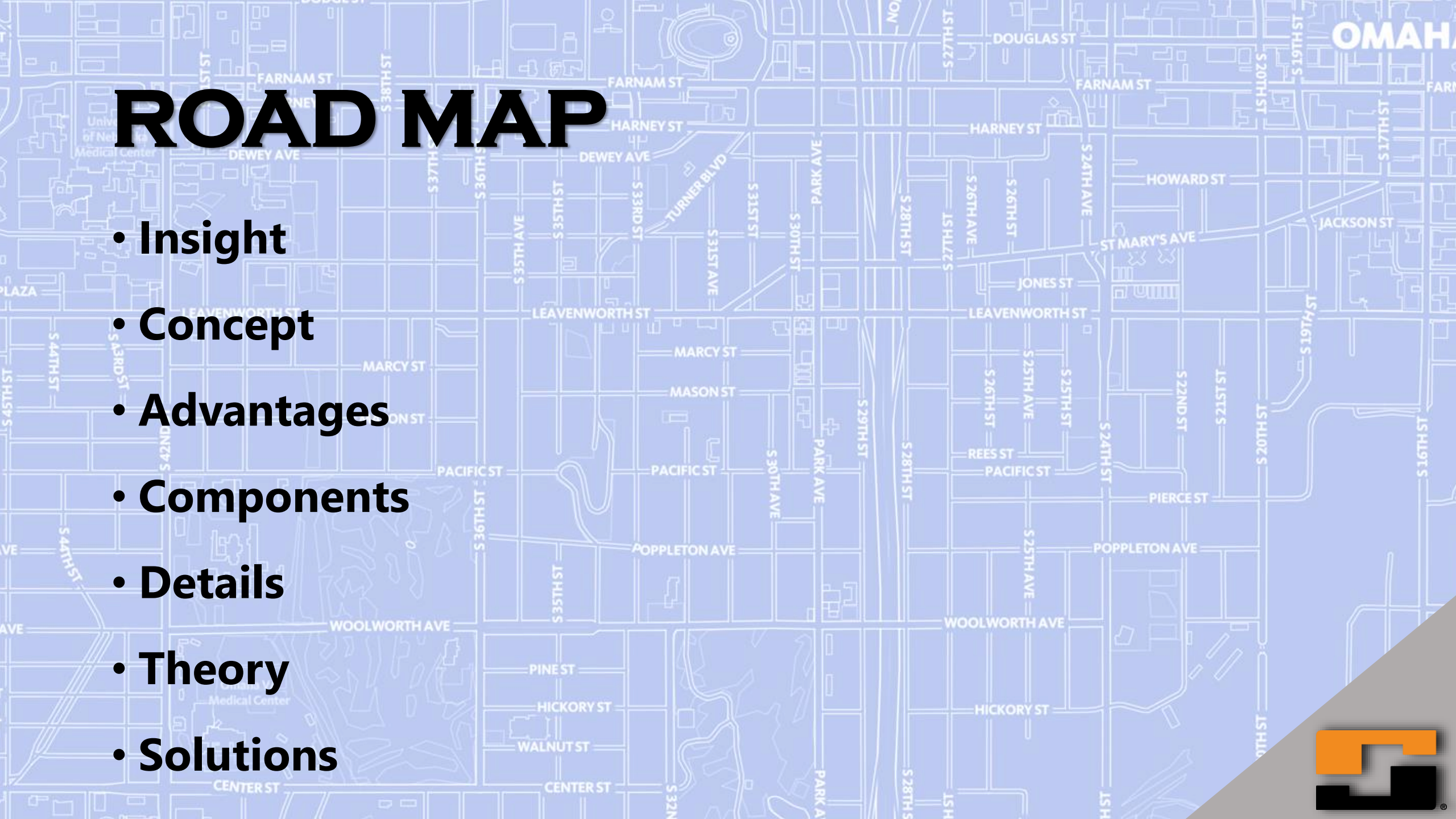
Precast Retaining Wall Solution

ROAD MAP

- Insight
- Concept
- Advantages
- Components
- Details
- Theory
- Solutions



The Insight

“Why must we sacrifice space for stability?”

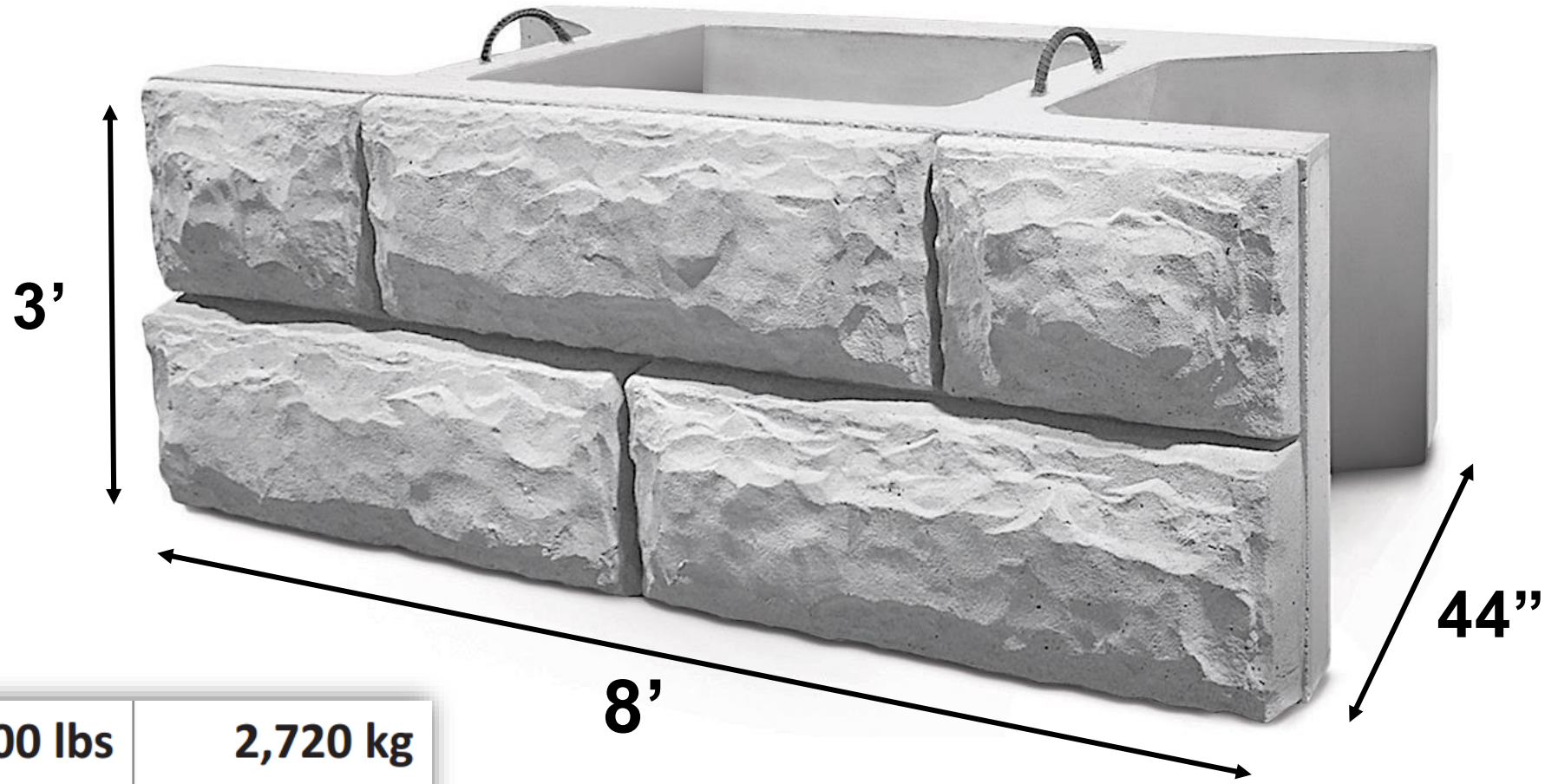
“What if bigger meant safer and faster, too?”

UNMISTAKABLE
REDUCED LABOR
RELIABLE
ENGINEERED
ORIGINAL
FAST
SMART
SOLID
SIMPLE
DURABLE
BEAUTIFUL
EFFECTIVE
DIMENSION
VERSITILE
ROBUST
10/10
INNOVATIVE
LIGHT
STABLE
BIG
SAFE
AESTHETIC
PROVEN
PRODUCTIVE
GRAVITY

The Concept

Create a fully and intelligently engineered retaining wall system.

24 SF BLOCK



Block Wt.	6,000 lbs	2,720 kg
Form Wt.	4,600 lbs	2,090 kg
Concrete Volume	1.50 CY	1.15 m^3
Aggregate Infill	1.60 CY	1.22 m^3
(per face area)	0.1 tons/sf	1,000 kg/m^2

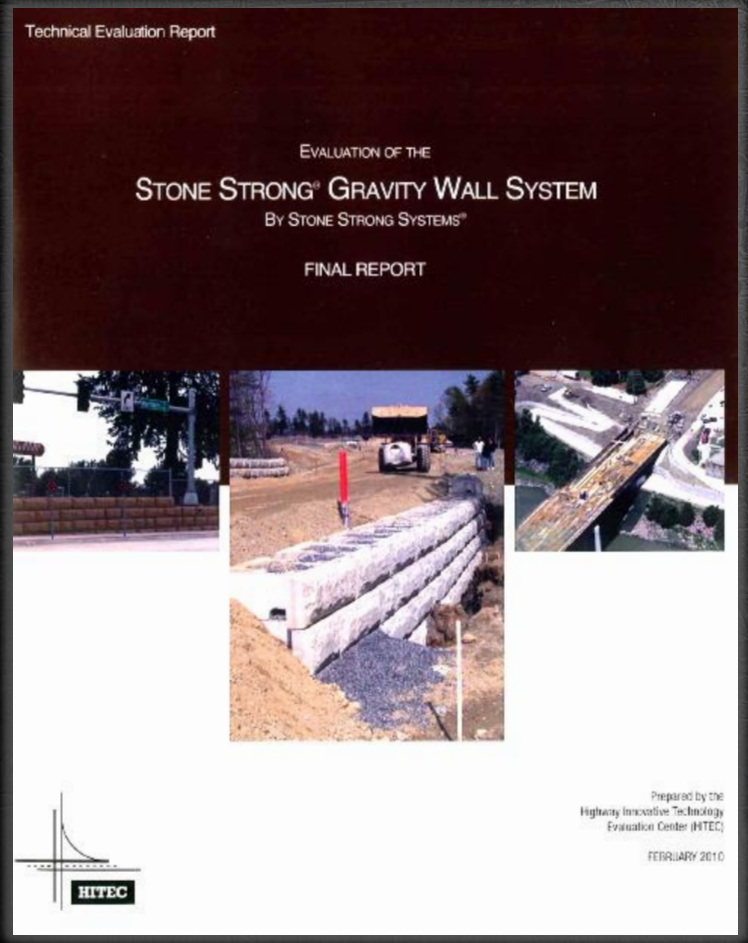
Not Just Bigger.

Better.

Don't just take our word for it...

HITEC Evaluation

Highway Innovative Technology Evaluation Center



Key Findings

- Viable alternative to traditional cast in place and MSE retaining wall systems
- Validation of methodologies and underlying engineering basis and concepts
- Evidence of conformance with AASHTO methodologies

ASTM C1776

This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.

Designation: C1776/C1776M – 17

Standard Specification for Wet-Cast Precast Modular Retaining Wall Units[1]

This standard is issued under the fixed designation C1776/C1776M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This specification covers wet-cast precast modular retaining wall units cast from first-purpose concrete with or without the inclusion of steel reinforcement. The precast units covered by this specification are machine-placed units intended for use in the construction of dry stacked modular retaining wall systems.

A884/A884M Specification for Epoxy-Coated Steel Wire and Welded Wire Reinforcement
A934/A934M Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars
A1055/A1055M Specification for Zinc and Epoxy Dual Coated Steel Reinforcing Bars
A1060/A1060M Specification for Zinc-Coated (Galvanized) Steel Welded Wire Reinforcement, Plain and Deformed


STONE
STRONG
SYSTEMS®

The Advantages

BIGGER

4x LARGER than the competition.

- Massive 24-square-foot block
- Structural strength without need for mechanical tieback
- Reduced labor costs
- Faster, easier installation process

LIGHTER

Install 1,200 square feet of block per day with a three-man crew.

- **Reduced transportation costs**
- **Faster, easier and less costly installation process**
- **Innovative hollow design**
- **Less weight per square foot**

SMARTER

Full structural and geotechnical engineering

- Voids provide integrated drainage system
- Aggregate infill ensures interlock between courses
- Lifting loops align precisely
- Recesses deliver automatic setback
- Tapered edges contour to any landscape
- Dense, less permeable air- entrained 4,000-psi concrete-minimum

