GRAVITY RETAINING WALL TECHNICAL MANUAL
The user is responsible for the final design and use of the CornerStone® products. All drawings, illustrations, and text are accurate to the best of our knowledge but a qualified engineer shall do the analysis and structural design for all aspects of the segmental retaining wall project. The sole responsibility of the suitability of the products or information in this manual lies with the user.
**STANDARD BLOCK**

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<tr>
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<th>Value</th>
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<tr>
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<tr>
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<td>Volume Voids</td>
<td>6.35 ft³</td>
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<tr>
<td>Gravel Filled Weight</td>
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<tr>
<td>Face Area</td>
<td>8 sq ft</td>
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<tr>
<td>Batter/Setback</td>
<td>4.5 deg</td>
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**TOP BLOCK**

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<td>Face Area</td>
<td>8 sq ft</td>
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<td>Batter/Setback</td>
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**BASE BLOCK**

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*Face Style Varies - Check with local producer. Weights and dimensions are nominal.
Assumption: Concrete = 143 pcf (22.5 Kn/m³) / Aggregate 110 pcf (5.267)
STANDARD LEFT END CAP

Height | 24" | 610mm
Depth  | 8"  | 203mm
Top Narrow Width | 48" | 1219mm
Bottom Narrow Width | 39" | 991mm
Weight  | 340 lbs | 154 Kgs
Face Area | 4.66 sq2 | 0.434 m2

STANDARD RIGHT END CAP

Height | 24" | 610mm
Depth  | 8"  | 203mm
Top Narrow Width | 48" | 1219mm
Bottom Narrow Width | 39" | 991mm
Weight  | 340 lbs | 154 Kgs
Face Area | 4.66 sq2 | 0.434 m2

HALF HIGH LEFT END CAP

Height | 12" | 305mm
Depth  | 9"  | 229mm
Top Narrow Width | 3"  | 76mm
Bottom Narrow Width | 4"  | 102mm
Weight  | 170 lbs | 77 Kgs
Face Area | 2.33 sq2 | 0.217 m2

HALF HIGH RIGHT END CAP

Height | 12" | 305mm
Depth  | 9"  | 229mm
Top Narrow Width | 3"  | 76mm
Bottom Narrow Width | 4"  | 102mm
Weight  | 170 lbs | 77 Kgs
Face Area | 2.33 sq2 | 0.217 m2

*Face Style Varies Check with local producer / Weights and dimensions are nominal
Assumption: Concrete = 143 pcf (22.5 Kn/m3) / Aggregate 110 pcf (5.267)
**48"(1219)**

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<tr>
<td>Depth</td>
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<tr>
<td>Gravel Filled Weight</td>
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<td>1780 Kg</td>
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**72"(1829)**

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</tr>
<tr>
<td>Depth</td>
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<tr>
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<td>1219mm</td>
</tr>
<tr>
<td>Back Width</td>
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<tr>
<td>Weight</td>
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<td>1006 Kgs</td>
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**96"(2438)**

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<tr>
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<td>2438mm</td>
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<tr>
<td>Weight</td>
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<td>Volume Voids</td>
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<td>Gravel Filled Weight</td>
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<td>3533 Kg</td>
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**120"(3048)**

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</thead>
<tbody>
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<td>Height</td>
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<td>610mm</td>
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<tr>
<td>Depth</td>
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<td>Weight</td>
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<td>Volume Voids</td>
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<tr>
<td>Gravel Filled Weight</td>
<td>9126 lbs</td>
<td>4139 Kg</td>
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</tbody>
</table>

*Face Style Varies Check with local producer. Weights and dimensions are nominal. Assumption: Concrete = 143 pcf (22.5 Kn/m³), Aggregate 110 pcf (5.267)*
Extender to MagnumStone block installation

After the MagnumStone block with the extender has been laid in its appropriate place, the extender unit is slowly dropped into the back center hollow portion. Once connected, the MagnumStone and extender will act as 1 unit and be secured with backfill materials and compaction.
Extender to Extender Installation
MagnumStone extenders can be used in any combination of standard lengths. The design will be based on what is best suited for the soils and loads. MagnumStone engineering design software will allow the user to choose what is best suited for the project. Once a back fill is chosen the contractor can backfill and compact around the extender units. Typically a free draining material clean stone or approved material will be used.

