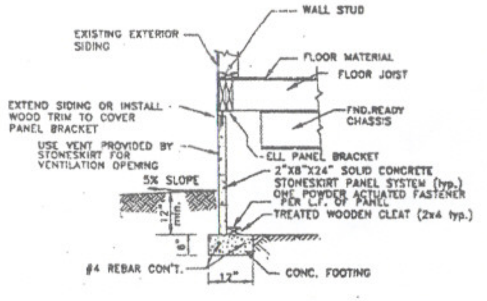
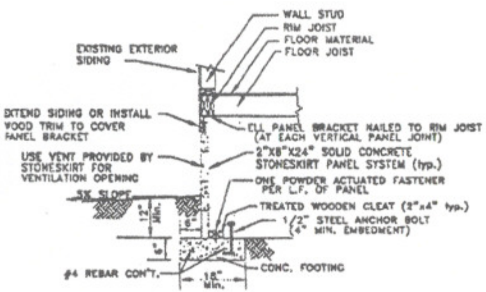
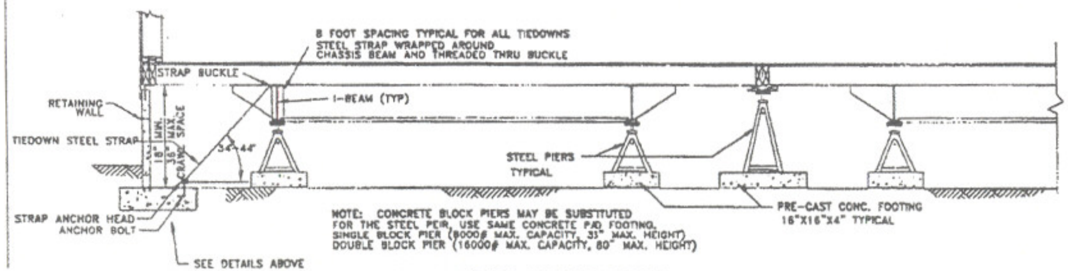


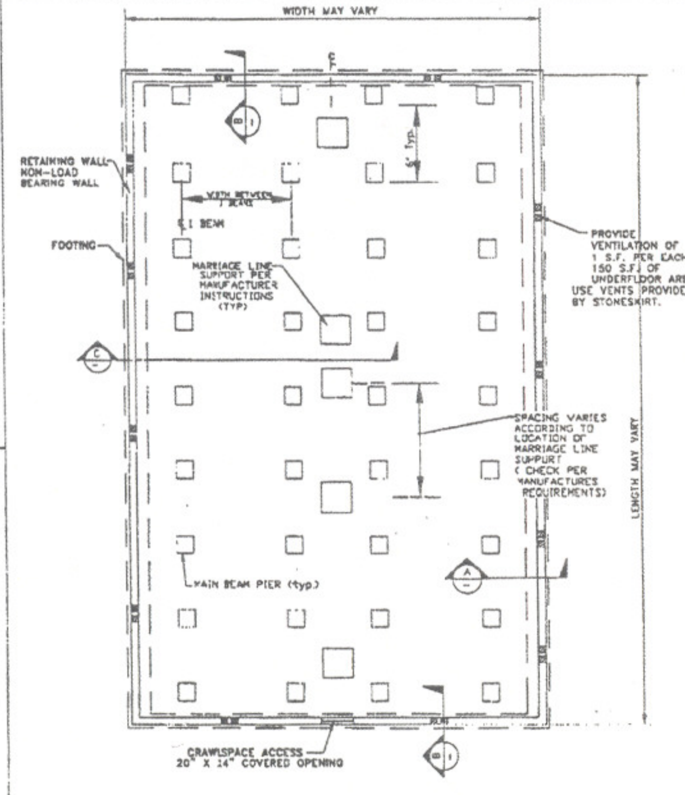
B RETAINING ENDWALL DETAIL
SCALE: 3/4"=1'0"



A RETAINING SIDEWALL DETAIL
SCALE: 3/4"=1'0"



