SEGMENTAL RETAINING WALLS

TECHNICAL GUIDE

UNILOCK®
DESIGNED TO CONNECT™

Pisa2® University of Michigan, Helipad. Ann Arbor, Michigan. **DESIGN:** Albert Kahn & Associates

UNILOCK®

DESIGNED TO CONNECT™

GOING TO NEW HEIGHTS

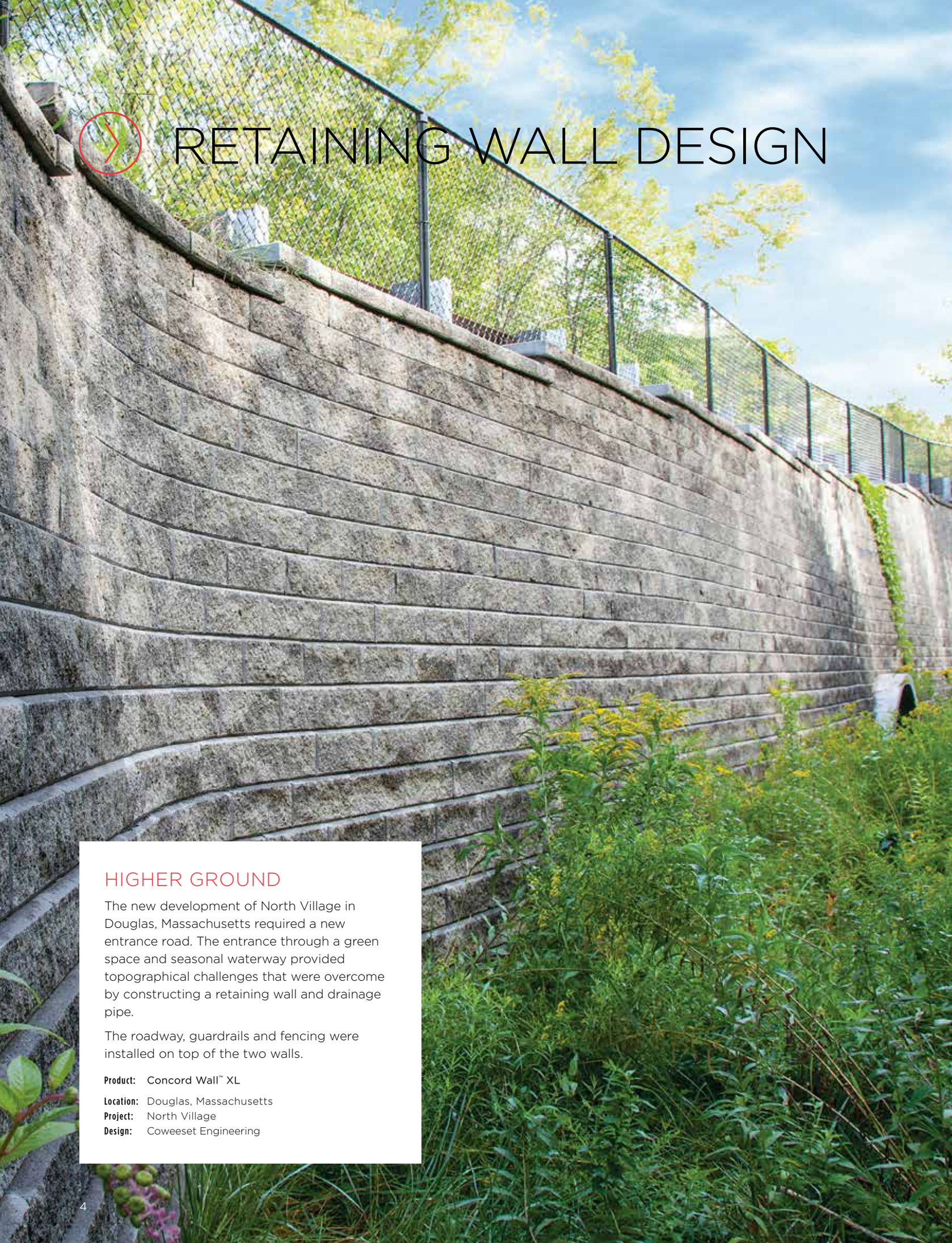
When the University of Michigan helipad was relocated to the northeast corner of the medical campus, there were a number of key design requirements: Safety, Aesthetics, Structural Design Life and Cost. A creative solution was required to deliver these requirements and make the helipad as unobtrusive as possible on the site.

Pisa2® was chosen for its well-proven structural integrity, color, texture and design flexibility. The original concept was for a 28 foot high wall, but it was determined that terracing would enhance the design, both aesthetically and in terms of structure, to deliver a 75 year design life.

Railings were not a suitable option for fall protection given the risk presented by rotor blades from helicopters landing on the pad. Therefore, fall protection was achieved with a system of attached nets or grates, anchored behind the wall.

The end result was a helipad that came in on budget which, thanks to landscaping installed on the multiple terraces, blends nicely into its habitat.

