CONCRETE MASONRY & HARDSCAPES ASSOCIATION

Introduction to Segmental Retaining Wall Systems

Materials, Systems, Terminology, and Standards

Course – S101

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Your Presenter

Gabriela Mariscal, P. E.

Division Engineer, SRW

Concrete Masonry & Hardscapes Association

Course Description

This presentation covers a basic overview of segmental retaining wall systems and materials; including how SRW units are manufactured, terminology, soils, geosynthetics, and construction practices and requirements. This program is best suited for those with little to no background in segmental retaining wall systems or materials; or for those desiring a refresher course in segmental retaining walls. The information presented here is built upon in more advanced topics covered in other programs by CMHA.

Learning Objectives

At the end of this program, participants will:

- Understand the segmental retaining wall terminology
- Understand the components of a SRW system
- Be familiar with the minimum material requirements for SRW systems
- Be familiar with the material testing for SRW components

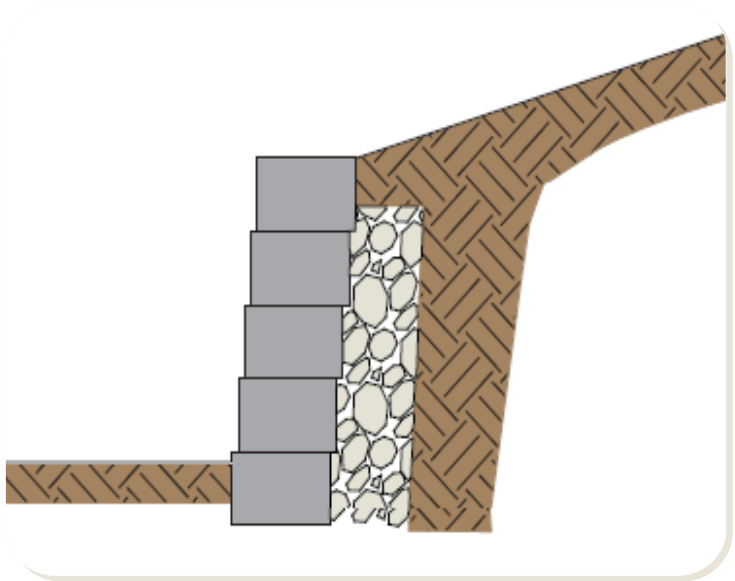
What is a Segmental Retaining Wall?

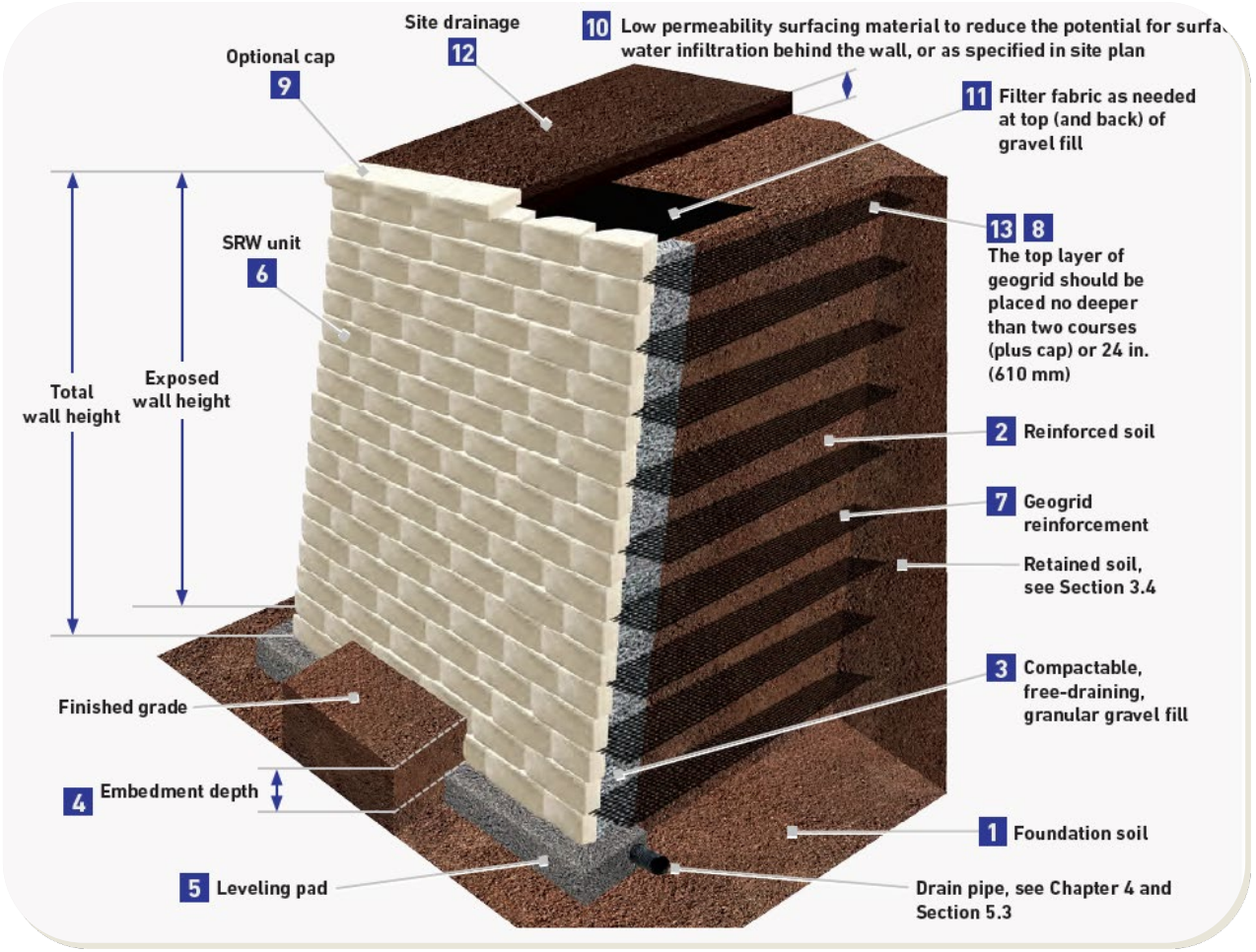
Earth retention wall comprised of dry-stack, modular concrete block units and compacted soil fill with or without the inclusion of soil reinforcement.

Two types:

- Conventional gravity retaining wall
- Geosynthetic reinforced soil retaining wall

Conventional vs. Reinforced SRW





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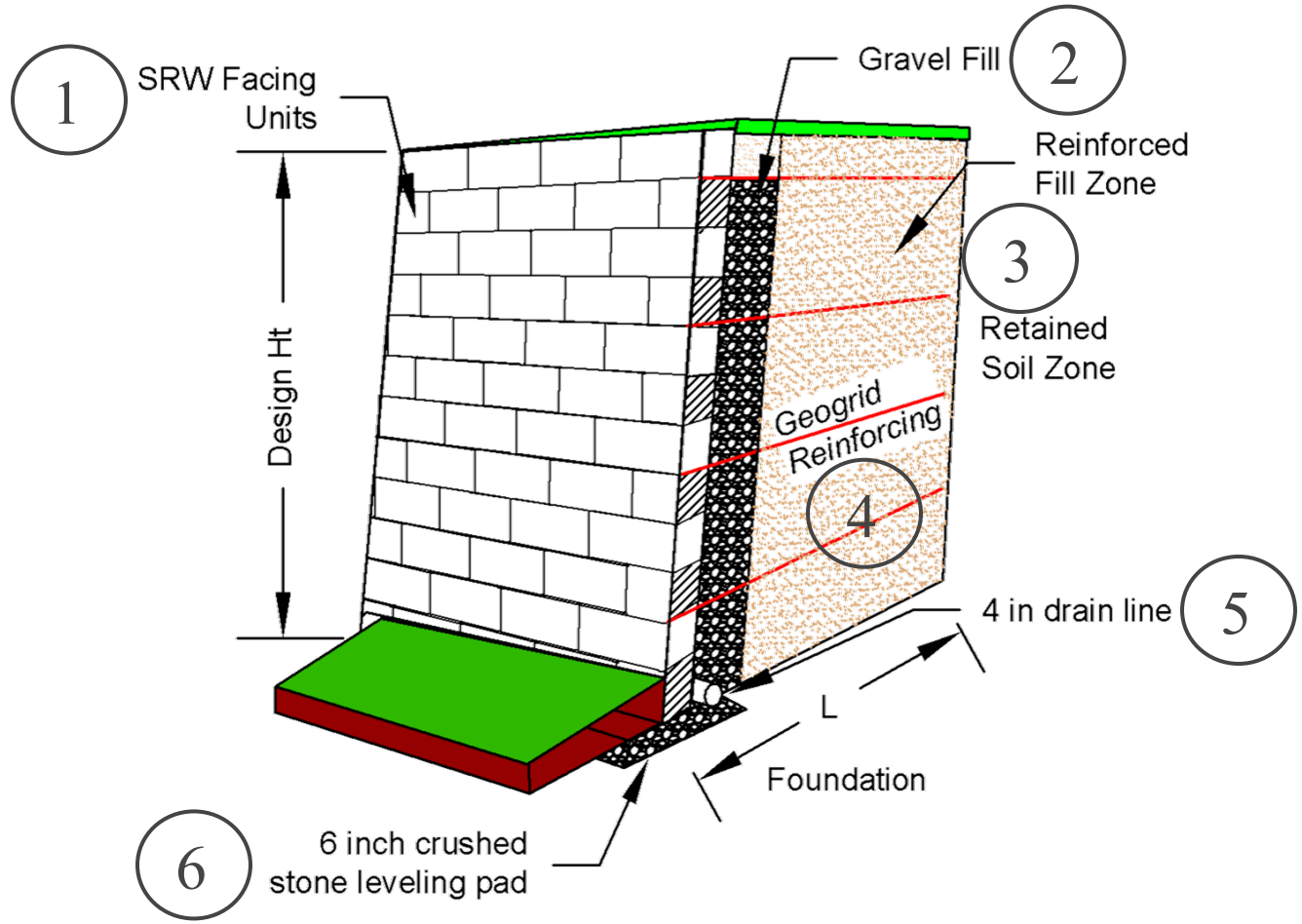
Segmental Retaining Walls Today

- Design flexibility, aesthetics, economics, ease of installation, performance and durability have made segmental retaining walls one the most popular retaining wall materials.
- Ingenuity in design has created a limitless palette of aesthetic options.

SRW Components

SRW Components

1. SRW Unit Facing
2. Gravel Fill
3. Reinforced Soil Fill
4. Geogrid Reinforcement (for reinforced Walls)
5. Drainage Pipe
6. Leveling Pad (Crushed Stone)



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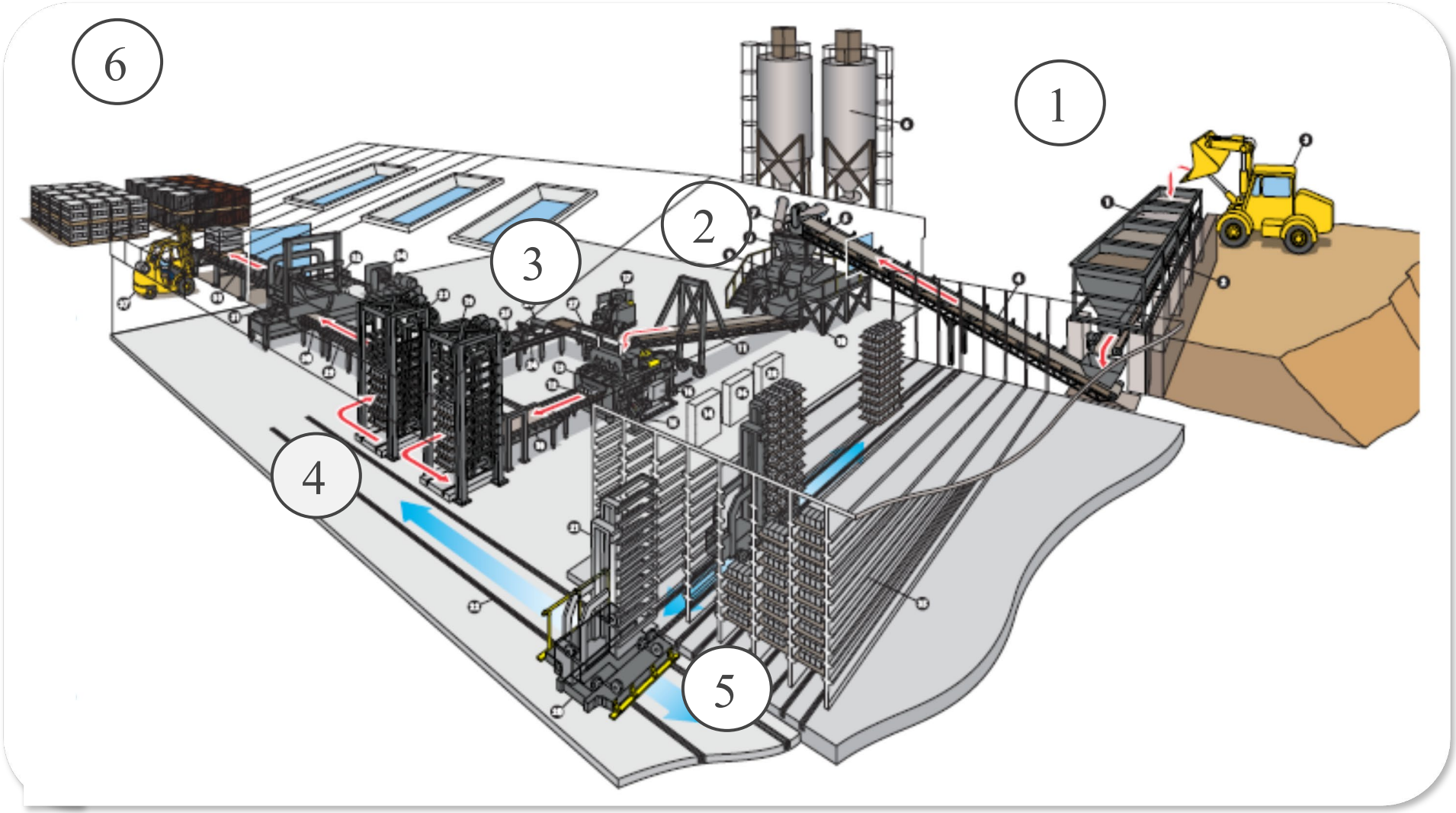
SRW Facing Production



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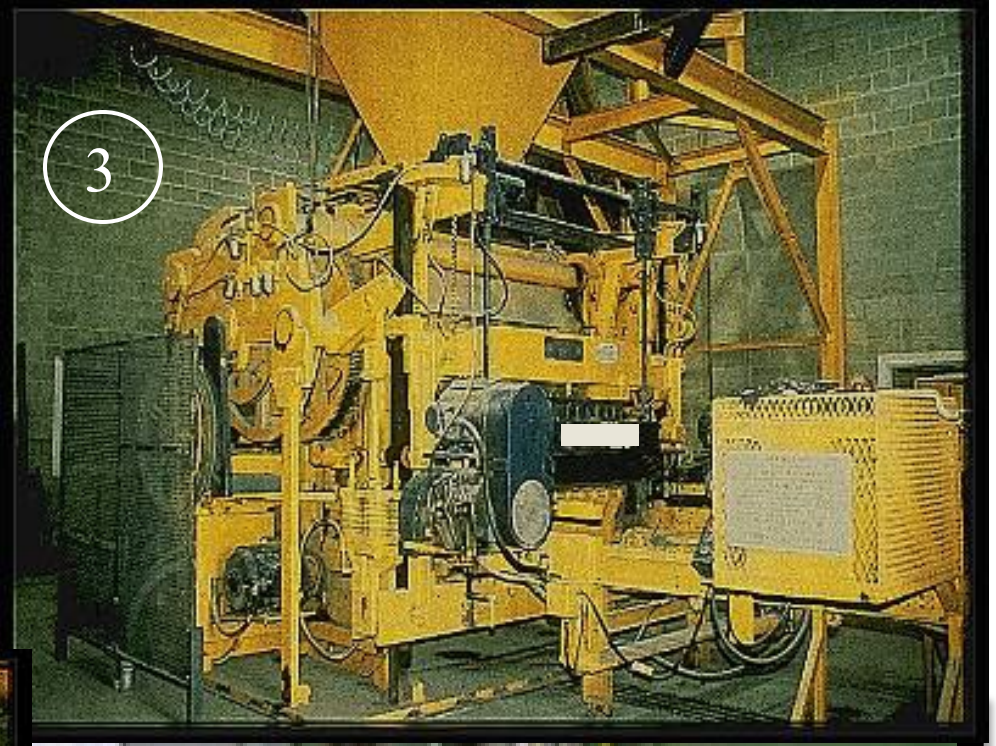
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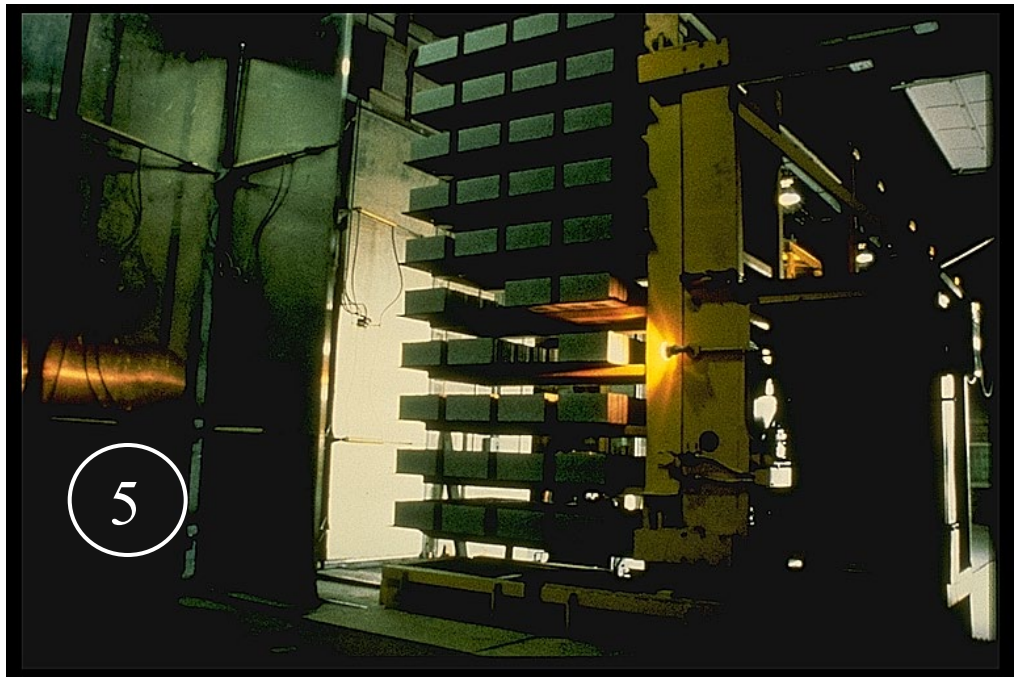
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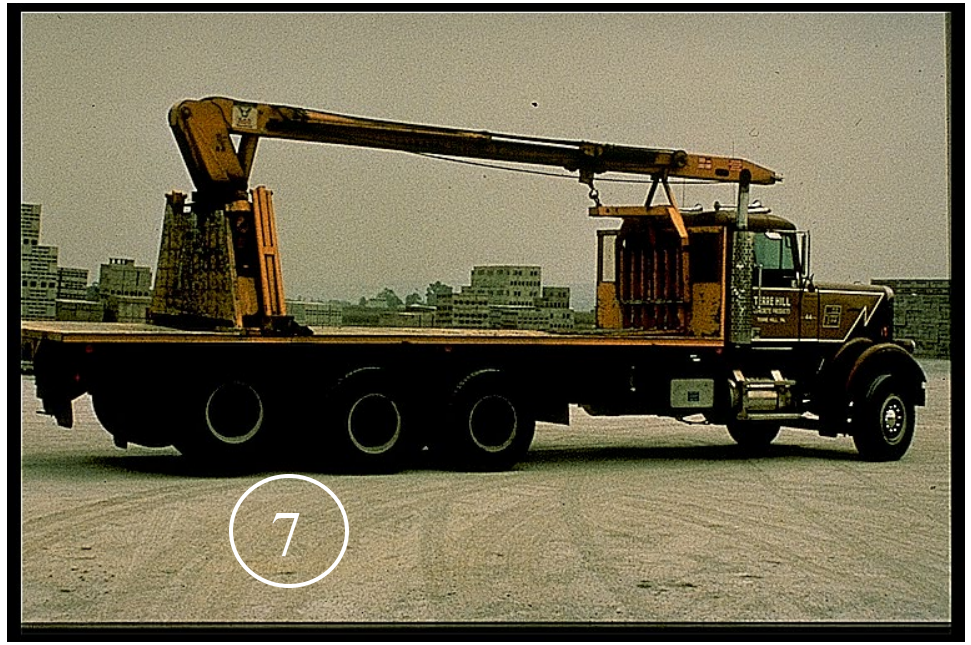
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Facing Units

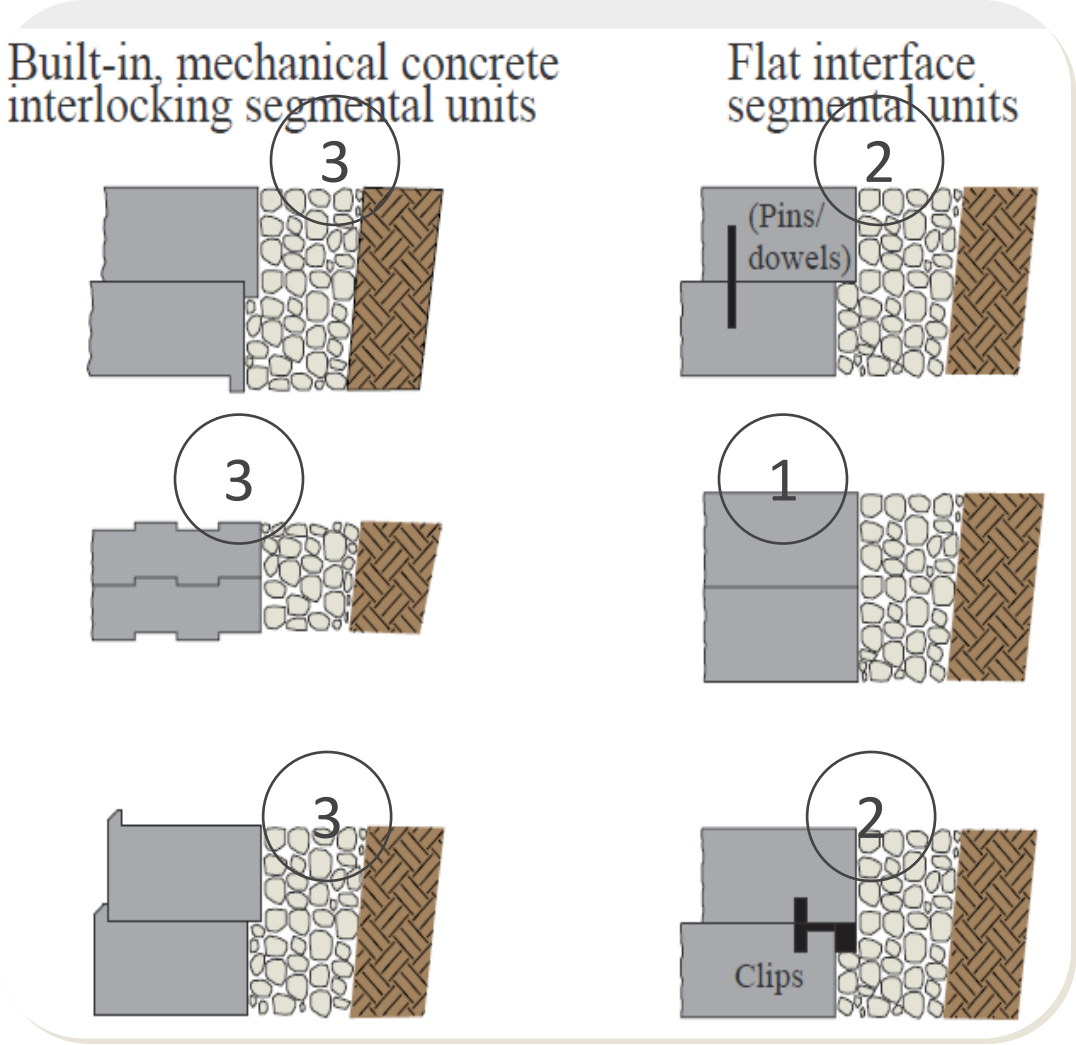
There are many different styles of face designs:

- 8 inch / 6 inch / 4 inch tall units
- Front Lip Units
- Rear Lip Units
- Pin Connections
- Core Locking Units
- Hollow Units
- Solid Unit
- 1 ft Deep Units
- 2 ft Deep Units
- Modular Units (multiple depth assemblies)

SRW Unit – Types of Connection

Facing Unit Interlock

1. Friction
2. Pin - Clip
3. Molded Flange
4. Built-In Batter



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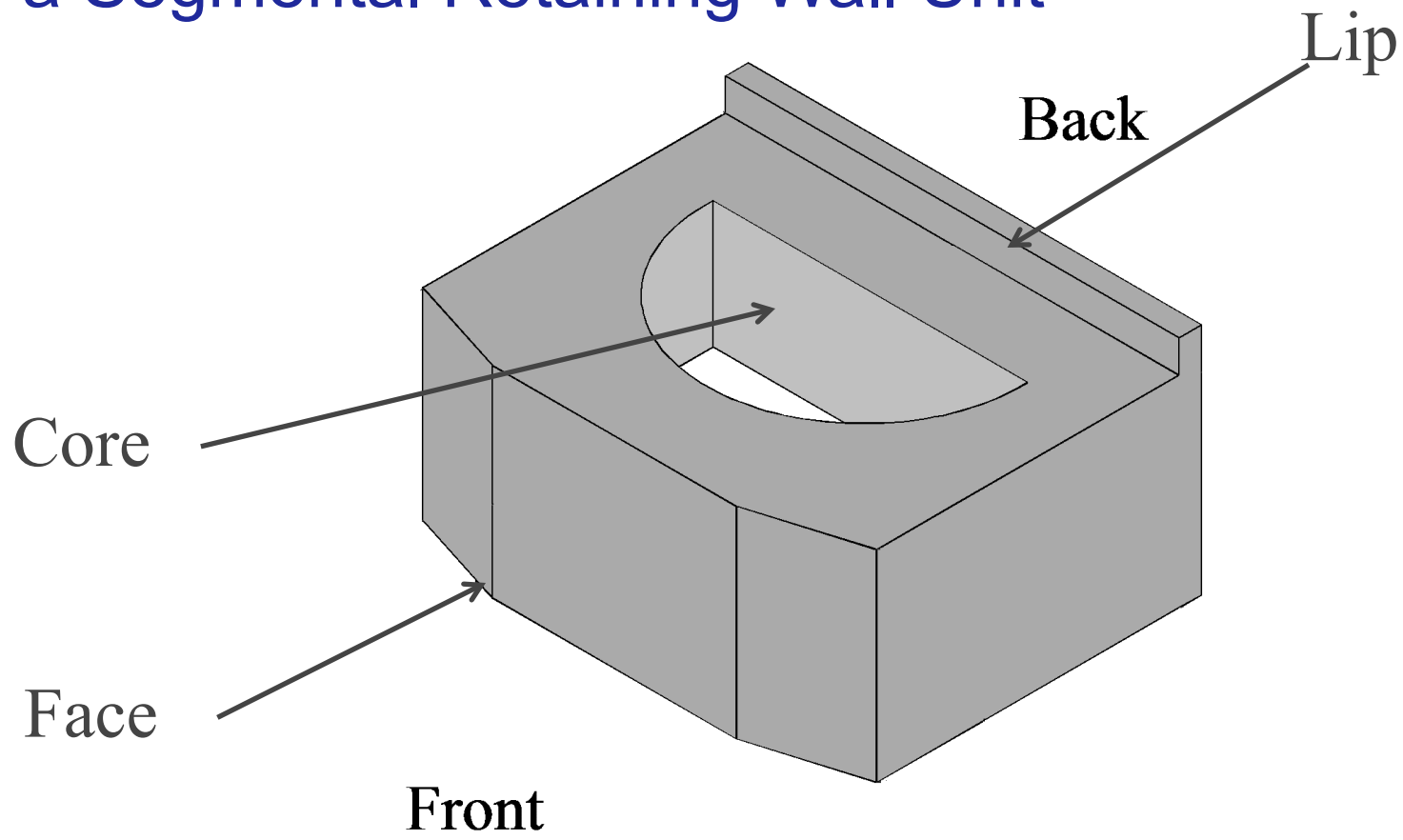
SRW Terminology

Parts of a Segmental Retaining Wall Unit



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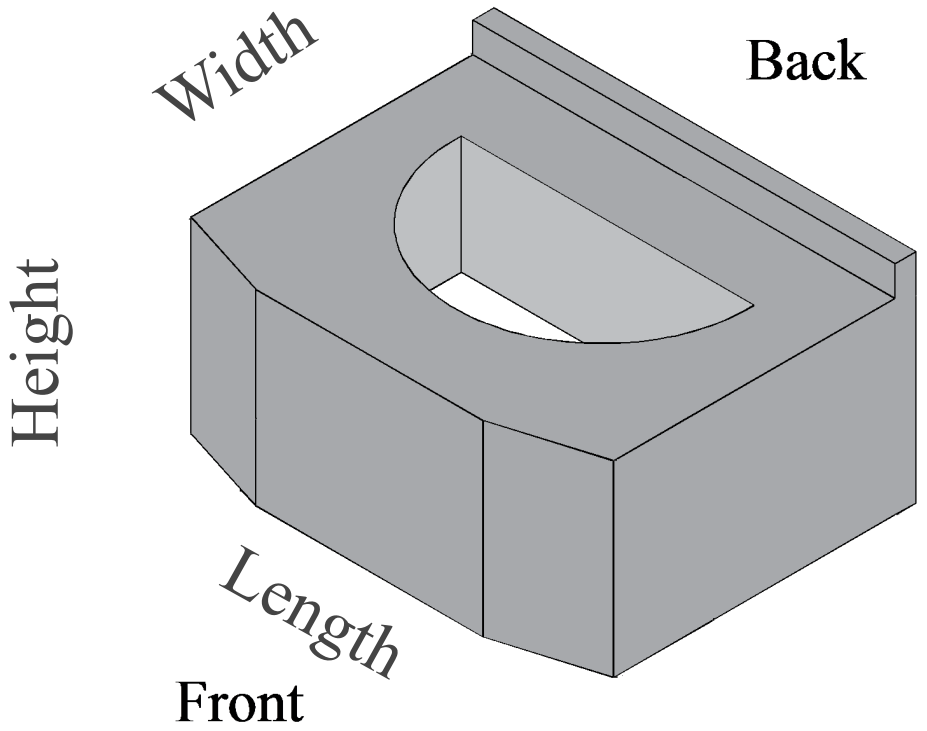
SRW Terminology

SRW Dimensions



Width is also sometimes referred as Depth of the SRW unit

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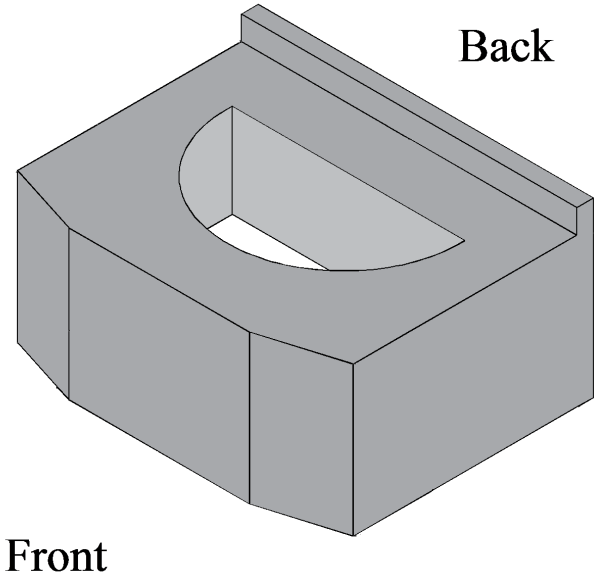
SRW Unit Front Face

- Selected primarily for their aesthetic appeal
- Every block type if different
- Know what block system is going to be used.
- There is no generic block type



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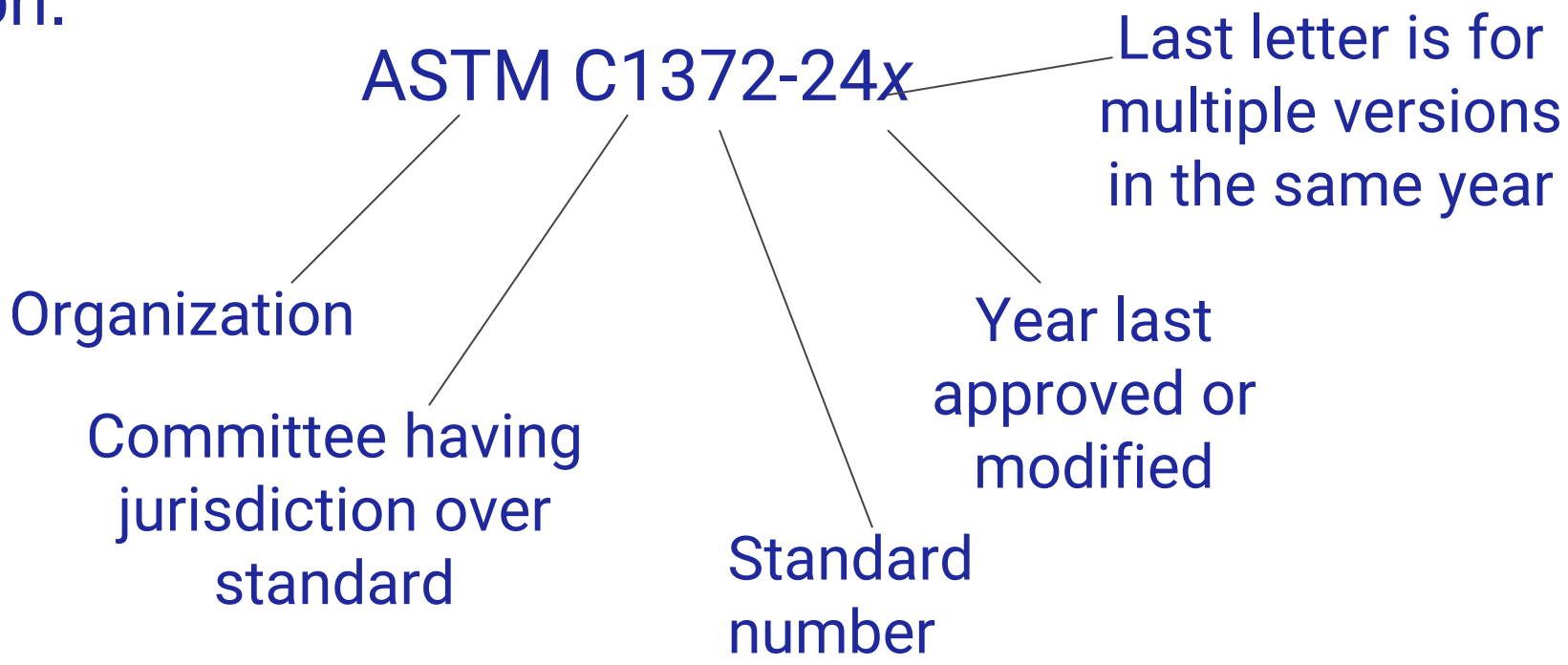
SRW Testing Standards

- ASTM C1372 *Standard Specification for Dry-Cast Segmental Retaining Wall Units*
- ASTM C140 *Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units (there is a section for SRWs)*
- ASTM C1262 *Standard Test Method for Evaluating the Freeze-Thaw Durability of Dry-Cast SRWs and Related Concrete Units*

ASTM Standards

All ASTM standards are titled with a fixed alpha-numeric designation.



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ASTM C1372 – Dry Cast SRW

Density Classifications

Density Classification	Oven-Dry Density of Concrete lb/ft^3 (kg/m^3)
	Average of Three Units
Lightweight	Less than 105 (1680)
Medium Weight	105 to less than 125 (1680 to 2000)
Normal Weight	125 (2000) or more

[A] Consult manufacturers for available densities.

The testing follows ASTM C140 procedures

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ASTM C1372 – Dry Cast SRW

Compressive Strength and Absorption

Density Classification	Maximum Water Absorption lb/ft^3 (kg/m^3)		Minimum Net Area Compressive Strength lb/in.^{2} (MPa)	
	Average of Three Units	Individual Units	Average of Three Units	Individual Units
Lightweight	18 (288)	20 (320)	3000 (20.7)	2500 (17.2)
Medium Weight	15 (240)	17 (272)	3000 (20.7)	2500 (17.2)
Normal Weight	13 (208)	15 (240)	3000 (20.7)	2500 (17.2)

The testing follows ASTM C140 procedures

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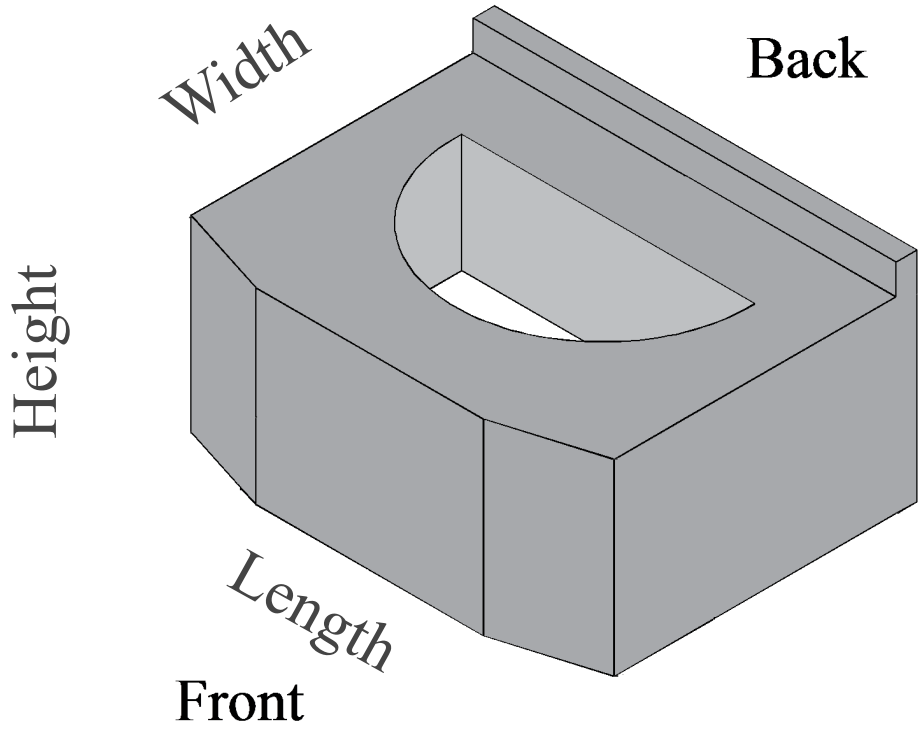
ASTM C1372 – Dry Cast SRW

Dimensional Tolerances - L, W, H +/- 1/8 inch

Width is exempt when architectural finishes are present



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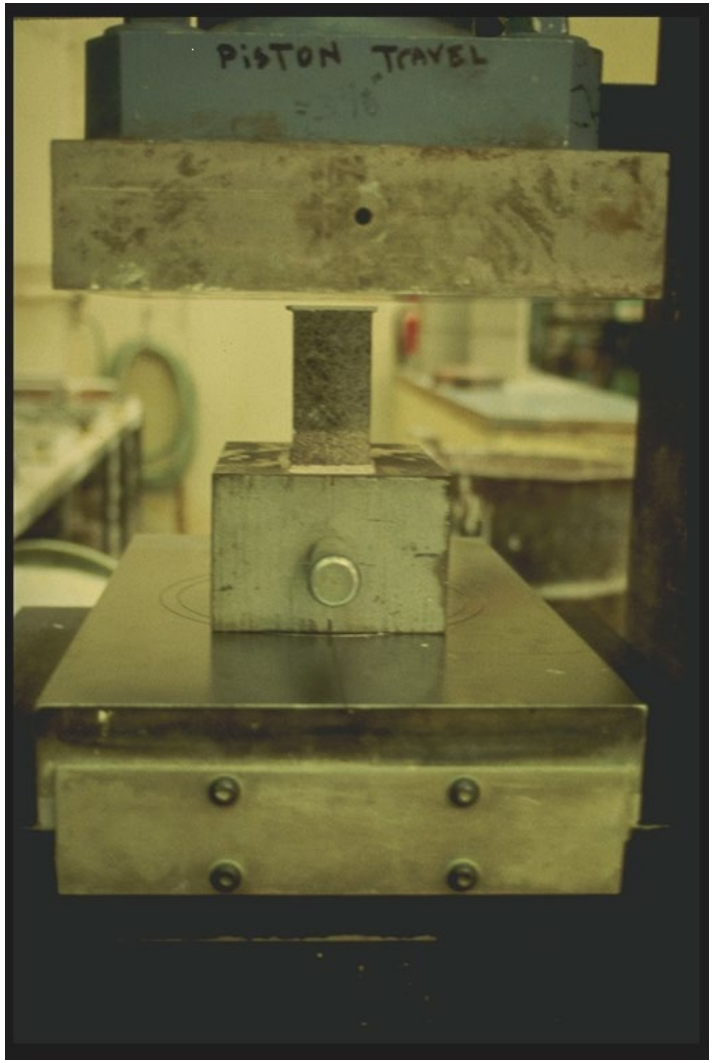
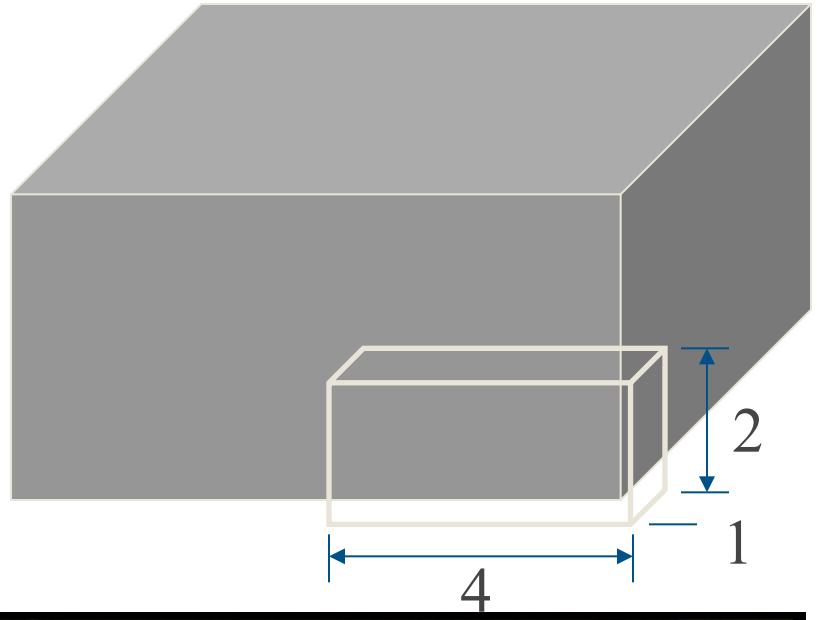
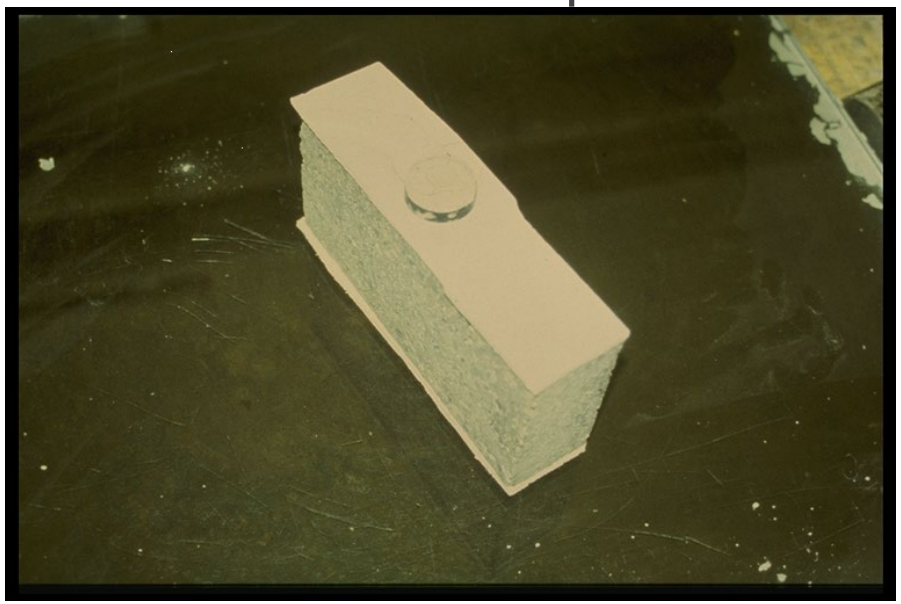
For testing SRWs, use coupons







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ASTM C1372 – Dry Cast SRW

Freeze–thaw damage occurs when concrete is exposed to continuous freezing and thawing conditions while saturated.

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ASTM C1372 – Dry Cast SRW

Freeze –thaw durability

When units are exposed to freezing and thawing under saturated conditions, ASTM C1372 includes 2 methods of satisfying the durability:

1. Proven field performance

OR

2. Testing Per C1262
   - 5/5 specimens shall have less than 1% weight loss after 100 cycles in water, or
   - 4/5 specimens shall have less than 1.5% weight loss after 150 cycles in water.

The testing follows ASTM C1262 procedure

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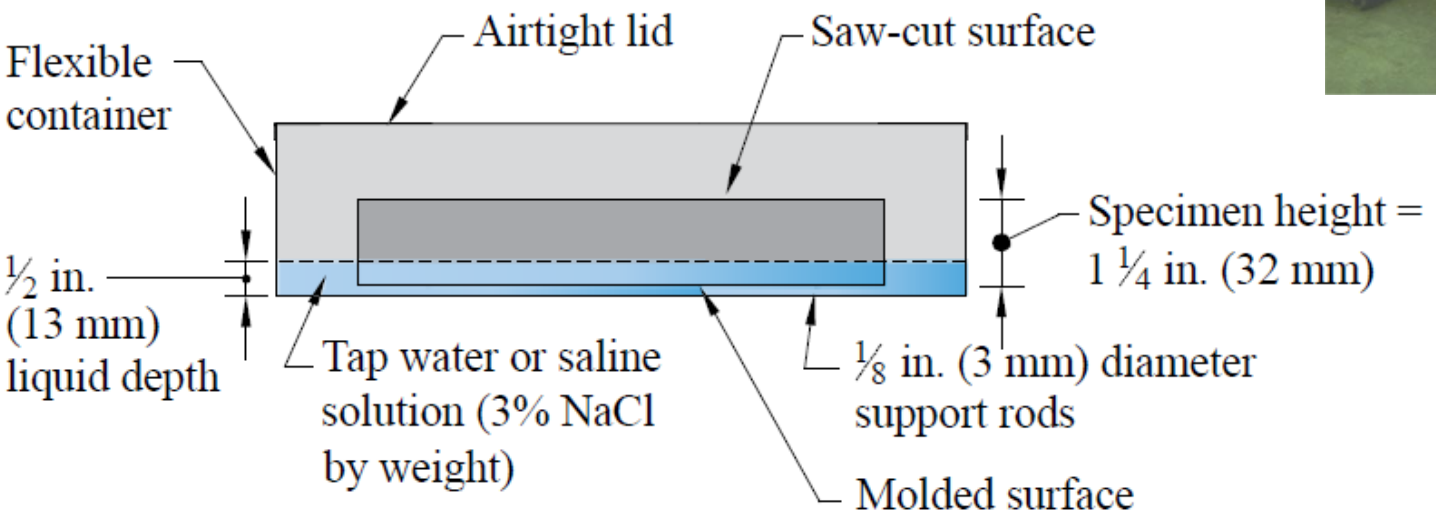
ASTM C1262 – Freeze-Thaw

- Saline or Water
- Partial Immersion
- Multiple cycles per day (up to 3)
- Applicable for different types of units
- Provides indicator of field performance



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Washing and collecting block residue

Results

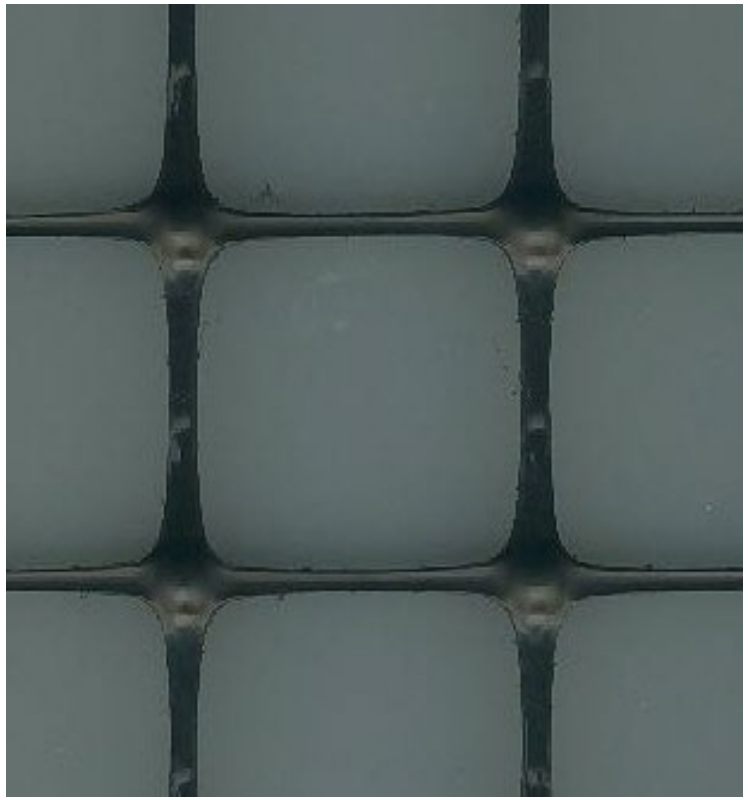
Sample failure

Geosynthetic Reinforcement

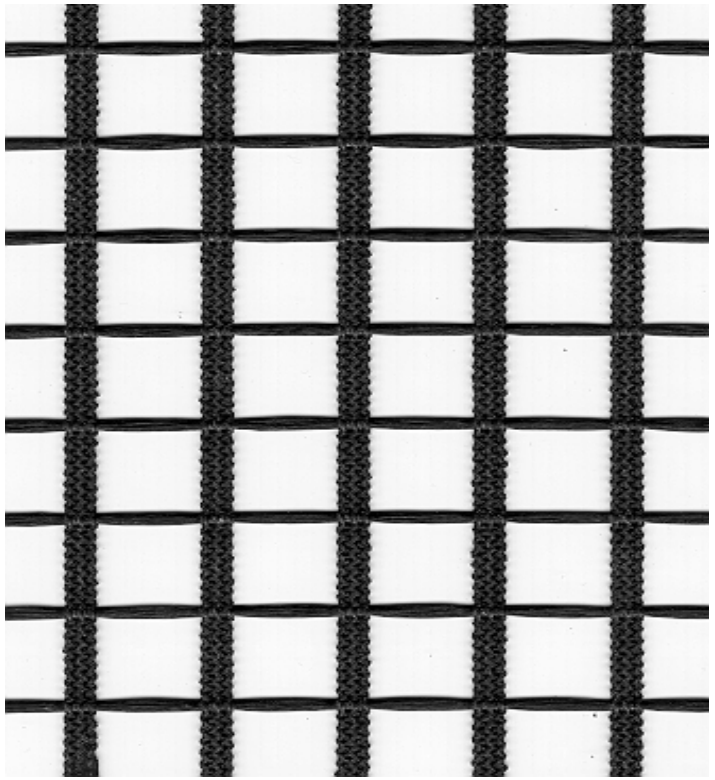
Functions:

- Unify the mass of the composite structure
- Reinforce the infill material
- Connect the facing to the soil mass

Two types of Geogrids



Rigid geogrid



Flexible geogrid

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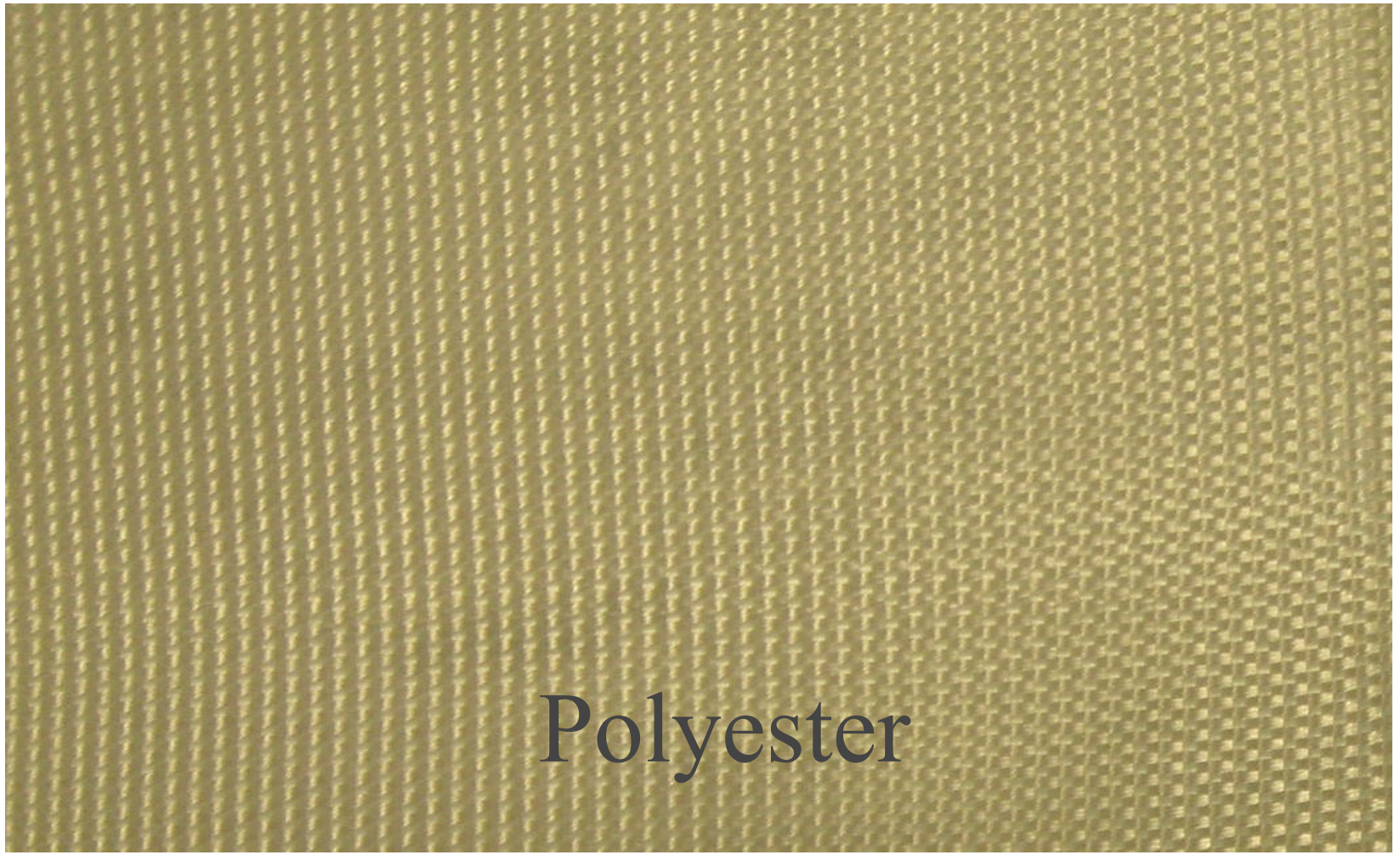
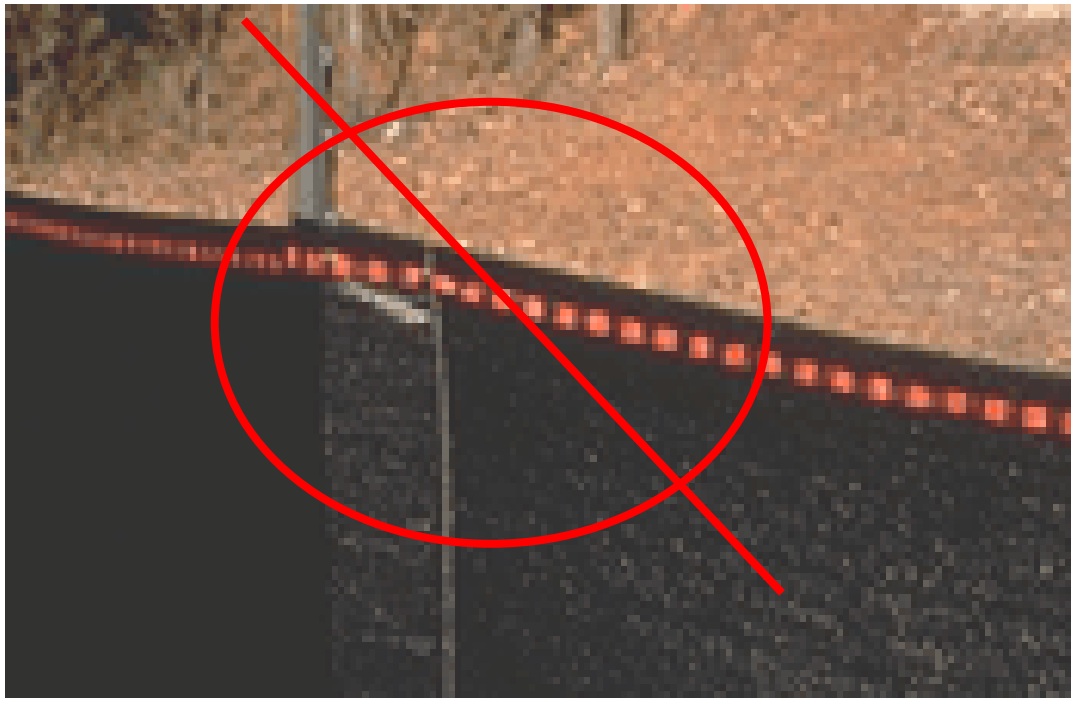
Materials can be polyester (PET), polypropylene (PP) or high density polyethylene (HDPE)

Some woven geotextiles are used



NOT Soil Reinforcement

Silt Fence



Snow Fence

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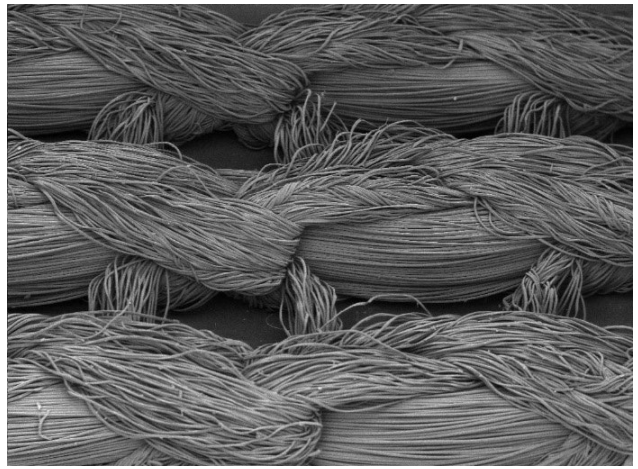
Geosynthetic Reinforcement

- All properties must be defined.
- Necessary quality for the useful life of the project
- SRW/reinforcement systems are all unique, so system properties are important!
- Geogrids Minimum Requirements:
  - Molecular weight > 25,000 g/mol
  - Caboxyl End Group < 30 mmol/Kg
  - NTPEP REGEO Report
  - Fiber Certification from the actual fiber manufacturer



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Geogrid/Geotextile Materials

- Most walls are internally reinforced with geogrids because:
  - They are a bit more contractor friendly
  - Geogrids tend to lay flat, without wrinkles
  - Handle-ability is better with smaller rolls
  - More geogrid producers competing for sales
- A few geotextile companies compete

Testing Provided by the Geosynthetic Supplier

Geosynthetic Properties:

- Ultimate tensile strength: ASTM D6637 for geogrids or ASTM D4595 for geotextiles
- Creep reduction factor: ASTM D5262 and D6992
- Installation damage: ASTM D5818
- Durability: FHWA guidance (FHWA NHI-00-043, FHWA NHI-00-044)
- Pullout Capacity: ASTM D6706

Testing Provided by the Geosynthetic Supplier

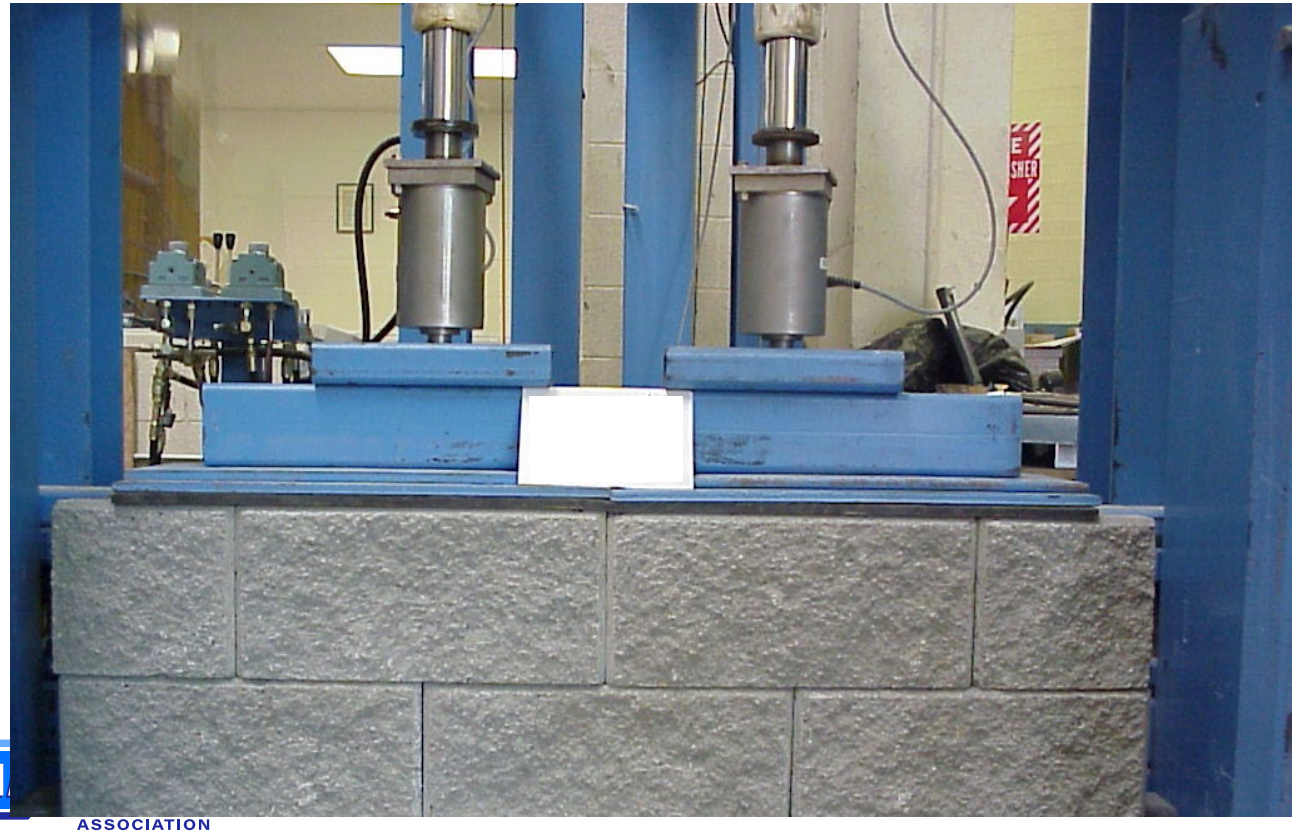
SRW-grid system:

- Connection strength test results for the proposed geogrid/block combination: ASTM D6638
- Block/Grid/Block and Block/Block shear testing results: ASTM D6916

The system properties are unique!!

SRW System Connection

ASTM D6638, *Std Method for Connection Strength of Geosynthetic Reinforcement and SRWs*



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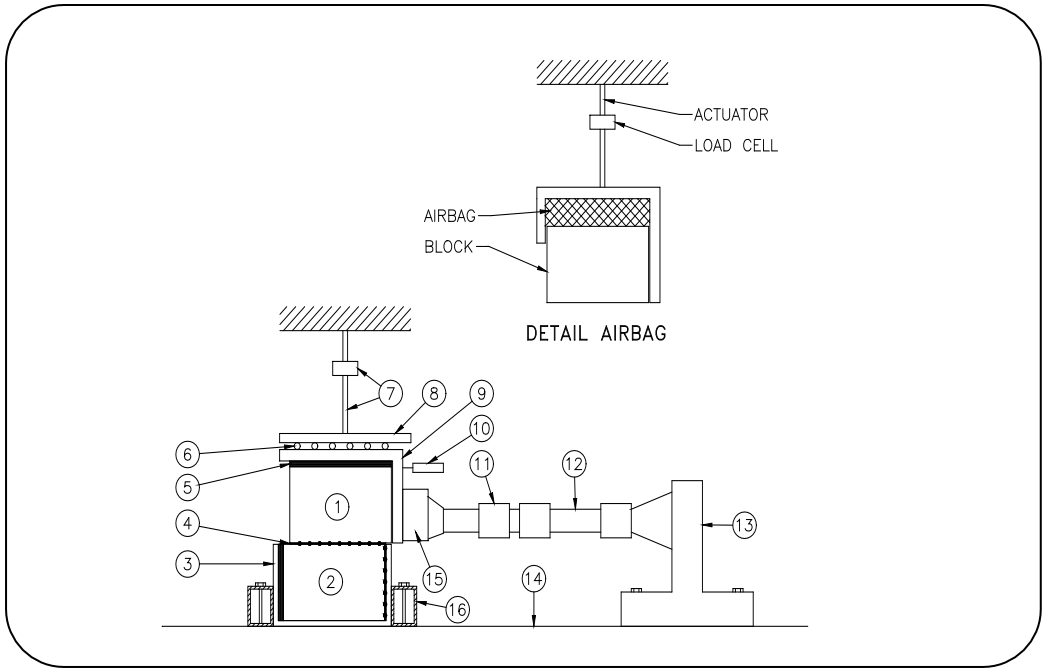
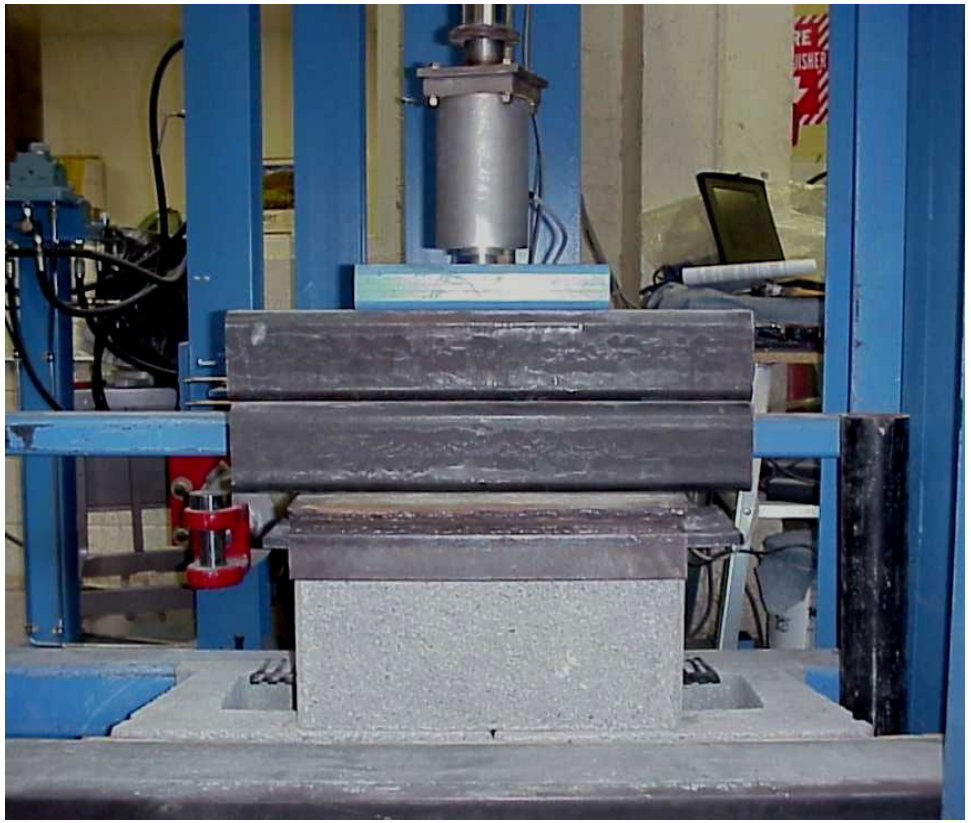
SRW System Shear

ASTM D6916, *Determination of Shear Strength between Segmental Concrete Units*





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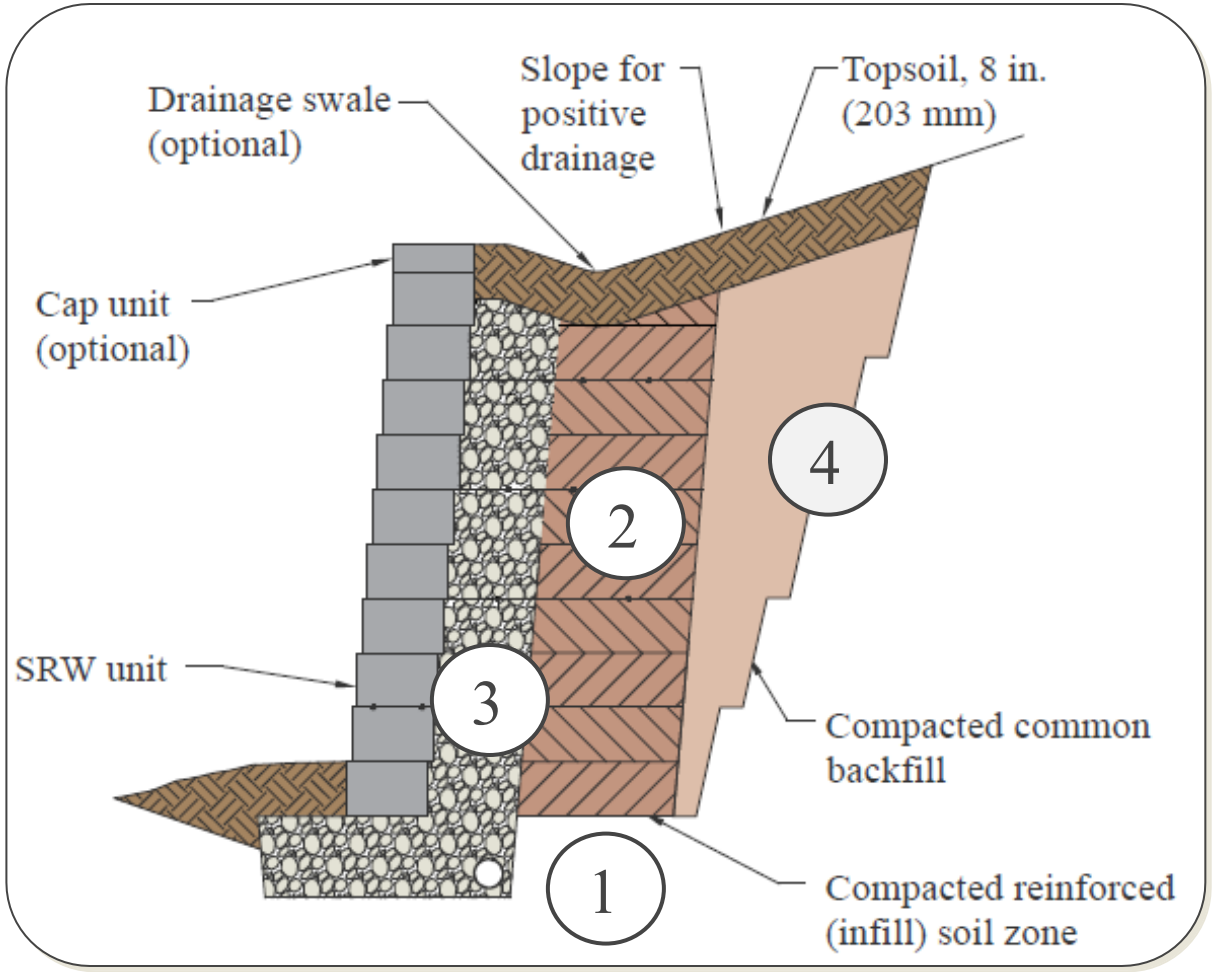
Soils for SRW Projects

1. Foundation soil
2. Reinforced soil
3. Gravel Fill
4. Retained soil



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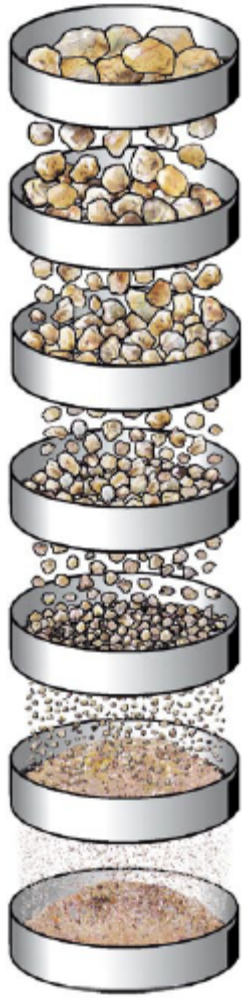
Soil Testing

