SECTION C

CONSTRUCTION OF CORNERS AND CURVES

So far the discussion regarding the installation of a Keystone retaining wall has centered on the installation of units through the straight line sections of the wall. Equally important to the final aesthetic and function of any wall is the construction of corners and curves.

A corner is typically constructed as either an outside 90° corner, inside 90° corner or acute outside corner (between 75° to 90°). When a wall needs to make a turn greater than 90° it is recommended that a radius curve for the wall be installed. For curves in the wall, Keystone units typically have a minimum radius depending on the face style, which is outlined later in this section by unit type. The flexibility of the Keystone units allows for the construction of multiple corners or curves within the same wall. The following information will provide a general explanation of construction techniques for building retaining walls with corner and curve conditions.

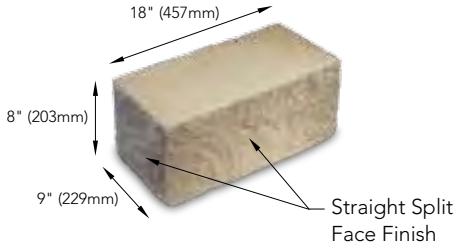
Tools and materials that will be required:

- 12 inch (305mm) and 48 inch levels (1.2m)
- Tape measure
- Concrete saw
- Block splitter
- Masonry cold chisel
- 5 lb (2.3kg) dead blow hammer
- Hammer drill with 5/8 inch (16mm) masonry drill bit
- Exterior grade concrete adhesive

90° Outside Corner : Introduction

For ease of construction of outside 90° corners, Keystone producers typically provide a corner unit specifically designed for this purpose. Corner unit options and product designs may vary by manufacturer; please contact your local manufacturer for availability before you begin your project planning. Details at right show a typical corner unit available in many locations.

CORNER UNIT

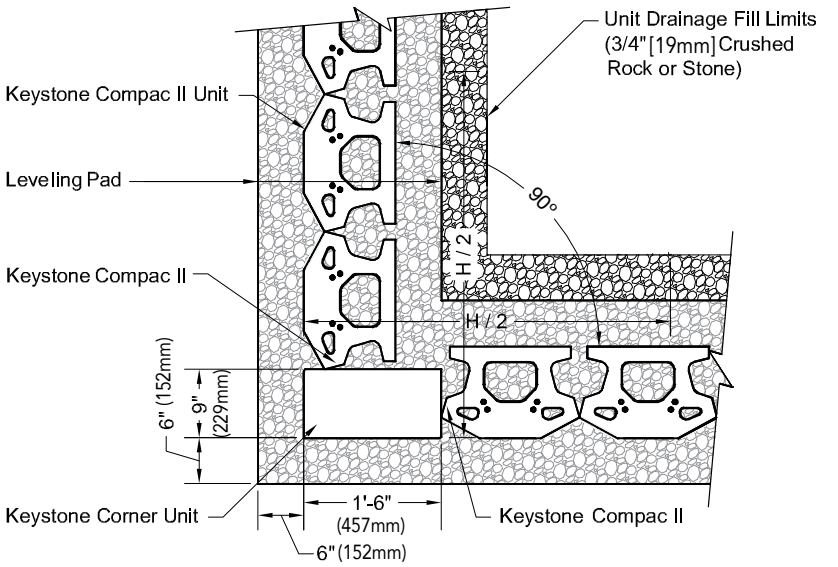


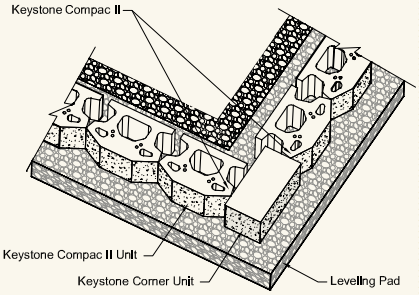
If corner units are not available, Keystone recommends transitioning the wall from a corner to a radius curve in the wall and avoiding mitered corners. This will enable the wall to maintain its pin connection integrity and running bond wall configuration for continued wall stability and performance.

If creating a radius is not an option, the alternative is to miter the Keystone units to create the outside 90° corner. Unfortunately mitering a corner can result in undesirable wall performance issues in the corner, including gapping of the units, or an entire separation of the wall corner due to soil movement. Keystone recommends using an integration of the mitered Keystone units with rebar and grout or concrete to prevent the unwanted performance issues. Please contact your local Keystone representative for assistance when attempting to construct mitered outside corners.

Battered walls (8°) present an additional challenge in outside corners: as the wall rises vertically, the wall will get smaller. See details on pages 42-43 for detailed installation and cutting instructions.

FIGURE C:1 - TYPICAL BASE (ODD COURSES)



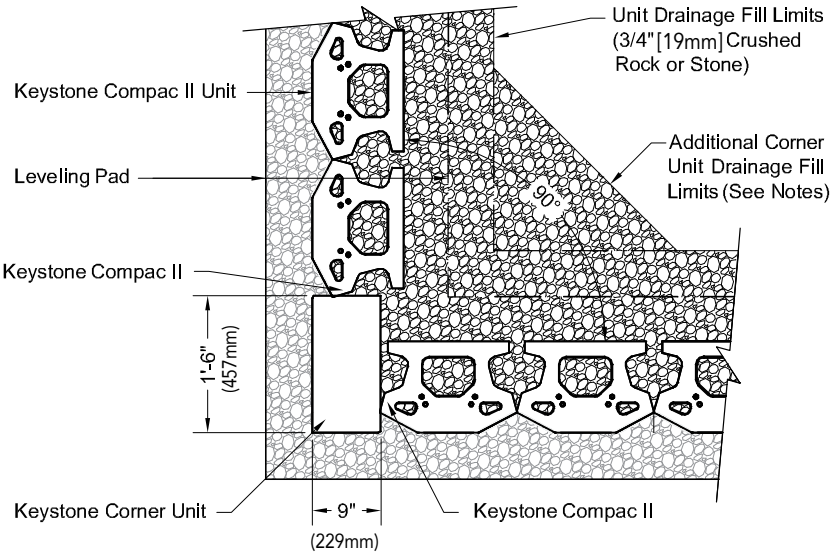


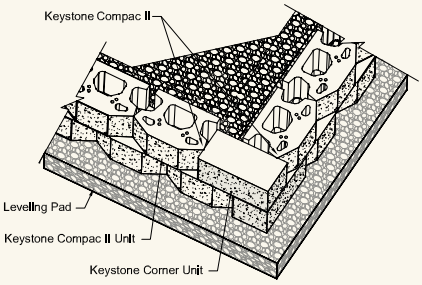
ISOMETRIC DETAIL

Note:

See Corner Construction, Figure C:4, for additional detail.

FIGURE C:2 - TYPICAL SECOND (EVEN COURSES)





ISOMETRIC DETAIL

Notes:

Place additional unit drainage fill at outside wall corner to extend back from wall face each way a distance equal to the wall height / 2 (H / 2).