Clean Stone between extenders and through hollow core or approved backfill materials
**Excavation**
Follow proper procedures for excavation cut lines and slopes etc. Consult your local Engineer for a proper design and soils testing / analysis.

**Base Preparation**
Follow proper procedures for excavation cut lines and slopes etc.

The width of the base leveling pad should be the depth of the block and or extender(s) on the first course plus 6” (152mm) front and back.

Example for a standard unit
24” + 6’ (front) + 6” (back)  = 48” total

Material should be a 3/4” (20mm) road crush or equivalent

The depth of the leveling pad should be minimum of 6” thick compacted to 95% standard proctor density.

Soil separating fabrics may be used between the sub-base and leveling pad.

**MagnumStone Block Installation**
All MagnumStone Units shall be installed and leveled front to back and side to side.
MagnumStone block and extender installation
Install the MagnumStone base block on the leveling pad. The base block should not have the lugs on the bottom. Ensure that the blocks are level front to back and side to side.
Place the tongue of the extender block inside the groove of the MagnumStone block. If extender to extender blocks are required place them in the same manner as the previous ensuring that the blocks stay level and true.

Backfill MagnumStone blocks and extender units
Backfilling the MagnumStone blocks and extender units with a clear crush gravel (#57 Stone) slightly above the units. Run a plate vibratory compactor over the stones and units allowing them to settle in the hollow cores. Sweep any excess stones off the top of the units and blocks.
Finish laying the MagnumStone Units and Extenders

4" Perforated Drain Pipe
Daylight front of wall min 35ft (11m)

Back Fill the Hollow cores and between extender units with clean stone or approved Backfill

Install the drain gravel slightly above the units and compact with a plate vibratory compactor. Sweep access rock and debris off the blocks before installing the next course

MagnumStone Block and Extender Installation
Every MagnumStone block and extender unit should be installed with proper care ensuring they are level and aligned

Lay the Next row on a running Bond pattern with the SecureLugs Connected in the hollow core below

Complete the 2nd row installation ensuring everything is level
Soil Separation Fabric
Install a soil separating fabric to separate the fines and compacted backfill material from the drainage aggregate. The filter fabric can be installed directly behind the MagnumStone extender units.

Compact the approved backfill material behind the filter fabric

Filter fabric wrapped around clean gravel to stop fines from migrating

Compaction
Once the blocks have been placed and leveled compact the approved backfill materials.
installation
Ensure that proper installation procedures and techniques are being used while installing each course. The blocks should be installed and levelled front to back and side to side.

Filter fabric placed behind extender units
Approved compacted backfill

Drainage Through Hollow Core

Clean Stone or approved Backfill materials between extender units and inside hollow cores

Filter Fabric

MagnumStone Top Unit
Typical Completed Cross Section

- Filter Fabric
- Approved backfill materials
- Filter Fabric at back of extenders
- Excavation
- Filter Fabric wrapped around wash rock to protect fines from migrating
- Clean Stone or approved Backfill materials between extender units and inside hollow cores
- Extender Units as designed by Engineer
- Compacted Base Material
- Drain Pipe
- Toe of Wall or Embedment
48" (1219) Extender Outside Corner
Corners in retaining walls are unavoidable. With the MagnumStone gravity system we have developed a solution that fits any situation.

