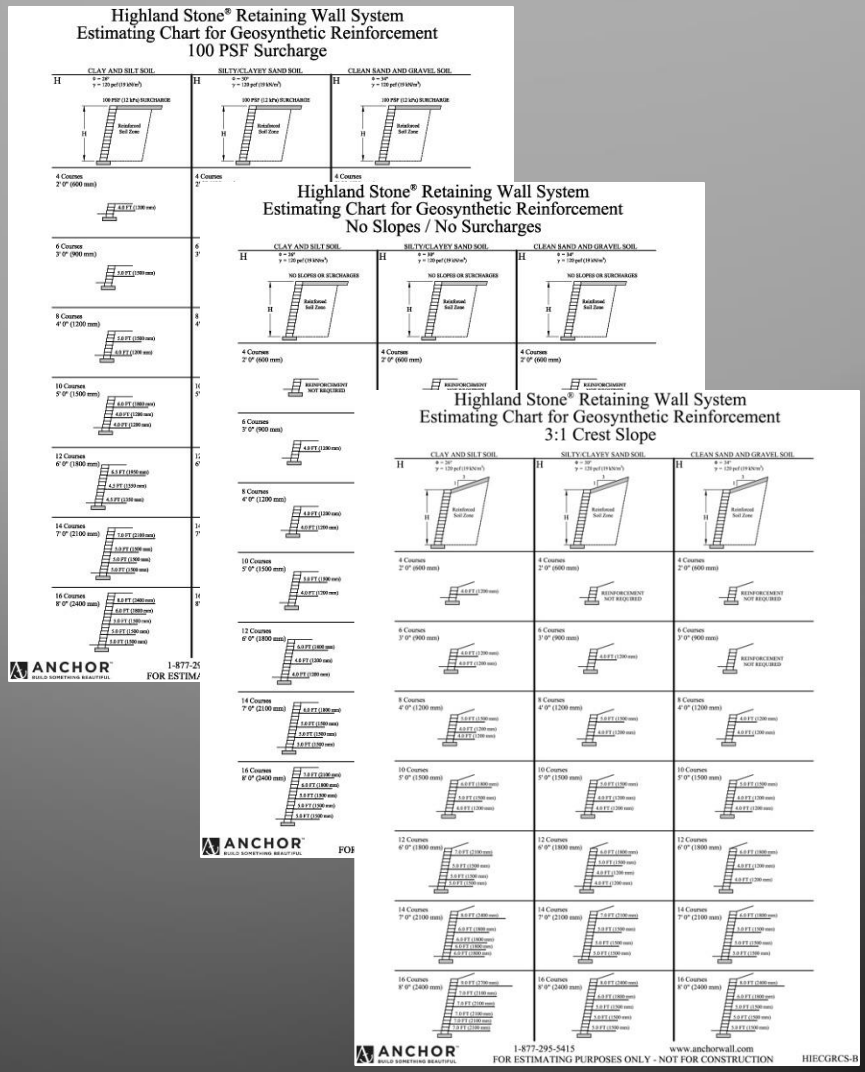
DO NOT USE!!

Silt Fence

Safety/Snow Fence

Geosynthetic and SRW Unit Connection

- ASTM D6638, Determining Connection Strength Between Geosynthetic Reinforcement and Segmental Concrete Units
- Specific for each SRW unit and geosynthetic reinforcement combination



NCMA Design Guidelines

When to Engineer SRW Projects

Segmental retaining walls fall under the requirement of the International Building Code, Section 105.2, which requires a building permit for earth retaining structures which are over 4 ft (1.2 m) measured from the bottom of the footing to the top of the wall. Building permits may be required for shorter walls if they support a surcharge load. In addition, local building codes may require a design prepared by a design professional. Where there is no specific requirement, NCMA recommends the following guidelines:

Design Method	Wall Height	Allowable Soil & Foundation Conditions	Recommended Engineering Required
Method 1: Non-Engineered	Less than or equal to 4 ft (1.2 m) from leveling pad to top of wall	Sand/gravel, silty sands, silt/lean clays	Use design chart provided by SRW system provider
Method 2: Engineered	Greater than 4 ft (1.2 m) from leveling pad to top of wall	Sand/gravel, silty sands, silt/lean clays	Have the design section reviewed/prepared by a registered professional.

Welcome to NCMA's Online Marketplace

For volume discounts or member pricing, please contact the NCMA publications

Segmental Retaining Wall Software Version 4
SRWallV4: $450.00

Click Here to download a 30 day Free Trial Version (Full Version).

SRW Systems

Table 1.3-1 | **Minimum SRW Design Requirements**

Minimum Safety Factor	Static	Dynamic (Seismic)*
Sliding (Base/Internal)	1.5	75% of Static
Overturning	2.0	75% of Static
Geogrid Overstress	1.5	75% of Static
Pullout from Soil/Block	1.5	75% of Static
Internal Compound Stability	1.3	1.1
Global Stability	1.3	1.1
Bearing Capacity	2.0	75% of Static
Additional Detailing Criteria		
Minimum Reinforced Zone Width	60% of Wall Height (*H*)	60% of Wall Height (*H*) for Bottom and Middle Layers; 90% of Wall Height (*H*) for Upper Layers
Minimum Wall Embedment	6 inches (152 mm)	6 inches (152 mm)
Minimum Anchorage Length	12 inches (305 mm)	12 inches (305 mm)
Maximum Wall Batter	20 degrees	20 degrees
Maximum Geogrid Spacing	See Table 1.3-2	16 inches (406 mm)

* See section 12.1 for conditions where seismic design should be considered

SRW Systems

Design Methods Basic Differences

NCMA

- L/H Ratio – 60%
- Variable Reinforcement Lengths – Min. 4'
- Native / Imported Select Fills
- Minimum Block Embedment – 1 unit

AASHTO

- L/H Ratio – 70%
- Uniform Reinforcement Lengths–Min. 8'
- Imported Select Fills
- Minimum Block Embedment – 2'

SRW Systems

Design Factors that Influence Grid Spacing

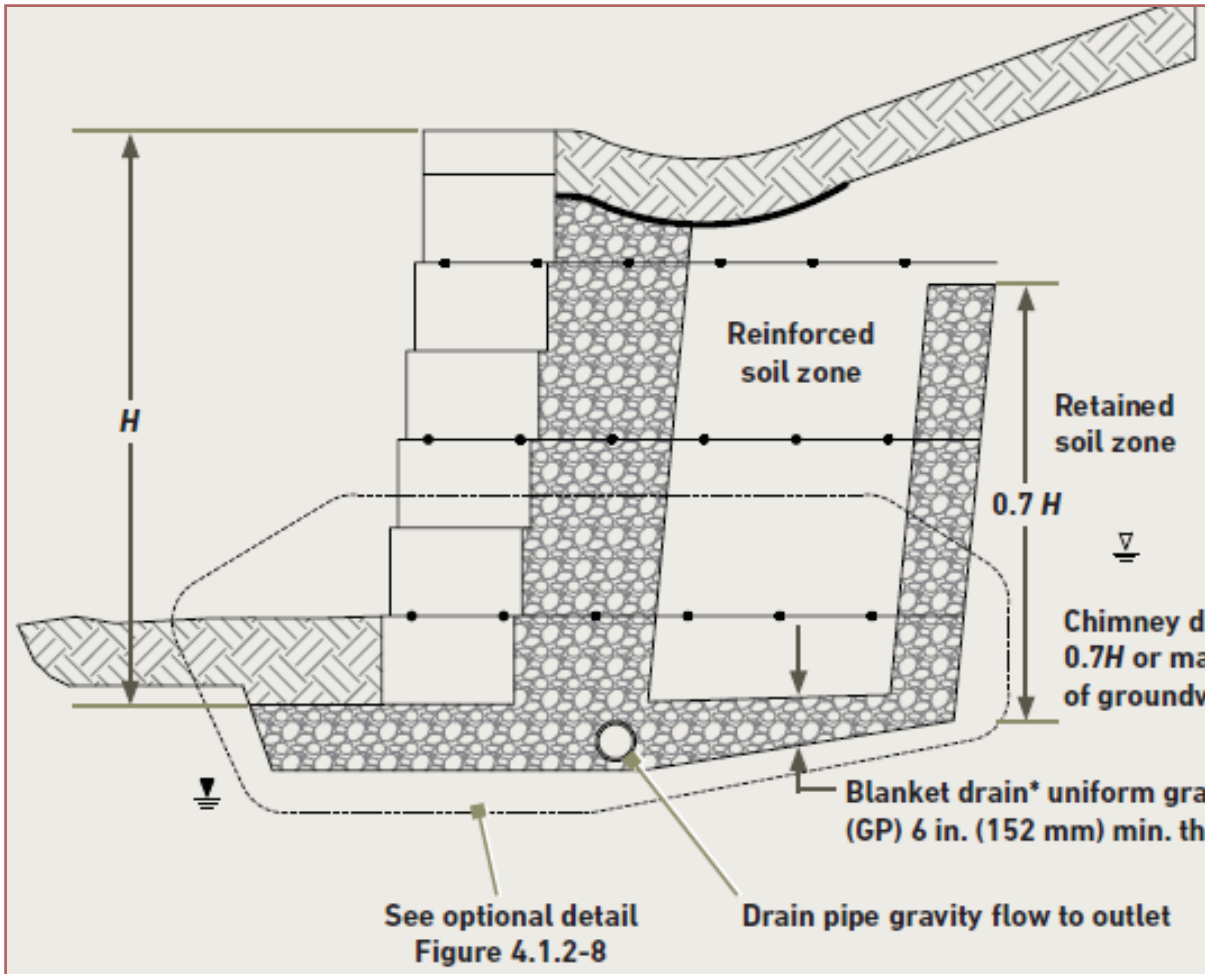
- Quality of backfill
- Internal and external stability
- Height of wall
- Slopes or surcharges
- Existing or proposed structures near wall

SRW Systems

Design Factors that Influence Wall Embedment Depth

- Toe slopes
- Surcharges
- Erosion of the toe

SRW Systems



Groundwater Conditions

1. Groundwater table near bottom of wall (▼) or lateral (horizontal) flow into reinforced soil and retained soil (▽).
2. This complete drainage system provides maximum protection for SRWs and should be utilized when there is uncertainty as to the actual site groundwater conditions.