C PIER AND FOOTING DETAIL
NO SCALE



GENERAL RETAINING WALL PLAN
NO SCALE

DESIGN NOTES

1. WIND LOADS -
   ASSUME DESIGN WIND SPEED OF 80 mph.
   TO CONVERT MPH TO A BASIC WIND VELOCITY PRESSURE (q) IN PSF,
   q = 0.00256 x Kz x V²
   WHERE V IS BASIC WIND SPEED AND Kz IS VELOCITY PRESSURE COEFFICIENT = 0.8
   q = 0.00256 x 0.8 x (80)² = 13.11 PSF
   DESIGN WIND PRESSURES (p) ARE BASED ON EXTERNAL AND INTERNAL EFFECTS UTILIZING THE FOLLOWING EQUATION:
   p = (q x Gh x Cp) − (q x GCpi)
   WHERE (Gh) THE GUST RESPONSE FACTOR = 1.32 AND (GCpi) THE INTERAL PRESSURE = .25 AND (Cp) EXTERNAL PRESSURE COEFFICIENTS = −0.9 (windward) and −0.7 (leeward).
   p = (13.11 x 1.32 x −0.9) − (13.11 x .25) = −18.85 PSF ON THE WINDWARD SIDE
   p = (13.11 x 1.32 x −0.7) − (13.11 x .25) = −15.39 PSF ON THE LEEWARD SIDE
   WIND PRESSURES AND SUCTIONS ARE TYPICALLY TREATED AS UNIFORMLY DISTRIBUTED AND TYPICALLY APPLIED PERPENDICULAR TO THE ORIENTATION OF ANY PLANAR SURFACE.
   THE VERTICAL PRESSURE COMPONENT (Pv) EQUALS THE PRESSURE (p) TIMES THE HORIZONTAL LENGTH OF THE SLOPE. A NEGATIVE PRESSURE INDICATES UPLIFT (WORKING AGAINST GRAVITY)
2. REQUIRED VERTICAL ANCHERAGE (Av) BASED ON OVERTURNING FORCES DUE TO WIND AND THE HOME DEAD LOADS PROVIDING RESISTANCE. THE OVERTURNING PIVOT POINT IS LOCATED AT THE EXTERIOR FOUNDATION WALL ON THE LEEWARD SIDE.
   UPLIFT IS WIND PRESSURE WORKING AT A LEVERAGE DISTANCE FROM THE PIVOT POINT.
   Mo = (Pt x Hn) +((Pvw x (3 x Wt/2)) + ((Pvl x (Wt/2)) = 7202.83 ft-lb
   THE TOTAL DEAD LOAD PROVIDES THE ONLY GRAVITY LOAD RESISTANCE TO OVERTURNING.
   Mr = DL x Wt = 7926.2 ft-lb, WHERE DL IS THE LIGHT DEAD LOAD FOR A MULTI-SECTION UNIT.
   Av = (1.5 x Mo − Mr)/(2 x Wt) = 102.72 lb/ft. THE PERIMETER WALL MUST PROVIDE AT LEAST THIS MUCH WITHDRAWAL RESISTANCE. THE POTENTIAL RESISTANCE IS COMPUTED BY ADDING THE WEIGHTS OF BUILDING MATERIALS AND SOIL OF THE TOP TO THE FOOTING, PLUS FOOTING WEIGHT. THE CONCRETE BLOCK WALL ...

GENERAL NOTES:

1. RETAINING WALL SHALL BE STONESKIRT PANEL SYSTEM CONSISTING OF THE STONESKIRT CONCRETE PANEL, THE I-BEAM TO CONNECT THE PANELS, THE ELL BRACKET ATTACHED TO THE RIM JOIST AND THE BASE BLOCK.
2. ALL CONCRETE SHALL HAVE A COMPRESSIVE STRENGTH OF 2500 P.S.I. IN 28 DAYS.
3. REINFORCING BAR TO BE ASTM A615 Gr40 DEFORMED WITH 30 DIAMETER JOINT OVERLAP. STEEL STRAP SHALL BE MIN. 2" x 0.035" ZINC COATED STEEL STAPPING CONFORMING TO ASTM D3953, TYPE 1, GRADE 1.
4. POWDER ACTUATED FASTENERS SHALL BE HILTI BRAND ZF82 DRIVEN PIN (OR EQUAL) 1" EMBEDDED IN CONCRETE. ALLOWABLE SHEAR LOAD OF ZF82 FOR THESE CONDITIONS = 135 lb. ONE FASTENER PER LINEAR FOOT OF PANEL.
5. PROVIDE ONE 20"x 24" CRAWL SPACE ACCESS. PROVIDE CRAWL SPACE VENTS SCREENED WITH 1/4" MESH AT THE RATE OF 1 SQ. FT. OF VENT AREA PER 150 SQ. FT. OF UNDERFLOOR AREA.
6. CONTRACTOR SHALL VERIFY ALL SITE CONDITIONS AND DIMENSIONS BEFORE STARTING WORK. CONCRETE PADS UNDER PIERS SHALL BE SIZED BASED ON ALLOWABLE SOIL BEARING PRESSURE AND THE LOAD EACH PIER HAS TO CARRY.
7. DESIGN LOADS:

ROOF LIVE LOAD	20 P.S.F.
FLOOR LIVE LOAD	40 P.S.F.
WIND LOAD	20 P.S.F.
SEISMIC	ZONE 2B
SOIL BEARING	1000 P.S.F.

8. THE DESIGN CONFORMS TO THE UNIFORM BUILDING CODE (UBC) 1997 EDITION-

Job No.
Designed
Drawn
Checked
Revised

LARRY E. WILKE
P.L.L.C.
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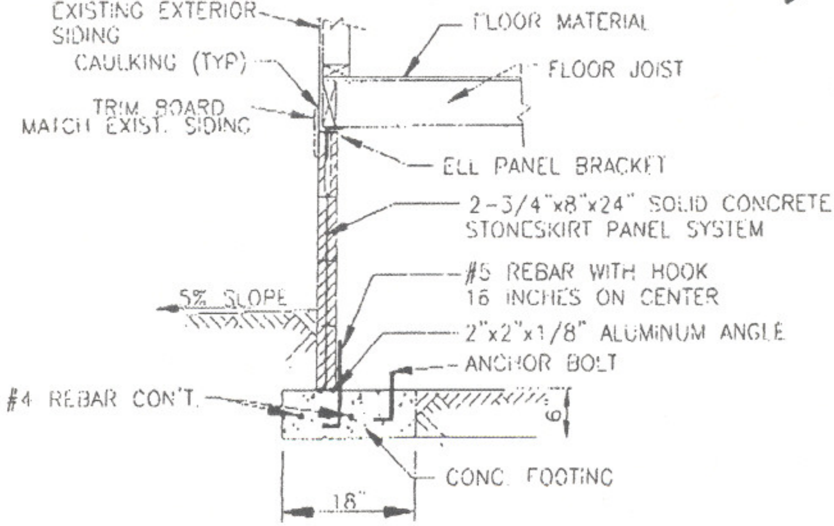
AZ BLOCK 2000
9311 N. CASA GRANDE HWY.
TUCSON, ARIZONA 85742

FACTORY MANUFACTURED HOUSING
STONESKIRT CONCRETE RETAINING WALL
PERMANENT FOUNDATION SYSTEM

Manufactured Housing
Solid Concrete Block Retaining Wall Design Calculations
Aluminum Angle Bottom Support



RETAINING SIDEWALL DETAIL

Use Coulomb's general equation for active earth load on a retaining wall:

$$P = \tfrac{1}{2} wH^2 \frac{1-\sin\phi}{1+\sin\phi}$$

Where:

- P = total pressure per linear foot of wall in lbs.
- w = specific (unit) weight of soil in lbs. per cu. Ft.
- H = height of wall in ft.
- ϕ = angle of internal friction of the soil

Soils = Fine Silty Sands to Silty Sands to Sandy Loams
w = 110 pcf
ϕ = 35° increases with compression

Maximum depth of fill over the concrete footing is 20 inches. Add a two-foot surcharge for this design; this is approximately equivalent to a heavy backhoe tractor that might be expected to operate close to the top of the wall during construction operations.

$$P = \tfrac{1}{2}(110\ \text{pcf})(3.67')^2\left(\frac{1-\sin 35^\circ}{1+\sin 35^\circ}\right)$$

P = 200.75 lbs. acting 6.7" above the base

Compute Equivalent Fluid Pressure

$\tfrac{1}{2}wH^2$ = 134.14 lbs.

The top of the wall is attached. Calculate the reactions R_1 and R_2 at the top and bottom of the wall by calculating moments about R_1.

R_2(32") = P(25.33") therefore R_2 = 158.93 lbs.

R_1 = P - R_2 = 41.82 lbs.

Check Maximum length of angle between support points (vertical rebar).

Aluminum Angle Properties:
Weight = 0.59 lb./ft.
Area = 0.49 sq. in.
I = moment of inertia = 0.23 in.^{4}
S = section of modulus = 0.18 in.^{3}
Tensile Strength = 9000 = σ
E = modulus of elasticity = 10,000,000

Calculate Resisting Moment of Angle (M_r)

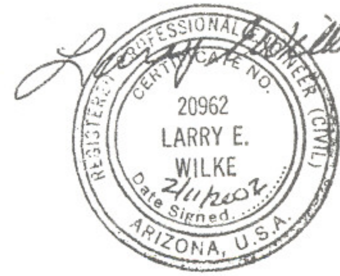
S = I/c
c = 0.23/0.18 = 1.28
M_r = σ x I/c = (9000)(0.23)/1.28 = 1617.19 in-lb

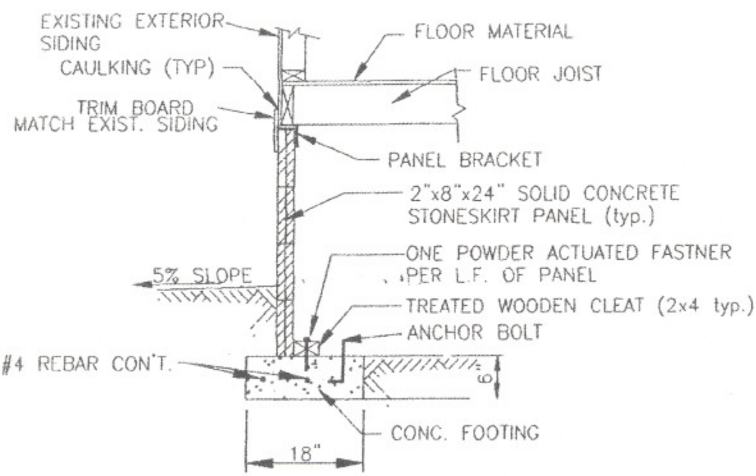
Solve for Maximum Length (ℓ) in Bending Moment Formula

W = 158.93 lb./ft = 13.24 lb./in.
M = wℓ^2 / 8
ℓ = ((1617.19)(8)/13.24)$^{.5}$ = 31.26 inches
Set vertical rebar at 16 inches on center,
Safety Factor = 31.26"/16" = 1.95

602-377-1327

Manufactured Housing
Concrete Block Retaining Wall Design Calculations





RETAINING SIDEWALL DETAIL

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Where:

P = total pressure per linear foot of wall in lbs.
w = specific (unit) weight of soil in lbs. per cu. Ft.
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Soils = Fine Silty Sands to Silty Sands to Sandy Loams
w = 110 pcf
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Maximum depth of fill over the concrete footing is 20 inches. Add a two-foot surcharge for this design; this is approximately equivalent to a heavy backhoe tractor that might be expected to operate close to the top of the wall during construction operations.

$$P = \tfrac{1}{2}(110\text{ pcf})(3.67')^2\left(\frac{1-\sin 35°}{1+\sin 35°}\right)$$

P = 200.75 lbs. acting 6.7" above the base

Compute Equivalent Fluid Pressure

$\tfrac{1}{2}wH^2$ = 134.14 lbs.
w = 134.14 X 2 / $(3.0')^2$ = 29.8 psf

The top of the wall is attached. Calculate the reactions R_1 and R_2 at the top and bottom of the wall by calculating moments about R_1.

$R_2(32") = P(25.33")$ therefore $R_2 = 158.93$ lbs.

$R_1 = P - R_2 = 41.82$ lbs.

Calculate Bending Moment: Assume the panel acts as a simply supported beam with concentrated load at 6.6 inches from the base (R_2)

M = P(a)(b)/length

M = (200.75 x 6.7" x 25.3")/32" = 1063.41 in-lb. (88.62 ft. lb.)

Based on testing, maximum point load on 2.67' wall equals 650 lb. Therefore, max. Moment wi safety factor of 3 equals 144.6 ft. lb.

88.62 ft. lb. < 144.6 ft. lb. == O.K.

Check Soil Bearing:

Weight of Stoneskirt Wall = 28 lb./s.f.		
Soil Bearing Capacity = 1000 psf (assumed)		
Concrete Footing Weight	= .75 s.f. X 150 pcf X 1 L.F. of width	= 112.50 lbs.
Weight of Block Wall	= 2.67 s.f. X 28 psf X 1 L.F. of width	= 75.00 lbs.
Soil Weight above Toe	= 1.32 s.f. X 110 pcf X 1 L.F. width	= 145.20 lbs.
Total Weight	=	332.70 lbs.

Soil Bearing Safety Factor =1000 psf/(332.70 lb./ 1.5 sf) = 4.5

Check Uplift

Wind Loads = Uplift

Assume design wind speed of 80 mph (W)

To convert MPH to a basic wind velocity pressure (q) in psf,

$q = 0.00256 \times Kz \times v^2$

Where V is basic wind speed and Kz is velocity pressure coefficient = 0.8

$q = 0.00256 \times 0.8 \times (80)^2 = 13.11$ psf

Design wind pressures (p) are based on external and internal effects utilizing th following equation:

