

SECTION B

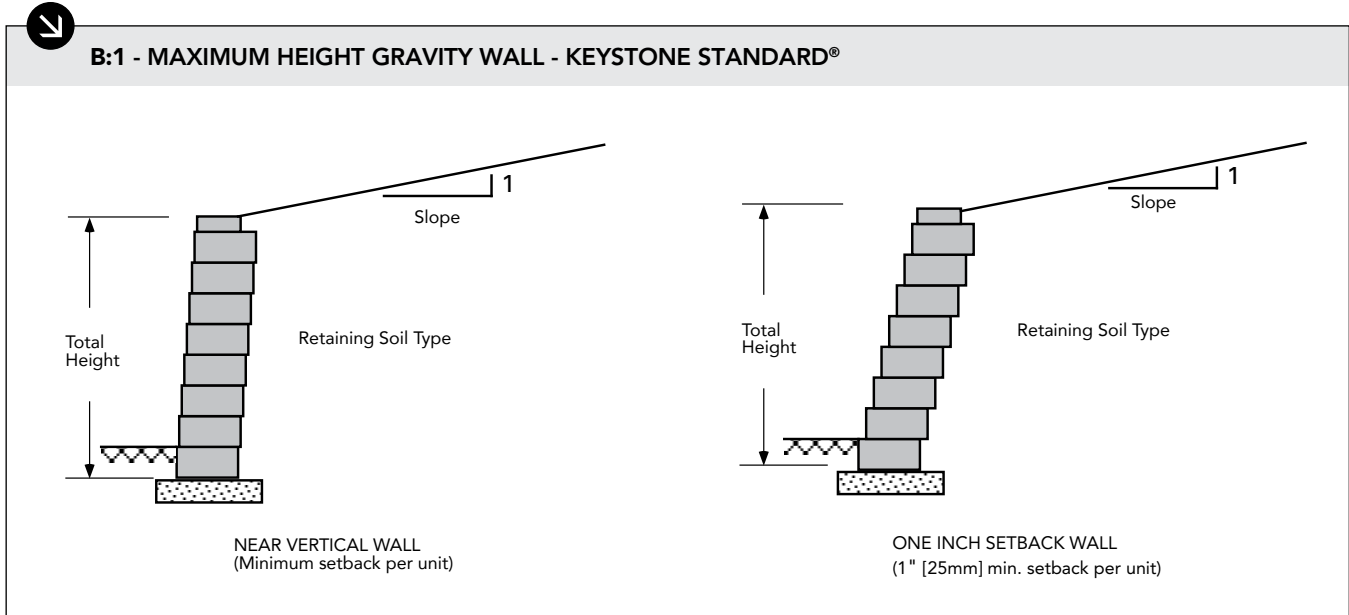
DESIGN/ESTIMATING CHARTS

This section contains Keystone's design/estimating charts for Keystone Standard® and Keystone Compac® gravity walls or geogrid-reinforced walls. The gravity wall charts help determine the maximum possible gravity wall height before geogrid reinforcement is required.

The wall charts consider multiple factors for determining gravity wall stability and the necessary geogrid length. First, determine the wall load condition that most closely resembles the final project conditions. Then select the soil condition that most closely matches the project site soils. Finally, select the wall height (including embedment) that will best fit the project wall profile.

The design/estimating charts in this section are to be used for reference and preliminary design and estimating only. These charts are not to be considered as a standardized engineering document. A qualified professional should be consulted for final design assistance. Keystone accepts no liability for the use of these charts.

Gravity Wall Schematic



Near Vertical Setback - 18" Depth

MAX HEIGHT	BACKSLOPE				
	Soil Type	Level	4H:1V	3H:1V	2H:1V
Sand/Gravel	5.00'	4.33'	3.67'	3.00'	
Silty Sand	4.33'	3.67'	3.00'	2.33'	
Silt/Lean Clay	3.67'	3.00'	2.33'	1.67'	

1 1/8-inch Setback - 18" Depth

MAX HGT.	BACKSLOPE				
	Soil Type	Level	4H:1V	3H:1V	2H:1V
Sand/Gravel	5.67'	5.00'	5.00'	4.33'	
Silty Sand	5.00'	4.33'	3.67'	3.00'	
Silt/Lean Clay	4.33'	3.00'	3.00'	1.67'	

Near Vertical Setback - 21" Depth

MAX HEIGHT	BACKSLOPE				
	Soil Type	Level	4H:1V	3H:1V	2H:1V
Sand/Gravel	5.67'	5.00'	4.33'	3.67'	
Silty Sand	5.00'	4.33'	3.67'	3.00'	
Silt/Lean Clay	4.33'	3.67'	3.00'	1.67'	

