

SECTION B

DESIGN / ESTIMATING CHARTS

This section contains Keystone's design/estimating charts for Keystone Compac and Keystone Standard unit series gravity walls or geogrid reinforced walls.

The gravity wall charts help determine the maximum possible gravity wall height for a Keystone Compac or Keystone Standard unit. First, select which unit will be used for the wall. Second, determine which soil type most closely represents the soil conditions on the project site. Finally, select the backslope condition that most closely represents the final constructed wall condition.

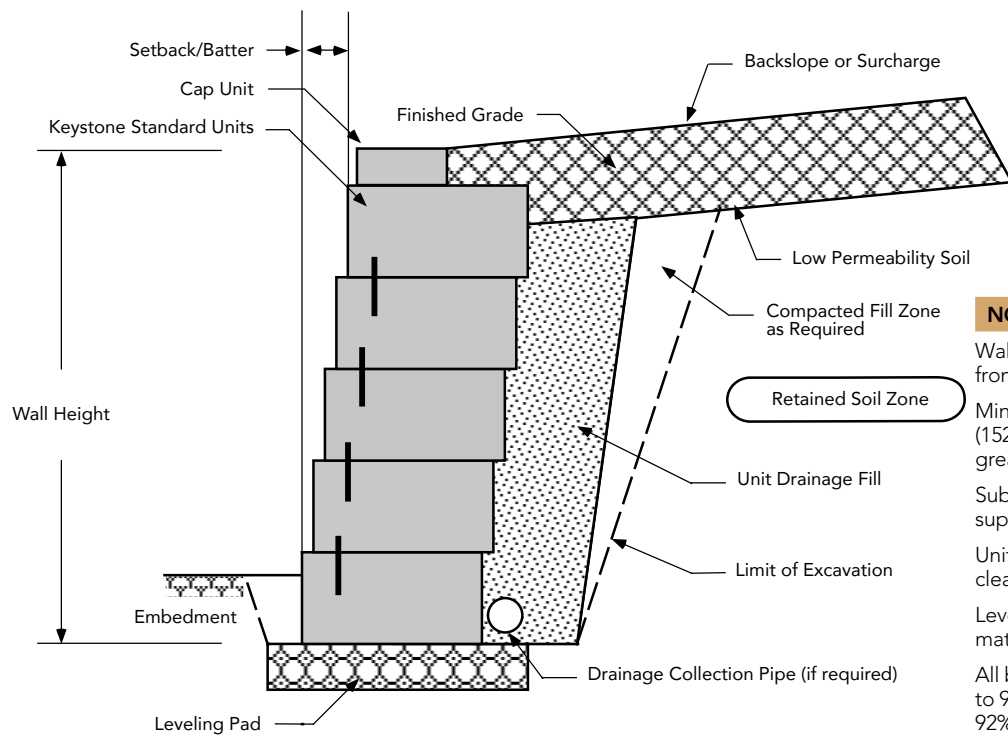
The reinforced wall charts consider multiple factors for determining the necessary geogrid length. First, select the appropriate unit type and wall batter. Next, determine the wall load condition that most closely resembles the final project conditions. Then select the soil condition that most closely 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 use 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



GRAVITY WALL SCHEMATIC

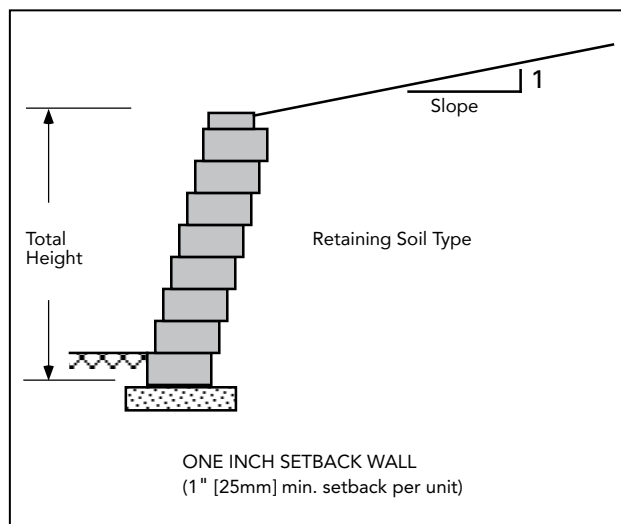
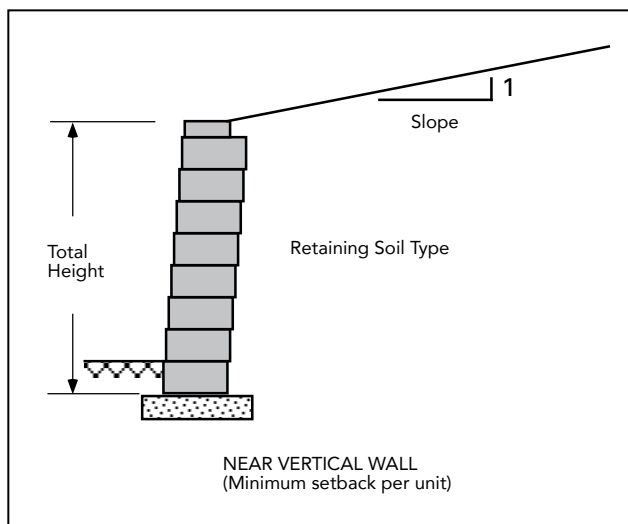


NOTES:

- Wall Height (H) is the total height from top to bottom.
- Minimum wall embedment is 6 inches (152mm) or Height/8, whichever is greater for level toe.
- Subsurface soils must be capable of supporting 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.
- Finished grade must provide positive drainage.

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Maximum Height Gravity Wall Charts



NEAR VERTICAL - KEystone STANDARD UNITS-18" (457mm)

MAX. HGT.	BACKSLOPE			
	Level	4H:1V	3H:1V	2H:1V
Soil Type				
Sand/Gravel	4.33' (1.3m)	3.67' (1.1m)	3.67' (1.1m)	3.00' (0.9m)
Silty Sand	3.67' (1.1m)	3.00' (0.9m)	3.00' (0.9m)	3.00' (0.9m)
Silt/Lean Clay	3.67' (1.1m)	3.00' (0.9m)	3.00' (0.9m)	<1.00' (0.3m)

SETBACK OPTION - KEystone STANDARD UNITS-18" (457mm)

MAX. HGT.	BACKSLOPE			
	Level	4H:1V	3H:1V	2H:1V
Soil Type				
Sand/Gravel	5.67' (1.7m)	5.00' (1.5m)	5.00' (1.5m)	4.33' (1.3m)
Silty Sand	5.00' (1.5m)	4.33' (1.3m)	4.33' (1.3m)	3.67' (1.1m)
Silt/Lean Clay	4.33' (1.3m)	3.67' (1.1m)	3.00' (0.9m)	2.33' (0.7m)

NEAR VERTICAL - KEystone STANDARD UNITS-21" (533mm)

MAX. HGT.	BACKSLOPE			
	Level	4H:1V	3H:1V	2H:1V
Soil Type				
Sand/Gravel	5.00' (1.5m)	4.33' (1.3m)	4.33' (1.3m)	3.67' (1.1m)
Silty Sand	4.33' (1.3m)	3.67' (1.1m)	3.67' (1.1m)	3.00' (0.9m)
Silt/Lean Clay	3.67' (1.1m)	3.67' (1.1m)	3.00' (0.9m)	2.33' (0.7m)

SETBACK OPTION - KEystone STANDARD UNITS-21" (533mm)

MAX. HGT.	BACKSLOPE			
	Level	4H:1V	3H:1V	2H:1V
Soil Type				
Sand/Gravel	7.00' (2.1m)	6.33' (1.9m)	5.67' (1.7m)	5.00' (1.5m)
Silty Sand	5.67' (1.7m)	5.00' (1.5m)	5.00' (1.5m)	4.33' (1.3m)
Silt/Lean Clay	5.00' (1.5m)	4.33' (1.3m)	3.67' (1.1m)	3.00' (0.9m)

NOTES:

