

KEYSTONE[®] STANDARD III

Standardized Manual for Engineered Retaining Walls up to 6 feet

SOILS REPORT REQUIRED.

PLEASE CHECK WITH YOUR LOCAL BUILDING
DEPARTMENT FOR FURTHER INFORMATION
ON BUILDING PERMIT REQUIREMENTS.



CHULA VISTA

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(619) 474-1516

LEMON GROVE

8240 Broadway
(619) 460-9101

SANTEE

8755 Magnolia Ave.
(619) 448-2240

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MURRIETA

25725 Jefferson Ave.
(951) 677-1489



DESIGNED EXCLUSIVELY FOR USE WITH KEYSTONE STANDARD III WALL UNITS, MANUFACTURED
BY RCP BLOCK & BRICK AND MIRAGRID 2XT MANUFACTURED BY TENCATE

KEYSTONE STANDARD III STANDARDIZED MANUAL

INTRODUCTION

This manual is specifically written, and all material contained within, for the Keystone Retaining Wall System. Each Keystone retaining wall unit has different strength, weight, and size considerations which requires an individual analysis. Geogrid soil reinforcement has performance properties which are unique to the polymer type and material designation also requiring individual analysis. Different Keystone retaining wall unit and geogrid combinations have unique design properties that require special analysis.

The purpose of Standardized Manual is to provide working parameters for the design and construction of small Keystone retaining walls in accordance with current standard of practice. Larger or more complex walls typically require site specific engineering analysis. Permitting may be required for any retaining wall of any height so please check local requirements before proceeding with construction.

This Standardized Manual provides pre-engineered design for construction of segmental block retaining walls (SRW) up to 6 feet high using 8-inch (203mm) high Keystone Standard III units. The designs provided are for walls no greater than 6' in total height with specific backfill and surcharge conditions. The design is consistent with the National Concrete Masonry Association (NCMA) "Design Manual for Segmental Retaining Walls, Third Edition."

KEYSTONE STANDARD III BLOCK DETAILS

KEYSTONE STANDARD III STANDARDIZED MANUAL

Standard III Block



Tri-plane Face Unit



Straight Split Unit

Piece	Height	Width	Depth	Core Dimension	Weight	Pcs/sq ft	Available Colors
Tri-plane	8"	18"	18"	(1) 3.5"x5" (1) 5x6.5"	82-93 lbs	1	Tan, Natural
Straight Split	8"	18"	18"	(1) 3.5"x5" (1) 5x6.5"	85-96 lbs	1	Tan, Natural

APPLICABILITY

This manual is applicable for retaining walls with total height of 6 feet or less, including a 6" deep embedment below grade. The wall has either level backfill, or sloping backfill with no greater than a 26.6-degree slope, or traffic load surcharge of 250 pounds per square foot. The soils at the site classify as sand, silty sand, clayey sand, silty gravel, clayey gravel, or mixtures thereof, and has the internal angle of friction of 30° or greater. Such soils are soil types considered to be California Building Code (CBC) Class 4 type soils.

BUILDING PERMIT

The user shall consult the local building authority for permit requirements for construction of retaining walls for specific conditions at the site. The user shall use experienced construction contractor or should have experience in construction of these walls and knowledge of soil compaction. The authority may require a report from a licensed soils engineer for soil type and its strength parameters, and for confirming applicability of this guideline.

DESIGN SUMMARY

The design presented in this manual meets minimum acceptable factors of safety of 1.5 against sliding failures, and 2.0 against overturning and bearing capacity failures. An Earthquake acceleration coefficient of 0.15g is used in the design. Wall batter considered is approximately 0-degree batter (almost vertical wall) and approximately 8-degree batter. Geogrid reinforcements are Miragrid 2XT manufactured by Tencate. The tables and plates that follow provide typical wall

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details and reinforcement schedule for Geosynthetic-Reinforced SRWs up to 6' in height. The grading around the wall allows positive drainage of surface water away from and around the wall. Hydrostatic pressures are not considered in the design.

STEPS FOR DESIGN SELECTION

- 1. Determine if Keystone Standard Manual is applicable to your project:** This manual can be used when acceptable to local building officials and when the wall height, surcharge load, and soil type are consistent with those indicated in this manual.
- 2. Determine total wall height including proposed embedment:** The total wall height is defined as the exposed height plus embedment depth. The minimum wall embedment required is 6" for level grade at the base of the wall.
- 3. Determine the type of soils that will be retained:** Estimate the soil type based on visual soil classification or soil testing. For more details on soil type at your site, contact a Soils Engineer.
- 4. Determine loading condition on the wall:** All cases apply for a near-level soil surface at the toe of the wall.
 - a. Case A depicts a near-level wall backfill with no surcharge load near the wall crest.
 - b. Case B depicts a near-level wall crest with surcharge load applied by traffic, for example, along a driveway or a parking lot at the top of the wall.
 - c. Case C depicts a 2H :1V sloping surcharge (26.6 degrees maximum) above the wall.
- 5. Select applicable wall design from the tables or charts:** Select geogrid reinforcement schedule from Design Tables 1-3, or Plates 2 and 3.
- 6. Determine if building permits are required for wall construction:** Building permit requirements for segmental retaining walls are unique to each jurisdiction and can only be determined through direct contact with local building officials. If permits are required, submit this Standard Engineering Manual along with other site drawings, survey plans, literature, etc. that may be required by the building department.
- 7. Wall Construction:** Start wall construction only after you confirm that you do not need a permit, or after a permit is obtained. Construct wall per details shown on Plate 1. Consult a Keystone representative or hire a licensed engineer to understand the construction details and methods.