1 1/8-inch Setback - 21" Depth

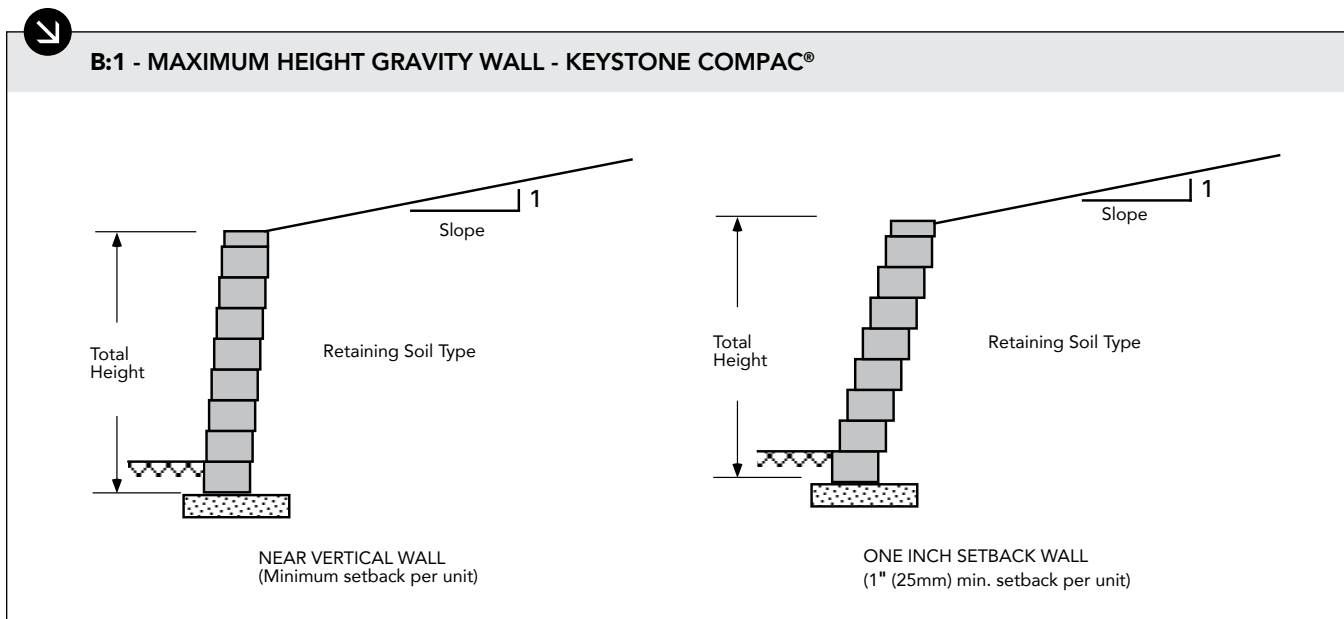
MAX HGT.	BACKSLOPE				
	Soil Type	Level	4H:1V	3H:1V	2H:1V
Sand/Gravel	7.00'	6.33'	5.67'	5.00'	
Silty Sand	5.67'	5.00'	5.00'	4.33'	
Silt/Lean Clay	5.00'	4.33'	3.67'	3.00'	

NOTES:

- Wall height (H) is the total height from top to bottom.
- Minimum wall embedment should be 6-inches or one unit below grade, whichever is greater. (See page 11)
- Subsurface soils must be capable of supporting wall system.
- Unit drainage fill is 3/4-inch clean crushed stone.
- Leveling pad is crushed stone base material.
- All backfill materials are compacted to minimum 95% standard proctor density or 92% modified proctor density.
- Finished grade must provide positive drainage.
- Calculations assume a unit weight of 120 Pcf for all soil types. Assumed angles for earth pressure calculations are: Sand/Gravel=34°, Silty Sand=30° and Sandy Silt/Lean Clay=26°. Walls are non-critical structures with FS>1.5. Gravity wall charts are performed using Coulomb earth pressure analysis. (NCMA 3rd Edition) Walls utilize 8° batter. No surcharges, except slopes, were used in the analysis.
- Surcharges or special loading conditions will reduce maximum wall heights. Sliding calculations assume a 6-inch crushed stone leveling pad as compacted foundation material. The information provided is for preliminary design use only. A qualified professional should be consulted. Keystone accepts no liability for the use of these tables.

The information contained herein has been compiled by Keystone Retaining Wall Systems® LLC and to the best of our knowledge, accurately represents the Keystone product used in the applications which are illustrated. Final determination of the suitability for the use contemplated and its manner of use are the sole responsibility of the user. Design and analysis shall be performed by a qualified engineer.

Gravity Wall Schematic



Near Vertical Setback

MAX HEIGHT	BACKSLOPE				
	Soil Type	Level	4H:1V	3H:1V	2H:1V
Sand/Gravel	3.00'	3.00'	3.00'	2.33'	
Silty Sand	3.00'	2.33'	2.33'	1.67'	
Silt/Lean Clay	2.33'	1.67'	1.67'	<1.00'	

1 1/8-inch Setback Option

MAX HGT.	BACKSLOPE				
	Soil Type	Level	4H:1V	3H:1V	2H:1V
Sand/Gravel	3.67'	3.67'	3.00'	3.00'	
Silty Sand	3.00'	2.33'	2.33'	1.67'	
Silt/Lean Clay	2.33'	2.33'	1.67'	<1.00'	

NOTES:

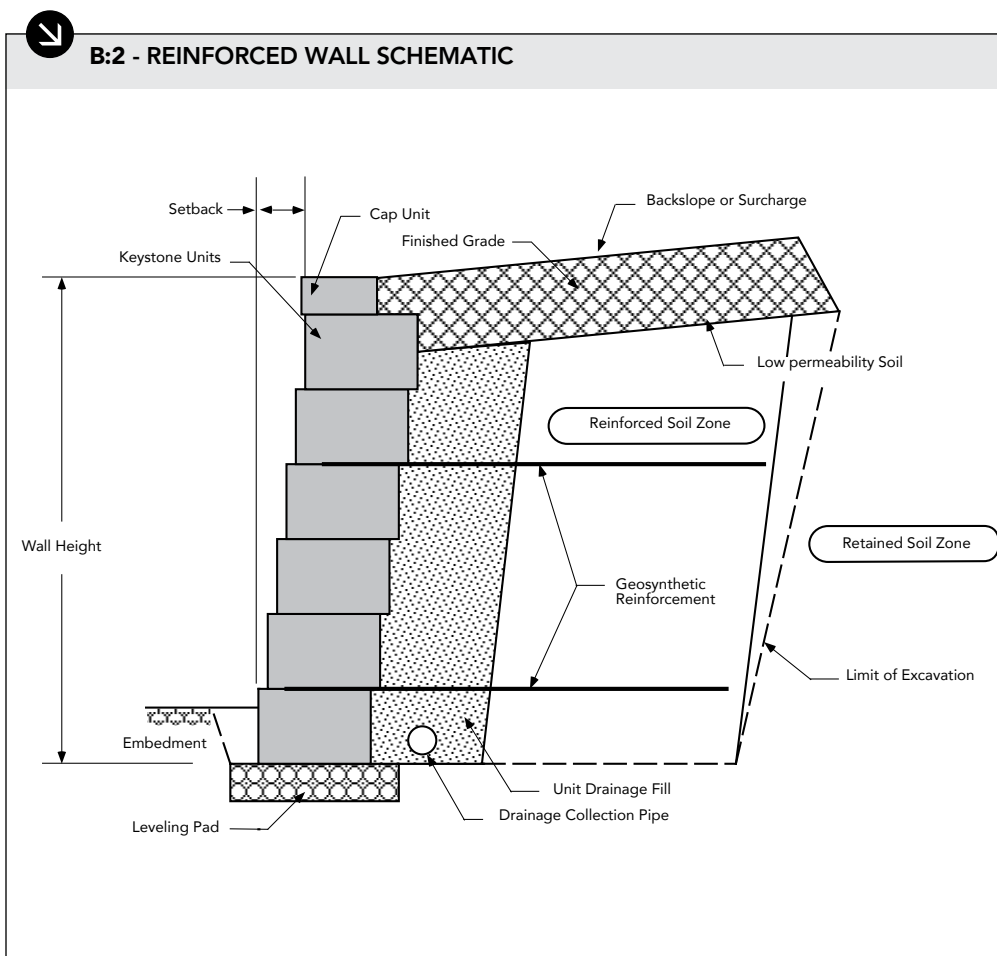
- Wall height (H) is the total height from top to bottom.
- Minimum wall embedment should be 6-inches or one unit below grade, whichever is greater. (See page 11)
- Subsurface soils must be capable of supporting wall system.
- Unit drainage fill is 3/4-inch clean crushed stone.
- Leveling pad is crushed stone base material.
- All backfill materials are compacted to minimum 95% standard proctor density or 92% modified proctor density.
- Finished grade must provide positive drainage.
- Calculations assume a unit weight of 120 Pcf for all soil types. Assumed angles for earth pressure calculations are: Sand/Gravel=34°, Silty Sand=30° and Sandy Silt/Lean Clay=26°. Walls are non-critical structures with FS>1.5. Gravity wall charts are performed using Coulomb earth pressure analysis. (NCMA 3rd Edition) Walls utilize 8° batter. No surcharges, except slopes, were used in the analysis.
- Surcharges or special loading conditions will reduce maximum wall heights. Sliding calculations assume a 6-inch crushed stone leveling pad as compacted foundation material. The information provided is for preliminary design use only. A qualified professional should be consulted. Keystone accepts no liability for the use of these tables.