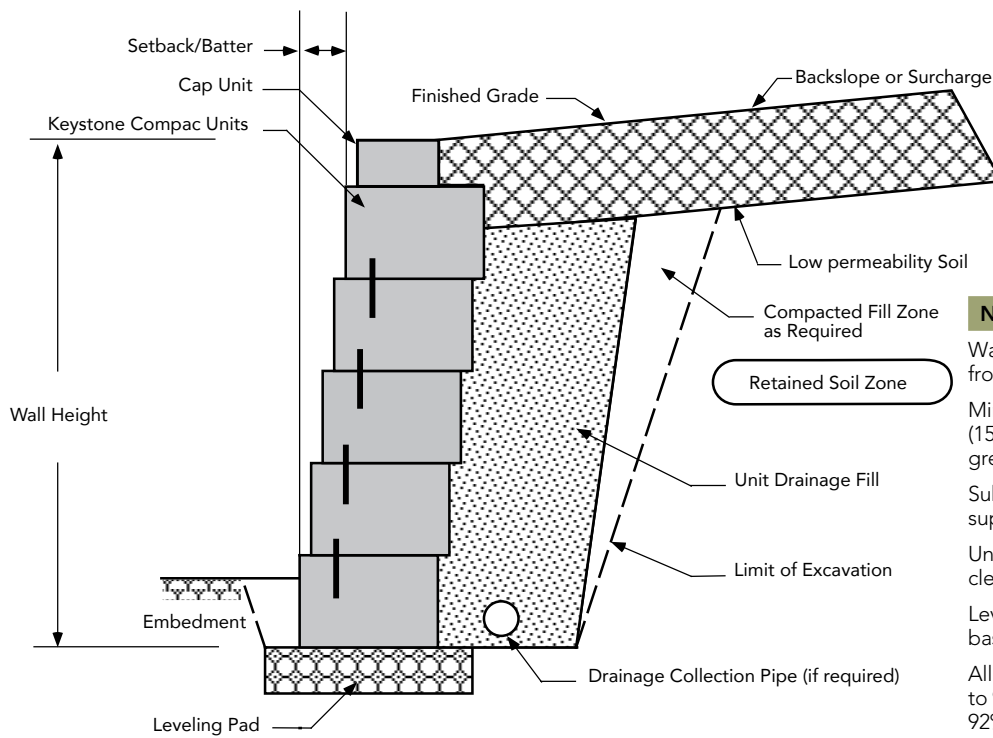
Calculations assume a unit weight of 120 Pcf (19kN/M²) for all soil types. Assumed ϕ angles for earth pressure calculations are: Sand/Gravel=34°, Silty Sand=30°, and Sandy Silt/Lean Clay=26°. Non-critical structures with FS>1.5. Gravity wall charts are performed using coulomb earth pressure analysis. (NCMA 3rd Edition) Near vertical walls utilize 1° batter and 1" (25mm) setback walls utilize 8° batter. No surcharges were used in the analysis. Surcharges or special loading conditions will reduce maximum wall heights. Sliding calculations assume a 6" (152mm) 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.

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Gravity Wall Schematic



GRAVITY WALL SCHEMATIC



NOTES:

Wall Height (H) is the total height from top to bottom.

Minimum wall embedment is 6 inches (150mm) or Height/8, whichever is greater for level toe.

Subsurface soils must be capable of supporting wall system.

Unit drainage fill is ¾ inch (20mm) clean crushed stone.

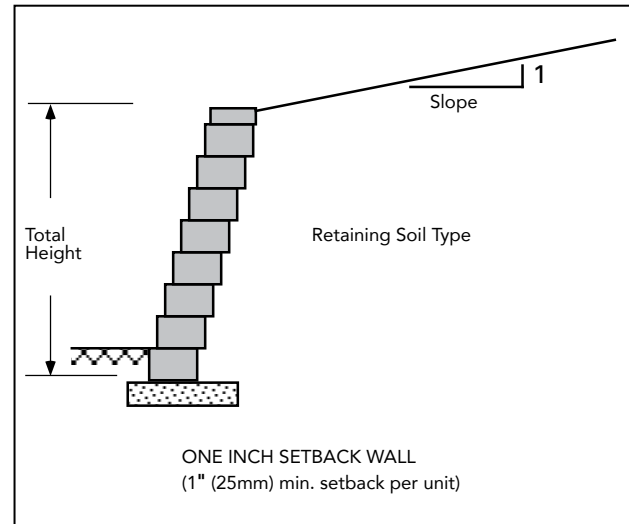
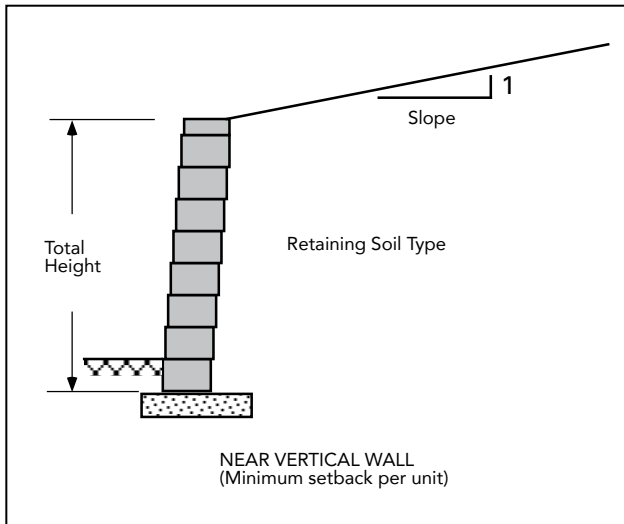
Leveling pad is crushed stone base material.

All backfill materials are compacted to 95% Standard Proctor Density or 92% Modified Proctor Density.

Finished grade must provide positive drainage.

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Maximum Height Gravity Wall Charts



NEAR VERTICAL - KEystone COMPAC UNITS

MAX. HGT.	BACKSLOPE				
	Soil Type	Level	4H:1V	3H:1V	2H:1V
Sand/Gravel	3.00' (0.9m)	2.33' (0.7m)	2.33' (0.7m)	2.33' (0.7m)	2.33' (0.7m)
Silty Sand	2.33' (0.7m)	2.33' (0.7m)	1.67' (0.5m)	1.67' (0.5m)	1.67' (0.5m)
Silt/Lean Clay	2.33' (0.7m)	1.67' (0.5m)	1.67' (0.5m)	<1.00' (0.3m)	<1.00' (0.3m)

SETBACK OPTION - KEystone COMPAC UNITS

MAX. HGT.	BACKSLOPE				
	Soil Type	Level	4H:1V	3H:1V	2H:1V
Sand/Gravel	3.67' (1.1m)	3.67' (1.1m)	3.00' (0.9m)	3.00' (0.9m)	3.00' (0.9m)
Silty Sand	3.00' (0.9m)	3.00' (0.9m)	3.00' (0.9m)	2.33' (0.7m)	2.33' (0.7m)
Silt/Lean Clay	3.00' (0.9m)	2.33' (0.7m)	2.33' (0.7m)	<1.00' (0.30m)	<1.00' (0.30m)

NOTES:

Calculations assume a unit weight of 120 Pcf (19kN/M²) for all soil types. Assumed ϕ angles for earth pressure calculations are: Sand/Gravel=34°, Silty Sand=30°, and Sandy Silt/Lean Clay=26°. Non-critical structures with FS>1.5. Gravity wall charts are performed using coulomb earth pressure analysis (NCMA 3rd Edition). Near vertical walls utilize 1° batter and 1" (25mm) setback walls utilize 8° batter. No surcharges were used in the analysis. Surcharges or special loading conditions will reduce maximum wall heights. Sliding calculations assume a 6" (152mm) 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 Notes

