



Project	Stone Strong Gravity Retaining Wall	Job #		Date	March 2003
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STRUCTURAL ANALYSIS OF GRAVITY RETAINING WALL
MAXIMUM HEIGHT OF 9 FEET
USING 24 SF BLOCKS

Discussion of Analysis: As the wall is constructed, granular fill is placed in the voids. This creates a "blow-out" force acting on the front and back faces of the block as well as on the webs which define the void. The pressure on the webs is balanced by fill on both sides. The blow-out force on the back face can be considered to be balanced by the active earth pressure of the backfill. The front face must be analyzed for an unbalanced pressure due to the blow-out force.

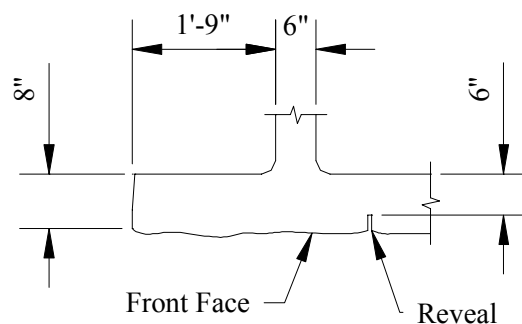
For the fill materials specified, the blow-out force will be taken equal to the at-rest pressure of the fill material assumed to be 40 pcf equivalent fluid pressure. This pressure theoretically increases proportional to the height of the fill. However, the pressure is limited to some maximum fill height above which the granular fill becomes "suspended" by friction on the wall. For this analysis any friction will be ignored and the blow-out force will be calculated using the full height of the column of fill in the void.

For this analysis, ACI 318-2002 *Building Code Requirements for Structural Concrete* will be used. The capacity of the block will be checked using Chapter 22 for Structural Plain Concrete. Only concrete with a 28-day compressive strength of 4000 psi or more shall be used. All concrete shall meet the quality, mixing, and placing requirements of ACI 318. Under no circumstances shall return or rejected concrete be used.

See Notes on page 5 of 5 for important limitations.

ANALYSIS OF FRONT FACE

Thickness of front face varies due to architectural form liner. For the cantilever portions, use minimum thickness of 8" because there are no vertical reveals. For the middle portion, use minimum thickness of 6" at the vertical reveal. Critical section for moment is at face of the web.

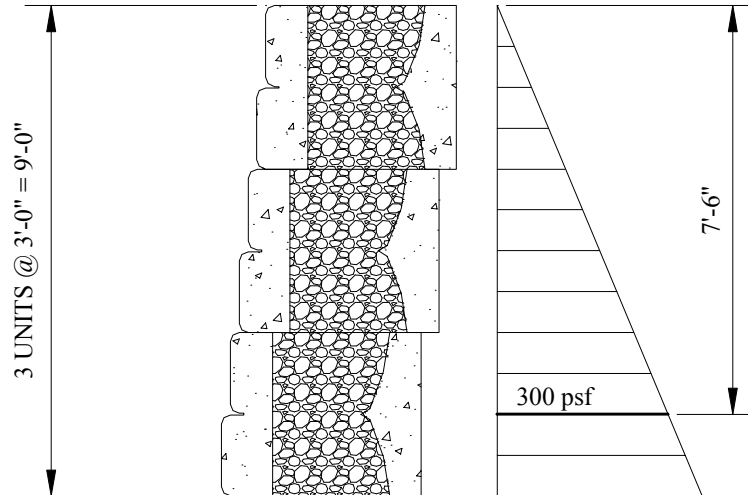


The upper half of the block is set back 2" from the lower half giving the appearance of two courses. For design purposes, conservatively use the pressure at midheight of the block as acting on the upper "course". Consider a 9' tall wall.