90° Outside Corner : Near Vertical Setback

ISOMETRIC DETAIL

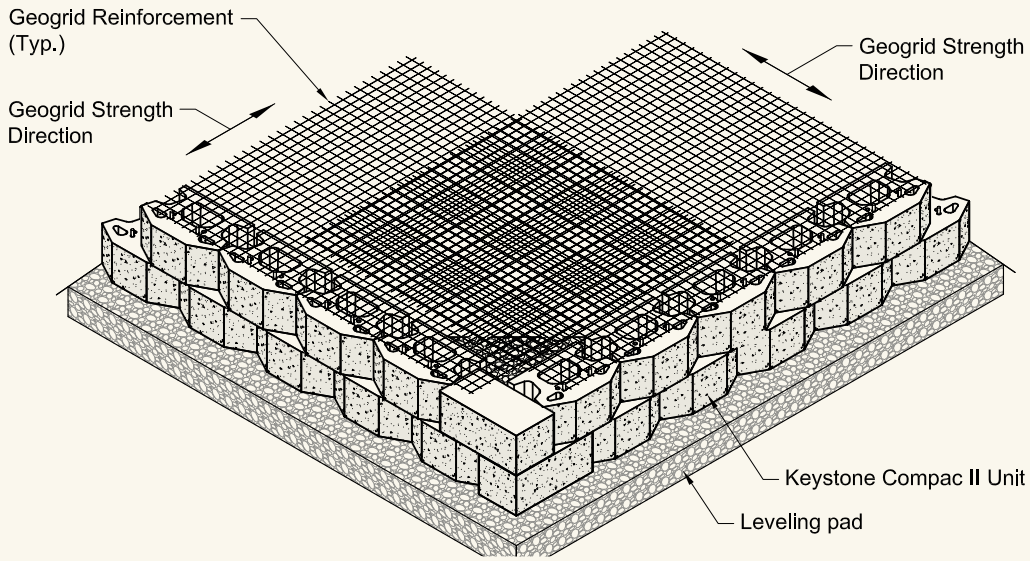
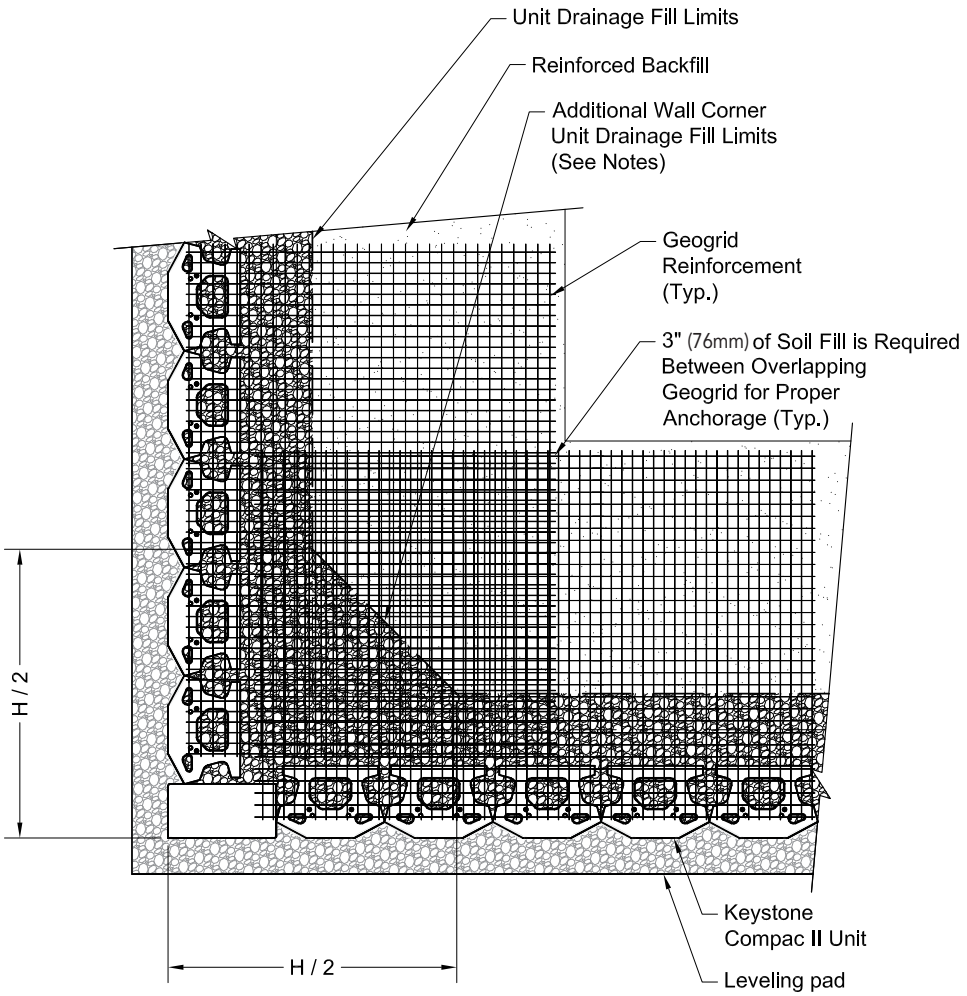


FIGURE C:3 - TYPICAL GEOGRID INSTALLATION FOR OUTSIDE CORNERS



Notes:

Place additional unit drainage fill at outside wall corners to extend back from wall face each way a distance equal to the wall height / 2 (H / 2).

Drainage zone and backfill materials should be placed compacted and up to the geogrid elevation and Keystone unit pins should be in place prior to geogrid installation.

Measure, cut and orient the geogrid, as per the engineer's design and/or the geogrid manufacturer's specifications in the correct strength direction.

Hook the geogrid over the Keystone unit pins and tension the geogrid by pulling it back away from the wall. Place a stake through the geogrid at the back to tension the geogrid in place.

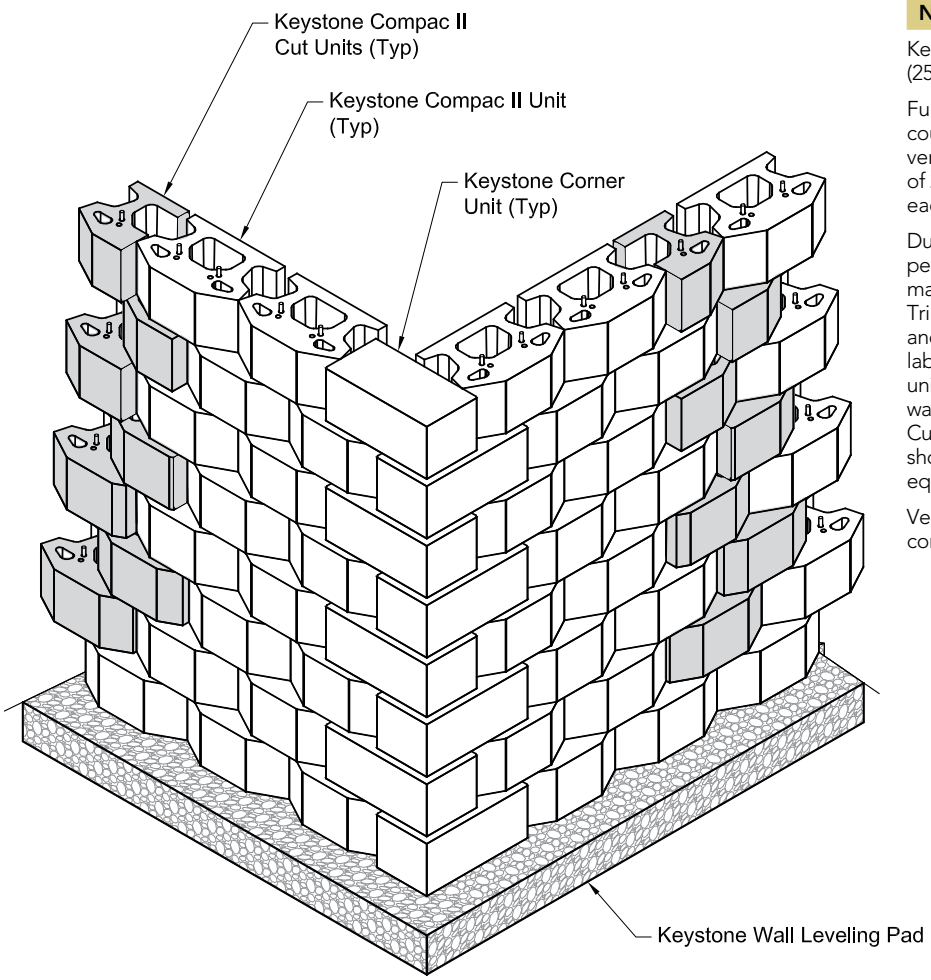
Proceed with placement of additional Keystone units, unit drainage fill. Start backfilling nearest the Keystone units and then move back away from the wall, placing backfill materials over the geogrid. After the backfilling process, the tension stakes may be removed for reuse.

Compact the backfill materials in 8 inch (203mm) lifts to the next reinforcement elevation, and repeat.

90° Outside Corner : Keystone Compac Unit

When constructing a battered wall there are construction issues at the corner as the wall rises vertically. Because the wall is set back, it creates a need to trim structural units on both sides of the corner to maintain a proper running bond pattern in the straight sections of the wall. Keystone has developed a sketch to show proper location for trim units. This illustration is based on a full running bond pattern on the base course, with no trimmed units. (In the case of two corners near each other, it is best to set each corner unit base first to establish corner location, and then set the base course of structural units running to the corners and trim units as necessary.)