72" (1829) Extender Outside Corner
- Follow proper procedures for excavation cut lines and slopes etc.
96" (2438) Extender Outside Corner

- Corner End Cap Base Block
- Standard Base Block

- Standard Block
- Standard Corner End Cap

120" (3048mm) Extender Outside Corner

- 120" (3048) Extender Base Block
- 96"(2438) Extender
- Corner End Cap Base Block
- Standard Base Blocks
- 72"(1829) Extender

72"(1829) Extender

- Standard Block
- Standard Corner End Cap

96"(2438) Extender

120"(3048) Extender
48" (1219) Extender Inside Corner

- 48" (1219) Extender & Base Block
- 48" (1219) Extender & Base Block in Middle of adjacent block
- 48" (1219) Extender & Standard Block in Middle of Adjacent Block
- 48" (1219) Extender & Standard Block

72" (1829) Extender Inside Corner

- 72" (1829) Extender & Base Block
- 72" (1829) Extender & Base Block in Middle of Adjacent Block
- 72" (1829) Extender & Standard Block in Middle of Adjacent Block
- 72" (1829) Extender & Standard Block
96" (2438) Extender Inside Corner

96"(2438) Extender & Base Block Placed in Middle of Adjacent Block

96"(2438) Extender & Base Block

96"(2438) Extender & Standard Block

96"(2438) Extender & Standard Block Placed in Middle of Adjacent Block

120" (3048mm) Extender Inside Corner

120"(3048) Extender & Base Block Placed in Middle of Adjacent Block

120"(3048) Extender & Base Block

120"(3048) Extender & Standard Block

120"(3048) Extender & Standard Block Placed in Middle of Adjacent Block
48" (1219) Inside Curve

48"(1219) Extender & Base Block

48"(1219) Extender & Standard Block

72" (1829mm) Inside Curve

72"(1829) Extender & Base Block

72"(1829) Extender & Standard Block
96" (2438) Inside Curve

96"(2438) Extender & Base Block

96"(2438) Extender & Standard Block

120" (3048mm) Inside Curve

120"(3048) Extender & Base Block

120"(3048) Extender & Standard Block
48" (1219) Outside Curve

48" (1219) Extender & Base Block

48" (1219) Extender & Standard Block

72" (1829mm) Outside Curve

72" (1829) Extender & Base Block

48" (1219) Extender & Base Block

72" (1829) Extender & Standard Block

48" (1219) Extender & Standard Block
96" (2438) Outside Curve

- 96"(2438) Extender & Base Block
- 72"(1829) Extender & Base Block

72"(1829) Extender & Standard Block

96"(2438) Extender & Standard Block

120" (3048mm) Outside Curve

- 120"(3048) Extender & Base Block
- 96"(2438) Extender & Base Block

120"(3048) Extender & Standard Block

96"(2438) Extender & Standard Block
### Gravity Retaining Wall Estimation Charts

<table>
<thead>
<tr>
<th>Slope Angle</th>
<th>0 Degrees</th>
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<tbody>
<tr>
<td>Live Load</td>
<td>0 PSF</td>
</tr>
<tr>
<td>Retained Soil</td>
<td>34 Degrees</td>
</tr>
<tr>
<td>Unit Refill</td>
<td>Crushed Gravel</td>
</tr>
</tbody>
</table>

Note: Calculations are for preliminary use only and should not be used for construction without the review of a qualified professional.

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**Diagram Descriptions:**

- **6' (1.8m):**
  - Height: 6 feet, 180 cm
  - Footing: 2 feet, 60 cm

- **8' (2.4m):**
  - Height: 8 feet, 240 cm
  - Footing: 4 feet, 120 cm

- **10' (3m):**
  - Height: 10 feet, 300 cm
  - Footing: 10 feet, 300 cm

- **12' (3.7m):**
  - Height: 12 feet, 370 cm
  - Footing: 12 feet, 360 cm

- **14' (4.2m):**
  - Height: 14 feet, 420 cm
  - Footing: 14 feet, 420 cm

- **16' (4.9m):**
  - Height: 16 feet, 490 cm
  - Footing: 16 feet, 480 cm

- **18' (5.4m):**
  - Height: 18 feet, 540 cm
  - Footing: 18 feet, 540 cm

- **20' (6m):**
  - Height: 20 feet, 600 cm
  - Footing: 20 feet, 600 cm

- **22' (6.7m):**
  - Height: 22 feet, 670 cm
  - Footing: 10 feet, 300 cm

- **24' (7.3m):**
  - Height: 24 feet, 730 cm
  - Footing: 10 feet, 300 cm
### Gravity Retaining Wall Estimation Charts