Note: Documentation of soil types by a licensed engineer or testing lab may be required to use Standardized Manual when obtaining permits. USCS soil classification types are defined by ASTM D2487 & ASTM D2488.

KEYSTONE STANDARD III STANDARDIZED MANUAL

EXCLUSIONS

Do not use this manual, if any of the following applies:

- 1) The user has no knowledge of strength parameters of soils,
- 2) Total wall height is in excess of 6 feet,
- 3) Back slope is steeper than 2 horizontal to 1 vertical (26.6 degrees),
- 4) Special surcharge loading conditions exist, such as, buildings or other structures, or,
- 5) Groundwater or drainage problems exist at the site.

LIMITATIONS

The design presented herein is based on the use of the specified product manufactured under license from RCP Blocks & Bricks and for specific soil conditions. It is the responsibility of the user of this manual to verify the actual site soil conditions, and to construct the wall in accordance with standard construction procedures and manufacturer's recommendations. A qualified geotechnical engineer may be retained to determine the soil type and any other geotechnical condition which may affect the design and stability of the wall and surrounding area, and to provide inspection and testing services during wall construction. The geotechnical engineer or his appointed representative shall observe and verify the installation of segmental blocks, geosynthetic reinforcement, and compaction of fill soils. All fill soils should be compacted to at least 90% of the maximum dry density determined using Modified Proctor Compaction Test per ASTM D1557 Test Standards.

The design of the retaining wall assumes no build-up of hydrostatic pressures within the reinforced fill zone of the wall. Therefore, construction of an effective subdrain system behind the wall is critical to the performance of the wall. Any back-cut drain required shall be determined by the project geotechnical engineer and shall be installed per the direction of the project geotechnical engineer.

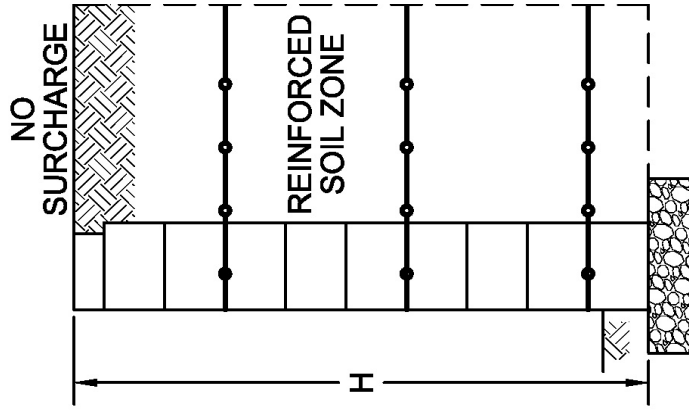
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KEYSTONE STANDARD III STANDARDIZED MANUAL

DESIGN TABLE 1(A)

Case A (I) - Level Backfill, No Surcharge – CBC soil type 4 or better ($\phi=30^\circ$)
 Wall batter: No Batter (minimum set back per unit)



Total Wall Height (H)	Numbers of Miragrid 2XT Layers	Grid Length and Position above the base, between the blocks of the wall face (Grid length is measured from the front face of the unit to the back of the geogrid)		
		Grid 1	Grid 2	Grid 3
2'-4"	-	-	-	-
3'-0"	-	-	-	-
3'-8"	2	(4'-0") 1 st & 2 nd	(5'-0") 3 rd & 4 th	-
4'-4"	2	(4'-0") 2 nd & 3 rd	(5'-0") 4 th & 5 th	-
5'-0"	2	(5'-0") 2 nd & 3 rd	(6'-0") 5 th & 6 th	-
5'-8"	3	(5'-0") 2 nd & 3 rd	(5'-0") 4 th & 5 th	(6'-0") 6 th & 7 th
6'-4"	3	(6'-0") 2 nd & 3 rd	(6'-0") 4 th & 5 th	(6'-0") 7 th & 8 th