FIGURE C:4 - BATTERED SETBACK AT 90º OUTSIDE CORNER



1" (25mm) Setback Corner Isometric View

Notes:

Keystone Compac II units shown in 1" (25mm) setback position.

Full uncut units to be used for the base course and as indicated in the details, vertically up the wall corner. A minimum of 2 full units should be placed adjacent to each corner unit.

Due to corner perpendicular wall setback per course, trimming units is necessary to maintain running bond course alignment. Trim block units a minimum 1 corner unit and 2 full units from the corner roughly labeled for cut length and shaded for cut unit designation in both directions from the wall corner for proper wall joint alignment. Cut pieces less than 6" (152mm) in length should not be used. Instead, cut 2 units to equal length.

Verify actual cut lengths as wall is constructed.

FIGURE C:5 - CUT CORNER UNIT COURSE

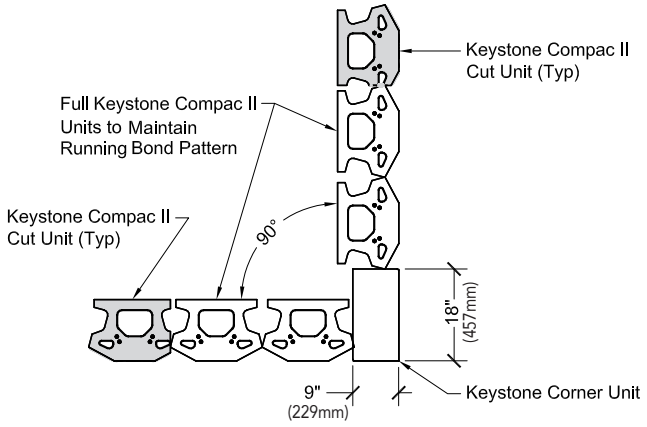
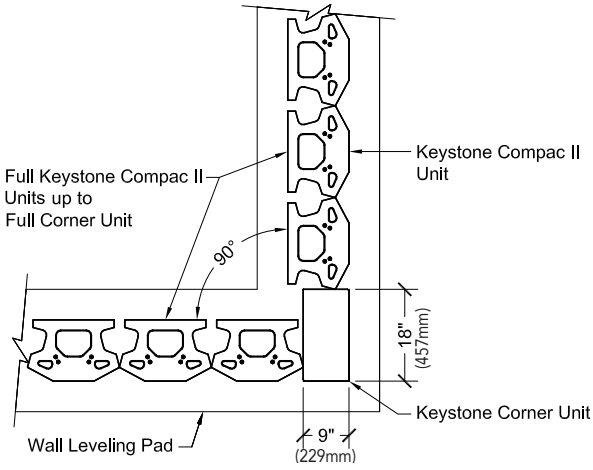
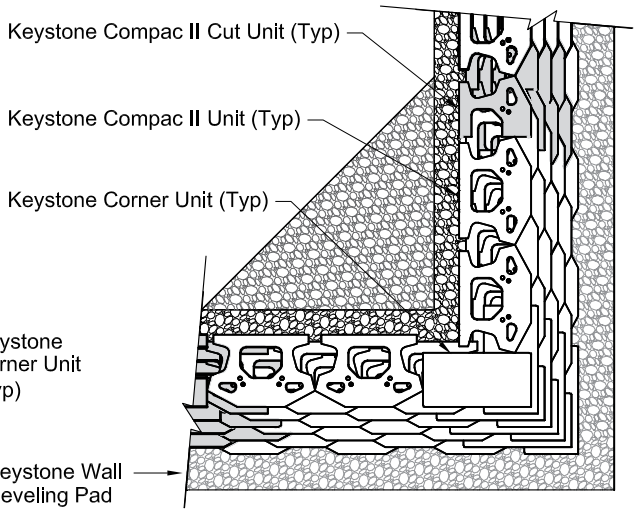
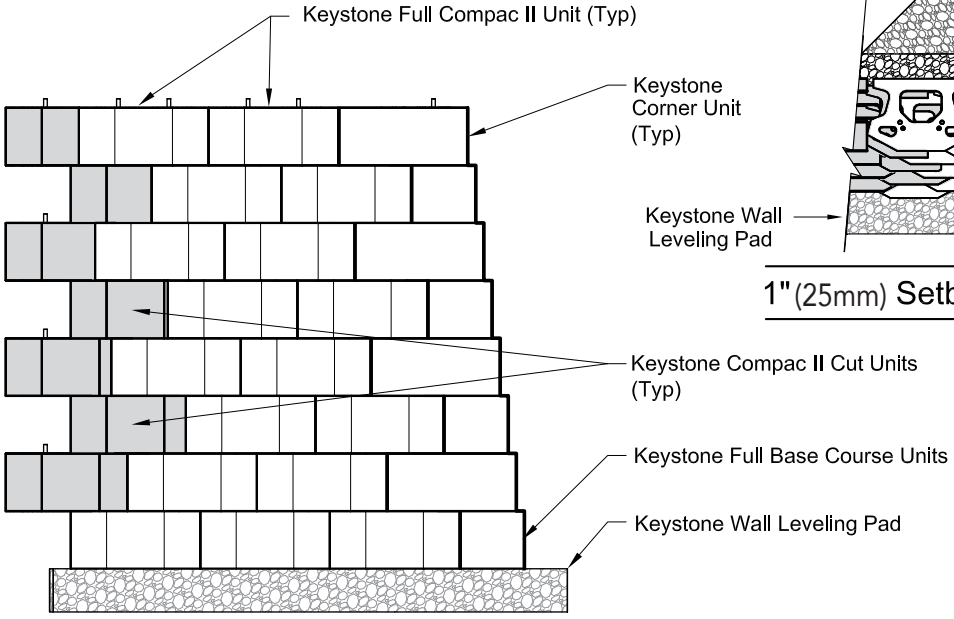


FIGURE C:6 - FULL CORNER UNIT COURSE





1" (25mm) Setback Corner Plan View

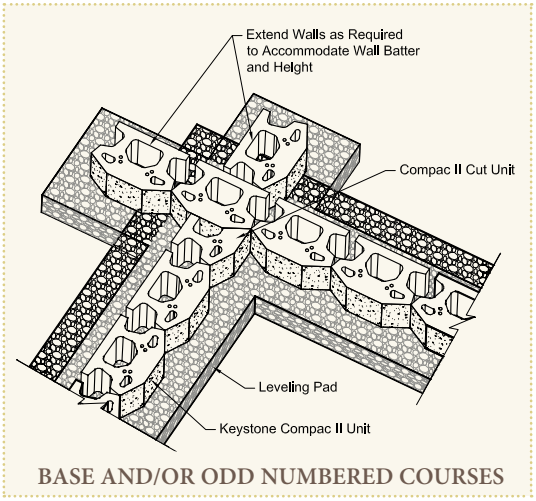


1" (25mm) Setback Corner Side Elevation View

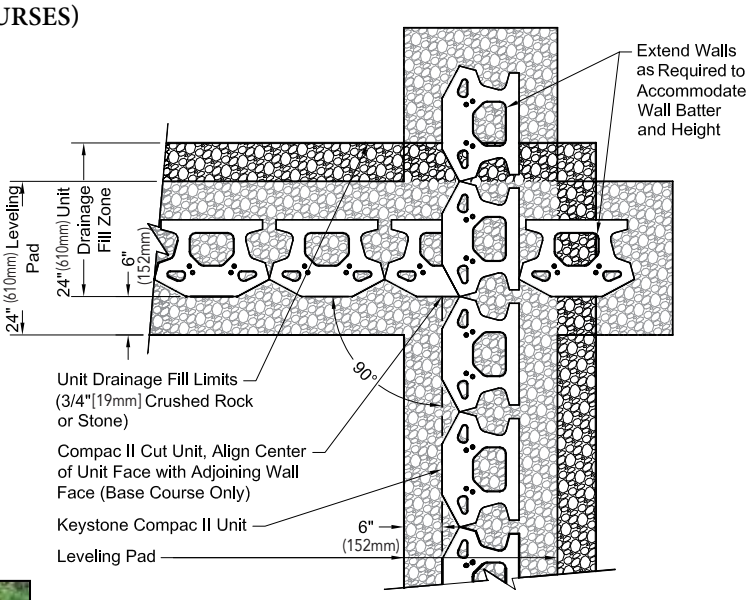
90° Inside Corner : Installation Details

The construction of inside corners is relatively simple, because no additional units are required. All you will need is your tape measure, concrete saw, block splitter blade or chisel and a level. There are two ways you can install an inside corner construction; you can butt one wall into the other wall, or you can use the interlocking method as shown below.