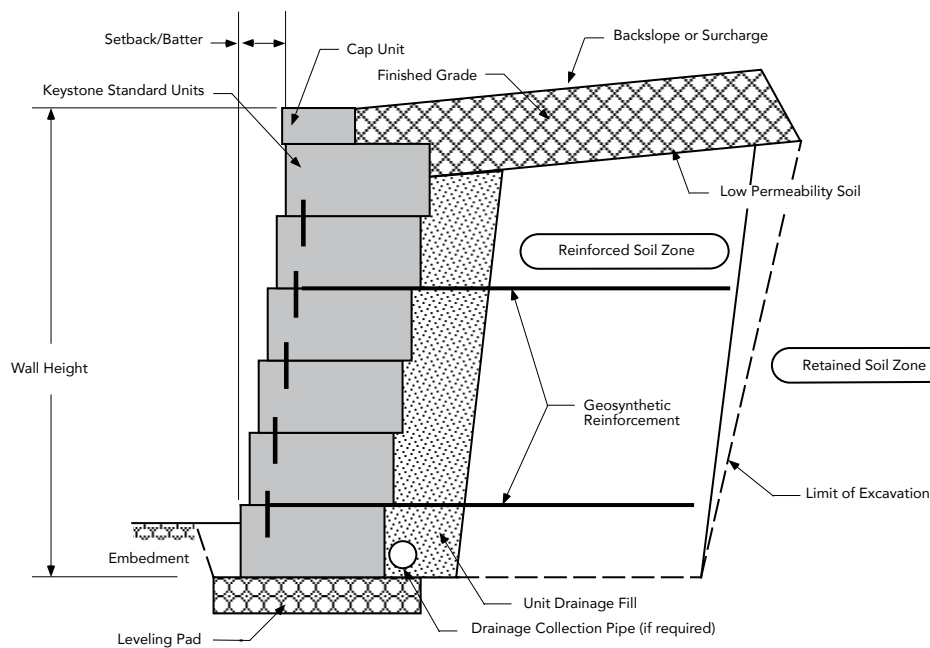
The Keystone reinforced wall charts are graphically presented to show the proper location and lengths of geogrids used with Keystone Standard units at the near vertical and 1 inch (25mm) setback batter (8°). Design heights were set in two block increments beginning at 4.3 feet (1.3m) and ending 11 feet (3.4m). Engineering judgement 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. Minimum reinforcement lengths were set for 5 feet (1.5m) and a 70% reinforcement length to wall height ratio. Always use the same vertical spacing of geogrid throughout the wall. If your maximum height of wall requires 3 units vertical spacing, then use that spacing even though lower wall heights in the charts may indicate 4 units. Top layers of geogrid shall never be more than 3 units from the top of the wall. Bottom layers of geogrid shall never be more than 3 units from the top of the leveling pad. Insert a geogrid layer at these locations where 3 unit courses are exceeded. 250 psf surcharge is applied 6 inches (152mm) behind the tail of the units. 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 charts use Rankine earth pressure for calculations. The following charts assume the use of a coated polyester geogrid with a minimum allowable design strength of: LTDS=1800 plf (26.3 kN/m) Tal=1200 plf (17.5 kN/m). The following geogrid types are suitable with these design charts:

- » Synteen SF35 by Synteen
- » Miragrid 3XT by TC Mirafi
- » Stratagrid 200 by Strata Systems
- » 55/30-20 by Huesker Inc.

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 (203mm) lifts to 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 use only. A qualified professional should be consulted for final design assistance. Keystone accepts no liability for the use of these charts.

REINFORCED WALL SCHEMATIC



NOTES:

Wall Height (H) is the total height from top to bottom.

Minimum wall embedment is 6 inches (152mm) or Height/20, whichever is greater for level toe.

Subsurface soils must be capable of supporting 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.

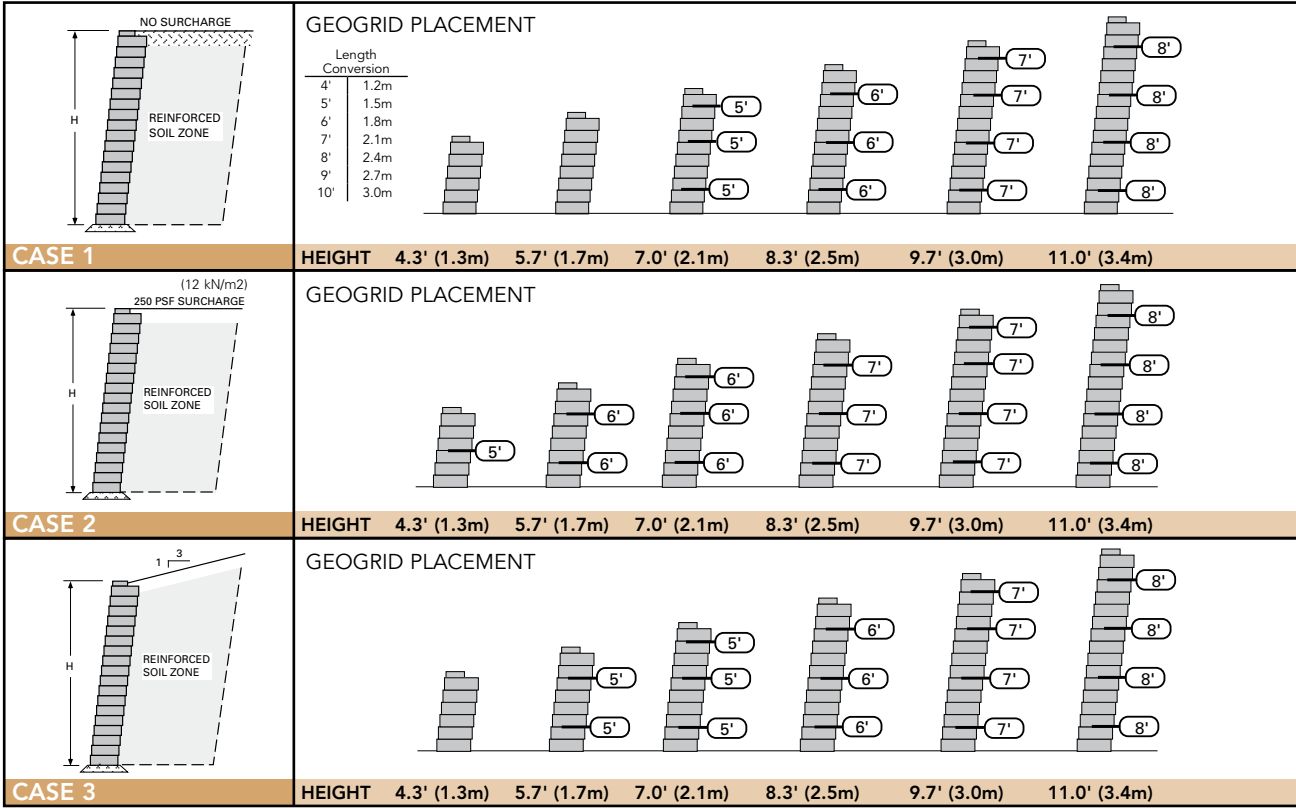
The symbol $\left(\frac{5'}{ } \right)$ indicates location and length of geogrid measured from the front of wall to the end of the geogrid.

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Design/Estimating Charts: Reinforced Wall Charts

