DOUBLE LOG CABIN- NAUVOO
PROJECT ID: CEEN_CPST_005

by

SEA Engineers
Isaac Averett
Julianna Edington
Josh Sweeten

A Capstone Project Draft Final Report

Submitted to

Bob Smith
I Dig Nauvoo

Department of Civil and Construction Engineering
Brigham Young University

April 8, 2024

Executive Summary

PROJECT TITLE:	DOUBLE LOG CABIN- NAUVOO
PROJECT ID:	CEEn_CPST_005
PROJECT SPONSOR:	I Dig Nauvoo
TEAM NAME:	SEA Engineers

We (SEA Engineers) drafted the construction documents for the Joseph Smtih Sr. double-log cabin to 95% completion. The construction documents include plan views of the cabin's roof, upper level, main level, and storm shelter, and can be found in Appendix A. All components of the log cabin were designed in accordance with the ICC 400, 2021 IBC, and all components of the storm shelter were designed in accordance with ICC 500 Requirements. Calculations for the design components can be found in Appendix A.

The remaining 5% of completion consists of detailing for specific components that will be completed by Dunn Associates, Inc.

Table of Contents

List of Figures

Figure 1 3D model created by Robert Smith

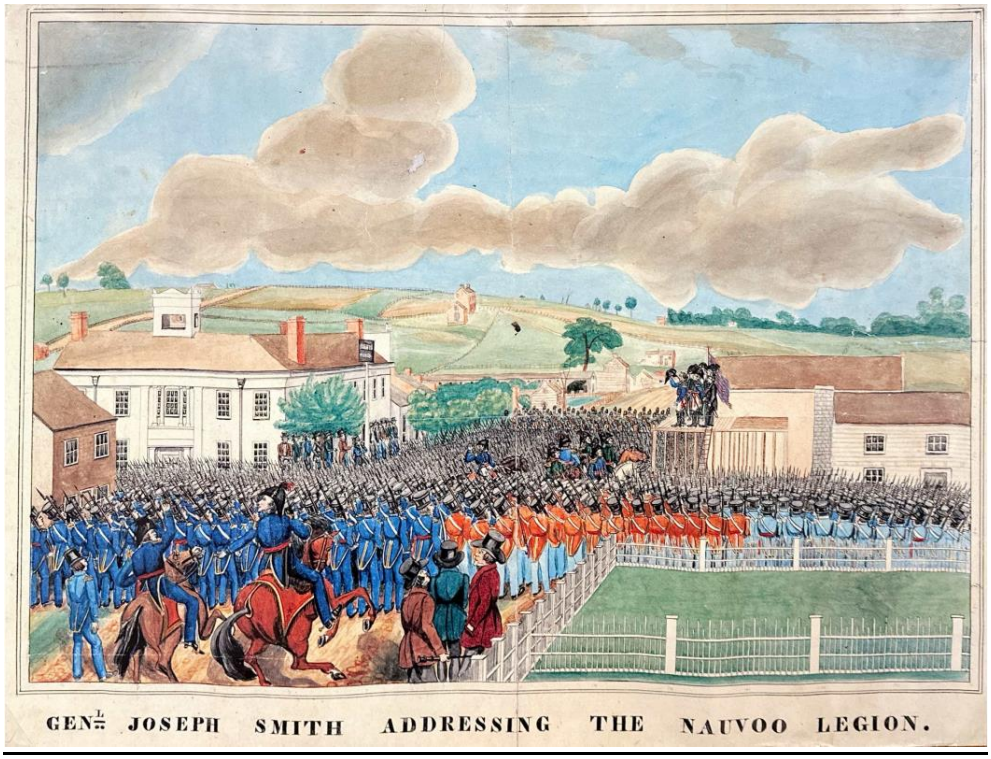


Figure 2 Poster with double cabin located on the right provided by Bob Smith

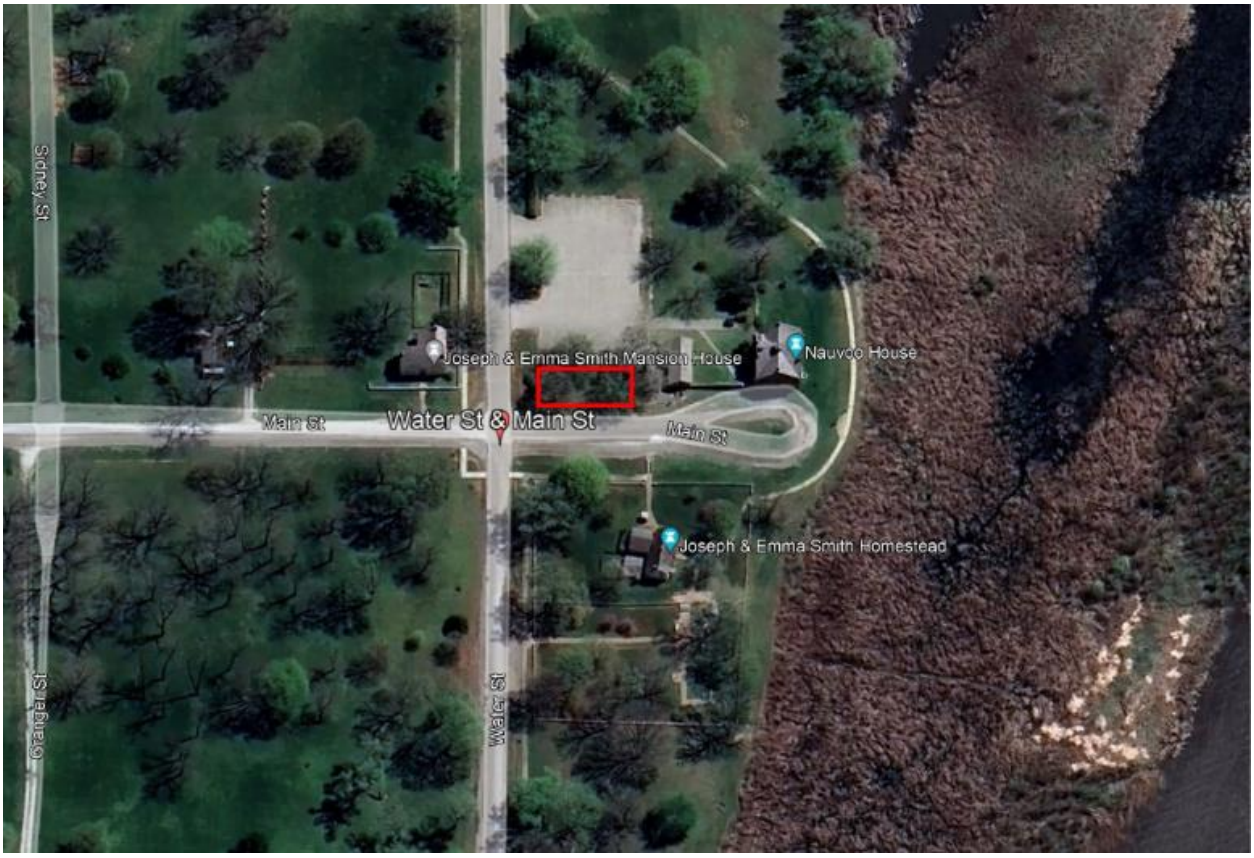


Figure 3 Aerial snapshot of original location taken from Google Earth

List of Tables

Table 1 Design Information

STANDARD	ASCE 7-16
RISK CAT.	II
WIND SPEED (mph)	109
SITE CLASS	D-DEFAULT
S_1:	0.105
S_D:	0.072
S_{DS}:	0.112
S_{D1}:	0.115

*See appendix A for ASCE Hazards Report

Introduction

This report outlines the project titled "Double Log Cabin" completed by Team 05 - SEA Engineers in collaboration with I Dig Nauvoo. This document provides a concise overview of the project's objectives, requirements, tasks, schedule, and deliverables.

We were assigned to design a double log cabin prototype. Requirements of the design include the following:

- Be historically accurate of log cabins built in Nauvoo in 1839
- Provide a template for a companion structure that will hopefully be built on the original site which was across the street of the Mansion House on the corner of Water and Main
- The prototype, unlike the structure on the original site, will be available for Church groups to stay in
- Provide handicapped access for structure and basement foundation location
- Create a basement space for a storm shelter (fulfilling all ICC 500 requirements)
- Maintain the historical look for the site.

We met twice a week to create structural analysis calculations and construction documents. The tasks done for calculations include lateral design regarding wind and seismic loads, beam sizing, determining efficient steel deck and concrete slab, and impact loads for storm shelter. We created construction documents showing roof, floor, and foundation plans of the double log cabin.

We met with mentors in the BYU CE department and Dunn Associates, Inc. to help in the design. Our schedule is included in this report.

Schedule

Test. Project Timeline: January 8, 2024 - April 18, 2024

Before January 8, 2024: Research & Data Collection

- Defined scope with I Dig Nauvoo, confirmed with Dunn Associates, Inc. and Dr. Judd.
- Set up and decided on project management tools.
- Assigned team members roles and responsibilities.
- Established communication channels with Dunn Associates, Inc.
- Gathered historical data on Nauvoo log cabins.
- Researched local building codes and regulations.
- Identified site-specific requirements.

Week 1-2 (Jan 8–Jan 21): Preliminary Design & Concept Development

- Formatted calculations. Began creating spreadsheets.
- Formatted construction documents. Created template and started drawings for roof and floor plan.
- Determined code requirements for design.

Week 3-5 (Jan 22–Feb 11):

- Met with Bob Smith. Determined cabin dimensions and floor plans. Design determined from a painting and 3D model he brought.
- Completed 50% of construction documents.
- Met with Dunn Associates, Inc mentors. Received help on concrete slab and deck.
- Beam section of calc spreadsheet completed.

Week 6-7 (Feb 12–Feb 25):

- Met with Dr. Judd, received help on wind and seismic lateral design.
- Completed seismic loads design.
- Completed 75% of construction documents.
- Began working on storm shelter calcs. Met with Dunn Associates, Inc. and received help using Verco for concrete lid.

Week 8-9 (Feb 26–Mar 10):

- Completed 90% of the construction documents.
- Completed wind loads design.
- Completed lateral design. Screw size determined.
- Began tension load calcs for screws.
- Began working on capstone poster.

Week 10-11 (Mar 11–Mar 24):

- Began working on draft final report.
- Began designing Capstone poster.
- Adjusted beam calcs.

Week 12-13 (Mar 25–Apr 8):

- Completed final draft report.
- Completed capstone poster.
- Completed calcs packet.

Week 14-15 (Apr 9–Apr 18):

- Finished detailing in construction documents.
- Completed construction documents.
- Presented final report to Bob Smith.

Assumptions & Limitations

Our first assumption made regarding the project was which building codes to use. After researching, we found that the City of Nauvoo has limited code requirements that do not address all the situations we would be facing. Because of this, we chose to use the following codes for the double-log cabin in the City of Nauvoo:

- ASCE 7-16 (design loading requirements)
- IBC 2021 (general building requirements)
- 2018 NDS & Supplement (wood design requirements)
- ICC 500 (storm shelter design requirements)
- ICC 400 (log cabin design requirements)

These codes align with current engineering practices and requirements.

Due to unforeseen circumstances, we were not supplied architectural drawings, so we had to make many assumptions regarding the dimensions of the double-log cabin. Below are our assumed cabin dimensions:

- Each building: 16.5”x16.5”; 8’ apart
- Log dimensions: 6” deep and 8” high
- Height of log cabin: 20’
- Windows: 3’ wide

We studied a 3D model created by Robert Smith shown in Figure 1, and a poster given from Bob Smith shown in Figure 2, in order to make these sizing estimates. We also researched architecture from the time period to learn standard window and door frame sizes.

In addition to the cabin’s dimensions, our team made assumptions regarding the structural strength of the logs used to construct the cabin. One of Bob Smith’s Nauvoo contacts donated lumber from a recently dissembled historic structure in the area. Although the lumber is likely hardwood, which is known to have exceptional shear strength, our team chose to assume a shear strength equivalent of spruce pine fir. Spruce pine fir’s shear strength is much lower than hardwood’s, so this assumption is conservative in ensuring structural safety. We assumed a “select structural” grade for the

lumber due to the likelihood of it being a hardwood and its age. This allowed for additional capacity within the material while maintaining a generally conservative approach. This assumption was made after discussion with Dunn, LLC.

The storm shelter will act as the basement and foundation of the structure and will support loads from the double log cabin. We have assumed a design soil bearing pressure of 1500 psf. We strongly recommend that a formal evaluation of the soil and the site be performed by a licensed professional prior to construction.

Design, Analysis & Results

We performed the following calculation in our design and analysis process:

- Beam design: determined the minimum required beam size at all openings and necessary bearing locations.
- Roof design: determined rafter framing and supporting member sizes.
- Lateral design: determined necessary wall design and connections needed to withstand wind and seismic loading and then properly transfer the load to the foundation.
- Storm shelter design: the storm shelter is comprised of lid, basement wall, and footings. Each of these components have been designed in accordance with the requirements of the ICC 500 and the 2021 IBC.

These calculations and results are included in **Appendix A**. We performed the calculations using the following sources:

- Microsoft Excel
    - Excel spreadsheets were used to determine:
        - Loads
        - Beams (wood and composite steel)
        - Lateral design
- Verco Floor Deck Design Tool
    - Used to determine max. Verco steel deck unshored span and capacity
- Enercalc (structural software)
    - Used to determine foundation wall and footing sizes
    - Used to confirm composite beam calculations
- Simpson Anchor Designer
    - Used to determine capacity of anchor bolts found at the sill of each wall

After we completed the calculations, we used them to draft the cabin's structural plan design. The structural plan design is shown in **Appendix A**. This plan set includes a general notes section, four plan views (foundation, main floor, upper floor, and roof), and general construction details. These are the results of our design and analysis.

Related Issues

As with all engineering projects, designing Joseph Smith Sr.'s double-log cabin directly and indirectly impacted related issues. The project notably impacted the following types of issues:

- Safety
- Cultural factors
- Social factors

The effects of these impacts are discussed below.

Safety

Safety is of paramount importance to civil engineers (Civil Engineering Code of Ethics). We designed the double log cabin with two primary safety concerns in mind – safety from emergency weather and structural robustness in order to safely occupy large tour groups visiting the building.

Nauvoo, Illinois has a tornado index of 174.79 (see here), which is above the national average, although lower than the Illinois average. In order to be prepared for the chance a tornado touched down nearby, we designed a storm shelter in accordance with ICC 500 requirements directly beneath the footprint of the structure. The ICC 500 standards mandate that the storm shelter must be engineered to withstand an impact load twice that of the weight of any structure above it and within a specified range. This specification ensures that, in the unlikely event that a tornado were to approach and demolish the structure, the storm shelter's roof or lid would endure the impact from the debris. This design provides optimal protection for any occupants. The storm shelter is accessible from an outdoor backdoor and has adequate space to house the planned for tour group sizes visiting the building.

Because the double-log cabin is built on top of a storm shelter (slab on deck) with the potential for large tour groups to visit, we performed calculations to ensure that the building could support a live load of 100 psf. A live load of 100 psf is the loading needed to support a commercial space. Even though the double-log cabin is not likely to support this kind of load, we designed it thus in the chance of large tour groups passing through the building at once. These safety factors will keep the cabin structurally sound, even through live loads it would not have experienced historically.

An additional requirement of the ICC 500 standards is that lid must be designed to support a live load of 100 psf. The lid of the storm shelter is being used as the main floor of the double log cabin. In addition to this, we have designed the upper floor for a 100 psf live load. This is being done in accordance with Table 4.3-1 in ASCE 7-16. Due to the nature of this being a recreation of a historic structure, we are assuming that the entire structure will be treated like an assembly area as tour groups will visit the building. However unlikely it is for the structure to see such tight packing of people all at one moment, we decided to take the conservative approach and overdesign the structure. This will allow that no matter the purpose of the structure, it will be capable of supporting any potential load scenarios.

Safety is of upmost importance to our team. Every reasonable effort was expended in order to ensure that the newly designed double-log cabin provides safety for its occupants.

Cultural/Social Factors

Nauvoo Illinois is a significant heritage site for members of the Church of Jesus Christ of Latter-day Saints and many other churches that trace their religion's founding back to Joseph Smith. The Nauvoo National Historic District contains 1,100 acres of authentically restored homes and shops, including Brigham Young's home. The historic district in the town of Nauvoo contains streets, 18 restored houses, shops, and a visitor center (information courtesy of the NPS). Joseph Smith Sr. is a prominent figure in the history of the Church of Jesus Christ, the religion's first Patriarch, and the father of its founding prophet, Joseph Smith Jr. Therefore, a restored version of his and Lucy Mack's cabin will be of cultural and religious significance to many people around the world.

We took utmost care to design the cabin to be historically accurate. We analyzed historical drawings of Nauvoo, researched architecture characteristic of the time period, and examined a 3D model of the building designed by one of Joseph Smith Sr.'s descendants. The completed building will become a historical landmark where visitors of Nauvoo can learn of and grow closer to Joseph Smith Sr. and his wife, Lucy Mack Smith.

Lessons Learned

Lessons learned come from challenges faced. One challenge we faced at the beginning of the semester was not receiving architectural drawings. Without architectural drawings, designing the structure seemed impossible. Despite this, our team decided to move forward and design with best known dimensions, researching the cabin layout through meetings with the sponsor and through personal research online. From this challenge, we learned the how to deliver a final product even when factors outside of personal control limited resources.

Another challenge we faced was designing the storm shelter. None of the team members had previous experience with storm shelter design. Our team asked for and received help from their mentors at Dunn Associates, Inc. Dunn provided guidance on how to calculate for composite steel deck using the Verco website. We referred to the code and learned about impact loads. Dr. Judd gave further guidance on how to perform calculations. Overall, designing the storm shelter was a lesson in asking for and receiving help. As an engineer, it is critical to know how and when to ask for help. This project taught us how to do this.

Lastly, throughout the course of this project we faced a giant learning curve in the form of codes and requirements. Not only are building codes written in difficult to decipher technical language, but they are buried away in thick codebooks or enormous online repositories. Designing the double-log cabin taught our team how to find, access, interpret, and implement building codes into design. Through the process, we also gained familiarity with codebook layouts, learning *where* to go to find answers to code requirements and gaining technical fluency.

We are confident that the lessons learned from this capstone project have set us up for success as we enter the workforce post-graduation. Additionally, it is our hope that these lessons may be shared with future capstone teams, aiding them in their endeavors through the engineering design process.

Conclusion

This project taught our team how to design a double log cabin. In order to design the cabin, we had to first find the codes to build it in accordance with (see Assumptions and Limitations), then calculate the design requirements according to these codes, and finally draft our design as construction documents. The construction documents and calculations can be found in Appendix A. For simplicity, these documents are considered the results of our project.

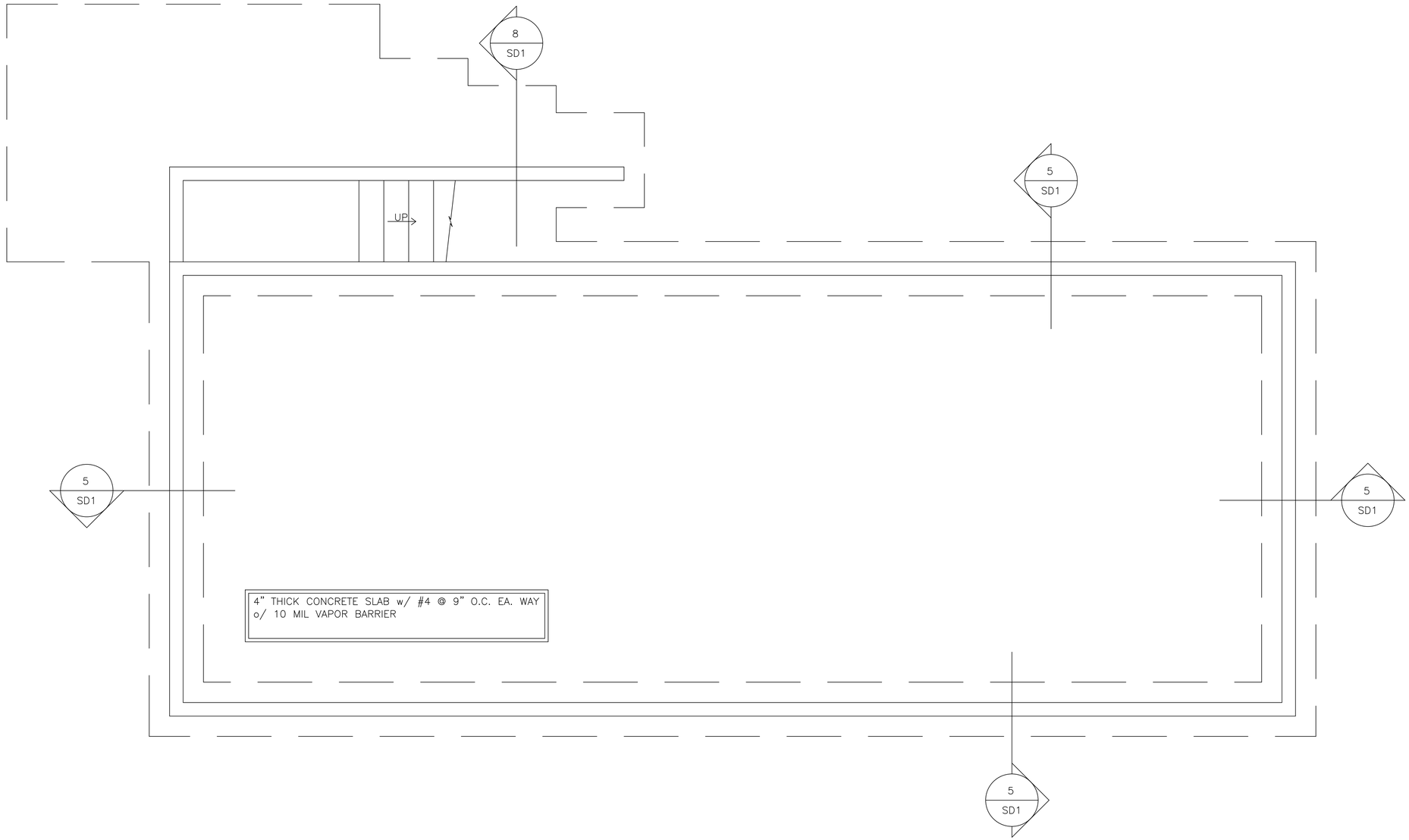
Recommendations

After performing a full structural analysis of the double log cabin and storm shelter, our recommendations are as follows:

1. All construction shall be done in accordance with the requirements specified in the construction documents found in Appendix A.
    a. Supporting calculations for the requirements can be found in Appendix A. Requirements without supporting calculations have been assumed as standard practice.
2. We strongly recommend that a professional structural engineer, licensed in the state of Illinois, perform a full review of all calculations and requirements prior to construction.

We have prepared the calculations and the construction documents according to our current level of understanding. Throughout this project, we have engaged in comprehensive discussions with mentors and industry professionals regarding the most effective methods to approach the various challenges we faced throughout this project. Any oversights in our calculations and construction documents may be attributed to our limited experience within the industry. Nevertheless, we have performed all tasks to the utmost of our abilities with the hope that our efforts meet all the criteria outlined in our original scope of work.

Appendix A



FOUNDATION PLAN

1/2"=1'-0"

SEA ENGINEERS
BYU CAPSTONE TEAM 5
JSWEETEN@BYU.EDU
BRIGHAM YOUNG UNIVERSITY, CAMPUS DR.
PROVO UT 84604

DESIGNED BY: SEA ENGINEERS
PROJECT NAME: DOUBLE LOG CABIN
PROJECT NUMBER: 001.01.224
BRIGHAM YOUNG UNIVERSITY CAPSTONE
SPONSOR: I DIG NAUVOO

S001

NOTES:

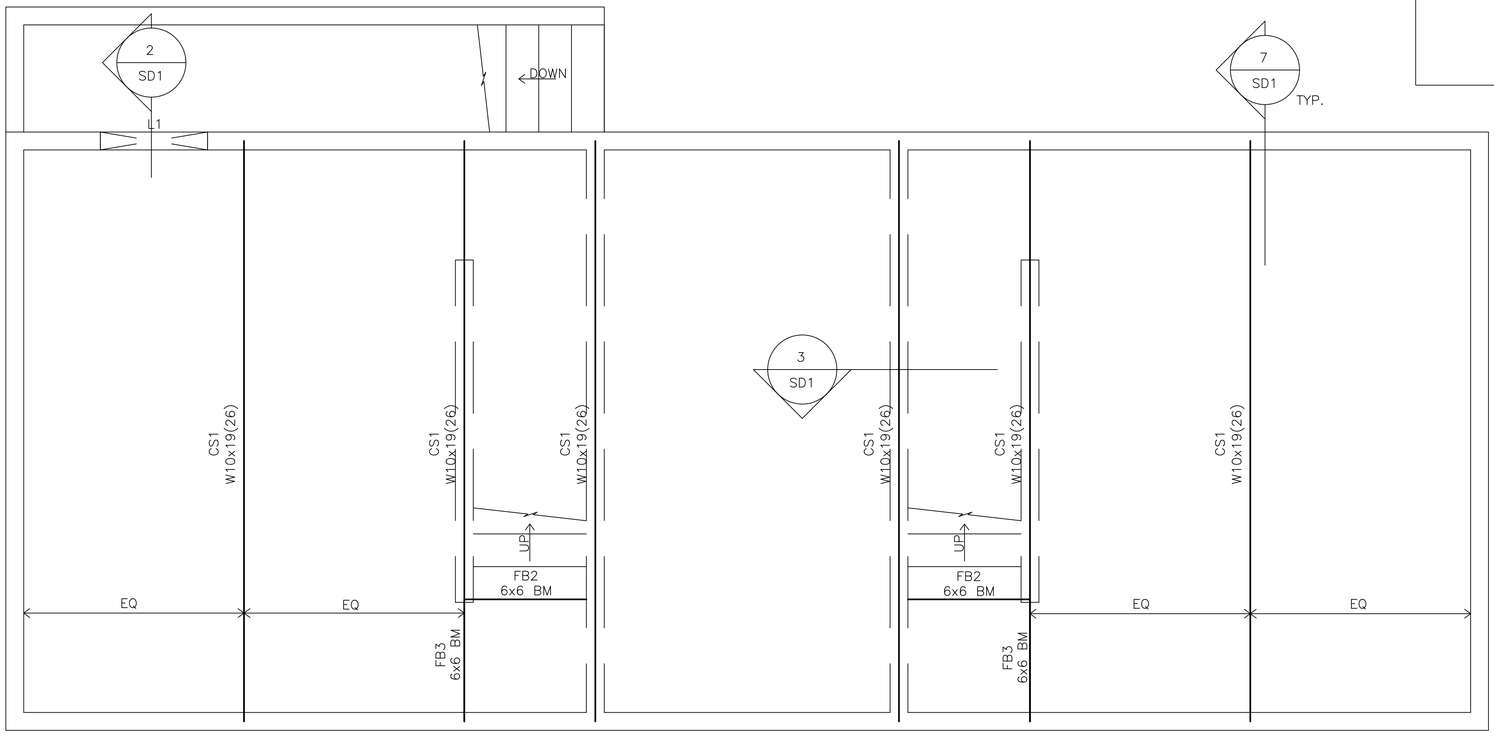
1. NOTCH LOGS PER DTL -/-
2. CONCRETE SLAB PER DTL -/-
3. STAIR WALL FOUNDATION PER DTL -/-
4. LINTEL PER DTL 2/SD1
5. WHERE LOG OF LOG WALL EXCEEDS SIZE OF REQUIRED HDR OR BM IT IS ACCEPTABLE FOR LOG TO ACT AS HDR OR BM. LOG SHALL HAVE MIN. 6" BEARING PAST EITHER END OF OPENING.