**Chimney drain and/or blanket drain may be replaced with an appropriate geocomposite at the discretion of the wall design engineer.*

SRW Systems

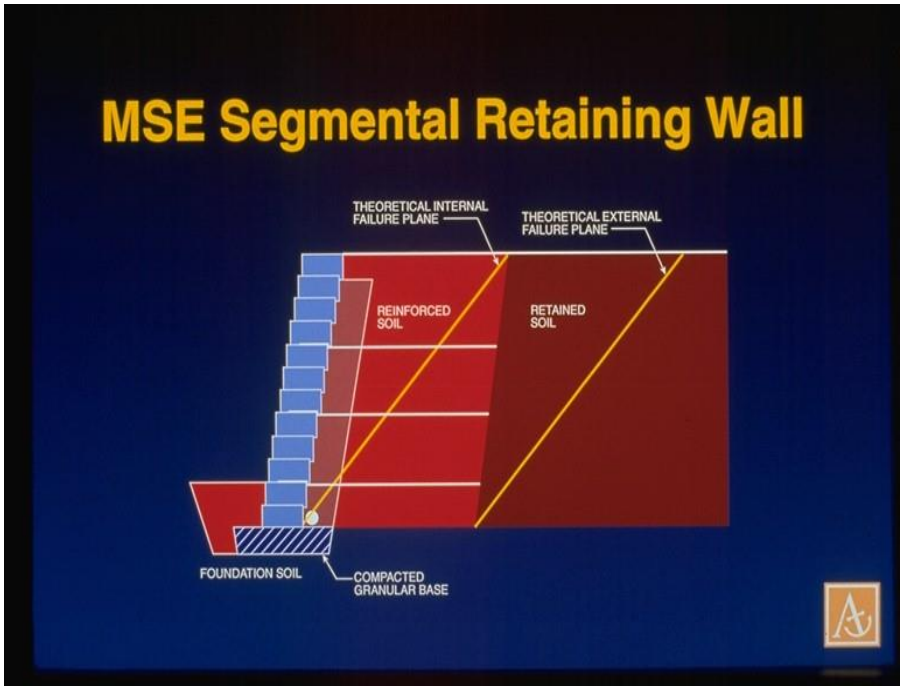
Design Information Required for Wall Designer

- **Representative Soil Information**
- **Site / Grading Plan @ Wall Location**
- **Current / Proposed Utility Plan**
- **Top & Bottom of Wall Elevations**

SRW Systems

Design Overview

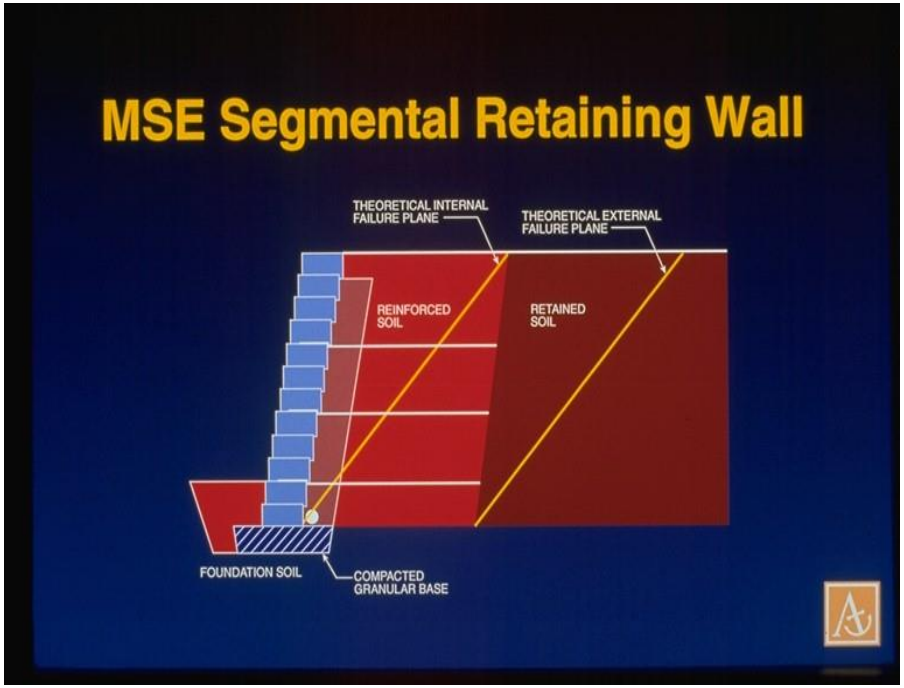
- **External Stability**
- **Internal Stability**
- **Local Stability**
- **Global Stability**



SRW Systems

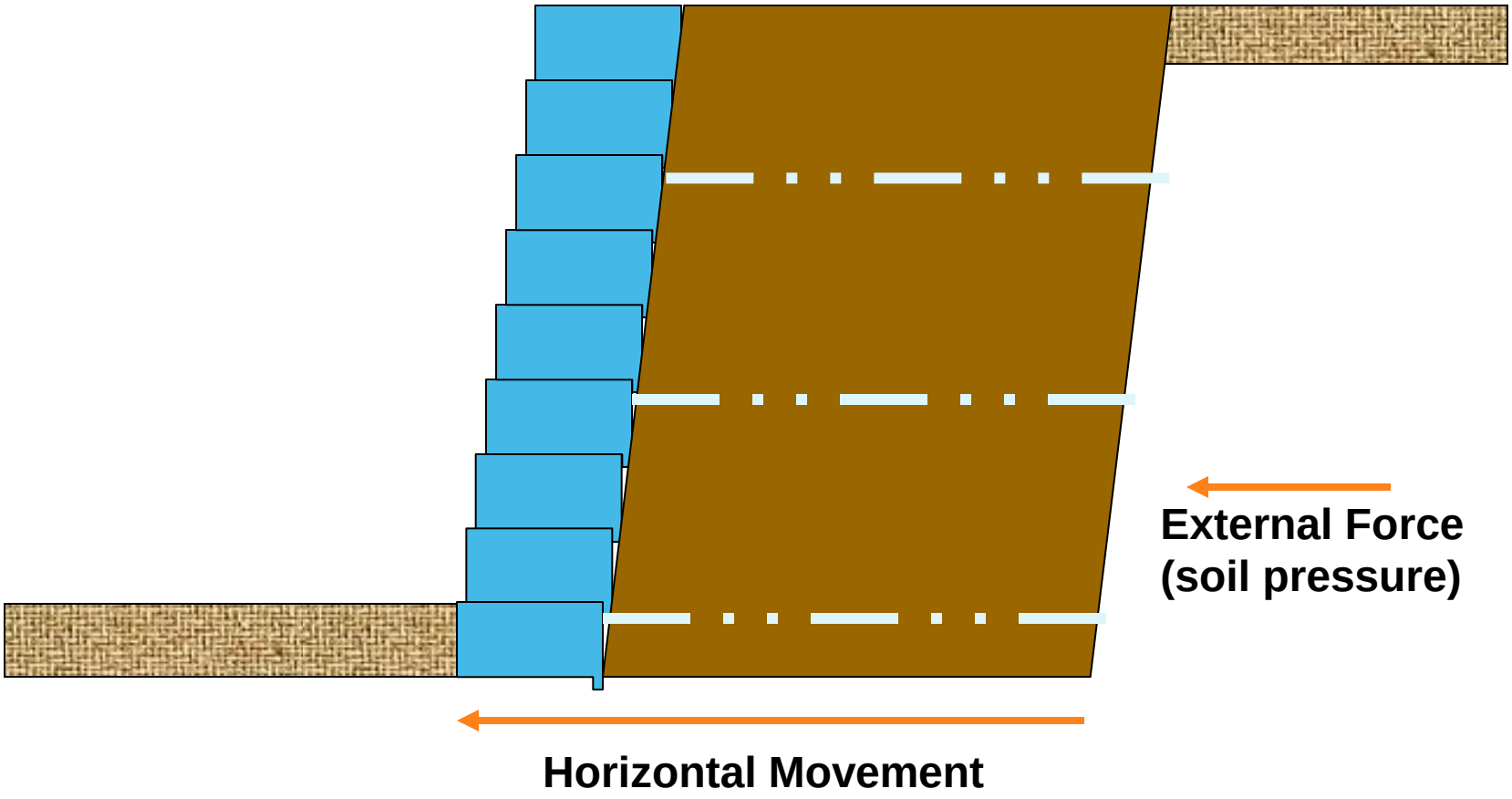
External Stability Considerations

- **Retained Earth Pressures / Forces**
- **Overturning**
- **Base Sliding**
- **Bearing Capacity**