$p = (q \times Gh \times Cp) - (q \times Gcpi)$

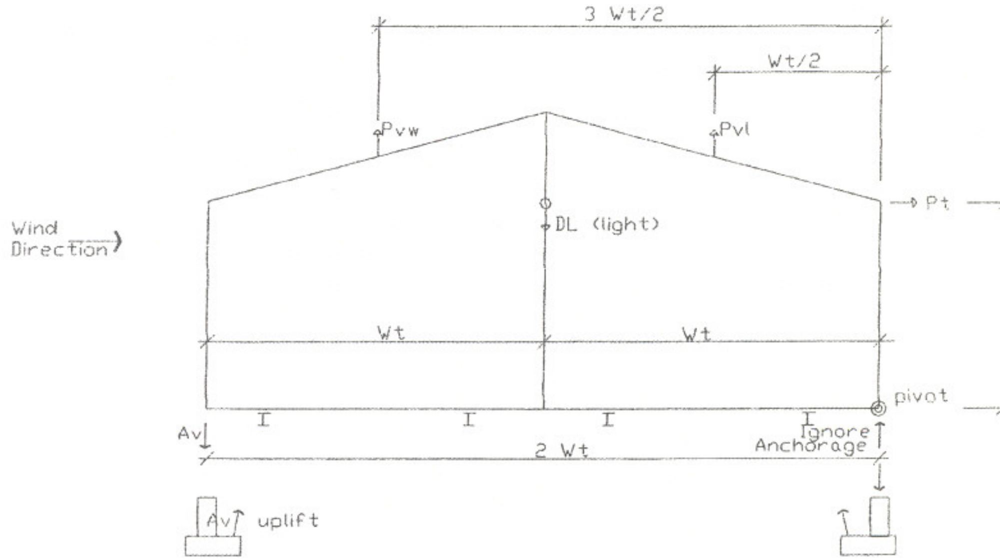
Where (Gh) the gust response factor = 1.32 and (Gcpi) the internal pressure coefficient = .25 and (Cp) external pressure coefficients = -0.9 (windward) and -0.7 (leeward).

$p = (13.11 \times 1.32 \times -0.9) - (13.11 \times .25) = -18.85$ psf on the windward side

$p = (13.11 \times 1.32 \times -0.7) - (13.11 \times .25) = -15.39$ psf on the leeward side

A negative pressure indicates uplift (working against gravity).

Wind pressures and suctions are typically treated as uniformly distributed and typically applied perpendicular to the orientation of any planar surface. The vertical pressure component (Pv) equals the pressure (p) times the horizontal length of the slope



<u>The wall and footing is attached to the exterior main beam and acts as anchor to resist up lift:</u>

Required vertical anchorage (Av) based on overturning forces due to wind and the home dead loads providing resistance. The overturning pivot point is located at the exterior foundation wall on the leeward side. Uplift is the wind pressure working at a leverage distance from the pivot point. Wt is equal to the width of a multi-section unit divided by 2.
Mo = (Pt x Hn) + (Pvw x (3xWt/2)) + (Pvl x (Wt/2)) = 7202.83 ft-lb

The total dead load provides the only gravity load resistance to overturning.
Mr = DL x Wt = 7928.2 ft-lb, where DL is the light dead load for a multi-section unit equal to 157.5+29.2(Wt) = 566.3

Av = (1.5 x Mo – Mr)/(2 x Wt) = 102.72 lb/ft, The perimeter wall must provide at least this much withdrawal resistance. The potential resistance is computed by adding the weighs to the building materials and soil on top of the footing, plus footing weight.

The 30" tall block wall with 18" footer = 332.70 lb/ft. Allowing a safety factor of 332.70 /102.72 = 3.2

Check spacing of anchors to resist uplift. Use steel strap, cross-section area = 0.2145 sq. in. Max. load per strap is 1900 lbs. according to manufacturer data. Spacing = 1900# /102.72#/ft = 18.5 ft.
Use standard spacing of 8 feet. Safety factor = 18.5/8 =2.3.

Check Safety Factor Against Sliding

Coefficient of friction of Concrete on Soil = Tan of Friction Angle
= Tan 23.3°
= 0.43

Friction force on base = (0.43)(306.66 lbs.)
= 131.87 lbs.

Resultant Active Pressure on stem = R_2 – Passive pressure (P_p) due to compression against undisturbed soil or compacted soil (P_p = 2.56 x 110 lb. x .5' = 140.8 lbs.)

Therefore the Resultant Active Pressure = 216.7 lbs. – 140.8 lbs
= 75.9 lbs.

Safety Factor for sliding = 1.74 OK!

Check Safety Factor Against Overturning

Overturning about the Toe is caused by the active pressures of the backfill. The active and passive forces create moments about the Toe. The correcting moments should be at least 1.5 times the overturning moments. When the top of the wall is attached to the house overturning is not a problem. During construction do not backfill until wall is complete to prevent overturning.