STEEL BEAM LEGEND

SIZE

NUMBER OF 3/4" HEADED STUDS EQUALLY SPACED BETWEEN BEAMS

W10x19 (26)



MAIN FLOOR PLAN

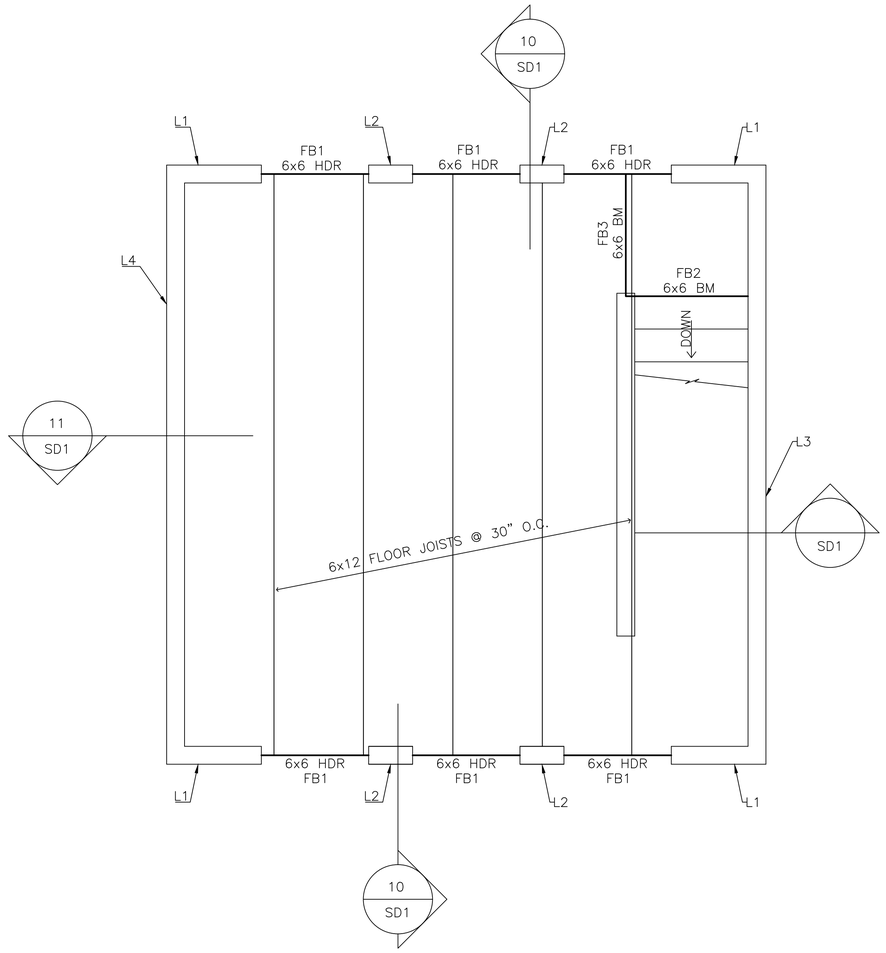
1/2"=1'-0"

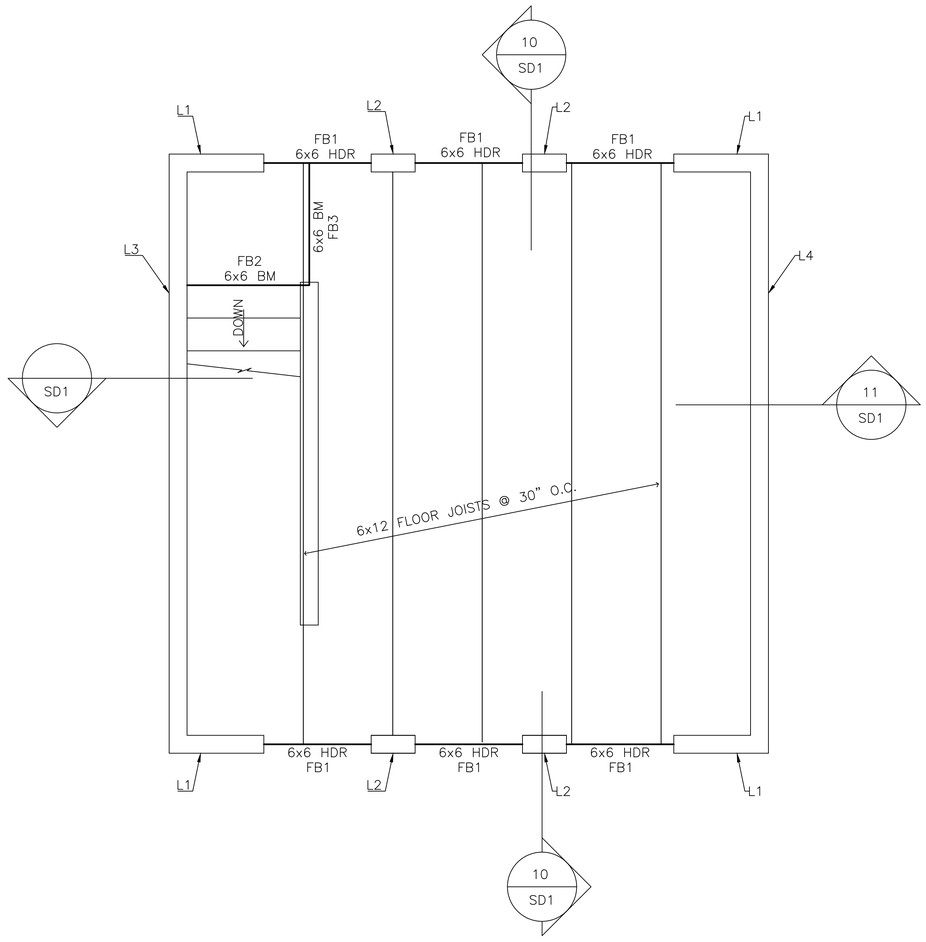
SEA ENGINEERS
BYU CAPSTONE TEAM 5
JSWEETEN@BYU.EDU
BRIGHAM YOUNG UNIVERSITY, CAMPUS DR.
PROVO UT 84604

DESIGNED BY: SEA ENGINEERS
PROJECT NAME: DOUBLE LOG CABIN
PROJECT NUMBER: 001.01.224
BRIGHAM YOUNG UNIVERSITY CAPSTONE
SPONSOR: I DIG NAUVOO

S002

LATERAL KEY NOTE
L1 PER DTL 1A/SD1
L2 PER DTL 1B/SD1
L3 (1) SDWS SCREW w/ 3" MIN EMBEDMENT @ 16" O.C. BETWEEN EA LOG
L4 (1) SDWS SCREW w/ 3" MIN EMBEDMENT @ 32" O.C. BETWEEN EA LOG





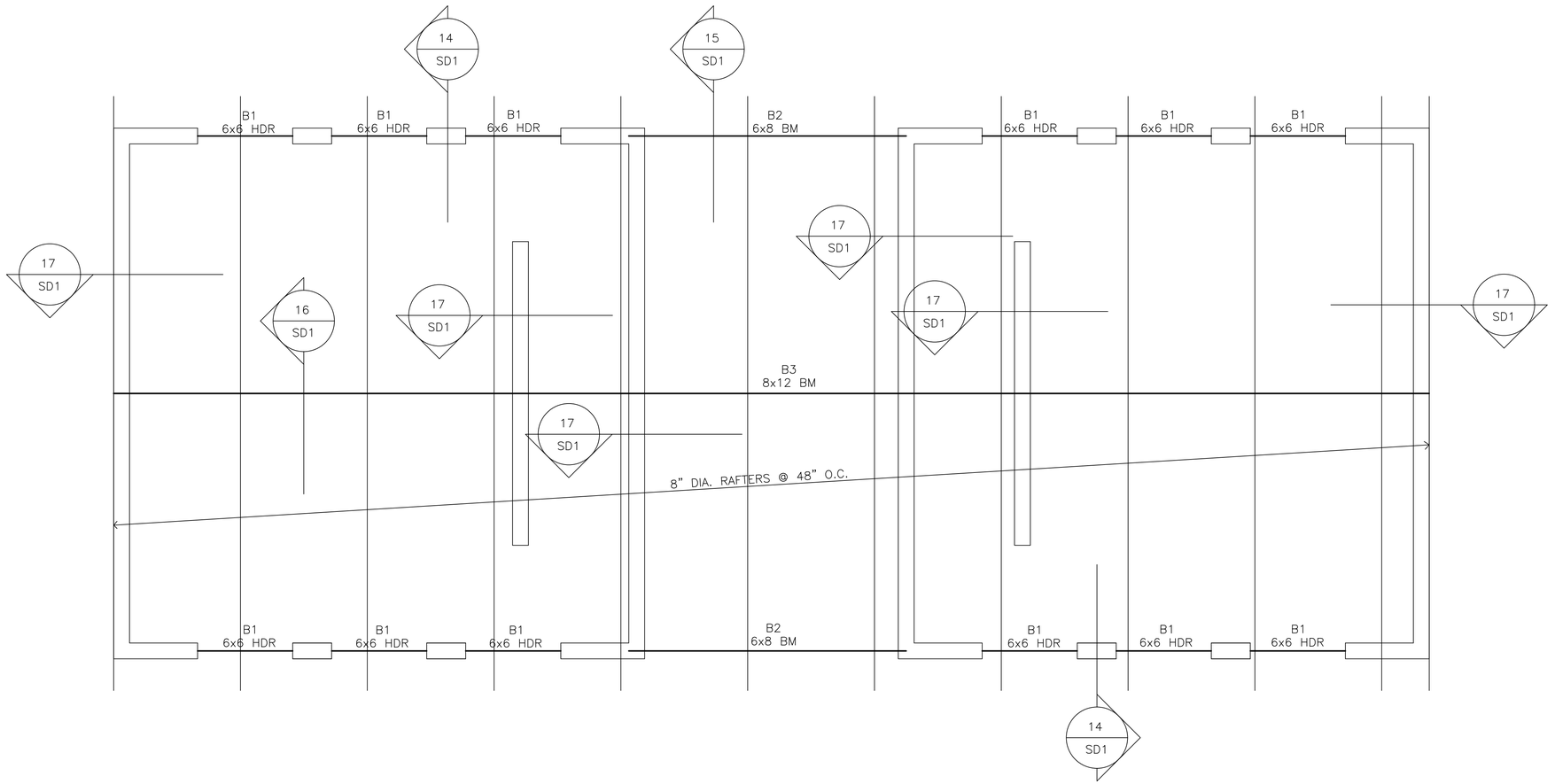
UPPER FLOOR PLAN

1/2"=1'-0"

SEA ENGINEERS
BYU CAPSTONE TEAM 5
JSWEETEN@BYU.EDU
BRIGHAM YOUNG UNIVERSITY, CAMPUS DR.
PROVO UT 84604

DESIGNED BY:: SEA ENGINEERS
PROJECT NAME: DOUBLE LOG CABIN
PROJECT NUMBER: 001.01.224
BRIGHAM YOUNG UNIVERSITY CAPSTONE
SPONSOR: I DIG NAUVOO

S003



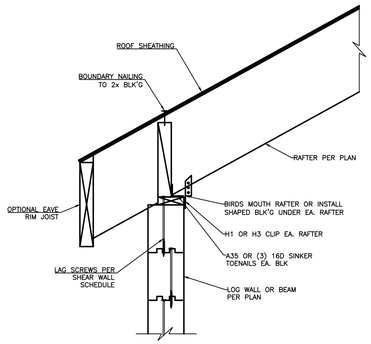
ROOF PLAN

1/2"=1'-0"

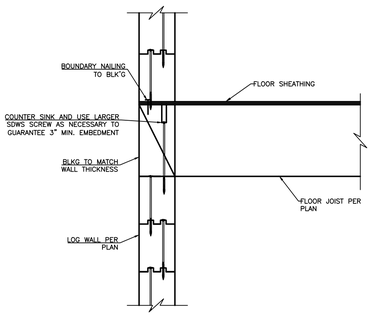
SEA ENGINEERS
BYU CAPSTONE TEAM 5
JSWEETEN@BYU.EDU
BRIGHAM YOUNG UNIVERSITY, CAMPUS DR.
PROVO UT 84604

DESIGNED BY: SEA ENGINEERS
PROJECT NAME: DOUBLE LOG CABIN
PROJECT NUMBER: 001.01.224
BRIGHAM YOUNG UNIVERSITY CAPSTONE
SPONSOR: I DIG NAUVOO

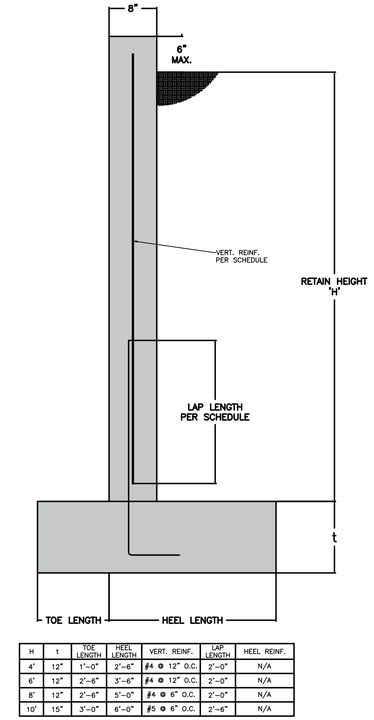
S004



NTS 14

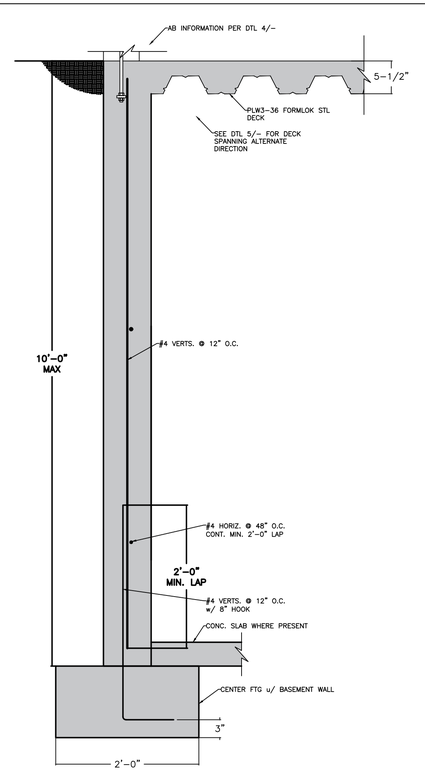


NTS 10

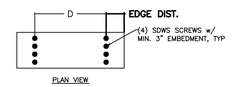


H	t	TOE LENGTH	HEEL LENGTH	VERT. REINF.	LAP LENGTH	HEEL REINF.
4'	12"	1'-0"	2'-6"	#4 @ 12" O.C.	2'-0"	N/A
6'	12"	2'-6"	3'-6"	#4 @ 12" O.C.	2'-0"	N/A
8'	12"	2'-6"	5'-0"	#4 @ 6" O.C.	2'-0"	N/A
10'	15"	3'-0"	6'-0"	#5 @ 6" O.C.	2'-6"	N/A

NTS 8



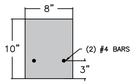
NTS 5



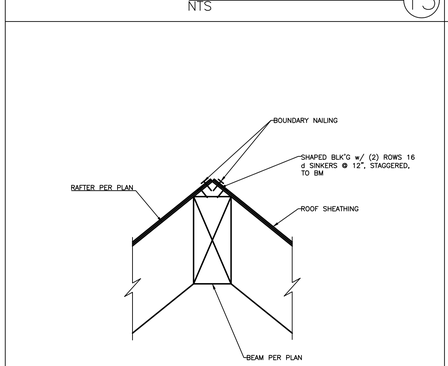
LABEL	D	EDGE DIST.
L1	9"	1-1/2"
L2	12"	3"

NOTE:
USE L2 AT EACH END OF WALL SEGMENT

NTS 1

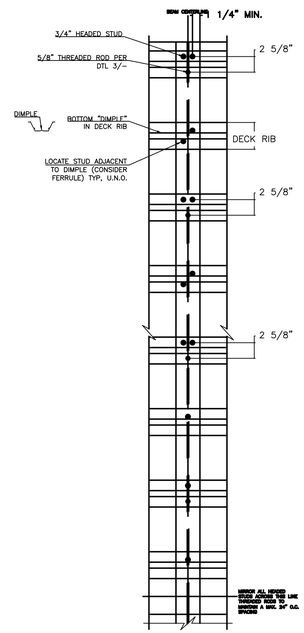


NTS 2

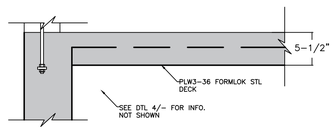


NTS 15

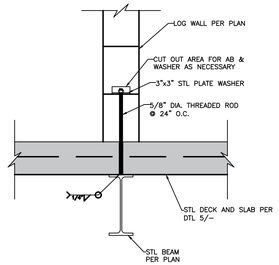
NTS 11



NTS 9

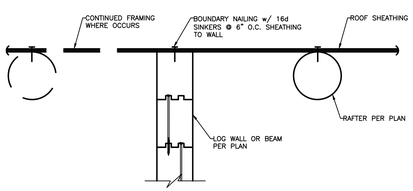


NTS 6



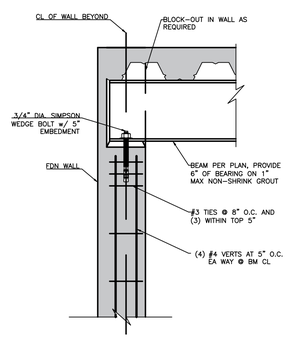
NTS 3

NTS 16

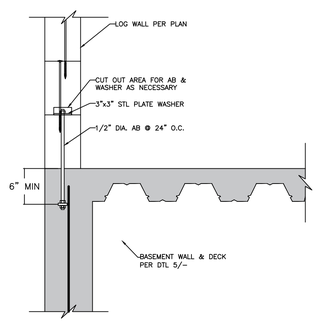


NTS 17

NTS 13



NTS 7



NTS 4

SEA ENGINEERS
BYU CAPSTONE TEAM 5
JSWEETEN@BYU.EDU
BRIGHAM YOUNG UNIVERSITY, CAMPUS DR.
PROVO UT 84604

DESIGNED BY: SEA ENGINEERS
PROJECT NAME: DOUBLE LOG CABIN
PROJECT NUMBER: 001.01.224
BRIGHAM YOUNG UNIVERSITY CAPSTONE
SPONSOR: I DIG NAUVOO

SD1

SEA ENGINEERS

BYU CAPSTONE TEAM 5

JSWEETEN@BYU.EDU
BRIGHAM YOUNG UNIVERSITY, CAMPUS DR. PROVO UT 84604

DESIGN LOADS

PROJECT NAME: Double Log Cabin *PROJECT NUMER:* 001.01.224

ROOF LOADS:

Roof Pitch:	6	:12
Roof Materials:	4	psf
Sheathing:	2.5	psf
Framing:	3	psf
Insulation:	1	psf
Misc. :	9.5	psf
DL:	20	psf
LL:	20	psf

FLOOR LOADS:

	UPPER			*MAIN*	
Floor Covering:	4	psf	Conc. & Stl. Deck:	52.7	psf
Sheathing:	4.5	psf			
Framing:	3	psf			
Insulation:	1	psf			
Misc. :	7.5	psf			
DL:	20	psf	DL:	52.7	psf
LL:	100	psf	LL:	100	psf

WALL LOADS:

Siding:	0	psf
Framing:	20	psf
Misc. :	3	psf
DL:	23	psf

SNOW LOADS:

Ground Snow - p_g:	20	psf	ASCE 7-98	FIGURE 7-1
C_s:	1		ASCE 7-98	FIGURE 7-2
C_e:	0.9		ASCE 7-98	TABLE 7-2
C_t:	1		ASCE 7-98	TABLE 7-3
I:	1		ASCE 7-98	TABLE 7-4
p_f:	12.6	psf	ASCE 7-98	EQ. 7-1
p_s:	12.6	psf	ASCE 7-98	EQ. 7-2

SEA ENGINEERS
BYU CAPSTONE TEAM 5

JSWEETEN@BYU.EDU
BRIGHAM YOUNG UNIVERSITY, CAMPUS DR. PROVO UT 84604

DESIGN LOADS

PROJECT NAME: Double Log Cabin Storm Shelter *PROJECT NUMER:* 001.01.224

IMPACT LOADS (ICC 500 - 305.3.3):

WALL LENGTH:	130	ft
WALL HEIGHT:	15	ft
ROOF A:	660.16	ft^2
FLOOR A:	528.13	ft^2
DL ABOVE:	68615.6	lb
LL ABOVE:	66015.6	lb
LID AREA:	660.2	ft^2
IMPACT DL:	207.9	psf
IMPACT LL:	200.0	psf

LID LOADS:

Impact DL:	207.9	psf	
Impact LL:	200.0	psf	
LL:	100.0	psf	ICC 500 303.3
Slab DL:	52.6545	psf	
DL:	260.5	psf	
LL:	300.0	psf	

SEA ENGINEERS
BYU CAPSTONE TEAM 5

JSWEETEN@BYU.EDU
BRIGHAMYOUNGUNIVERSITY, CANPUS DR. PROVO UT 84604

BEAMS

LOADS (psf)

	ROOF	FLOOR	WALL
D:	20	20	23
L:	20	100	-
S:	12.6	-	-

COMBINATIONS (ASD)

1.	D
2.	D+L
3.	D+L+(L_r or S)

DEFLECTION CRITERIA

	L	D+L
ROOF	ℓ/240	ℓ/180
FLOOR	ℓ/360	ℓ/240

NDS VALUES

SPRUCE-PINE-FIR (SOUTH)						
grade	dim	F_b	F_v	E	E_min	G
No.1	5" & wider	900	125	1200000	440000	0.36
No.2	5" & wider	575	125	1000000	370000	0.36

		TRIBUTARY WIDTH (ft.)			*ADDITIONAL PLFs*			MEMBER CLASSIFICATION			MEMBER FACTORS									
LABEL	**LENGTH**	**ROOF**	**FLOOR**	**WALL**	**L_r**	**L**	**D**	**GRADE**	**SIZE**	**B/H**	**C_d**	**C_f**	**C_r**	**V_{max}**	**$V_{allowable}$**	**M_{max}**	**$M_{allowable}$**	**D_{max}**	**$D_{allowable}$**	**Check**
B1	3.5	8						No.1	6x6	H	0.9	1	1	15.556	112.500	163.333	809.086	0.008	0.117	**0.2 M**
B2	8.75	8						No.1	6x8	B	0.9	1	1	29.167	112.500	574.219	806.802	0.137	0.292	**0.71 M**
B3	16.5	8						No.1	8x12	B	0.9	1	1	27.500	112.500	680.625	804.692	0.386	0.550	**0.85 M**
RAFTER	8.5	4						No.1	8" Dia.		0.9	1	1	13.528	112.500	344.968	809.750	0.078	0.283	**0.43 M**
FB1	3.5	8	8	10				No.1	6x6	H	1	1	1	73.403	125.000	770.729	898.869	0.039	0.117	**0.86 M**
FB2	3.5		6.5					No.1	6x6	H	1	1	1	37.917	125.000	398.125	898.869	0.020	0.117	**0.44 M**
FB3	3.5		3					No.1	6x6	H	1	1	1	17.500	125.000	183.750	898.869	0.009	0.117	**0.2 M**
JOIST	16.5		2.5					No.1	6x12		1	1	1	34.375	125.000	850.781	886.876	0.483	0.550	**0.96 M**