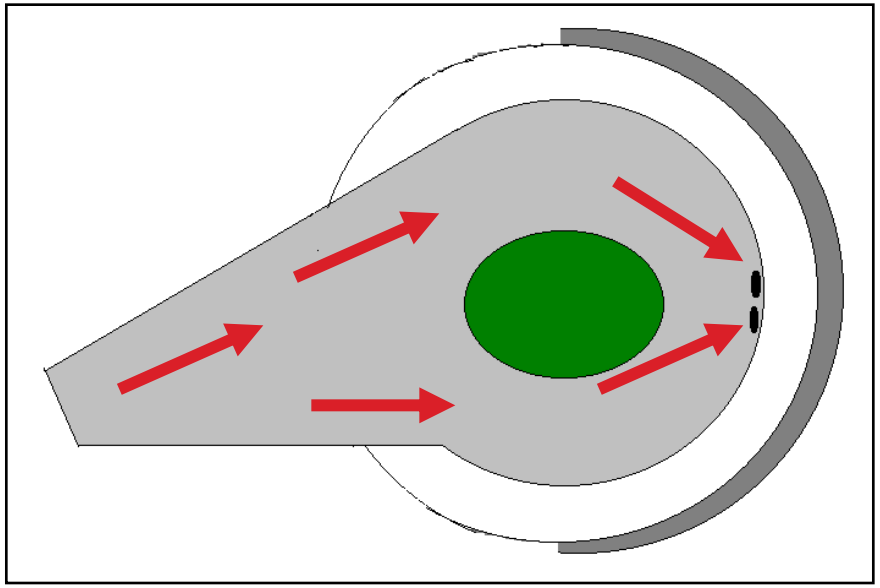


Controls the Base Length, L

Base Sliding



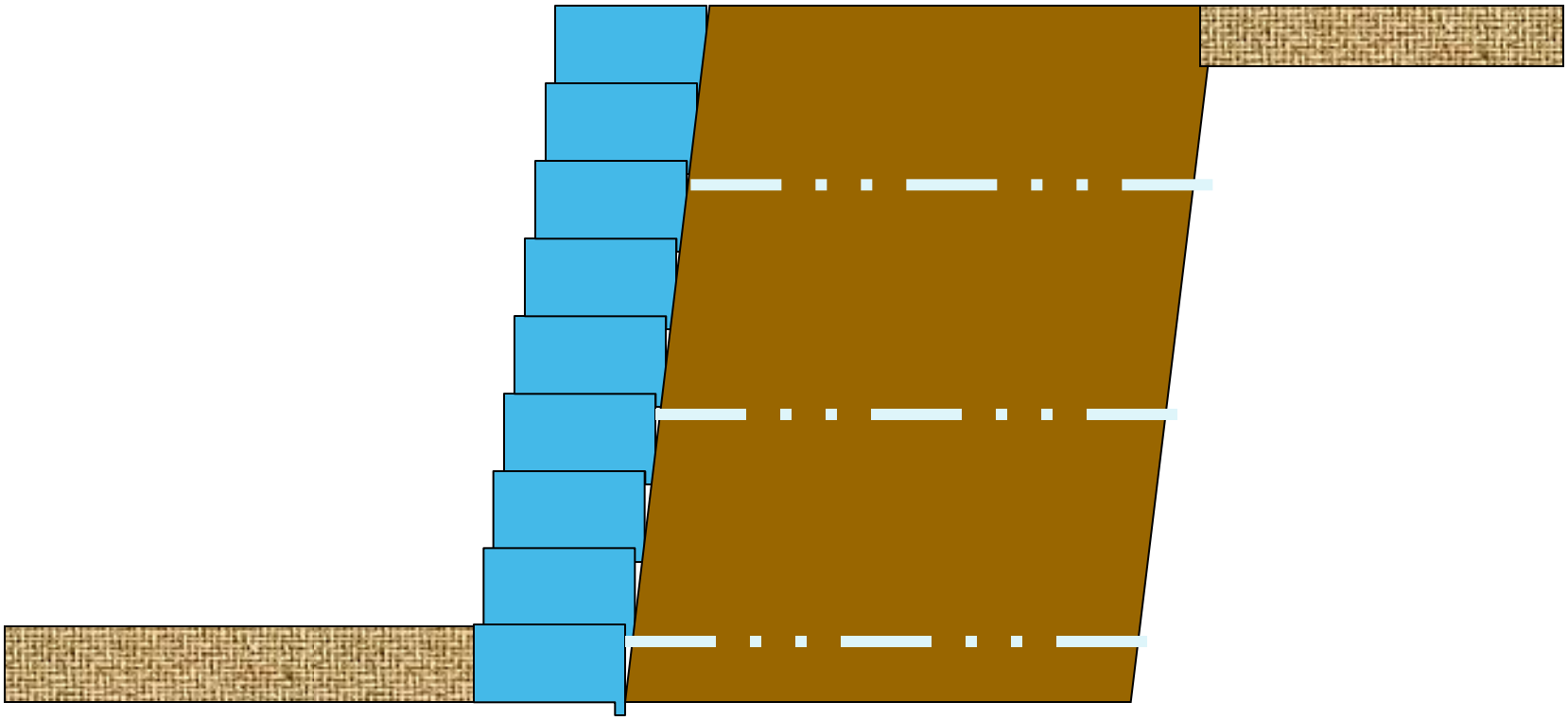
Base Sliding



Base Sliding

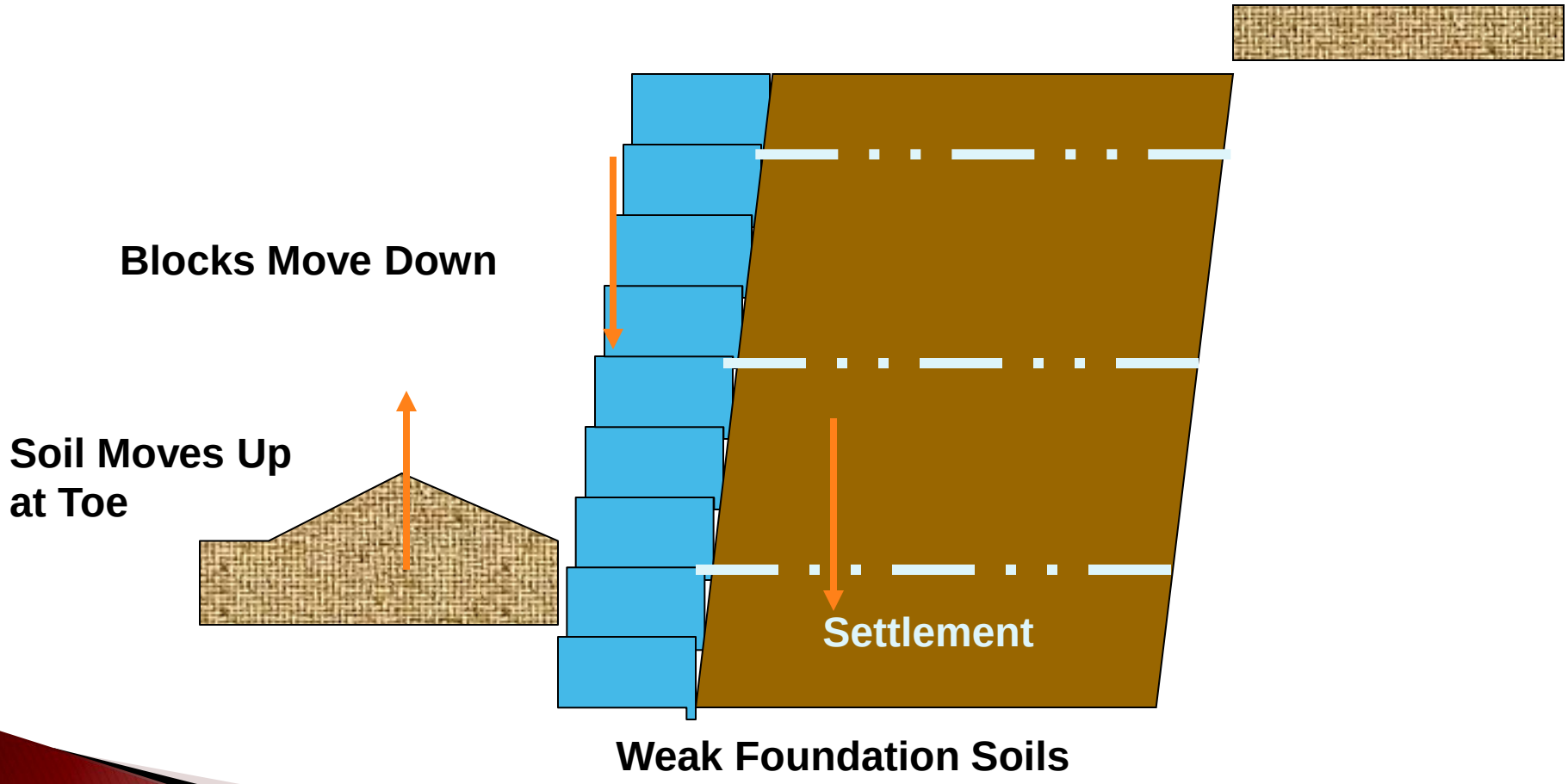
Base Sliding

Bearing Capacity



Weak Foundation Soils

Bearing Capacity

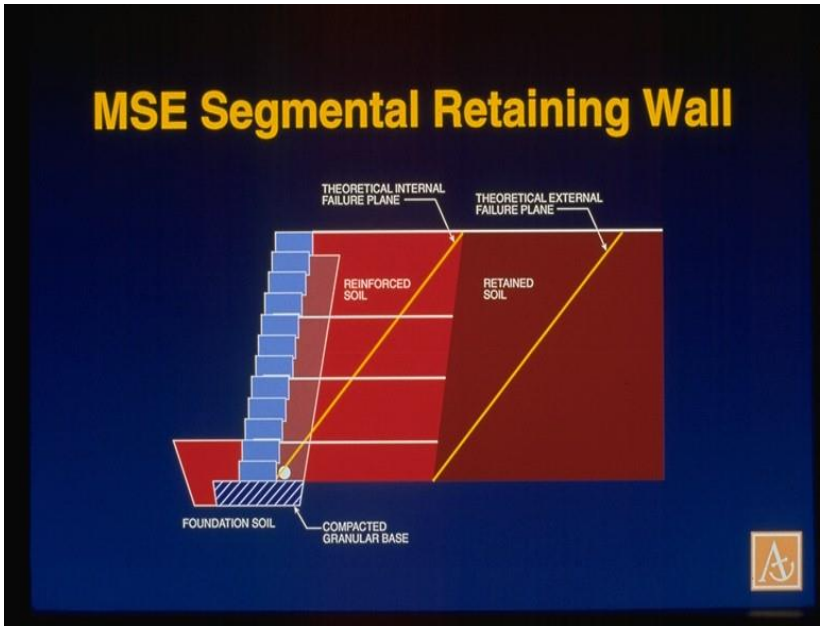