<table>
<thead>
<tr>
<th>Slope Angle</th>
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<td>250 PSF</td>
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<tr>
<td>Retained Soil</td>
<td>34 Degrees</td>
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<tr>
<td>Unit Refill</td>
<td>Crushed Gravel</td>
</tr>
</tbody>
</table>

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### Gravity Retaining Wall Estimation Charts

<table>
<thead>
<tr>
<th>Slope Angle</th>
<th>Live Load</th>
<th>Retained Soil</th>
<th>Unit Fill</th>
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<tbody>
<tr>
<td>20 Degrees</td>
<td>0 PSF</td>
<td>34 Degrees</td>
<td>Crushed Gravel</td>
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</table>

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MagnumStone Wall Designer

In the following pages we have completed a sample design analysis using CornerStone Wall Designer engineering program.

http://magnumstone.com/magnumstone-wall-designer/

For preliminary design purposes we have used certain design assumptions
Gravity Wall Analysis - Output

**REAwall**

*Version: 4.0.16099*

**Project:** Sample Project  
**Location:** Site Location  
**Designer:** xxx  
**Date:** 4/29/2016  
**Section:** Section 1  
**Design Method:** NCMA_09_3rd_Ed  
**Design Unit:** MagnumStone

**SOIL PARAMETERS**

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<th>γ</th>
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<td>Retained Soil:</td>
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<td>0 psf</td>
<td>120 psf</td>
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<tr>
<td>Foundation Soil:</td>
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<td>0 psf</td>
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<tr>
<td>Leveling Pad:</td>
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<td>130 psf</td>
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<tr>
<td>Crushed Stone</td>
<td></td>
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</tbody>
</table>

**GEOMETRY**

| Design Height: | 24.00 ft | Live Load: | 0 psf |
| Wall Batter/Tilt: | 4.77/0.00 deg | Live Load Offset: | 0.00 ft |
| Embedment: | 0.50 ft | Live Load Width: | 100 ft |
| Leveling Pad Depth: | 0.50 ft | Dead Load: | 0 psf |
| Slope Angle: | 0.0 deg | Dead Load Offset: | 0.0 ft |
| Slope Length: | 0.0 ft | Dead Load Width: | 100 ft |
| Slope Toe Offset: | 0.0 ft | Leveling Pad Width: | 11.00 ft |

**FACTORs OF SAFETY**

| Sliding: | 1.50 | Overturning: | 1.50 |
| Bearing: | 2.00 |

**RESULTS**

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<tr>
<th>Name</th>
<th>Elevation</th>
<th>Elev [ft]</th>
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<th>Pa</th>
<th>Preq</th>
<th>Preqd</th>
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<th>kPa</th>
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<td>42%</td>
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<td>0.378</td>
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<td>0</td>
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<td>42%</td>
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</tbody>
</table>

CornerStone Analysis and Design 4.0.16099
Gravity Wall Analysis - Output

NOTES ON DESIGN UNITS

The wall section is designed on a ‘per unit width bases’ (lb/ft² of wall or kN/m of wall). In the calculations the software shows lb/ft² or kN/m, neglecting the unit width factor for simplicity.

The weights for the wall unit are shown as lbs/ft³ (kN/m³). For SRW design a 1 sf unit is typically 1 ft deep, 1.5 ft wide and 8 inches tall (or 1 ft³), therefore a typical value of 120 psf is shown. With larger units the unit weight will vary with the size of the unit. Say we have 4 ft wide unit, 1.5 ft tall and 24 inches deep with a tapered shape (sides narrow), built with 150 psf concrete. We add up the concrete, the gravel fill and divide by the volume and the results may come out to 140 psf, as shown in the table. The units with more gravel may have lower effective unit weights based on the calculations.