RETAINING WALL DESIGN



HIGHER GROUND

The new development of North Village in Douglas, Massachusetts required a new entrance road. The entrance through a green space and seasonal waterway provided topographical challenges that were overcome by constructing a retaining wall and drainage pipe.

The roadway, guardrails and fencing were installed on top of the two walls.

Product: Concord Wall™ XL

Location: Douglas, Massachusetts
Project: North Village
Design: Coweeset Engineering

SUPPORT AND ASSISTANCE

UNILOCK & RISI STONE®

Unilock manufactures Risi Stone Systems licensed retaining walls Pisa2®, Concord Wall™, RomanPisa®, RomanWall®, Rivercrest® Wall, SienaStone®, SonomaStone™, DuraHold® and DuraHold2®. With installations more than 25 years old, we offer the most proven SRW systems on the market.

DESIGN ASSISTANCE

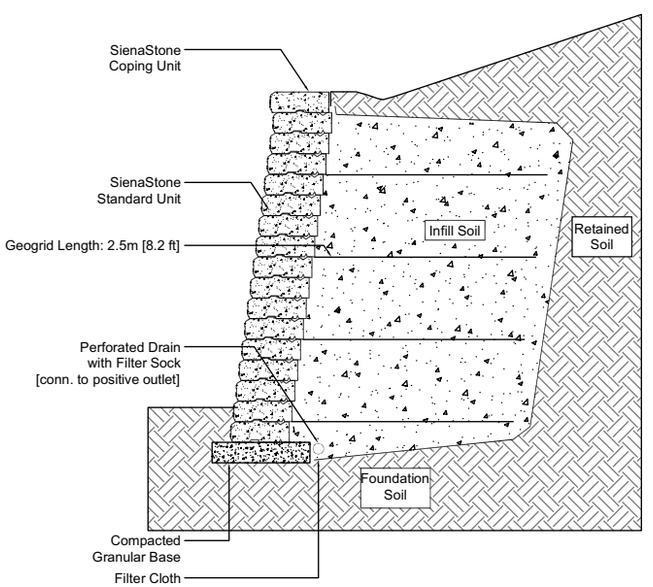
Risi Stone offers many different levels of assistance. From general product information, typical cross-sections and software programs, to site-specific final design packages, they will work with you to achieve the best possible design solution.

PRELIMINARY SECTIONS

For preliminary design, bidding or feasibility purposes, Risi Stone Systems have created one of the industry's most comprehensive collections of pre-engineered typical cross-section drawings for a variety of applications. These sections have been designed to meet very specific criteria in an attempt to be as close to your particular project as possible. They are sorted according to the main criteria used in the design of a segmental retaining wall. The search tool at www.unilock.com allows you to select the Risi Stone licensed product, the loading and the height of the wall, according to your project requirements to find cross sections that most closely match your project needs.

An example of a typical cross section is shown below.

TYPICAL SECTION - NOT FOR CONSTRUCTION



Design Specific Geometric Information

Retaining Wall System	SienaStone w/ Geogrid	Geogrid Type and Manufacturer	See Notes
Maximum Height mm (in)	3150 (123)	Minimum Geogrid LTDS kN/m (lb/ft)	See Notes
Maximum Slope Above Wall	1V:3H	Maximum Slope Below Wall	None
Max. Surcharge Above Wall kPa (lb/sq.ft)	None	Depth of Embedment mm (in)	313 (12)
Batter of Wall	7.12 °	Compacted Base Dimension mm (in)	879 x 186 (35 x 7)

Design Specific Soil Information

	Soil Region				
	Infill	Retained	Foundation	Base	Drainage
Description (by USCS)	GW Well graded, free draining Granular	CL Inorganic Clays Low Plasticity	CL Inorganic Clays Low Plasticity	GW Well graded, free draining Granular	see infill
Effective Internal Friction Angle	35 °	28 °	28 °	39 °	NR
Moist Unit Weight kN/cu.m (lb/cu.ft)	22 (140)	20 (127)	20 (127)	22 (140)	NR
Effective Cohesion kPa (lb/sq.ft)	NR	NR	NR	NR	NR
Soil Notes	Placed in 150mm (6") lifts and compacted to 95 % SPD.	Undisturbed dense soil or well compacted Eng. fill.	Allowable bearing cap.must exceed 150kPa (3125 psf).	Crushed Gravel (free draining) compacted to 98 % SPD.	Gravel infill must be well graded, angular, free drain w/max. 8 % fines

NR - Not Required

Notes:
1. This design meets or exceeds the minimum factors of safety required by Risi Stone Systems based on the design parameters listed above. The analysis was performed as outlined in the National Concrete Masonry Association Design Manual for Segmental Retaining Walls, Second Edition. This is a typical, non site-specific Design.
2. No analysis of global stability, total or differential settlement, or seismic effects has been performed.
3. This design is only provided to illustrate the general arrangement of the SRW structure for preliminary costing and feasibility purposes only. This drawing is not for construction. A qualified Engineer must be retained to provide the Final Design prior to construction.
4. Structures such as handrails, guardrails, fences, terraces, and site conditions such as water applications, drainage and soil conditions, additional live and dead loads, etc., have significant effects on the wall design and have not been taken into account in this typical section. When accounted for in the Final Design, other conditions and elements may result in additional design measures (geogrid, drainage, etc) and cost.
5. For geogrid reinforced structures, a minimum Long Term Allowable Design Strength of 14 kN/m was assumed. Contact your manufacturer or Risi Stone Systems for a list of approved geogrid reinforcements.