Design/Estimating Charts: Reinforced Wall Charts

The Keystone reinforced wall charts are graphically presented to show the proper location and lengths of geogrids used with Keystone Standard and Keystone Compac units at near vertical and 1½ inch setback. The chart includes design heights from 4.3 feet tall to 11 feet tall. Engineering judgment should be used when interpolating between heights. In general, geogrid should be placed at the design elevation for the entire wall length or until a wall step is reached. These preliminary design and estimating charts are for individual walls and do not apply to any tiered wall applications.

Minimum reinforcement lengths were set for 4-foot and a 70% reinforcement length-to-wall height ratio. For the Keystone Compac unit, top layers of geogrid shall never be more than 2 units from the top of the wall. Bottom layers of geogrid shall never be more than 2 units from the top of the leveling pad. Soil ranges were selected to approximate good, medium and poor soil conditions to cover the typical design range. Wall height is the total height of the wall from the top of the leveling pad to the top of the wall. The 1½-inch setback charts use Coulomb earth pressure theory, based on NCMA 3rd Edition for calculations. The near vertical charts use Rankine earth pressure theory for calculations. The following charts assume the use of a coated polyester geogrid with a minimum allowable design strength of: LTDS=1,800 plf, Tal=1,200 plf. The following geogrid types are suitable with these design charts: (1) Miragrid 3XT by TC Mirafi, (2) Stratagrid 200 by Strata Systems and (3) Synteen SF35 by Synteen. 250 psf surcharge is applied 6-inches behind the tail of the units.

All geogrid lengths shown are the actual lengths of geogrid required as measured from the front wall face to the end of the geogrid. The charts assume that the walls are constructed in accordance with Keystone specifications and good construction practice. All soil zones (reinforced, retained, and foundation) must be compacted in 8-inch lifts to minimum 95% standard proctor density or 92% modified proctor density as determined by laboratory testing. The information contained in the design/estimating charts are for preliminary design and estimating use only. A qualified professional should be consulted for final design assistance. Keystone accepts no liability for the use of these



NOTES:

- Wall height (H) is the total height from top to bottom.
- Minimum wall embedment is 6-inches (see page 11).
- Subsurface soils must be capable of supporting the wall system.
- Unit drainage fill is ¾-inch (19mm) clean crushed stone.
- Leveling pad is crushed stone base material.
- All backfill materials are compacted to 95% standard proctor density or 92% modified proctor density.
- Geogrids must be of appropriate type and length per the design.
- Finished grade must provide positive drainage.
- The symbol $\ominus 5'$ indicates location and length of geogrid measured from the front of the wall to the end of the geogrid.

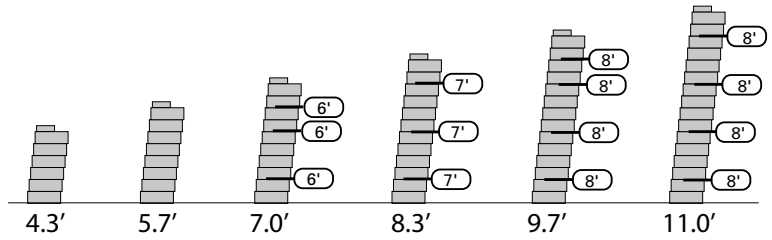
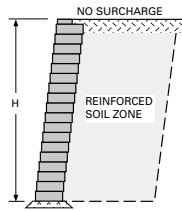
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Design/Estimating Charts: Reinforced Wall Charts

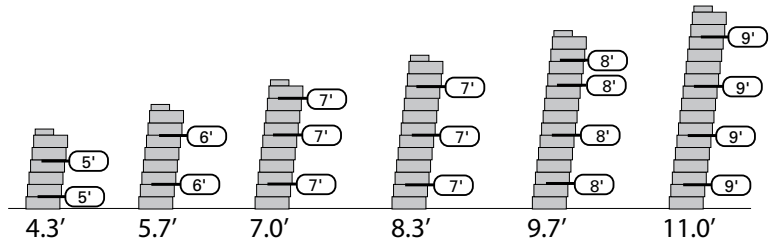
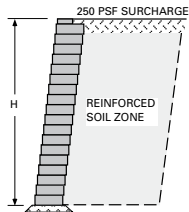
KEYSTONE STANDARD UNITS - 1 1/8 - INCH SETBACK