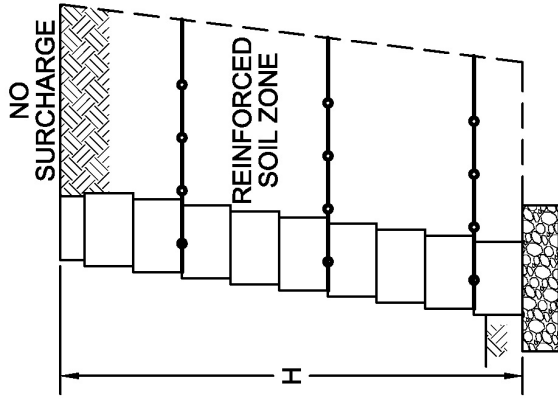
Note: Minimum Embedment Depth = 0'-6"

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KEYSTONE STANDARD III STANDARDIZED MANUAL

DESIGN TABLE 1(B)

Case A (II) – Level Backfill, No Surcharge – CBC soil type 4 or better ($\phi=30^\circ$)
 Wall Batter: 8 Degrees (1" setback per unit)



Total Wall Height (H)	Numbers of Miragrid 2XT Layers	Grid Length and Position above the base, between the blocks of the wall face (Grid length is measured from the front face of the unit to the back of the geogrid)		
		Grid 1	Grid 2	Grid 3
4'-0"	-	-	-	-
5'-0"	2	(5'-0") 2 nd & 3 rd	(5'-0") 5 th & 6 th	-
5'-8"	3	(5'-0") 2 nd & 3 rd	(5'-0") 4 th & 5 th	(5'-0") 6 th & 7 th
6'-4"	3	(6'-0") 2 nd & 3 rd	(6'-0") 4 th & 5 th	(6'-0") 7 th & 8 th

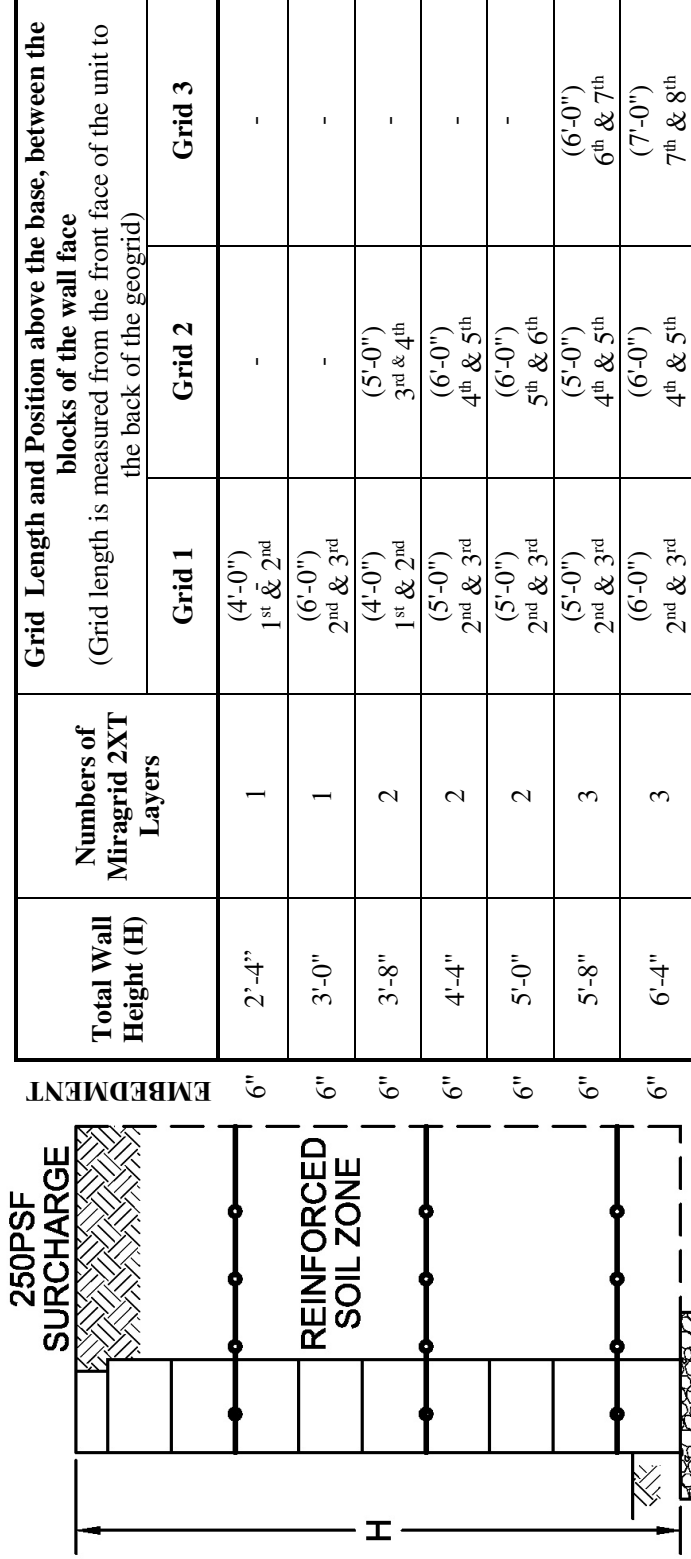
Note: Minimum Embedment Depth = 0'-6"