FIGURE C:7 - TYPICAL BASE (ODD COURSES)



BASE AND/OR ODD NUMBERED COURSES

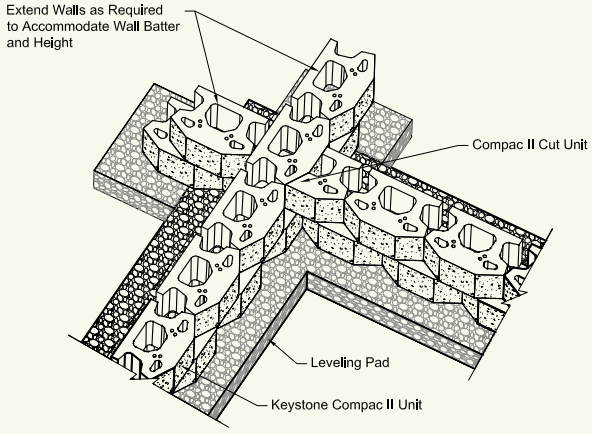


Notes:

Add extra full or half units, leveled and aligned beyond the corner in both directions to support the full or partial units to be placed above the current course. These units should project a minimum of ½ unit (9" [229mm]) beyond the block of the adjacent row.

Due to corner perpendicular wall setback per course, to maintain running bond course alignment, cut the adjoining unit to the perpendicular wall face labeled "Compac II Cut Unit" as needed in both directions for proper wall joint alignment.

FIGURE C:8 - TYPICAL SECOND (EVEN COURSES)



SECOND AND/OR EVEN NUMBERED COURSES

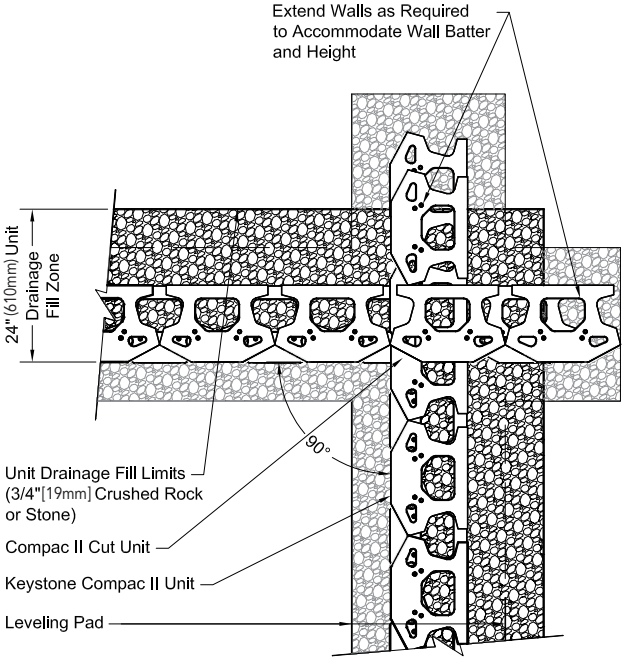


FIGURE C:9 - TYPICAL GEOGRID INSTALLATION FOR INSIDE CORNERS

Notes:

Drainage zone and backfill materials should be placed compacted and up to the geogrid elevation and Keystone unit pins should be in place prior to geogrid installation.

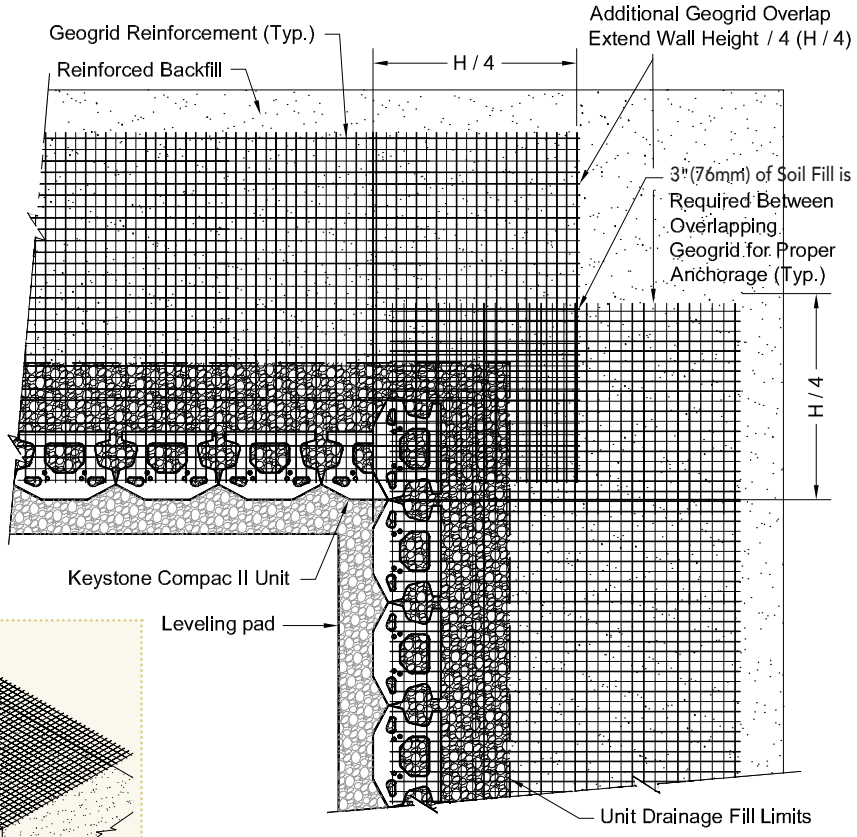
Measure, cut and orient the geogrid, as per the engineers design and the geogrid manufacturer's specifications on correct strength direction.

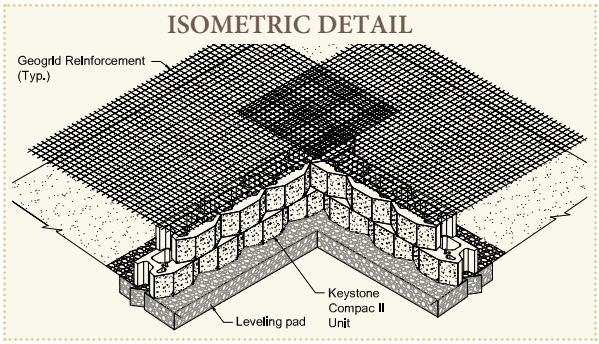
Place the geogrid over the Keystone unit pins and tension the geogrid by pulling it back away from the wall. Place a stake through the geogrid at the back to tension the geogrid in place.

Proceed with placement of additional Keystone units, then drainage zone and backfill material. Starting at the wall and moving back away from the wall, place the drainage zone and backfill materials over the geogrid to hold the geogrid in place under tension. After the backfilling process, the tension stakes may be removed for reuse.

Then backfill materials up to the next wall elevation where a geogrid is to be place.

Extend geogrid the wall height / 4 (H / 4) beyond the adjoining wall face at inside wall corners.

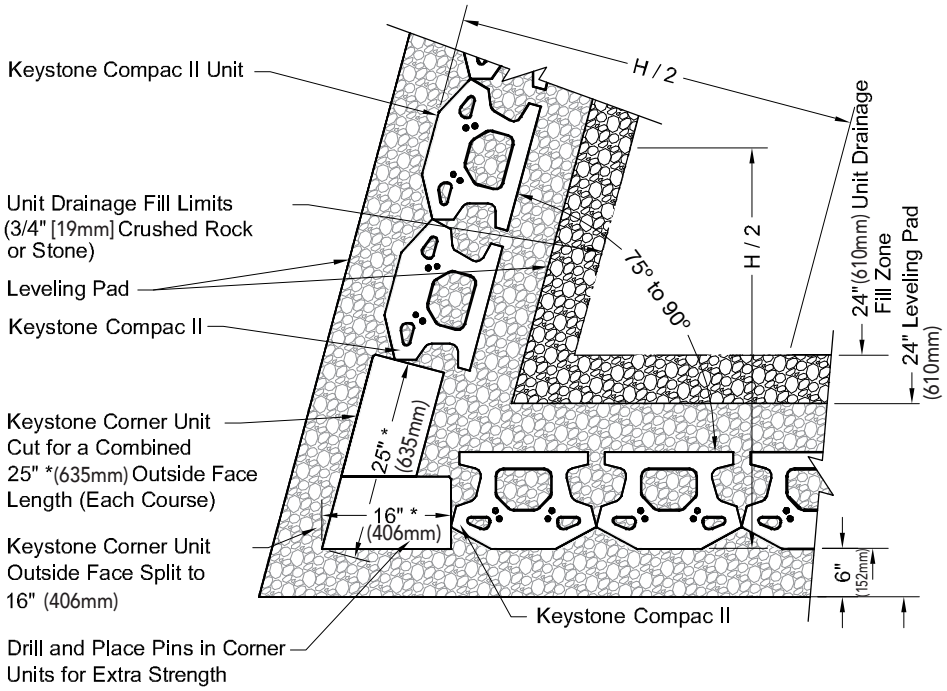


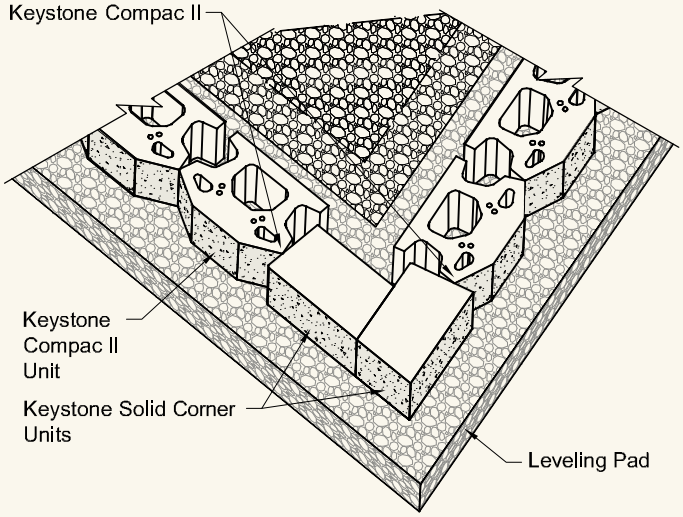


Acute Corner : Installation Details

In special cases, an acute corner construction is needed. No special units are necessary for the construction of acute corners; you will just need to field split or cut the corner units. All you will need is your tape measure, concrete saw, splitter blade or chisel and a level. The following is the recommended installation procedure for acute corners.

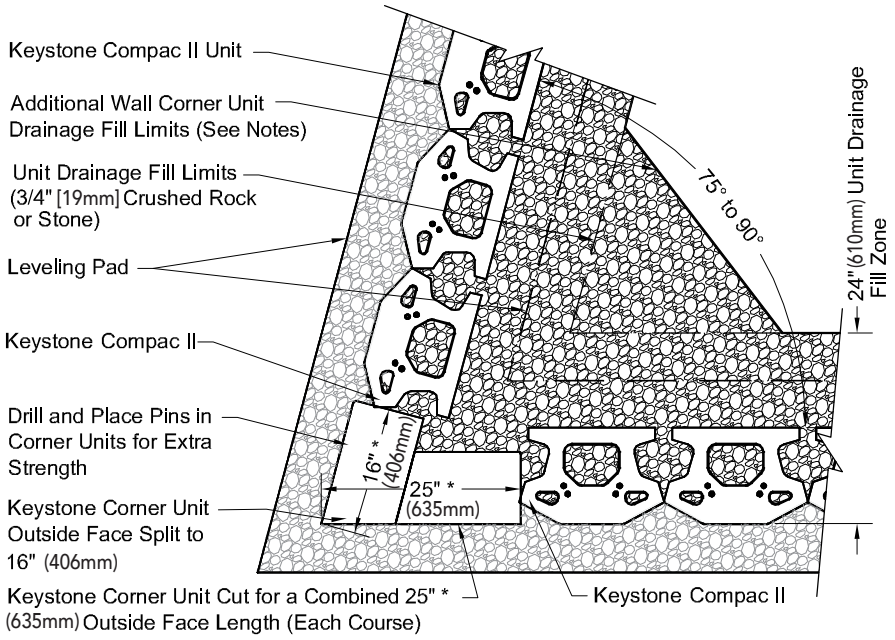
FIGURE C:10 - TYPICAL BASE (ODD COURSES)

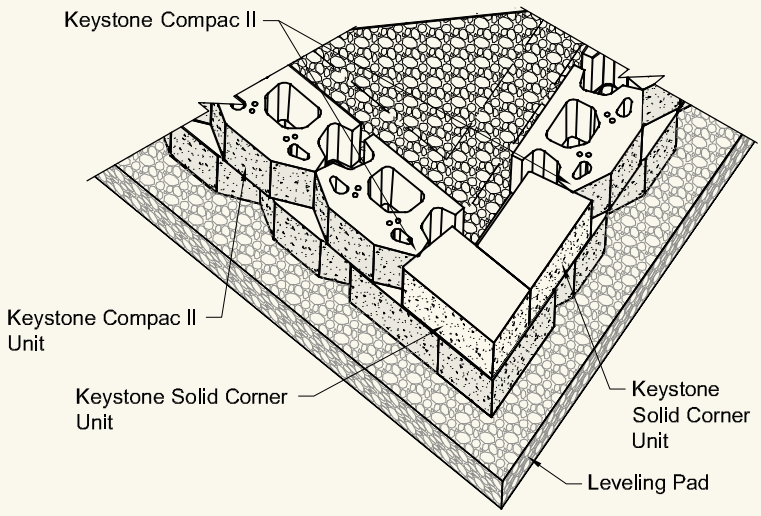




ISOMETRIC DETAIL

FIGURE C:11 - TYPICAL SECOND (EVEN COURSES)





ISOMETRIC DETAIL

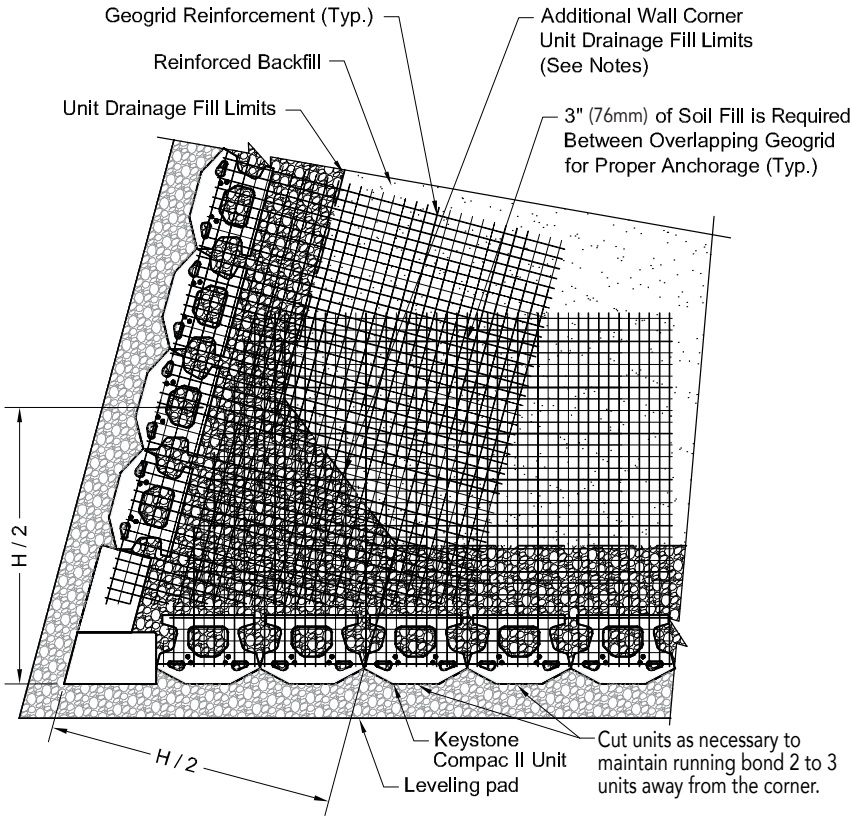
Notes:

Cut corner piece units to be used for each odd or even course vertically up the wall corner. Corner units to be cut the same for each alternating odd or even course.

Additional crushed rock or stone drainage fill at outside wall corners to extend back from wall face each way at wall height / 2 (H / 2.).

* Distance varies as angle increases.

FIGURE C:12 - TYPICAL GEOGRID INSTALLATION FOR OUTSIDE ACUTE CORNERS



Notes:

Unit drainage fill and backfill materials should be placed compacted to the geogrid elevation and Keystone unit pins should be in place prior to geogrid installation.

Place additional unit drainage fill at acute wall corner to extend back from wall face, each way, a distance equal to the wall height / 2 (H / 2).

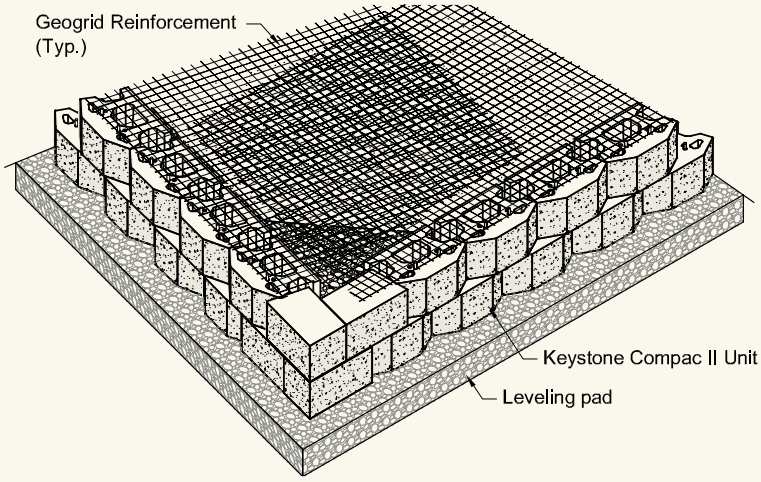
Measure, cut and orient the geogrid, as per the engineer's design and/or the geogrid manufacturer's specifications in the correct strength direction.

Place the geogrid over the Keystone unit pins, place an additional course of units and tension the geogrid by pulling it back away from the wall. Place a stake through the geogrid at the back to tension the geogrid in place.

Proceed with placement of additional Keystone units, unit drainage fill and backfill material. Start backfilling nearest the Keystone units and then move back away from the wall, placing backfill materials over the geogrid to hold the geogrid in place under tension. After the backfilling process, the tension stakes may be removed for reuse.

Compact the backfill materials in 8 inch (203mm) lifts to the next reinforcement elevation, and repeat.

ISOMETRIC DETAIL



Inside curves for moderately tall Keystone walls are more difficult to construct than a straight wall due to the complex geometry resulting from a battered wall face in a curve. Inside curves allow good access for compaction and the wall face units tend to support each other like an arch when the soil strain associated with the active earth pressure condition develops.

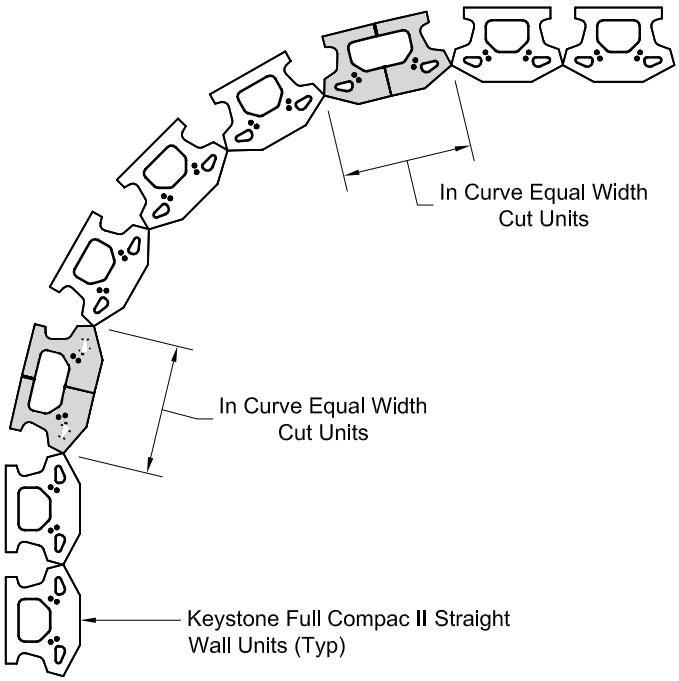
As the wall gets taller, inside curves will result in the top of the wall becoming longer than the base. For wall systems to maintain the desired running bond configuration, gaps between units tend to form. The gapping is less significant for a wall in the near vertical pin postion (<1°) than it is for a battered wall (8°).

The following is an outline to a process of constructing inside curves in taller battered walls while helping to maintain the integrity of Keystone's pin connection system and running bond. See the illustration below and on the next page.

1. Creating filler pieces will be necessary. For example, if a course can be built with pins being contained in the pin receiving holes and a 2" (51mm) gap is created, leave the gap and one adjacent unit out of the wall, cut two blocks 10" (254mm) wide (2" [51mm]+ 18" [457mm] = 20"[508mm], 20"[508mm]/2 block = 10" [254mm] each) and place the two 10" (254mm) cut blocks adjacent to each other in the wall. Cut wall units should not be less than 6" (152mm) in length. All cut pieces should be glued in place.

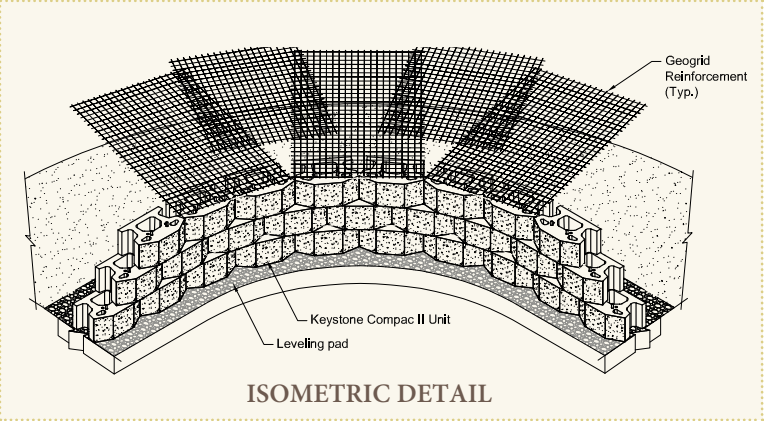
2. Eventually an entire unit fills the gap and the process is repeated.

FIGURE C:13 - IN CURVE CUT UNITS EXAMPLE COURSE

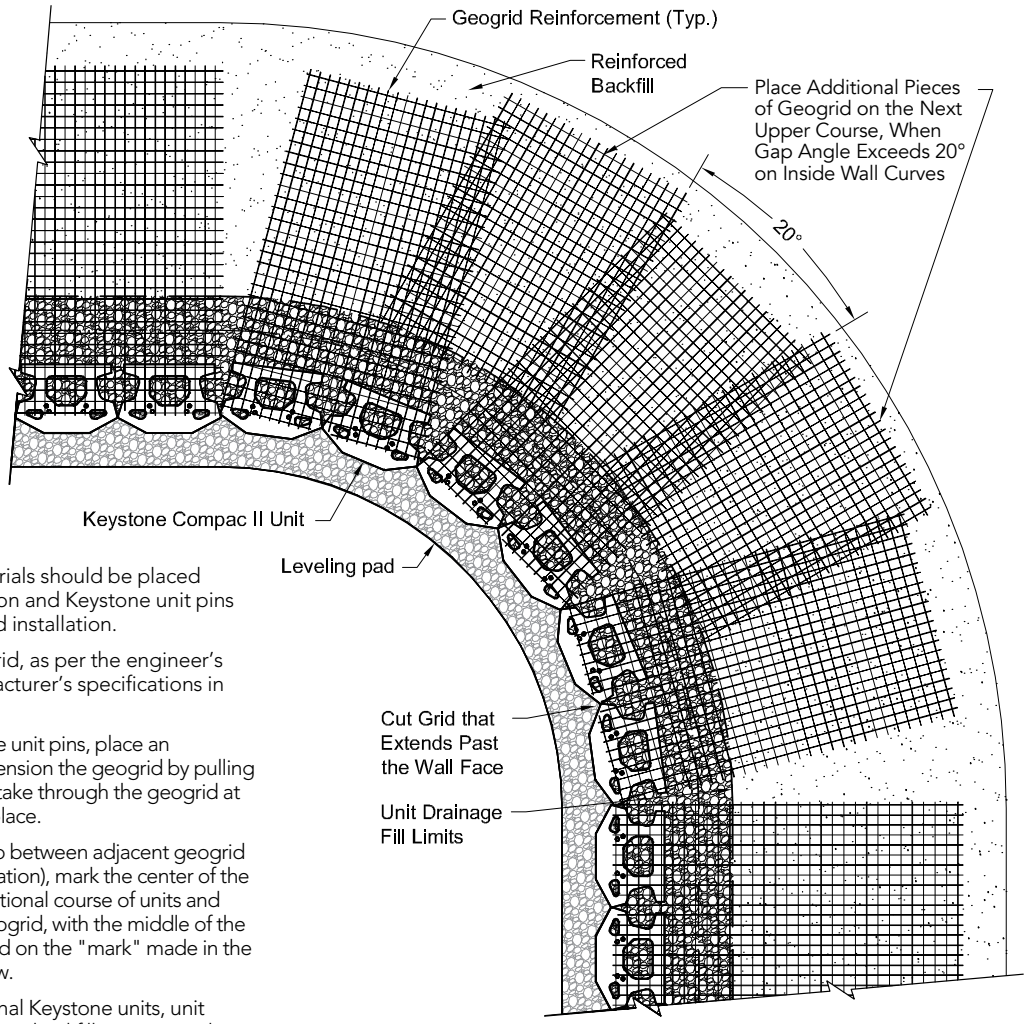


In Curve Cut Units Example Course

FIGURE C:14 - CONCAVE CURVE GEOGRID INSTALLATION



ISOMETRIC DETAIL



Notes:

Unit drainage fill and backfill materials should be placed compacted to the geogrid elevation and Keystone unit pins should be in place prior to geogrid installation.

Measure, cut and orient the geogrid, as per the engineer's design and/or the geogrid manufacturer's specifications in the correct strength direction.

Place the geogrid over the Keystone unit pins, place an additional course of wall units and tension the geogrid by pulling it back away from the wall. Place a stake through the geogrid at the back to tension the geogrid in place.

If the radius of the wall creates a gap between adjacent geogrid layers of greater than 20° (see illustration), mark the center of the "gap" in the geogrid, place an additional course of units and then place an additional layer of geogrid, with the middle of the additional piece of geogrid centered on the "mark" made in the center of the gapped geogrid below.

Proceed with placement of additional Keystone units, unit drainage fill and backfill material. Start backfilling nearest the Keystone units and then move back away from the wall, placing backfill materials over the geogrid to hold the geogrid in place under tension. After the backfilling process, the tension stakes may be removed for reuse.

Compact the backfill materials in 8 inch (203mm) lifts to the next reinforcement elevation, and repeat.

Convex curves are an aesthetically pleasing accent to any retaining wall. Keystone units can be easily integrated with multiple curves within the same wall. However, convex curves require attention to the details during construction. Every wall system has a minimum radius that can be built before the tails of the units come into contact with each other. This minimum radius is unique to the shape of each individual block system. In convex curves with wall batter, the tightest radius will always be the top course of the wall. This means that the radius at the base course of a convex curve wall will be larger than the desired radius at the top of the wall. Care should be taken when laying out a wall horizontal location in the field given these wall batter and radius relationships. The following is a minimum radius table for Keystone Compac and Keystone Standard units.

Minimum Radius Table

Unit Type	Series	Face Style	
		Tri-plane	Straight Split
Keystone Compac II & III	II	4' (1.2m)	6' (1.8m)
	III	4' (1.2m)	6' (1.8m)
Keystone Standard (18" [457mm] deep)	I	5' (1.5m)	6' (1.8m)
	II	6' (1.8m)	8' (2.4m)
	III	5' (1.5m)	6' (1.8m)
Keystone Standard (21" [533mm] deep)	I	5' (1.5m)	6' (1.8m)
	III	5' (1.5m)	6' (1.8m)

Notes:

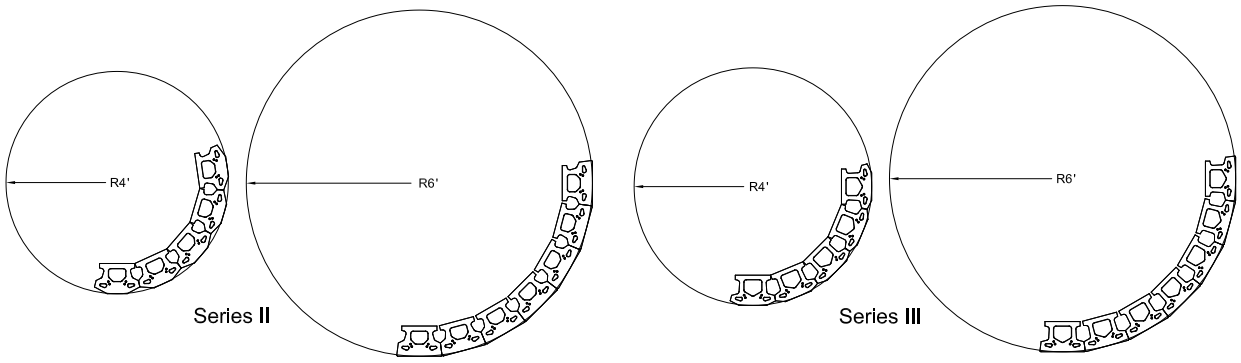
1) The table shows the minimum radius the units can turn without trimming.

2) Minimum radius was determined as being able to complete a full circle with units.

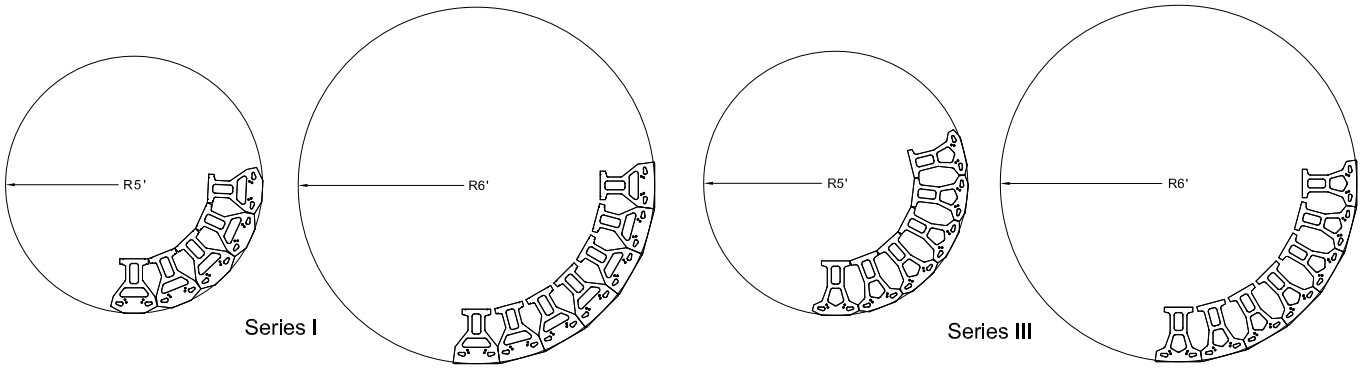
3) Quarter circle diagrams are shown below.

4) Minimum radius is for one course of units / or at top of wall. Radius at the base of the wall will need to be larger to account for wall batter.

FIGURE C:15 -MINIMUM RADIUS - KEYSTONE COMPAC UNITS



Keystone Compac Units Minimum Radius Examples



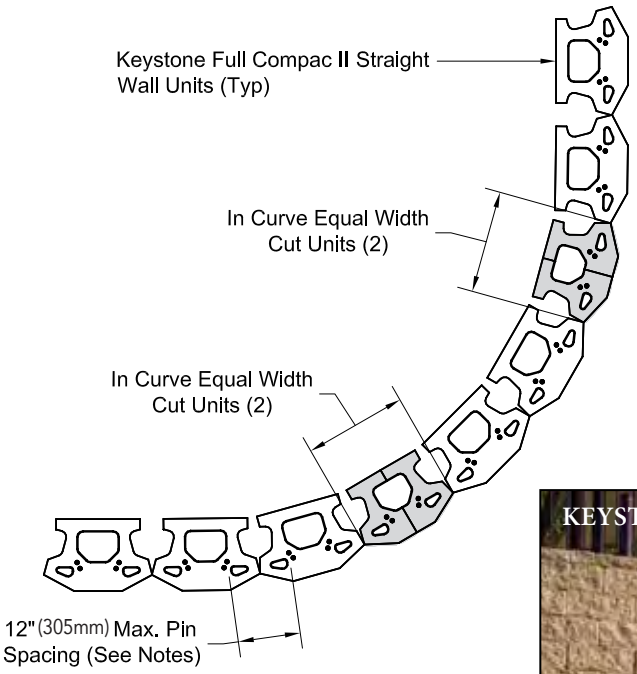
Keystone Standard Units (21" [533mm] Deep) Minimum Radius Examples

Convex Curves: With Setback

A setback battered convex curve wall requires some trimming of the units. When constructing an outside curve with batter, we recommend performing the following steps to maintain pin integrity and running bond configuration. It is recommended to construct the wall into the curve, maintaining a running bond pattern in the straight sections of the wall on either side of the curve. See Figure C:16 for additional details.

When building a battered wall in a convex or outside radius curve, the radius of the upper courses will become less than the radius of each lower course due to wall batter or setback. This will cause the units in upper courses to run off bond and the pins to migrate to the edge of the pin receiving hole. When this occurs, it will be necessary to cut a block the required amount to cause the pin on the next adjacent block to be at the opposite side of the pin receiving hole as the block on the other side of the cut. When coming out of the radius, cutting of another block may be required to maintain a more precise running bond on the straight wall extending away from the curve.

FIGURE C:16 - IN CURVE CUT UNITS EXAMPLE COURSE



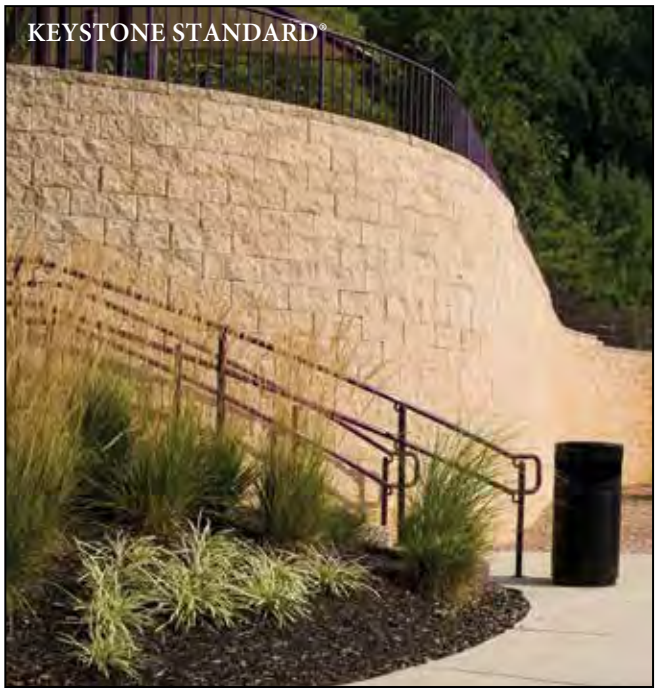
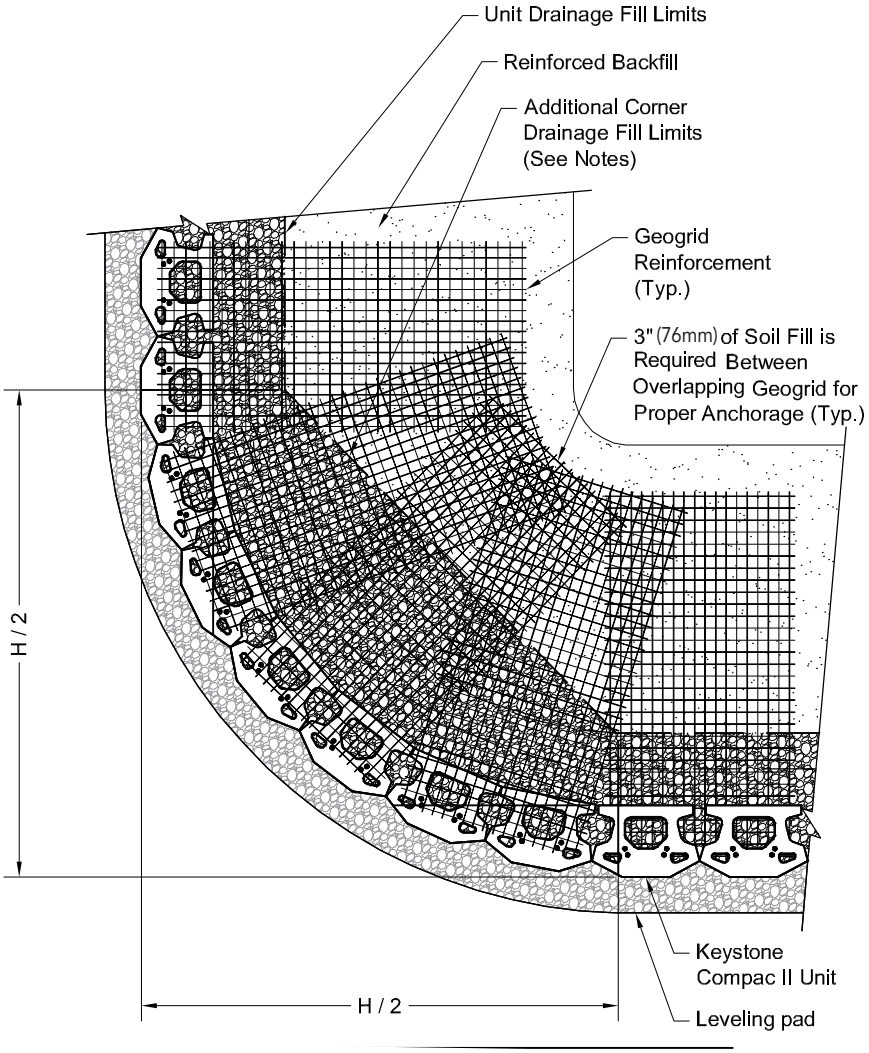


FIGURE C:17 - CONVEX CURVE GEOGRID INSTALLATION



Notes:

Unit drainage fill and backfill materials should be placed compacted to the geogrid elevation and Keystone unit pins should be in place prior to geogrid installation.

Place additional unit drainage fill at outside wall curve to extend back from wall face each way a distance equal to the wall height / 2 (H / 2).

Measure, cut and orient the geogrid, as per the engineer's design and/or the geogrid manufacturer's specifications in the correct strength direction.

Place the geogrid over the Keystone unit pins, place an additional course of units and tension the geogrid by pulling it back away from the wall. Place a stake through the geogrid at the back to tension the geogrid in place.

Proceed with placement of additional Keystone units, unit drainage fill and backfill material. Start backfilling nearest the Keystone units and then move back away from the wall, placing backfill materials over the geogrid to hold the geogrid in place under tension. After the backfilling process, the tension stakes may be removed for reuse.

Compact the backfill materials in 8 inch lifts to the next reinforcement elevation, and repeat.

ISOMETRIC DETAIL