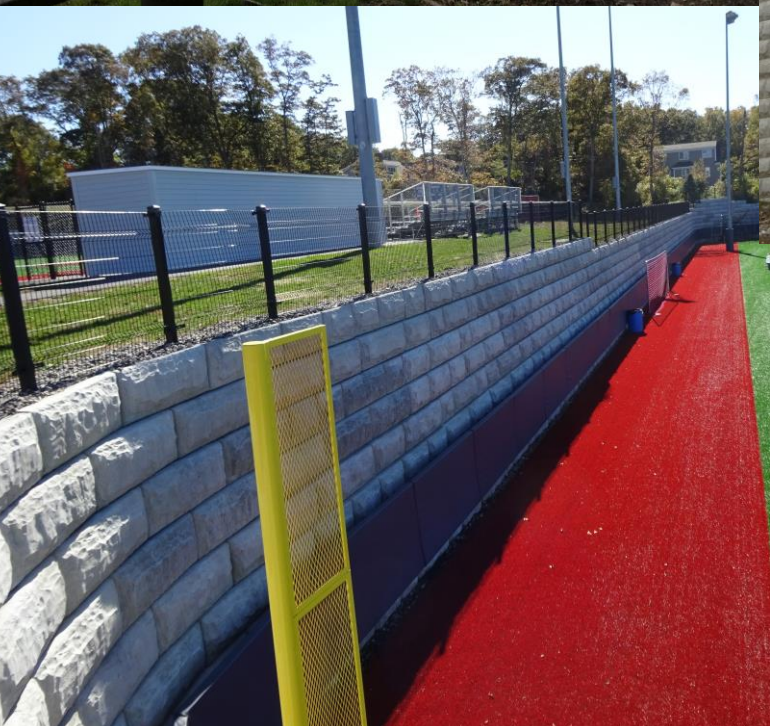
AESTHETICALLY ATTRACTIVE

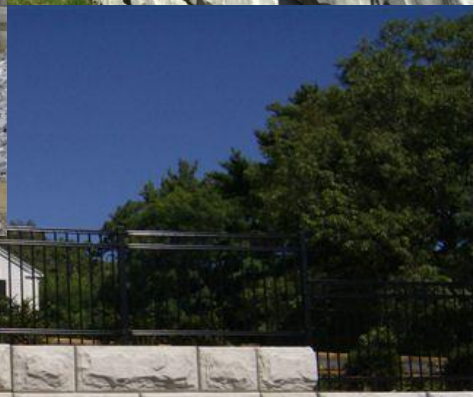
BIG AND BEAUTIFUL

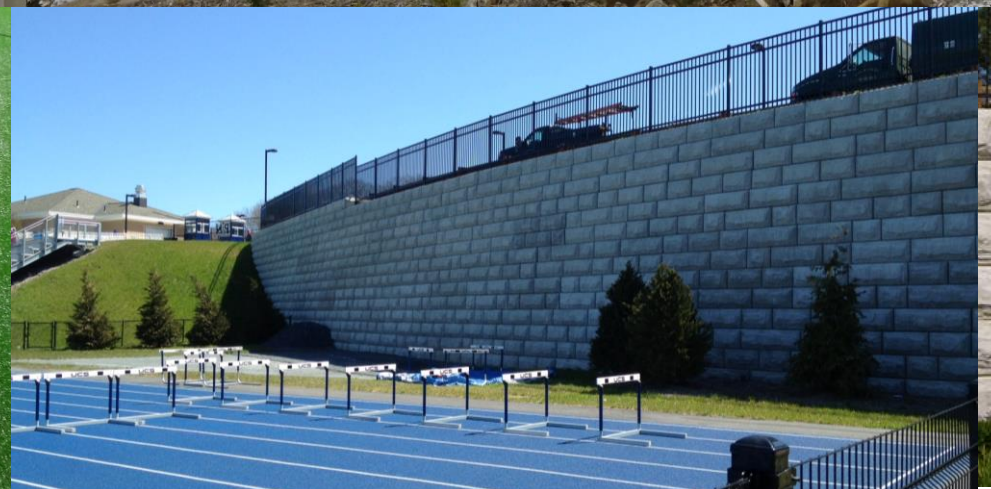
Customizable patterns

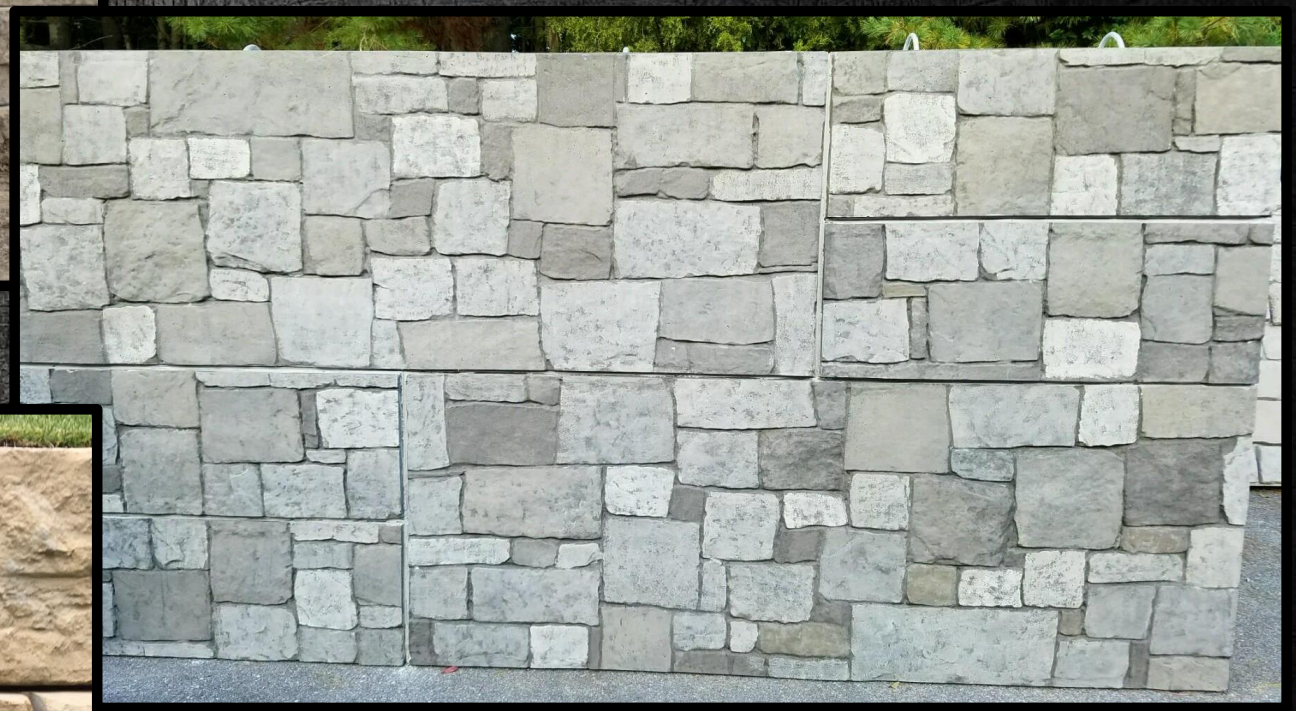
Handcrafted by real artisans

Fits seamlessly into any landscape







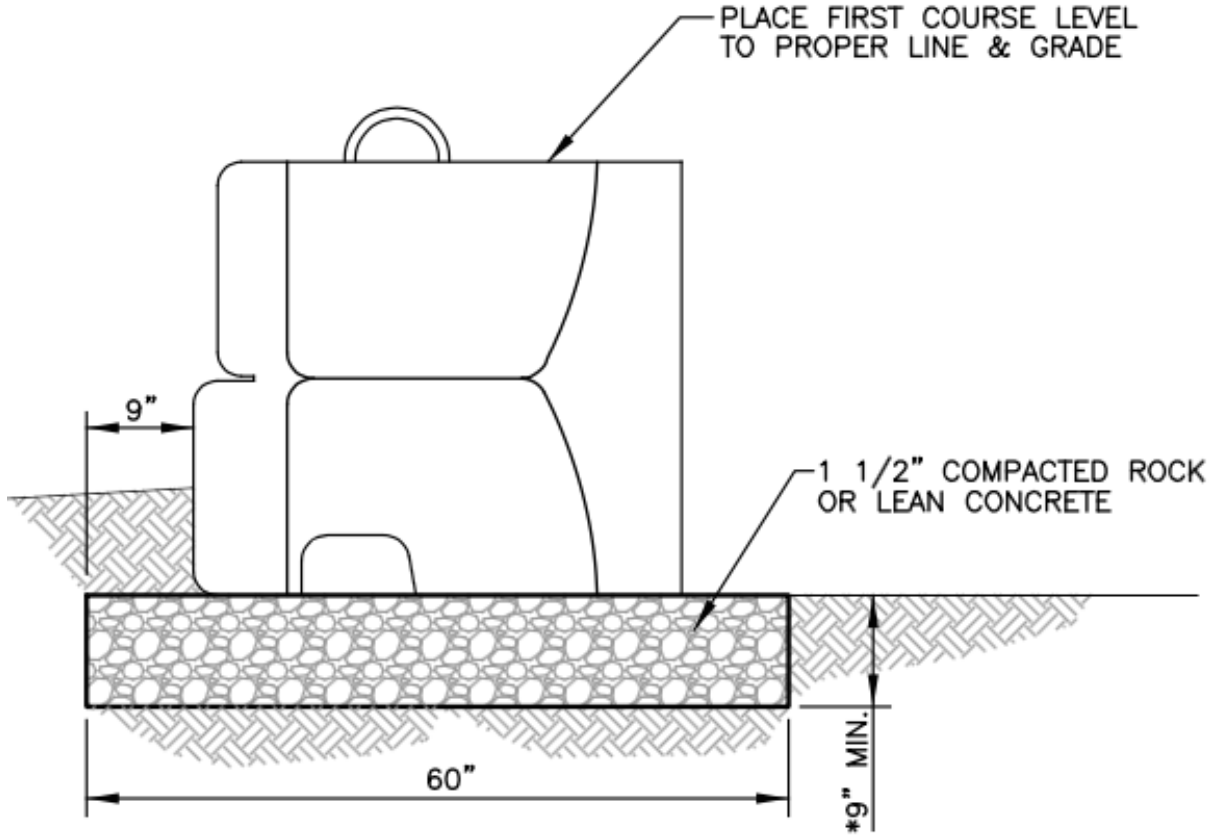


Endless Possibilities

The Components

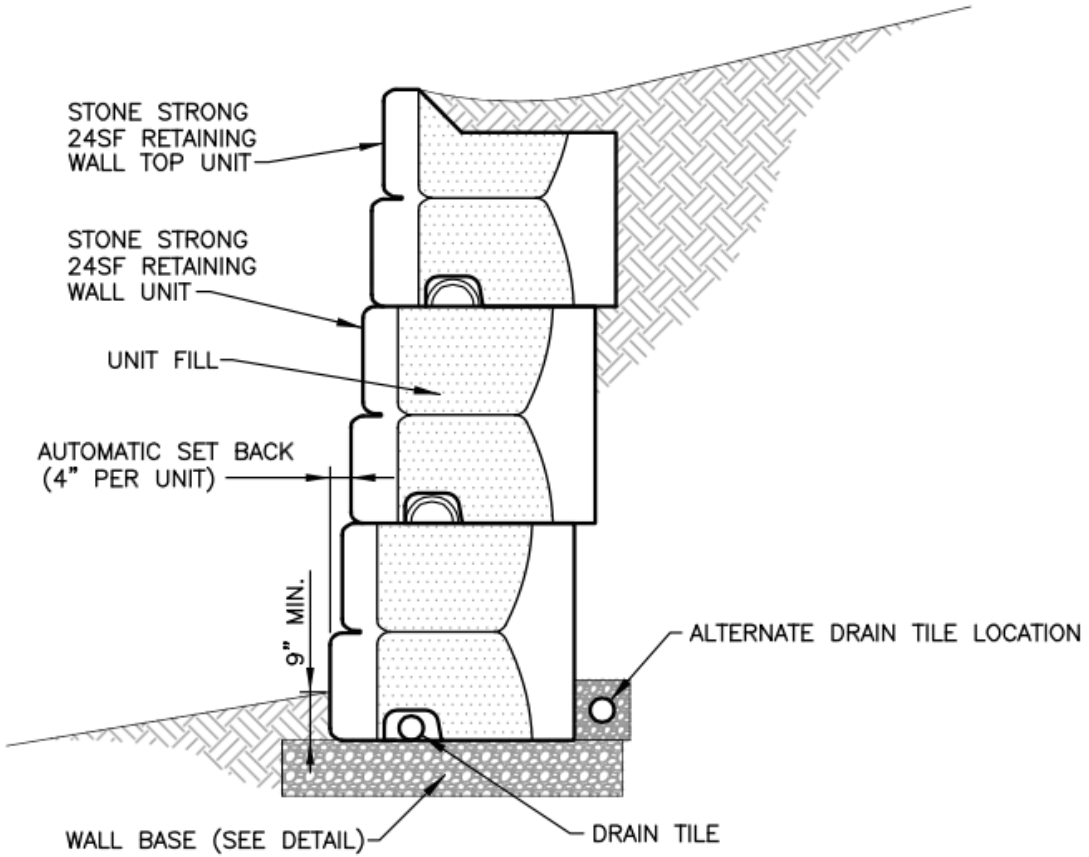
24 SF Block

Face: 8’ x 3’; Width 44”
Weight: 6,000 lbs.



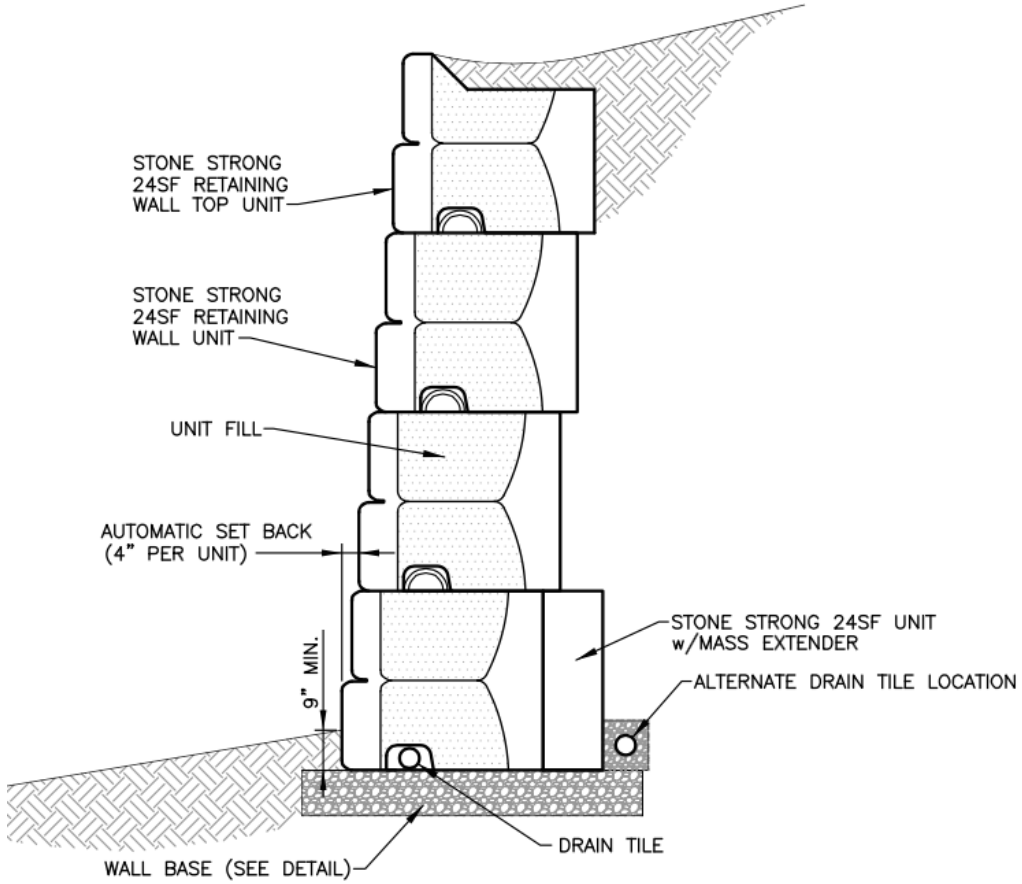
24 SF Top Block

Face: 8’ x 3’; Width 44”
Weight: 5,400 lbs.



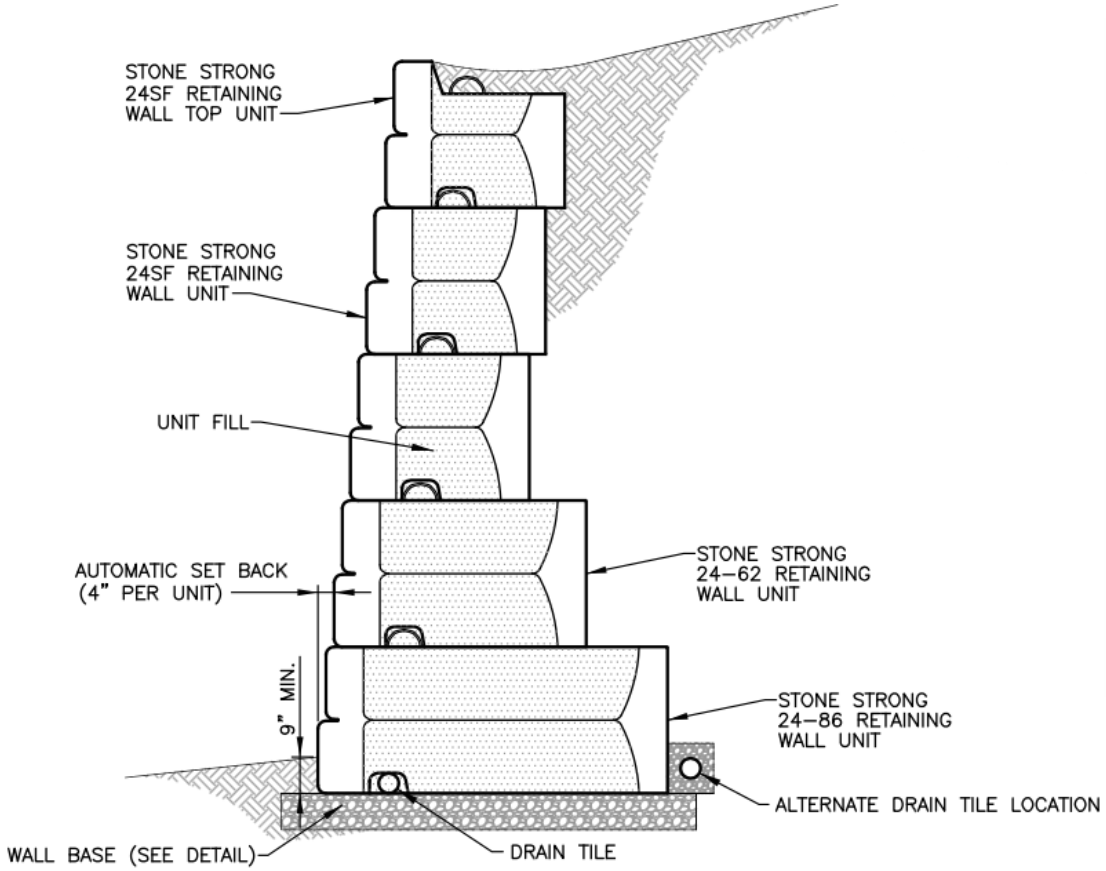
24 SF Mass Extender Block

Face: 8’ x 3’; Width 56”
Weight: 10,000 lbs.



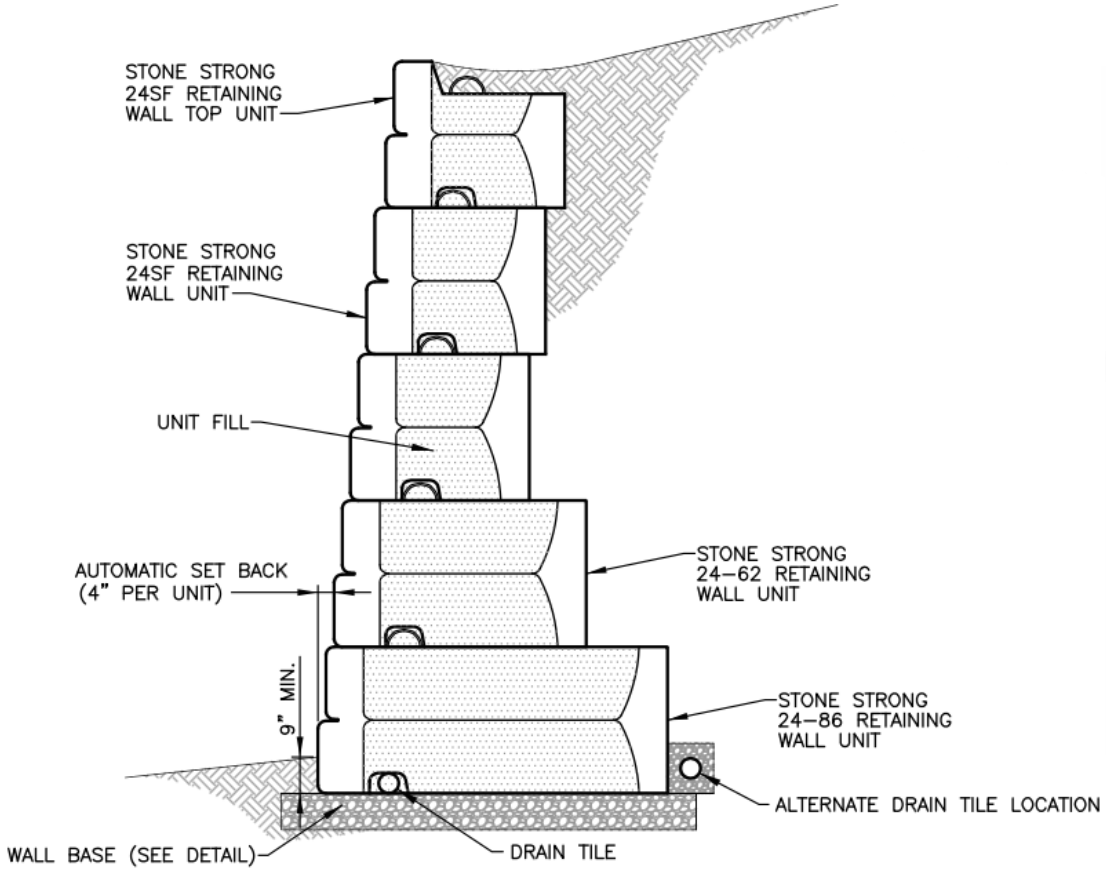
24-62 Block

Face: 8’ x 3’; Width 62”
Weight: 6,600 lbs.



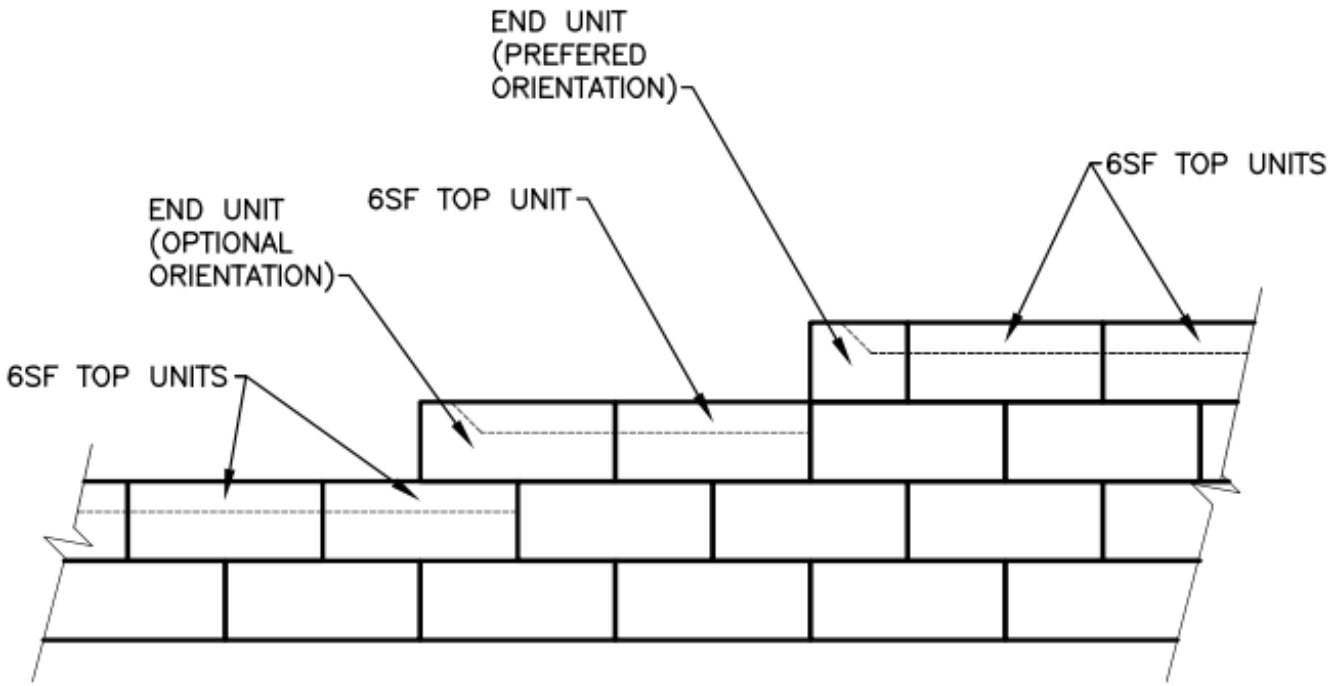
24-86 Block

Face: 8’ x 3’; Width 86”
Weight: 7,400 lbs.



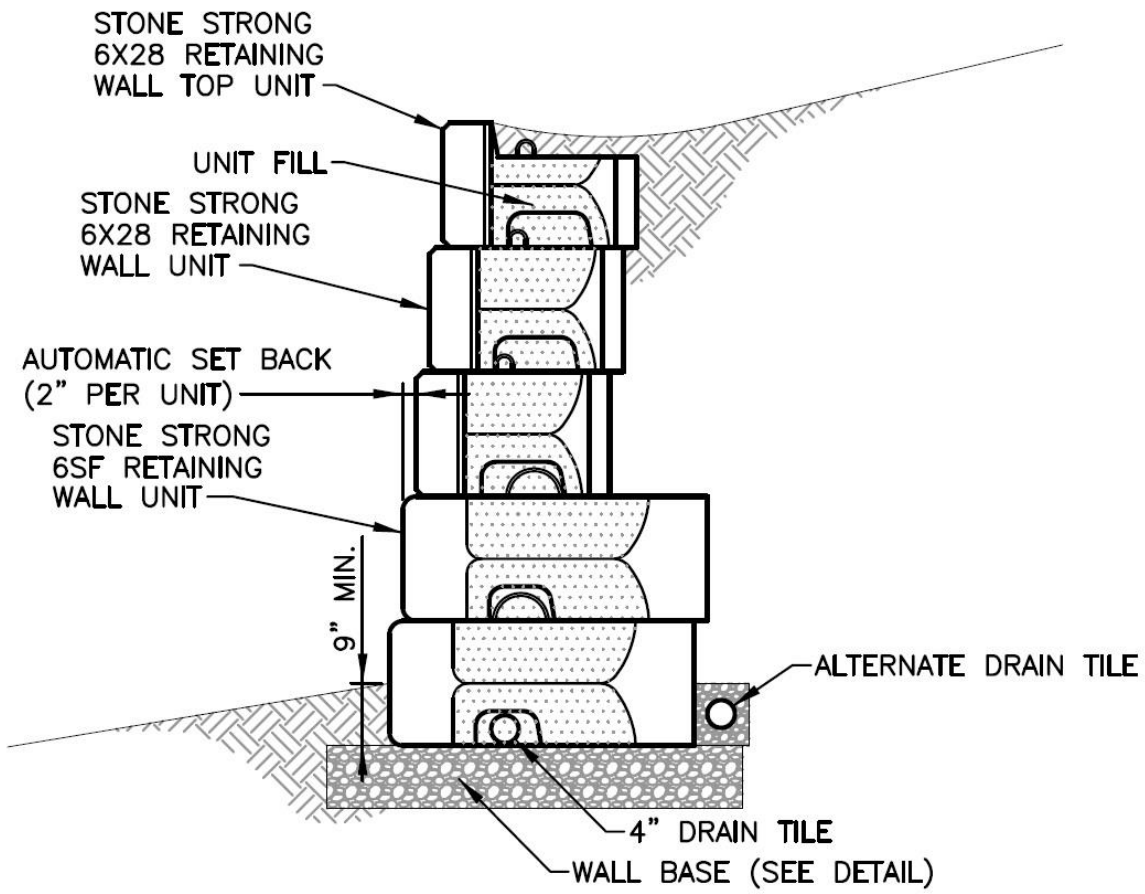
6 SF Block

Face: 4’ x 18”; Width 44”
Weight: 1,600 lbs.



6-28 Block

Face: 4’ x 18”; Width 28”
Weight: 950 lbs.



Accessories

3 SF Block

45° Block

90° Block

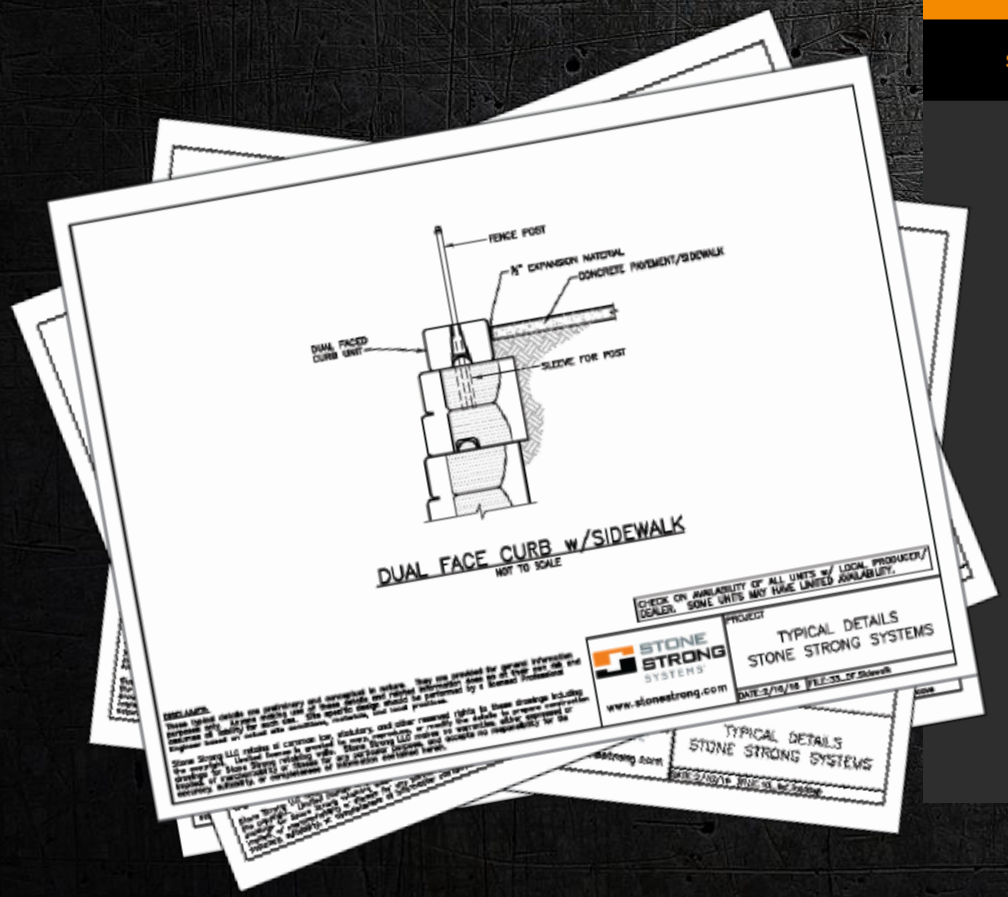
End/Corner Block

Dual Face Block

The Details

Download Center

stonestrong.com



STONE STRONG SYSTEMS®

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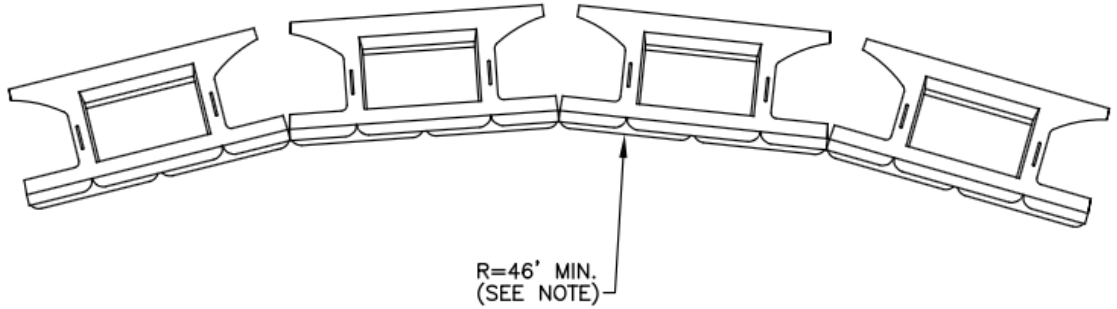
SORT ALL | GENERAL INFORMATION | ENGINEERING | DETAILS / CAD FILES | INTERACTION TESTING REPORTS | TECH MEMOS

GRAVITY ANALYSIS SPREADSHEET V5.6 (UPDATED 1.10.17)	PDF
24 SF BLOCK TESTING REPORT	PDF
6-28 SALES SHEET	PDF
6 SF BLOCK TESTING REPORT	PDF
COMPONENTS METRIC	DWG PDF
COMPONENTS SAE	DWG PDF
CORNER DETAILS METRIC	DWG PDF
CORNER DETAILS SAE	DWG PDF
CROSS SECTIONS METRIC	DWG PDF
CROSS SECTIONS SAE	DWG PDF
DETAILS INTRODUCTION	PDF

Corners/Radius

24 SF Block

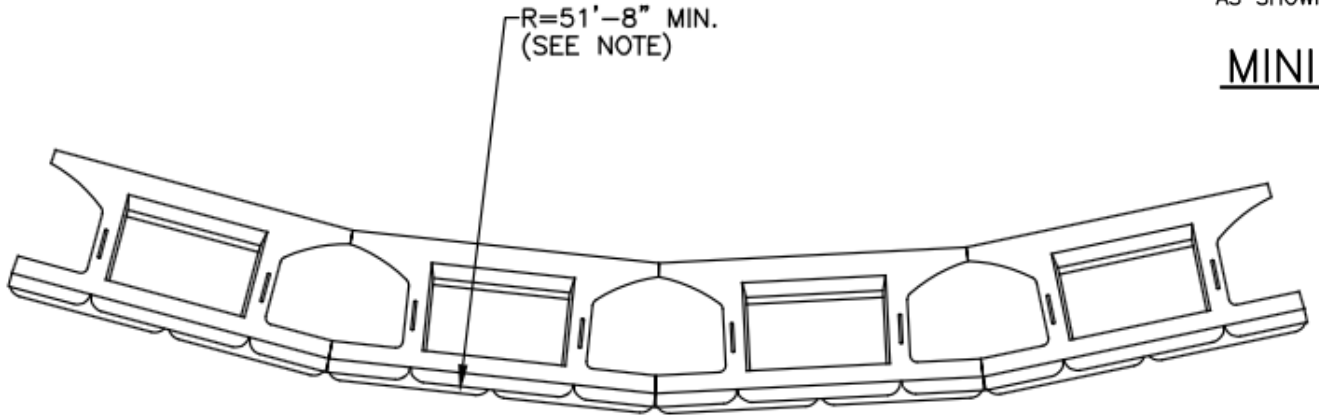


NOTE:
MINIMUM RADIUS OCCURS AT LOWEST COURSE.
RADIUS INCREASES 4" PER COURSE ABOVE,
AS SHOWN ON TABLE.

Minimum Concave Radius		
Wall Height (ft)	Total # of Courses	Reqd. Radius at Top Course
6	2	46' 4"
9	3	46' 8"
12	4	47' 0"
15	5	47' 4"
18	6	47' 8"
21	7	48' 0"
24	8	48' 4"

MINIMUM CONCAVE RADIUS–24SF UNITS

NOT TO SCALE



NOTE:
MINIMUM RADIUS OCCURS AT TOP COURSE.
REQUIRED RADIUS INCREASES 4" PER COURSE
BELOW, AS SHOWN ON TABLE.

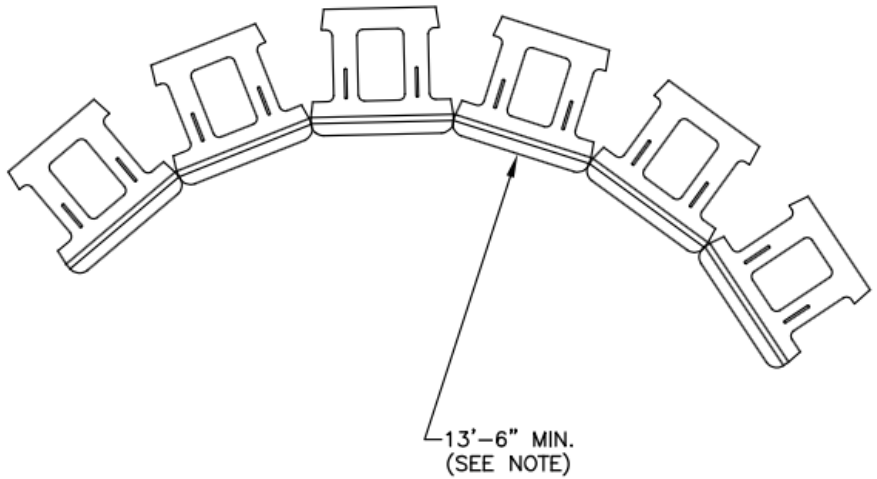
Minimum Convex Radius		
Wall Height (ft)	Total # of Courses	Reqd. Radius at First Course
6	2	52' 0"
9	3	52' 4"
12	4	52' 8"
15	5	53' 0"
18	6	53' 4"
21	7	53' 8"
24	8	54' 0"

MINIMUM CONVEX RADIUS–24SF UNITS

NOT TO SCALE

Corners/Radius

6 SF Block

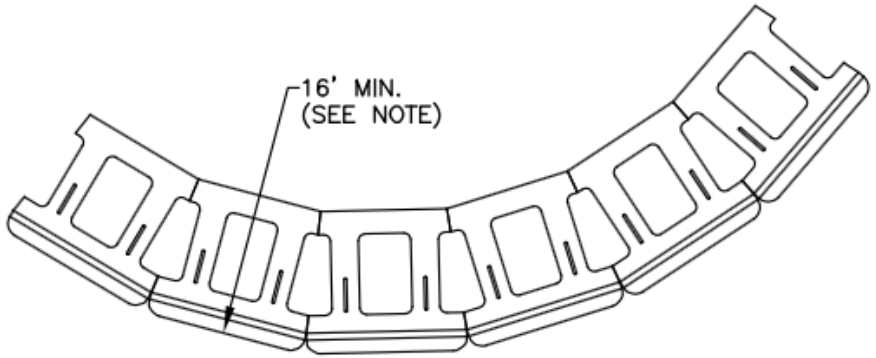


Minimum Concave Radius		
Wall Height (ft)	Total # of Courses	Reqd. Radius at Top Course
3	2	13' 8"
4 1/2	3	13' 10"
6	4	14' 0"
7 1/2	5	14' 2"
9	6	14"4"
10 1/2	7	14' 6"
12	8	14' 8"

NOTE:
MINIMUM RADIUS OCCURS AT LOWEST COURSE.
RADIUS INCREASES 2" PER COURSE
ABOVE, AS SHOWN ON TABLE.

MINIMUM CONCAVE RADIUS–6SF UNITS

NOT TO SCALE



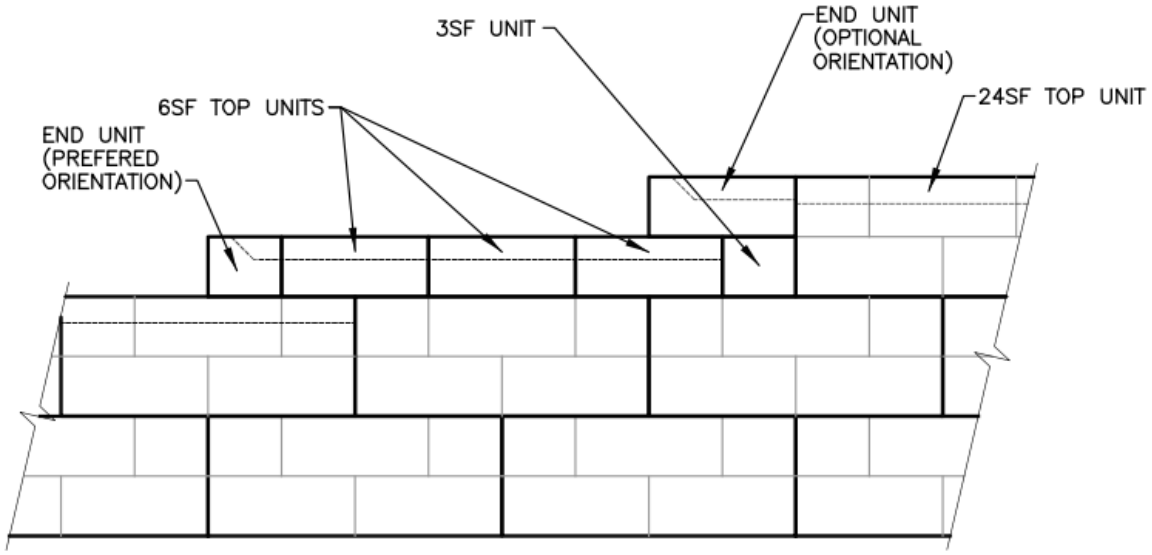
NOTE:
NOTE: MINIMUM RADIUS OCCURS AT TOP COURSE.
REQUIRED RADIUS INCREASES 2" PER COURSE
BELOW, AS SHOWN ON TABLE.

MINIMUM CONVEX RADIUS–6SF UNITS

NOT TO SCALE

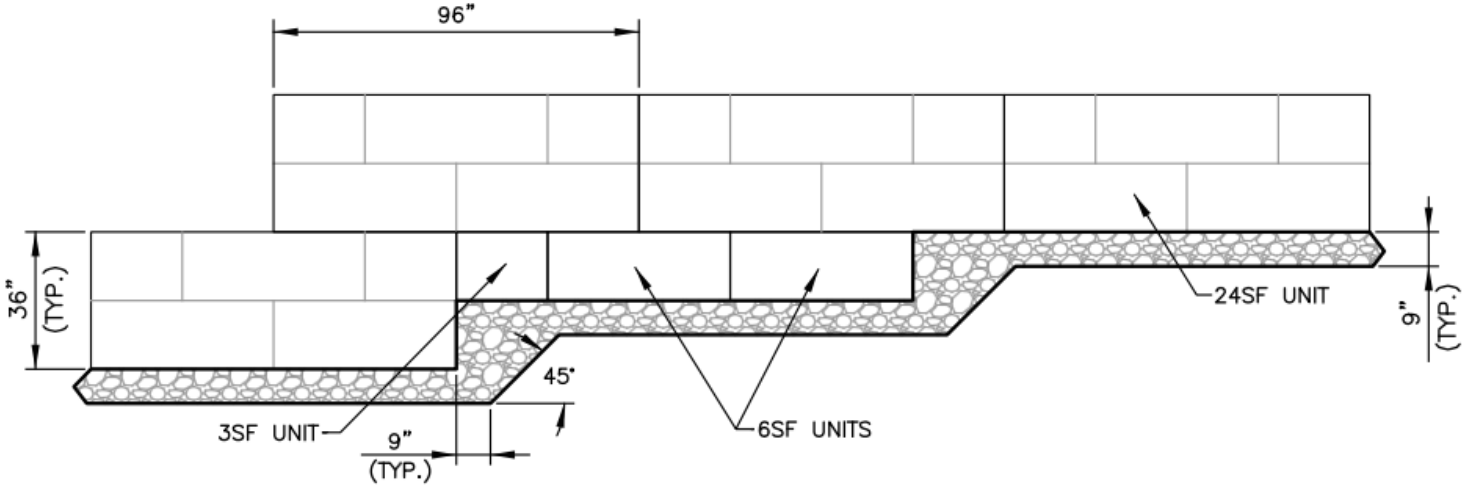
Minimum Convex Radius		
Wall Height (ft)	Total # of Courses	Reqd. Radius at First Course
3	2	16' 2"
4 1/2	3	16' 4"
6	4	16' 6"
7 1/2	5	16' 8"
9	6	16' 10"
10 1/2	7	17' 0"
12	8	17' 2"