Hollow Units
Hollow units with gravel fill are treated differently in AASHTO. If the fill can fall out as the unit is lifted, then AASHTO only allows 80% of the weight of the fill to be used for eccentricity (overturning calculations). In the properties page for the units the weight of the concrete may be as low as 75 psf. This is the effective unit weight of the concrete only (e.g. the weight of the concrete divided by the volume of the unit). The density of the concrete maybe 150 psf, but not the effective weight including the volume of the void spaces used for gravel fill.

Rounding Errors
When doing hand calculations the values may vary from the values shown in the software. The program is designed using double precision values (64 bit precision: 14 decimal places). Over several calculations the results may differ from the single calculation the user is making, probably inputting one or two already rounded values.

Result Rounding
As noted above the software is based on double precision values. For example, using an NCMA design method an allowable factor of safety of 1.5 the software may calculate a value of 1.499999999999999, since this is less than 1.5, it would be false (NG), even though the results shown is 1.50 (results are rounded to 2 places on the screen). In the design check we round to 2 decimal place to check against the suggested value (1.499999999999999 rounds to 1.50). Given the precision of the calculation, this will provide a safe design even though the ‘absolute’ value is less than the minimum suggested.
Gravity Wall Analysis - Output

**TARGET DESIGN VALUES (Factors of Safety)**
- Minimum Factor of Safety for the sliding along the base: FSel = 1.50
- Minimum Factor of Safety for overturning about the toe: FSot = 1.50
- Minimum Factor of Safety for bearing (foundation shear failure): FSbr = 2.00

**MINIMUM DESIGN REQUIREMENTS**
- Minimum embedment depth: Min_emb = 0.50 ft

**INPUT DATA**

**Geometry**
- **Wall Geometry**
  - Design Height, top of leveling pad to finished grade at top of wall: H = 24.00 ft
  - Embedment, measured from top of leveling pad to finished grade: emb = 0.50 ft
  - Leveling Pad Depth: LP_Thickness = 0.50 ft
  - Face Batter, measured from vertical: i = 4.77 deg

- **Slope Geometry**
  - Slope Angle, measured from horizontal: β = 0.00 deg
  - Slope toe offset, measured from back of the face unit: STL_offset = 0.00 ft
  - Slope Length, measured from back of wall facing: SL_length = 0.00 ft

**NOTE:** If the slope toe is offset or the slope breaks within three times the wall height, a Coulomb Triax Wedge method of analysis is used.

**Surcharge Loading**
- Live Load, assumed transient loading (e.g. traffic): LL = 0.00 psf
- Live Load Offset, measured from back face of wall: LL_offset = 0.00 ft
- Live Load Width, assumed strip loading: LL_width = 100.00 ft
- Dead Load, assumed permanent loading (e.g. buildings): DL = 0.00 psf
- Dead Load Offset, measured from back face of wall: DL_offset = 0.00 ft
- Dead Load Width, assumed strip loading: DL_width = 100.00 ft

**Soil Parameters**

**Retained Zone**
- Angle of Internal Friction: φ = 34.00 deg
- Cohesion: c = 0.00 psf
- Moist Unit Weight: γ = 120.00 psf

**Foundation**
- Angle of Internal Friction: φ = 34.00 deg
- Cohesion: c = 0.00 psf
- Moist Unit Weight: γ = 120.00 psf
Gravity Wall Analysis - Output

RETAINING WALL DESIGNER

STRUCTURAL PROPERTIES:
- N is the normal force [or factored normal load] on the base unit.
- The default leveling pad to base unit shear is 0.8 tan(θ) or may be the manufacturer supplied data. θ is assumed to be 40 degrees for a stone leveling pad.

Table of Values:

<table>
<thead>
<tr>
<th>Unit</th>
<th>Height (in)</th>
<th>Width (in)</th>
<th>Depth (in)</th>
<th>Conc. vol (cft)</th>
<th>Conc. Density (pcf)</th>
<th>CG (in)</th>
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<td>60.16</td>
<td>12.00</td>
<td>112.43</td>
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</table>
Gravity Wall Analysis - Output

**FORCE DETAILS**

The details below show how the forces and moments are calculated for each force component. The values shown are not factored. All loads are based on a unit width (pfp / kNpm).

<table>
<thead>
<tr>
<th>Layer</th>
<th>Block Wt</th>
<th>X-Arm</th>
<th>Moment</th>
<th>Soil Fill Wt</th>
<th>X-Arm</th>
<th>Moment</th>
<th>Soil Wt</th>
<th>X-Arm</th>
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<td>8701.19</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
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</table>

Block Weight (Force V) = block 6234
Soil Fill: 9270 pfp
Soils Block Weight (Force V) = 1780 pfp

Active Earth Pressure Pa = 13078 pfp

\[ P_a (Force \ H) = P_a \cos(batter + \theta) = 13078 \times \cos(14.4 + 25.5) = 10332 \text{ pfp} \]

Y-Arm = 8.00 ft

\[ P_a (Force \ V) = P_a \sin(batter + \theta) = 13078 \times \sin(14.4 + 25.5) = 8360 \text{ pfp} \]

X-Arm = 7.85 ft

Passive Earth Pressures:
Passive earth pressures are used for resistance of the Leveling Pad, but may be extended upward to assist with the resistance of the wall facing for walls that have deep embedments.

Passive Earth Pressure:

\[ k_p = 3.54 \]

\[ F_p = 159.17 \text{ pfp} \]
Gravity Wall Analysis - Output

Calculation Results

Overview
CornerStone calculates stability assuming the wall is a rigid body. Forces and moments are calculated about the base and the front toe of the wall. The base block width is used in the calculations. The concrete units and granular fill over the blocks are used as resisting forces.

Earth Pressures
The method of analysis uses the Coulomb Earth Pressure equation (below) to calculate active earth pressures. Wall friction is assumed to act at the back of the wall face. The component of earth pressure is assumed to act perpendicular to the boundary surface. The effective δ angle is δ minus the wall batter at the back face. If the slope breaks within the failure zone, a trial wedge method of analysis is used.

External Earth Pressures
Effective δ angle (3/4 retained phi)  δ = 25.5 deg
Coefficient of active earth pressure

External failure plane
Effective Angle from horizontal
Coefficient of passive earth pressure: kp = (1 + sin(δ)) / (1 - sin(δ))  kp = 3.64  p = 63 deg  Eff. Angle = 76.60 deg

W0: stone within units
W1: facing units
W2: stone over the tails
W9: Driving force Pa
W10: Driving Surcharge load Paq
W11: Driving Dead Load Surcharge Paqd

Forces and Moments
The program resolves all the geometry into simple geometric shapes to make checking easier. All x and y coordinates are referenced to a zero point at the front toe of the base block.

Unfactored Loads

<table>
<thead>
<tr>
<th>Name</th>
<th>Factory Force (V)</th>
<th>Forces (H)</th>
<th>X-Len</th>
<th>Y-Len</th>
<th>Mo</th>
<th>Mr</th>
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</thead>
<tbody>
<tr>
<td>Face Blocks(W1)</td>
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<tr>
<td>Soil Wedge(W2)</td>
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<td></td>
<td>6666</td>
</tr>
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<td>LmPad(W18)</td>
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<td></td>
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<td>Pa_h</td>
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<td>28364</td>
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<td>10032</td>
<td>Sum Mom</td>
<td>40260</td>
</tr>
</tbody>
</table>

Note: Live load forces and moments are not included in SumV or Mr as live loads are not included as resisting forces.

CornerStone Analysis and Design 4.0.16090
Gravity Wall Analysis - Output

BASE SLIDING:
Sliding at the base is checked at the block to leveling pad interface between the base block and the leveling pad. Sliding is also checked between the leveling pad and the foundation soils.

Forces Resisting sliding = W0 + W1 + W2 + Pav
9276 + 6234 + 1798 + 8390
N = 25668 ppf

Resisting force at pad = W0 tan(slope1) + (W1 + W2 + Pav) tan(slope) + intercept x L
[\text{slope 1 is the friction between the unit fill and the leveling pad, tan(36.0)}]
9276 x tan(36) + 16422 x tan(33.9) + 0.0 x 10.0
RF1 = 17763
where L is the base block width

Friction angle is the lesser of the leveling pad and Fnd
\( \phi = 34.00 \text{ deg} \)
N1 includes N (the leveling pad) + leveling pad (LP)
25668 + 666
N1 = 26364 ppf

Passive resistance is calculated using \( kp = \frac{1 + \sin(34)}{1 - \sin(34)} \)
kp = 3.54
Pressure at top of resisting trapezoid, \( d1 = 0.50 \)
Fp1 = 212.23
Pressure at base of resisting trapezoid, \( d2 = 0.50 \)
Fp2 = 212.23
Depth of trapezoid
\( \text{depth} = 0.00 \)
159.17
PP = (Fp1 + Fp2) / \( 2 * \text{depth} \)
Resisting force at fnd = (N1 tan(\phi)) + (L + PP) \( \text{PP} = 159.17 \)
26364 x tan(34) + 0 x 10.3 + 159
RF2 = 17942
where LP = lv pad thickness * 130pcf * (L + lv pad thickness/2)

Driving force is the horizontal component of Pah
10032
\( Df = 10032 \)

FSsi = RF / DF
FSsi = 1.77 / 1.79
Gravity Wall Analysis - Output

OVERTURNING ABOUT THE TOE

Overturning at the base is checked by assuming rotation about the front toe by the block mass and the soil retained on the blocks. Allowable overturning can be defined by eccentricity (e/L). For concrete leveling pads eccentricity is checked at the base of the pad.

Moments resisting eccentricity = M1 + M2 + MSoil + fill + MLvIPad + MPav
20389 + 43177 + 6665 + 66669

Mr = 136880 ft-lbs

Moments causing eccentricity = MPah + MPq
80260

Mo = 80260 ft-lbs

\[
e = \frac{(Mr - Mo)N_1}{N_1}
\]
\[
e = \frac{10.002 - (136880 - 80260)}{26384}
\]
e = 2.80

\[
e/L = 0.28
\]

FSot = Mr / Mo
FSot = 136880 / 80260

FSot = 1.71
Gravity Wall Analysis - Output

CORNERSTONE WALL DESIGNER

ECCENTRICITY AND BEARING
Eccentricity is the calculation of the distance of the resultant away from the centroid of mass. In wall design the eccentricity is used to calculate an effective footing width.

Calculation of Eccentricity
\[ \text{SumV} = (W1 + W2 + Pa_v) \]
\[ e = \frac{L}{2} \cdot \frac{(\text{SumM}_x - \text{SumM}_y)}{(\text{SumV})} \]
\[ e = \frac{10.00}{2} \cdot \frac{(56621 - 26597.70)}{26597.70} \]
\[ e = 2.797 \text{ ft} \]

Calculation of Bearing Pressures
\[ Qu = c \cdot No + q \cdot Nq + 0.5 \cdot y^* \cdot (B')^* \cdot Ng \]
where:
\[ No = 42.16 \]
\[ Nq = 29.44 \]
\[ Ng = 41.06 \]
\[ c = 0.09 \text{ psf} \]
\[ q = 120.00 \text{ psf} \]
\[ B' = B - 2e + Mpad = 4.91 \text{ ft} \]
\[ \text{Gamma(LP)} = 130 \text{ psf} \]

Calculate Ultimate Bearing, Quut
\[ \text{Bearing Pressure} = \frac{(\text{SumVert} / B')}{((2B + \text{LP depth})/2 \cdot \text{LP depth} \cdot \text{gamma})} \]
\[ \text{Quut} = 16622 \text{ psf} \]
\[ \text{sigma} = 5288.86 \text{ psf} \]
\[ \text{Quut/sigma} = 2.95 \]