Project Title:
Engineer:
Project ID:
Project Descr:

Composite Steel Beam

Project File: STORM SHELTER.ec

LIC# : KW-06090828, Build:20.24.02.03 - Educational Version Licensed User : BRIGHAM YOUNG UNIVERSITY (c) ENERCALC INC 1983-202

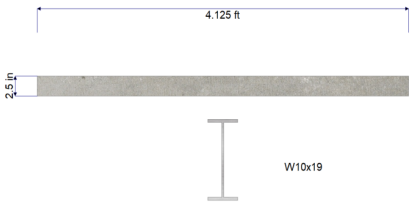
DESCRIPTION: CS1

CODE REFERENCES

Calculations per AISC 360-16, IBC 2018, CBC 2019, ASCE 7-16
Load Combination Set : IBC 2021

Material Properties

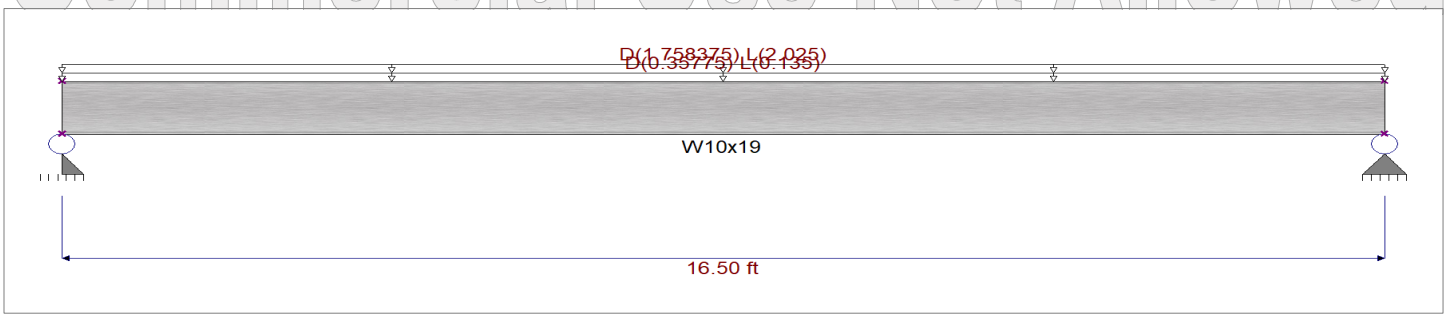
Analysis Method: Load Resistance Factor Design
Beam Bracing : Beam is Fully Braced against lateral-torsional b
Load Combinatior: IBC 2021
Fy : Steel Yield : 50.0 ksi E: Modulus : 29,000.0 ksi



Beam is UNSHORED for Concrete Placement

Composite Beam Section Data

Total Slab Thickness	5.50 in	Concrete f'c	3.0 ksi	Stud Diameter	3/4" in
Effective Width	4.125 ft	Concrete Density	145.0 pcf	Qn : Stud Capacity	17.24 k
Metal Deck . .	Verco, PLW3 Formlok	Rib Height	3.0 in	Top Width	7.50 in
Ribs :	Perpendicular	Rib Spacing	12.0 in	Btm Width	4.50 in



Applied Loads

Service loads entered. Load Factors will be applied for calculatic

Beam self weight calculated and added to loads
Load for Span Number 1
Uniform Load : D = 0.0530, L = 0.020 ksf, Tributary Width = 6.750 ft, Non-Composite Only
Uniform Load : D = 0.2605, L = 0.30 ksf, Tributary Width = 6.750 ft, Post Composite Only

DESIGN SUMMARY

Design OK

MAX Bending Ratio = **0.999** : 1
Steel section **W10x19**

Composite

% Composite Action **67** %
Mu : Applied 182.845 k-ft
Mn * Phi : Allow 183.055 k-ft
Location of maximum 8.250 ft
Load Combination
+1.20D+0.50Lr+1.60L+1.60

Pre-Composite

Mu : Applied 25.301 k-ft
Mn * Phi : Allowable 81.0 k-ft

MAX Shear Ratio = **0.579** : 1
Vu : Applied 44.326 k
Vn * Phi : Allow 76.50 k
Location of maximum 0.0 ft
Load Combination
+1.20D+0.50Lr+1.60L+1.60

DEFLECTIONS

FINAL Composite
Max Downward 0.709 in
Max Upward 0.000 in
Defl Ratio 279
+D+L+H

Transient Composite
Max Downward 0.373 in
Max Upward 0.000 in
Defl Ratio 530
L Only

NonComposite
Max Downward 0.309 in
Max Upward 0.000 in
Defl Ratio 641
PreCompDL+PreCompL

Shear Stud Requirements

From Support 1 to 8.25 ft use 11 studs.
From 8.25 ft to Support 2 use 11 studs.

Maximum Forces & Stresses for Load Combinations

Load Comb & Design Length | Max Stress Ratios | Bending Summary | Shear Summary

Project Title:
Engineer:
Project ID:
Project Descr:

Composite Steel Beam

Project File: STORM SHELTER.ec

LIC# : KW-06090828, Build:20.24.02.03 - Educational Version Licensed User : BRIGHAM YOUNG UNIVERSITY (c) ENERCALC INC 1983-202

DESCRIPTION: CS1

Load Comb & Design Length	Span #	Max Stress Ratios M	V	Bending Summary Mu-Applied	MnTr * Ph	Shear Summary Va	Vn * Ph
Span L = 16.5 ft	1	0.312	0.080	25.30	81.00	6.13	76.50
Final Composite : +1.40D+1.60							
Span L = 16.5 ft	1	0.463	0.268	84.68	183.05	20.53	76.50
Final Composite : +1.20D+0.50							
Span L = 16.5 ft	1	0.999	0.579	182.84	183.05	44.33	76.50
Final Composite : +1.20D+1.60							
Span L = 16.5 ft	1	0.999	0.579	182.84	183.05	44.33	76.50
Final Composite : +1.20D+1.60							
Span L = 16.5 ft	1	0.585	0.339	107.04	183.05	25.95	76.50
Final Composite : +1.20D+1.60							
Span L = 16.5 ft	1	0.397	0.230	72.58	183.05	17.60	76.50
Final Composite : +1.20D+0.50							
Span L = 16.5 ft	1	0.585	0.339	107.04	183.05	25.95	76.50
Final Composite : +1.20D+1.60							
Span L = 16.5 ft	1	0.397	0.230	72.58	183.05	17.60	76.50
Final Composite : +1.20D+0.50							
Span L = 16.5 ft	1	0.585	0.339	107.04	183.05	25.95	76.50
Final Composite : +1.20D+0.50							
Span L = 16.5 ft	1	0.585	0.339	107.04	183.05	25.95	76.50
Final Composite : +1.20D+0.50							
Span L = 16.5 ft	1	0.585	0.339	107.04	183.05	25.95	76.50
Final Composite : +0.90D+W+0							
Span L = 16.5 ft	1	0.297	0.173	54.44	183.05	13.20	76.50
Final Composite : +0.90D+E+0							
Span L = 16.5 ft	1	0.297	0.173	54.44	183.05	13.20	76.50

Maximum Deflections for Load Combinations

Load Combination		Location in Span (ft)	FINAL	DEFLECTIONS (in) Pre-Composite	onComposite Remov	Added Post Composite	Ixx - Used in^4
Precomposite	Downward	8.360	**0.000**	0.3089			96.30
Precomposite	Upward	0.000	**0.000**				96.30
NonComposite Removed	Downward	8.360	**0.000**	0.3089	-0.297		0.00
NonComposite Removed	Upward	0.000	**0.000**				0.00
Final Composite : +D+H	Downward	8.360	**0.324**	0.2274	-0.216	0.011	315.25
Final Composite : +D+H	Upward	0.000	**0.000**				315.25
Final Composite : +D+L+H	Downward	8.360	**0.698**	0.3089	-0.297	0.011	315.25
Final Composite : +D+L+H	Upward	0.000	**0.000**				315.25
Final Composite : +D+Lr+H	Downward	8.360	**0.324**	0.2274	-0.216	0.011	315.25
Final Composite : +D+Lr+H	Upward	0.000	**0.000**				315.25
Final Composite : +D+S+H	Downward	8.360	**0.324**	0.2274	-0.216	0.011	315.25
Final Composite : +D+S+H	Upward	0.000	**0.000**				315.25
Final Composite : +D+0.750Lr+0	Downward	8.360	**0.604**	0.2885	-0.277	0.011	315.25
Final Composite : +D+0.750Lr+0	Upward	0.000	**0.000**				315.25
Final Composite : +D+0.750L+0.	Downward	8.360	**0.604**	0.2885	-0.277	0.011	315.25
Final Composite : +D+0.750L+0.	Upward	0.000	**0.000**				315.25
Final Composite : +D+0.60W+H	Downward	8.360	**0.324**	0.2274	-0.216	0.011	315.25
Final Composite : +D+0.60W+H	Upward	0.000	**0.000**				315.25
Final Composite : +D+0.70E+H	Downward	8.360	**0.324**	0.2274	-0.216	0.011	315.25
Final Composite : +D+0.70E+H	Upward	0.000	**0.000**				315.25
Final Composite : +D+0.750Lr+0	Downward	8.360	**0.604**	0.2885	-0.277	0.011	315.25
Final Composite : +D+0.750Lr+0	Upward	0.000	**0.000**				315.25
Final Composite : +D+0.750L+0.	Downward	8.360	**0.604**	0.2885	-0.277	0.011	315.25
Final Composite : +D+0.750L+0.	Upward	0.000	**0.000**				315.25
Final Composite : +D+0.750L+0.	Downward	8.360	**0.604**	0.2885	-0.277	0.011	315.25
Final Composite : +D+0.750L+0.	Upward	0.000	**0.000**				315.25
Final Composite : +0.60D+0.60V	Downward	8.360	**0.195**	0.1364	-0.130	0.007	315.25
Final Composite : +0.60D+0.60V	Upward	0.000	**0.000**				315.25
Final Composite : +0.60D+0.70E	Downward	8.360	**0.195**	0.1364	-0.130	0.007	315.25
Final Composite : +0.60D+0.70E	Upward	0.000	**0.000**				315.25
Final Composite : D Only	Downward	8.360	**0.324**	0.2274	-0.216	0.011	315.25
Final Composite : D Only	Upward	0.000	**0.000**				315.25
Final Composite : Lr Only	Downward	16.500	**0.000**				315.25
Final Composite : Lr Only	Upward	16.500	**0.000**				315.25
Final Composite : L Only	Downward	8.360	**0.373**	0.0815	-0.081		315.25
Final Composite : L Only	Upward	0.000	**0.000**				315.25
Final Composite : S Only	Downward	16.500	**0.000**				315.25
Final Composite : S Only	Upward	16.500	**0.000**				315.25
Final Composite : W Only	Downward	16.500	**0.000**				315.25

Project Title:
Engineer:
Project ID:
Project Descr:

Composite Steel Beam

Project File: STORM SHELTER.ec

DESCRIPTION: CS1

Maximum Deflections for Load Combinations

Load Combination		Location in Span (ft)	FINAL DEFLECTIONS (in) Pre-Composite	Post-Composite	Added Post Composite	Ixx - Used in^4
Final Composite : E Only	Upward	16.500	**0.000**			315.25
Final Composite : H Only	Downward	16.500	**0.000**			315.25
Final Composite : H Only	Upward	16.500	**0.000**			315.25

Maximum Vertical Reactions

Support notation : Far left is

Load Combination	Support 1	Support 2
Overall MAXimum333	31.370	31.370
Precomposite Loads	4.222	4.222
NonComposite Removed	0.157	0.157
Final Composite : +D+H	14.663	14.663
Final Composite : +D+L+H	31.370	31.370
Final Composite : +D+Lr+H	14.663	14.663
Final Composite : +D+S+H	14.663	14.663
Final Composite : +D+0.750Lr+0.750L+H	27.193	27.193
Final Composite : +D+0.750L+0.750S+H	27.193	27.193
Final Composite : +D+0.60W+H	14.663	14.663
Final Composite : +D+0.70E+H	14.663	14.663
Final Composite : +D+0.750Lr+0.750L+0.450W+H	27.193	27.193
Final Composite : +D+0.750L+0.750S+0.450W+H	27.193	27.193
Final Composite : +D+0.750L+0.750S+0.5250E+H	27.193	27.193
Final Composite : +0.60D+0.60W+0.60H	8.798	8.798
Final Composite : +0.60D+0.70E+0.60H	8.798	8.798
Final Composite : D Only	14.663	14.663
Final Composite : Lr Only		
Final Composite : L Only	16.706	16.706
Final Composite : S Only		
Final Composite : W Only		
Final Composite : E Only		
Final Composite : H Only		

Steel Section Properties: W10x19

Depth	=	10.200	in	I xx	=	96.30	in^4	I yy	=	4.290	in^4
Web Thick	=	0.250	in	S xx	=	18.80	in^3	S yy	=	2.140	in^3
Flange Width	=	4.020	in	R xx	=	4.140	in	R yy	=	0.874	in
Flange Thick	=	0.395	in	Zx	=	21.600	in^3	Zy	=	3.350	in^3
Area	=	5.620	in^2					J	=	0.233	in^4
Weight	=	19.000	plf								

Composite Section Properties

Span Number Plastic N. A. Location	Analysis Type	% Shear Connection	Plastic N.A. from Bottom	Sum Qn Shear (k)	# Studs per 1/2 Span	Mn - Capacit k-ft	Moment of Inertia I-Steel	I-Trans	I-Lwr Bound
PNA in Slab		100.0	10.200	281.000	17	222.15	96.3	450.0	349.2
PNA in Flange		95.0	10.165	266.950	16	222.15	96.3	450.0	345.6
PNA in Flange		90.0	10.130	252.900	15	222.15	96.3	450.0	341.5
PNA in Flange		85.0	10.095	238.850	14	222.15	96.3	450.0	337.0
PNA in Flange		80.0	10.060	224.800	14	220.18	96.3	450.0	331.8
PNA in Flange		75.0	10.025	210.750	13	213.76	96.3	450.0	326.0
PNA in Flange		70.0	9.990	196.700	12	207.29	96.3	450.0	319.5
PNA in Flange		65.0	9.955	182.650	11	200.79	96.3	450.0	312.3
PNA in Flange		60.0	9.920	168.600	10	194.25	96.3	450.0	304.2
PNA in Flange		55.0	9.885	154.550	9	187.67	96.3	450.0	295.2
PNA in Flange		50.0	9.850	140.500	9	181.06	96.3	450.0	285.3
PNA in Flange		45.0	9.816	126.450	8	174.41	96.3	450.0	274.2
PNA in Web		40.0	9.413	112.400	7	165.11	96.3	450.0	261.9
PNA in Web		35.0	8.851	98.350	6	157.77	96.3	450.0	248.2
PNA in Web		30.0	8.289	84.300	5	149.78	96.3	450.0	233.0
PNA in Web		25.0	7.727	70.250	5	141.12	96.3	450.0	216.0

Span 1

Project Title:
Engineer:
Project ID:
Project Descr:

Concrete Beam

Project File: STORM SHELTER.ec

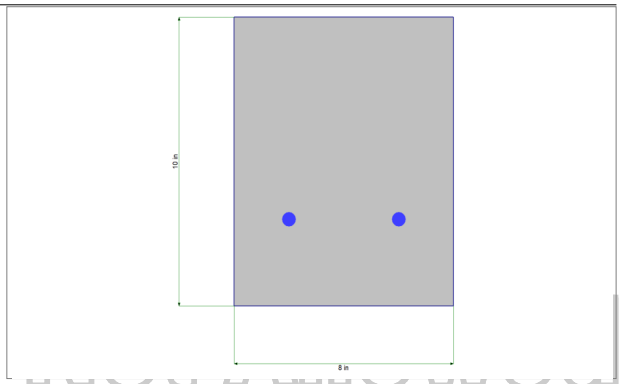
DESCRIPTION: L1-IMPACT

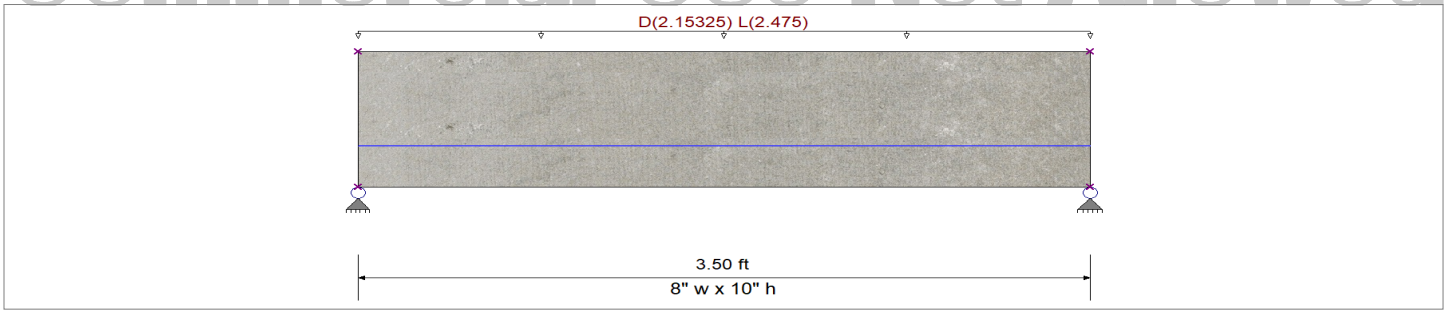
CODE REFERENCES

Calculations per ACI 318-14, IBC 2018, CBC 2019, ASCE 7-16
Load Combination Set : IBC 2021

General Information

f'c	=	3.0 ksi	ϕ Phi Values	Flexure	0.90
fr = f'c^1/2 7.50	=	410.792 psi		Shear	0.750
ψ Density	=	145.0 pcf	β 1	=	0.850
λ LtWt Factor	=	1.0			
Elastic Modulus	=	3,122.0 ksi	Fy - Stirrups		40.0 ksi
fy - Main Rebar	=	60.0 ksi	E - Stirrups	=	29,000.0 ksi
E - Main Rebar	=	29,000.0 ksi	Stirrup Bar Size #		3
			Number of Resisting Legs Per Stirr	=	2





Cross Section & Reinforcing Details

Rectangular Section, Width = 8.0 in, Height = 10.0 in
Span #1 Reinforcing....
2-#4 at 3.0 in from Bottom, from 0.0 to 3.50 ft in this span

Beam self weight calculated and added to loads
Load for Span Number 1
Uniform Load : D = 0.2610, L = 0.30 ksf, Tributary Width = 8.250 ft, (ABOVE/IMPACT)

DESIGN SUMMARY

Design OK

Maximum Bending Stress Ratio =	**0.881**	: 1
Section used for this span	**Typical Sectio**	
Mu : Applied	10.168	k-ft
Mn * Phi : Allowable	11.541	k-ft
Location of maximum on span	1.753	ft
Span # where maximum occurs	Span # 1	

Maximum Deflection

Max Downward Transient Deflection	0.004 in	Ratio =	10464 >=360.0	L Only
Max Upward Transient Deflection	0.000 in	Ratio =	0 <360.0	L Only
Max Downward Total Deflection	0.020 in	Ratio =	2106 >=180.0	Span: 1 : +D+L
Max Upward Total Deflection	0.000 in	Ratio =	0 <180.0	Span: 1 : +D+L

Vertical Reactions

Support notation : Far left is #1

Load Combination	Support 1	Support 2
Max Upward from all Load Conditions	8.240	8.240
Max Upward from Load Combinations	8.240	8.240
Max Upward from Load Cases	4.331	4.331
D Only	3.909	3.909
+D+L	8.240	8.240

Project Title:
Engineer:
Project ID:
Project Descr:

Concrete Beam

Project File: STORM SHELTER.ec

DESCRIPTION: L1-IMPACT

Vertical Reactions

Support notation : Far left is #1

Load Combination	Support 1	Support 2
L Only	4.331	4.331

Shear Stirrup Requirements

Between 0.00 to 1.40 ft, Phi*Vc / 2 < Vu <= Phi*Vc, Req'd Vs = Min per 9.6.3.1, use #3 stirrups spaced at 3.000 in
Between 1.41 to 2.09 ft, Vu < Phi*Vc / 2, Req'd Vs = Not Reqd per 9.6.3.1, Stirrups are not required.
Between 2.10 to 3.49 ft, Phi*Vc < Vu, Req'd Vs = 6.50, use #3 stirrups spaced at 3.000 in

Detailed Shear Information

Load Combinatior	Span Number	Distance (ft)	'd' (in)	Vu (k) Actual	Vu (k) Design	Mu (k-ft)	d*Vu/Mu	Phi*Vc (k)	Comment	Phi*Vs (k)	Phi*Vn (k)	Spacing (in) Req'd
+1.20D+1.60L	1	0.00	7.00	11.62	11.62	0.00	1.00	5.12	Phi*Vc < Vu	6.50	20.5	3.5
+1.20D+1.60L	1	0.04	7.00	11.37	11.37	0.44	1.00	5.12	Phi*Vc < Vu	6.246	20.5	3.5
+1.20D+1.60L	1	0.08	7.00	11.11	11.11	0.87	1.00	5.12	Phi*Vc < Vu	5.992	20.5	3.5
+1.20D+1.60L	1	0.11	7.00	10.86	10.86	1.29	1.00	5.12	Phi*Vc < Vu	5.738	20.5	3.5
+1.20D+1.60L	1	0.15	7.00	10.60	10.60	1.70	1.00	5.12	Phi*Vc < Vu	5.484	20.5	3.5
+1.20D+1.60L	1	0.19	7.00	10.35	10.35	2.10	1.00	5.12	Phi*Vc < Vu	5.230	20.5	3.5
+1.20D+1.60L	1	0.23	7.00	10.10	10.10	2.49	1.00	5.12	Phi*Vc < Vu	4.976	20.5	3.5
+1.20D+1.60L	1	0.27	7.00	9.84	9.84	2.87	1.00	5.12	Phi*Vc < Vu	4.722	20.5	3.5
+1.20D+1.60L	1	0.31	7.00	9.59	9.59	3.25	1.00	5.12	Phi*Vc < Vu	4.468	20.5	3.5
+1.20D+1.60L	1	0.34	7.00	9.33	9.33	3.61	1.00	5.12	Phi*Vc < Vu	4.214	20.5	3.5
+1.20D+1.60L	1	0.38	7.00	9.08	9.08	3.96	1.00	5.12	Phi*Vc < Vu	3.960	20.5	3.5
+1.20D+1.60L	1	0.42	7.00	8.83	8.83	4.30	1.00	5.12	Phi*Vc < Vu	3.706	20.5	3.5
+1.20D+1.60L	1	0.46	7.00	8.57	8.57	4.63	1.00	5.12	Phi*Vc < Vu	3.452	20.5	3.5
+1.20D+1.60L	1	0.50	7.00	8.32	8.32	4.96	0.98	5.10	Phi*Vc < Vu	3.214	20.5	3.5
+1.20D+1.60L	1	0.54	7.00	8.06	8.06	5.27	0.89	5.04	Phi*Vc < Vu	3.025	20.4	3.5
+1.20D+1.60L	1	0.57	7.00	7.81	7.81	5.57	0.82	4.98	Phi*Vc < Vu	2.827	20.4	3.5
+1.20D+1.60L	1	0.61	7.00	7.56	7.56	5.87	0.75	4.93	Phi*Vc < Vu	2.623	20.3	3.5
+1.20D+1.60L	1	0.65	7.00	7.30	7.30	6.15	0.69	4.89	Phi*Vc < Vu	2.413	20.3	3.5
+1.20D+1.60L	1	0.69	7.00	7.05	7.05	6.43	0.64	4.85	Phi*Vc < Vu	2.198	20.3	3.5
+1.20D+1.60L	1	0.73	7.00	6.79	6.79	6.69	0.59	4.82	Phi*Vc < Vu	1.980	20.2	3.5
+1.20D+1.60L	1	0.77	7.00	6.54	6.54	6.95	0.55	4.78	Phi*Vc < Vu	1.758	20.2	3.5
+1.20D+1.60L	1	0.80	7.00	6.29	6.29	7.19	0.51	4.75	Phi*Vc < Vu	1.534	20.2	3.5
+1.20D+1.60L	1	0.84	7.00	6.03	6.03	7.43	0.47	4.73	Phi*Vc < Vu	1.307	20.1	3.5
+1.20D+1.60L	1	0.88	7.00	5.78	5.78	7.65	0.44	4.70	Phi*Vc < Vu	1.078	20.1	3.5
+1.20D+1.60L	1	0.92	7.00	5.52	5.52	7.87	0.41	4.68	Phi*Vc < Vu	0.8468	20.1	3.5
+1.20D+1.60L	1	0.96	7.00	5.27	5.27	8.08	0.38	4.66	Phi*Vc < Vu	0.6144	20.1	3.5
+1.20D+1.60L	1	0.99	7.00	5.02	5.02	8.27	0.35	4.64	Phi*Vc < Vu	0.3806	20.0	3.5
+1.20D+1.60L	1	1.03	7.00	4.76	4.76	8.46	0.33	4.62	Phi*Vc < Vu	0.1456	20.0	3.5
+1.20D+1.60L	1	1.07	7.00	4.51	4.51	8.64	0.30	4.60	Phi*Vc / 2 < Vu	lin per 9.6	20.0	3.5
+1.20D+1.60L	1	1.11	7.00	4.25	4.25	8.81	0.28	4.60	Phi*Vc / 2 < Vu	lin per 9.6	20.0	3.5
+1.20D+1.60L	1	1.15	7.00	4.00	4.00	8.96	0.26	4.60	Phi*Vc / 2 < Vu	lin per 9.6	20.0	3.5
+1.20D+1.60L	1	1.19	7.00	3.75	3.75	9.11	0.24	4.60	Phi*Vc / 2 < Vu	lin per 9.6	20.0	3.5
+1.20D+1.60L	1	1.22	7.00	3.49	3.49	9.25	0.22	4.60	Phi*Vc / 2 < Vu	lin per 9.6	20.0	3.5
+1.20D+1.60L	1	1.26	7.00	3.24	3.24	9.38	0.20	4.60	Phi*Vc / 2 < Vu	lin per 9.6	20.0	3.5
+1.20D+1.60L	1	1.30	7.00	2.98	2.98	9.50	0.18	4.60	Phi*Vc / 2 < Vu	lin per 9.6	20.0	3.5
+1.20D+1.60L	1	1.34	7.00	2.73	2.73	9.61	0.17	4.60	Phi*Vc / 2 < Vu	lin per 9.6	20.0	3.5
+1.20D+1.60L	1	1.38	7.00	2.48	2.48	9.71	0.15	4.60	Phi*Vc / 2 < Vu	lin per 9.6	20.0	3.5
+1.20D+1.60L	1	1.42	7.00	2.22	2.22	9.80	0.13	4.60	Vu < Phi*Vc / 2	ot Reqd pe	4.6	0.0
+1.20D+1.60L	1	1.45	7.00	1.97	1.97	9.88	0.12	4.60	Vu < Phi*Vc / 2	ot Reqd pe	4.6	0.0
+1.20D+1.60L	1	1.49	7.00	1.71	1.71	9.95	0.10	4.60	Vu < Phi*Vc / 2	ot Reqd pe	4.6	0.0
+1.20D+1.60L	1	1.53	7.00	1.46	1.46	10.01	0.09	4.60	Vu < Phi*Vc / 2	ot Reqd pe	4.6	0.0
+1.20D+1.60L	1	1.57	7.00	1.21	1.21	10.06	0.07	4.60	Vu < Phi*Vc / 2	ot Reqd pe	4.6	0.0
+1.20D+1.60L	1	1.61	7.00	0.95	0.95	10.10	0.06	4.60	Vu < Phi*Vc / 2	ot Reqd pe	4.6	0.0
+1.20D+1.60L	1	1.64	7.00	0.70	0.70	10.13	0.04	4.60	Vu < Phi*Vc / 2	ot Reqd pe	4.6	0.0
+1.20D+1.60L	1	1.68	7.00	0.44	0.44	10.15	0.03	4.60	Vu < Phi*Vc / 2	ot Reqd pe	4.6	0.0
+1.20D+1.60L	1	1.72	7.00	0.19	0.19	10.17	0.01	4.60	Vu < Phi*Vc / 2	ot Reqd pe	4.6	0.0
+1.20D+1.60L	1	1.76	7.00	-0.06	0.06	10.17	0.00	4.60	Vu < Phi*Vc / 2	ot Reqd pe	4.6	0.0
+1.20D+1.60L	1	1.80	7.00	-0.32	0.32	10.16	0.02	4.60	Vu < Phi*Vc / 2	ot Reqd pe	4.6	0.0