Top End/Steps



TOP OF WALL STEPS

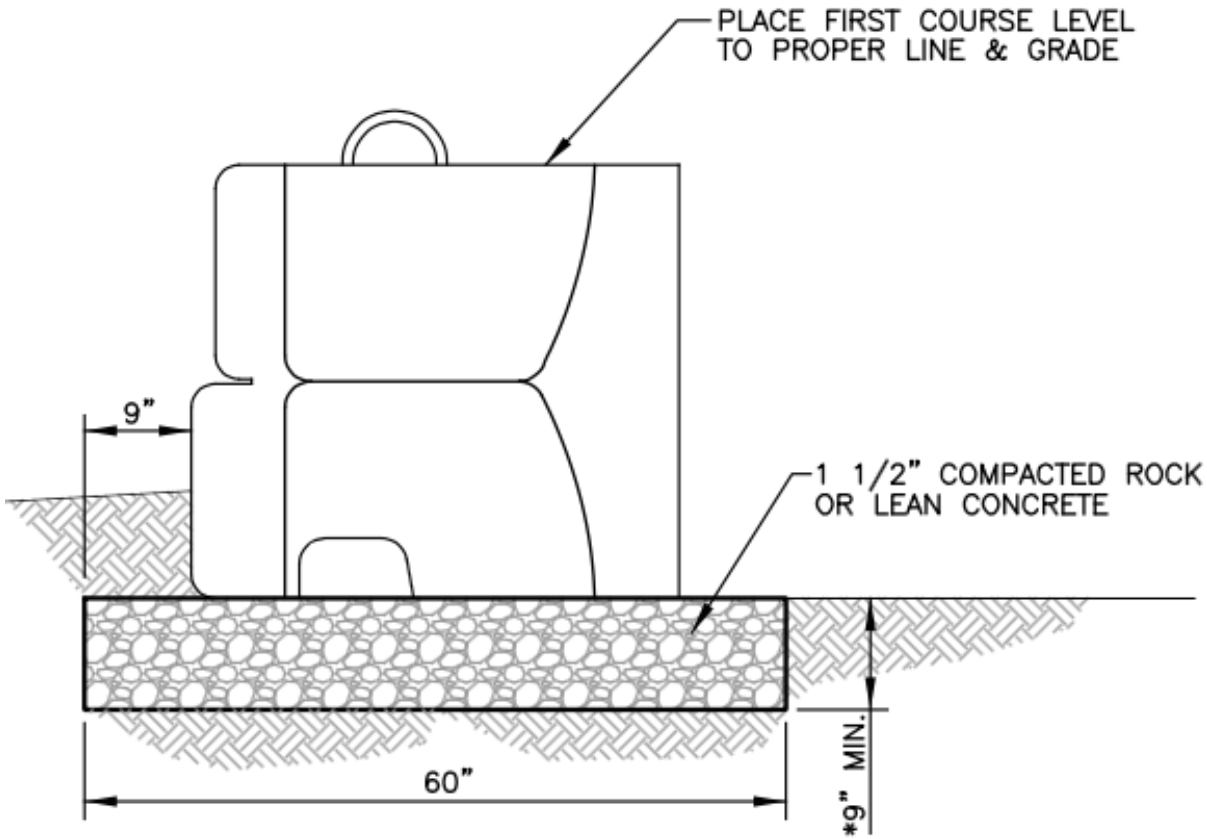
NOT TO SCALE



24SF WALL BASE STEP

NOT TO SCALE

Base/Embedment & Backfill Compaction



Proper backfill compaction is critical to wall stability

No reduced compaction requirement behind face

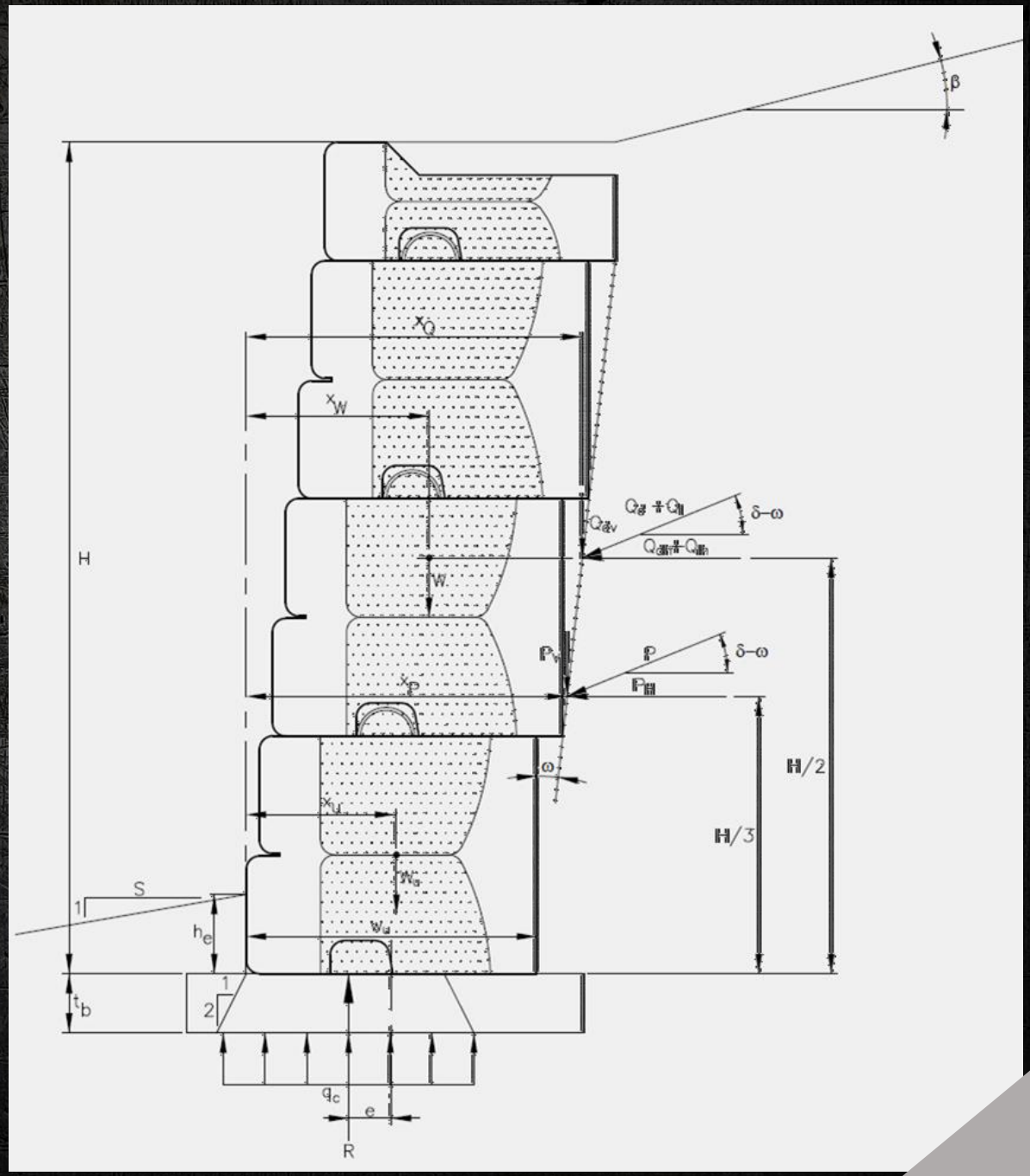
Less sensitive to displacement – 10,000 lb. mass can support equipment

The Theory

Coulomb's Active Earth Pressure Theory

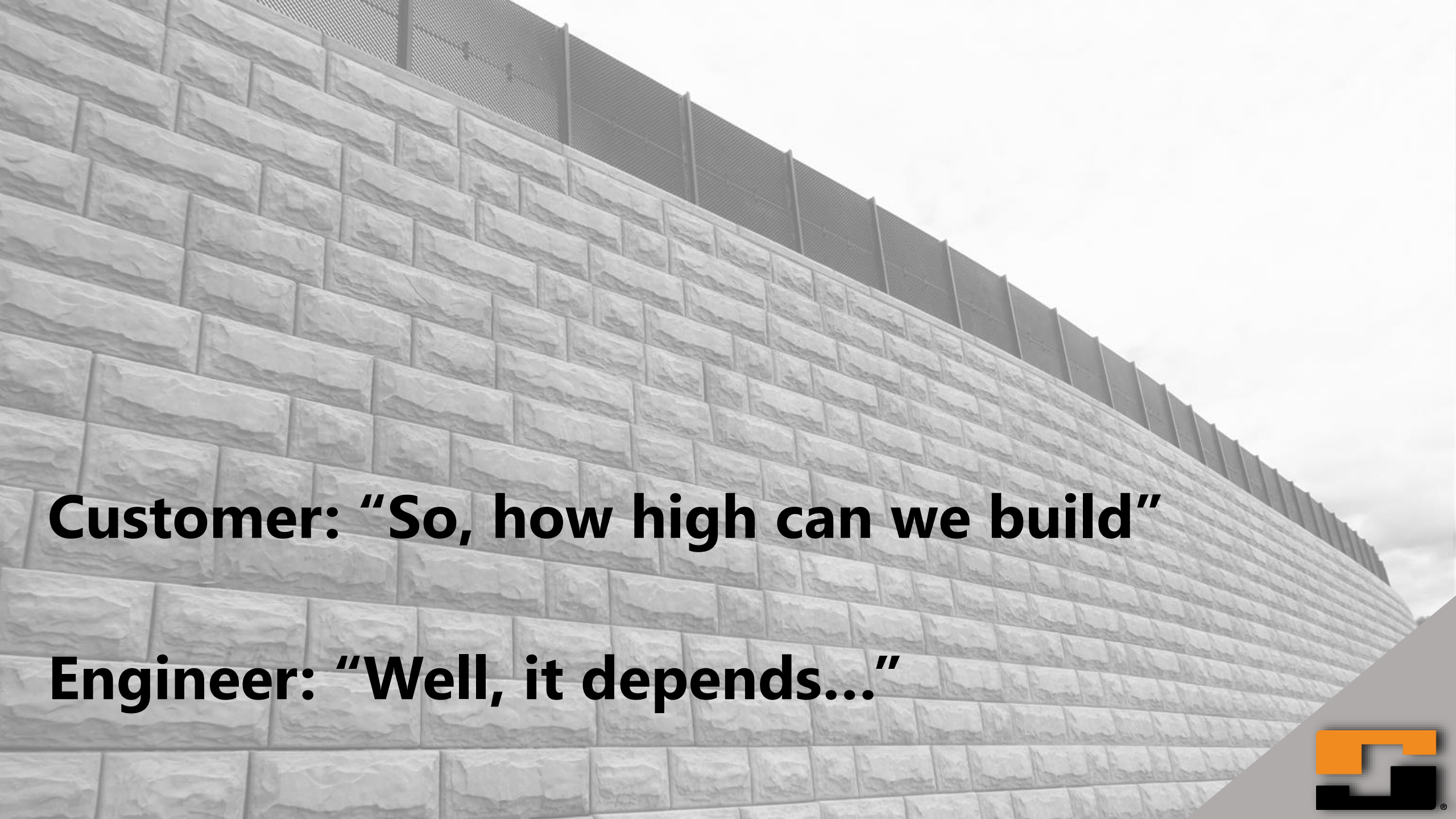
$$K_a = \frac{\cos^2(\phi + \omega)}{\cos^2(\omega)\cos(\omega - \delta)\left[1 + \sqrt{\frac{\sin(\phi + \delta)\sin(\phi - \beta)}{\cos(\omega - \delta)\cos(\omega + \beta)}}\right]^2}$$

Coulomb's Active Earth Pressure Theory



Reference Standards

- AASHTO Bridge Manual
- FHWA-NHI-10-024, MSE Walls and Reinforced Soil Slopes
- CAN-CSA-S6-06, Canadian Highway Bridge Design Code
- NZTA SP/M/022, New Zealand Transport Agency Bridge Manual
- International Building Code



Customer: “So, how high can we build”

Engineer: “Well, it depends…”

International Building Code

24SF & 6SF units only

Soil Type / Backfill Slope	Level	Level	Level	3H:1V
Surcharge	0 psf	150 psf	0 psf	0 psf
Seismic PGA	0g	0g	0.20g	0g
Clay, ϕ = 26°	9.0 ft.	7.5 ft.	9.0 ft.	7.5 ft.
Sand, ϕ = 30°	10.5 ft.	7.5 ft.	9.0 ft.	7.5 ft.
Sand/Gravel, ϕ = 34°	12.0 ft.	10.5 ft.	10.5 ft.	10.5 ft.
Crushed Stone, ϕ = 38°	13.5 ft.	10.5 ft.	12.0 ft.	12.0 ft.

Table based on minimum recommneded safety factors:

Overturning FS=1.5 Sliding FS=1.5 Bearing FS=2.0

Seismic safety factors reduced by 25%

clay soil includes 150 psf cohesion in foundation soil

unit weight 120 pcf for clay, 125 pcf for all other soils

foundation soil limited to ϕ = 30°

24-62 base unit

Soil Type / Backfill Slope	Level	Level	Level	3H:1V
Surcharge	0 psf	150 psf	0 psf	0 psf
Seismic PGA	0g	0g	0.20g	0g
Clay, ϕ = 26°	12.0 ft.	10.5 ft.	12.0 ft.	9.0 ft.
Sand, ϕ = 30°	13.5 ft.	10.5 ft.	13.5 ft.	10.5 ft.
Sand/Gravel, ϕ = 34°	15.0 ft.	13.5 ft.	13.5 ft.	13.5 ft.
Crushed Stone, ϕ = 38°	18.0 ft.	16.5 ft.	15.0 ft.	16.5 ft.

24-ME (12" extension) base unit

Soil Type / Backfill Slope	Level	Level	Level	3H:1V
Surcharge	0 psf	150 psf	0 psf	0 psf
Seismic PGA	0g	0g	0.20g	0g
Clay, ϕ = 26°	12.0 ft.	9.0 ft.	12.0 ft.	9.0 ft.
Sand, ϕ = 30°	13.5 ft.	10.5 ft.	12.0 ft.	10.5 ft.
Sand/Gravel, ϕ = 34°	15.0 ft.	13.5 ft.	13.5 ft.	13.5 ft.
Crushed Stone, ϕ = 38°	16.5 ft.	15.0 ft.	15.0 ft.	15.0 ft.

24-86 & 24-62 base units

Soil Type / Backfill Slope	Level	Level	Level	3H:1V
Surcharge	0 psf	150 psf	0 psf	0 psf
Seismic PGA	0g	0g	0.20g	0g
Clay, ϕ = 26°	15.0 ft.	12.0 ft.	15.0 ft.	10.5 ft.
Sand, ϕ = 30°	16.5 ft.	13.5 ft.	16.5 ft.	12.0 ft.
Sand/Gravel, ϕ = 34°	19.5 ft.	16.5 ft.	18.0 ft.	15.0 ft.
Crushed Stone, ϕ = 38°	22.5 ft.	19.5 ft.	19.5 ft.	19.5 ft.

24" CIP tail extension

Soil Type / Backfill Slope	Level	Level	Level	3H:1V
Surcharge	0 psf	150 psf	0 psf	0 psf
Seismic PGA	0g	0g	0.20g	0g
Clay, ϕ = 26°	13.5 ft.	10.5 ft.	13.5 ft.	10.5 ft.
Sand, ϕ = 30°	15.0 ft.	13.5 ft.	15.0 ft.	12.0 ft.
Sand/Gravel, ϕ = 34°	18.0 ft.	16.5 ft.	15.0 ft.	15.0 ft.
Crushed Stone, ϕ = 38°	19.5 ft.	18.0 ft.	16.5 ft.	18.0 ft.

AASHTO LRFD

24SF & 6SF units only

Soil Type / Backfill Slope / Surcharge / Seismic PGA	Level 0 psf 0g	Level 250 psf 0g	Level 0 psf 0.20g	3H:1V 0 psf 0g
Clay, ϕ = 26°	7.5 ft.	4.5 ft.	7.5 ft.	6.0 ft.
Sand, ϕ = 30°	9.0 ft.	4.5 ft.	7.5 ft.	7.5 ft.
Sand/Gravel, ϕ = 34°	10.5 ft.	7.5 ft.	10.5 ft.	9.0 ft.
Crushed Stone, ϕ = 38°	12.0 ft.	9.0 ft.	12.0 ft.	10.5 ft.

24-86 & 24-62 base units

Soil Type / Backfill Slope / Surcharge / Seismic PGA	Level 0 psf 0g	Level 250 psf 0g	Level 0 psf 0.20g	3H:1V 0 psf 0g
Clay, ϕ = 26°	13.5 ft.	10.5 ft.	13.5 ft.	10.5 ft.
Sand, ϕ = 30°	16.5 ft.	12.0 ft.	16.5 ft.	12.0 ft.
Sand/Gravel, ϕ = 34°	18.0 ft.	15.0 ft.	18.0 ft.	15.0 ft.
Crushed Stone, ϕ = 38°	19.5 ft.	16.5 ft.	19.5 ft.	18.0 ft.

AASHTO LRFD – Vertical Face

24SF & 6SF units only

Soil Type / Backfill Slope	Level	Level	Level	3H:1V
Surcharge	0 psf	250 psf	0 psf	0 psf
Seismic PGA	0g	0g	0.20g	0g
Clay, ϕ = 26°	7.5 ft.	4.5 ft.	7.5 ft.	7.5 ft.
Sand, ϕ = 30°	7.5 ft.	4.5 ft.	7.5 ft.	7.5 ft.
Sand/Gravel, ϕ = 34°	9.0 ft.	7.5 ft.	9.0 ft.	9.0 ft.
Crushed Stone, ϕ = 38°	10.5 ft.	7.5 ft.	10.5 ft.	10.5 ft.

24-86 & 24-62 base units

Soil Type / Backfill Slope	Level	Level	Level	3H:1V
Surcharge	0 psf	250 psf	0 psf	0 psf
Seismic PGA	0g	0g	0.20g	0g
Clay, ϕ = 26°	13.5 ft.	10.5 ft.	13.5 ft.	10.5 ft.
Sand, ϕ = 30°	15.0 ft.	12.0 ft.	15.0 ft.	12.0 ft.
Sand/Gravel, ϕ = 34°	15.0 ft.	13.5 ft.	15.0 ft.	13.5 ft.
Crushed Stone, ϕ = 38°	16.5 ft.	13.5 ft.	16.5 ft.	15.0 ft.

STONE STRONG SYSTEMS®

Landscape Design Tables

11/3/16

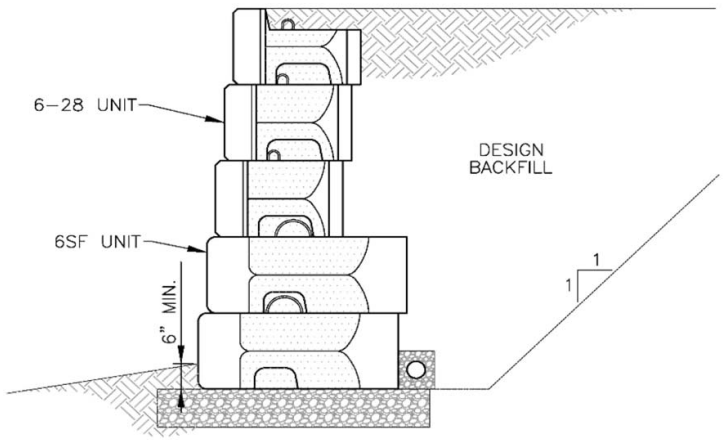
Load Case 1 - Level Backfill

(Battered Face)

Backslope: nearly level (or sloping away from wall)

Surcharge: 25 psf (nominal surcharge/snow load)

Based on IBC safety factors, 1.5 for sliding/overturning



Cohesive Backfill*	Total Wall Height (feet)					
ϕ=26°, c=100psf, γ=125pcf	3.0	4.5	6.0	7.5	9.0	10.5
7th Course						- -
6th Course					- -	- -
5th Course				6-28	- -	- -
4th Course			6-28	6-28	- -	- -
3rd Course		6-28	6-28	6SF	- -	- -
2nd Course	6-28	6-28	6SF	6SF	- -	- -
Bottom Course	6-28	6-28	6SF	6SF	- -	- -

*design for soil within 1 foot of heel, extending up at 1H:1V slope, assumes clay foundation soil

Coarse Sand Backfill*	Total Wall Height (feet)					
ϕ=32°, c=0psf, γ=125pcf	3.0	4.5	6.0	7.5	9.0	10.5
7th Course						6-28
6th Course					6-28	6-28
5th Course				6-28	6-28	6-28
4th Course			6-28	6-28	6-28	6SF
3rd Course		6-28	6-28	6-28	6SF	6SF
2nd Course	6-28	6-28	6-28	6SF	6SF	6SF
Bottom Course	6-28	6-28	6-28	6SF	6SF	6SF

*design for soil within 1 foot of heel, extending up at 1H:1V slope, assumes sand foundation soil

Sand Backfill*	Total Wall Height (feet)					
ϕ=30°, c=0psf, γ=125pcf	3.0	4.5	6.0	7.5	9.0	10.5
7th Course						- -
6th Course					6-28	- -
5th Course				6-28	6-28	- -
4th Course			6-28	6-28	6-28	- -
3rd Course		6-28	6-28	6-28	6SF	- -
2nd Course	6-28	6-28	6-28	6SF	6SF	- -
Bottom Course	6-28	6-28	6-28	6SF	6SF	- -

*design for soil within 1 foot of heel, extending up at 1H:1V slope, assumes sand foundation soil

Gravel Backfill*	Total Wall Height (feet)					
ϕ=34°, c=0psf, γ=125pcf	3.0	4.5	6.0	7.5	9.0	10.5
7th Course						6-28
6th Course					6-28	6-28
5th Course				6-28	6-28	6-28
4th Course			6-28	6-28	6-28	6-28
3rd Course		6-28	6-28	6-28	6-28	6SF
2nd Course	6-28	6-28	6-28	6-28	6SF	6SF
Bottom Course	6-28	6-28	6-28	6SF	6SF	6SF

*design for soil within 1 foot of heel, extending up at 1H:1V slope, assumes sand foundation soil

STONE STRONG SYSTEMS®

Landscape Design Tables

11/3/16

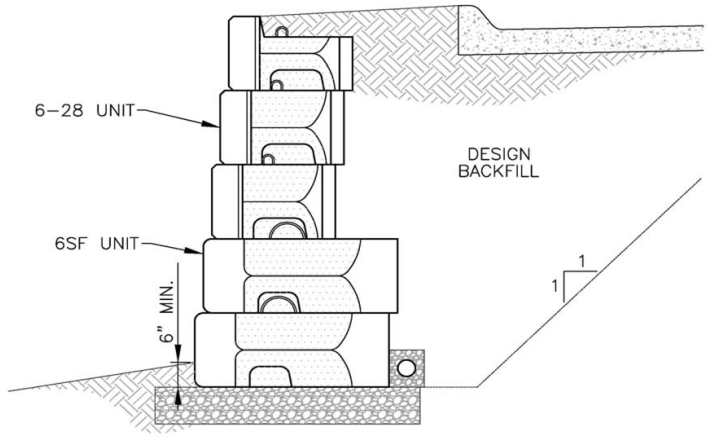
Load Case 2 - Parking Lot Surcharge

(Battered Face)

Backslope: nearly level (or sloping away from wall)

Surcharge: 150 psf (parking lot, set back min 2 feet behinds)

Based on IBC safety factors, 1.5 for sliding/overturning



Cohesive Backfill*

ϕ=26°, c=100psf, γ=125pcf

	Total Wall Height (feet)					
	3.0	4.5	6.0	7.5	9.0	10.5
7th Course						- -
6th Course					- -	- -
5th Course				- -	- -	- -
4th Course			6-28	- -	- -	- -
3rd Course		6-28	6-28	- -	- -	- -
2nd Course	6-28	6-28	6SF	- -	- -	- -
Bottom Course	6-28	6-28	6SF	- -	- -	- -

*design for soil within 1 foot of heel, extending up at 1H:1V slope, assumes clay foundation soil

Coarse Sand Backfill*

ϕ=32°, c=0psf, γ=125pcf

	Total Wall Height (feet)					
	3.0	4.5	6.0	7.5	9.0	10.5
7th Course						- -
6th Course					- -	- -
5th Course				6-28	- -	- -
4th Course			6-28	6-28	- -	- -
3rd Course		6-28	6-28	6-28	- -	- -
2nd Course	6-28	6-28	6-28	6SF	- -	- -
Bottom Course	6-28	6-28	6SF	6SF	- -	- -

*design for soil within 1 foot of heel, extending up at 1H:1V slope, assumes sand foundation soil

Sand Backfill*

ϕ=30°, c=0psf, γ=125pcf

	Total Wall Height (feet)					
	3.0	4.5	6.0	7.5	9.0	10.5
7th Course						- -
6th Course					- -	- -
5th Course				6-28	- -	- -
4th Course			6-28	6-28	- -	- -
3rd Course		6-28	6-28	6-28	- -	- -
2nd Course	6-28	6-28	6-28	6SF	- -	- -
Bottom Course	6-28	6-28	6SF	6SF	- -	- -

*design for soil within 1 foot of heel, extending up at 1H:1V slope, assumes sand foundation soil

Gravel Backfill*

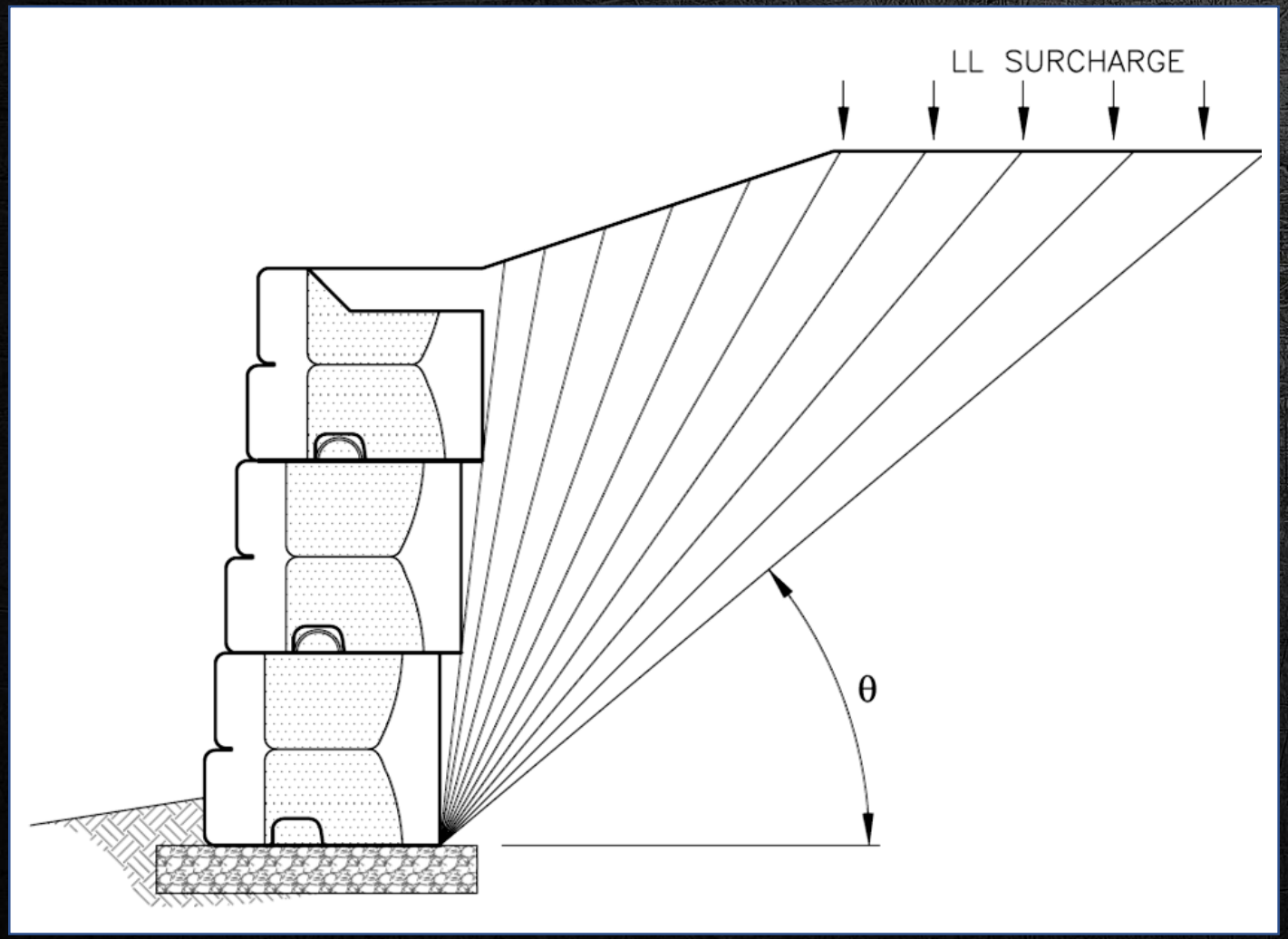
ϕ=34°, c=0psf, γ=125pcf

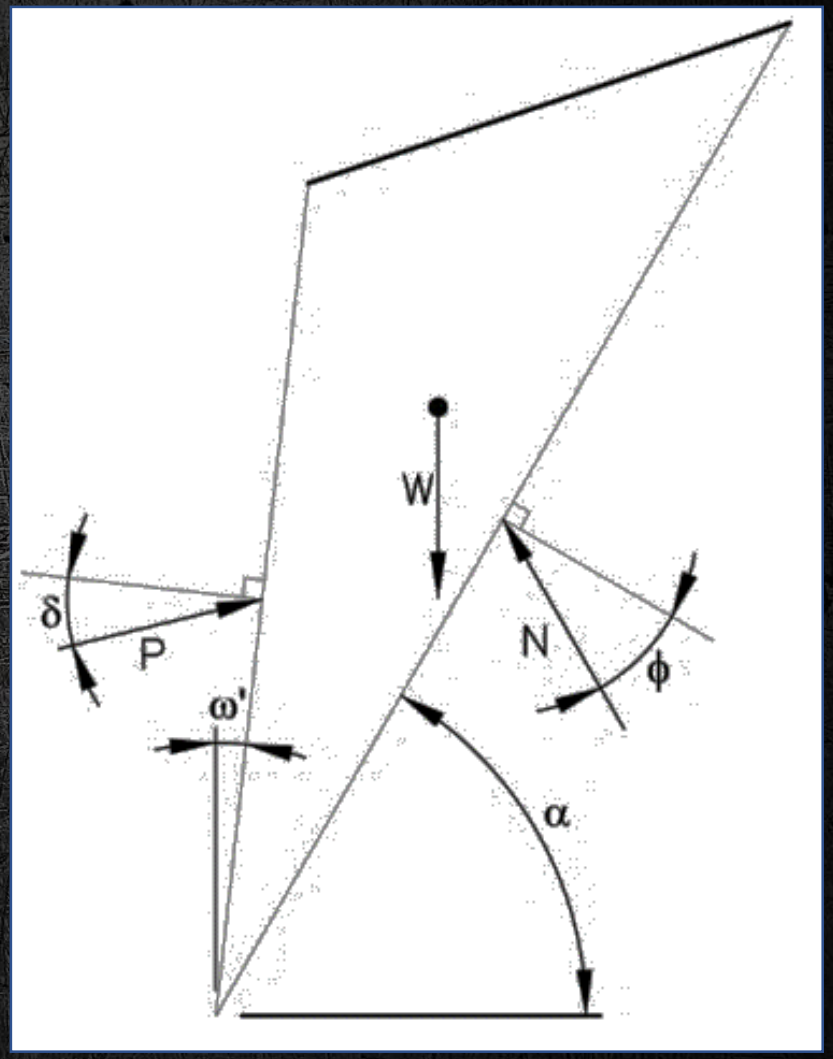
	Total Wall Height (feet)					
	3.0	4.5	6.0	7.5	9.0	10.5
7th Course						- -
6th Course					6-28	- -
5th Course				6-28	6-28	- -
4th Course			6-28	6-28	6-28	- -
3rd Course		6-28	6-28	6-28	6SF	- -
2nd Course	6-28	6-28	6-28	6SF	6SF	- -
Bottom Course	6-28	6-28	6-28	6SF	6SF	- -

*design for soil within 1 foot of heel, extending up at 1H:1V slope, assumes sand foundation soil

Trial Wedge Method

Variation of Coulomb Technique





Not commonly used due to computational effort.

“Fine, we’ll create a solution ourselves.”

Defining Complex Boundary Conditions

STONE STRONG SYSTEMS

STONE STRONG GRAVITY CALCULATIONS - ver 5.3

Project Name: Gravity Retaining Wall
Location: Omaha, NE
Job#:
Section: Examplee
Calc by: D Thiele

8/9/16 10:47

Notes

Wall Configuration

unit	w (in)	h (ft)	setback (in) face	setback (in) tail	modular units Wb (lb)	modular units xb (in)	unit fill Wa (lb)	unit fill xa (in)	soil wedge Ws (lb)	soil wedge xs (in)	CIP Extension we (in)	CIP Extension h_t	Internal Stability FS Topple	Internal Stability FS Shear	Seismic Internal FS Topple	Seismic Internal FS Shear	
6	44.0	1.50	12.0	-6.0	400	31.0	296	33.5	8	54.4			43.71	17.93	25.84	12.33	OK!
24	44.0	3.00	8.0	-10.0	750	27.2	594	30.8	176	53.2			6.16	4.95	4.69	4.13	OK!
24	44.0	3.00	4.0	-14.0	750	23.2	594	26.8	352	52.4			2.40	2.70	2.07	2.46	OK!
24-62	62.0	3.00	0.0	0.0	857	27.1	1,043	31.0	0	0.0							
	62.0	10.50	12.0	-6.0	2,757	26.6	2,527	30.3	536	52.7	5,820		External Stability OK!				

backfill height 10.50 feet ω= 6.34 deg interface friction angle
exposed height 9.75 feet ω'= -2.73 deg δ 24.0 deg

Retained Soil
γ 125 pcf
ϕ 32 deg

Foundation Soil
γ 125 pcf
c' psf
ϕ 30 deg
(if specified)
allowable bearing pressure n/a psf (net)

Aggregate Unit Fill
γ 110 pcf

base embedment 9 in
base thickness 9 in
base material agg
toe slope H:1V slope

composite friction coefficient μ_b 0.69

© S T O N E S T R O N G S Y S T E M S

Seismic Load Ss 0.20 G site class (A to E or 1) D Fa 1.60 k_h 0.03

Backfill Slope & Surcharge

		rise in grade	LL surcharge	tier height
length 1	11 feet (horizontal)	2 ft	psf	ft
length 2	14 feet (horizontal)	ft	150 psf	ft
length 3	feet (horizontal)	ft	psf	ft
length 4	feet (horizontal)	ft	psf	

effective slope 4.11 H:1V slope β 13.7 deg avg q 52 psf
failure plane α 53.58 deg zone of influence 14.39 ft

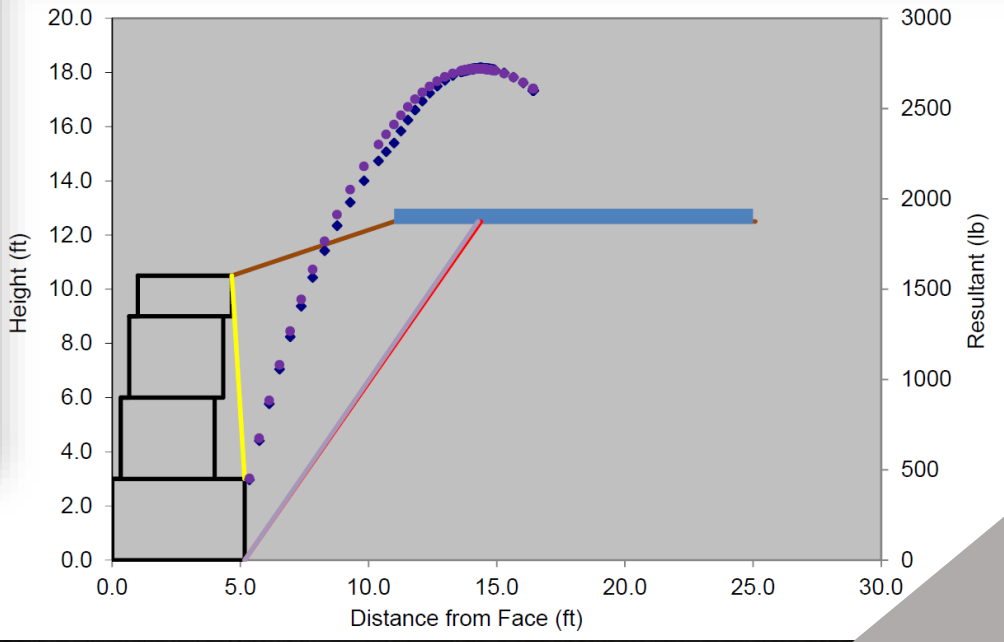
Analysis

K_a = 0.368 Q_{lh} = 168 lb ΔK_{AE} = 0.027 e= 0.80 ft
P_h = 2265 lb Q_{lv} = 84 lb P_{IR} = 167 lb B_f' = 4.14 ft
P_v = 1140 lb R_s = 4019 lb ΔP_{AEh} = 165 lb e_{eq}= 0.89 ft
q_{ult} = 9,251 psf ΔP_{AEv} = 83 lb $B_{f\,eq}'$ = 3.96 ft

Results

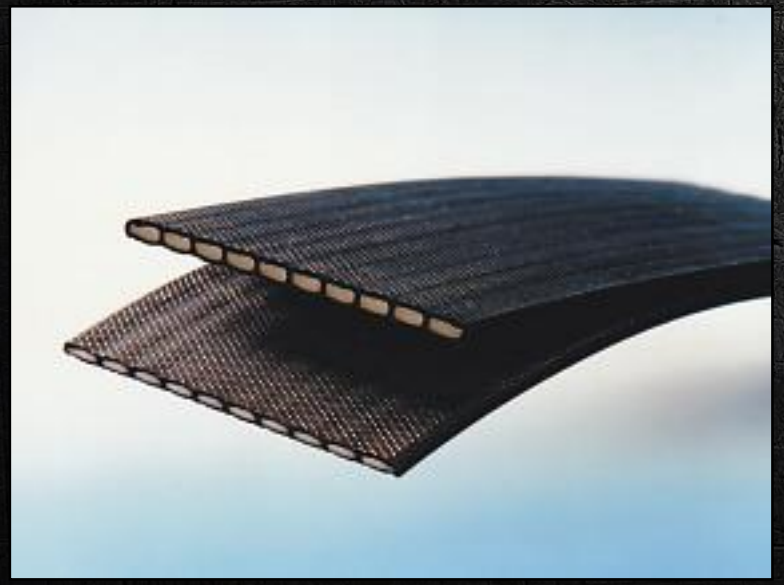
Overturning:	Desired FS = 1.5	**Actual FS = 2.16**	***OK!***
Sliding:	Desired FS = 1.5	**Actual FS = 1.65**	***OK!***
Bearing Capacity:	Desired FS = 2	**Actual FS = 5.16**	***OK!***
	q_{all} = 4,626 psf	q_c = 1,794 psf	
Seismic Overturning:	Desired FS = 1.13	**Actual FS = 2.03**	***OK!***
Seismic Sliding:	Desired FS = 1.13	**Actual FS = 1.61**	***OK!***
Seismic Bearing:	Desired FS = 1.5	**Actual FS = 4.86**	***OK!***
	q_{all} = 5,999 psf	q_c = 1,871 psf	

Ground Surface & Trial Wedge Plot



Stone Strong / Paraweb

- Conforms to AASHTO standards
- Innovative MSE system
- Polyester yarn bundles encased in tough and durable polyethylene sheath
- Positive connection
- Stable face



Interaction Testing Reports

24SF Block & 6SF Block

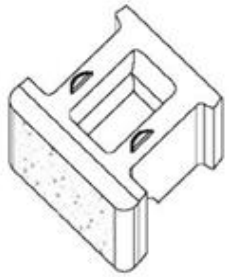
Tadros Associates, LLC
Structural Engineering Consultants

thiele geotech inc TG

Interaction Testing Report

6 SF Units with Synteen Geogrids

Stone Strong Systems
Lincoln, Nebraska



Prepared for:
Stone Strong Systems
3801 Union Drive, Suite 102
Lincoln, Nebraska 68516

May 27, 2005
TG Project No. 02546.2

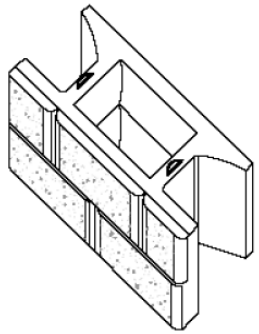
Tadros Associates, LLC
Structural Engineering Consultants

thiele geotech inc TG

Interaction Testing Report

24 SF Units with Synteen Geogrids

Stone Strong Systems
Lincoln, Nebraska

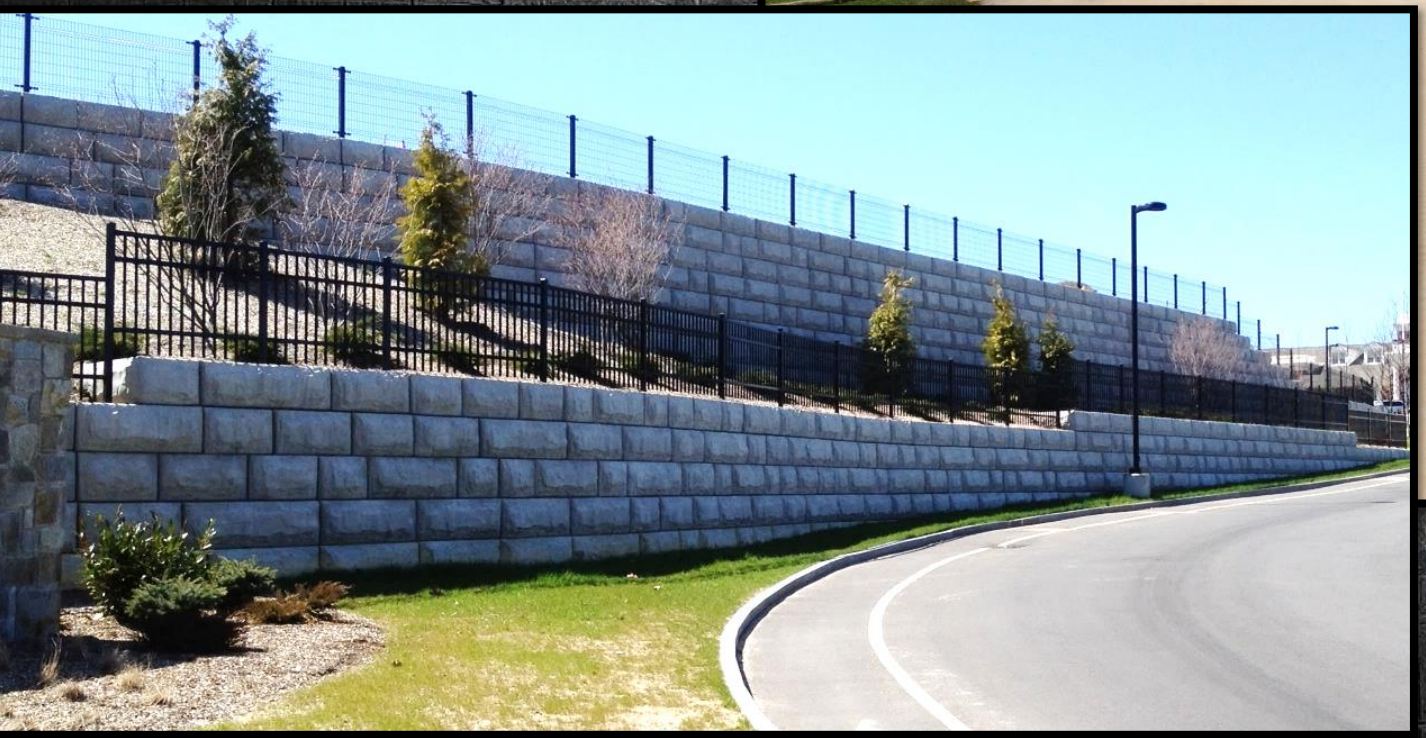


Prepared for:
Stone Strong Systems
3801 Union Drive, Suite 102
Lincoln, Nebraska 68516

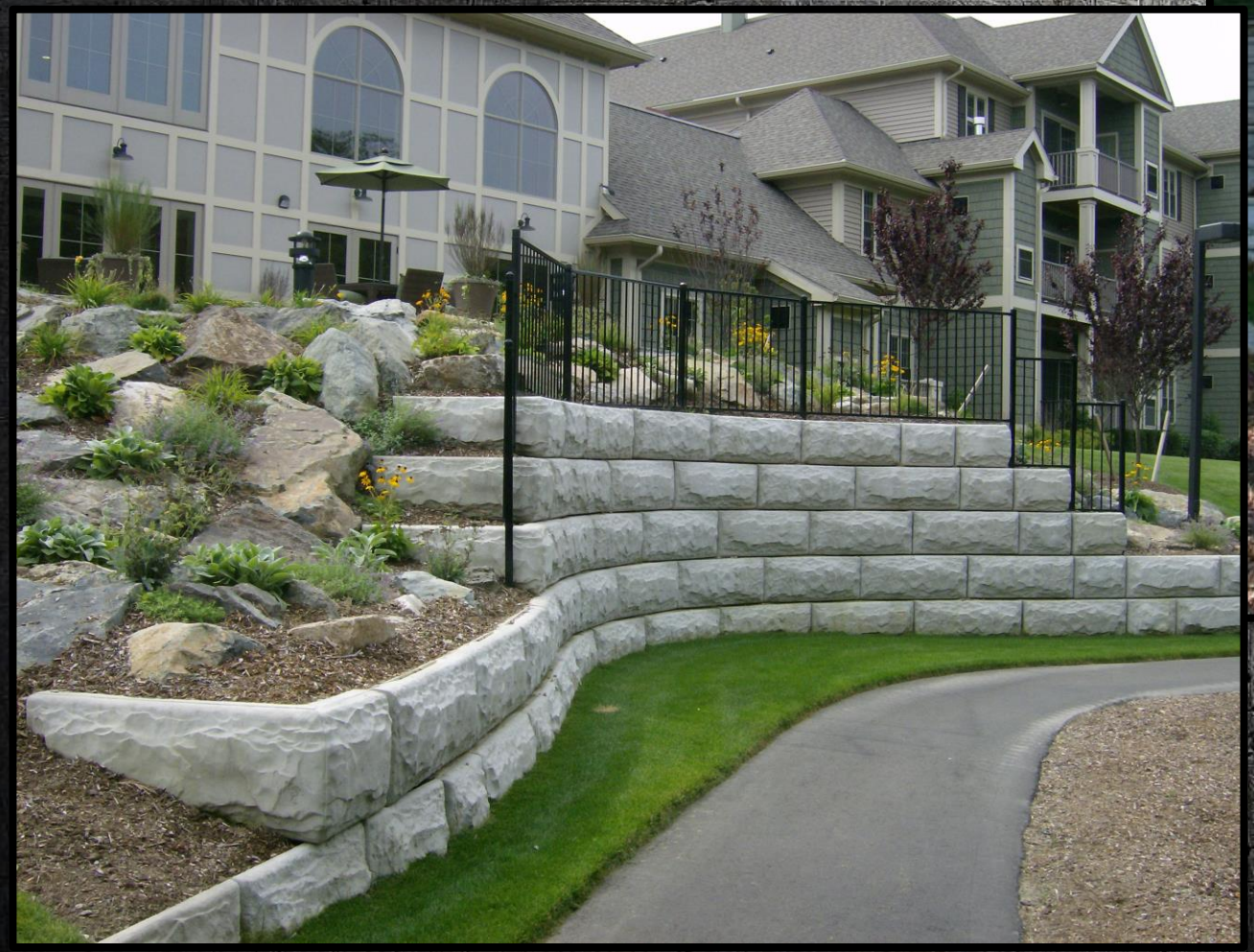
September 17, 2004
TG Project No. 02546.2

The Solutions

ROADWAY

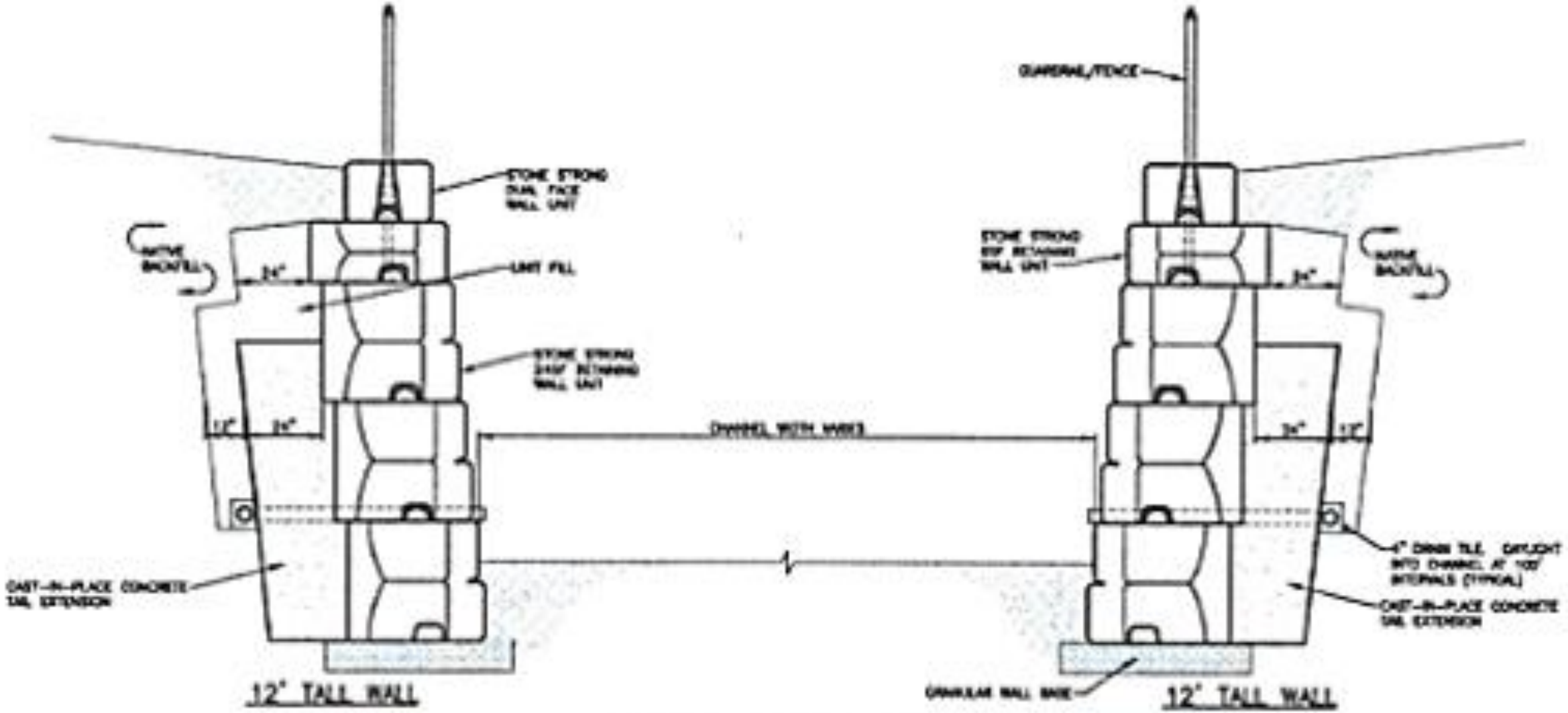


COMMERCIAL



RESIDENTIAL

SHORELINE



CHANNEL CROSS SECTION

NOT TO SCALE

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MIDLAND
CITY OF MIDLAND

Safety and Risk Mgmt.