Bearing Capacity

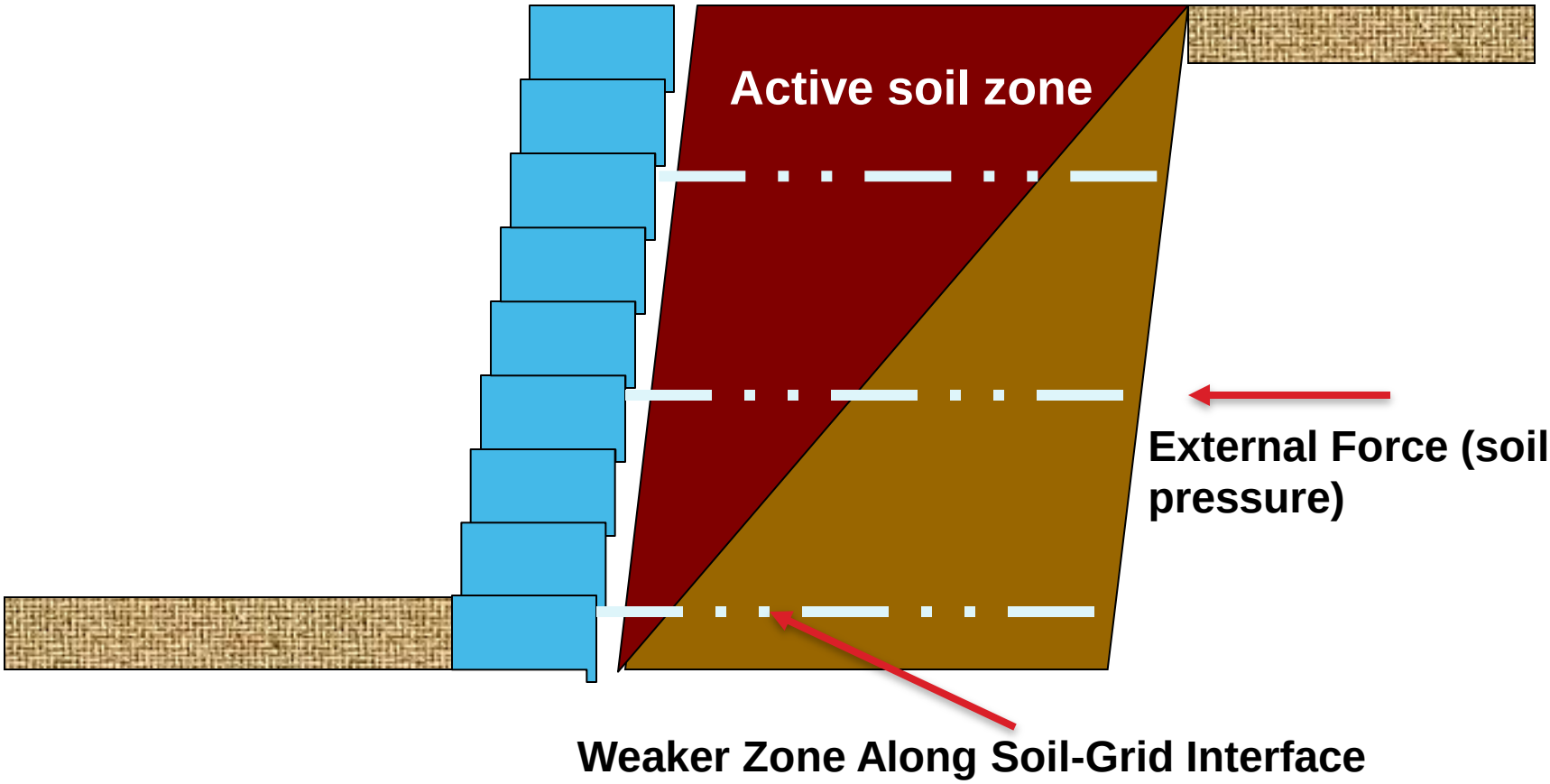
SRW Systems

Internal Stability Considerations

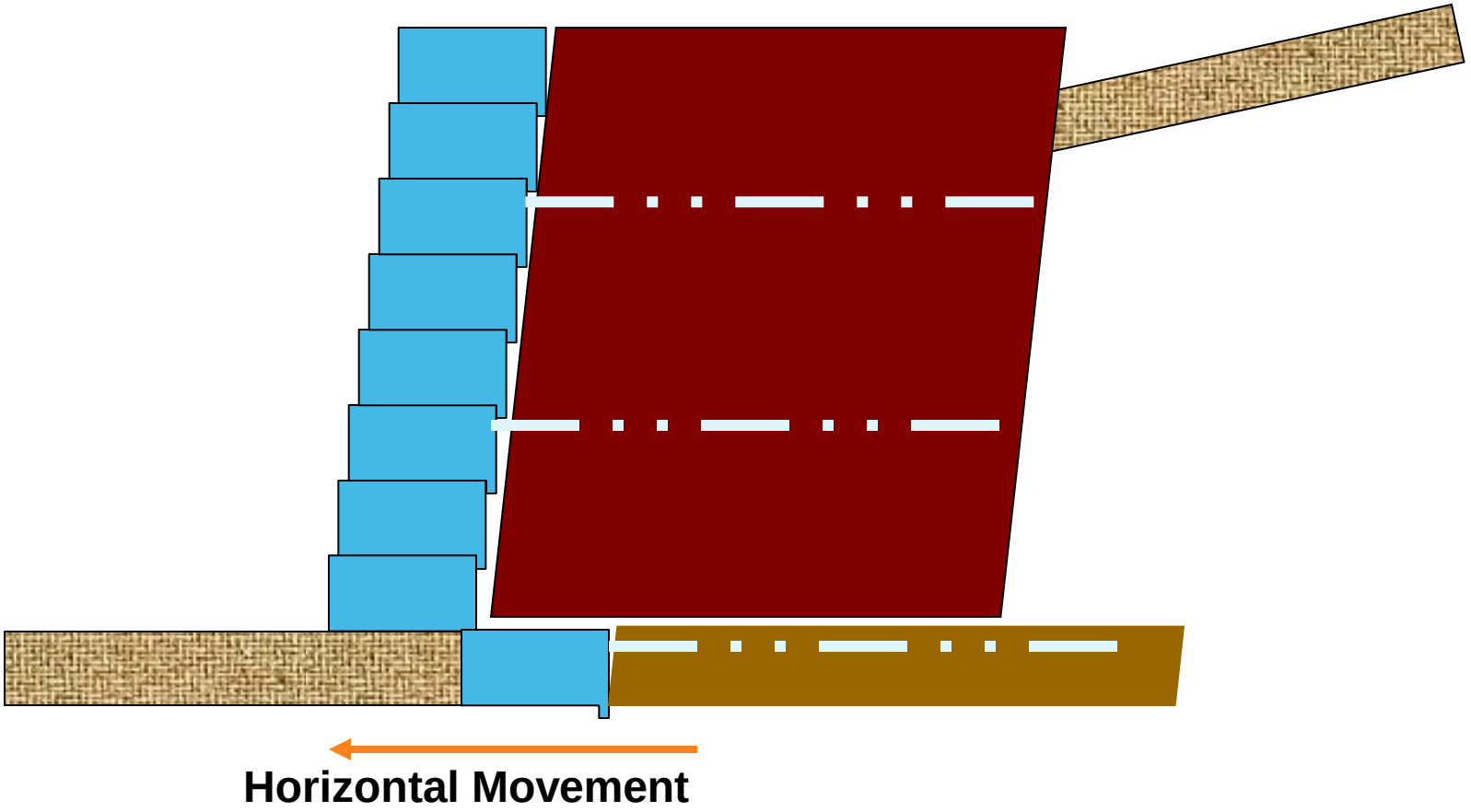
- **Reinforced Earth Pressures / Forces**
- **Reinforcement Tensile Overstress (grid breaks)**
- **Reinforcement Pullout**
- **Internal Sliding**