Project Title:
Engineer:
Project ID:
Project Descr:

Concrete Beam

Project File: STORM SHELTER.ec

LIC# : KW-06090828, Build:20.24.02.03 - Educational Version Licensed User : BRIGHAM YOUNG UNIVERSITY (c) ENERCALC INC 1983-202

DESCRIPTION: L1-IMPACT

Detailed Shear Information

Load Combinatior	Span Number	Distance (ft)	'd' (in)	Vu Actual	(k) Design	Mu (k-ft)	d*Vu/Mu	Phi*Vc (k)	Comment	Phi*Vs (k)	Phi*Vn (k)	Spacing (in) Req'd
+1.20D+1.60L	1	1.91	7.00	-1.08	1.08	10.08	0.06	4.60	Vu < Phi*Vc / 2	ot Reqd pe	4.6	0.0
+1.20D+1.60L	1	1.95	7.00	-1.33	1.33	10.03	0.08	4.60	Vu < Phi*Vc / 2	ot Reqd pe	4.6	0.0
+1.20D+1.60L	1	1.99	7.00	-1.59	1.59	9.98	0.09	4.60	Vu < Phi*Vc / 2	ot Reqd pe	4.6	0.0
+1.20D+1.60L	1	2.03	7.00	-1.84	1.84	9.91	0.11	4.60	Vu < Phi*Vc / 2	ot Reqd pe	4.6	0.0
+1.20D+1.60L	1	2.07	7.00	-2.10	2.10	9.84	0.12	4.60	Vu < Phi*Vc / 2	ot Reqd pe	4.6	0.0
+1.20D+1.60L	1	2.10	7.00	-2.35	2.35	9.75	0.14	4.60	Phi*Vc / 2 < Vu	lin per 9.6	20.0	3.5
+1.20D+1.60L	1	2.14	7.00	-2.60	2.60	9.66	0.16	4.60	Phi*Vc / 2 < Vu	lin per 9.6	20.0	3.5
+1.20D+1.60L	1	2.18	7.00	-2.86	2.86	9.55	0.17	4.60	Phi*Vc / 2 < Vu	lin per 9.6	20.0	3.5
+1.20D+1.60L	1	2.22	7.00	-3.11	3.11	9.44	0.19	4.60	Phi*Vc / 2 < Vu	lin per 9.6	20.0	3.5
+1.20D+1.60L	1	2.26	7.00	-3.37	3.37	9.32	0.21	4.60	Phi*Vc / 2 < Vu	lin per 9.6	20.0	3.5
+1.20D+1.60L	1	2.30	7.00	-3.62	3.62	9.18	0.23	4.60	Phi*Vc / 2 < Vu	lin per 9.6	20.0	3.5
+1.20D+1.60L	1	2.33	7.00	-3.87	3.87	9.04	0.25	4.60	Phi*Vc / 2 < Vu	lin per 9.6	20.0	3.5
+1.20D+1.60L	1	2.37	7.00	-4.13	4.13	8.89	0.27	4.60	Phi*Vc / 2 < Vu	lin per 9.6	20.0	3.5
+1.20D+1.60L	1	2.41	7.00	-4.38	4.38	8.72	0.29	4.60	Phi*Vc / 2 < Vu	lin per 9.6	20.0	3.5
+1.20D+1.60L	1	2.45	7.00	-4.64	4.64	8.55	0.32	4.61	Phi*Vc < Vu	0.02767	20.0	3.5
+1.20D+1.60L	1	2.49	7.00	-4.89	4.89	8.37	0.34	4.63	Phi*Vc < Vu	0.2632	20.0	3.5
+1.20D+1.60L	1	2.52	7.00	-5.14	5.14	8.18	0.37	4.65	Phi*Vc < Vu	0.4977	20.0	3.5
+1.20D+1.60L	1	2.56	7.00	-5.40	5.40	7.97	0.39	4.67	Phi*Vc < Vu	0.7308	20.1	3.5
+1.20D+1.60L	1	2.60	7.00	-5.65	5.65	7.76	0.42	4.69	Phi*Vc < Vu	0.9624	20.1	3.5
+1.20D+1.60L	1	2.64	7.00	-5.91	5.91	7.54	0.46	4.71	Phi*Vc < Vu	1.192	20.1	3.5
+1.20D+1.60L	1	2.68	7.00	-6.16	6.16	7.31	0.49	4.74	Phi*Vc < Vu	1.420	20.1	3.5
+1.20D+1.60L	1	2.72	7.00	-6.41	6.41	7.07	0.53	4.77	Phi*Vc < Vu	1.646	20.2	3.5
+1.20D+1.60L	1	2.75	7.00	-6.67	6.67	6.82	0.57	4.80	Phi*Vc < Vu	1.869	20.2	3.5
+1.20D+1.60L	1	2.79	7.00	-6.92	6.92	6.56	0.62	4.83	Phi*Vc < Vu	2.089	20.2	3.5
+1.20D+1.60L	1	2.83	7.00	-7.18	7.18	6.29	0.67	4.87	Phi*Vc < Vu	2.306	20.3	3.5
+1.20D+1.60L	1	2.87	7.00	-7.43	7.43	6.01	0.72	4.91	Phi*Vc < Vu	2.518	20.3	3.5
+1.20D+1.60L	1	2.91	7.00	-7.68	7.68	5.72	0.78	4.96	Phi*Vc < Vu	2.726	20.4	3.5
+1.20D+1.60L	1	2.95	7.00	-7.94	7.94	5.42	0.85	5.01	Phi*Vc < Vu	2.927	20.4	3.5
+1.20D+1.60L	1	2.98	7.00	-8.19	8.19	5.12	0.93	5.07	Phi*Vc < Vu	3.120	20.5	3.5
+1.20D+1.60L	1	3.02	7.00	-8.45	8.45	4.80	1.00	5.12	Phi*Vc < Vu	3.325	20.5	3.5
+1.20D+1.60L	1	3.06	7.00	-8.70	8.70	4.47	1.00	5.12	Phi*Vc < Vu	3.579	20.5	3.5
+1.20D+1.60L	1	3.10	7.00	-8.95	8.95	4.13	1.00	5.12	Phi*Vc < Vu	3.833	20.5	3.5
+1.20D+1.60L	1	3.14	7.00	-9.21	9.21	3.78	1.00	5.12	Phi*Vc < Vu	4.087	20.5	3.5
+1.20D+1.60L	1	3.17	7.00	-9.46	9.46	3.43	1.00	5.12	Phi*Vc < Vu	4.341	20.5	3.5
+1.20D+1.60L	1	3.21	7.00	-9.72	9.72	3.06	1.00	5.12	Phi*Vc < Vu	4.595	20.5	3.5
+1.20D+1.60L	1	3.25	7.00	-9.97	9.97	2.68	1.00	5.12	Phi*Vc < Vu	4.849	20.5	3.5
+1.20D+1.60L	1	3.29	7.00	-10.22	10.22	2.30	1.00	5.12	Phi*Vc < Vu	5.103	20.5	3.5
+1.20D+1.60L	1	3.33	7.00	-10.48	10.48	1.90	1.00	5.12	Phi*Vc < Vu	5.357	20.5	3.5
+1.20D+1.60L	1	3.37	7.00	-10.73	10.73	1.50	1.00	5.12	Phi*Vc < Vu	5.611	20.5	3.5
+1.20D+1.60L	1	3.40	7.00	-10.99	10.99	1.08	1.00	5.12	Phi*Vc < Vu	5.865	20.5	3.5
+1.20D+1.60L	1	3.44	7.00	-11.24	11.24	0.66	1.00	5.12	Phi*Vc < Vu	6.119	20.5	3.5
+1.20D+1.60L	1	3.48	7.00	-11.49	11.49	0.22	1.00	5.12	Phi*Vc < Vu	6.373	20.5	3.5

Maximum Forces & Stresses for Load Combinations

Load Combination / Segment	Span #	Location (ft) along Beam	Bending Stress Results (k-ft) Mu : Ma›	Phi*Mn›	Stress Ratio
MAXimum BENDING Envelope					
Span # 1	1	3.500	10.17	11.54	0.88
+1.40D					
Span # 1	1	3.500	4.79	11.54	0.41
+1.20D+1.60L					
Span # 1	1	3.500	10.17	11.54	0.88
+1.20D+0.50L					
Span # 1	1	3.500	6.00	11.54	0.52
+1.20D					
Span # 1	1	3.500	4.10	11.54	0.36
+0.90D					
Span # 1	1	3.500	3.08	11.54	0.27

Project Title:
Engineer:
Project ID:
Project Descr:

Concrete Beam

Project File: STORM SHELTER.ec

LIC# : KW-06090828, Build:20.24.02.03 - Educational Version Licensed User : BRIGHAM YOUNG UNIVERSITY (c) ENERCALC INC 1983-202

DESCRIPTION: L1-IMPACT

Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	(in Location in Span (	Load Combination	Max. "+" Defl	(in Location in Span (
+D+L	1	0.0199	1.750		0.0000	0.000

SEA ENGINEERS
BYU CAPSTONE TEAM 5

J3WEETEN@BYU.EDU
BRIGHAM YOUNG UNIVERSITY, CAMPUS DR. PROVO UT 84604

COMPOSITE STEEL BEAMS

CONSTRUCTION LOADS (psf)

	MAIN FLR
D:	53
L:	20

LOADS (psf)

	ROOF	MAIN FLR	UPPER FLR	WALL	IMPACT
D:	20	53	20	23	261
L:	20	100	100	-	300
S:	12.6	-	-	-	

COMBINATIONS (LRFD)

1.	1.4D
2.	1.2D+1.6L

DEFLECTION CRITERIA

	L	D+L
FLOOR	ℓ/360	ℓ/240

BEAM INFORMATION

LABEL	CS1
LENGTH	16.5 ft.
TRIB.	6.75 ft.
B/H	B

MEMBER	W10x19

CONSTRUCTION PHASE

Wu	0.64	klf
Vu	5.3	k
Mu	21.9	k-ft

ϕVn	76.5	k **TABLE 3-2**
ϕMn	24.0	k-ft **TABLE 3-10**
CHECK	**0.9**	**OK**

OCCUPANCY PHASE

Wu	5.35	klf
Vu	44.1	k
Mu	182.1	k-ft

STL YIELD

v'	281	k

CONC. T	5.5	in
f_c'	3.0	ksi
b_e	4.125	ft

CRUSHING

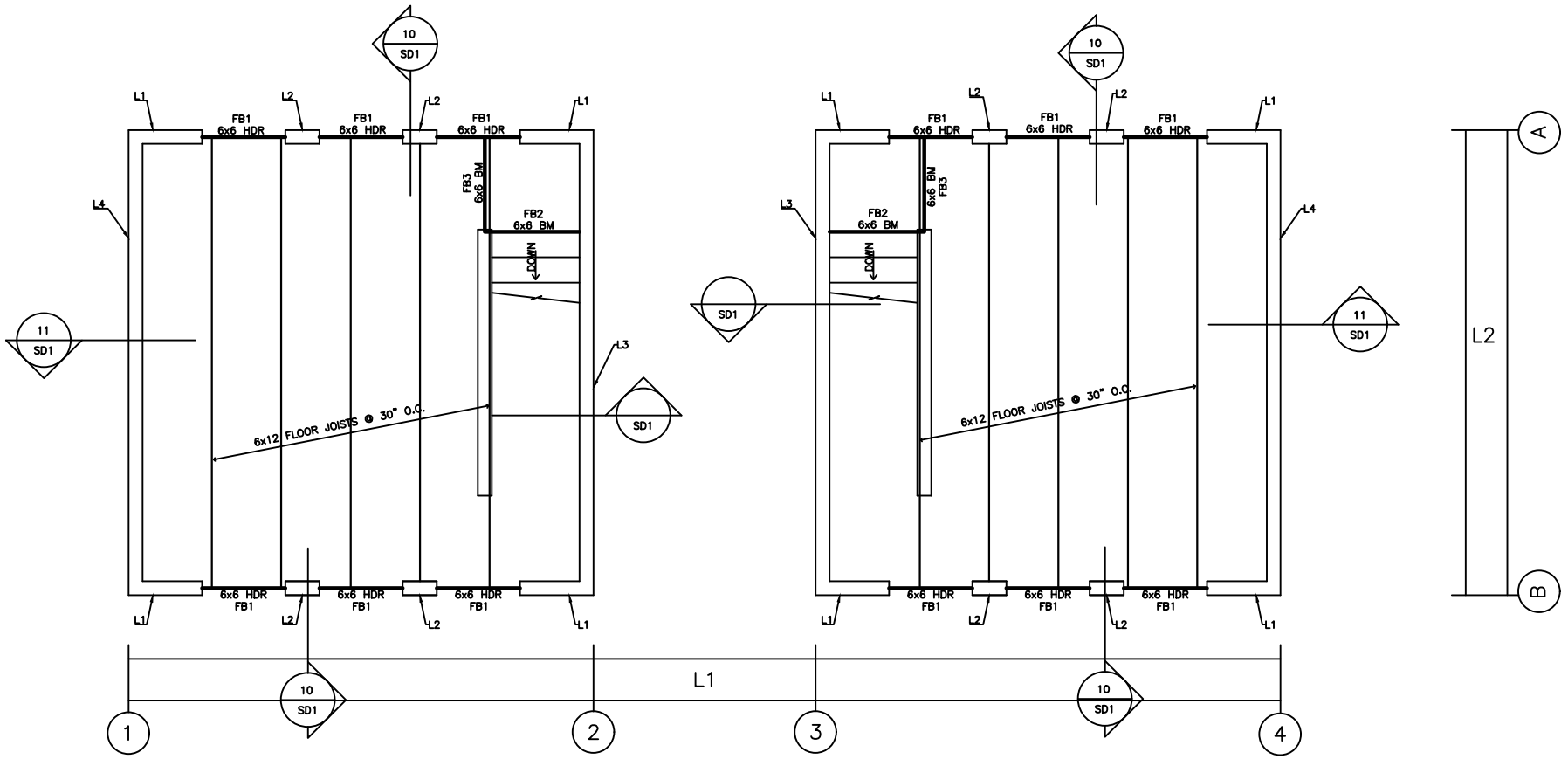
v'	694	k
CHECK	**0.06**	**OK**

STUDS	3/4" (26)	
∑Qn	242.6	k
a	1.92	in
Y2	4.54	in
ϕMn	199.0	k-ft
M CHECK	**0.91**	**OK**
V CHECK	**0.58**	**OK**

DEFLECTION (ASD)

Wu	2.03	klf
Mu	68.9	k-ft
Δ_L	0.3	in
l/360	0.6	in
CHECK	**0.59**	**OK**

Wu	3.78	klf
Mu	128.8	k-ft
Δ_{TL}	0.6	in
l/240	0.8	in
CHECK	**0.73**	**OK**


10
SD1
L1
L2
FB1
6x6 HDR
FB3
6x6 BM
FB2
6x6 BM
DOWN
L3
L4
11
SD1
6x12 FLOOR JOISTS @ 30" O.C.
6x6 HDR
FB1
L1
L2
1
2
3
4
A
B
L2

SEA ENGINEERS

BYU CAPSTONE TEAM 5

JSWEETEN@BYU.EDU
BRIGHAM YOUNG UNIVERSITY, CAMPUS DR. PROVO UT 84604

WIND DESIGN LOADS

PROJECT NAME: Double Log Cabin *PROJECT NUMER:* 001.01.224

VALUES:

Mean Roof H:	20	
Roof Pitch:	6	26.6

V:	109	mph
P_0:	30.42	psf
Wind Exp.:	C	
K_{zt}:	1	
K_d:	1	
K_e:	1	
K_{0-15}:	0.85	
K_h:	0.9	
q_{0-15}:	25.85	psf
q_h:	27.37	psf
G:	0.85	

Longitudinal (N/S)			***Transverse (E/W)***	
ASCE 7-16 FIGURE 27.3-1				
Wall	C_p		***Wall***	C_p
L/B:	2.5		L/B:	0.4
Windward:	0.8		Windward:	0.8
Leeward:	-0.275		Leeward:	-0.5
Roof			***Roof***	
h/L:	0.485		**NO ROOF IN THIS DIRECTION**	
Windward:	-0.17			
Leeward:	-0.6			
p_{0-15}	23.62	psf	p_{0-15}	28.57 psf
p_h	25.01	psf	p_h	30.25 psf
p_{roof}	10.08	psf	p_{roof}	N/A psf

LINE LOADS:

LEVELS	HEIGHT
Roof	20
Upper Floo	10

tributary widths

Label	Width	Level	Dir.	Wall (ft)	Roof (ft)	0.6 Press.(plf)
L1	40	Roof	NS	4	4.06	84.59
L2	16.5	Roof	EW	6.03		90.52
L3	40	Upper Floor	NS	7		99.22
L4	16.5	Upper Floor	EW	7		99.22

SEA ENGINEERS

BYU CAPSTONE TEAM 5

JSWEETEN@BYU.EDU
BRIGHAM YOUNG UNIVERSITY, CAMPUS DR. PROVO UT 84604

SEISMIC LOADS

PROJECT NAME: Double Log Cabin *PROJECT NUMER:* 001.01.224

S_{DS}:	0.112		ASCE Hazard Tool	
S_{D1}:	0.115			
T_a:	$C_tH_n^x$	sec	ASCE 7-16	EQ. 12.8-7
C_t:	0.02		ASCE 7-16	TABLE 12.8-2
h_n:	20	ft		
x:	0.75		ASCE 7-16	TABLE 12.8-2
T_a:	0.19	sec		
$C_{s:}$	S_{DS}/R		ASCE 7-16	EQ. 12.8-2
R:	3		ASCE 7-16	TABLE 12.2-1
C_s:	0.04			
V_{bs}:	ma			
	(m/g)*a			
	$W*C_s$		ASCE 7-16	EQ. 12.8-1
W:	68.6	k		
V_{bs}:	2.6	k		

LINE LOADS:

Label	Width	Level	Dir.	0.7 Press.(plf)
L1	40	Roof	NS	
L2	16.5	Roof	EW	
L3	40	Upper Floo	NS	44.83
L4	16.5	Upper Floo	EW	108.68

SEA ENGINEERS
BYU CAPSTONE TEAM 5

JSWEETEN@BYU.EDU
BRIGHAM YOUNG UNIVERSITY, CAMPUS DR. PROVO UT 84604

	ROOF	FLOOR	WALL
DL	20	20	23

PROJECT NAME: Double Log Cabin *PROJECT NUMER:* 001.01.224

SHEAR LINE CALCS

LINE:	**1**	**PLATE HEIGHT (ft)**	**8**
LOAD	WIDTH		
L1	8.25		
L3	8.25		

LENGTH	CONN.	WALL THICK. (in.)	SPACING (in.)	LOAD FROM ABV. (lb)	HD	CAPACITY (plf)	WIND SHEAR (plf)	SEISMIC SHEAR (plf)	CHECK	HD CAPACITY	F_{PIER} (lb)	T	CHECK
16	SDWS221200	6	32	1472	NO H.D.	105	94.8	23.1	**0.90**	0	840.0	-1052.0	**OK**

NOTES:

LINE:	**2**	**PLATE HEIGHT (ft)**	**8**
LOAD	WIDTH		
L1	16.5		
L3	16.5		

LENGTH	CONN.	WALL THICK. (in.)	CONN. SPACING (in.)	LOAD FROM ABV. (lb)	HD	CONN. CAPACITY (plf)	WIND SHEAR (plf)	SEISMIC SHEAR (plf)	CHECK	HD CAPACITY	F_{PIER} (lb)	T	CHECK
16	SDWS221200	6	16	1472	NO H.D.	210	189.6	46.2	**0.90**	0	1680.0	-632.0	**OK**

NOTES:

LINE:	**3**	**PLATE HEIGHT (ft)**	**8**
LOAD	WIDTH		
L1	16.5		
L3	16.5		

LENGTH	CONN.	WALL THICK. (in.)	CONN. SPACING (in.)	LOAD FROM ABV. (lb)	HD	CONN. CAPACITY (plf)	WIND SHEAR (plf)	SEISMIC SHEAR (plf)	CHECK	HD CAPACITY	F_{PIER} (lb)	T	CHECK
16	SDWS221200	6	16	1472	NO H.D.	210	189.6	46.2	**0.90**	0	1680.0	-632.0	**OK**

NOTES:

LINE:	4	PLATE HEIGHT (ft)	8
LOAD	WIDTH		
L1	8.25		
L3	8.25		

LENGTH	CONN.	WALL THICK. (in.)	CONN. SPACING (in.)	LOAD FROM ABV. (lb)	HD	CONN. CAPACITY (plf)	WIND SHEAR (plf)	SEISMIC SHEAR (plf)	CHECK	HD CAPACITY	F_{PIER} (lb)	T	CHECK
16	SDWS221200	6	32	1472	NO H.D.	105	94.8	23.1	**0.90**	0	840.0	-1052.0	**OK**

NOTES:

LINE:	A	PLATE HEIGHT (ft)	8
LOAD	WIDTH		
L2	8.25		
L4	8.25		

LENGTH	CONN.	WALL THICK. (in.)	CONN. SPACING (in.)	# ROWS OF SCREWS	CONN. EMBED. (in.)	HD	CONN. CAPACITY (plf)	WIND SHEAR (plf)	SEISMIC SHEAR (plf)	SHEAR CHECK	CONN. CAPACITY (TENSION) (lb)	F_{PIER} (lb)	T	CONN. CHECK	HD CAPACITY (lb)	HD CHECK
1.5	SDWS221200	6	12	4	3	1/2" AB	1120	313.1	179.3	**0.28**	1980	469.6	1878.4	**0.95**	2000	**0.94**
1	SDWS221200	6	9	4	3	1/2" AB	1493.333	313.1	179.3	**0.21**	1980	313.1	1669.6	**0.84**	2000	**0.83**
1	SDWS221200	6	9	4	3	1/2" AB	1493.333	313.1	179.3	**0.21**	1980	313.1	1669.6	**0.84**	2000	**0.83**
1.5	SDWS221200	6	12	4	3	1/2" AB	1120	313.1	179.3	**0.28**	1980	469.6	1878.4	**0.95**	2000	**0.94**

NOTES:

LINE:	B	PLATE HEIGHT (ft)	8
LOAD	WIDTH		
L2	8.25		
L4	8.25		

LENGTH	CONN.	WALL THICK. (in.)	CONN. SPACING (in.)	# ROWS OF SCREWS	CONN. EMBED. (in.)	HD	CONN. CAPACITY (plf)	WIND SHEAR (plf)	SEISMIC SHEAR (plf)	SHEAR CHECK	CONN. CAPACITY (TENSION) (lb)	F_{PIER} (lb)	T	CONN. CHECK	HD CAPACITY (lb)	HD CHECK
1.5	SDWS221200	6	12	4	3	1/2" AB	1120	313.1	179.3	**0.28**	1980	469.6	1878.4	**0.95**	2000	**0.94**
1	SDWS221200	6	9	4	3	1/2" AB	1493.333	313.1	179.3	**0.21**	1980	313.1	1669.6	**0.84**	2000	**0.83**
1	SDWS221200	6	9	4	3	1/2" AB	1493.333	313.1	179.3	**0.21**	1980	313.1	1669.6	**0.84**	2000	**0.83**
1.5	SDWS221200	6	12	4	3	1/2" AB	1120	313.1	179.3	**0.28**	1980	469.6	1878.4	**0.95**	2000	**0.94**

NOTES:

SEA ENGINEERS

BYU CAPSTONE TEAM 5

JSWEETEN@BYU.EDU

BRIGHAM YOUNG UNIVERSITY, CAMPUS DR. PROVO UT 84604

PROJECT NAME: Double Log Cabin *PROJECT NUMER:* 001.01.224

LINE(S):	**2 & 3**								
ROD DIA. (in.)	ROD SPACING (in.)	WELD SIZE # (in.)	WELD CAPACITY V (k)	WELD CAPACITY T (k)	ROD CAPACITY V (k)	ROD CAPACITY T (k)	APPLIED V (k)	APPLIED T (k)	CHECK
5/8	24	1/4	10.9	16.4	6.23	10.4	0.38	-0.632	0.06
			*AISC EQ. 8-2a	*AISC EQ. J2-5	*VALUES PER AISC TABLES 7-1 & 7-2				

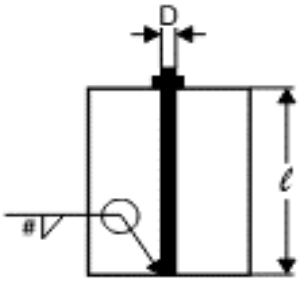
WOOD MEMBER YIELD LIMIT

MAIN MEMBER SPECIES	MAIN MEMBER ℓ (in.)	MAX ANGLE BETWEEN LOAD AND GRAIN (°)	D	G	$F_{e\_parrallel}$ (psi)	F_{e_perp} (psi)	R_d	YEILD LIMIT (k)	APPLIED LOAD (k)	CHECK
SPF	2	90	0.527	0.36	4050	1910	5	0.40	0.38	0.94
		*WORST CASE = 90°	*AISC TABLE 7-17	*NDS TABLE 12.3.3A	*NDS TABLE 12.3.3	*NDS TABLE 12.3.3 NOTE 2	*NDS TABLE 12.3.1B			

LINE(S):	**1, 4, A & B**	
ROD DIA. (in.)	MAX ROD SPACING (in.)	APPLIED V (k)
5/8	24	0.63

WOOD MEMBER YIELD LIMIT

MAIN MEMBER SPECIES	MAIN MEMBER ℓ (in.)	MAX ANGLE BETWEEN LOAD AND GRAIN (°)	D	G	$F_{e\_parrallel}$ (psi)	F_{e_perp} (psi)	R_d	YEILD LIMIT (k)	APPLIED LOAD (k)	CHECK
SPF	3.5	90	0.500	0.36	4050	1961	5	0.69	0.63	0.91



PLW3-36 FormLok® Composite Steel Deck-Slab (ASD)

with 5.5 in. 145 pcf 3000 psi NWC

Maximum Unshored Span

Gage	1 Span	2 Span	3 Span
22	9'-8"	9'-7"	10'-8"
21	10'-7"	11'-2"	11'-6"
20	11'-4"	11'-11"	12'-3"
19	11'-10"	13'-3"	13'-8"
18	12'-3"	14'-5"	14'-4"
16	12'-11"	16'-1"	15'-1"

Maximum Unshored Span based on:

Construction Live Load w/ Concrete	20.00	psf			
Constructio	50.00	psf	Minimum end bearing	3.00	in.
Concentrated Construction Load	150.00	plf	Minimum interior bearing	5.50	in.
Concrete Ponding Allowance	2.00	psf	Maximum Deflection L/	180	≤ 0.75 in.
Concrete Volume	1.23	yd^3 / 100 ft^2 (Note: Does not include allowance for ponding)			

Composite Steel Deck Properties (steel deck only)

Gage	F_y ksi	w_{dd} psf	S_e^+ $in.^3/ft$	S_e^- $in.^3/ft$	I_d^+ $in.^4/ft$	I_d^- $in.^4/ft$	V_n/Ω kip/ft
22	50	1.90	0.393	0.410	0.736	0.730	1.364
21	50	2.10	0.453	0.470	0.824	0.817	1.832
20	50	2.30	0.510	0.528	0.907	0.899	2.360
19	50	2.70	0.636	0.652	1.067	1.061	3.309
18	50	2.90	0.752	0.768	1.213	1.211	4.286
16	50	3.50	0.968	0.966	1.516	1.516	6.199

Superimposed Allowable Load, Wn/Ω, Limited by L/360, psf [1]

Gage	6'-0"	6'-6"	7'-0"	7'-6"	8'-0"	8'-6"	9'-0"	9'-6"	10'-0"
22	793	668	569	489	424	370	324	286	253
21	870	733	625	538	467	408	358	316	280
20	941	794	678	584	507	443	390	345	306
19	1087	919	785	677	589	516	454	403	358
18	1223	1034	884	764	665	583	515	457	407
16	1404	1264	1083	936	817	717	634	564	504

Notes: [1] For high loads, long term concrete creep should be considered.

Composite Steel Deck-Slab Properties							Min. Temperature & Shrinkage	
Gage	w_1 psf	Ic $in.^4/ft$	Iu $in.^4/ft$	Id [1] $in.^4/ft$	Mno/Ω kip-ft/ft	Vno/Ω kip/ft	As min [2] $in.^2/ft$	or Dramix® Steel Fiber 4D 65/60BG, lbs/cy
22	50.2	5.35	14.35	9.85	3.80	3.43	0.028	18
21	50.4	5.76	14.55	10.16	4.14	3.86	0.028	18
20	50.6	6.14	14.74	10.44	4.47	4.34	0.028	18
19	51.0	6.89	15.13	11.01	5.12	4.37	0.028	18
18	51.2	7.56	15.49	11.52	5.73	4.37	0.028	18
16	51.8	8.83	16.21	12.52	6.95	4.37	0.028	18

Notes: [1] Id = (Ic + Iu)/2

[2] Minimum area of steel for temperature and shrinkage

Composite Deck-Slab V4.0 is based on:
ANSI/SDI C-2017, IAPMO UES ER-2018, and IAPMO UES ER-0423

Date: 3/12/2024

Company:		Date:	2/17/2023
Engineer:		Page:	1/5
Project:			
Address:			
Phone:			
E-mail:			

1.Project information

Project description:
Location:
Fastening description:

2. Input Data & Anchor Parameters

General
Design method:ACI 318-19
Units: Imperial units

Anchor Information:
Anchor type: Cast-in-place
Material: AB
Diameter (inch): 0.500
Effective Embedment depth, h_{ef} (inch): 6.000
Anchor category: -
Anchor ductility: Yes
h_{min} (inch): 7.88
C_{min} (inch): 3.00
S_{min} (inch): 3.00

Base Material
Concrete: Normal-weight
Concrete thickness, h (inch): 18.00
State: Cracked
Compressive strength, f'_c (psi): 2500
$\Psi_{c,V}$: 1.0
Reinforcement condition: Supplementary reinforcement not present
Supplemental edge reinforcement: Not applicable
Reinforcement provided at corners: No
Ignore concrete breakout in tension: No
Ignore concrete breakout in shear: No
Ignore 6do requirement: No
Build-up grout pad: No

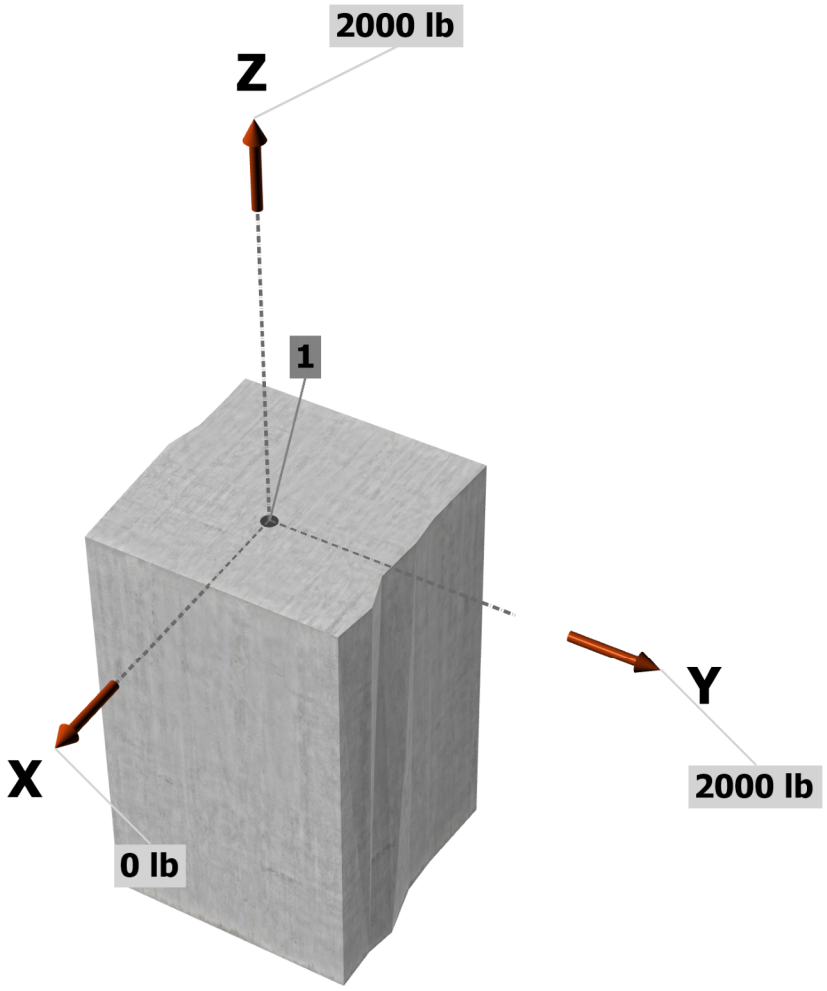
Recommended Anchor
Anchor Name: PAB Pre-Assembled Anchor Bolt - PAB4 (1/2"Ø)

Load and Geometry
Load factor source: ACI 318 Section 5.3
Load combination: not set
Seismic design: No
Anchors subjected to sustained tension: Not applicable
Apply entire shear load at front row: Yes
Anchors only resisting wind and/or seismic loads: No

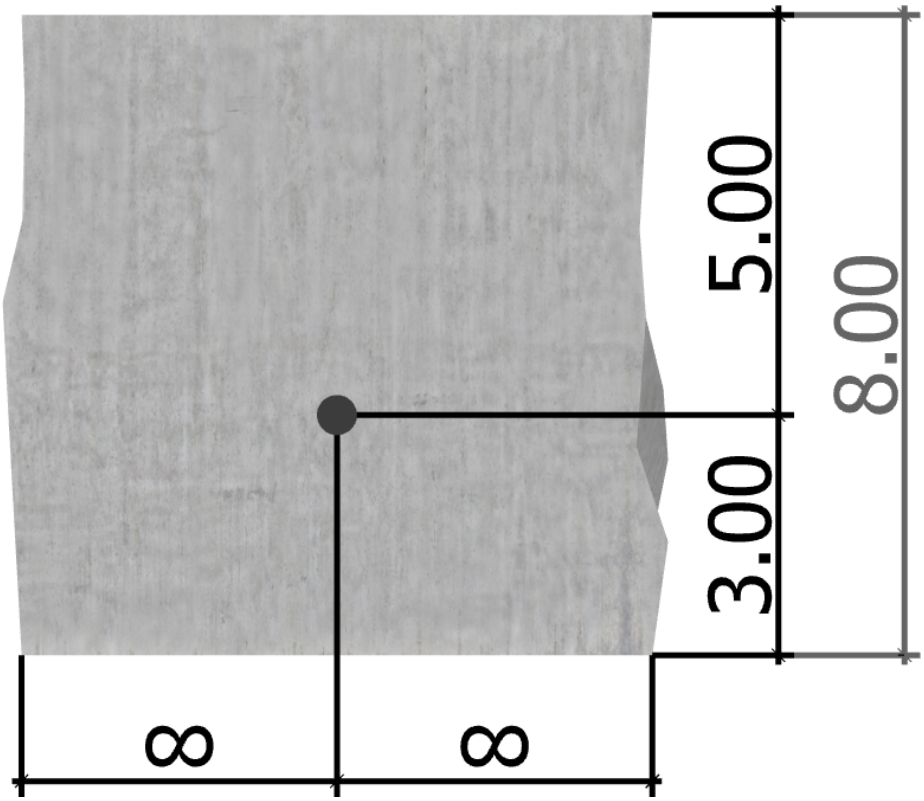
Strength level loads:

N_{ua} [lb]: 2000
V_{uax} [lb]: 0
V_{uay} [lb]: 2000

<Figure 1>



<Figure 2>



3. Resulting Anchor Forces

Anchor	Tension load, N_{ua} (lb)	Shear load x, V_{uax} (lb)	Shear load y, V_{uay} (lb)	Shear load combined, $\sqrt{(V_{uax})^2+(V_{uay})^2}$ (lb)
1	2000.0	0.0	2000.0	2000.0
Sum	2000.0	0.0	2000.0	2000.0

Maximum concrete compression strain (‰): 0.00
Maximum concrete compression stress (psi): 0
Resultant tension force (lb): 2000
Resultant compression force (lb): 0
Eccentricity of resultant tension forces in x-axis, e'_{Nx} (inch): 0.00
Eccentricity of resultant tension forces in y-axis, e'_{Ny} (inch): 0.00
Eccentricity of resultant shear forces in x-axis, e'_{Vx} (inch): 0.00
Eccentricity of resultant shear forces in y-axis, e'_{Vy} (inch): 0.00

4. Steel Strength of Anchor in Tension (Sec. 17.6.1)

N_{sa} (lb)	ϕ	ϕN_{sa} (lb)
8235	0.75	6176

5. Concrete Breakout Strength of Anchor in Tension (Sec. 17.6.2)

$N_b = k_c \lambda_a \sqrt{f'_c} h_{ef}^{1.5}$ (Eq. 17.6.2.2.1)

k_c	λ_a	f'_c (psi)	h_{ef} (in)	N_b (lb)
24.0	1.00	2500	6.000	17636

$\phi N_{cb} = \phi (A_{Nc} / A_{Nco}) \Psi_{ed,N} \Psi_{c,N} \Psi_{cp,N} N_b$ (Sec. 17.5.1.2 & Eq. 17.6.2.1a)

A_{Nc} (in^2)	A_{Nco} (in^2)	$c_{a,min}$ (in)	$\Psi_{ed,N}$	$\Psi_{c,N}$	$\Psi_{cp,N}$	N_b (lb)	ϕ	ϕN_{cb} (lb)
156.00	324.00	3.00	0.800	1.00	1.000	17636	0.70	4755

6. Pullout Strength of Anchor in Tension (Sec. 17.6.3)

$\phi N_{pn} = \phi \Psi_{c,P} N_p = \phi \Psi_{c,P} 8 A_{brg} f'_c$ (Sec. 17.5.1.2, Eq. 17.6.3.1 & 17.6.3.2.2a)

$\Psi_{c,P}$	A_{brg} (in^2)	f'_c (psi)	ϕ	ϕN_{pn} (lb)
1.0	1.57	2500	0.70	21994

8. Steel Strength of Anchor in Shear (Sec. 17.7.1)

V_{sa} (lb)	ϕ_{grout}	ϕ	$\phi_{grout}\phi V_{sa}$ (lb)
4940	1.0	0.65	3211

9. Concrete Breakout Strength of Anchor in Shear (Sec. 17.7.2)

Shear parallel to edge in x-direction:

$V_{by} = \min|7(l_e / d_a)^{0.2}\sqrt{d_a}\lambda_a\sqrt{f'_c}c_{a1}^{1.5};\ 9\lambda_a\sqrt{f'_c}c_{a1}^{1.5}|$ (Eq. 17.7.2.2.1a & Eq. 17.7.2.2.1b)

l_e (in)	d_a (in)	λ_a	f'_c (psi)	c_{a1} (in)	V_{by} (lb)
4.00	0.500	1.00	2500	3.00	1949

$\phi V_{cbx} = \phi\ (2)(A_{Vc} / A_{Vco})\Psi_{ed,V}\Psi_{c,V}\Psi_{h,V}V_{by}$ (Sec. 17.5.1.2, 17.7.2.1(c) & Eq. 17.7.2.1a)

A_{Vc} (in^2)	A_{Vco} (in^2)	$\Psi_{ed,V}$	$\Psi_{c,V}$	$\Psi_{h,V}$	V_{by} (lb)	ϕ	ϕV_{cbx} (lb)
40.50	40.50	1.000	1.000	1.000	1949	0.70	2729

10. Concrete Pryout Strength of Anchor in Shear (Sec. 17.7.3)

$\phi V_{cp} = \phi k_{cp} N_{cb} = \phi k_{cp}(A_{Nc} / A_{Nco})\Psi_{ed,N}\Psi_{c,N}\Psi_{cp,N}N_b$ (Sec. 17.5.1.2 & Eq. 17.7.3.1a)

k_{cp}	A_{Nc} (in^2)	A_{Nco} (in^2)	$\Psi_{ed,N}$	$\Psi_{c,N}$	$\Psi_{cp,N}$	N_b (lb)	ϕ	ϕV_{cp} (lb)
2.0	156.00	324.00	0.800	1.000	1.000	17636	0.70	9511

11. Results

Interaction of Tensile and Shear Forces (Sec. R17.8)

Tension	Factored Load, N_{ua} (lb)	Design Strength, øN_n (lb)	Ratio	Status
Steel	2000	6176	0.32	Pass
Concrete breakout	**2000**	**4755**	**0.42**	**Pass (Governs)**
Pullout	2000	21994	0.09	Pass

Shear	Factored Load, V_{ua} (lb)	Design Strength, øV_n (lb)	Ratio	Status
Steel	2000	3211	0.62	Pass
|| Concrete breakout x+	**2000**	**2729**	**0.73**	**Pass (Governs)**
Pryout	2000	9511	0.21	Pass

Interaction check	$(N_{ua}/\phi N_{ua})^{5/3}$	$(V_{ua}/\phi V_{ua})^{5/3}$	Combined Ratio	Permissible	Status
Sec. R17.8	0.24	0.60	83.2%	1.0	Pass

PAB4 (1/2"Ø) with hef = 6.000 inch meets the selected design criteria.

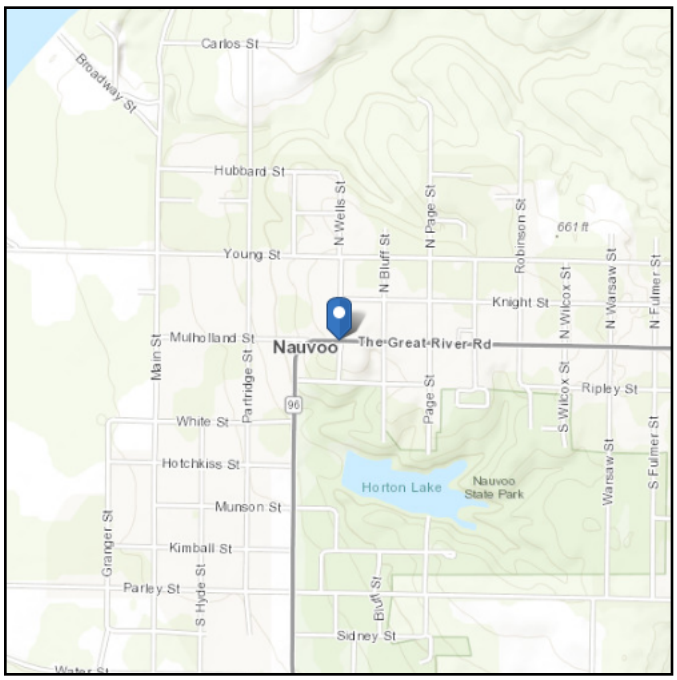
12. Warnings

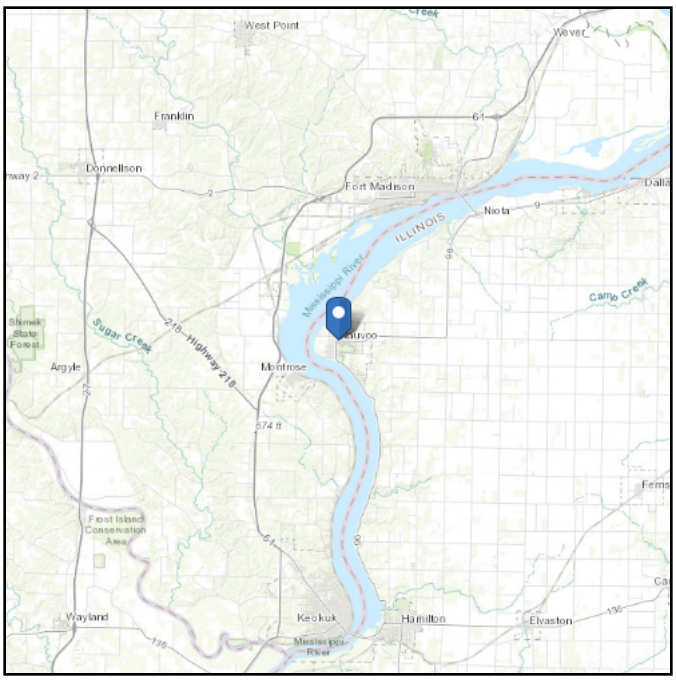
- Designer must exercise own judgement to determine if this design is suitable.

ASCE Hazards Report

Address:
Nauvoo
Illinois,

Standard:	ASCE/SEI 7-16	**Latitude:**	40.54982
Risk Category:	II	**Longitude:**	-91.38501
Soil Class:	D - Default (see Section 11.4.3)	**Elevation:**	646.3884074888904 ft (NAVD 88)





Wind

Results:

Wind Speed	109 Vmph
10-year MRI	75 Vmph
25-year MRI	81 Vmph
50-year MRI	87 Vmph
100-year MRI	94 Vmph

Data Source: ASCE/SEI 7-16, Fig. 26.5-1B and Figs. CC.2-1–CC.2-4, and Section 26.5.2
Date Accessed: Tue Feb 27 2024

Value provided is 3-second gust wind speeds at 33 ft above ground for Exposure C Category, based on linear interpolation between contours. Wind speeds are interpolated in accordance with the 7-16 Standard. Wind speeds correspond to approximately a 7% probability of exceedance in 50 years (annual exceedance probability = 0.00143, MRI = 700 years).

Site is not in a hurricane-prone region as defined in ASCE/SEI 7-16 Section 26.2.

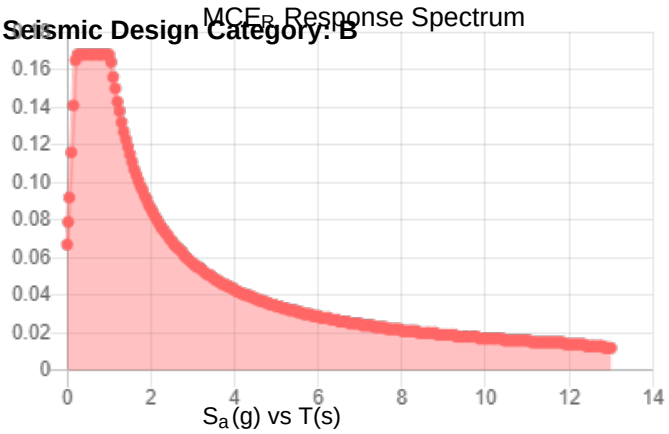
Seismic

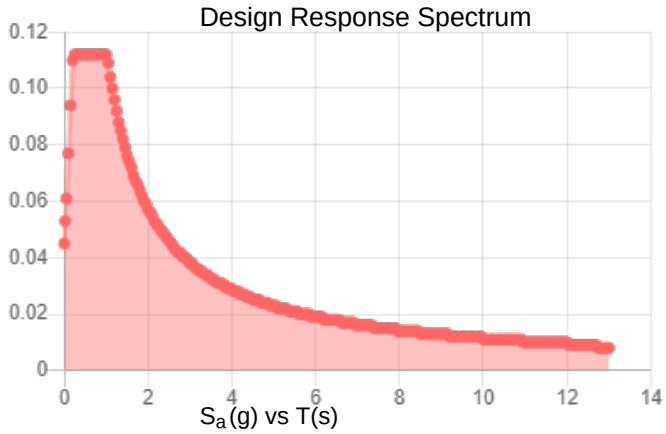
Site Soil Class: D - Default (see Section 11.4.3)

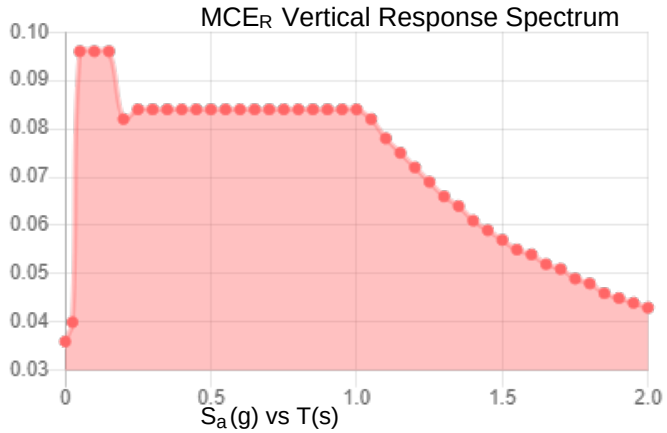
Results:

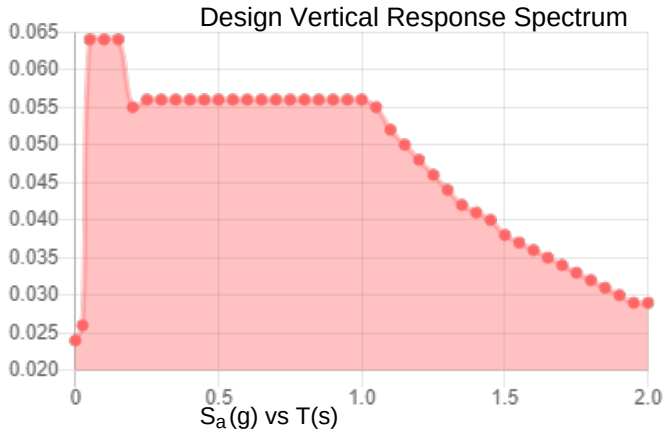
S_S :	0.105	S_{D1} :	0.115
S_1 :	0.072	T_L :	12
F_a :	1.6	PGA :	0.049
F_v :	2.4	PGA_M :	0.079
S_{MS} :	0.168	F_{PGA} :	1.6
S_{M1} :	0.172	I_e :	1
S_{DS} :	0.112	C_v :	0.7

Seismic Design Category: B









Data Accessed: **Tue Feb 27 2024**

Date Source:

USGS Seismic Design Maps based on ASCE/SEI 7-16 and ASCE/SEI 7-16 Table 1.5-2. Additional data for site-specific ground motion procedures in accordance with ASCE/SEI 7-16 Ch. 21 are available from USGS.

The ASCE Hazard Tool is provided for your convenience, for informational purposes only, and is provided “as is” and without warranties of any kind. The location data included herein has been obtained from information developed, produced, and maintained by third party providers; or has been extrapolated from maps incorporated in the ASCE standard. While ASCE has made every effort to use data obtained from reliable sources or methodologies, ASCE does not make any representations or warranties as to the accuracy, completeness, reliability, currency, or quality of any data provided herein. Any third-party links provided by this Tool should not be construed as an endorsement, affiliation, relationship, or sponsorship of such third-party content by or from ASCE.

ASCE does not intend, nor should anyone interpret, the results provided by this Tool to replace the sound judgment of a competent professional, having knowledge and experience in the appropriate field(s) of practice, nor to substitute for the standard of care required of such professionals in interpreting and applying the contents of this Tool or the ASCE standard.

In using this Tool, you expressly assume all risks associated with your use. Under no circumstances shall ASCE or its officers, directors, employees, members, affiliates, or agents be liable to you or any other person for any direct, indirect, special, incidental, or consequential damages arising from or related to your use of, or reliance on, the Tool or any information obtained therein. To the fullest extent permitted by law, you agree to release and hold harmless ASCE from any and all liability of any nature arising out of or resulting from any use of data provided by the ASCE Hazard Tool.

Project Title:
Engineer:
Project ID:
Project Descr:

Restrained Retaining Wall

Project File: storm shelter.ec6

DESCRIPTION: BASEMENT WALL

Code References

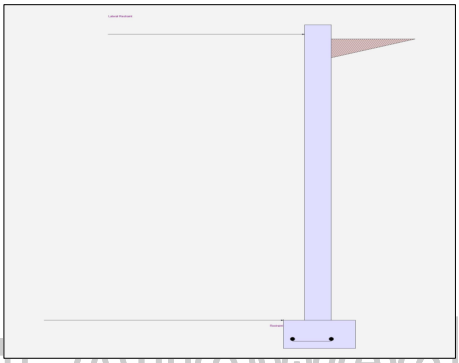
Calculations per IBC 2018 1807.3, CBC 2019, ASCE 7-16

Criteria

Retained Height	=	10 ft
Wall height above soil	=	0.50 ft
Total Wall Height	=	10.50 ft
Top Support Height	=	10 ft
Slope Behind Wall	=	0
Height of Soil over Toe	=	in

Soil Data

Allow Soil Bearing	=	1,500.0 psf
Equivalent Fluid Pressure Method		
At-Rest Heel Pressure	=	32.0 psf/ft
	=	0.0 psf/ft
Passive Pressure	=	250.0 psf/ft
Soil Density	=	110 pcf
Footing||Soil Friction	=	0.4 psf
Soil height to ignore for passive pressure	=	12 in



Surcharge Loads

Surcharge Over Heel = psf
>>>Used To Resist Sliding & Overturning
Surcharge Over Toe = psf
Used for Sliding & Overturning

Axial Load Applied to Stem

Axial Dead Load	=	1.720 lbs
Axial Live Load	=	2.50 lbs
Axial Load Eccentricity	=	in

Earth Pressure Seismic Load

Uniform Lateral Load Applied to Stem

Lateral Load	=	#/ft
...Height to Top	=	ft
...Height to Bottom	=	ft
Load Type	=	Wind (W) (Strength Level)
Wind on Exposed Stem	=	0.00 psf (Strength Level)

Wind acts left-to-right toward retention side.

Adjacent Footing Load

Adjacent Footing Load	=	lbs
Footing Width	=	ft
Eccentricity	=	in
Wall to Ftg CL Dist	=	ft
Footing Type		Line Load
Base Above/Below Soil at Back of Wall	=	ft
Poisson's Ratio	=	0.3

K_h Soil Density Multiplier = 0.2 g Added seismic per unit area = 0.0 psf

Design Summary

Total Bearing Load	=	2,087.55 lbs	
...resultant ecc.	=	0.0 in	
Soil Pressure @ Toe	=	1,043.78 psf	OK
Soil Pressure @ Heel	=	1,043.78 psf	OK
Allowable	=	psf	
Soil Pressure Less Than Allowable			
ACI Factored @ Toe	=	1,253.03 psf	
ACI Factored @ Heel	=	1,253.03 psf	
Footing Shear @ Toe	=	0.08212 psi	OK
Footing Shear @ Heel	=	-1.372 psi	OK
Allowable	=	82.158 psi	
Reaction at Top	=	318.970 lbs	
Reaction at Bottom	=	1,616.0 lbs	

Sliding Calcs
Lateral Sliding Force = 1,616.0 lbs

Vertical component of active lateral soil pressure IS NOT considered in the calculation of soil bearing

Load Factors

Building Code	
Dead Load	1.200
Live Load	1.600
Earth, H	1.600
Wind, W	1.000
Seismic, E	1.000

Concrete Stem Construction

Thickness = 8.00 in Fy = 60000 psi
Wall Weight = 100.0 psf f'c = 3000 psi
Stem is FIXED to top of footing

	@ Top Support	Mmax Between Top & Base	@ Base of Wall
	Stem OK	Stem OK	Stem OK
Design Height Above Ftg =	10 ft	5.582 ft	0.00 ft
Rebar Size =	# 4	# 4	# 4
Rebar Spacing =	12.00 in	12.00 in	12.00 in
Rebar Placed at =	Edge	Edge	Edge
Rebar Depth 'd' =	4.750 in	4.750 in	4.750 in
Design Data			
fb/FB + fa/Fa =		0.372	0.833
Mu....Actual =	0.0 ft-#	1,526.47 ft-#	3,413.40 ft-#
Mn * Phi.....Allowable =	4,098.0 ft-#	4,098.0 ft-#	4,098.0 ft-#
Shear Force @ this height =	511.99 lbs		2,048.01 lbs
Shear.....Actual =	8.982 psi		35.930 psi
Shear.....Allowable =	82.158 psi		82.158 psi

Project Title:
Engineer:
Project ID:
Project Descr:

Restrained Retaining Wall

Project File: storm shelter.ec6

DESCRIPTION: BASEMENT WALL

Footing Strengths & Dimensions

Toe Width	=	.66666666 ft
Heel Width	=	.33333333
Total Footing Width	=	2.0
Footing Thickness	=	12.0 in

f'c = 3,000 psi Fy = 60000 psi
Footing Concrete Density = 150 pcf
Min. As % = 0.0018
Cover @ Top = 2 in @ Btm.= 3 in

Footing Design Results

		Toe	Heel	
Factored Pressure	=	1,253.03	1,253.03	psf
Mu' : Upward	=	278.452		ft-#
Mu' : Downward	=	40.0		ft-#
Mu: Design	=	238	55	ft-#
Actual 1-Way Shear	=	0.08212	-1.372	psi
Allow 1-Way Shear	=	82.158	82.158	psi

Other Acceptable Sizes & Spacings:

Toe: # 7 @ 18.00 in -or- phiMn = phi * 5 * lambda * sqrt(fc) * Sm
Heel: None Spec'd -or- phiMn = phi * 5 * lambda * sqrt(fc) * Sm

Min footing T&S reinf Area 0.52 in2
Min footing T&S reinf Area per foot 0.26 in2 /ft

If one layer of horizontal bars:	If two layers of horizontal bars:
#4@ 9.26 in	#4@ 18.52 in
#5@ 14.35 in	#5@ 28.70 in
#6@ 20.37 in	#6@ 40.74 in

Summary of Forces on Footing : Slab RESISTS sliding, stem is FIXED at footing

Forces acting on footing for soil pressure

>>> Sliding Forces are restrained by the adjacent slab

Load & Moment Summary For Footing : For Soil Pressure Calcs

Moment @ Top of Footing Applied from Stem			=		-2,133.38 ft-#
Surcharge Over Heel	=	0.0 lbs		0.0 ft	0.0 ft-#
Adjacent Footing Load	=	0.0 lbs		0.0 ft	0.0 ft-#
Axial Dead Load on Stem	=	4.220 lbs		1.0 ft	4.220 ft-#
Soil Over Toe	=	0.0 lbs		0.0 ft	0.0 ft-#
Surcharge Over Toe	=	0.0 lbs		0.0 ft	0.0 ft-#
Stem Weight	=	1,050.0 lbs		1.0 ft	1,050.0 ft-#
Soil Over Heel	=	733.33 lbs		1.667 ft	1,222.22 ft-#
Footing Weight	=	300.0 lbs		1.0 ft	300.0 ft-#
Total Vertical Force	=	2,087.55 lbs	Base Moment	=	443.066 ft-#

Stem is specified to be fixed to footing, and top restraint is assumed to react out any tendency for moment at the footing/soil interface, so uniform soil pressure is assumed.

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Sliding Resistance.

Project Title:
Engineer:
Project ID:
Project Descr:

Restrained Retaining Wall

Project File: storm shelter.ec6

DESCRIPTION: BASEMENT WALL

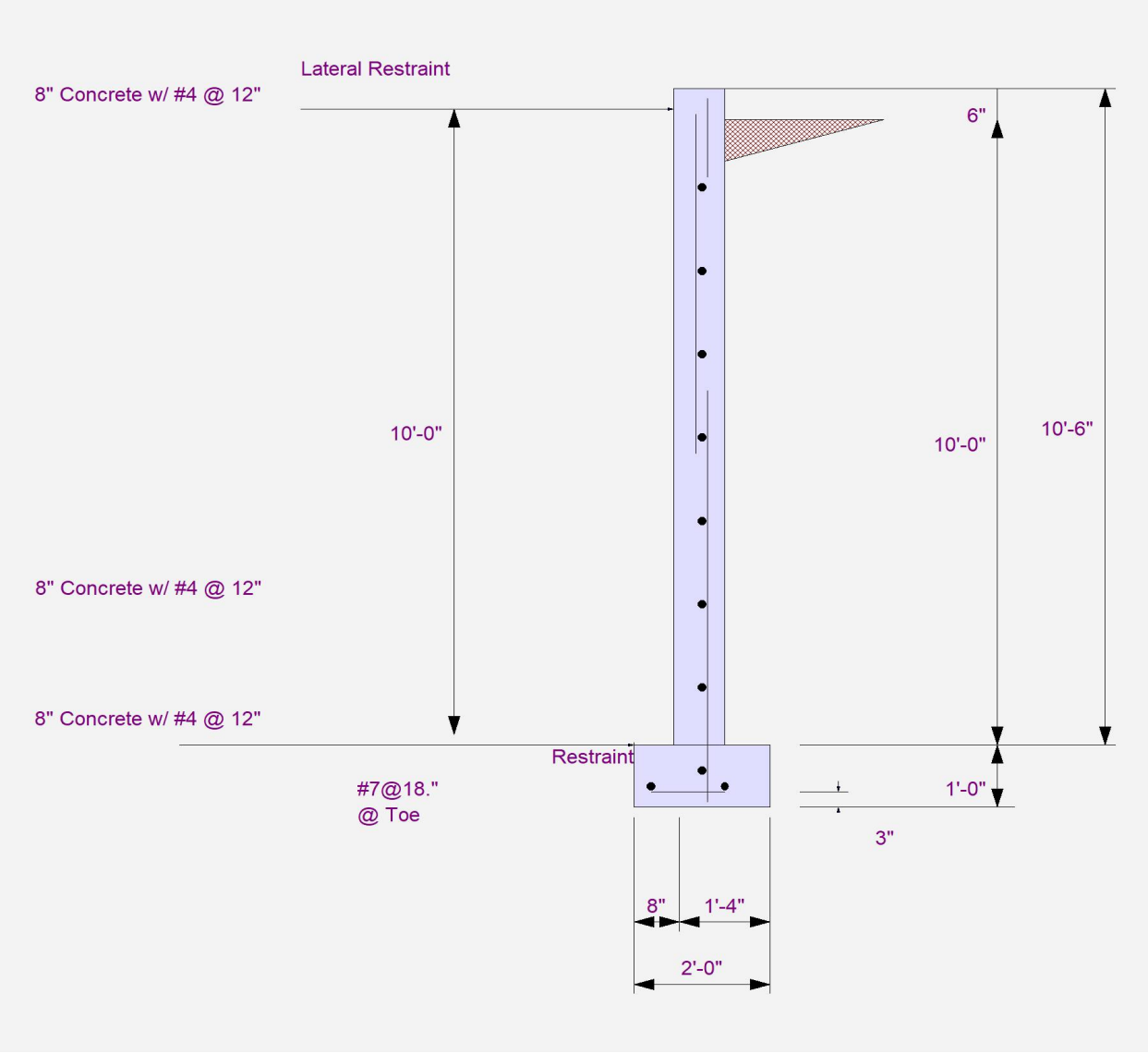
Rebar Lap & Embedment Lengths Information

Project Title:
Engineer:
Project ID:
Project Descr:

Restrained Retaining Wall

Project File: storm shelter.ec6

DESCRIPTION: BASEMENT WALL

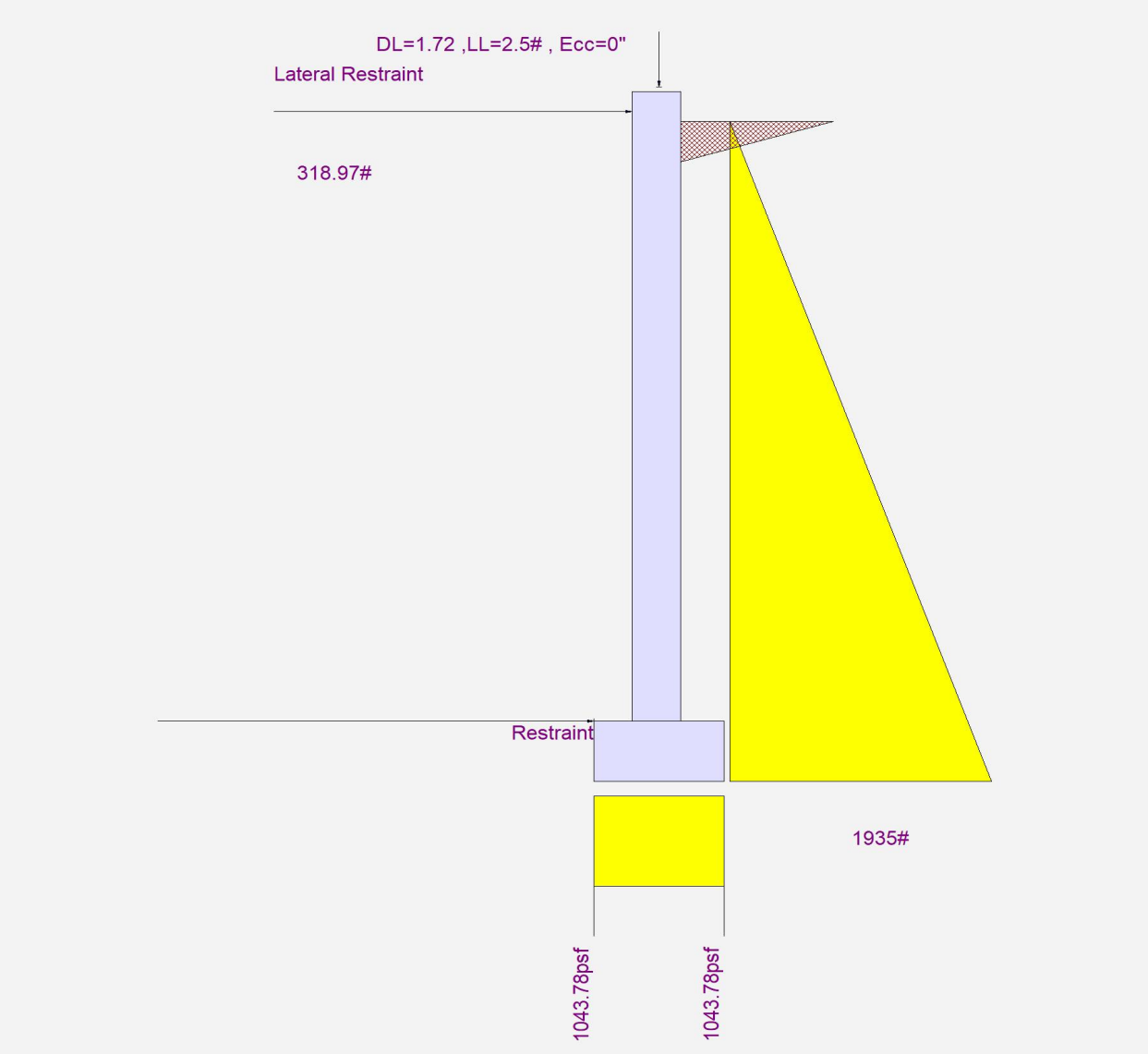


Project Title:
Engineer:
Project ID:
Project Descr:

Restrained Retaining Wall

Project File: storm shelter.ec6

DESCRIPTION: BASEMENT WALL



Project Title:
Engineer:
Project ID:
Project Descr:

Cantilevered Retaining Wall

Project File: storm shelter.ec6

DESCRIPTION: STAIR WALL 10'-0"

Code References

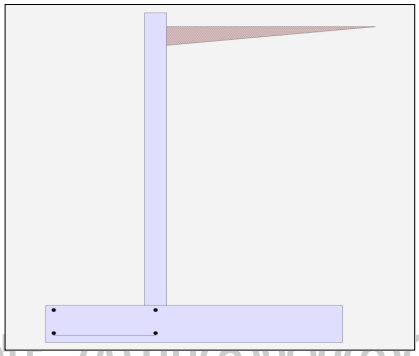
Calculations per IBC 2018 1807.3, CBC 2019, ASCE 7-16

Criteria

Retained Height	=	10.00 ft
Wall height above soil	=	0.50 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	0.00 in
Water table above bottom of footing	=	0.0 ft

Soil Data

Allow Soil Bearing	=	1,500.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	35.0 psf/ft
	=	
Passive Pressure	=	250.0 psf/ft
Soil Density, Heel	=	110.00 pcf
Soil Density, Toe	=	110.00 pcf
Footing||Soil Friction	=	0.400
Soil height to ignore for passive pressure	=	12.00 in



Surcharge Loads

Surcharge Over Heel	=	0.0 psf
Used To Resist Sliding & Overturning		
Surcharge Over Toe	=	0.0
Used for Sliding & Overturning		

Axial Load Applied to Stem

Axial Dead Load	=	0.0 lbs
Axial Live Load	=	0.0 lbs
Axial Load Eccentricity	=	0.0 in

Lateral Load Applied to Stem

Lateral Load	=	0.0 #/ft
...Height to Top	=	0.00 ft
...Height to Bottom	=	0.00 ft
Load Type	=	Wind (W) (Service Level)
Wind on Exposed Stem (Strength Level)	=	0.0 psf

Adjacent Footing Load

Adjacent Footing Load	=	0.0 lbs
Footing Width	=	0.00 ft
Eccentricity	=	0.00 in
Wall to Ftg CL Dist	=	0.00 ft
Footing Type		Spread Footing
Base Above/Below Soil at Back of Wall	=	0.0 ft
Poisson's Ratio	=	0.300

Project Title:
Engineer:
Project ID:
Project Descr:

Cantilevered Retaining Wall

Project File: storm shelter.ec6

DESCRIPTION: STAIR WALL 10'-0"

Design Summary

Wall Stability Ratios

Overturning	=	5.74	OK
Sliding	=	1.59	OK
Global Stability	=	2.09	

Total Bearing Load	=	9,709	lbs
...resultant ecc.	=	1.43	in

Eccentricity within middle third

Soil Pressure @ Toe	=	892 psf	OK
Soil Pressure @ Heel	=	1,045 psf	OK
Allowable	=	1,500 psf	

Soil Pressure Less Than Allowable

ACI Factored @ Toe	=	1,248 psf	
ACI Factored @ Heel	=	1,464 psf	
Footing Shear @ Toe	=	13.5 psi	OK
Footing Shear @ Heel	=	5.1 psi	OK
Allowable	=	82.2 psi	

Sliding Calcs

Lateral Sliding Force	=	2,247.8	lbs
less 100% Passive Force	-	97.2	lbs
less 100% Friction Force	= -	3,486.7	lbs
Added Force Req'd	=	0.0	lbs OK
....for 1.5 Stability	=	0.0	lbs OK

Vertical component of active lateral soil pressure IS NOT considered in the calculation of soil bearing

Load Factors

Building Code	
Dead Load	1.200
Live Load	1.600
Earth, H	1.600
Wind, W	1.600
Seismic, E	1.000

Stem Construction

		Bottom		
		Stem OK		
Design Height Above Ftg	ft =	0.00		
Wall Material Above "Ht"	=	Concrete		
Design Method	=	SD	SD	SD
Thickness	=	8.00		
Rebar Size	=	# 5		
Rebar Spacing	=	6.00		
Rebar Placed at	=	Center		
Design Data				
fb/FB + fa/Fa	=	**0.986**		
Total Force @ Section				
Service Level	lbs =			
Strength Level	lbs =	2,800.0		
Moment....Actual				
Service Level	ft-# =			
Strength Level	ft-# =	9,333.3		
Moment.....Allowable	=	9,459.0		
Shear.....Actual				
Service Level	psi =			
Strength Level	psi =	58.3		
Shear.....Allowable	psi =	82.2		
Anet (Masonry)	in2 =			
Wall Weight	psf =	100.0		
Rebar Depth 'd'	in =	4.00		

Masonry Data

f'm	psi =	
Fs	psi =	
Solid Grouting	=	
Modular Ratio 'n'	=	
Equiv. Solid Thick.	=	
Masonry Block Type	=	
Masonry Design Method	=	ASD

Concrete Data

f'c	psi =	3,000.0
Fy	psi =	60,000.0

Project Title:
Engineer:
Project ID:
Project Descr:

Cantilevered Retaining Wall

Project File: storm shelter.ec6

DESCRIPTION: STAIR WALL 10'-0"

Concrete Stem Rebar Area Details

Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing	
As (based on applied moment) :	0.5634 in2/ft		
(4/3) * As :	0.7512 in2/ft	Min Stem T&S Reinf Area 2.016 in2	
200bd/fy : 200(12)(4)/60000 :	0.16 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.192 in2/ft	
0.0018bh : 0.0018(12)(8) :	0.1728 in2/ft	Horizontal Reinforcing Options :	
	==========	One layer of :	Two layers of :
Required Area :	0.5634 in2/ft	#4@ 12.50 in	#4@ 25.00 in
Provided Area :	0.62 in2/ft	#5@ 19.38 in	#5@ 38.75 in
Maximum Area :	0.6503 in2/ft	#6@ 27.50 in	#6@ 55.00 in

Footing Data

Toe Width	=	3.00 ft
Heel Width	=	6.00
Total Footing Width	=	9.00
Footing Thickness	=	16.00 in
Key Width	=	0.00 in
Key Depth	=	0.00 in
Key Distance from Toe	=	2.83 ft

f'c = 3,000 psi Fy = 60,000 psi
Footing Concrete Density = 150.00 pcf
Min. As % = 0.0018
Cover @ Top 3.00 @ Btm.= 3.00 in

Footing Design Results

		Toe	Heel	
Factored Pressure	=	1,248	1,464	psf
Mu' : Upward	=	5,725	19,682	ft-#
Mu' : Downward	=	1,080	22,187	ft-#
Mu: Design	=	4,645 OK	2,505	ft-# OK
phiMn	=	33,702	5,368	ft-#
Actual 1-Way Shear	=	13.47	5.09	psi
Allow 1-Way Shear	=	82.16	43.82	psi

Toe Reinforcing = # 5 @ 6.00 in
Heel Reinforcing = None Spec'd
Key Reinforcing = None Spec'd
Footing Torsion, Tu = 0.00 ft-lbs
Footing Allow. Torsion, phi Tu = 0.00 ft-lbs

If torsion exceeds allowable, provide supplemental design for footing torsion.

Other Acceptable Sizes & Spacings

Toe: #4@ 6.94 in, #5@ 10.76 in, #6@ 15.27 in, #7@ 20.83 in, #8@ 27.43 in, #9@ 34.72 in, #10@ 44.09 in

Heel: phiMn = phi*5*lambda*sqrt(fc)*Sm

Key: No key defined

Min footing T&S reinf Area	3.11	in2
Min footing T&S reinf Area per foot	0.35	in2 /ft

If one layer of horizontal bars:	If two layers of horizontal bars:
#4@ 6.94 in	#4@ 13.89 in
#5@ 10.76 in	#5@ 21.53 in
#6@ 15.28 in	#6@ 30.56 in

Project Title:
Engineer:
Project ID:
Project Descr:

Cantilevered Retaining Wall

Project File: storm shelter.ec6

DESCRIPTION: STAIR WALL 10'-0"

Summary of Overturning & Resisting Forces & Moments

Item	.....OVERTURNING..... Force lbs	Distance ft	Moment ft-#	.....RESISTING..... Force lbs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl)	2,247.8	3.78	8,491.6	Soil Over HL (ab. water tbl)	5,866.7	6.33	37,155.6
HL Act Pres (be water tbl)				Soil Over HL (bel. water tbl)		6.33	37,155.6
Hydrostatic Force				Water Table			
Buoyant Force =				Sloped Soil Over Heel =			
Surcharge over Heel =				Surcharge Over Heel =			
Surcharge Over Toe =				Adjacent Footing Load =			
Adjacent Footing Load =				Axial Dead Load on Stem =			
Added Lateral Load =				* Axial Live Load on Stem =			
Load @ Stem Above Soil =				Soil Over Toe =			
=				Surcharge Over Toe =			
				Stem Weight(s) =	1,050.0	3.33	3,500.0
				Earth @ Stem Transitions =			
				Footing Weight =	1,800.0	4.50	8,100.0
				Key Weight =		2.83	
				Vert. Component =			
Total =	2,247.8	**O.T.M.** =	8,491.6	**Total =**	8,716.7 lbs	**R.M.=**	48,755.6

* Axial live load NOT included in total displayed, or used for overturning resistance, but is included for soil pressure calculation.

Resisting/Overturning Ratio = **5.74**

Vertical Loads used for Soil Pressure = 9,708.9 lbs

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Sliding Resistance.

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Overturning Resistance.

Tilt

Horizontal Deflection at Top of Wall due to settlement of soil

(Deflection due to wall bending not considered)

Soil Spring Reaction Modulus	250.0	pci
Horizontal Defl @ Top of Wall (approximate only)	0.000	in

The above calculation is not valid if the heel soil bearing pressure exceeds that of the toe, because the wall would then tend to rotate into the retained soil.

Project Title:
Engineer:
Project ID:
Project Descr:

Cantilevered Retaining Wall

Project File: storm shelter.ec6

DESCRIPTION: STAIR WALL 10'-0"

Rebar Lap & Embedment Lengths Information

Stem Design Segment: Bottom
Stem Design Height: 0.00 ft above top of footing

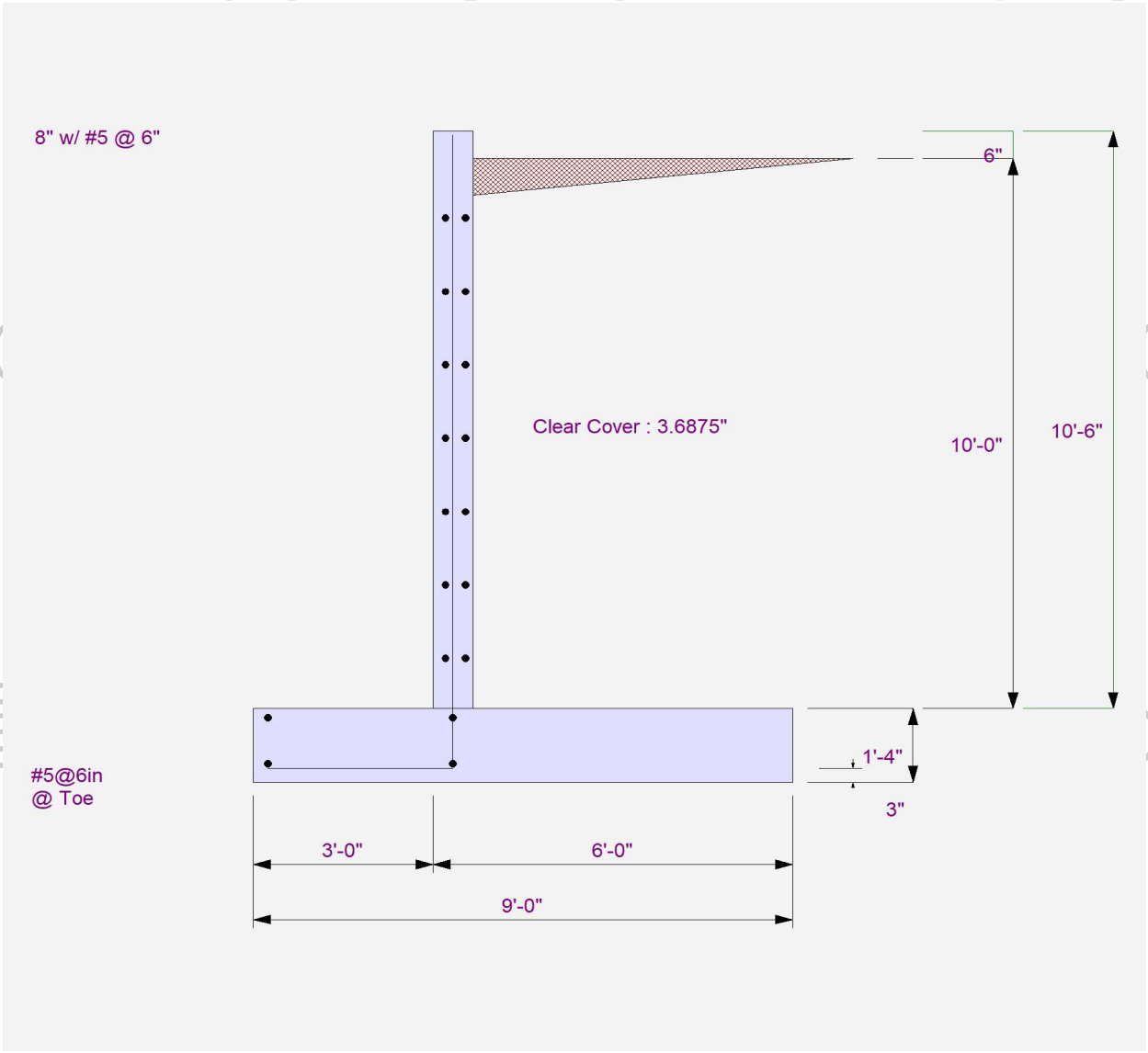
Lap Splice length for #5 bar specified in this stem design segment (25.4.2.3a) =	21.36 in
Development length for #5 bar specified in this stem design segment =	16.43 in
Hooked embedment length into footing for #5 bar specified in this stem design segment =	9.59 in
As Provided =	0.6200 in2/ft
As Required =	0.5634 in2/ft

Project Title:
Engineer:
Project ID:
Project Descr:

Cantilevered Retaining Wall

Project File: storm shelter.ec6

DESCRIPTION: STAIR WALL 10'-0"

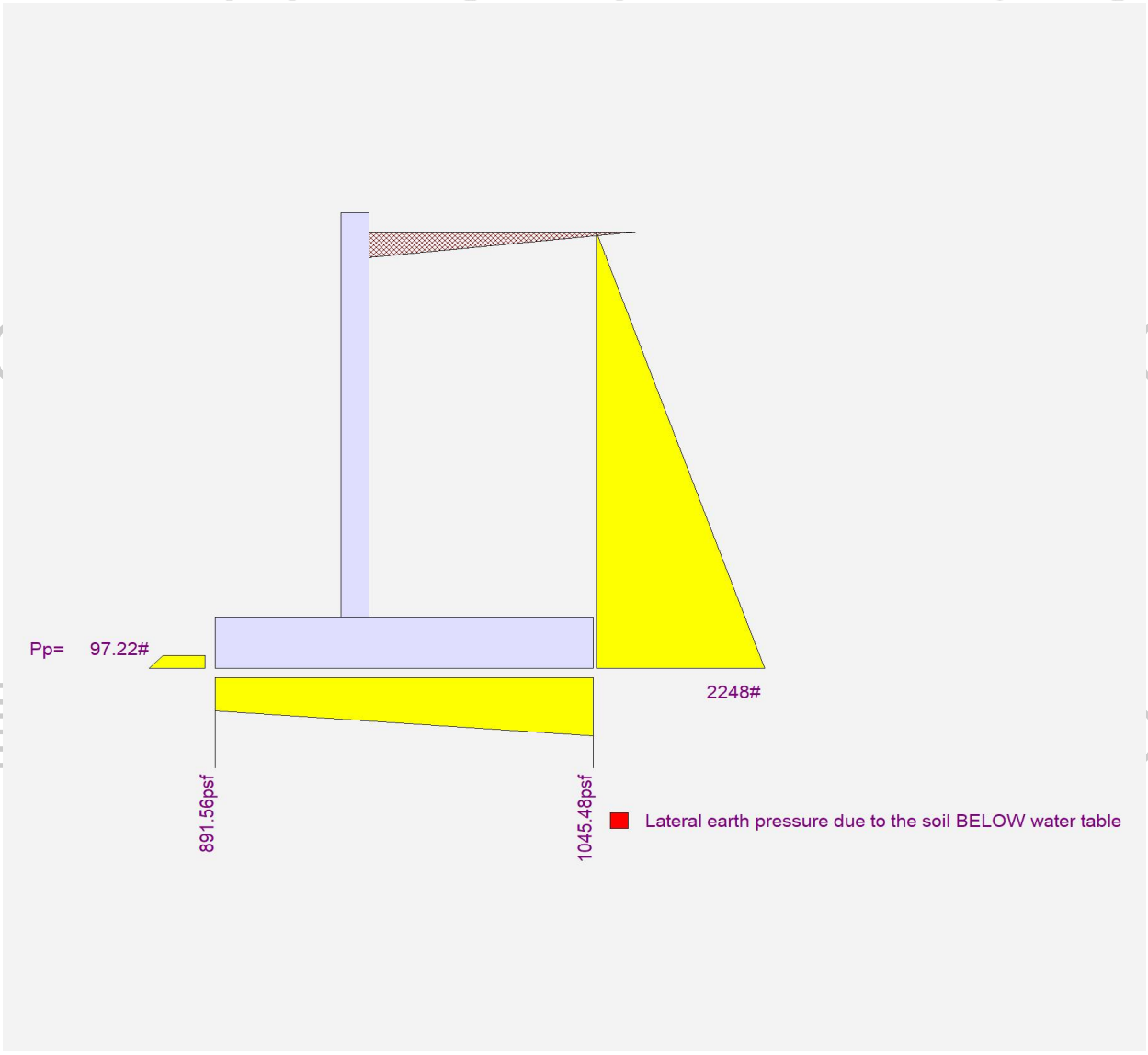


Project Title:
Engineer:
Project ID:
Project Descr:

Cantilevered Retaining Wall

Project File: storm shelter.ec6

DESCRIPTION: STAIR WALL 10'-0"



Project Title:
Engineer:
Project ID:
Project Descr:

Cantilevered Retaining Wall

Project File: storm shelter.ec6

DESCRIPTION: STAIR WALL 8'-0"

Code Reference

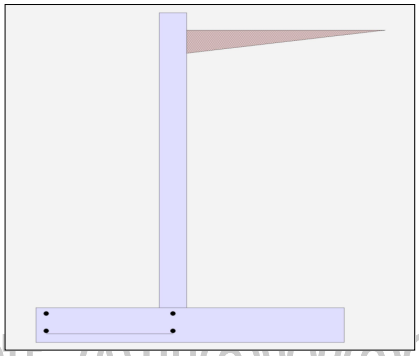
Calculations per IBC 2018 1807.3, CBC 2019, ASCE 7-16

Criteria

Retained Height	=	8.00 ft
Wall height above soil	=	0.50 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	0.00 in
Water table above bottom of footing	=	0.0 ft

Soil Data

Allow Soil Bearing	=	1,500.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	35.0 psf/ft
	=	
Passive Pressure	=	250.0 psf/ft
Soil Density, Heel	=	110.00 pcf
Soil Density, Toe	=	110.00 pcf
Footing||Soil Friction	=	0.400
Soil height to ignore for passive pressure	=	12.00 in



Surcharge Loads

Surcharge Over Heel	=	0.0 psf
Used To Resist Sliding & Overturning		
Surcharge Over Toe	=	0.0
Used for Sliding & Overturning		

Axial Load Applied to Stem

Axial Dead Load	=	0.0 lbs
Axial Live Load	=	0.0 lbs
Axial Load Eccentricity	=	0.0 in

Lateral Load Applied to Stem

Lateral Load	=	0.0 #/ft
...Height to Top	=	0.00 ft
...Height to Bottom	=	0.00 ft
Load Type	=	Wind (W) (Service Level)
Wind on Exposed Stem (Strength Level)	=	0.0 psf

Adjacent Footing Load

Adjacent Footing Load	=	0.0 lbs
Footing Width	=	0.00 ft
Eccentricity	=	0.00 in
Wall to Ftg CL Dist	=	0.00 ft
Footing Type		Spread Footing
Base Above/Below Soil at Back of Wall	=	0.0 ft
Poisson's Ratio	=	0.300

Project Title:
Engineer:
Project ID:
Project Descr:

Cantilevered Retaining Wall

Project File: storm shelter.ec6

DESCRIPTION: STAIR WALL 8'-0"

Design Summary

Wall Stability Ratios

Overturning	=	6.09	OK
Sliding	=	1.51	OK
Global Stability	=	2.01	

Total Bearing Load	=	5,974	lbs
...resultant ecc.	=	3.54	in

Eccentricity within middle third

Soil Pressure @ Toe	=	545	psf OK
Soil Pressure @ Heel	=	881	psf OK
Allowable	=	1,500	psf

Soil Pressure Less Than Allowable

ACI Factored @ Toe	=	763	psf
ACI Factored @ Heel	=	1,234	psf
Footing Shear @ Toe	=	14.7	psi OK
Footing Shear @ Heel	=	3.9	psi OK
Allowable	=	82.2	psi

Sliding Calcs

Lateral Sliding Force	=	1,417.5	lbs
less 100% Passive Force	-	0.0	lbs
less 100% Friction Force	-	2,139.3	lbs
Added Force Req'd	=	0.0	lbs OK
....for 1.5 Stability	=	0.0	lbs OK

Vertical component of active lateral soil pressure IS NOT considered in the calculation of soil bearing

Load Factors

Building Code	
Dead Load	1.200
Live Load	1.600
Earth, H	1.600
Wind, W	1.600
Seismic, E	1.000

Stem Construction

		Bottom		
		Stem OK		
Design Height Above Ftg	ft =	0.00		
Wall Material Above "Ht"	=	Concrete		
Design Method	=	SD	SD	SD
Thickness	=	8.00		
Rebar Size	=	# 4		
Rebar Spacing	=	6.00		
Rebar Placed at	=	Center		

Design Data

fb/FB + fa/Fa	=	**0.736**
Total Force @ Section		
Service Level	lbs =	
Strength Level	lbs =	1,792.0
Moment....Actual		
Service Level	ft-# =	
Strength Level	ft-# =	4,778.7
Moment.....Allowable	=	6,492.0
Shear.....Actual		
Service Level	psi =	
Strength Level	psi =	37.3
Shear.....Allowable	psi =	82.2
Anet (Masonry)	in2 =	
Wall Weight	psf =	100.0
Rebar Depth 'd'	in =	4.00

Masonry Data

f'm	psi =	
Fs	psi =	
Solid Grouting	=	
Modular Ratio 'n'	=	
Equiv. Solid Thick.	=	
Masonry Block Type	=	
Masonry Design Method	=	ASD

Concrete Data

f'c	psi =	3,000.0
Fy	psi =	60,000.0

Project Title:
Engineer:
Project ID:
Project Descr:

Cantilevered Retaining Wall

Project File: storm shelter.ec6

DESCRIPTION: STAIR WALL 8'-0"

Concrete Stem Rebar Area Details

Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing	
As (based on applied moment) :	0.2885 in2/ft		
(4/3) * As :	0.3846 in2/ft	Min Stem T&S Reinf Area 1.632 in2	
200bd/fy : 200(12)(4)/60000 :	0.16 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.192 in2/ft	
0.0018bh : 0.0018(12)(8) :	0.1728 in2/ft	Horizontal Reinforcing Options :	
	==========	One layer of :	Two layers of :
Required Area :	0.2885 in2/ft	#4@ 12.50 in	#4@ 25.00 in
Provided Area :	0.4 in2/ft	#5@ 19.38 in	#5@ 38.75 in
Maximum Area :	0.6503 in2/ft	#6@ 27.50 in	#6@ 55.00 in

Footing Data

Toe Width	=	3.00 ft
Heel Width	=	4.50
Total Footing Width	=	7.50
Footing Thickness	=	12.00 in
Key Width	=	0.00 in
Key Depth	=	0.00 in
Key Distance from Toe	=	2.83 ft

f'c = 3,000 psi Fy = 60,000 psi
Footing Concrete Density = 150.00 pcf
Min. As % = 0.0018
Cover @ Top 3.00 @ Btm.= 3.00 in

Footing Design Results

		Toe	Heel	
Factored Pressure	=	763	1,234	psf
Mu' : Upward	=	3,715	8,220	ft-#
Mu' : Downward	=	810	9,081	ft-#
Mu: Design	=	2,905 OK	861	ft-# OK
phiMn	=	15,044	2,739	ft-#
Actual 1-Way Shear	=	14.71	3.91	psi
Allow 1-Way Shear	=	82.16	43.82	psi

Toe Reinforcing = # 4 @ 6.00 in
Heel Reinforcing = None Spec'd
Key Reinforcing = None Spec'd
Footing Torsion, Tu = 0.00 ft-lbs
Footing Allow. Torsion, phi Tu = 0.00 ft-lbs

If torsion exceeds allowable, provide supplemental design for footing torsion.

Other Acceptable Sizes & Spacings

Toe: #4@ 9.25 in, #5@ 14.35 in, #6@ 20.37 in, #7@ 27.77 in, #8@ 36.57 in, #9@ 46.29 in, #10@ 58.79 in

Heel: phiMn = phi*5*lambda*sqrt(fc)*Sm

Key: No key defined

Min footing T&S reinf Area 1.94 in2
Min footing T&S reinf Area per foot 0.26 in2 /ft

If one layer of horizontal bars:	If two layers of horizontal bars:
#4@ 9.26 in	#4@ 18.52 in
#5@ 14.35 in	#5@ 28.70 in
#6@ 20.37 in	#6@ 40.74 in

Project Title:
Engineer:
Project ID:
Project Descr:

Cantilevered Retaining Wall

Project File: storm shelter.ec6

DESCRIPTION: STAIR WALL 8'-0"

Summary of Overturning & Resisting Forces & Moments

Item	.....OVERTURNING..... Force lbs	Distance ft	Moment ft-#	.....RESISTING..... Force lbs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl)	1,417.5	3.00	4,252.5			
HL Act Pres (be water tbl)						
Hydrostatic Force						
Buoyant Force =						
Surcharge over Heel =						
Surcharge Over Toe =						
Adjacent Footing Load =						
Added Lateral Load =						
Load @ Stem Above Soil =						
=						
Soil Over HL (ab. water tbl)				3,373.3	5.58	18,834.4
Soil Over HL (bel. water tbl)					5.58	18,834.4
Water Table						
Sloped Soil Over Heel =						
Surcharge Over Heel =						
Adjacent Footing Load =						
Axial Dead Load on Stem =						
* Axial Live Load on Stem =						
Soil Over Toe =						
Surcharge Over Toe =						
Stem Weight(s) =				850.0	3.33	2,833.3
Earth @ Stem Transitions =						
Footing Weight =				1,125.0	3.75	4,218.8
Key Weight =					2.83	
Vert. Component =						
Total =	1,417.5	**O.T.M.** =	4,252.5	**Total =** 5,348.3 lbs	**R.M.=**	25,886.5

Resisting/Overturning Ratio = **6.09**

Vertical Loads used for Soil Pressure = 5,974.0 lbs

* Axial live load NOT included in total displayed, or used for overturning resistance, but is included for soil pressure calculation.

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Sliding Resistance.

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Overturning Resistance.

Tilt

Horizontal Deflection at Top of Wall due to settlement of soil

(Deflection due to wall bending not considered)

Soil Spring Reaction Modulus	250.0	pci
Horizontal Defl @ Top of Wall (approximate only)	0.000	in

The above calculation is not valid if the heel soil bearing pressure exceeds that of the toe, because the wall would then tend to rotate into the retained soil.

Project Title:
Engineer:
Project ID:
Project Descr:

Cantilevered Retaining Wall

Project File: storm shelter.ec6

DESCRIPTION: STAIR WALL 8'-0"

Rebar Lap & Embedment Lengths Information

Stem Design Segment: Bottom
Stem Design Height: 0.00 ft above top of footing

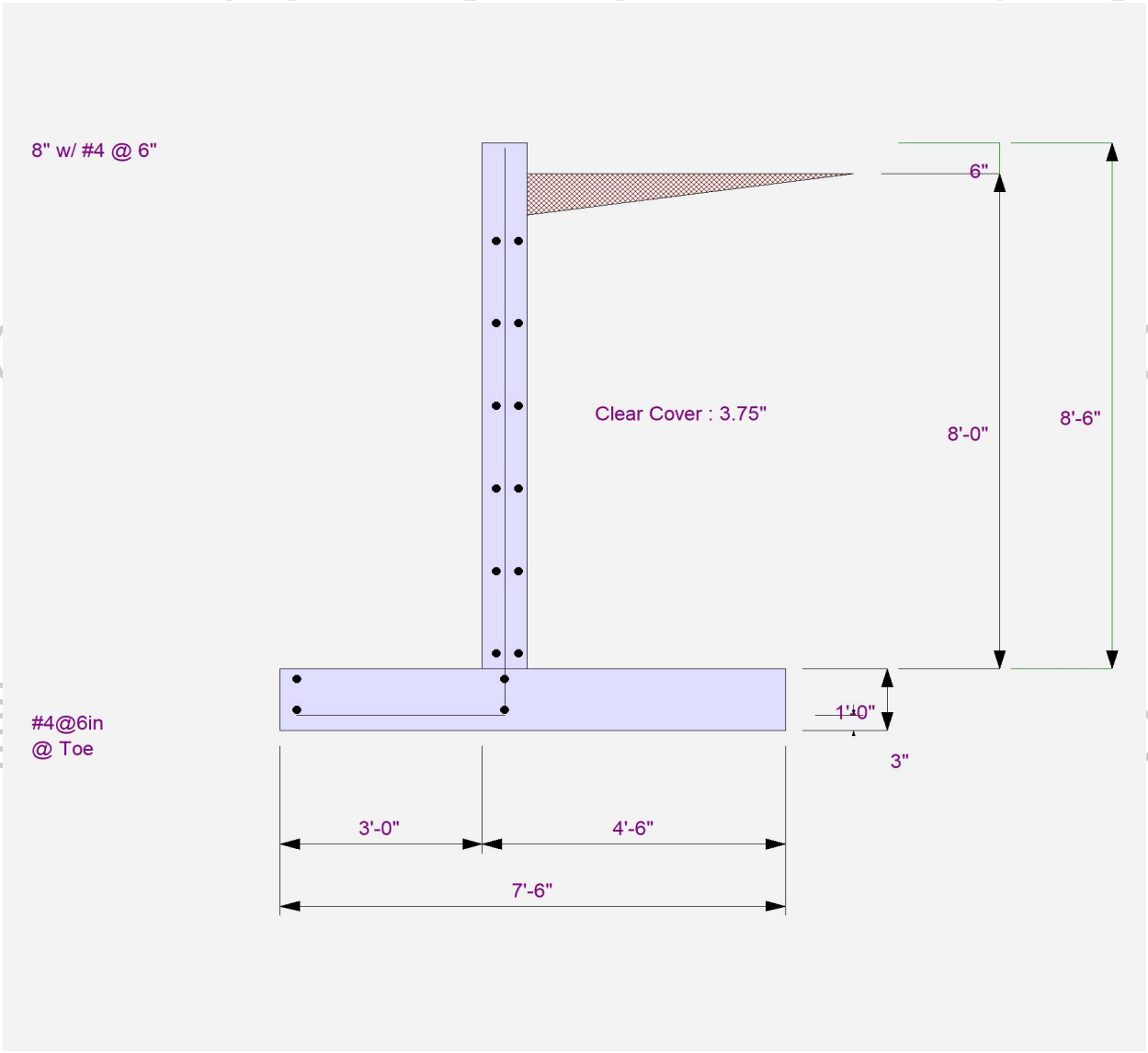
Lap Splice length for #4 bar specified in this stem design segment (25.4.2.3a) =	17.09 in
Development length for #4 bar specified in this stem design segment =	13.15 in
Hooked embedment length into footing for #4 bar specified in this stem design segment =	7.67 in
As Provided =	0.4000 in2/ft
As Required =	0.2885 in2/ft