RisiStone® retaining wall systems

8500 Leslie Street, Suite 390
Thornhill, ON Canada L3T 7M8
Phone:905.882.5898 Fax: 905.882.4556
www.risistone.com

SienaStone®
Retaining Wall
Geogrid Section
3150mm (10.33ft)
Site: 3H:1V Slope - Clays
Infill: Granular
SS2RBSAI315

Risi Stone wall search utility will choose from hundreds of pre-engineered cross-sections, and return the possible options for your specific project. They can be downloaded as CAD or PDF files.

SEGMENTAL RETAINING WALLS

Why do so many engineers select Unilock® for retaining walls? In a word: confidence. Confidence that Unilock manufactured products have the structural, safety and weathering capabilities needed for the project. Confidence in the field performance of a vast portfolio of structures which have encompassed just about every shape, size and application. Confidence that Risi Stone will provide the engineering support required to get the job done accurately and expeditiously.

SOLID CORE CONSTRUCTION

The solid body tongue and groove design provides engineers with the assurance that the structural properties are guaranteed. Not having to fill a hollow block core and the ability to easily modify blocks on-site is a considerable labor savings. Owners can be confident in the proven long-term performance of the wall's integrity.

BUILT TO LAST

Unilock manufactured retaining wall systems are engineered to last. Individual units range from 19lbs (8.6kg) to 1,700lbs (772.7kg), and some can be used to construct walls up to 40ft (12.2m) high. The mechanical installation characteristics of Unilock retaining walls surpass conventional modular wall systems in speed and performance. Vespa.RS advanced engineering software from Risi Stone lets you analyze all important factors including height, differing soil types, unique site conditions and loading requirements directly from CAD, saving valuable time.

QUALITY MANUFACTURING

Each unit's structural integrity and performance is ensured by manufacturing to specifications that meet or exceed American Society of Testing and Materials (ASTM) standards.

	ASTM STD.	UNILOCK STD.
Compressive Strength - Minimum (No individual unit less than)	2500 PSI	± 5000 PSI
Absorption - Maximum (No individual unit greater than)	10.5%	± 5%
Dimensional Tolerance (length, width, or height)	± 1/8" (± 3.2mm)	± 1/8" (± 3.2mm)

The Unilock manufacturing system provides peace of mind by exceeding technical standards set by the National Concrete Masonry Association (NCMA), as well as local building codes.

Product: SienaStone®

Project: Newmarket Honda
Location: Newmarket, Ontario

Product: Pisa2®/Concord Wall™

Project: Roadway Retaining Wall
Location: Uxbridge, Massachusetts
Consultant: Risi Stone Systems

Product: DuraHold®

Project: Public Storage
Location: Richmond Hill, Ontario
Consultant: Risi Stone Systems

Product: DuraHold2®

Project: Erie Canal
Location: North Tonawanda, NY
Consultant: EDR Consulting

SOLID ADVANTAGES

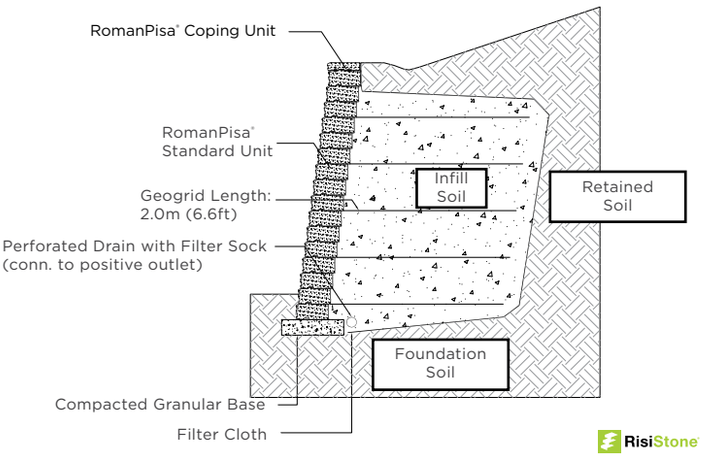
FEATURE	ADVANTAGE	BENEFIT
SOLID BLOCKS	Provides greater durability	• More resistant to breakage & minor damage
	Easy to split or modify	• Blocks can be simply cut/altered with no risk to final wall integrity
	No hollow cores to fill with gravel & compact	• Ensures maximum weight of each block is present • Maximum resistance to overturning • Reduced installation time & labour costs
MODULAR SYSTEM	Wall is flexible, while still retains its structural integrity	• Absorbs movement & settlement • Requires minimal embedment
	Array of complementing special blocks	• Easily create site-specific features • Coping can be selected for various wall arrangements • Pre-fabricated corner blocks intensify corner strength & appearance, while speeding construction
	Requires only a compact granular base	• Reduces installation cost
INTERLOCKING TONGUE & GROOVE	Interlocking mechanism is molded directly in to the block	• Easy, quick installation • No separate pins or clips to install
	Maximum shear strength	• Shear strength is maintained along the entire length of block • Allows for superior geogrid connection
	Automatic alignment & self-battering	• Once the first course is installed flat and level, successive blocks stack quick & easily
	Blocks are dry-stacked	• Lower cost — No mortar requirements • Minimal training is required to achieve excellent results
	Continuous interlock achieved throughout the wall	• Creates a stronger, more damage resistant structure
COMBINED WITH GEOGRID REINFORCEMENT	Higher walls can be achieved	• Able to use the same facia throughout the project on lower & higher walls (ie. Mix gravity & geogrid reinforced wall as site conditions dictate)

Product: Concord Wall™ / Pisa2®

Project: Bishops Place
Location: West Hartford, Connecticut
Consultant: CR3 LLP

TYPICAL GEOGRID REINFORCED APPLICATION

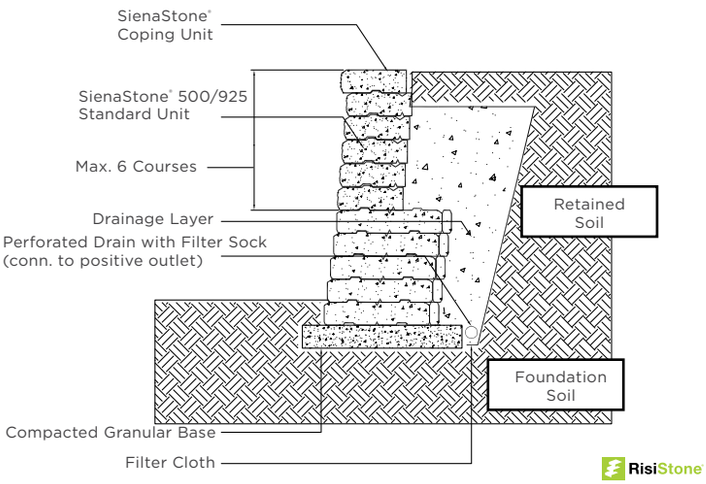
PISA2®/CONCORD WALL™ / ROMANPISA®/ROMANWALL®



Product: SienaStone®

Project: BankOne
Location: Frankfort, Illinois
Consultant: W.T. Engineering

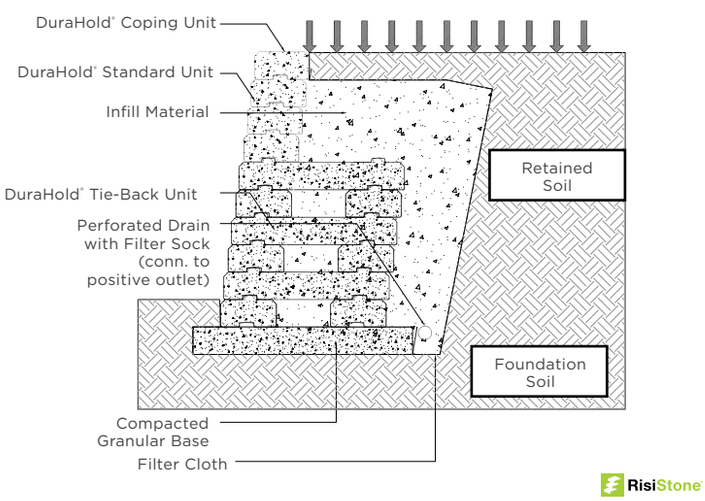
TYPICAL GRAVITY APPLICATION – SIENASTONE®



Product: DuraHold®

Project: Home Depot Warehouse
Location: Vaughan, Ontario
Consultant: Risi Stone®

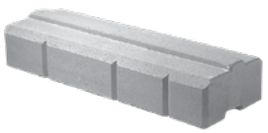
TYPICAL GRAVITY APPLICATION – DURAHOLD®



DURAHOLD®

The large size of DuraHold (1680lbs/762kg) makes it an appropriate choice for demanding structures up to 40ft (12.2m) high. Proper engineering and a good selection of components make this an exceptional wall system for gravity, tie-back or geo-grid reinforced walls. A great alternative to “poured-in-place” concrete.

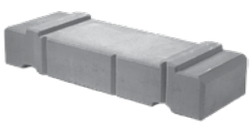
Gravity walls up to 6 ft (1.8 m) in typical conditions.



Standard Unit / Half Unit
12" x 24" x 72" / 12" x 24" x 36"
30cm x 60cm x 183cm / 30cm x 60cm x 91.5cm

Coping Unit
12" x 24" x 72"
30cm x 60cm x 183cm

Corner 90 Unit
12" x 24" x 60"
30cm x 60cm x 152cm



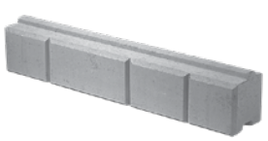
Tie-Back Unit
12" x 24" x 72"
30cm x 60cm x 183cm

Product: DuraHold
Location: London, Ontario
Project: London Dike
Consultant: Risi Stone®

DURAHOLD2®

DuraHold2 is similar to DuraHold in appearance, but is almost half the size, (820lbs/363kg), making it economical for low walls. Concrete tiebacks or geogrid reinforcement expands the various engineering options, allowing for structures up to 25 ft (7.62m) high.

Gravity walls up to 4 ft (1.2 m) in typical conditions.



Standard Unit
12" x 14" x 72"
30cm x 36cm x 183cm

Coping Unit
12" x 14" x 72"
30cm x 36cm x 183cm

Corner 90 Unit
12" x 14" x 36"
30cm x 36cm x 90cm

Tie-Back Unit
72" x 12" x 14"
183cm x 30cm x 36cm

Product: DuraHold2
Location: Detroit, Michigan
Project: Charles H. Wright Museum of African American History

SIENASTONE®

This big, bold stone is impressive as a wall or as treads in large outdoor staircases. SienaStone's long lines and split face or NEW smooth face appearance make it an attractive alternative for heavier load bearing applications. For walls up to 40 ft (12m) high. Gravity walls up to 10 ft (3 m) in typical conditions.

Units are 48" (1.2m) wide in selected markets.
Contact Unilock for specific information.

Product: SienaStone
Location: Whitby, Ontario
Project: Church Parking Lot
Consultant: Risi Stone

Standard 333 Unit*
7¼" x 13½" x 39"
18.5cm x 33cm x 100cm

Standard 500 Unit
7¼" x 20" x 39"
18.5cm x 50cm x 100cm

Standard 925 Unit
7¼" x 36½" x 39"
18.5cm x 92.5cm x 100cm

Corner Unit (left & right)
7¼" x 20" x 36½"
18.5cm x 50cm x 92.5cm

Coping Unit
7¼" x 36½" x 39"
18.5cm x 50cm x 100cm

Closed-End Coping*
7¼ x 20" x 39"
18.5cm x 50cm x 100cm

* Available in select markets

RIVERCREST® WALL

The Rivercrest Wall System is Unilock's most natural, versatile and easy-to-use landscape wall system. The unique engineered S-shape design creates vertical and lateral interlock for added strength, making it ideal for retaining walls up to 1.8m (6.0') when combined with geogrid reinforcement.

Gravity walls up to 2 ft (0.6 m) in typical conditions.

Standard Bundle

8" x 9-10" x 2¼"
20cm x 23-25cm x 5.7cm

12" x 9-10" x 2¼"
31cm x 23-25cm x 5.7cm

12" x 9-10" x 2¼"
31cm x 23-25cm x 5.7cm

17" x 9-10" x 2¼"
42.5cm x 23-25cm x 5.7cm

Jumper Bundle

8" x 9-10" x 4½"
20cm x 23-25cm x 11.4cm

12" x 9-10" x 4½"
31cm x 23-25cm x 11.4cm

12" x 9-10" x 4½"
31cm x 23-25cm x 11.4cm

17" x 9-10" x 4½"
42.5cm x 23-25cm x 11.4cm

Corner Bundle

17½" x 9-10" x 2¼"
45cm x 23-25cm x 5.7cm

14½" x 9-10" x 2¼"
37.5cm x 23-25cm x 5.7cm

Jumper Corner

12" x 9-10" x 4½"
31cm x 23-25cm x 11.4cm

Product: Rivercrest Wall
Location: Shelby Township, Michigan
Project: Private Residence
Consultant: Visionary Landscaping Design & Build

PISA2®/CONCORD WALL™

Pisa2/Concord Wall's natural, quarried look is perfect for all applications, including walls, planters and step construction. Pisa2/Concord Wall modular units interlock with a built-in setback that automatically forms the correct slope, ensuring a stable wall. Special wedge-shaped units help form curved walls and steps. For walls up to 25 ft (7.5m) high.

Gravity walls up to 3.5 ft (1 m) in typical conditions.

Standard Unit*
6" x 8" x 12"
15cm x 20cm x 30cm

Tapered Unit
6" x 8" x 12"
15cm x 20cm x 30cm

XL Tapered Unit
6" x16" x 12"
15cm x 40cm x 30cm

Coping Unit
3" x 24" x 12"
7.5cm x 60cm x 30cm

Half Coping Unit*
3" x 12" x 12"
7.5cm x 30cm x 30cm

Corner Unit
6" x 8" x 12"
15cm x 20cm x 30cm

Product: Pisa2
Location: Toronto, Ontario
Project: Industrial Park
Consultant: Regent Engineering

ROMANPISA2®/ROMANWALL®

The antiqued appearance of RomanPisa/RomanWall provides a rugged look that is popular in current landscape design. RomanPisa/RomanWall is a versatile retaining wall system which allows for the creation of straight or curved walls, planters and steps. For walls up to 25 ft (7.5m) high.

Gravity walls up to 3.5 ft (1 m) in typical conditions.

Standard Unit*
6" x 8" x 12"
15cm x 20cm x 30cm

Tapered Unit
6" x 8" x 12"
15cm x 20cm x 30cm

Corner Unit
6" x 8" x 12"
15cm x 20cm x 30cm

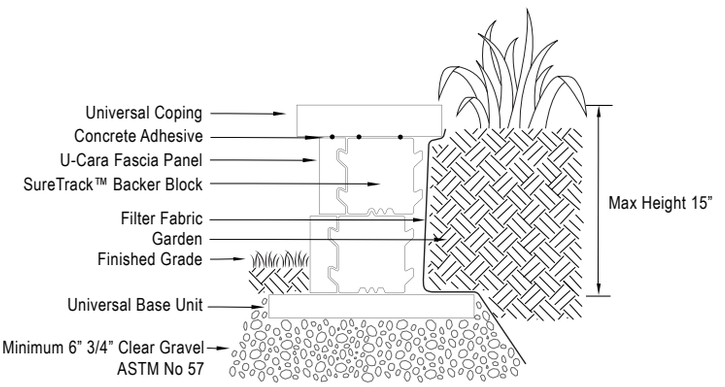
Coping Unit*
3" x 12" x 12"
7.5cm x 30cm x 30cm

* Available in select markets

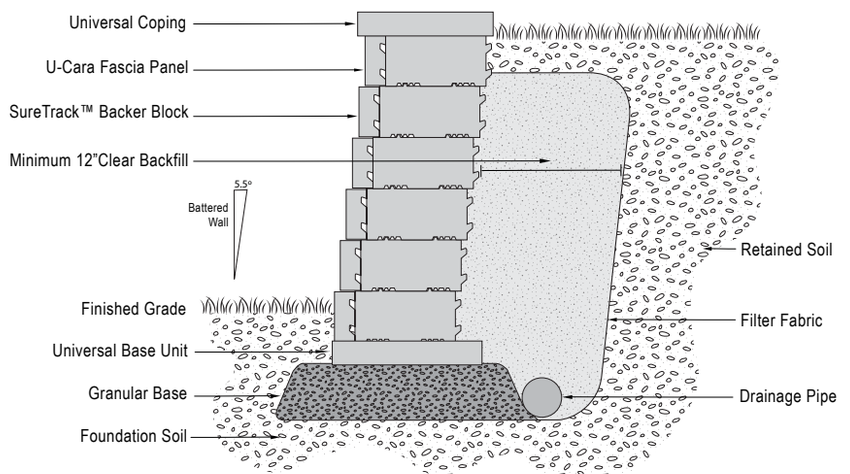
Product: RomanPisa
Location: Hope Township, New York
Project: Storm Water Management Pond

U-CARA® GARDEN WALLS TO ENGINEERED WALLS

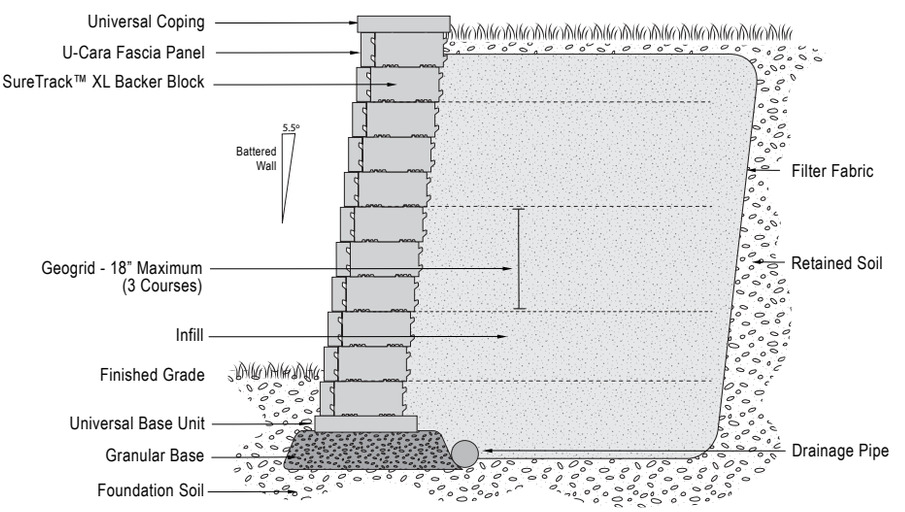
GARDEN WALL



RETAINING WALL UNDER 4'



GEOGRID REINFORCED SETBACK RETAINING WALL



U-CARA®

The patented U-Cara wall system gives you more design options for complete creative flexibility. That's because a U-Cara Fascia Panel can be placed anywhere on the Sure Track™ Backer Blocks, allowing for a variety of pattern, color and texture combinations not possible with other systems.

Unilock is pushing design and technology forward to inspirational levels by combining easy installation with an ever-expanding pallet of design colors and finishes.

- Seamlessly coordinate with Unilock pavers
- Interchangeable fascia panels for creative flexibility
- Site-specific engineering available for low or high walls
- Create single-sided or double-sided walls

Product: U-Cara **Location:** Rockwood, Ontario

SureTrack Standard Backer
6" x 8" x 6"
15cm x 20cm x 15cm

SureTrack Large Backer
6" x 8" x 12"
15cm x 20cm x 30cm

Standard Fascia Panel
6" x 18 3/8" x 2 5/16"
15cm x 46.6cm x 6cm

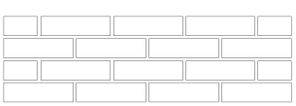
CORNER BUNDLE

Standard Fascia Half Panel
6" x 9 3/16" x 2 5/16"
15cm x 23.3cm x 6cm

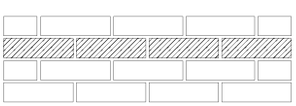
Closed-End Fascia Panel
6" x 20 7/8" x 2 5/16"
15cm x 53m x 6cm

Universal Coping
2 3/4" x 19" x 14"
7cm x 48.2m x 35.5cm

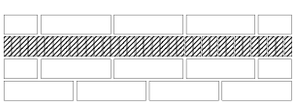
U-Cara fascia panels are available in a variety of colors and textures, including, for the first time ever, exclusive Unilock® EnduraColor™ finishes.



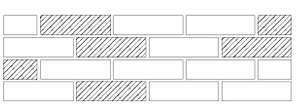
1/2 Running Bond



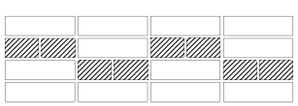
1/2 Running Bond with Linear Accents



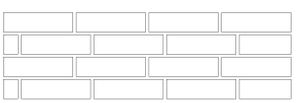
1/2 Running Bond with Paver Accents



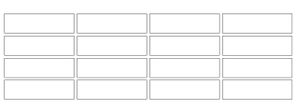
1/2 Running Bond with Random Accents



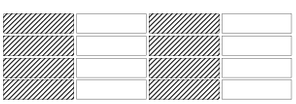
Mixed Bond



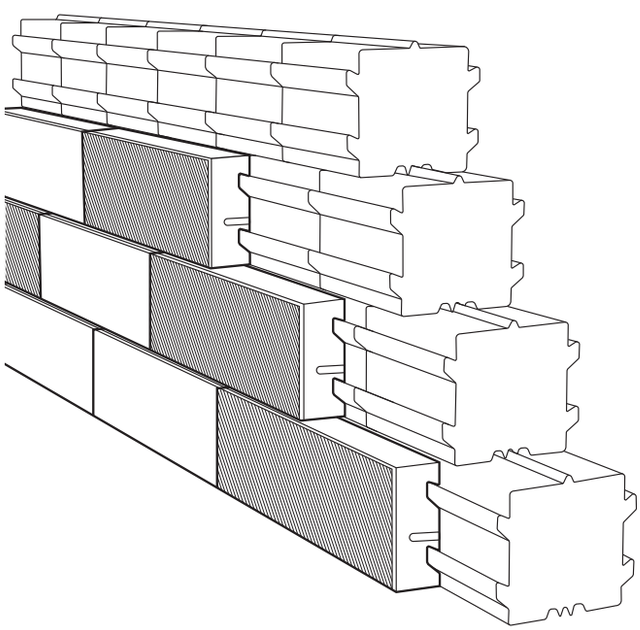
1/3 Running Bond



Stacked Bond



Stacked Bond with Accents



URBAN REHABILITATION

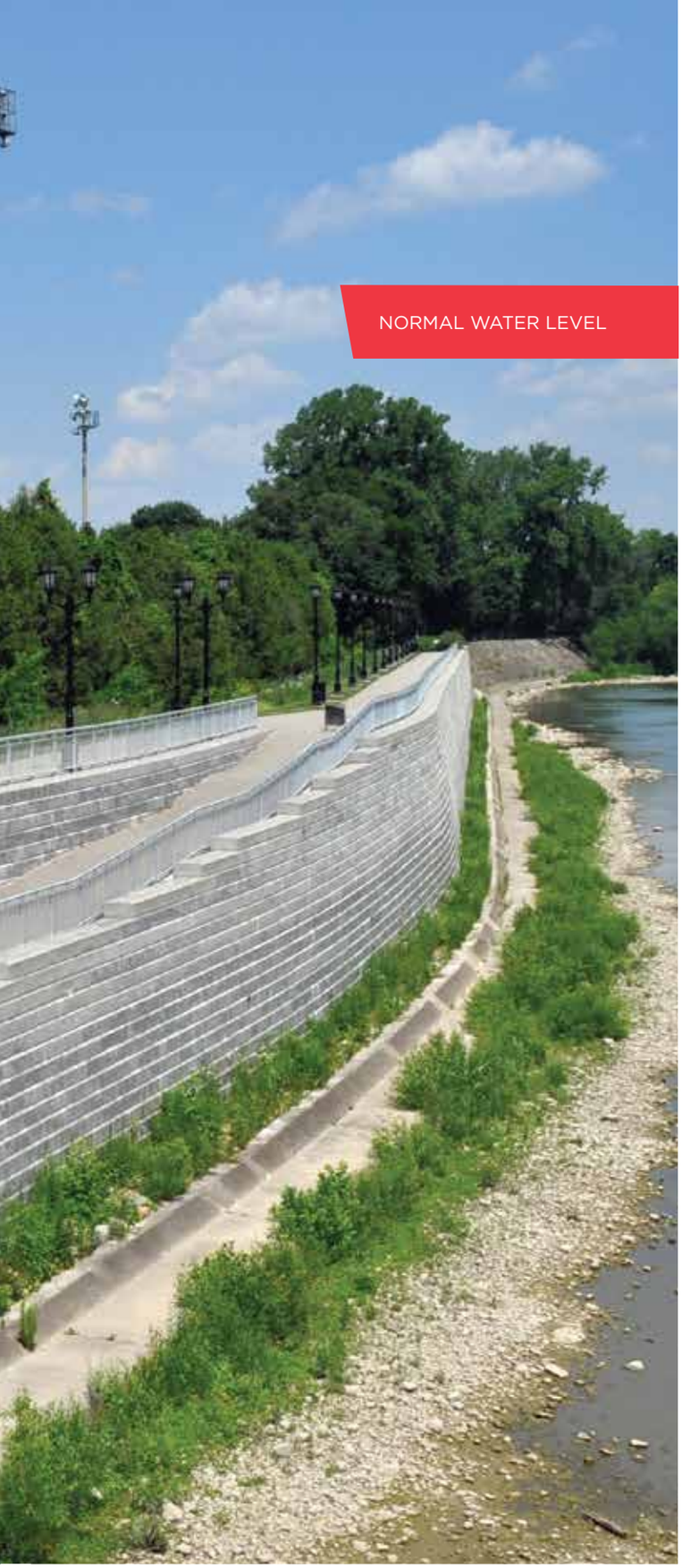
As part of the large-scale reconstruction of an existing dike system along the Thames River in London, Ontario, 200m (1,000ft) was replaced with a new 8m high (26ft) DuraHold wall.

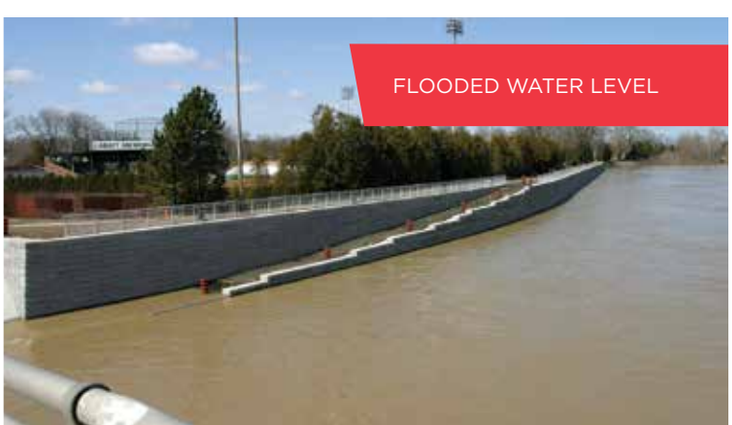
The wall needed to be able to withstand rapid flowing hydraulic conditions of extreme two year and 75 year flood events which have the potential to completely submerge the full height of the wall. DuraHold was the ideal choice because its smooth surface reduces drag effect from flowing water, and it has a proven track record of structural stability. As well, DuraHold offers the benefit of installation efficiency in straight or curved applications thanks to the availability of tapered wall units.

A pathway running alongside the Thames River was incorporated into the layout atop the new DuraHold wall. The south end of the wall was terraced, allowing the pathway to extend down under Queens Avenue and Kensington Bridges, and connect to Riverside Park.

Product: DuraHold®

Location: London, Ontario
Project: West London Dike
Design: Risi Stone® Inc and Stantec London





THE UNILOCK ADVANTAGE

At Unilock, our job is to make your job easier. That's why we maintain a dedicated team of professionals to work with you on your project.

- Background engineering
- Site specific engineering for walls*
- Budget pricing
- Specifications, cross-sections and details for pavers and walls*
- Lunch and Learn - Continuing Education Credits Samples

Contact your Unilock Representative to see how we can help you.

SOFTWARE

Vespa.RS* is a retaining wall engineering software program which enables the user to input grading and layout information directly from the CAD design. The software will easily produce full wall layouts with accurate quantity estimates and comprehensive reports that are specific to your site. Contact a Unilock representative for more information.

Lockpave Pro® is a pavement engineering software program developed by Dr. Brian Shackel, the world's leading authority on unit paver pavement design. This powerful software is capable of designing pavement structures for parking lots and roadways, and has even been used to design international shipping ports.

PCSWMM™ (PP) is software that can be used to analyze permeable pavement applications that specifically incorporate the hydraulic properties of Unilock permeable pavements. It allows the user to develop a simple model of a permeable pavement design, run the program with specific storm water data, and analyze the results of the model.
Contact your Unilock Representative for more information.

VISIT US ONLINE FOR:

> The complete Unilock Architectural catalog
> Over 250 hatch patterns for CAD
> Retaining wall engineering software*
> Unit paver and retaining wall specifications
> Over 250 CAD cross-section drawings*

** from Risi Stone*®

UNILOCK®

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