Internal Sliding



Internal Sliding

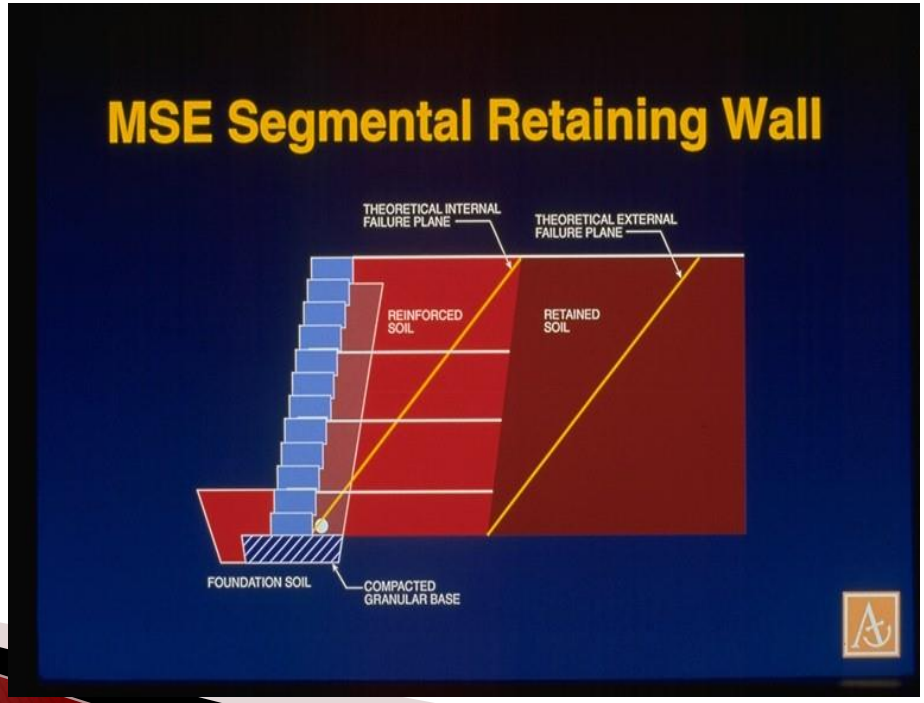


Do Not Cheat on Reinforcement Lengths

SRW Systems

Local Stability Considerations

- Connection Failure
- Bulging or Shear Failure
- Facing Overturning



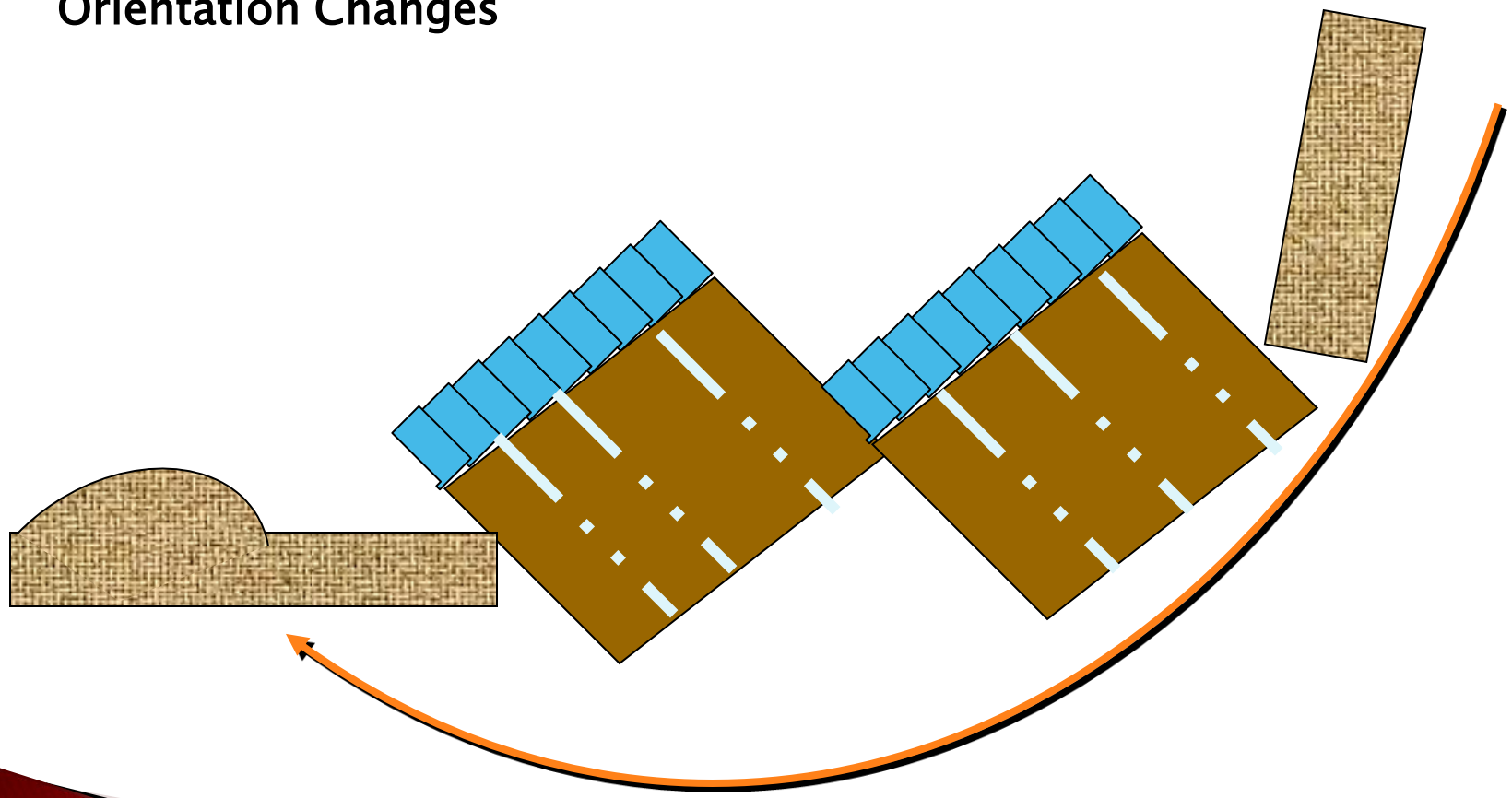
SRW Systems

Global Stability Considerations

- **Slope Geometry (slopes above or below the wall?)**
- **Soil Stratification & Properties (clay or silt?)**
- **Maximum Surcharge Loadings**
- **Shallow groundwater or water at the face**

Global Stability

Walls Remain Relatively Intact
Orientation Changes



SRW Systems

Special Considerations

- **Groundwater Influence**
- **Submerged Placements**
- **Tiered Walls**
- **Seismic Areas**

Waverly Park Drainage Channel Improvements

ARTICULATING CONCRETE BLOCKS & SEGMENTAL RETAINING WALLS

V820 3-Way

36,432 sq. ft.