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DESIGN TABLE 2(A)

Case B (I) – Level Backfill, Uniform Surcharge of 250psf – CBC soil type 4 or better ($\phi=30^\circ$)
 Wall Batter: No Batter (minimum setback per unit)



Total Wall Height (H)	Numbers of Miragrid 2XT Layers	Grid Length and Position above the base, between the blocks of the wall face (Grid length is measured from the front face of the unit to the back of the geogrid)		
		Grid 1	Grid 2	Grid 3
2'-4"	1	(4'-0") 1 st & 2 nd	-	-
3'-0"	1	(6'-0") 2 nd & 3 rd	-	-
3'-8"	2	(4'-0") 1 st & 2 nd	(5'-0") 3 rd & 4 th	-
4'-4"	2	(5'-0") 2 nd & 3 rd	(6'-0") 4 th & 5 th	-
5'-0"	2	(5'-0") 2 nd & 3 rd	(6'-0") 5 th & 6 th	-
5'-8"	3	(5'-0") 2 nd & 3 rd	(5'-0") 4 th & 5 th	(6'-0") 6 th & 7 th
6'-4"	3	(6'-0") 2 nd & 3 rd	(6'-0") 4 th & 5 th	(7'-0") 7 th & 8 th

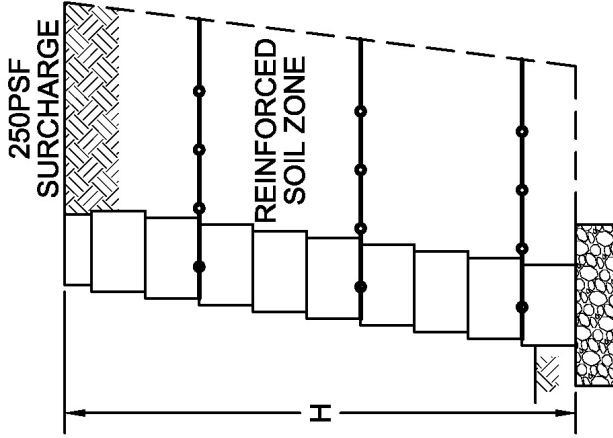
Note: Minimum Embedment Depth = 0'-6"

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DESIGN TABLE 2(B)

Case B (II) – Level Backfill, Uniform Surcharge of 250psf – CBC soil type 4 or better ($\phi=30^\circ$)
 Wall Batter: 8 degree (1" setback per unit)



Total Wall Height (H)	Numbers of Miragrid 2XT Layers	Grid Length and Position above the base, between the blocks of the wall face (Grid length is measured from the front face of the unit to the back of the geogrid)		
		Grid 1	Grid 2	Grid 3
3'-0"	1	(4'-0") 1 st & 2 nd	-	-
3'-8"	2	(4'-0") 1 st & 2 nd	(4'-0") 3 rd & 4 th	-
4'-4"	2	(4'-0") 2 nd & 3 rd	(5'-0") 4 th & 5 th	-
5'-0"	2	(5'-0") 2 nd & 3 rd	(5'-6") 5 th & 6 th	-
5'-8"	3	(5'-0") 2 nd & 3 rd	(5'-0") 4 th & 5 th	(5'-0") 6 th & 7 th
6'-4"	3	(5'-0") 2 nd & 3 rd	(5'-0") 4 th & 5 th	(6'-0") 7 th & 8 th

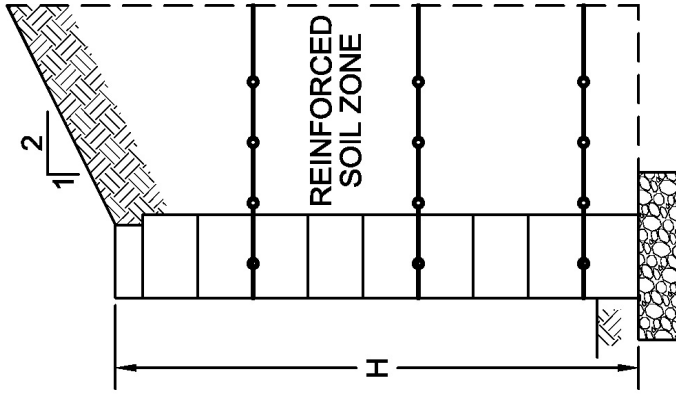
Note: Minimum Embedment Depth = 0'6"

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DESIGN TABLE 3(A)

Case C (I) – 2H: 1V (26.6°) sloped backfill, no surcharge – CBC soil type 4 or better ($\phi = 30^\circ$)
 Wall Batter: No Batter (minimum setback per unit)



Total Wall Height (H)	Numbers of Miragrid 2XT Layers	Grid Length and Position above the base, between the blocks of the wall face (Grid length is measured from the front face of the unit to the back of the geogrid)		
		Grid 1	Grid 2	Grid 3
2'-4"	-	-	-	-
3'-0"	1	(5'-0") 2 nd & 3 rd	-	-
3'-8"	2	(4'-0") 1 st & 2 nd	(5'-0") 3 rd & 4 th	-
4'-4"	2	(4'-0") 2 nd & 3 rd	(5'-0") 4 th & 5 th	-
5'-0"	2	(5'-0") 2 nd & 3 rd	(6'-0") 5 th & 6 th	-
5'-8"	3	(5'-0") 2 nd & 3 rd	(5'-0") 4 th & 5 th	(6'-0") 6 th & 7 th
6'-4"	3	(6'-0") 2 nd & 3 rd	(6'-0") 4 th & 5 th	(6'-0") 7 th & 8 th

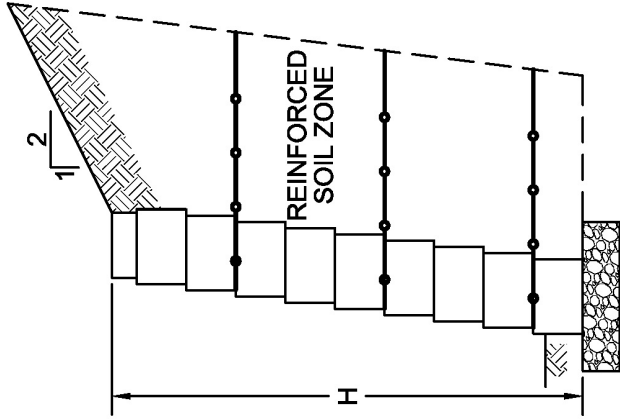
Note: Minimum Embedment Depth = 0'-6"

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DESIGN TABLE 3(B)

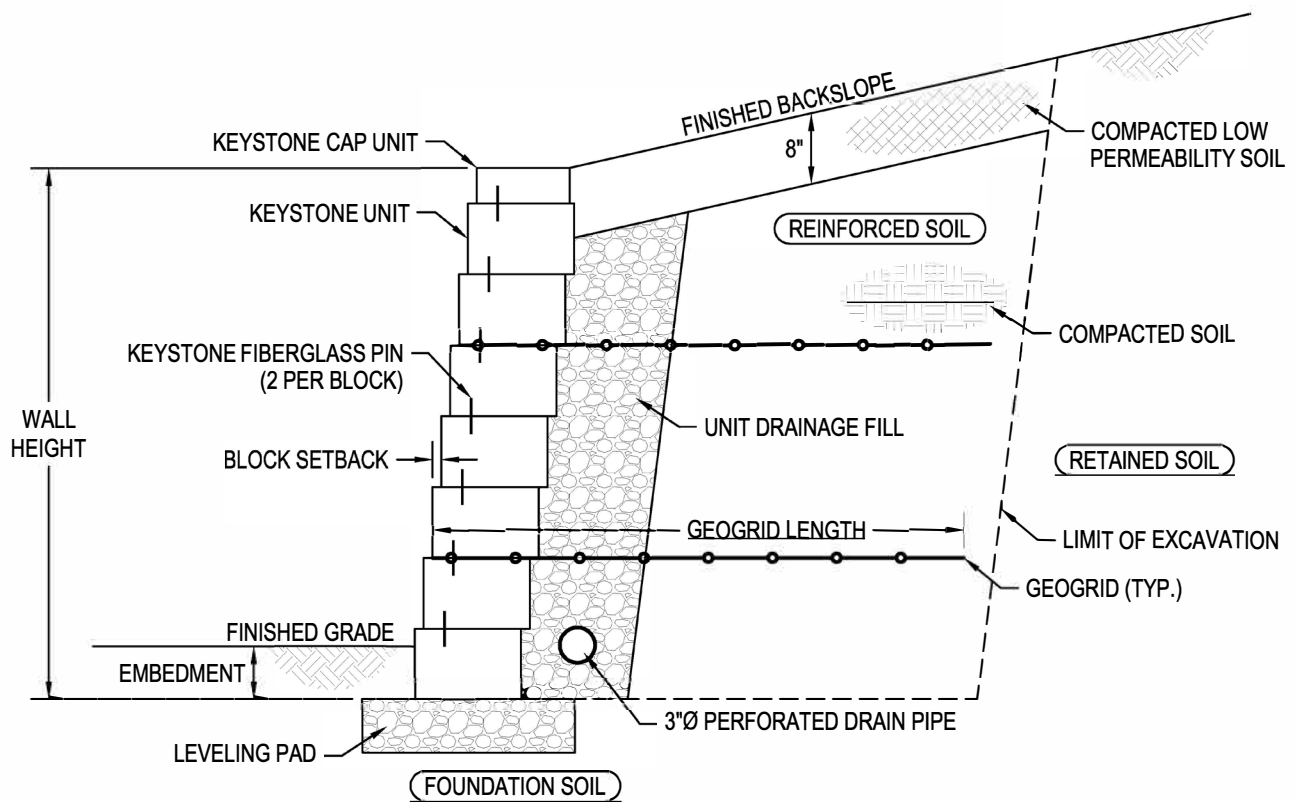
Case C (II) – 2H: 1V (26.6°) sloped backfill, no surcharge – CBC soil type 4 or better ($\phi=30^\circ$)
 Wall Batter: 8 Degree (1" setback per unit)



Total Wall Height (H)	Numbers of Miragrid 2XT Layers	Grid Length and Position above the base, between the blocks of the wall face (Grid length is measured from the front face of the unit to the back of the geogrid)		
		Grid 1	Grid 2	Grid 3
3'-0"	-	-	-	-
3'-8"	2	(4'-0") 1 st & 2 nd	(4'-0") 3 rd & 4 th	-
4'-4"	2	(4'-0") 2 nd & 3 rd	(5'-0") 4 th & 5 th	-
5'-0"	2	(4'-0") 2 nd & 3 rd	(5'-0") 5 th & 6 th	-
5'-8"	3	(5'-0") 2 nd & 3 rd	(5'-0") 4 th & 5 th	(5'-0") 6 th & 7 th
6'-4"	3	(5'-0") 2 nd & 3 rd	(5'-0") 4 th & 5 th	(5'-0") 7 th & 8 th

Note: Minimum Embedment Depth = 0'-6"

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Glossary

KEYSTONE UNIT -	Keystone Standard III pinned units. Fill core with 3/4" clean crushed stone.
KEYSTONE CAP UNIT -	4" high cap unit. Cap units are secured to upper wall units with KapSeal adhesive per manufacturer's recommendations.
BLOCK SETBACK -	Block setback is determined by the multiple pin locations in each unit as required by the wall geometry and design.
EMBEDMENT -	Embedment required is a function of wall height and top slope. General recommendation is minimum embedment of 6" below the grade in front of the wall.
WALL HEIGHT -	Wall height is defined as the total wall height from top of leveling pad to top of wall.
LIMIT OF EXCAVATION -	The limit of excavation is defined as the excavation necessary to install the wall system, leveling pad, drainage fill, drain pipe, and the geogrid reinforcement when required.
LEVELING PAD -	Leveling pad is typically constructed of compacted 3/4" crushed stone or gravel, 6" deep and 6" wider than the wall units front and back. Concrete may also be used.
DRAIN PIPE -	3" perforated pipe placed behind bottom of wall to provide additional drainage. Pipe shall be discharged to drainage swale or storm drainage system.
UNIT DRAINAGE FILL -	Drainage fill is a free draining crushed stone that is placed within units and for a distance of 6" behind the wall units.
REINFORCED SOIL -	Reinforced soil backfill is placed and compacted in 8" thick lifts to a minimum 90% maximum dry density (ASTM D1557) with geogrid levels included at the design locations and lengths.
GEOGRID -	Geogrid is Mirafi Miragrid 2XT polyester reinforcement. Geogrid lengths are measured from the wall face to the end of reinforcement. Geogrid is placed on level compacted backfill and tensioned behind wall prior to backfilling.
FINISHED BACKSLOPE -	Finished backslope shall be low permeable soil to prevent surface runoff into wall backfill.

KEYSTONE SEGMENTAL BLOCK WALL - STANDARD III UNIT GEOGRID REINFORCED WALL TYPICAL SECTION

SOIL TYPE = CBC SOIL TYPE 4 OR BETTER ($\phi=30^\circ$)
SEISMIC DESIGN ACCELERATION = 0.15g

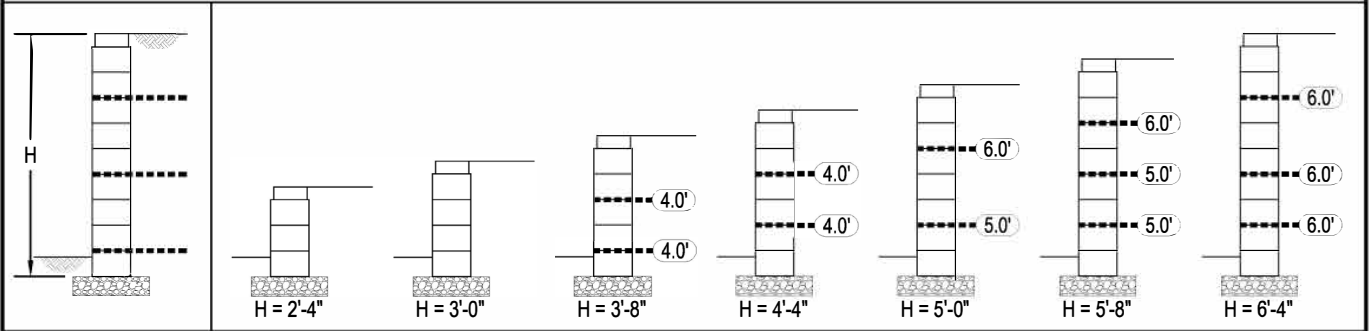


PLATE

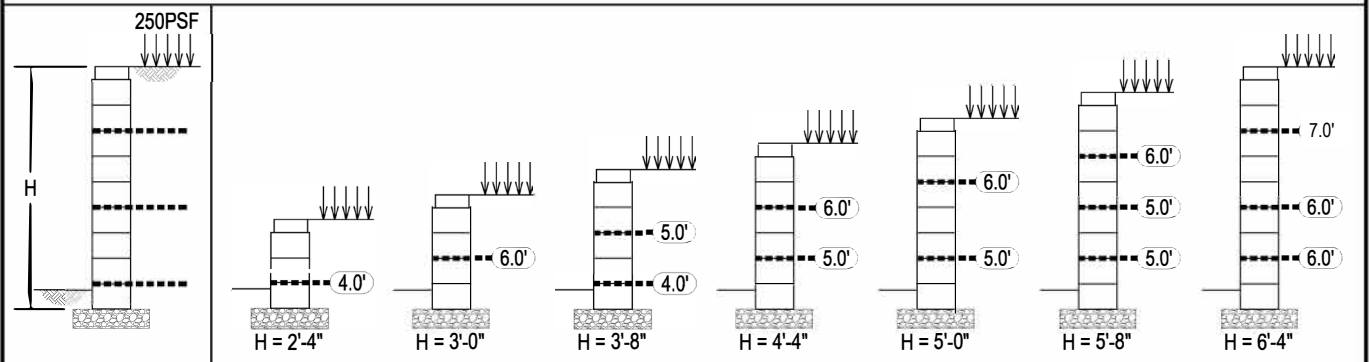
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0" SETBACK WALL-NEAR VERTICAL WALL

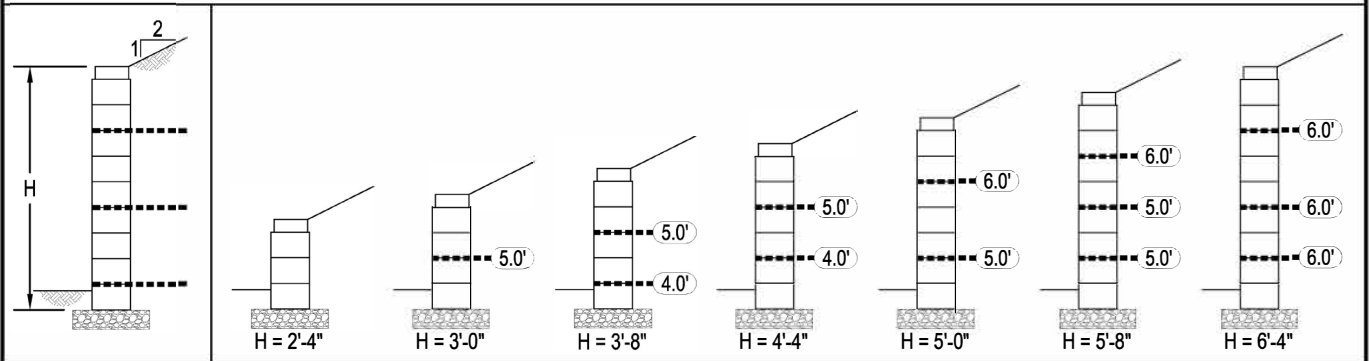
CASE A - LEVEL BACKFILL WITH NO SURCHARGE



CASE B - LEVEL BACKFILL WITH 250PSF SURCHARGE



CASE C - 2H:1V SLOPING BACKFILL



LEGEND

- GEOGRID LOCATION
- (X.0') GEOGRID LENGTH
- H TOTAL WALL HEIGHT

KEYSTONE SEGMENTAL BLOCK WALL - STANDARD III UNIT
GEOGRID REINFORCED WALL DESIGN CHART - 0" BLOCK SETBACK VERTICAL WALL

SOIL TYPE = CBC SOIL TYPE 4 OR BETTER ($\phi=30^\circ$)
 SEISMIC DESIGN ACCELERATION = 0.15g
 GEOGRID = MIRAFI MIRAGRID 2XT

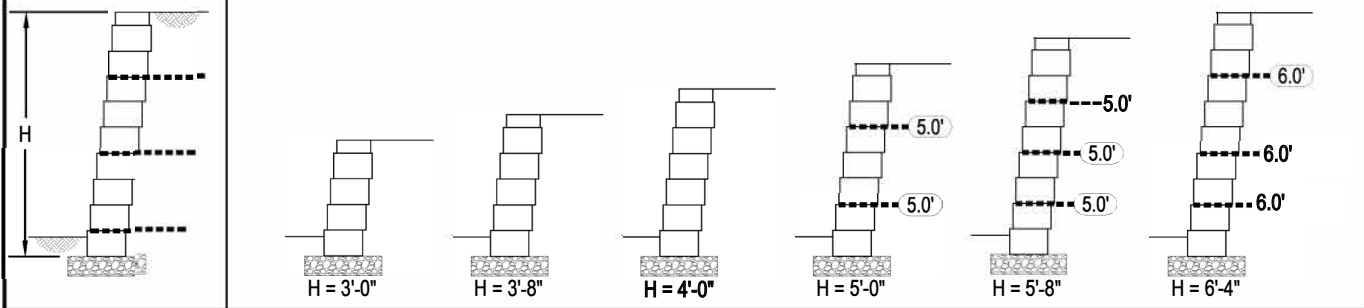


PLATE

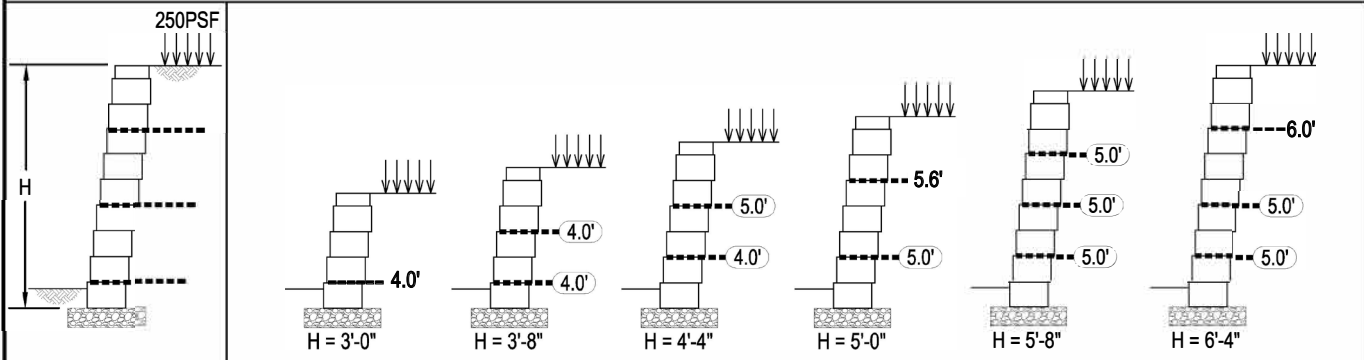
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1" SETBACK WALL-NEAR VERTICAL WALL

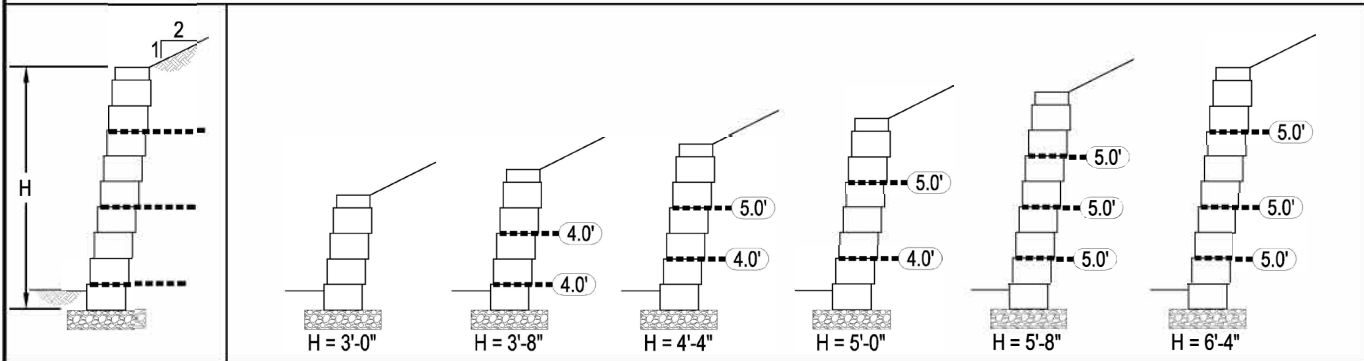
CASE A - LEVEL BACKFILL WITH NO SURCHARGE



CASE B - LEVEL BACKFILL WITH 250PSF SURCHARGE



CASE C - 2H:1V SLOPING BACKFILL

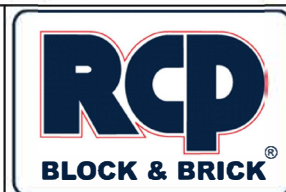


LEGEND

- GEOGRID LOCATION
- (X.0') GEOGRID LENGTH
- H TOTAL WALL HEIGHT

KEYSTONE SEGMENTAL BLOCK WALL - STANDARD III UNIT
GEOGRID REINFORCED WALL DESIGN CHART - 1" BLOCK SETBACK 8° BATTER WALL

SOIL TYPE = CBC SOIL TYPE 4 OR BETTER ($\phi=30^\circ$)
 SEISMIC DESIGN ACCELERATION = 0.15g
 GEOGRID = MIRAFI MIRAGRID 2XT



PLATE

3