Purchasing Division
432.685.7234
Fax 685.0523

Warehouse
432.685.7244
Fax 432.686.1648

Department of Facilities and Fleet Management
Post Office Box 1152
Midland, Texas 79702-1152

Fleet Services
432.685.7455

Service Center
432.685.7460

Facilities Services
432.685.7271

March 1, 2010

Stone Strong Systems
Attn: Jody DuBois
P. O. Box 835
Justin, TX 76247

Subject: Annual Purchase Agreement, PA0310-10, for Precast Concrete Retaining Wall Blocks

Dear Mr. DuBois:

Attached you will find two copies of the purchase agreement transmitted previously with the subject Request for Sealed Bid.

Please execute and ***notarize*** both purchase agreement copies and return them to this office as soon as possible.

Upon receipt of all information in an acceptable manner, we shall execute the duplicate copies of the agreement and return one copy for your files.

Please contact this office if you have any questions.

Sincerely,

Eddie Price, C.P.M.
Purchasing Agent

CITY OF DENTON

MATERIALS MANAGEMENT DIVISION • 901-B TEXAS STREET • DENTON, TEXAS 76209
940.349.7100 • FAX 940.349.7302

August 19, 2014

Jody DuBois
Stone Strong of Texas
PO Box 835
Justin, TX 76247
jody@stonestrongoftexas.com

Ref: File 4834- Renewal of Contract for Retaining Wall Blocks

Dear Jody:

The City of Denton would like to renew its contract with Stone Strong of Texas for the above referenced File for an additional one-year period through October 18, 2015, if agreed to by both parties, with all prices, terms and conditions remaining the same. If your company is in agreement, please sign a copy of this letter and return it to me.

Thank you for your continued interest in the City of Denton. If you have any questions, please contact me.

Regards,

Elton D. Brock, MBA, CTPM, CTCM, C.P.M.
Purchasing Manager

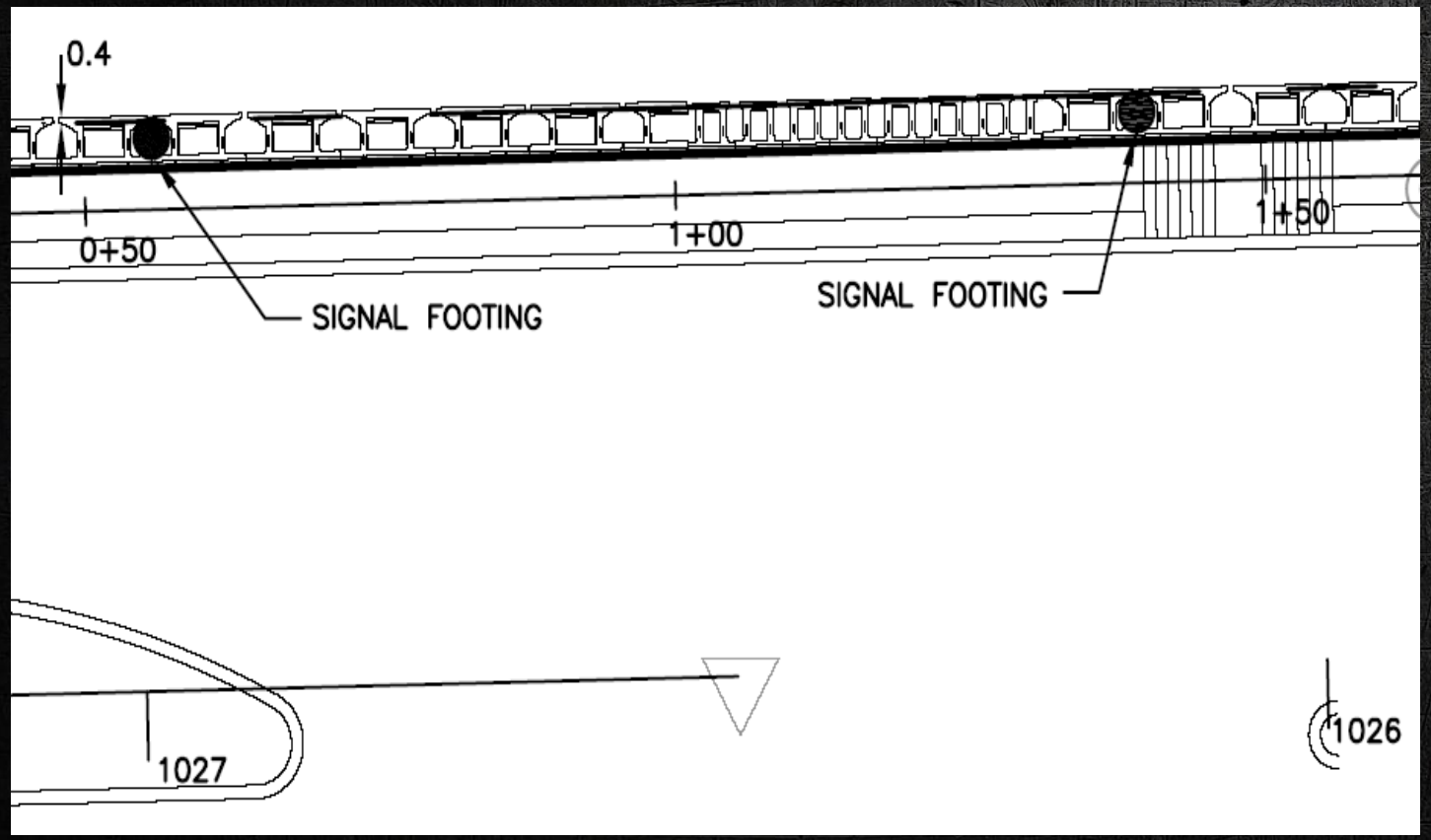
Authorized Rep.

8/20/2014
Date

"Dedicated to Quality and Service"

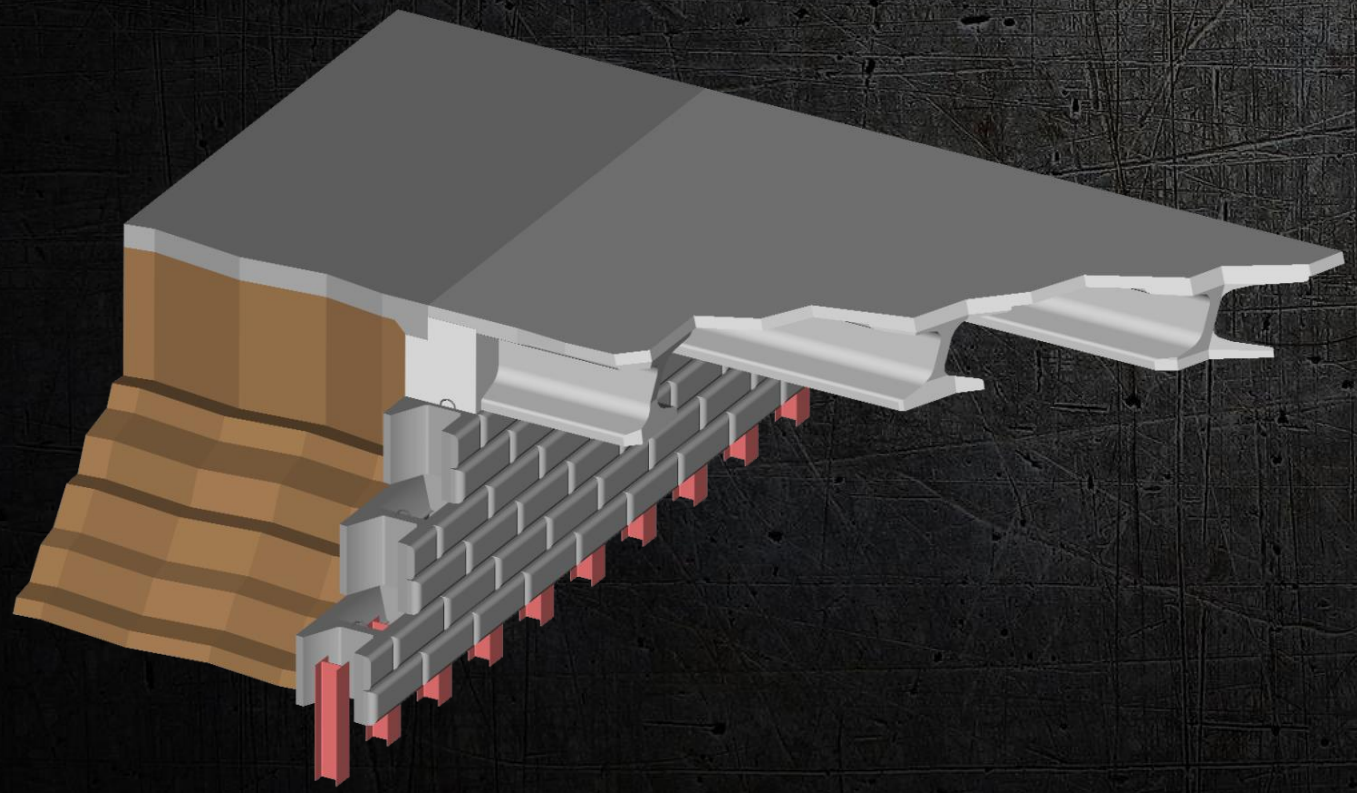
Integrated Structures

Harrison Street | Omaha, Nebraska

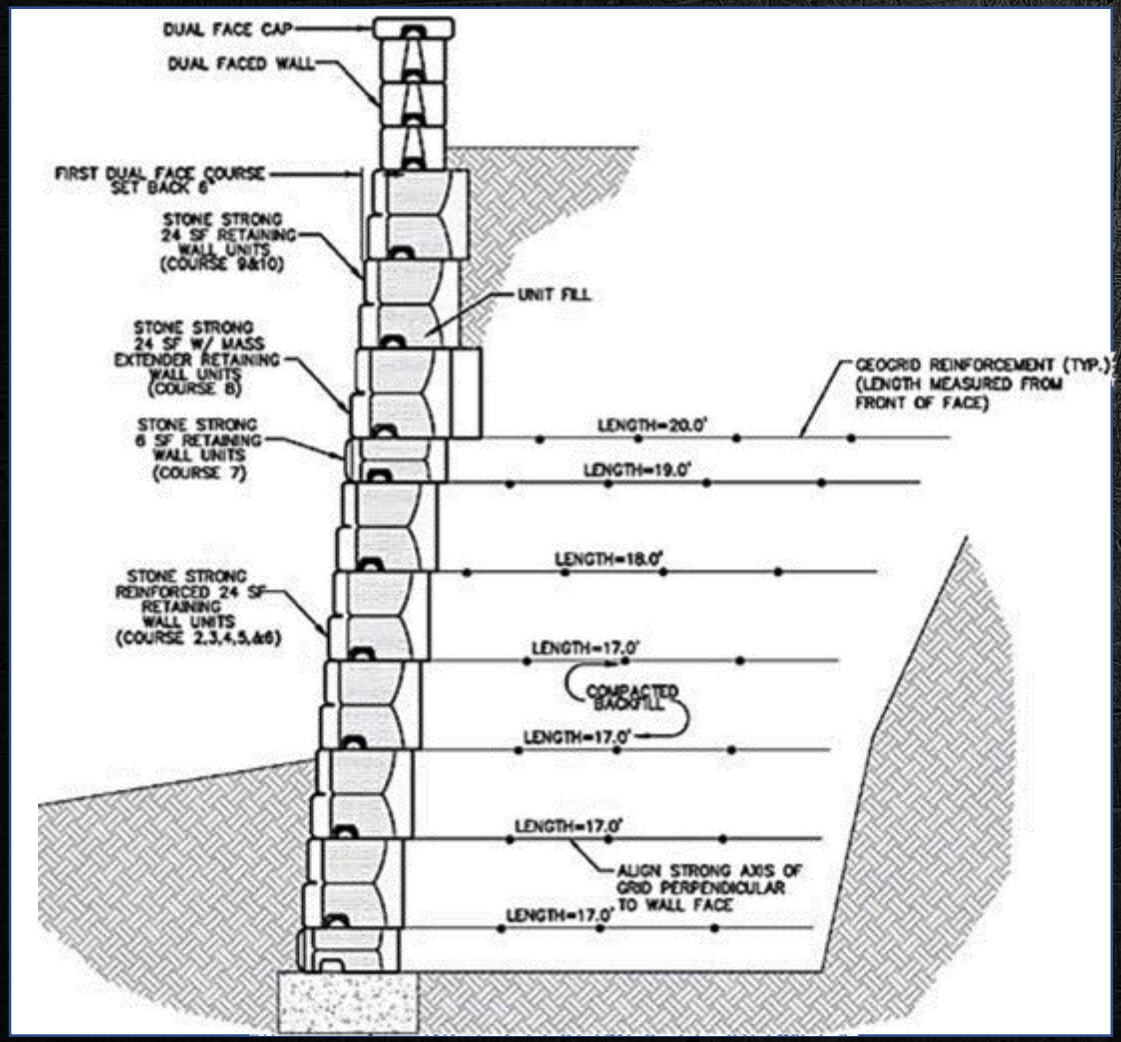


Bridge Abutments

Ulster County | Kingston, New York



Hybrid Applications



ATTRACTIVE
SMARTER
LIGHTER
BIGGER

STONE STRONG SYSTEMS®

THE SOLUTION