Conlock II

30,000 sq. ft

R812 Rockface Combo

Installation

SRW Systems

Base Course Leveling

Leveling of Base Course Front to Back & Side to Side

Check Level Every Course

SRW Systems

Place Underdrain and Daylight as Needed

SRW Systems

Block Placement

Place Unit Snug to Front of Wall

SRW Systems

Geogrid Connection

Insure that Grid is Placed to Front of Block

SRW Systems

Reinforcement Layout & Backfill

Grid Layers Taught and Placed in Machine Direction

SRW Systems

Reinforced Backfill

Do not Exceed 8” Compaction Lifts

Installation of Backfill Soil Meeting Design Parameters

SRW System

Embankment Termination

Termination of Each Block Course Minimum 1.5 Units into Embankment

SRW Systems

Install Pipes for Fencing

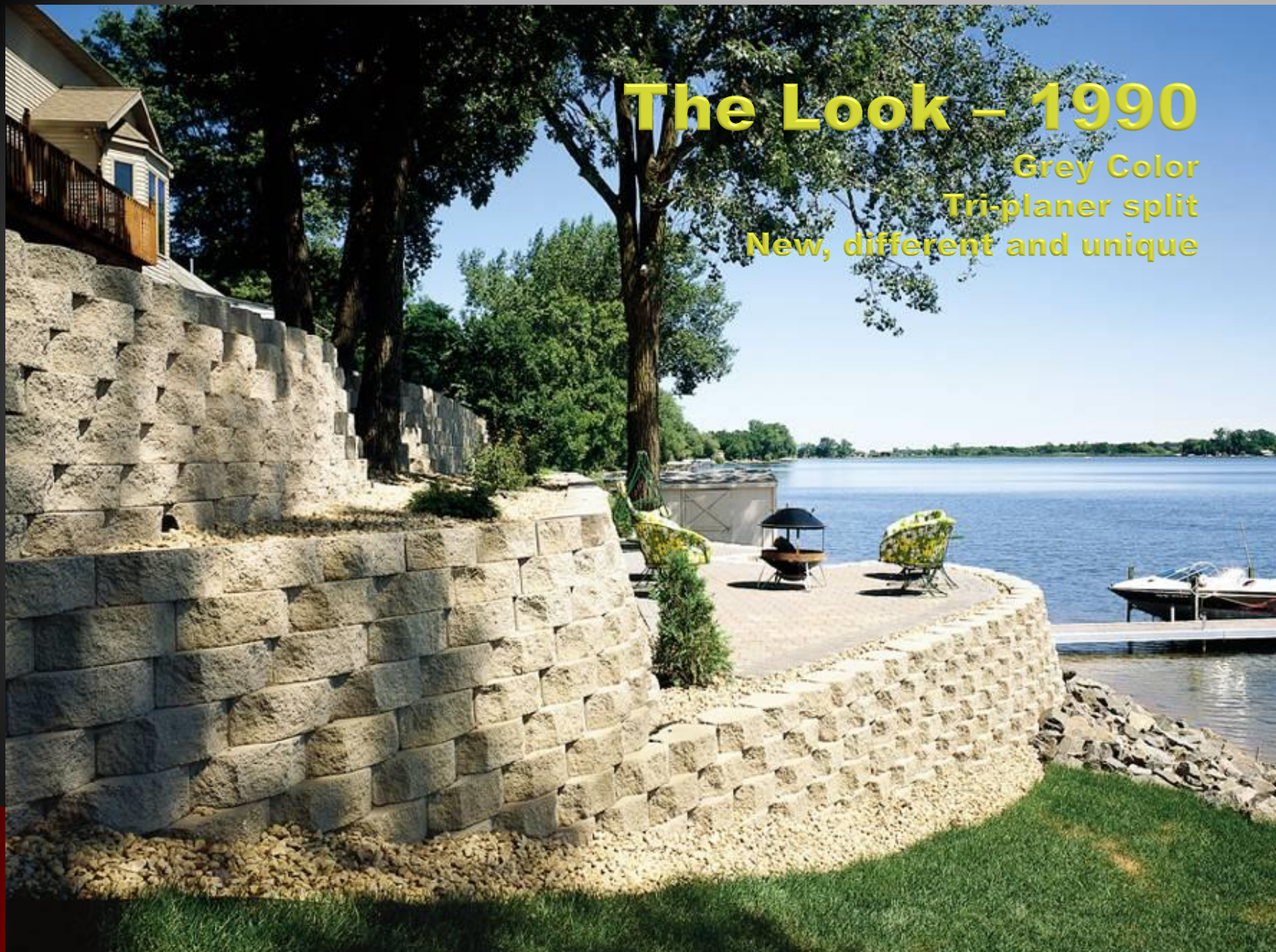
SRW Systems

Cap the Wall

SRW Systems

Block Placement

Install Utilities

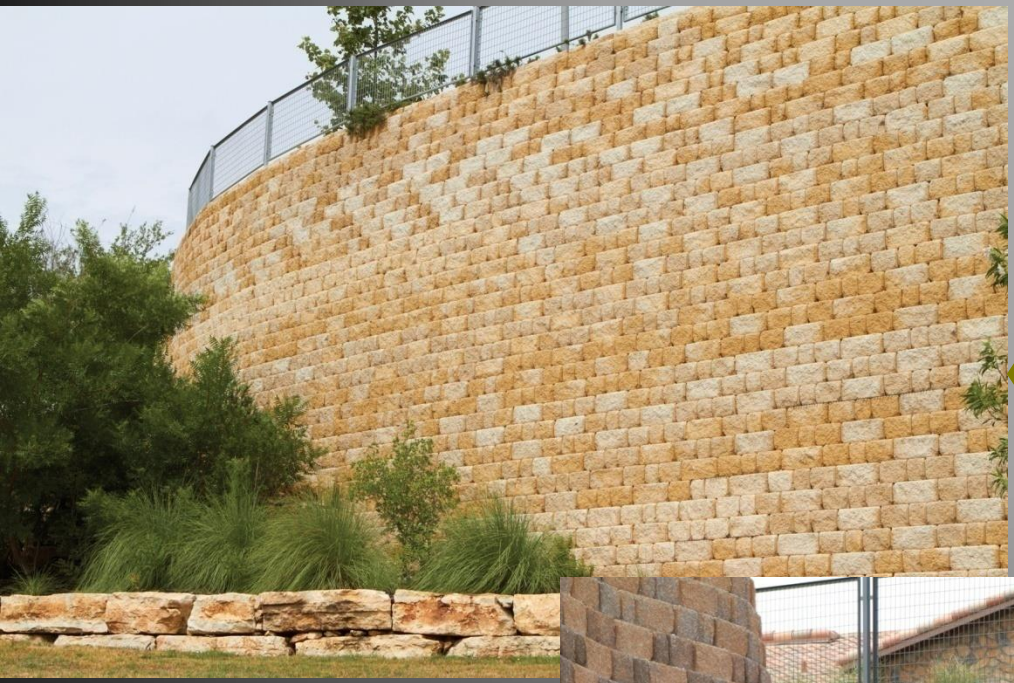

The Look – 1990
Grey Color
Tri-planer split
New, different and unique

The Look – 2016

Tumbled, Aged Look
Color Blended Blocks
Multiple Size Units
Continued Evolution
Enhanced Beauty

Minimal Cost Impact

R812 Rockface Combo



Stone Ridge Market,
San Antonio, TX

Tacara Phase I,
San Antonio, TX

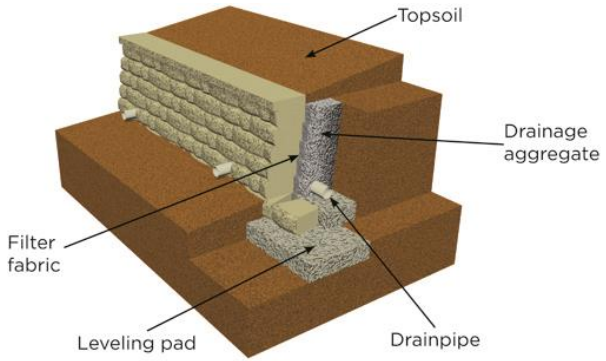
R812 Rockface Combo

R812 Rockface Combo

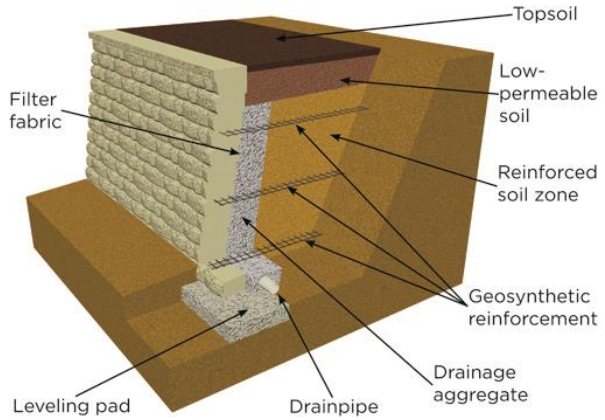
R812 Rockface Combo

Retaining Wall Design Options

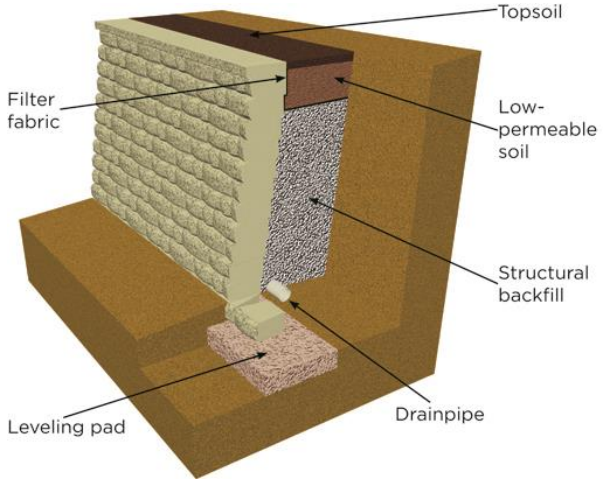
Gravity Retaining Wall



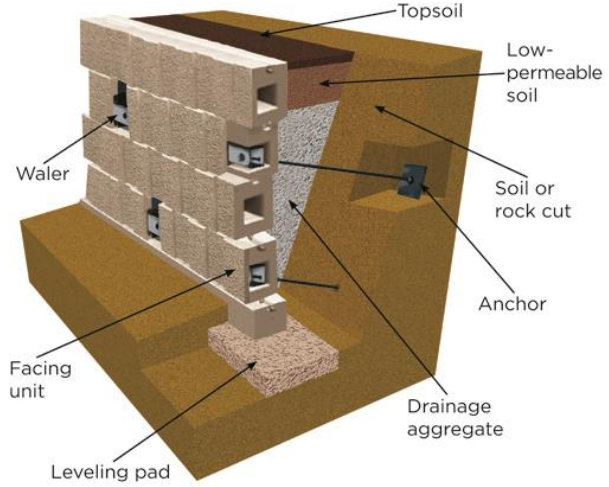
Geosynthetic-Reinforced Retaining Wall



Structural Backfill Retaining Wall



Direct-Anchorage Retaining Wall

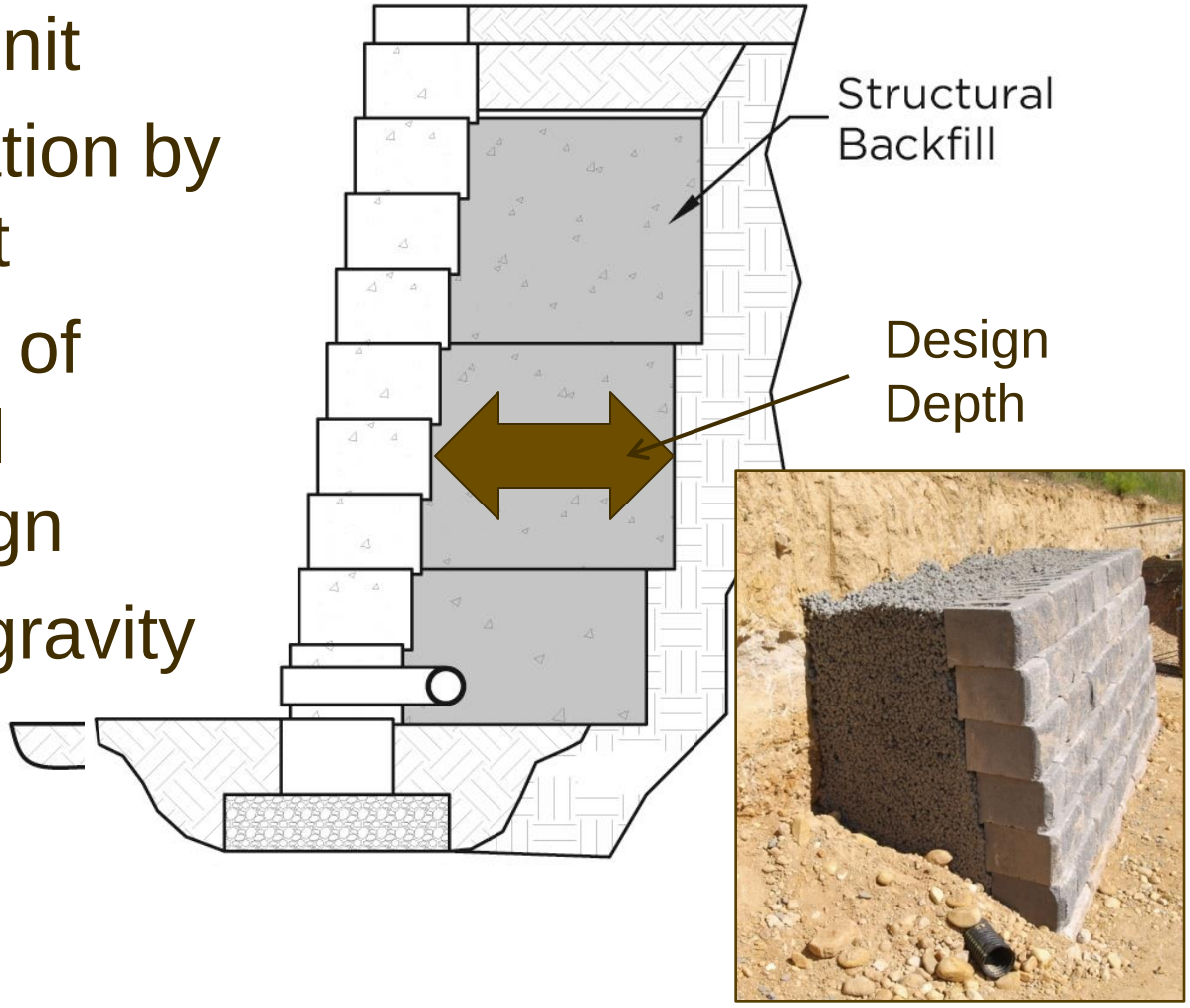


Innovative Installation Solution
Structural Backfill Retaining Wall System

- Reduces required excavation and compaction
- More efficient than geogrid-reinforced walls
- More economical than big block systems
- Attractive system

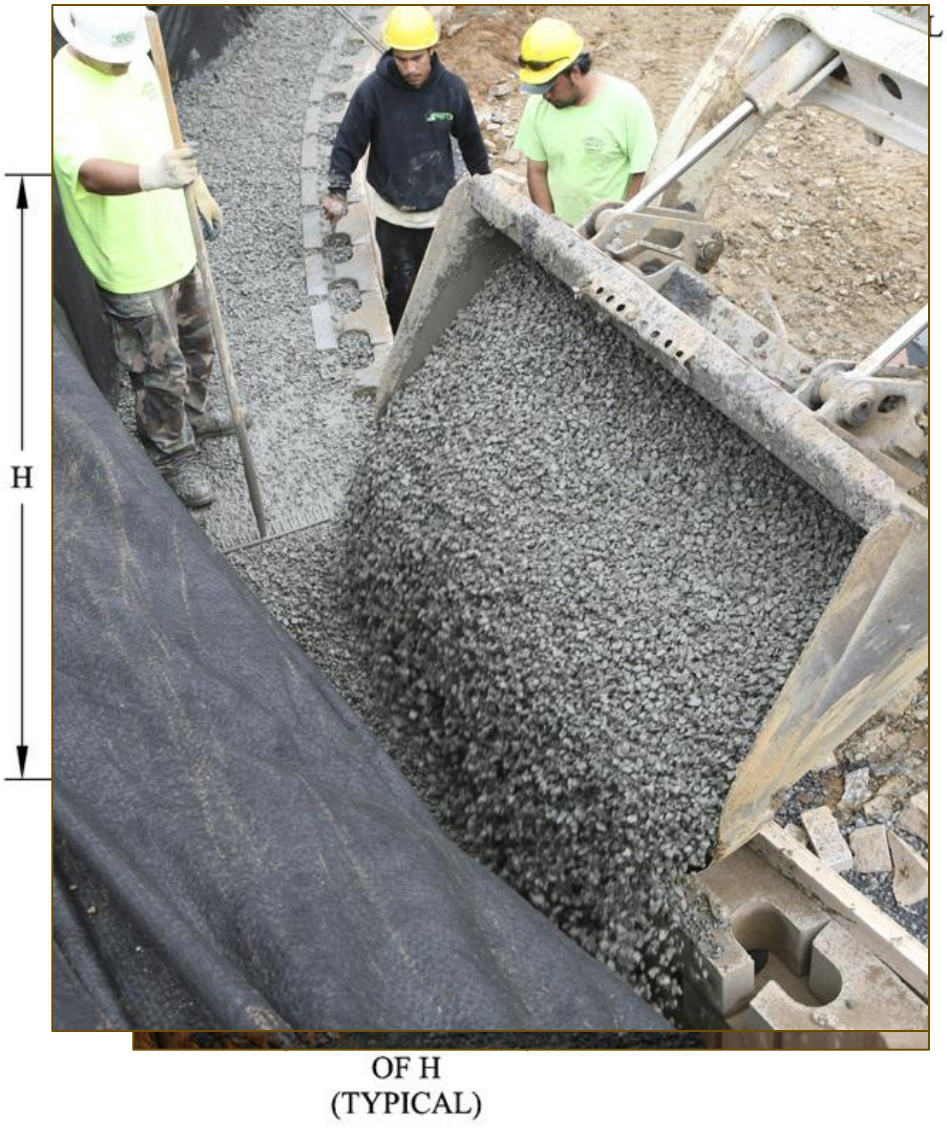
Advantages of the Structural Backfill Retaining Wall System

- Effectively increases depth of facing unit
- Reduces excavation by about 60 percent
- Only need depth of structural backfill required by design
- Allows for taller gravity wall heights



The Structural Backfill Retaining Wall System

- Retaining wall built with
  - Self-compacting structural backfill that meets specifications
  - Backed by engineering support tools

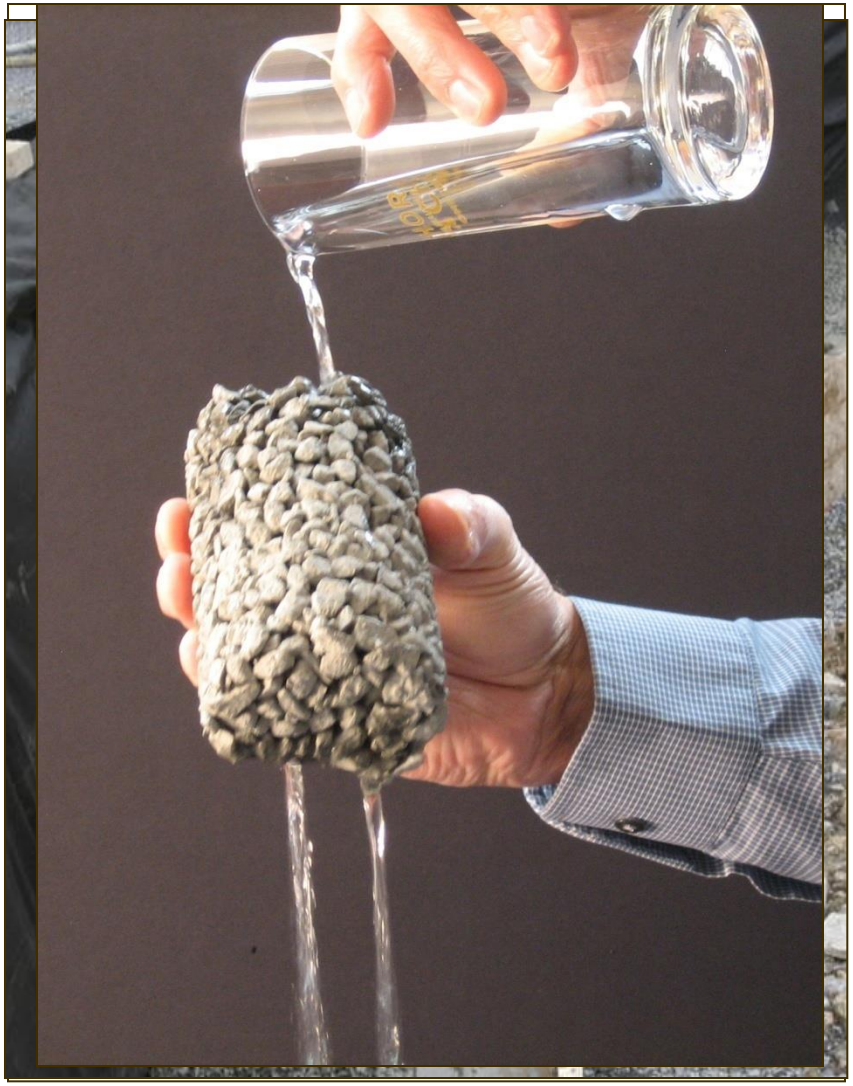


Structural Backfill Mix Design

	Concrete Mix Data	Batch Weight/Cubic Yard	
Specifications	Water/cement ratio (lb./lbs.)	0.41	
	Air voids	25%	
	Slump	1 to 2 in.	
Cement	Portland type 1 cement	400 lbs.	Specific gravity 3.15
Alternative	Fly ash Portland type 1 cement	200 lbs. 200 lbs.	Specific gravity 2.50 Specific gravity 3.15
Aggregates	Concrete sand SSD Coarse aggregates #6, #8 or #57 (½ or ¾ in.) Unit weight 98.88 lbs./ft.^{3} rodded	0 lbs. 2,540 lbs.	 Specific gravity 2.62
Water	Maximum total weight	166 lbs.	Specific gravity 1.00
Admixture	Pozzolith 100x, retarder	8.0 oz./yd.	

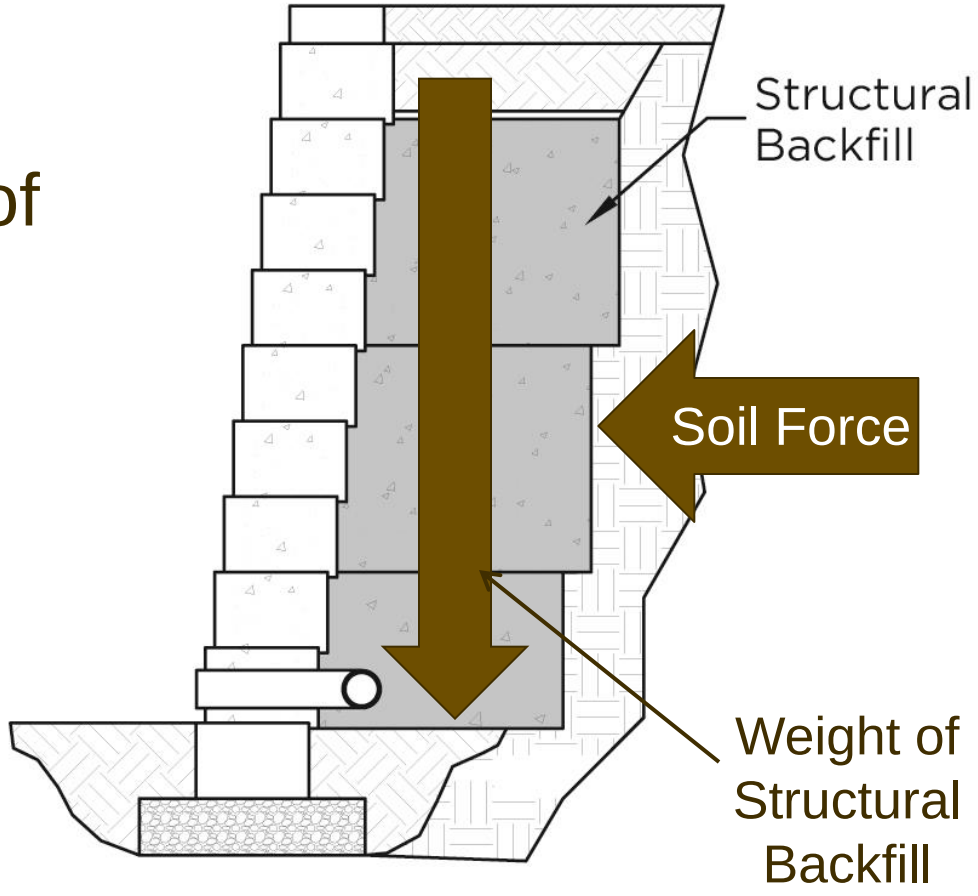
What Is Structural Backfill?