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Pressure = 40 pcf * 7.5' = 300 psf



Cantilever:

Span = 1.75' (to face of web, ignoring fillets)

$$M_u = 1.6 * 300 \text{ psf} * (1.75')^2 / 2 = 735 \text{ lb-ft per foot of width}$$

$$h = 8''$$

$$S = 12'' * (8'')^2 / 6 = 128 \text{ in}^3$$

$$\Phi M_n = 0.55 * 5 * \sqrt{4000} * 128 \text{ in}^3 / 12 = 1855 \text{ lb-ft} > 735 \text{ lb-ft} \quad \text{OK}$$

$$V_u = 1.6 * 300 \text{ psf} * 1.75' = 840 \text{ lb per foot of width}$$

$$\Phi V_n = 0.55 * 4/3 * \sqrt{4000} * 12'' * 8'' = 4450 \text{ lb} > 840 \text{ lb} \quad \text{OK}$$



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Middle Span:

Span = 4' center to center of webs

$M_u = 1.6 * 300 \text{ psf} * (4')^2 / 12 = 640 \text{ lb-ft per foot of width}$
(conservatively taken at centerline of webs)

$h = 6''$ (at vertical reveal, location varies)

$$S = 12 * (6)^2 / 6 = 72 \text{ in}^3$$

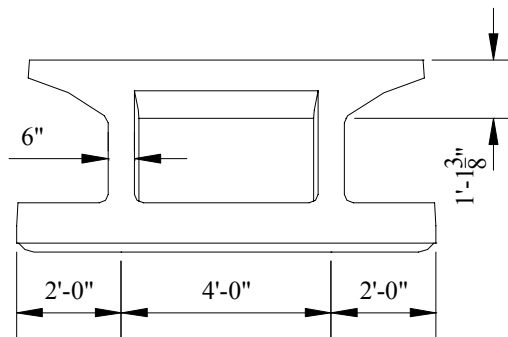
$$\Phi M_n = 0.55 * 5 * \sqrt{4000} * 72 \text{ in}^3 / 12 = 1040 \text{ lb-ft} > 640 \text{ lb-ft} \quad \text{OK}$$

$V_u = 1.6 * 300 \text{ psf} * 2' = 960 \text{ lb per foot of width}$
(conservatively taken at centerline of webs)

$$\Phi V_n = 0.55 * 4/3 * \sqrt{4000} * 12'' * 6'' = 3340 \text{ lb} > 960 \text{ lb} \quad \text{OK}$$

ANALYSIS OF BACK FACE

Although the back face should not see unbalanced pressure as discussed above, an analysis of the capacity will be made.





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Cantilever:

$$h = 13.4'' \text{ at face of web}$$

$$S = 12 \cdot (13.4)^2 / 6 = 359 \text{ in}^3$$

$$\Phi M_n = 0.55 \cdot 5 \cdot \sqrt{4000} \cdot 359 \text{ in}^3 / 12 = 5200 \text{ lb-ft}$$

$$\text{Span} = 1.75' \text{ (to face of web, ignoring fillets)}$$

$$M_u = 1.6 \cdot w \cdot (1.75')^2 / 2 = 5200 \text{ lb-ft}$$

$$w = 2120 \text{ psf}$$

Note that this capacity far exceeds any pressure resulting from this gravity wall analysis. The geometry of the back face is designed for the high earth pressure that results from tall mechanically stabilized earth retaining walls. For the gravity wall, the back face provides additional mass for stability against overturning.

ANALYSIS OF WEBS

During construction, the block is picked up by lifting devices in the webs. The webs must also be able to resist the blow-out forces on the front face.

Web shear during lifting:

$$\text{Approximate weight of front face} = 3000 \text{ lb}$$

$$\text{Web height} = 36'' - 5'' \text{ notch} = 31''$$

$$V_u = 1.4 \cdot 3000 \text{ lb} = 4200 \text{ lb}$$

$$\Phi V_n = 0.55 \cdot 4/3 \cdot \sqrt{4000} \cdot (2@6'' \text{ webs}) \cdot 31'' = 17,250 \text{ lb} > 4200 \text{ lb} \quad \text{OK}$$