SAND/GRAVEL: $\phi=34^\circ$, $\gamma=120$ pcf

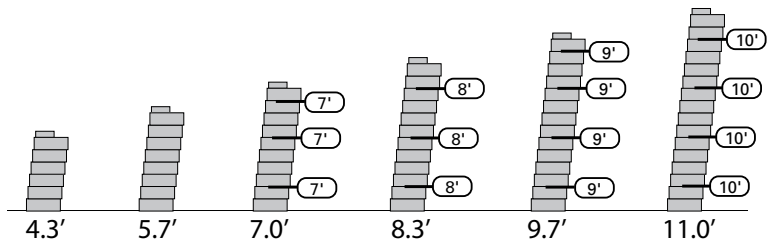
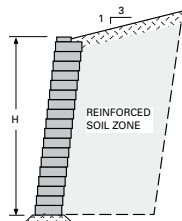
CASE 1:
Level - No Surcharge



CASE 2:
Level - 250 psf Surcharge



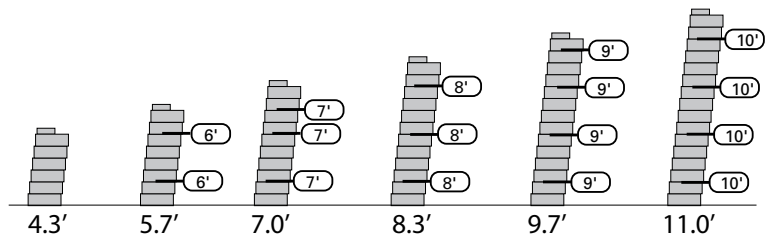
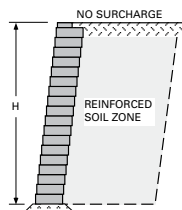
CASE 3:
3H:1V Backslope



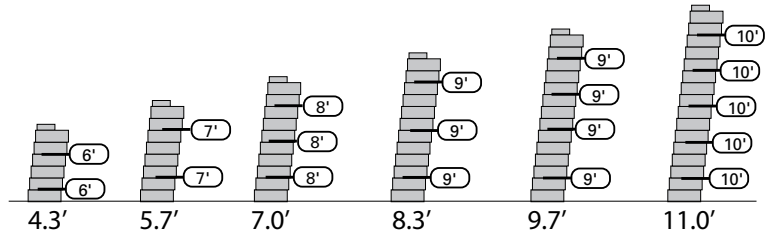
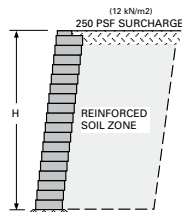
KEYSTONE STANDARD UNITS - 1 1/8 - INCH SETBACK

SILTY SAND: $\phi=30^\circ$, $\gamma=120$ pcf

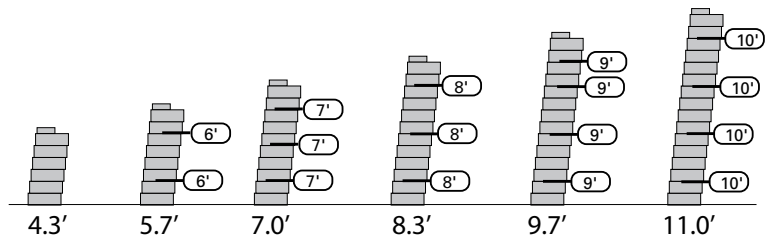
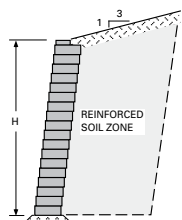
CASE 1:
Level - No Surcharge



CASE 2:
Level - 250 psf Surcharge



CASE 3:
3H:1V Backslope



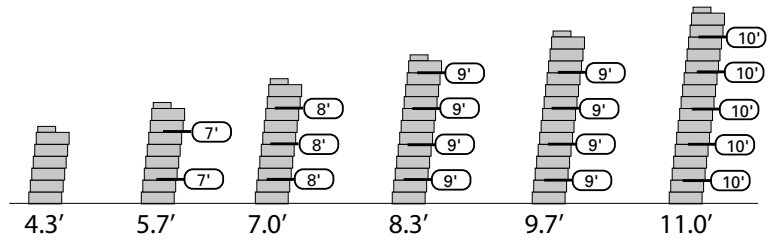
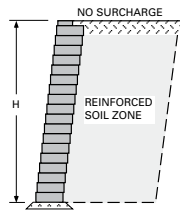
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Design/Estimating Charts: Reinforced Wall Charts

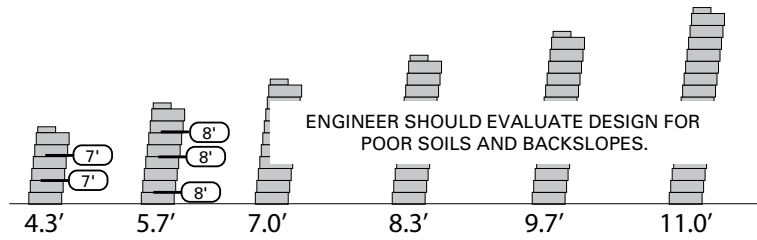
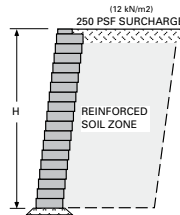
KEYSTONE STANDARD UNITS - 1 1/8" - INCH SETBACK

SILT/LEAN CLAY: $\phi=26^\circ, \gamma=120$ pcf

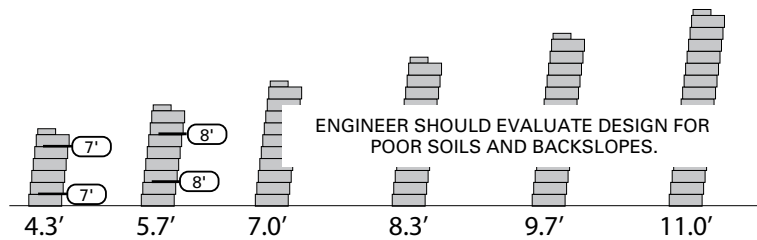
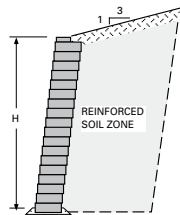
CASE 1:
Level - No Surcharge



CASE 2:
Level - 250 psf Surcharge



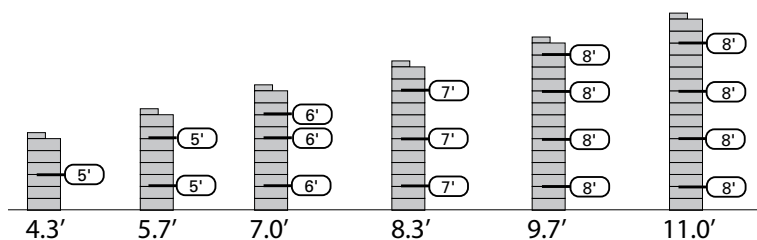
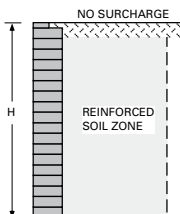
CASE 3:
3H:1V Backslope



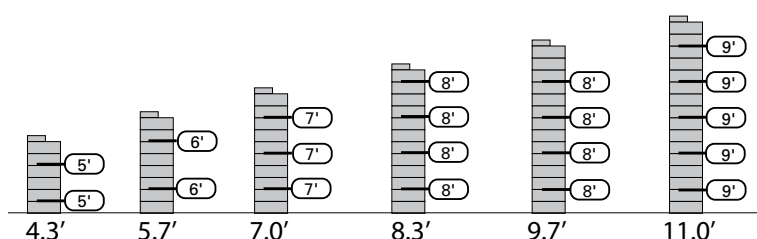
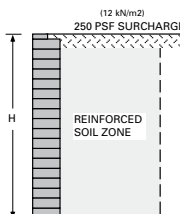
KEYSTONE STANDARD UNITS - NEAR VERTICAL

SAND/GRAVEL: $\phi=34^\circ, \gamma=120$ pcf

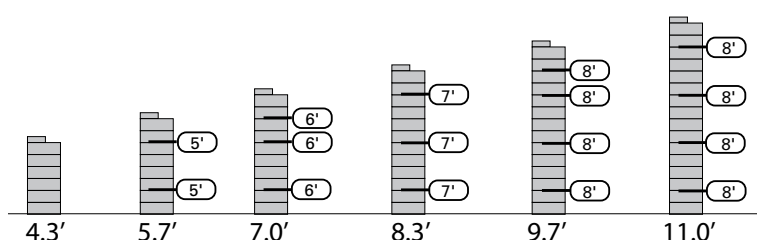
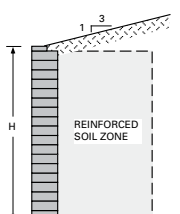
CASE 1:
Level - No Surcharge



CASE 2:
Level - 250 psf Surcharge



CASE 3:
3H:1V Backslope



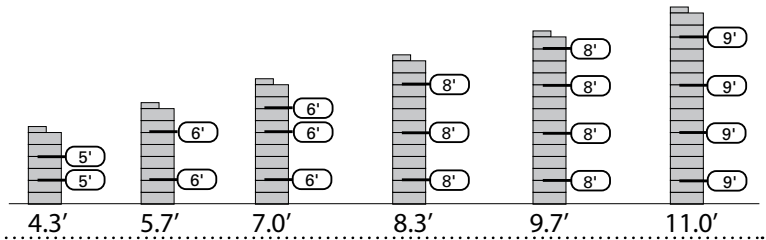
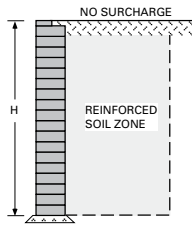
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Design/Estimating Charts: Reinforced Wall Charts

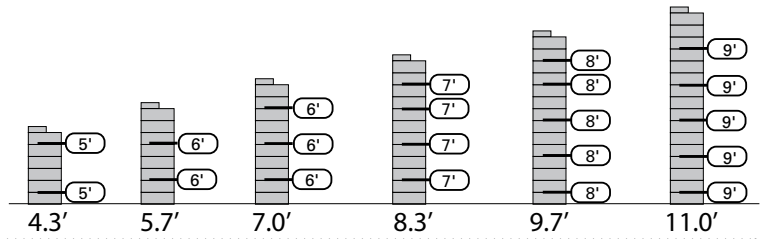
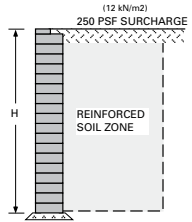
KEYSTONE STANDARD UNITS - NEAR VERTICAL

SILTY SAND: $\phi=30^\circ$, $\gamma=120$ pcf

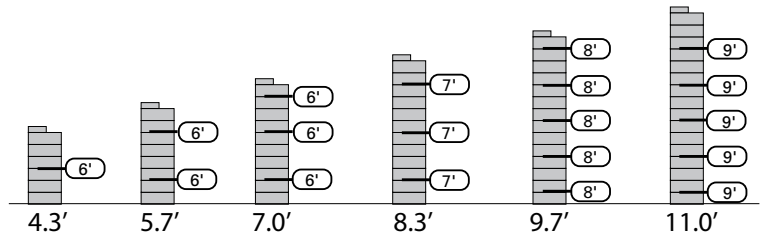
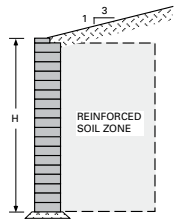
CASE 1:
Level - No Surcharge



CASE 2:
Level - 250 psf Surcharge



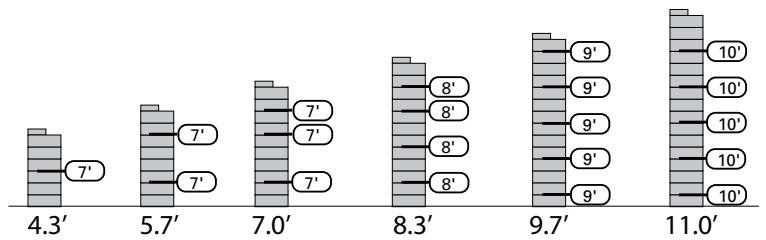
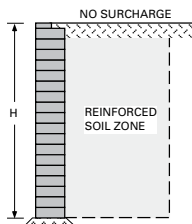
CASE 3:
3H:1V Backslope



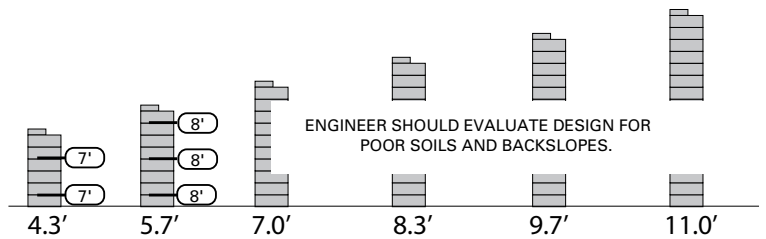
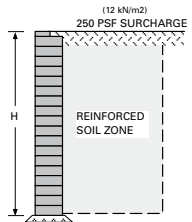
KEYSTONE STANDARD UNITS - NEAR VERTICAL

SILT/LEAN CLAY: $\phi=26^\circ$, $\gamma=120$ pcf

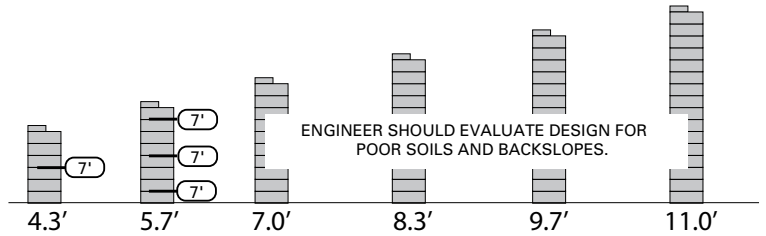
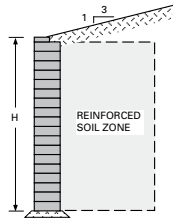
CASE 1:
Level - No Surcharge



CASE 2:
Level - 250 psf Surcharge



CASE 3:
3H:1V Backslope



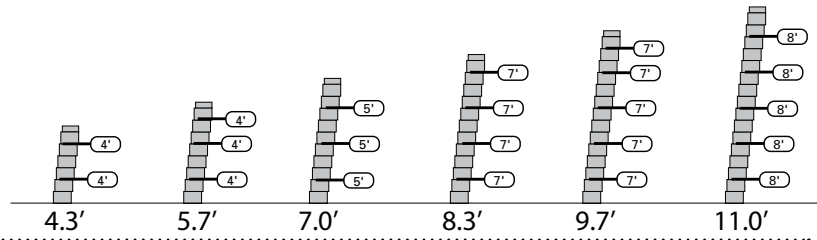
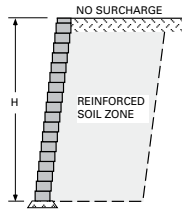
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Design/Estimating Charts: Reinforced Wall Charts

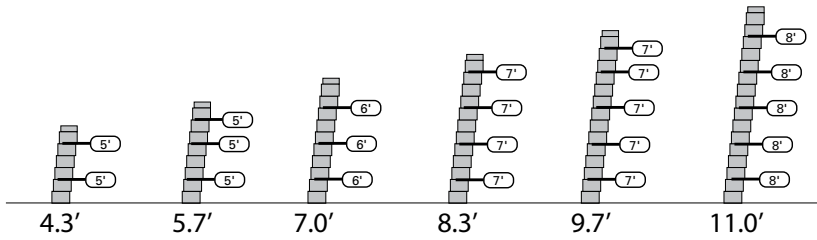
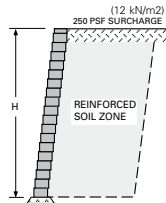
KEYSTONE COMPAC UNITS - 1 1/8 - INCH SETBACK

SAND/GRAVEL: $\phi=34^\circ$, $\gamma=120$ pcf

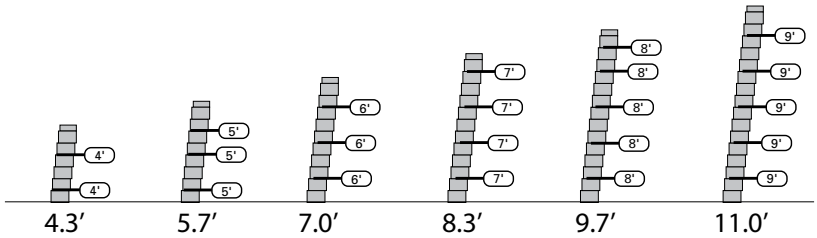
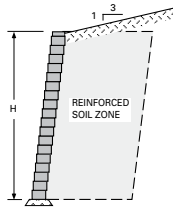
CASE 1:
Level - No Surcharge



CASE 2:
Level - 250 psf Surcharge



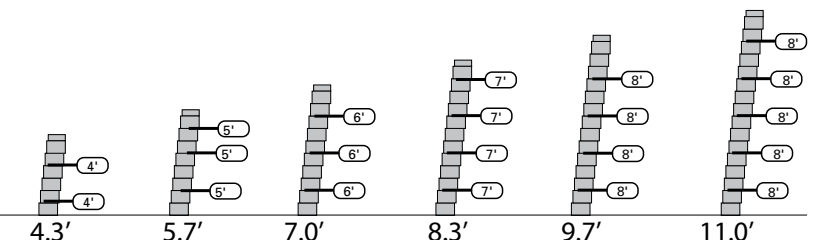
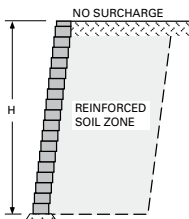
CASE 3:
3H:1V Backslope



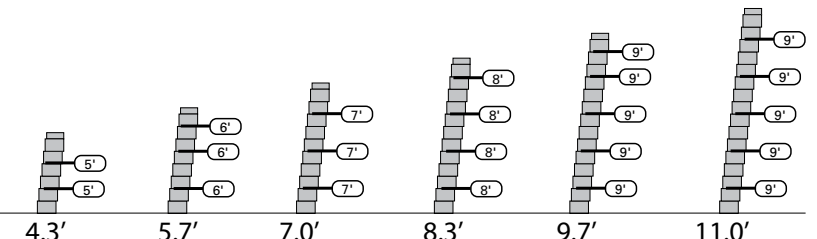
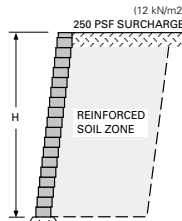
KEYSTONE COMPAC UNITS - 1 1/8 - INCH SETBACK

SILTY SAND: $\phi=30^\circ$, $\gamma=120$ pcf

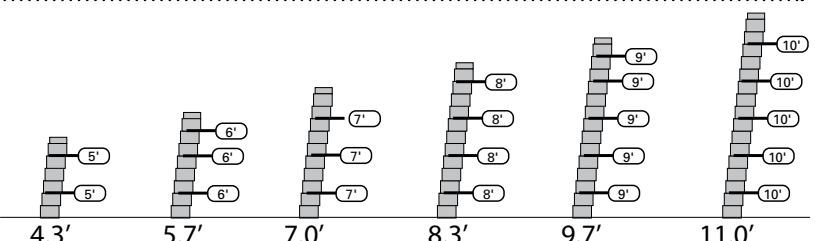
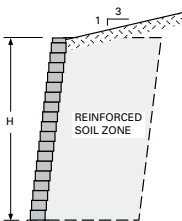
CASE 1:
Level - No Surcharge



CASE 2:
Level - 250 psf Surcharge



CASE 3:
3H:1V Backslope



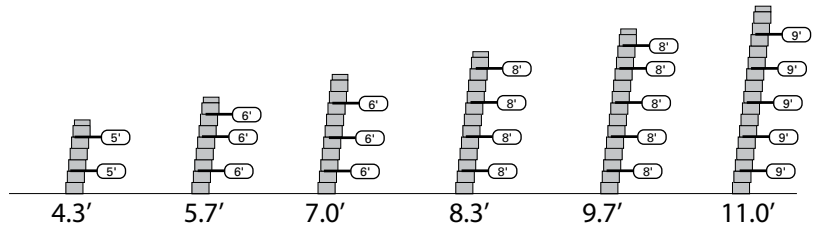
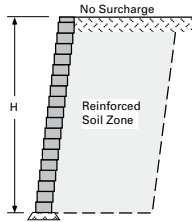
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Design/Estimating Charts: Reinforced Wall Charts

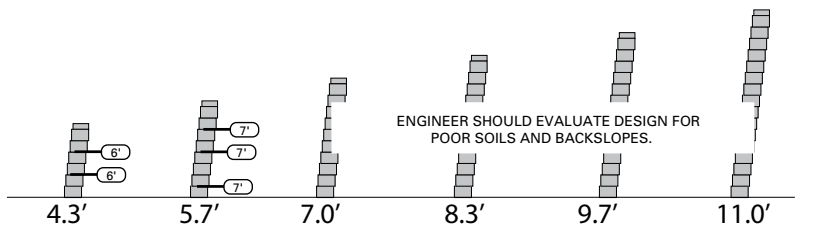
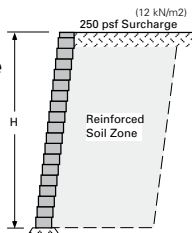
KEYSTONE COMPAC UNITS - 1 1/8" - INCH SETBACK

SILT/LEAN CLAY: $\phi=26^\circ, \gamma=120$ pcf

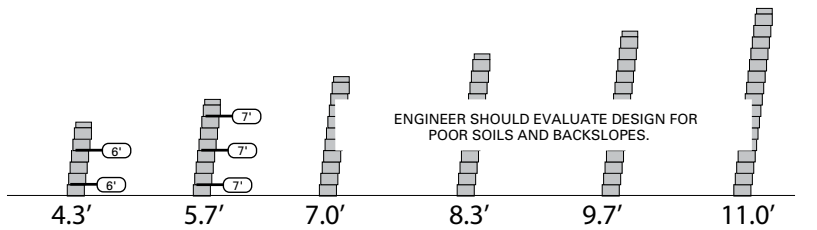
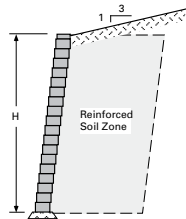
CASE 1:
Level - No Surcharge



CASE 2:
Level - 250 psf Surcharge



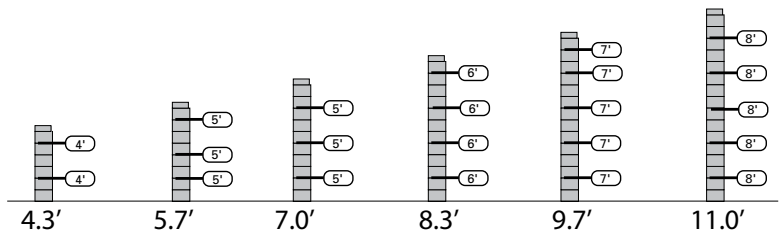
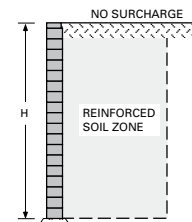
CASE 3:
3H:1V Backslope



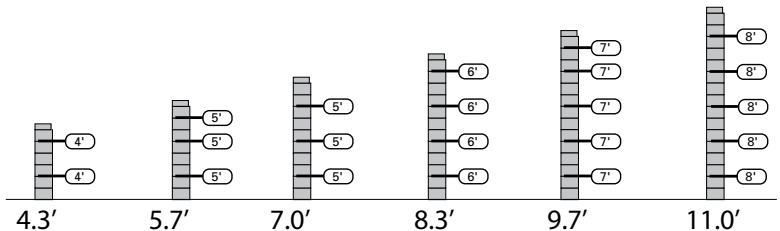
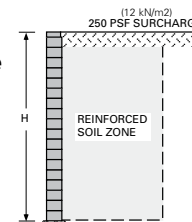
KEYSTONE COMPAC UNITS - NEAR VERTICAL

SAND/GRAVEL: $\phi=34^\circ, \gamma=120$ pcf

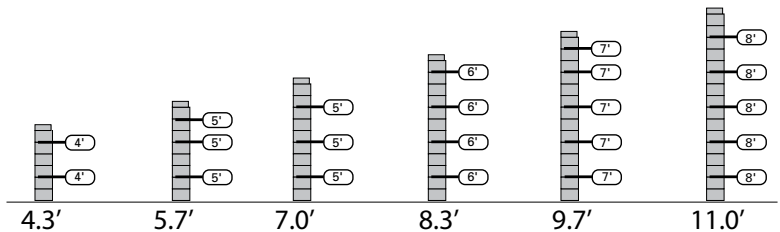
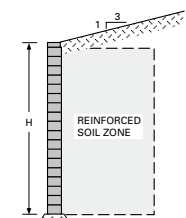
CASE 1:
Level - No Surcharge



CASE 2:
Level - 250 psf Surcharge



CASE 3:
3H:1V Backslope



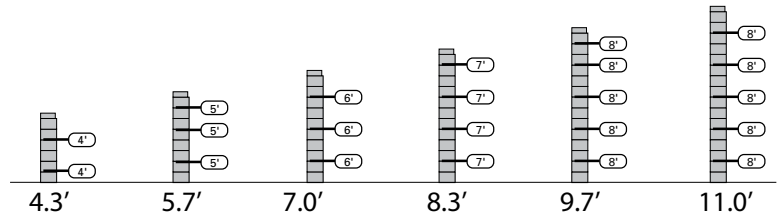
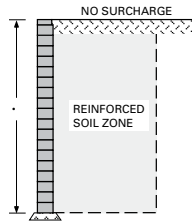
The information contained herein has been compiled by Keystone Retaining Wall Systems® LLC and to the best of our knowledge, accurately represents the Keystone product used in the applications which are illustrated. Final determination of the suitability for the use contemplated and its manner of use are the sole responsibility of the user. Design and analysis shall be performed by a qualified engineer.

Design/Estimating Charts: Reinforced Wall Charts

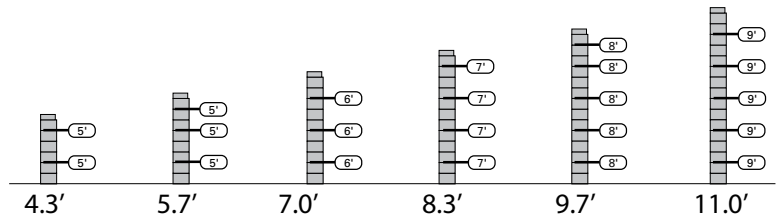
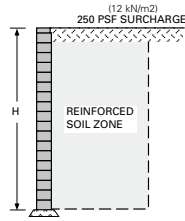
KEYSTONE COMPAC UNITS - NEAR VERTICAL

SILTY SAND: $\phi=30^\circ$, $\gamma=120$ pcf

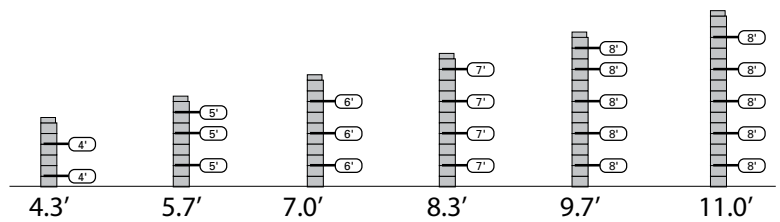
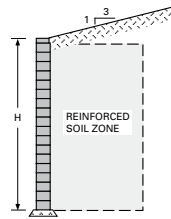
CASE 1:
Level - No Surcharge



CASE 2:
Level - 250 psf Surcharge



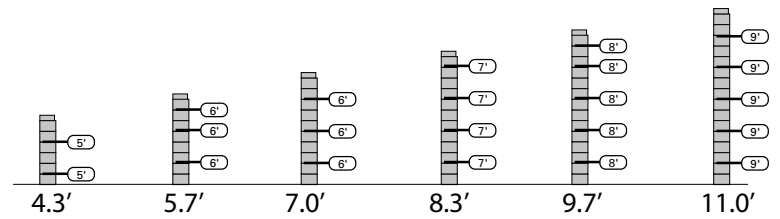
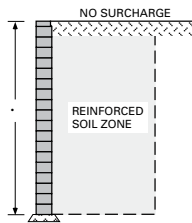
CASE 3:
3H:1V Backslope



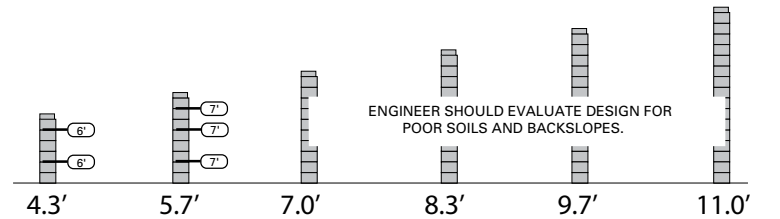
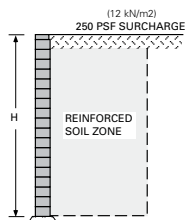
KEYSTONE COMPAC UNITS - NEAR VERTICAL

SILT/LEAN CLAY: $\phi=26^\circ$, $\gamma=120$ pcf

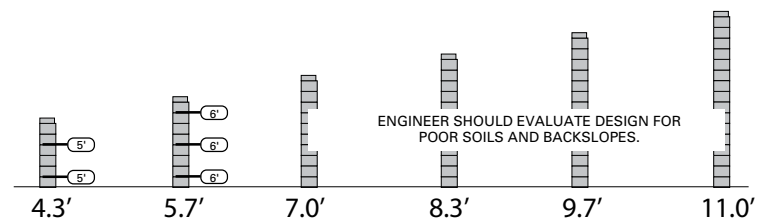
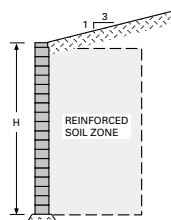
CASE 1:
Level - No Surcharge



CASE 2:
Level - 250 psf Surcharge



CASE 3:
3H:1V Backslope



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