- Particle size distribution: ASTM D422 *Standard Test Method for Particle-Size Analysis of Soils*
- A sample goes through standardized sieves
- Material weight that passes is recorded
- Classification follows USCS on ASTM D2487



#200 sieve

Soil Testing

Atterberg limits: Soil Plasticity

Characteristic of **fine-grained fraction of soils**

Measures the water content at:

- Plasticity Limit (PL)
- Liquid Limit (LL)
- Plasticity Index (PI) = LL-PL
  - 0: Non plastic
  - 5-10: Slightly Plastic
  - 10-20: Low plasticity
  - 20-40: Medium plasticity
  - >40 Highly Plastic

ASTM D4318 Std. Test for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

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Unified Soil Classification System (USCS)

Letter system that describes soil

XY

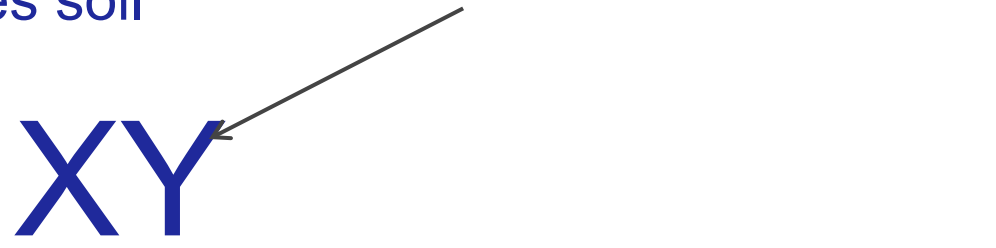
Predominant material on sample

- Coarse Grained Soils, > 50% sand or gravel
  - Gravel (G) or Sand (S)
- Fine Grained Soils, < 50% sand
  - Silt (M) or Clay (C)

Unified Soil Classification System (USCS)

Letter system that describes soil

Describes the mix



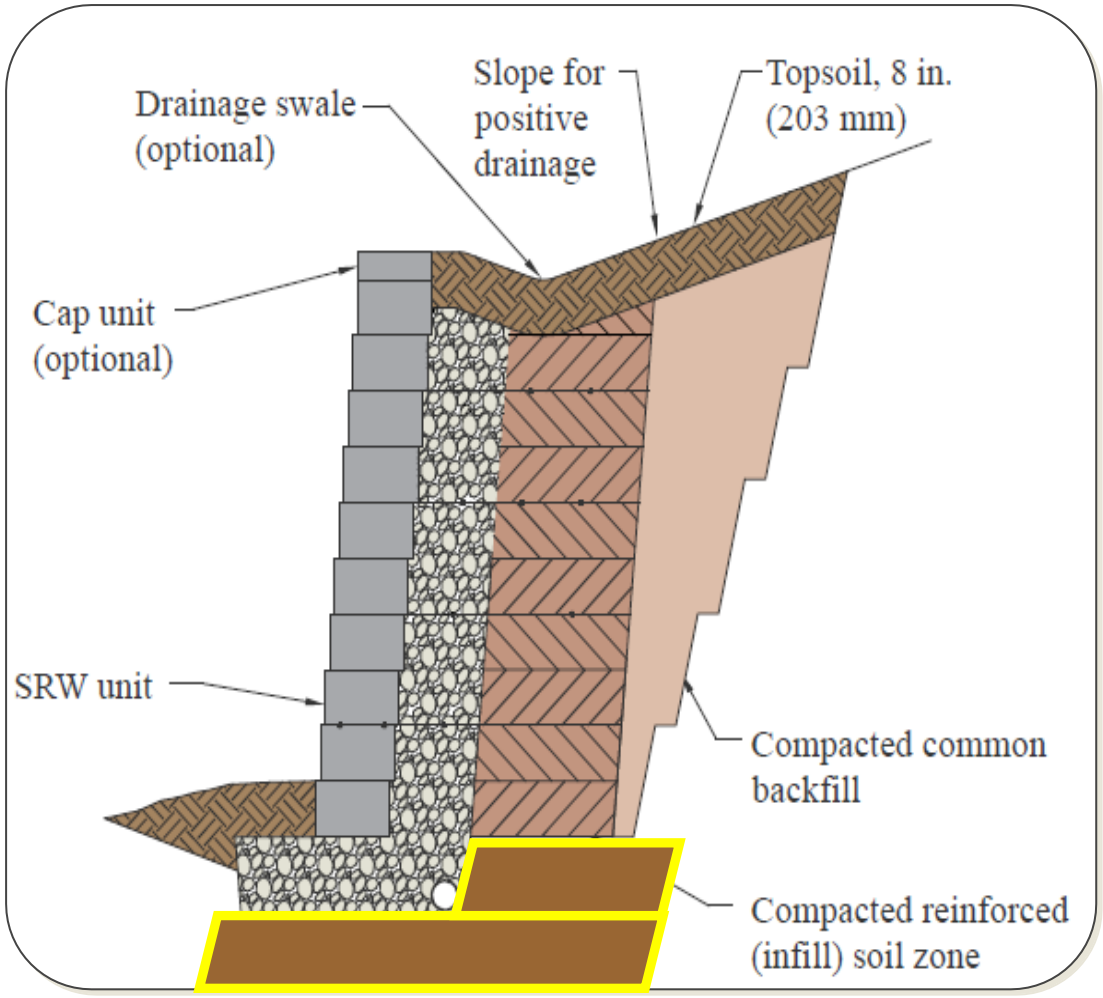
Description of the sample

- Well graded is W
- Poorly graded is P
- High plasticity is H
- Low plasticity is L
- If fines are present C or M can be used

Divisions			Symbol	Description
COARSE GRAINED SOILS Sands Gravels Over 50% retained on #200 sieve	GRAVELS Over 50% of coarse material retained on #4 sieve	CLEAN GRAVEL <5% fines	GW	Well graded gravel, many particle sizes, no fines
			GP	Poorly graded, few different particle sizes, no fines
		GRAVEL WITH FINES	GM	Silty gravels, gravel-sand-silt mixtures
			GC	Clayey gravels, gravel-sand-clay mixtures
	SAND Over 50% of coarse material passed #4 sieve	CLEAN SANDS Less than 5% passing #200 sieve	SW	Well graded gravel, many different particle sizes, little or no fines
			SP	Poorly graded, few different particle sizes, no fines
		SAND WITH FINES	SM	Silty gravels, gravel-sand-silt mixtures
			SC	Clayey gravels, gravel-sand-clay mixtures
FINE GRAINED SOILS Silts Clays (Over 50% passing the #200 sieve)	SILTS AND Liquid limit than	CLAYS is less 50 %	ML	Inorganic silts, slight to no plasticity
			CL	Inorganic clays, low to moderate plasticity
			OL	Organic silts and clays of low plasticity
	SILTS AND Liquid limit than	CLAYS is more 50 %	MH	Inorganic silts, moderate to high plasticity
			CH	Inorganic clays, high plasticity, fat clays
			OH	Organic silts and clays of high plasticity

Foundation Soil

- Function is to provides structural support to wall
- Must be stable
- If there are issues with the soil, engineered solutions are available.
- Want: GW, GP, GM, SW, SP, SM
- Avoid: ML, MH, CL, CH, OL, OH, PT



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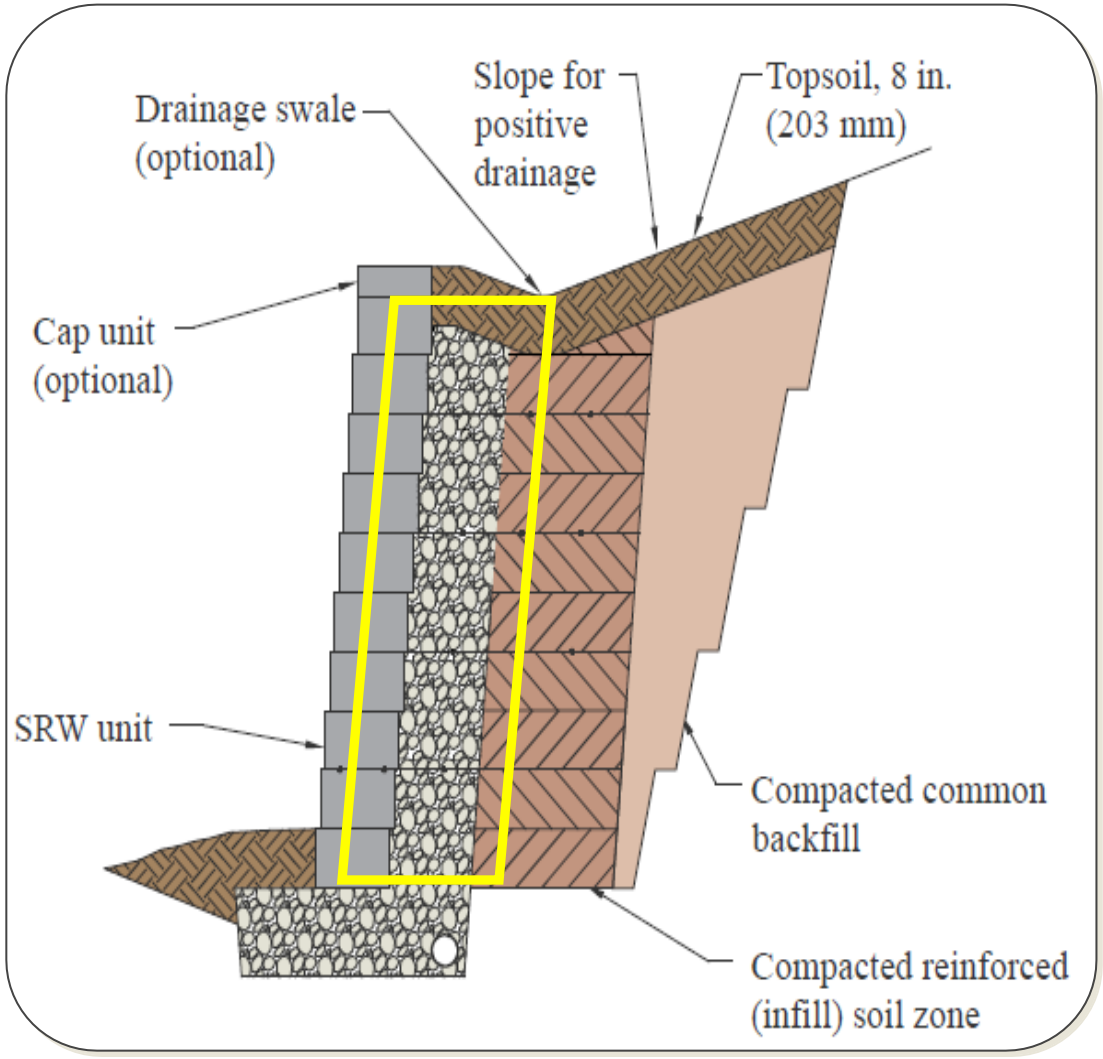
Reinforced Fill

- Creates a composite mass
- Increases stability
- It is placed behind gravel fill to the end of the grid



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Reinforced Fill

- Free draining (granular) soils are preferred
- CMHA Recommended Gradation

Sieve Size	Percent Passing
4 inch	100 – 75
No. 4	100 – 20
No. 40	0 – 60
No. 200	0 – 35*

Plasticity Index (P.I.) < 20

Liquid limit (LL) < 40
Want: GW, GP, GM, SW, SP, SM
Avoid: ML, MH, CL, CH, OL, OH, PT

*These values can be reduced depending on wall height and the application

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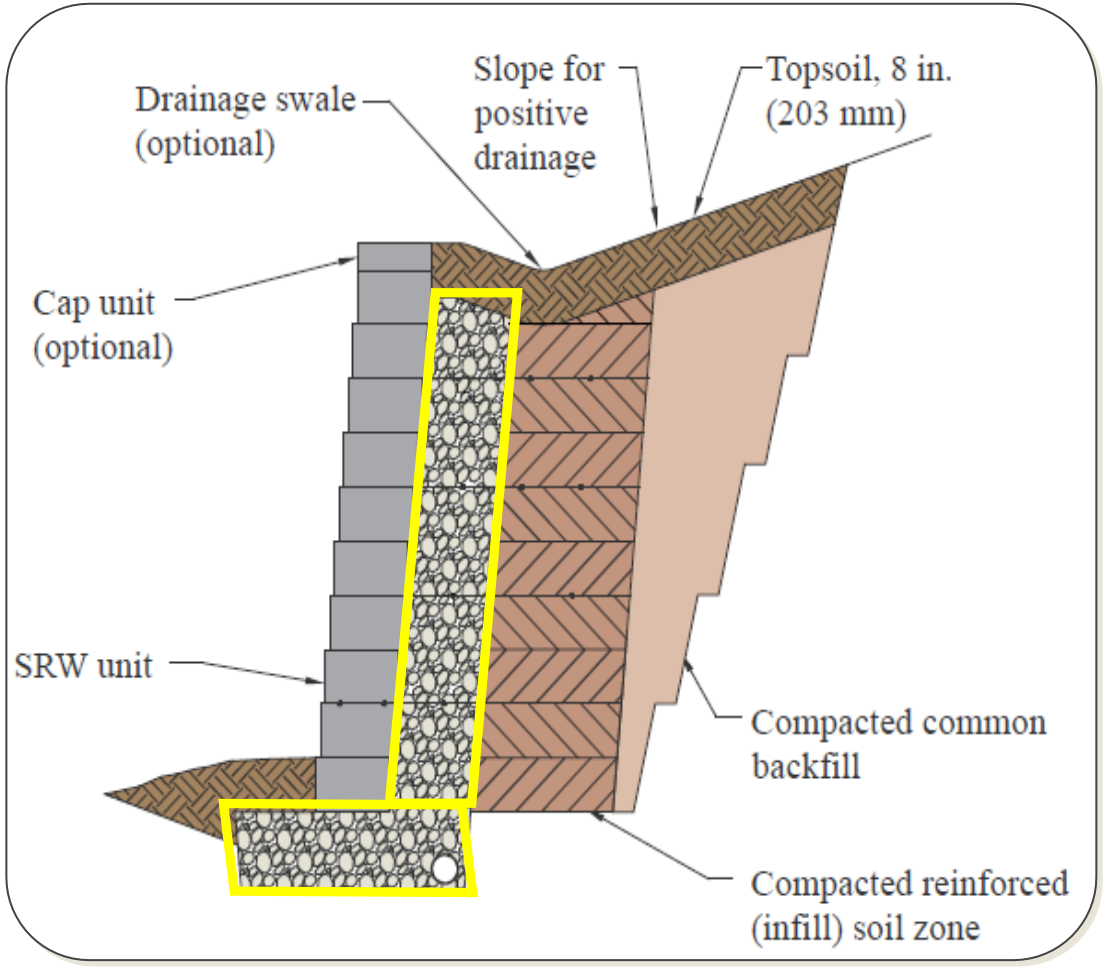
Gravel Fill

What are the purposes of gravel fill?

- Helps draining incidental water build up behind the SRW units
- Provides a stiffer transition zone between the SRW units and the soil.
- Aids compaction of soil directly behind the SRW units
- Fill voids/cavities in, between and 12” behind the SRW unit



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Gravel Fill

CMHA Recommended Gradation

Sieve Size	Percent Passing
1 inch	100 %
¾ inch	75 – 100
No. 4	0 – 60
No. 40	0 – 50
No. 200	0 – 5

Want: GW, GP, SW, SP

Avoid: GM, SM, ML, MH, CL, CH, OL, OH, PT

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Pea gravel (single size, round gravel) is not recommended

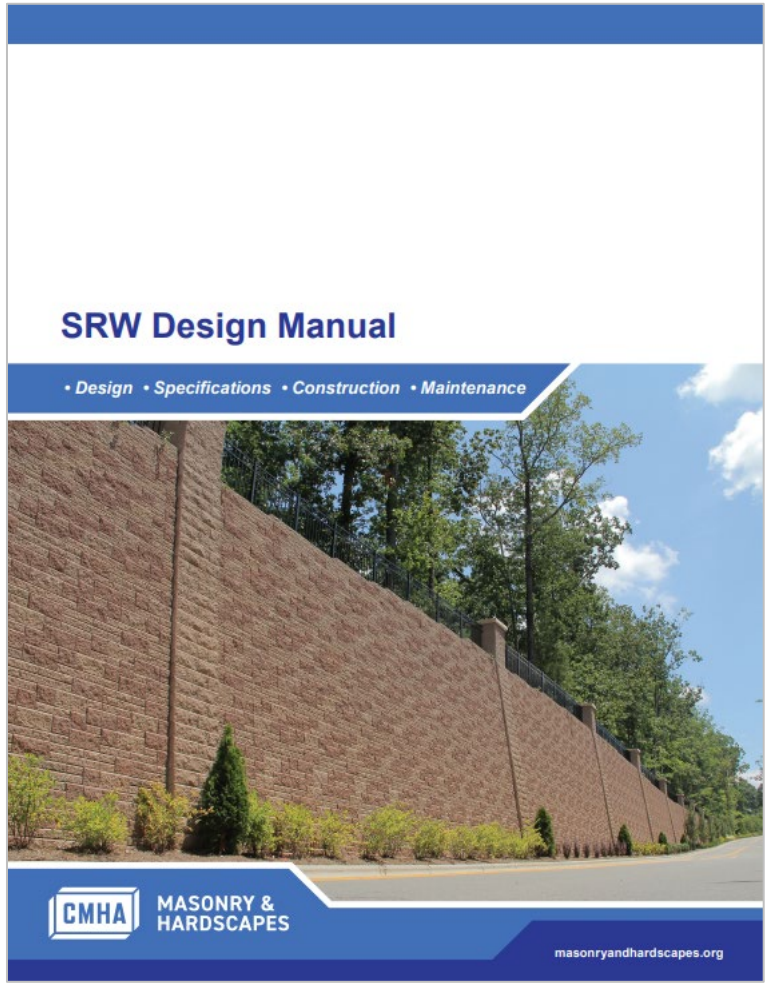
Retained Soil

- This soil is applying load on the retaining wall
- Composition varies
  - uncontrolled fill
  - miscellaneous materials
  - variable soil matrix

Design and Construction Requirements

The minimum requirements for the design and construction of segmental retaining wall structures is addressed in the following document published by CMHA:

- Design Manual for Segmental Retaining Walls



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SRW Applications

SRW Applications

- Residential: D.I.Y. or Contractor / Installer Structures
- Commercial: Landscape or Structural
- Public Transportation / Municipal
  - Landscape
  - Structural

SRW Applications - Residential

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SRW Applications - Commercial

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SRW Applications – Multi-Family

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SRW Application - Transportation

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Visitor
Parking
LOT V

Recap

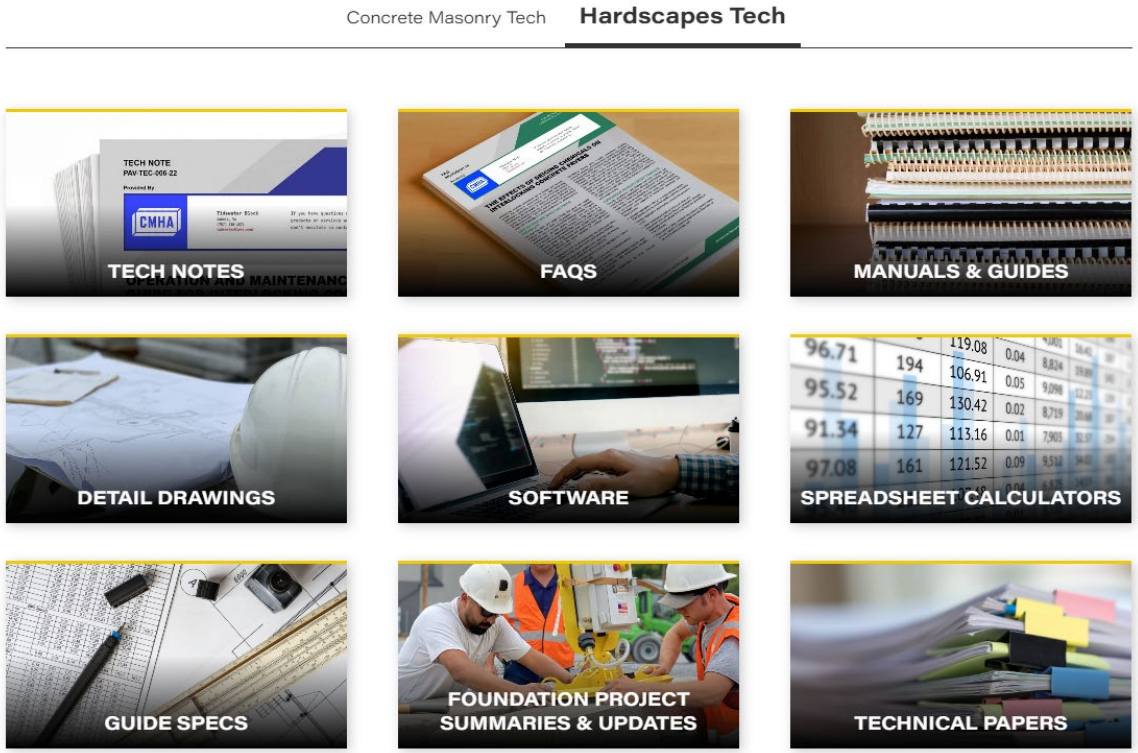
Introduction to:

- Segmental Retaining Wall Systems
- Segmental Retaining Wall Materials
- SRW Terms and Nomenclature
- Design Guide and Standards

Additional Resources

Free access to CMHA:

- Tech Note
- Manuals and Guides
- Software
- And much more…



SRW-FAQ 002-14 What are the basic components of an SRW system?

SRW-TEC-001-15 SEGMENTAL RETAINING WALL UNITS

SRW-TEC-008-12 INSPECTION GUIDE FOR SEGMENTAL RETAINING WALLS

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Course Evaluations

- In order to maintain a high-quality learning experience, a required course evaluation will be available at the end of this education session.

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Questions?

Please use the Q&A and chat functions to type your questions for our presenter

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November 13
Introduction to Segmental Concrete Pavement

December 11
Operation and Maintenance of ICP

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👉 **Learn more and register at:**
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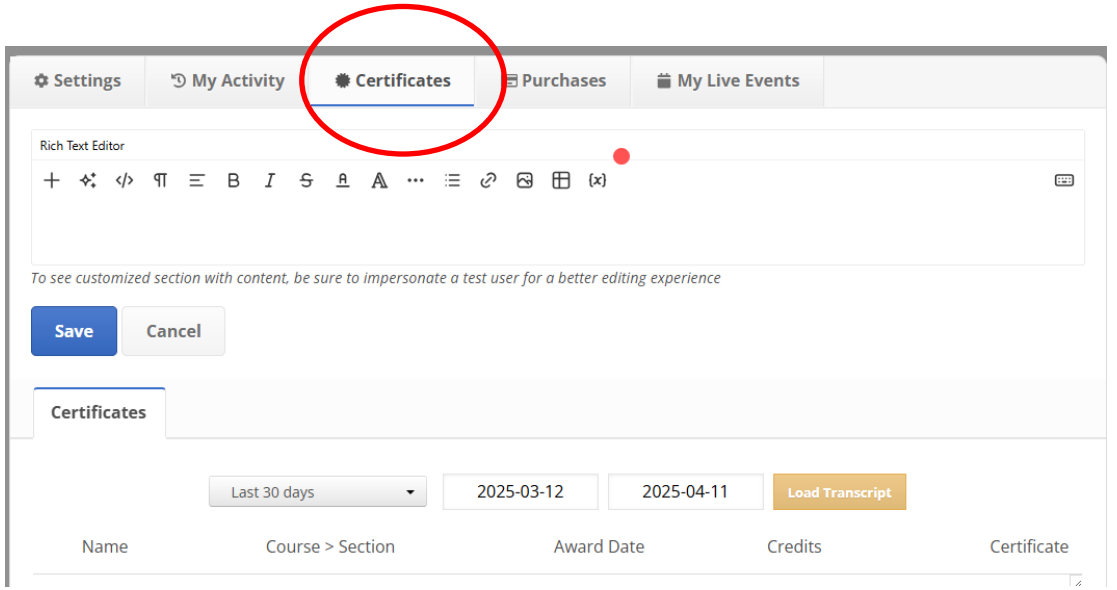
Certificate of Completion

Your certificate will be available in your **CMHA Learning Management Profile** under the **“Certificates”** tab.



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Thank You!

For more information, contact:

Concrete Masonry & Hardscapes Association

703-713-1900

info@masonryandhardscapes.org

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