Web tension resisting blow-out:

$$\text{Factored blow-out on front face} = 1.6 \cdot 300 \text{ psf} \cdot 3' \cdot 8' = 11,520 \text{ lb}$$

$$\begin{aligned} \text{Say tension capacity of web} &= 0.55 \cdot 5 \cdot \sqrt{4000} \cdot (2@6'' \text{ webs}) \cdot 31'' \\ &= 64,700 \text{ lb} > 11,520 \text{ lb} \quad \text{OK} \end{aligned}$$

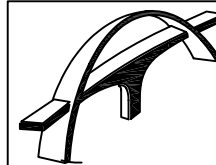
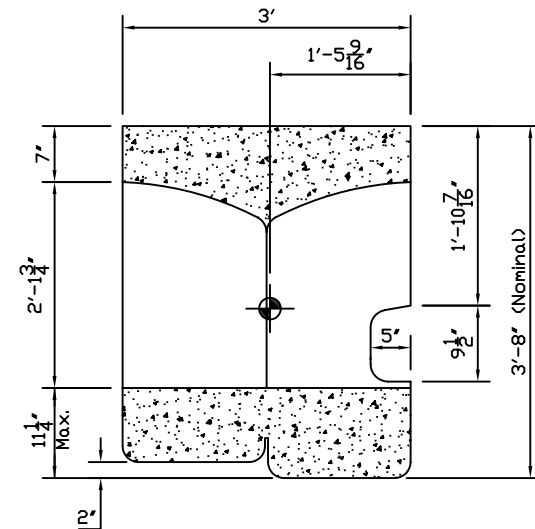
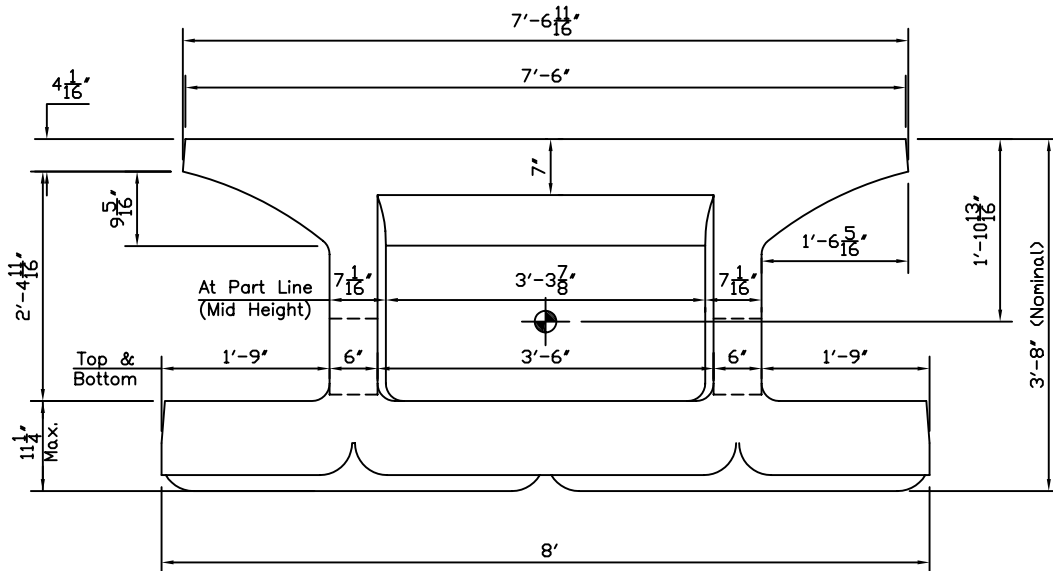


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Notes:

The analysis provided in these example calculations are for general information purposes only. Anyone making use of this information does so at their own risk and assumes all liability resulting from such use. The soil properties used in these calculations are assumed based on general soil types and may not be applicable to any given project. Site specific design should be performed by a licensed Professional Engineer who is familiar with the actual site conditions and materials, including the supporting and retained soils and ground water.

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PROJECT

DETAILS
STONE STRONG SYSTEMS

JOB #

DATE:

FILE: