Stormwater Utilities
Floodplain Management
700 Wood Street
PO Box 580
Fort Collins, CO 80522
970.221.6700
970.221.6619 – fax
970.224.6003 – TDD
utilities@fcgov.com
fcgov.com/utilities

Foundation Analysis and Certification
For Vertical Additions (pop tops) Guidance

City Code Chapter 10-138(3)c.

For vertical additions (pop-tops), section 10-138(3)c requires an analysis of the structural stability of the existing building's foundation. **This only applies to City Basin Floodplains** where the value of the addition is not being counted toward calculation of substantial improvement. A recommended report outline is shown below and an example of a previously approved report is attached for reference.

EXAMPLE REPORT STRUCTURE

[Date]

[Name]
[Address]

RE: Foundation Analysis for vertical addition at 1111 Main Street, Fort Collins, CO

Background
- Why are you doing the report
- Brief description of the project
- Applicable City Code, i.e. Chapter 10-138(3)c of City Code requires the foundation analysis
- Name, title and credentials of person inspecting foundation
- Date of inspection

Existing Building Description
- Age, number of stories
- Foundation description (materials, type, dimensions, fenestrations, condition, basement or crawl space etc.…)
- Location in relation to the regulatory floodplain
- Name of regulatory floodplain, level of risk, and Base Flood Elevation (BFE)
- Local drainage description around building

Technical Analysis
- List assumptions
- Describe existing condition velocity and depth of flood waters
- Calculations of lateral pressure and hydrodynamic loading for 3 conditions; (1) hydrodynamic velocity impact only, (2) hydrostatic depth only, and (3) velocity and depth combined.

Conclusions
- Summary of conclusions
- Summary of compliance with City Code

Recommendations for Certification
- Improvements that must be made to support addition or statement indicating existing foundation is adequate to handle the addition.

Attachments
1. Calculations
2. Supporting documentation and analysis
3. Site or building photos

Engineer's Stamp
Signature
And Date

Robinson Engineering, Inc (970) 217-4960

105 South Meldrum Street #4 **PO Box 2459, Fort Collins, Colorado 80522**

November 9, 2006

City of Fort Collins Storm Water Division
and
Steve Josephs
Craftsmen Builders
319 East Magnolia Street
Fort Collins, CO 80523

RE: Review of Storm Water Flooding – Foundation Issues, ' t, Fort Collins, Colorado, 80521.

Dear Sirs,

My office was asked to review the effects of the established 100 year floodplain flow pressures on the residence at Street specifically with regard to a proposed 2nd story addition. I have been on site and visually inspected the foundation of the home to assess the structural appropriateness of the foundation for the added structural loads.

The home is a traditional 1-story home built in 1924 over a concrete basement. The basement walls are nominally 8" thick and approximately 7' tall with the slab of the basement floor is approximately 4.5' below the final grade. Based on the age of the home and typical construction practice in Fort Collins in the mid-1920s it is assumed that the basement walls are non-reinforced of good quality concrete (likely F_c' of 4000 to 4500 psi). There exist several widow openings of approximately 30" width in the foundation walls.

Load Definition:

The flow pressure for this location is derived from the "Summary of Results for the Old Town Floodplain Analysis" and "100-Year Floodplain Map" supplied by the city of Fort Collins. Using the floodplain map elevations while on site, I estimated the sidewalk in front of the home to be 5016.0'. The lot is relatively flat with a slight positive grade away from the home, generally draining south east towards Magnolia Street. My assessment is the lowest point of grade on the foundation is 5016.1'. Please keep in mind that the elevations mentioned are reasonable estimates, not survey data. The cross section 6296 appears approximately 100' west of the structure while cross section 6120 is directly in front of the structure. As the structure is at the edge of the cross section, the maximum fluid pressure and water depth would most likely be between the two gradients. While the data for both cross sections were similar, I chose to use the 6296 data as most representative. From the data supplied, I have interpreted the max 100-year flood velocity to be 6.1 fps, the maximum water surface elevation of 5017.6' for this home. In simplified terms, this exerts a maximum water depth of 1.5' above grade with a 6.1 fps velocity against the foundation. The water pressures would be exerted entirely on either the concrete walls or window openings, from the estimated grade level of 4.5' above the interior slab to maximum water surface elevation 6' above the slab.

The summary page illustrates the three lateral pressure cases I considered in assessing the affects of the flood flow. The three cases are 1) just the lateral pressure from the flood flow, 2) typical lateral pressures exerted from saturated soils and 3) combined lateral pressures from saturated soils and flood flow. With the flood flow data being a water depth and associated velocity, I used Euler's equation often known as the Bernoulli Equation. With reasonable assumptions and simplifications, the equation can be presented as

$$P = p_e + \frac{1}{2}\rho V_e^2$$

Where P is the pressure at any level on the foundation wall, p_e is the pressure on the wall based on water depth, $\frac{1}{2}\rho V_e^2$ is the pressure on the wall based on flood water velocity with ρ as density and V as velocity.

To summarize, I determined the pressure from the flood flow to be 35 psf on vertical surface area with pressure as a result of depth varying from zero at the fluid surface to 93 psf at the grade. For Case 1, at maximum flood levels this creates a pressure of 35 psf at the water surface and 128 psf at grade. This represents the load case of a flood with only several inches of saturated soil below grade. For case two, I modeled saturated soils with no lateral flood pressures. I used 35 pcf equivalent fluid pressure to analyze the foundation wall typical in foundation wall design for new structures. This is a common value often used for current design for "Old Town" properties. For this load, the lateral pressure would be zero at the grade level increasing to 158 psf at the base of the foundation wall. This represents a situation were the soil is saturated from grade height to the full depth of the foundation. The final case I considered was flood pressures added to lateral loads from fully saturated soils. This case is slightly more harsh than simply combining the pressures from case 1 and case 2 as the saturated soil pressure is governed by the water surface depth. The resulting pressures were 35 psf at the water surface changing linearly to 128 psf at grade height then decreasing to 52 psf at the grade height increasing linearly to 209 psf at the foundation wall base. My "Summary Page" illustrates the three load cases at the top of the page.

Analysis Summary:
For each load case, I determined the moment in the foundation wall due to the lateral pressures defined in each load case. A structural analysis output is included for each of the three load cases. The max moment for each load case was 2376 in-lbs, 4152 in-lbs and 8388 in-lbs for Cases 1, 2 and 3 respectfully. Using the relationship of σ=M/c where σ is stress at an extreme fiber, M is the moment in the wall and c is the distance from the nutral axis to the extreme fiber. I also have included two other notes pages to show my progression of thought for the analysis.

(For this, I used a program typically used to analyses wood structures. Please realize that this is an analysis tool that I am very familiar with, have a high degree of confidence in defining load application and that I only used it for moment analysis, not material stresses. Any structural analysis software can produce similar results. Bending moment is not dependent on specific material properties.)

Since concrete is strong in compression but weak in tension, the tensile stress is the governing issue. The associated tensile stress would be 594 psi, 1038 psi and 2097 psi for Cases 1, 2 and 3. One additional issue is the axial load from the structure reduces the tensile stress. I determined the structure weight applies 85 psi to the top of the wall so the tensile stresses would reduce to 510 psi, 953 psi and 2012 psi for each of the load cases.

Good quality concrete typically has a ratio of the tensile capacity being no more than 15% of the F_c' compressive strength. Using the tensile stresses, one can calculate what compressive strength the concrete would need to be to function at that load. For Cases 1, 2 and 3 the required F_c' would be 3400 psi, 6354 psi and 13413 psi. Compare these F_c' values to approximately 4000 psi.

Interpretation of the analysis results:
The analysis indicates several issues. First, if the soils are not saturated, the defined load conditions would load the concrete wall in bending to approximately 85% of its estimated capacity. This would indicate that the wall could withstand the flood pressures alone. Second, without the flood loading, if the soils were fully saturated, the wall would be at 159% of its estimated capacity. This would indicate that the wall could fail if a water source fully saturated the soil. This is typically the governing factor in current foundation design that requires installation of vertical rebar. This type of loading is rarely experienced unless there is a water line failure, water compaction of fill or sustained water collection against the foundation. Third, if the soil was fully saturated and experienced the flood loading, the wall would be at 336% capacity.

Interestingly, the wall is capable of withstanding flood loads with dry soils but fails the current typical design criteria for saturated soils with or without the flood loads. This illustrates why typical current design of concrete foundations require vertical rebar. At the same time, it illustrates that current design criteria is somewhat above and beyond the locally imposed loads.

As an engineer, it is my opinion, given the dry environment, that most foundations in "Old Town" rarely experience fully saturated soils. Having both grown up and worked in "Old Town" Fort Collins, I have observed the soils are typically "dry" condition 6" below grade and lower. The times I have seen saturated soils have obvious water sources, such as ditch seepage or water line leakage. Most excavations are 90 degree cuts, perpendicular to grade surface, with obviously stable soil. Keep in mind that to deeply saturate many soils by rain takes a long time. After the initial surface layer becomes saturated, most added water distributes laterally on the surface. In this case with the dry environment, I believe the likelihood of the soils becoming deeply saturated prior to a flood is very minimal.

The home has a history of 85 years of what appears to be acceptable performance even with a number of know local heavy rain storms. There exist no indications of previous problems or repairs. This would indicate the home in its present state performs adequately resisting the local site lateral loads and past levels of soil saturation. The proposed vertical addition adds approximately 35% additional structure weight, reasonably well distributed to the structure perimeter. This added weight actually improves the bending resistance of the wall by slightly due to the added initial compression stress prior to addition of short term tension stress from lateral loads. The increase is small, about 200 plf added load, distributed over the width of the 8" wall, really only adds 16-17 pli. At the same time, it is an improvement. The added vertical structure weight will in essence slightly improve the existing foundation components ability to withstand induced lateral loads.

It is my opinion, as a structural engineer, having structurally reviewed the addition plans for this home and having reviewed the present floodplain criteria, that the addition will have no detrimental effect on the existing foundation's ability to resist lateral loads and that the foundation is capable of resisting the loads imposed by the flood design criteria given an initial non-saturated soil.

Other recommendations:
Having looked at the site with regard to flood issues, there are a couple of suggestions I would like to make. 1) Given the flat nature of the lot, and the fact that the top of the foundation is approximately 2.5 feet above existing grade, it would be prudent to increase the surrounding soil grade height against the foundation 6"-8" to allow a positive surface flow (6-10%) away from the home for a distance of 5'-6'. 2) Some care should be taken to ensure the window well for the egress window is extended to several inches above the final grade. If grade level is added to the point of being above the bottom of the existing window, care should be taken to protect those windows also.

Please call if there are further questions.

Sincerely,

COLORADO REGISTERED PROFESSIONAL ENGINEER
GEOFFREY C. ROBINSON
34656

Geoff Robinson, PE
Civil / Structural Engineer

The inspection and comments in this letter are specific items as presented and in no way imply a certification or complete inspection of the structure, its systems or site work. No liability is assumed for future loss of value, marketability or any other loss claims.

Robinson Engineering, Inc.
105 S. Meldrum, Unit #4
Fort Collins, Colorado 80521
(970) 217-4960 office / (970) 482-6776 fax
gcrobinson@juno.com

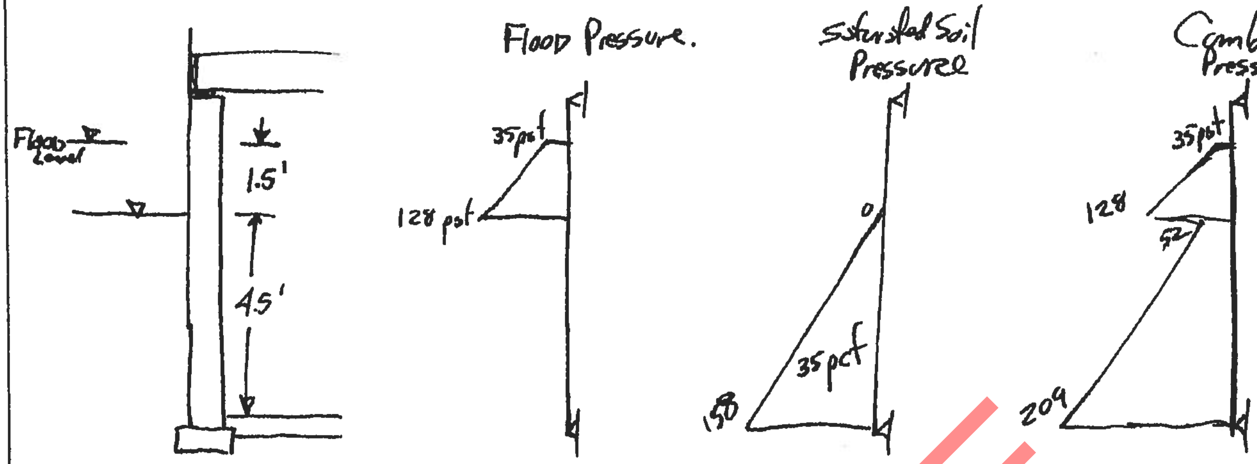
Project: 6-061 Craftsman Builders

Date: October 19, 2006

SUMMARY PAGE

GR

	CASE 1	CASE 2	CASE 3
	Flood Pressure.	Saturated Soil Pressure	Combined Pressure



MOMENT →	Moment.	198 ft-lbs 2376 in-lbs	346 ft-lbs 4152 in-lbs	699 ft-lbs 8388 in-lbs.
STRESS CONVERSION → Concrete tensile σ (psi)	$\sigma = \frac{M}{C}$ $c = 4''$	594 psi	1038 psi	2097 psi

assume 15% of F_c

$F_c' =$ 3960 psi

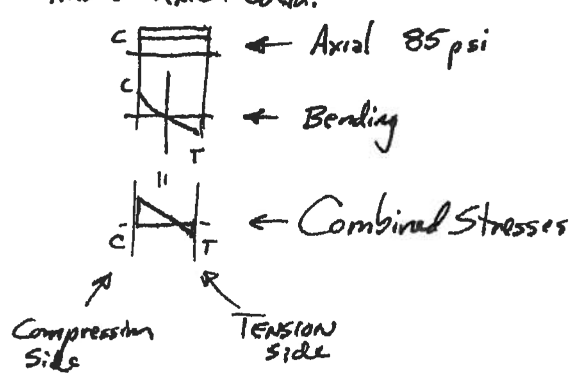
Compression 200 lb/ft DL walls. 400 lb/ft DL floors 80 lb/ft DL roof. 680 85 lb/in² ≐ 510 psi ⇒ 3400 psi Flood only 85%

(Adjusted Max) Tensile | F_c'

Added Axial Load.

953 psi ⇒ 6354 psi Saturated 159%

2012 psi ⇒ 13413 psi Combined 336%

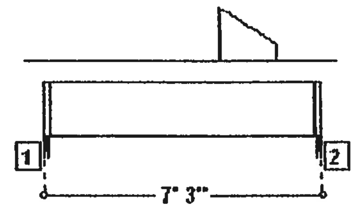


Trus Joist
A Weyerhaeuser Business
TJ-Beam® 6.25 Serial Number: 7005105304
User: 2 10/19/2006 2:01:12 PM
Page 1 Engine Version: 6.25.71

FND Wall Simularion - best quick tool - just fluid flow

1 3/4" x 9 1/4" 1.9E Microllam® LVL

THIS PRODUCT MEETS OR EXCEEDS THE SET DESIGN CONTROLS FOR THE APPLICATION AND LOADS LISTED



Product Diagram is Conceptual.

LOADS:

Analysis is for a Drop Beam Member. Tributary Load Width: 1'
Primary Load Group - Residential - Living Areas (psf): 40.0 Live at 100 % duration, 20.0 Dead
Vertical Loads:

Type	Class	Live	Dead	Location	Application	Comment
Uniform(plf)	Wind(1.60)	1.0	1.0	0 To 4' 7 1/2"	Replaces	
Tapered(plf)	Wind(1.60)	128.0 To 35.0	1.0 To 1.0	4' 7 1/2" To 6' 1 1/2"	Replaces	
Uniform(plf)	Wind(1.60)	1.0	1.0	6' 1 1/2" To 7' 3"	Replaces	

SUPPORTS:

		Input Width	Bearing Length	Vertical Reactions (lbs) Live/Dead/Uplift/Total	Detail	Other
1	Stud wall	1.50"	1.50"	37 / 20 / 0 / 57	L1: Blocking	Custom Blocking
2	Stud wall	1.50"	1.50"	91 / 20 / 0 / 111	L1: Blocking	Custom Blocking

-See TJ SPECIFIER'S / BUILDERS GUIDE for detail(s): L1: Blocking

DESIGN CONTROLS:

	Maximum	Design	Control	Control	Location
Shear (lbs)	-111	-105	4921	Passed (2%)	Rt. end Span 1 under Wind loading
Moment (Ft-Lbs)	198	198	8963	Passed (2%)	MID Span 1 under Wind loading
Live Load Defl (in)		0.007	0.242	Passed (L/999+)	MID Span 1 under Wind loading
Total Load Defl (in)		0.009	0.363	Passed (L/999+)	MID Span 1 under Wind loading

OUTPUT ONLY USED FOR MOMENT ANALYSIS

-Deflection Criteria: STANDARD(LL:L/360,TL:L/240).
-Bracing(Lu): All compression edges (top and bottom) must be braced at 7' 3" o/c unless detailed otherwise. Proper attachment and positioning of lateral bracing is required to achieve member stability.

ADDITIONAL NOTES:

-IMPORTANT! The analysis presented is output from software developed by Trus Joist (TJ). TJ warrants the sizing of its products by this software will be accomplished in accordance with TJ product design criteria and code accepted design values. The specific product application, input design loads, and stated dimensions have been provided by the software user. This output has not been reviewed by a TJ Associate.
-Not all products are readily available. Check with your supplier or TJ technical representative for product availability.
-THIS ANALYSIS FOR TRUS JOIST PRODUCTS ONLY! PRODUCT SUBSTITUTION VOIDS THIS ANALYSIS.
-Allowable Stress Design methodology was used for Building Code IBC analyzing the TJ Distribution product listed above.
-CAUTION: Floor loads were applied simultaneously with Wind loads during analysis.

PROJECT INFORMATION:

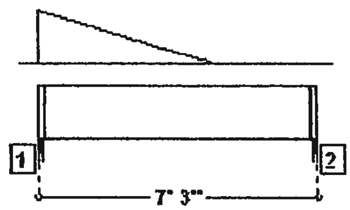
OPERATOR INFORMATION:

Geoff Robinson
Robinson Engineering
PO Box 2459
Fort Collins, CO 80522-2459
Phone : (970) 217-4960
Fax : (970) 482-6776
gcrobinson@juno.com

FND Wall Simularion - best quick tool - saturated soil only

1 3/4" x 9 1/4" 1.9E Microllam® LVL

THIS PRODUCT MEETS OR EXCEEDS THE SET DESIGN CONTROLS FOR THE APPLICATION AND LOADS LISTED



Product Diagram is Conceptual.

LOADS:

Analysis is for a Drop Beam Member. Tributary Load Width: 1'
Primary Load Group - Residential - Living Areas (psf): 40.0 Live at 100 % duration, 20.0 Dead
Vertical Loads:

Type	Class	Live	Dead	Location	Application	Comment
Tapered(plf)	Wind(1.60)	157.0 To 0.0	1.0 To 1.0	0 To 4' 7 1/2"	Replaces	
Uniform(plf)	Wind(1.60)	1.0	1.0	4' 7 1/2" To 6' 1 1/2"	Replaces	
Uniform(plf)	Wind(1.60)	1.0	1.0	6' 1 1/2" To 7' 3"	Replaces	

SUPPORTS:

		Input Width	Bearing Length	Vertical Reactions (lbs) Live/Dead/Uplift/Total	Detail	Other
1	Stud wall	1.50"	1.50"	286 / 20 / 0 / 306	L1: Blocking	Custom Blocking
2	Stud wall	1.50"	1.50"	79 / 20 / 0 / 99	L1: Blocking	Custom Blocking

-See TJ SPECIFIER'S / BUILDERS GUIDE for detail(s): L1: Blocking

DESIGN CONTROLS:

	Maximum	Design	Control	Control	Location
Shear (lbs)	306	174	4921	Passed (4%)	Lt. end Span 1 under Wind loading
Moment (Ft-Lbs)	346	346	8963	Passed (4%)	MID Span 1 under Wind loading
Live Load Defl (in)		0.014	0.242	Passed (L/999+)	MID Span 1 under Wind loading
Total Load Defl (in)		0.016	0.363	Passed (L/999+)	MID Span 1 under Wind loading

OUTPUT ONLY USED FOR MOMENT ANALYSIS

-Deflection Criteria: STANDARD(LL:L/360,TL:L/240).
-Bracing(Lu): All compression edges (top and bottom) must be braced at 7' 3" o/c unless detailed otherwise. Proper attachment and positioning of lateral bracing is required to achieve member stability.

ADDITIONAL NOTES:

-IMPORTANT! The analysis presented is output from software developed by Trus Joist (TJ). TJ warrants the sizing of its products by this software will be accomplished in accordance with TJ product design criteria and code accepted design values. The specific product application, input design loads, and stated dimensions have been provided by the software user. This output has not been reviewed by a TJ Associate.
-Not all products are readily available. Check with your supplier or TJ technical representative for product availability.
-THIS ANALYSIS FOR TRUS JOIST PRODUCTS ONLY! PRODUCT SUBSTITUTION VOIDS THIS ANALYSIS.
-Allowable Stress Design methodology was used for Building Code IBC analyzing the TJ Distribution product listed above.
-CAUTION: Floor loads were applied simultaneously with Wind loads during analysis.

PROJECT INFORMATION:

OPERATOR INFORMATION:

Geoff Robinson
Robinson Engineering
PO Box 2459
Fort Collins, CO 80522-2459
Phone : (970) 217-4960
Fax : (970) 482-6776
gcrobinson@juno.com

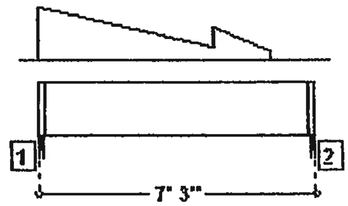
EXAMPLE

Trus Joist
A Weyerhaeuser Business
TJ-Beam® 6.25 Serial Number: 7005105394
User: 2 10/19/2006 2:02:45 PM
Page 1 Engine Version: 6.25.71

FND Wall Simularion - best quick tool

1 3/4" x 9 1/4" 1.9E Microllam® LVL

THIS PRODUCT MEETS OR EXCEEDS THE SET DESIGN CONTROLS FOR THE APPLICATION AND LOADS LISTED



Product Diagram is Conceptual.

LOADS:

Analysis is for a Drop Beam Member. Tributary Load Width: 1'

Primary Load Group - Residential - Living Areas (psf): 40.0 Live at 100 % duration, 20.0 Dead

Vertical Loads:

Type	Class	Live	Dead	Location	Application	Comment
Tapered(plf)	Wind(1.60)	209.0 To 52.0	1.0 To 1.0	0 To 4' 7 1/2"	Replaces	
Tapered(plf)	Wind(1.60)	128.0 To 35.0	1.0 To 1.0	4' 7 1/2" To 6' 1 1/2"	Replaces	
Uniform(plf)	Wind(1.60)	1.0	1.0	6' 1 1/2" To 7' 3"	Replaces	

SUPPORTS:

		Input Width	Bearing Length	Vertical Reactions (lbs) Live/Dead/Uplift/Total	Detail	Other
1	Stud wall	1.50"	1.50"	484 / 20 / 0 / 504	L1: Blocking	Custom Blocking
2	Stud wall	1.50"	1.50"	243 / 20 / 0 / 263	L1: Blocking	Custom Blocking

-See TJ SPECIFIER'S / BUILDERS GUIDE for detail(s): L1: Blocking

DESIGN CONTROLS:

	Maximum	Design	Control	Control	Location
Shear (lbs)	504	325	4921	Passed (7%)	Lt. end Span 1 under Wind loading
Moment (Ft-Lbs)	699	699	8963	Passed (8%)	MID Span 1 under Wind loading
Live Load Defl (in)		0.033	0.242	Passed (L/999+)	MID Span 1 under Wind loading
Total Load Defl (in)		0.035	0.363	Passed (L/999+)	MID Span 1 under Wind loading

OUTPUT ONLY USED FOR MOMENT ANALYSIS

-Deflection Criteria: STANDARD(LL:L/360,TL:L/240).

-Bracing(Lu): All compression edges (top and bottom) must be braced at 7' 3" o/c unless detailed otherwise. Proper attachment and positioning of lateral bracing is required to achieve member stability.

ADDITIONAL NOTES:

-IMPORTANT! The analysis presented is output from software developed by Trus Joist (TJ). TJ warrants the sizing of its products by this software will be accomplished in accordance with TJ product design criteria and code accepted design values. The specific product application, input design loads, and stated dimensions have been provided by the software user. This output has not been reviewed by a TJ Associate.

-Not all products are readily available. Check with your supplier or TJ technical representative for product availability.

-THIS ANALYSIS FOR TRUS JOIST PRODUCTS ONLY! PRODUCT SUBSTITUTION VOIDS THIS ANALYSIS.

-Allowable Stress Design methodology was used for Building Code IBC analyzing the TJ Distribution product listed above.

-CAUTION: Floor loads were applied simultaneously with Wind loads during analysis.

PROJECT INFORMATION:

OPERATOR INFORMATION:

Geoff Robinson
Robinson Engineering
PO Box 2459
Fort Collins, CO 80522-2459
Phone : (970) 217-4960
Fax : (970) 482-6776
gcrobinson@juno.com

Robinson Engineering, Inc.
105 S. Meldrum, Unit #4
Fort Collins, Colorado 80521
(970) 217-4960 office / (970) 482-6776 fax
gcrobinson@juno.com

Project: 6-061

Date: Oct 19, 2006

General Calculations - Page 1

GCR

Pressure DEFINITION

Grade - 5016.5 ±

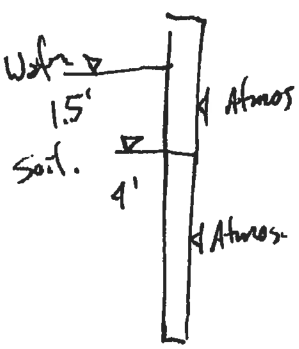
100 yr. flood → 5017.6   1.1' @ 6.1 fps. (4.16 mph)

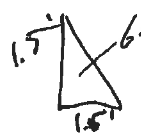
36 lbs/ft width

62.4 lbs/ft³ × 6.1 ft/sec   lbs/ft²-sec

$\frac{1}{2} m V^2$

0.5 × 1.94258 slugs · 6.1 ft/sec. = 36.14 slug·ft²/sec²

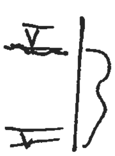




$\frac{2}{3}$ 140 lbs stbtr.

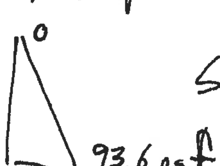
$\frac{1}{3}$

1 lb = 6.85222 lb/s



0 stbtz.

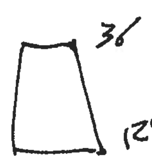
P = .65 psi ⇒ 93.6 psf.



stbtz.

= P_e

70.2 lbs/ft²

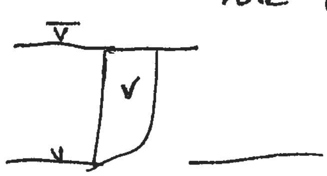


F = ma

~~P_0 = 70.2 +~~

P_o - 190 lb/ft

P_e - 284 lb



$\frac{1}{2} \rho V^2 + \rho g h$

lb · ft²

0.5 · 62.4 lb/ft³ · 6.1 ft · sec²

$\frac{lb}{ft}$ sec² $\frac{lb}{ft^3}$ ft² - sec²   180 ~~/~~ 36 pcf.

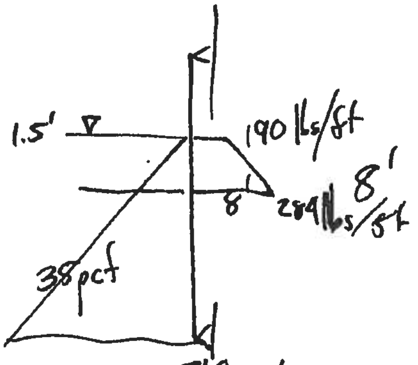
Robinson Engineering, Inc.
105 S. Meldrum, Unit #4
Fort Collins, Colorado 80521
(970) 217-4960 office / (970) 482-6776 fax
gcrobinson@juno.com

Project: 6-061

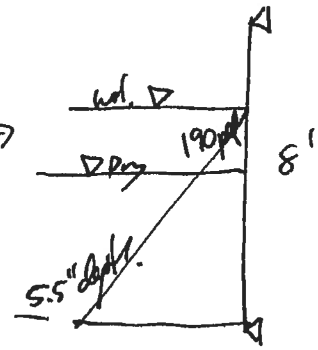
Date: Oct 19, 2006

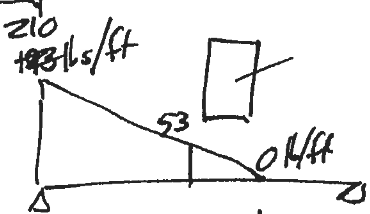
General Calculation - Page 2 GCR

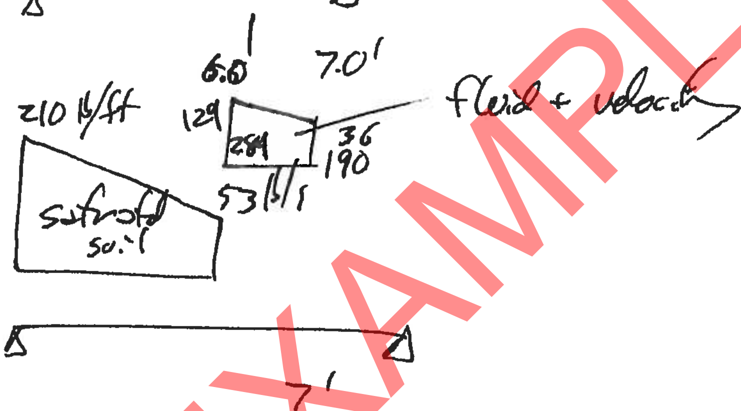
SET UP MODELLING



no →

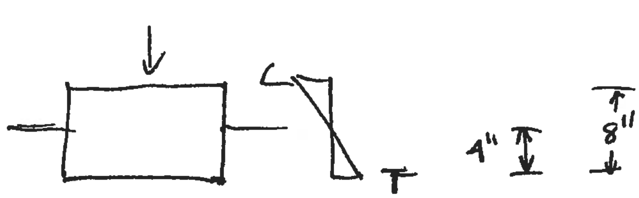






Moment on 1' width concrete wall. 904 ft-lbs.

old cement
~~20~~ 4500 psi Comp
450 psi Tensile.
Use 300psi.



M $\sigma = \frac{M}{c}$

$\sigma = 300$ psi
$M = 904$ ft-lbs $= 10848$ in-lbs
$c = 4"$

$\frac{M}{c} =$ $\sigma = 2712$ in-lbs
for

Just Dynamic Pressures.
486 ft-lbs = 5832 in-lbs

Concrete ⇒ 1458 psi tensile.

2712 ⟷ 10848
1/4 →