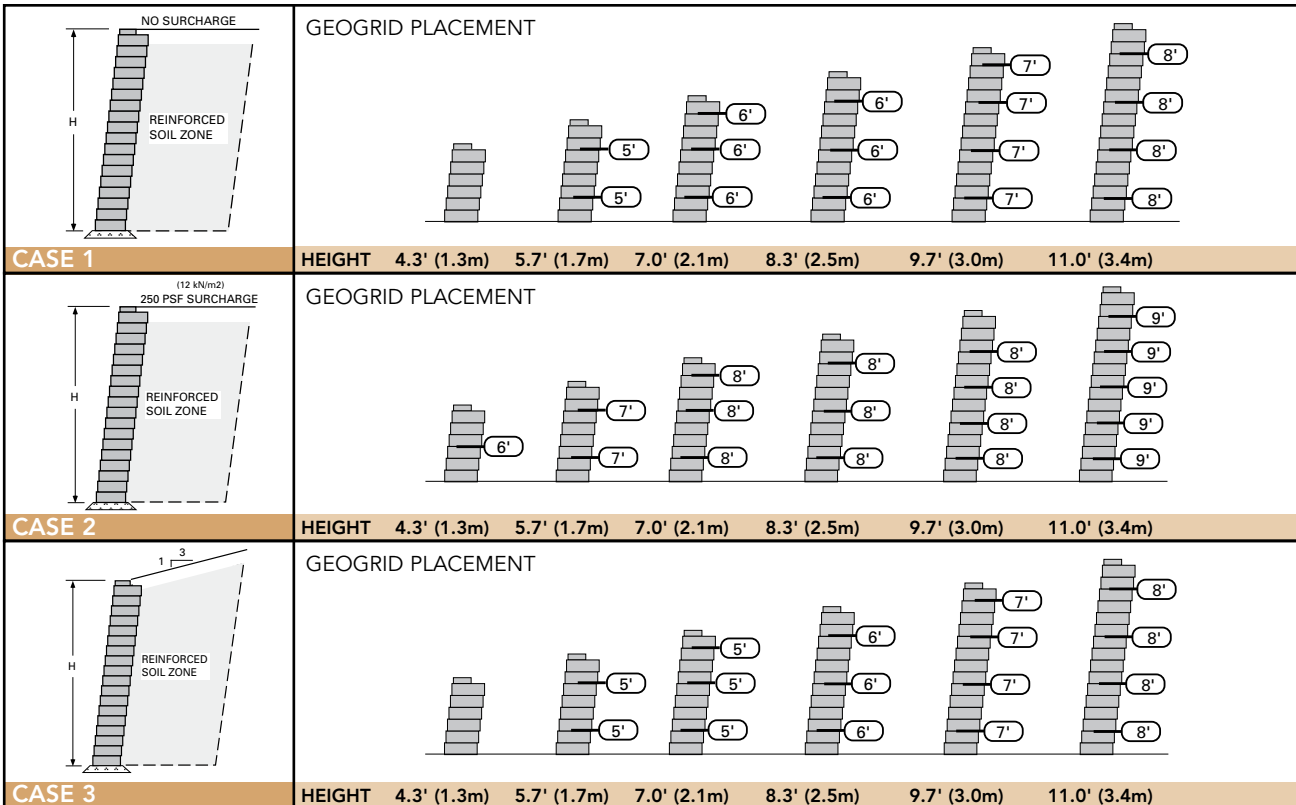
KEYSTONE STANDARD UNITS - 1" (25mm) SETBACK

SAND/GRAVEL: $\phi=34^\circ$, $\gamma=120$ pcf (19kN/m³)



KEYSTONE STANDARD UNITS - 1" (25mm) SETBACK

SILTY SAND: $\phi=30^\circ$, $\gamma=120$ pcf (19kN/m³)

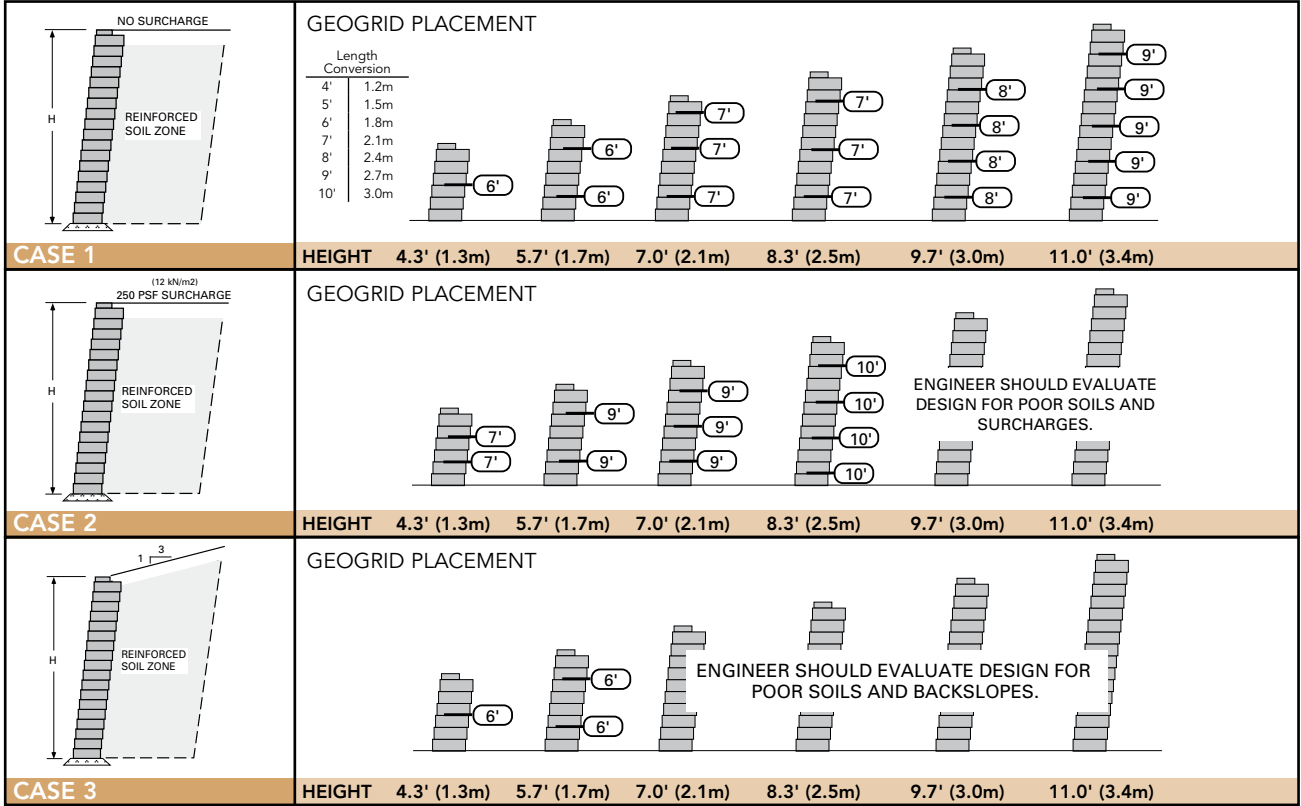


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Design/Estimating Charts: Reinforced Wall Charts

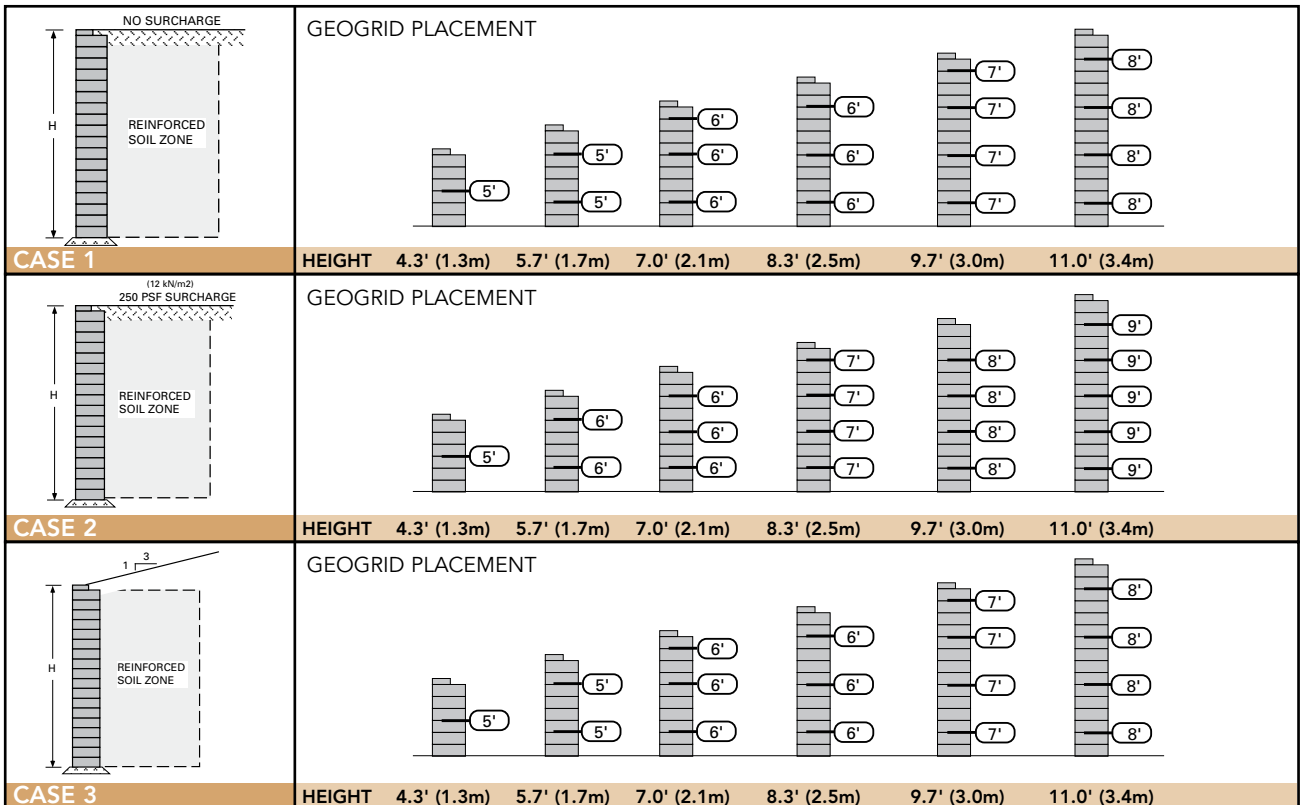
KEYSTONE STANDARD UNITS - 1" (25mm) SETBACK

SILT/LEAN CLAY: $\phi=26^\circ$, $\gamma=120$ pcf (19kN/m³)



KEYSTONE STANDARD UNITS - NEAR VERTICAL

SAND/GRAVEL: $\phi=34^\circ$, $\gamma=120$ pcf (19kN/m³)

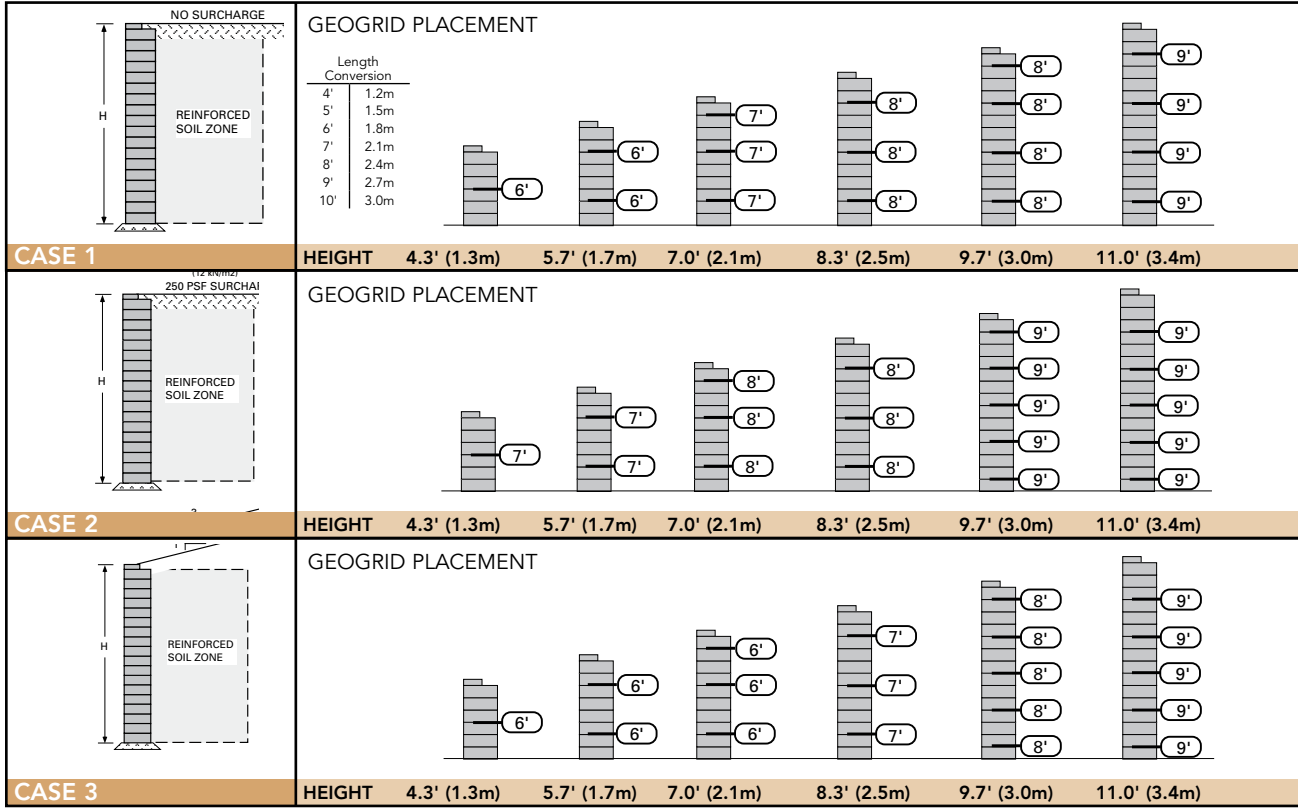


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Design/Estimating Charts: Reinforced Wall Charts

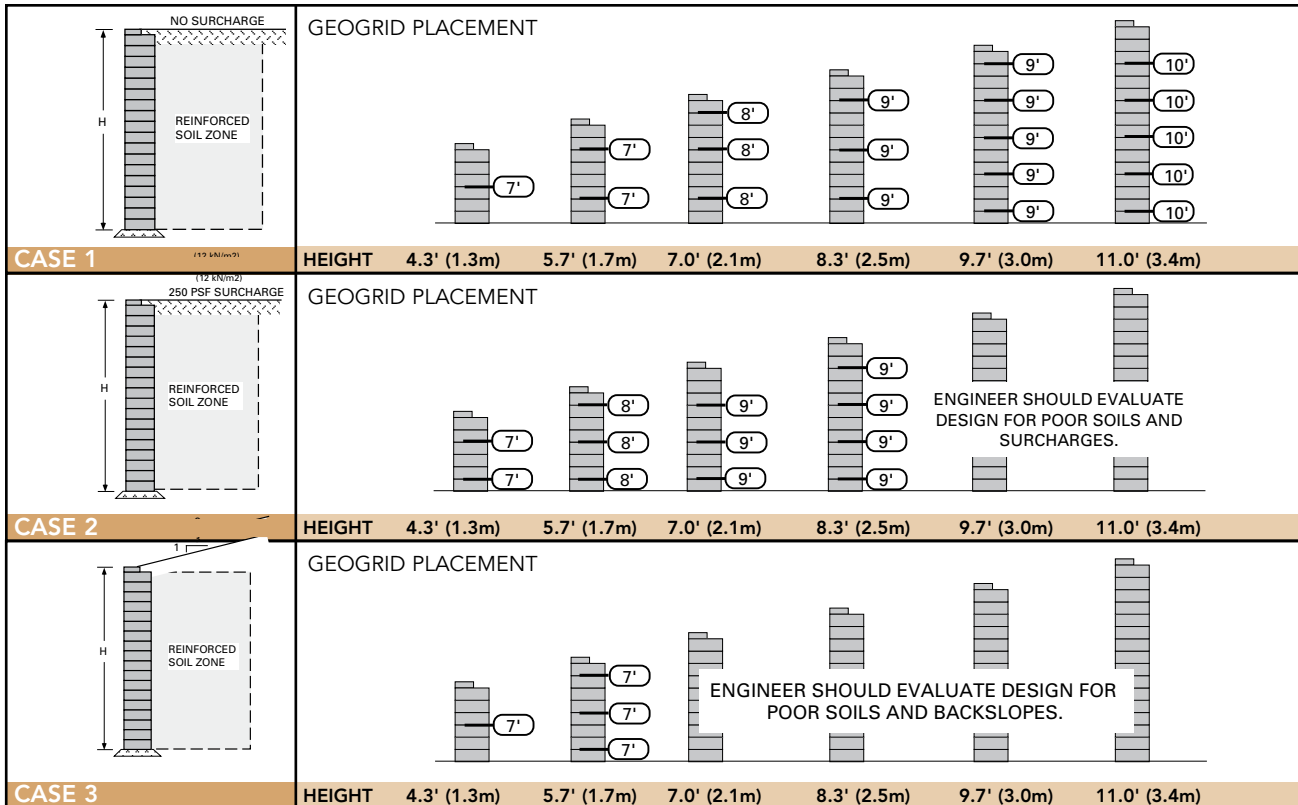
KEYSTONE STANDARD UNITS - NEAR VERTICAL

SILTY SAND: $\phi=30^\circ$, $\gamma=120$ pcf (19kN/m³)



KEYSTONE STANDARD UNITS - NEAR VERTICAL

SILTY/LEAN CLAY: $\phi=26^\circ$, $\gamma=120$ pcf (19kN/m³)



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Design/Estimating Charts : Reinforced Wall Chart Notes

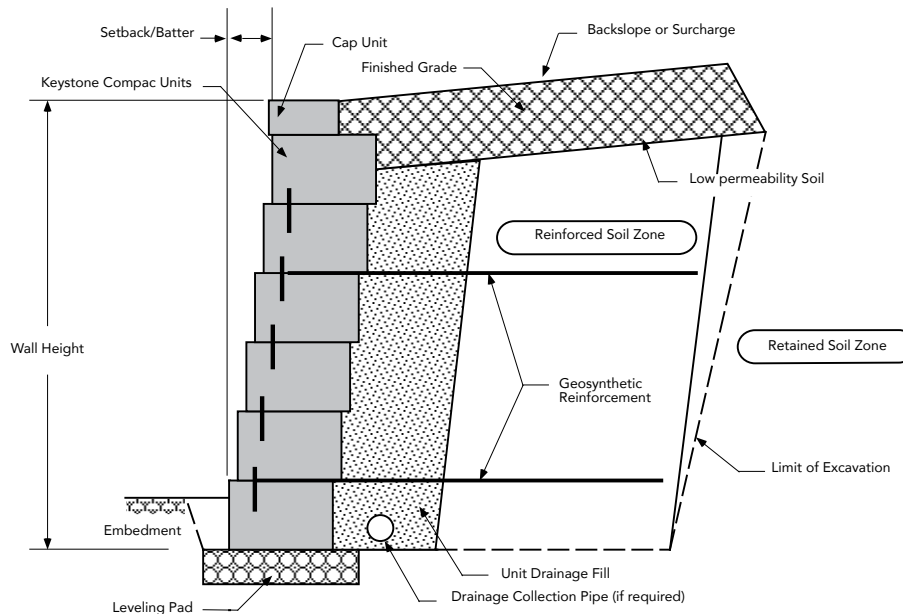
The Keystone reinforced wall charts are graphically presented to show the proper location and lengths of geogrids used with Keystone Compac units at the near vertical and 1 inch (25mm) setback batter (8°). Design heights were set in two block increments beginning at 4.3 feet (1.3m) and ending 11 feet (3.4m). Engineering judgement 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. Minimum reinforcement lengths were set for 4 feet (1.2m) minimum and a 70% reinforcement length to wall height ratio. Always use the same vertical spacing of geogrid throughout the wall. 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. Insert a geogrid layer at these locations where 2 unit courses are exceeded. 250 psf surcharge is applied 6 inches (152mm) behind the tail of the units. 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 top of wall.

The charts use Rankine earth pressure for calculations. The following charts assume the use of a coated polyester geogrid with a minimum allowable design strength of: LTDS=1875 plf (27.4 kN/m) Tal=1250 plf (18.3 kN/m). The following geogrid types are suitable with these design charts:

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- » Miragrid 3XT by TC Mirafi
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REINFORCED WALL SCHEMATIC



NOTES:

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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.

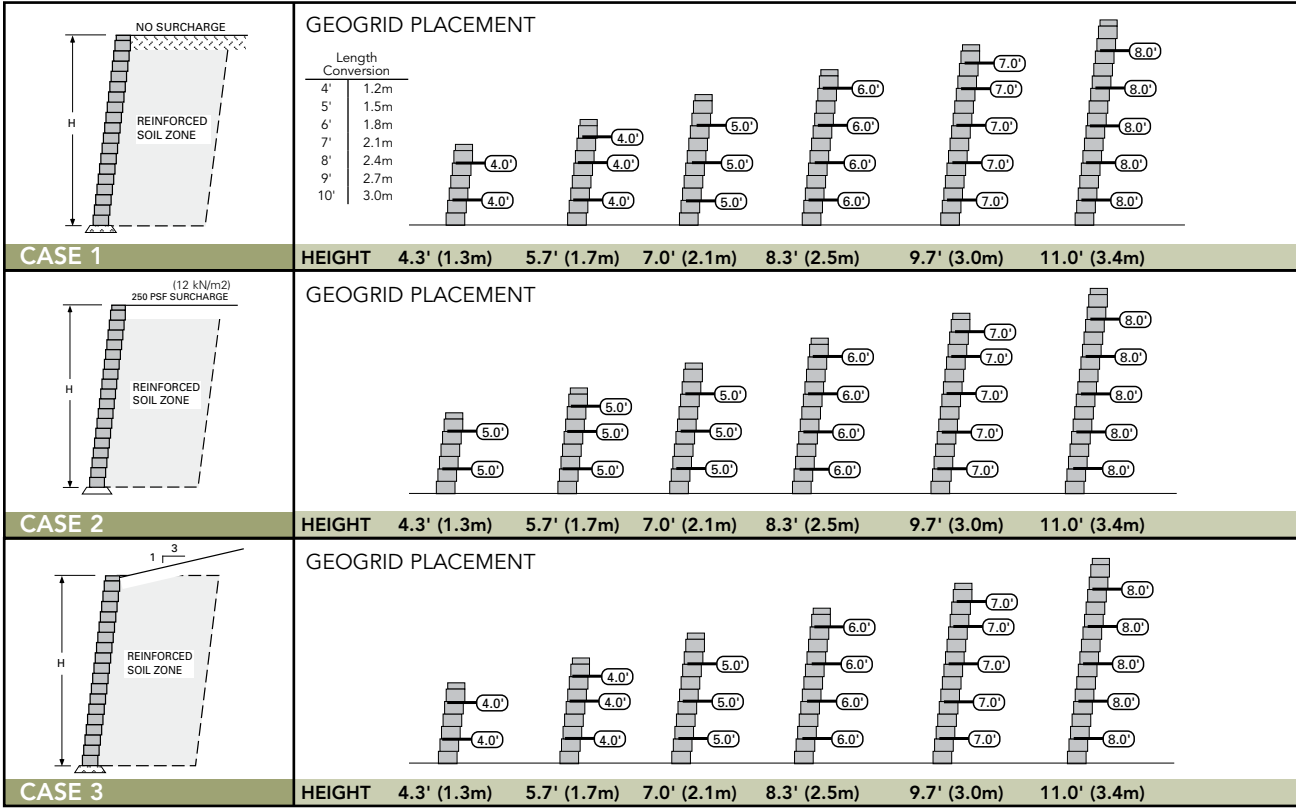
Finished grade must provide positive drainage.

The symbol $\left(5'\right)$ indicates location and length of geogrid measured from the front of wall to the end of the geogrid.

Design/Estimating Charts : Reinforced Wall Charts

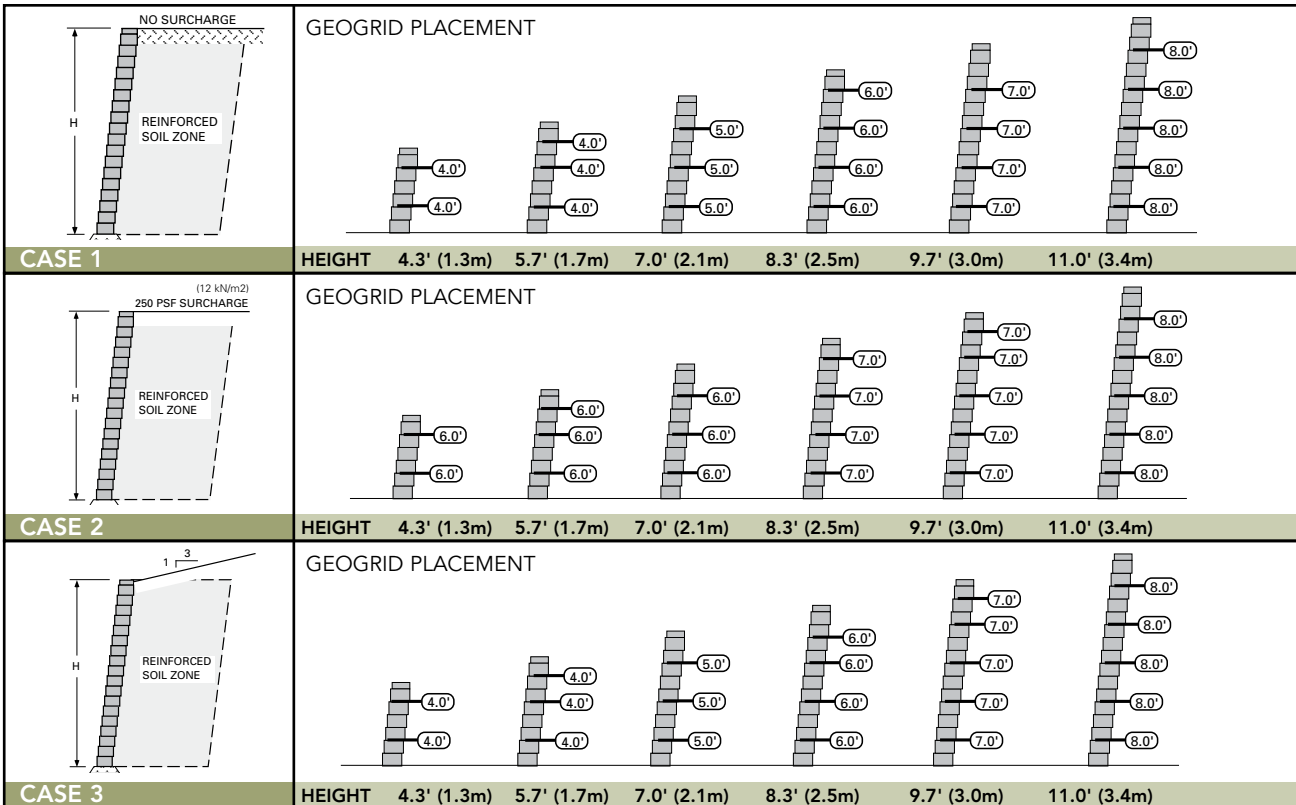
KEYSTONE COMPAC UNITS - 1" (25mm) SETBACK

SAND/GRAVEL: $\phi=34^\circ$, $\gamma=120$ pcf (19kN/m^3)



KEYSTONE COMPAC UNITS - 1" (25mm) SETBACK

SILTY SAND: $\phi=30^\circ$, $\gamma=120$ pcf (19kN/m^3)

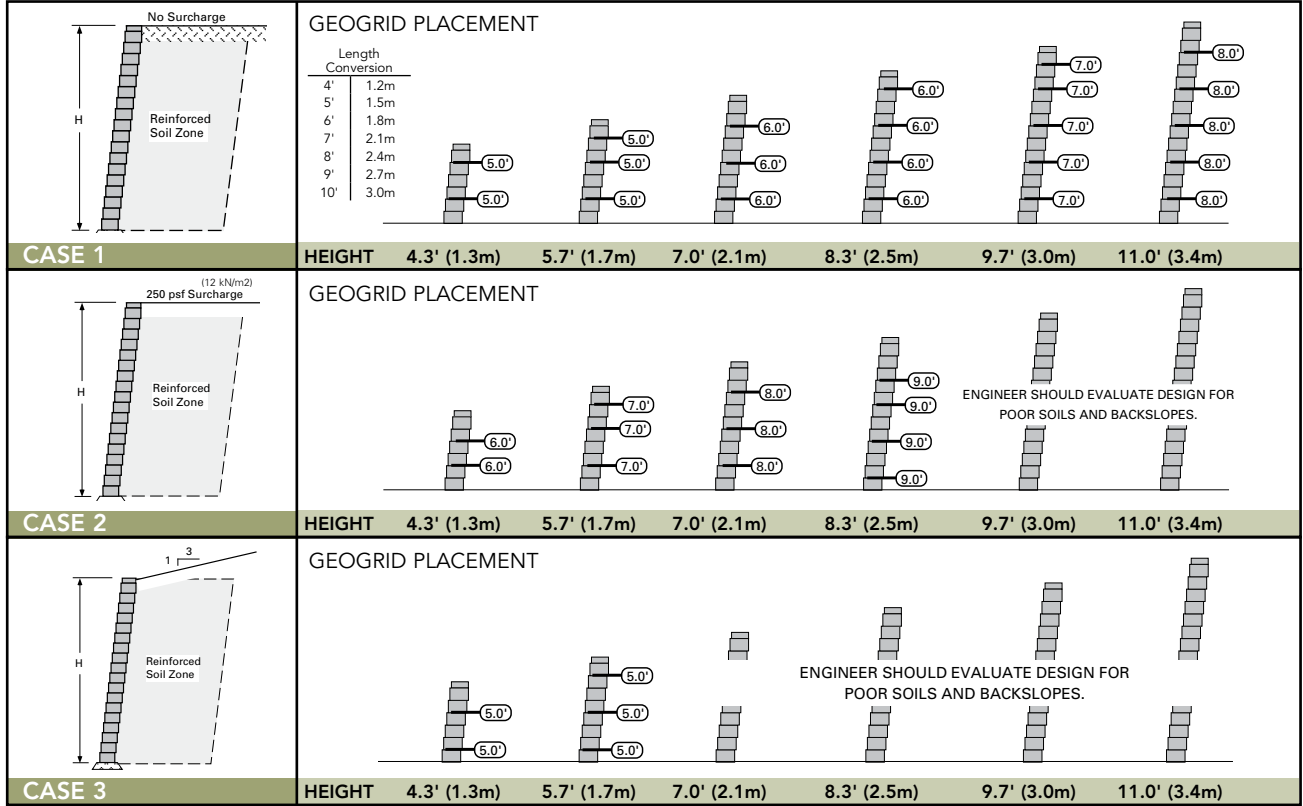


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Design/Estimating Charts : Reinforced Wall Charts

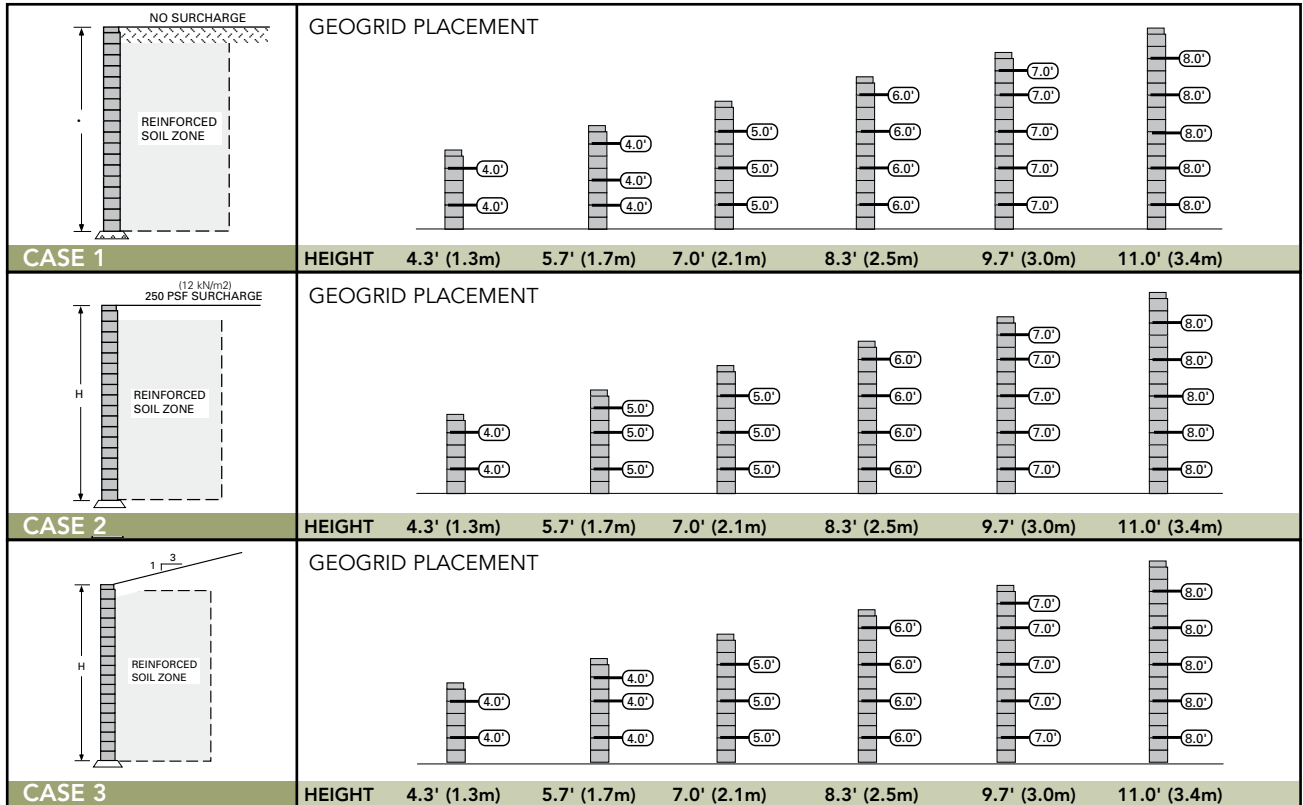
KEYSTONE COMPAC UNITS - 1" (25mm) SETBACK

SILT/LEAN CLAY: $\phi=26^\circ$, $\gamma=120$ pcf (19kN/m³)



KEYSTONE COMPAC UNITS - NEAR VERTICAL

SAND/GRAVEL: $\phi=34^\circ$, $\gamma=120$ pcf (19kN/m³)

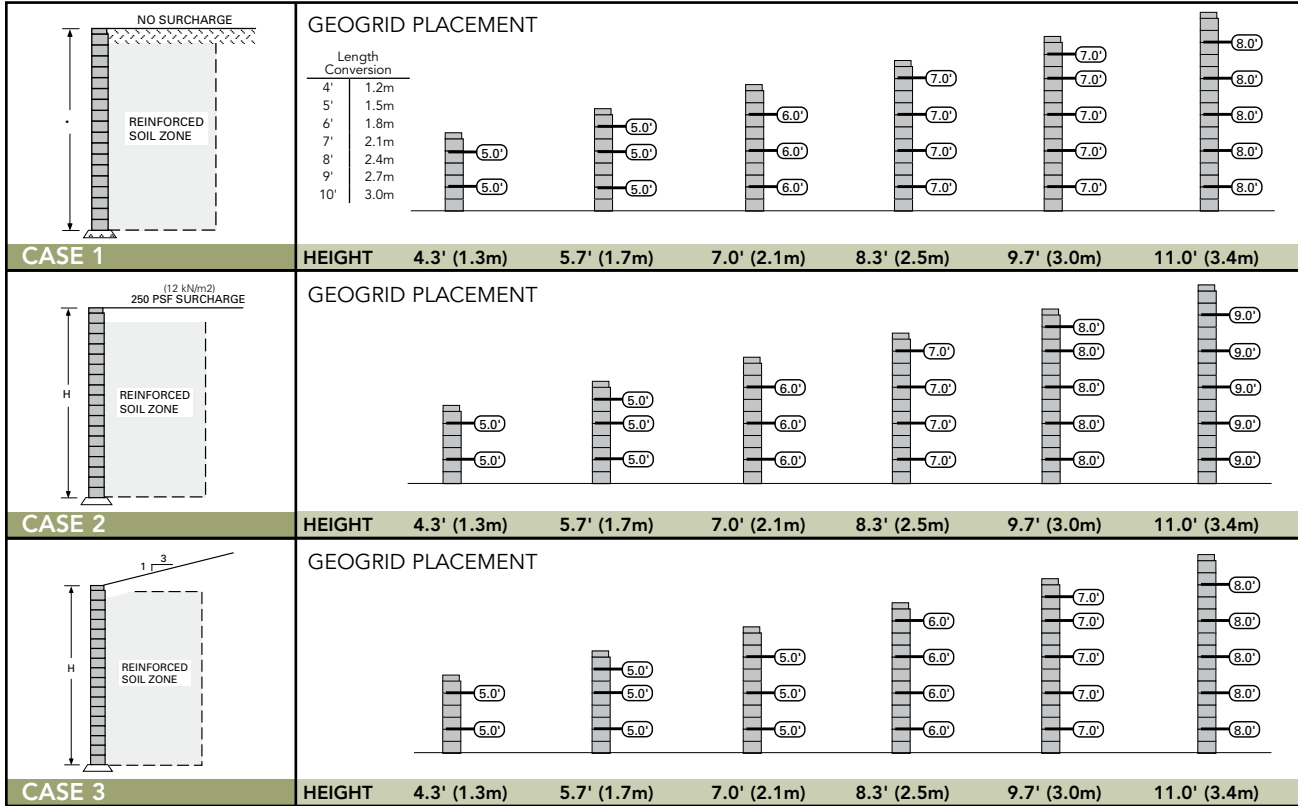


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Design/Estimating Charts : Reinforced Wall Charts

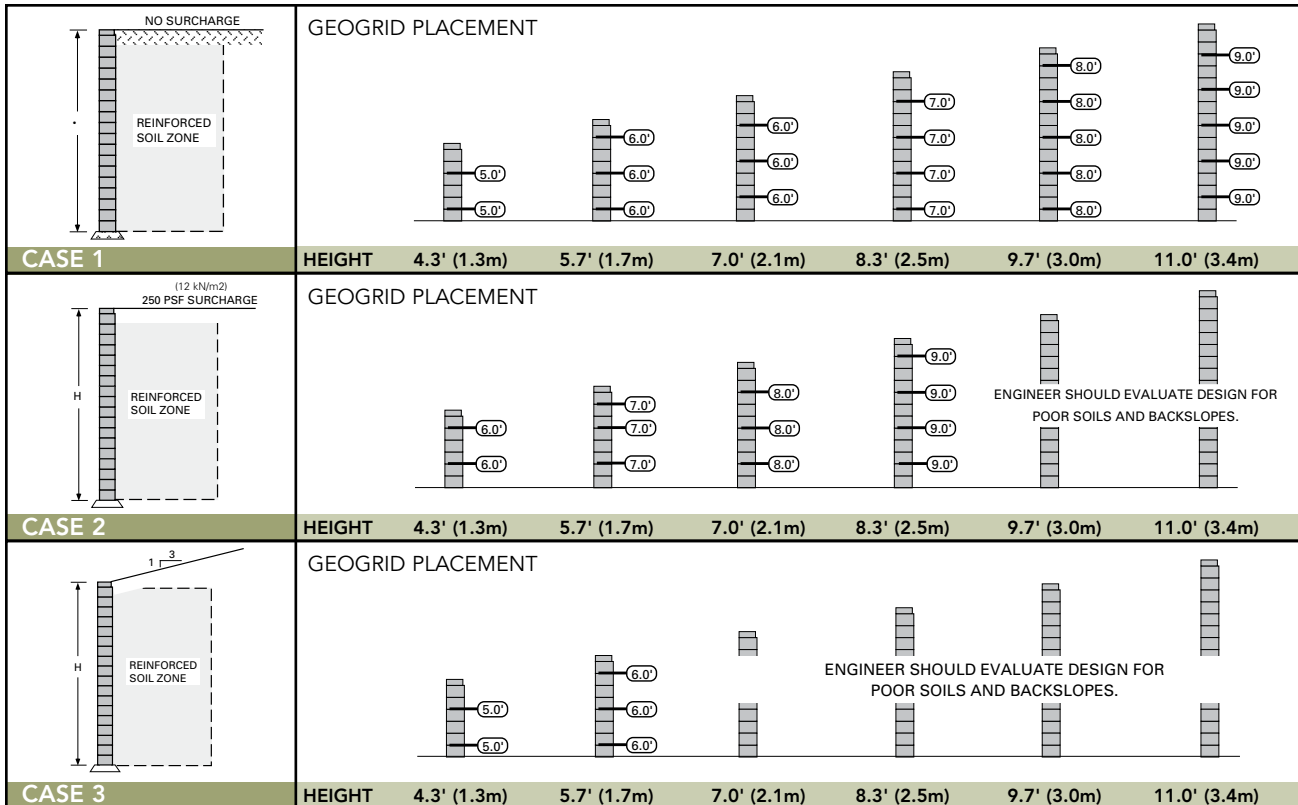
KEYSTONE COMPAC UNITS - NEAR VERTICAL

SILTY SAND: $\phi=30^\circ$, $\gamma=120$ pcf (19kN/m^3)



KEYSTONE COMPAC UNITS - NEAR VERTICAL

SILTY/LEAN CLAY: $\phi=26^\circ$, $\gamma=120$ pcf (19kN/m^3)



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