- Porous cement-treated aggregate (CTPB)
- Self-compacting
- Aggregate sizes can vary
- Mix components
  - 6:1 to 7:1 ratio of stone to cement
  - Clean, crushed stone
  - 5 gallons +/- of water to 100 pounds of cement



Design Methodology

- Calculation of lateral earth pressures
- Calculation of weight of the structural backfill system
- Factor of safety



When Should You Use the Structural Backfill Wall System?

- Limited access for geogrid reinforcement
- To replace failing structures
- To save existing landscape

Installing a Structural Backfill Retaining Wall System

Excavation and Leveling Pad

- Lay out wall and excavate
- Prepare leveling pad
- Install base course

Building an Structural Backfill Wall

- Install wall up to 2 feet
- Place first lift of structural backfill
- Spray surface between pours if structural backfill dries
- Boards can keep material from going over wall face

Finished First Pour


NATIONAL
Sovereign Bank

Straight Face Wall System

Save the Trees – San Antonio, TX


DEERE
Mack


S300
TURBO

Hampton Inn - Georgetown, TX

Utilities Issues – Kingwood, TX


BEST REDI-MIX
STOP

Structural Backfill and Geogrid

The Power of Stabilized Aggregate

How good is this stuff???

Durability of a Structural Backfill System

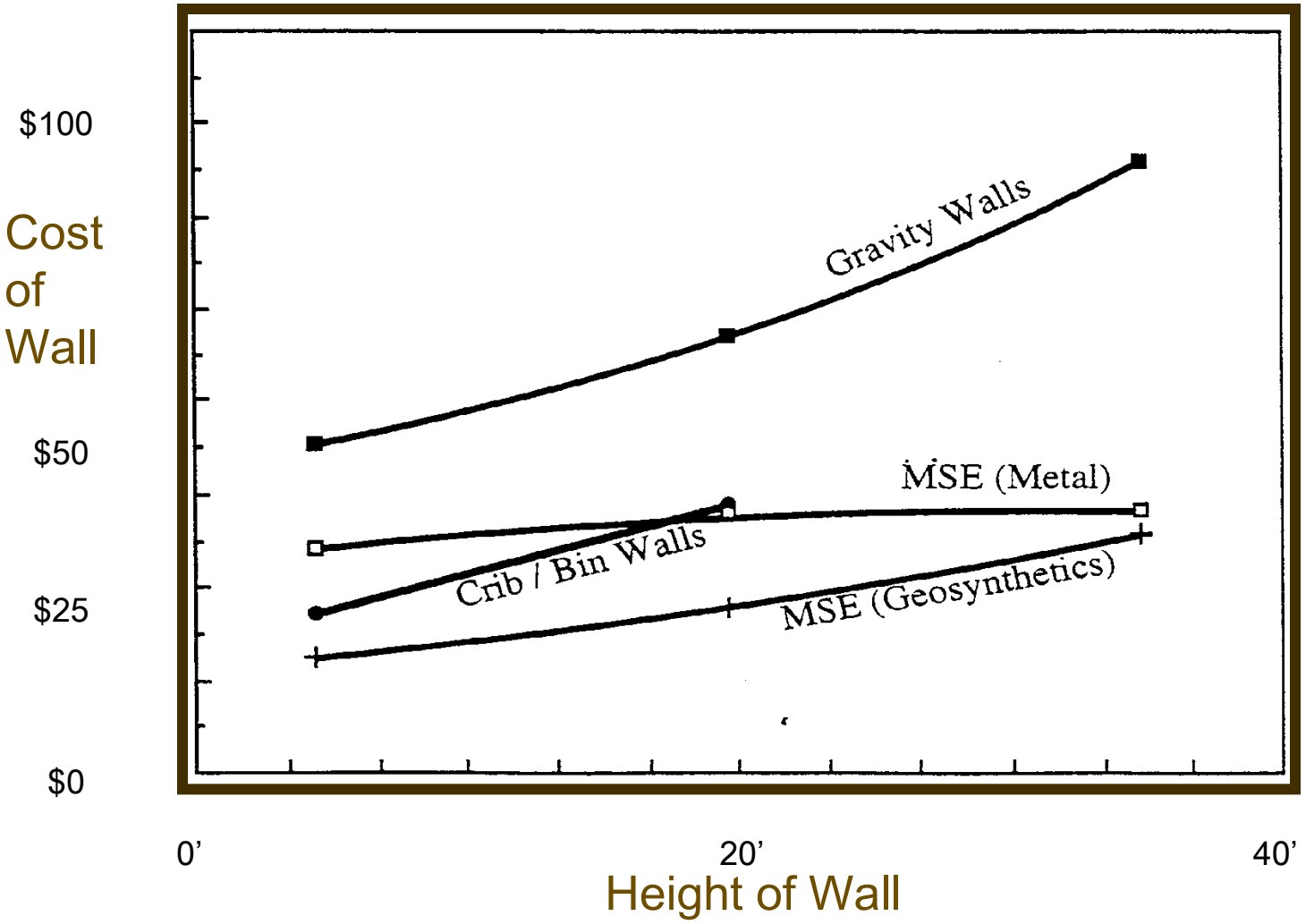
- 36" of rain in 24 hours
- Topsoil was eroded and exposed structural backfill
- Structure was submerged during flood

Why specify SRWs?

Design Versatility

Installation – Local Crews & Equipment

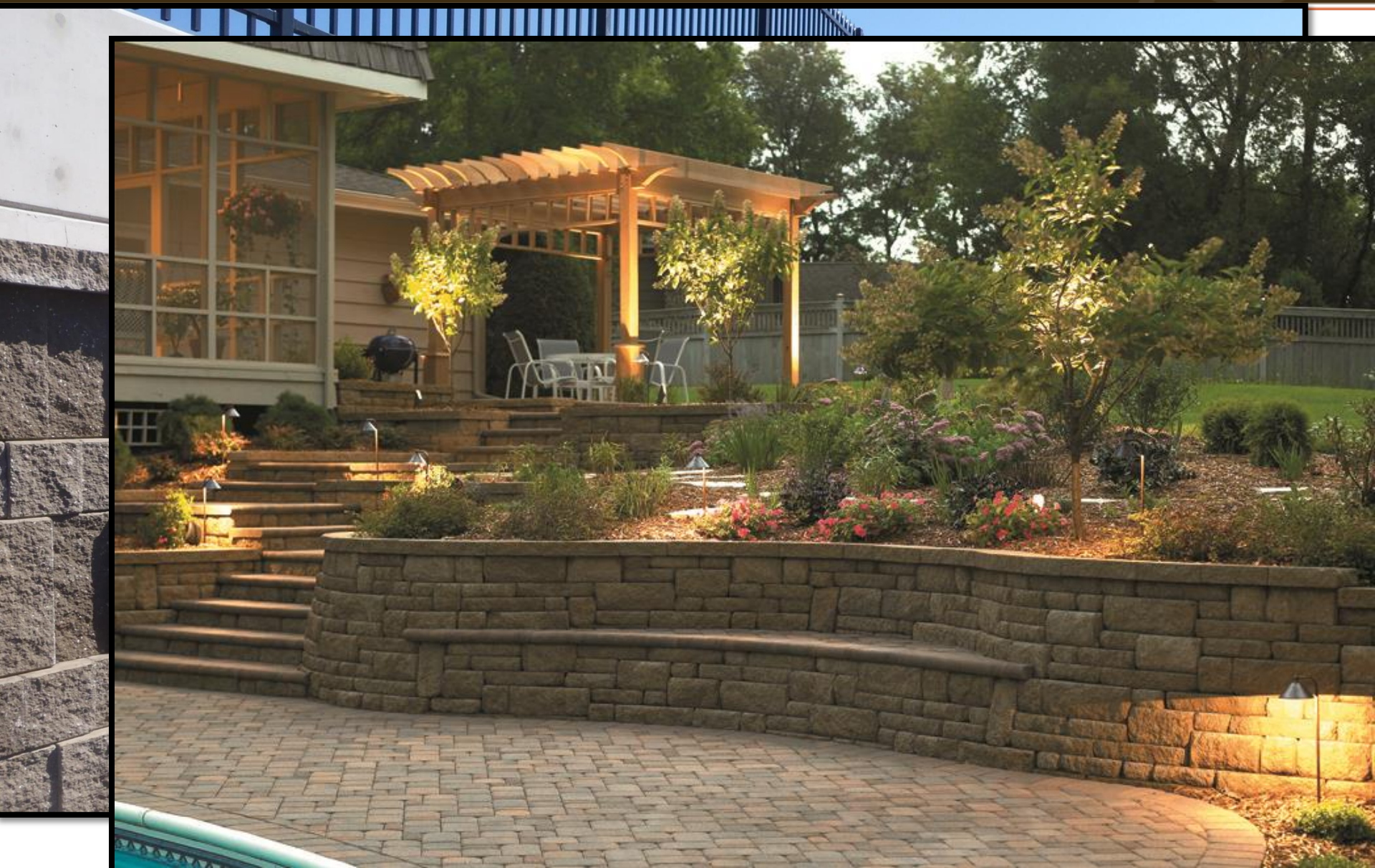
Economics



GRI survey of 50 DOTs : 20'high wall ≈ $25/ft²

Service Life

Aesthetics



Technical Support

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Questions?