Project Title:
Engineer:
Project ID:
Project Descr:

Cantilevered Retaining Wall

Project File: storm shelter.ec6

DESCRIPTION: STAIR WALL 8'-0"

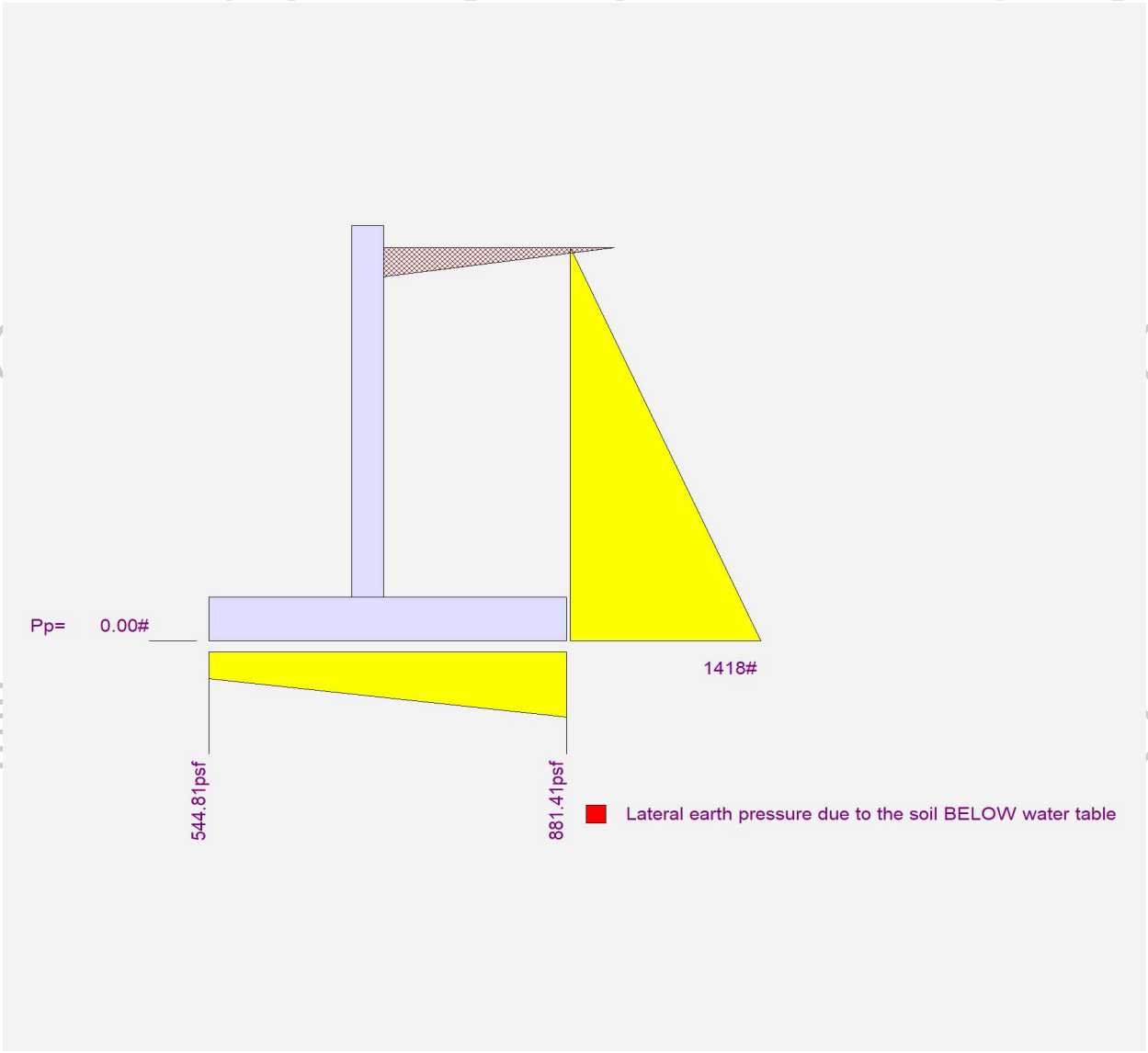


Project Title:
Engineer:
Project ID:
Project Descr:

Cantilevered Retaining Wall

Project File: storm shelter.ec6

DESCRIPTION: STAIR WALL 8'-0"



Project Title:
Engineer:
Project ID:
Project Descr:

Cantilevered Retaining Wall

Project File: storm shelter.ec6

DESCRIPTION: STAIR WALL 6'-0"

Code Reference

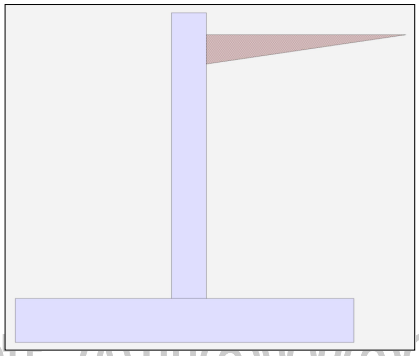
Calculations per IBC 2018 1807.3, CBC 2019, ASCE 7-16

Criteria

Retained Height	=	6.00 ft
Wall height above soil	=	0.50 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	0.00 in
Water table above bottom of footing	=	0.0 ft

Soil Data

Allow Soil Bearing	=	1,500.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	35.0 psf/ft
	=	
Passive Pressure	=	250.0 psf/ft
Soil Density, Heel	=	110.00 pcf
Soil Density, Toe	=	110.00 pcf
Footing||Soil Friction	=	0.400
Soil height to ignore for passive pressure	=	12.00 in



Surcharge Loads

Surcharge Over Heel	=	0.0 psf
Used To Resist Sliding & Overturning		
Surcharge Over Toe	=	0.0
Used for Sliding & Overturning		

Axial Load Applied to Stem

Axial Dead Load	=	0.0 lbs
Axial Live Load	=	0.0 lbs
Axial Load Eccentricity	=	0.0 in

Lateral Load Applied to Stem

Lateral Load	=	0.0 #/ft
...Height to Top	=	0.00 ft
...Height to Bottom	=	0.00 ft
Load Type	=	Wind (W) (Service Level)
Wind on Exposed Stem (Strength Level)	=	0.0 psf

Adjacent Footing Load

Adjacent Footing Load	=	0.0 lbs
Footing Width	=	0.00 ft
Eccentricity	=	0.00 in
Wall to Ftg CL Dist	=	0.00 ft
Footing Type		Spread Footing
Base Above/Below Soil at Back of Wall	=	0.0 ft
Poisson's Ratio	=	0.300

Project Title:
Engineer:
Project ID:
Project Descr:

Cantilevered Retaining Wall

Project File: storm shelter.ec6

DESCRIPTION: STAIR WALL 6'-0"

Design Summary

Wall Stability Ratios

Overturning	=	7.42	OK
Sliding	=	1.63	OK
Global Stability	=	2.18	

Total Bearing Load	=	3,874	lbs
...resultant ecc.	=	5.09	in

Eccentricity within middle third

Soil Pressure @ Toe	=	327	psf OK
Soil Pressure @ Heel	=	748	psf OK
Allowable	=	1,500	psf

Soil Pressure Less Than Allowable

ACI Factored @ Toe	=	458	psf
ACI Factored @ Heel	=	1,047	psf
Footing Shear @ Toe	=	7.3	psi OK
Footing Shear @ Heel	=	1.3	psi OK
Allowable	=	82.2	psi

Sliding Calcs

Lateral Sliding Force	=	857.5	lbs
less 100% Passive Force	-	0.0	lbs
less 100% Friction Force	-	1,398.0	lbs
Added Force Req'd	=	0.0	lbs OK
....for 1.5 Stability	=	0.0	lbs OK

Vertical component of active lateral soil pressure IS NOT considered in the calculation of soil bearing

Load Factors

Building Code	
Dead Load	1.200
Live Load	1.600
Earth, H	1.600
Wind, W	1.600
Seismic, E	1.000

Stem Construction

		Bottom		
		Stem OK		
Design Height Above Ftg	ft =	0.00		
Wall Material Above "Ht"	=	Concrete		
Design Method	=	SD	SD	SD
Thickness	=	8.00		
Rebar Size	=	# 4		
Rebar Spacing	=	12.00		
Rebar Placed at	=	Center		
Design Data				
fb/FB + fa/Fa	=	**0.588**		
Total Force @ Section				
Service Level	lbs =			
Strength Level	lbs =	1,008.0		
Moment....Actual				
Service Level	ft-# =			
Strength Level	ft-# =	2,016.0		
Moment.....Allowable	=	3,423.0		
Shear.....Actual				
Service Level	psi =			
Strength Level	psi =	21.0		
Shear.....Allowable	psi =	82.2		
Anet (Masonry)	in2 =			
Wall Weight	psf =	100.0		
Rebar Depth 'd'	in =	4.00		

Masonry Data

f'm	psi =	
Fs	psi =	
Solid Grouting	=	
Modular Ratio 'n'	=	
Equiv. Solid Thick.	=	
Masonry Block Type	=	
Masonry Design Method	=	ASD

Concrete Data

f'c	psi =	3,000.0
Fy	psi =	60,000.0

Project Title:
Engineer:
Project ID:
Project Descr:

Cantilevered Retaining Wall

Project File: storm shelter.ec6

DESCRIPTION: STAIR WALL 6'-0"

Concrete Stem Rebar Area Details

Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing	
As (based on applied moment) :	0.1217 in2/ft		
(4/3) * As :	0.1623 in2/ft	Min Stem T&S Reinf Area 1.248 in2	
200bd/fy : 200(12)(4)/60000 :	0.16 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.192 in2/ft	
0.0018bh : 0.0018(12)(8) :	0.1728 in2/ft	Horizontal Reinforcing Options :	
	==========	One layer of :	Two layers of :
Required Area :	0.16 in2/ft	#4@ 12.50 in	#4@ 25.00 in
Provided Area :	0.2 in2/ft	#5@ 19.38 in	#5@ 38.75 in
Maximum Area :	0.6503 in2/ft	#6@ 27.50 in	#6@ 55.00 in

Footing Data

Toe Width	=	3.00 ft
Heel Width	=	3.50
Total Footing Width	=	6.50
Footing Thickness	=	12.00 in
Key Width	=	0.00 in
Key Depth	=	0.00 in
Key Distance from Toe	=	2.83 ft

f'c = 3,000 psi Fy = 60,000 psi
Footing Concrete Density = 150.00 pcf
Min. As % = 0.0018
Cover @ Top 3.00 @ Btm.= 3.00 in

Footing Design Results

		Toe	Heel	
Factored Pressure	=	458	1,047	psf
Mu' : Upward	=	2,470	3,901	ft-#
Mu' : Downward	=	810	3,902	ft-#
Mu: Design	=	1,660 OK	1	ft-# OK
phiMn	=	2,739	2,739	ft-#
Actual 1-Way Shear	=	7.30	1.25	psi
Allow 1-Way Shear	=	43.82	43.82	psi
Toe Reinforcing	=	None Spec'd		
Heel Reinforcing	=	None Spec'd		
Key Reinforcing	=	None Spec'd		
Footing Torsion, Tu	=	0.00		ft-lbs
Footing Allow. Torsion, phi Tu	=	0.00		ft-lbs

If torsion exceeds allowable, provide supplemental design for footing torsion.

Other Acceptable Sizes & Spacings

Toe: phiMn = phi*5*lambda*sqrt(fc)*Sm

Heel: phiMn = phi*5*lambda*sqrt(fc)*Sm

Key: No key defined

Min footing T&S reinf Area	1.68	in2
Min footing T&S reinf Area per foot	0.26	in2 /ft

If one layer of horizontal bars:	If two layers of horizontal bars:
#4@ 9.26 in	#4@ 18.52 in
#5@ 14.35 in	#5@ 28.70 in
#6@ 20.37 in	#6@ 40.74 in

Project Title:
Engineer:
Project ID:
Project Descr:

Cantilevered Retaining Wall

Project File: storm shelter.ec6

DESCRIPTION: STAIR WALL 6'-0"

Summary of Overturning & Resisting Forces & Moments

Item	.....OVERTURNING..... Force lbs	Distance ft	Moment ft-#	.....RESISTING..... Force lbs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl)	857.5	2.33	2,000.8			
HL Act Pres (be water tbl)						
Hydrostatic Force						
Buoyant Force =						
Surcharge over Heel =						
Surcharge Over Toe =						
Adjacent Footing Load =						
Added Lateral Load =						
Load @ Stem Above Soil =						
=						
Soil Over HL (ab. water tbl)				1,870.0	5.08	9,505.8
Soil Over HL (bel. water tbl)					5.08	9,505.8
Water Table						
Sloped Soil Over Heel =						
Surcharge Over Heel =						
Adjacent Footing Load =						
Axial Dead Load on Stem =						
* Axial Live Load on Stem =						
Soil Over Toe =						
Surcharge Over Toe =						
Stem Weight(s) =				650.0	3.33	2,166.7
Earth @ Stem Transitions =						
Footing Weight =				975.0	3.25	3,168.8
Key Weight =					2.83	
Vert. Component =						
Total =	857.5	**O.T.M.** =	2,000.8	**Total =** 3,495.0 lbs	**R.M.=**	14,841.3

Resisting/Overturning Ratio = **7.42**

Vertical Loads used for Soil Pressure = 3,873.5 lbs

* Axial live load NOT included in total displayed, or used for overturning resistance, but is included for soil pressure calculation.

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Sliding Resistance.

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Overturning Resistance.

Tilt

Horizontal Deflection at Top of Wall due to settlement of soil

(Deflection due to wall bending not considered)

Soil Spring Reaction Modulus	250.0	pci
Horizontal Defl @ Top of Wall (approximate only)	0.000	in

The above calculation is not valid if the heel soil bearing pressure exceeds that of the toe, because the wall would then tend to rotate into the retained soil.

Project Title:
Engineer:
Project ID:
Project Descr:

Cantilevered Retaining Wall

Project File: storm shelter.ec6

DESCRIPTION: STAIR WALL 6'-0"

Rebar Lap & Embedment Lengths Information

Stem Design Segment: Bottom
Stem Design Height: 0.00 ft above top of footing

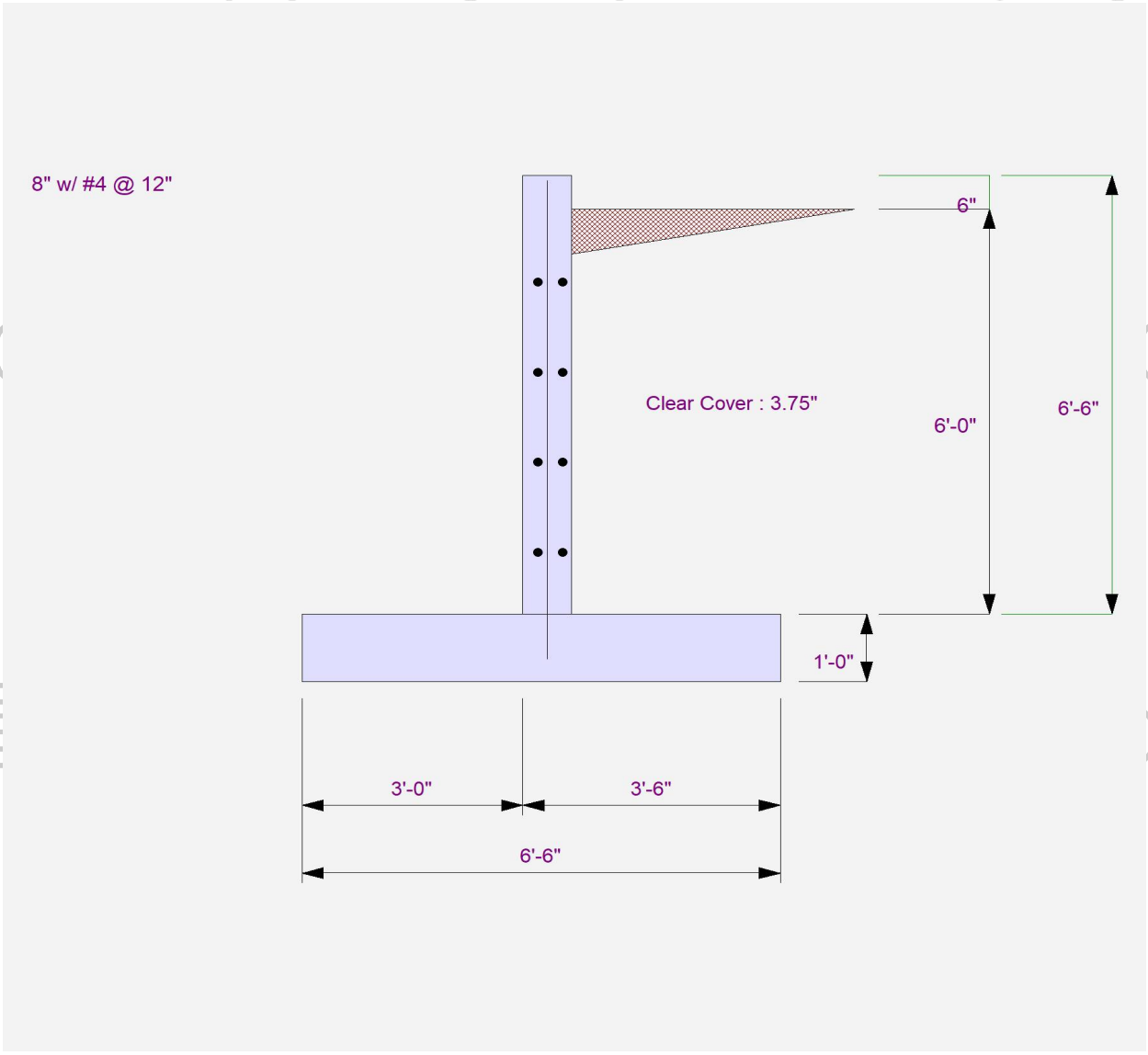
Lap Splice length for #4 bar specified in this stem design segment (25.4.2.3a) =	17.09 in
Development length for #4 bar specified in this stem design segment =	13.15 in
Hooked embedment length into footing for #4 bar specified in this stem design segment =	7.67 in
As Provided =	0.2000 in2/ft
As Required =	0.1600 in2/ft

Project Title:
Engineer:
Project ID:
Project Descr:

Cantilevered Retaining Wall

Project File: storm shelter.ec6

DESCRIPTION: STAIR WALL 6'-0"

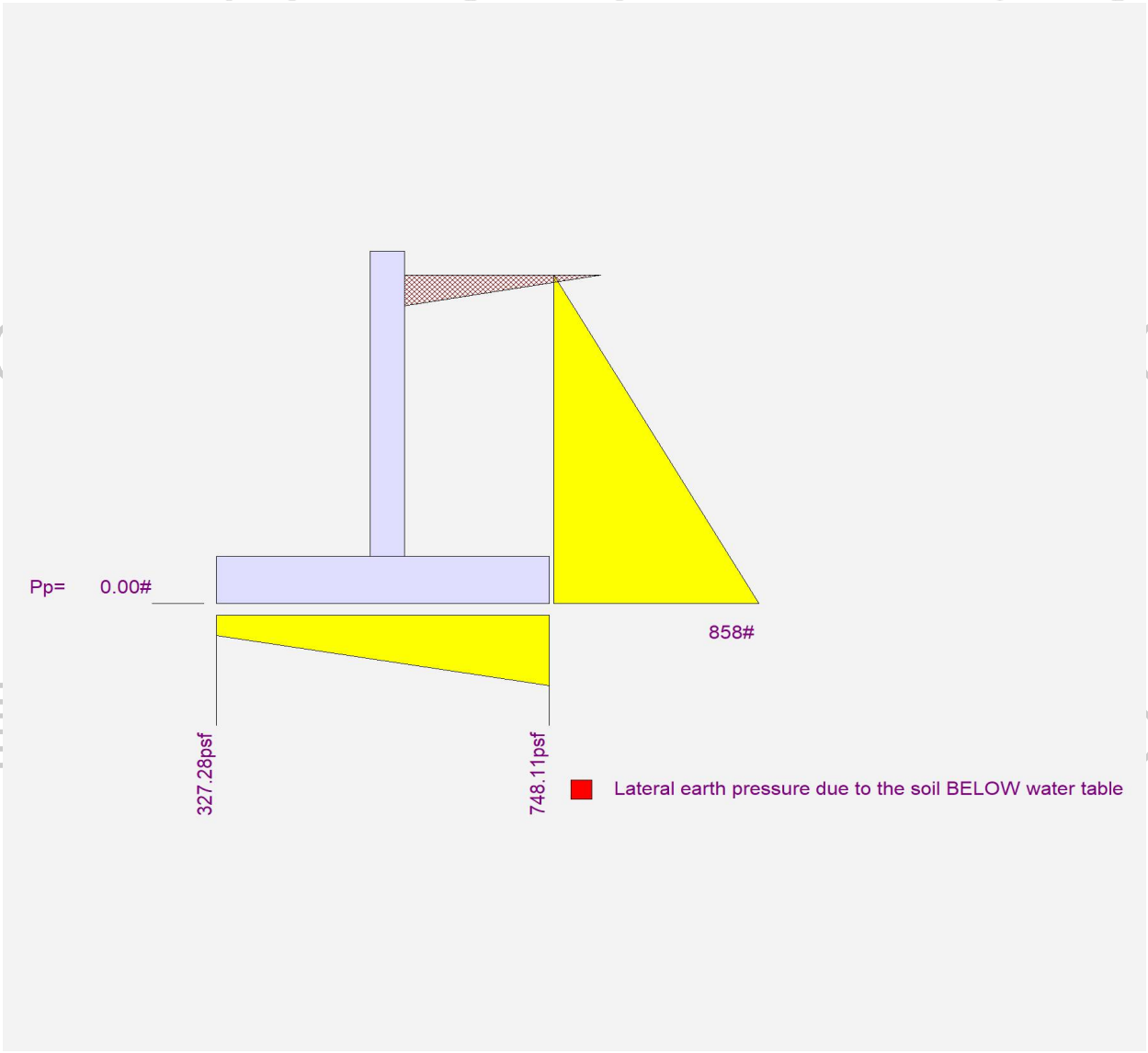


Project Title:
Engineer:
Project ID:
Project Descr:

Cantilevered Retaining Wall

Project File: storm shelter.ec6

DESCRIPTION: STAIR WALL 6'-0"



Project Title:
Engineer:
Project ID:
Project Descr:

Cantilevered Retaining Wall

Project File: storm shelter.ec6

DESCRIPTION: STAIR WALL 4'-0"

Code Reference

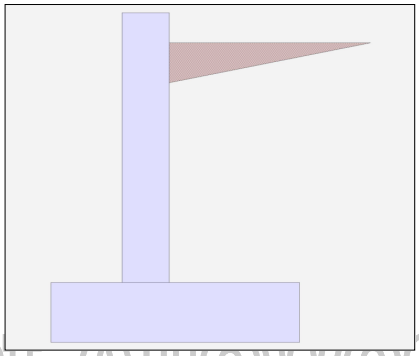
Calculations per IBC 2018 1807.3, CBC 2019, ASCE 7-16

Criteria

Retained Height	=	4.00 ft
Wall height above soil	=	0.50 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	0.00 in
Water table above bottom of footing	=	0.0 ft

Soil Data

Allow Soil Bearing	=	1,500.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	35.0 psf/ft
	=	
Passive Pressure	=	250.0 psf/ft
Soil Density, Heel	=	110.00 pcf
Soil Density, Toe	=	110.00 pcf
Footing||Soil Friction	=	0.400
Soil height to ignore for passive pressure	=	12.00 in



Surcharge Loads

Surcharge Over Heel	=	0.0 psf
Used To Resist Sliding & Overturning		
Surcharge Over Toe	=	0.0
Used for Sliding & Overturning		

Axial Load Applied to Stem

Axial Dead Load	=	0.0 lbs
Axial Live Load	=	0.0 lbs
Axial Load Eccentricity	=	0.0 in

Lateral Load Applied to Stem

Lateral Load	=	0.0 #/ft
...Height to Top	=	0.00 ft
...Height to Bottom	=	0.00 ft
Load Type	=	Wind (W) (Service Level)
Wind on Exposed Stem (Strength Level)	=	0.0 psf

Adjacent Footing Load

Adjacent Footing Load	=	0.0 lbs
Footing Width	=	0.00 ft
Eccentricity	=	0.00 in
Wall to Ftg CL Dist	=	0.00 ft
Footing Type		Spread Footing
Base Above/Below Soil at Back of Wall	=	0.0 ft
Poisson's Ratio	=	0.300

Project Title:
Engineer:
Project ID:
Project Descr:

Cantilevered Retaining Wall

Project File: storm shelter.ec6

DESCRIPTION: STAIR WALL 4'-0"

Design Summary

Wall Stability Ratios

Overturning	=	4.94	OK
Sliding	=	1.63	OK
Global Stability	=	2.50	

Total Bearing Load	=	1,975	lbs
...resultant ecc.	=	1.65	in

Eccentricity within middle third

Soil Pressure @ Toe	=	629	psf OK
Soil Pressure @ Heel	=	389	psf OK
Allowable	=	1,500	psf

Soil Pressure Less Than Allowable

ACI Factored @ Toe	=	880	psf
ACI Factored @ Heel	=	545	psf
Footing Shear @ Toe	=	1.7	psi OK
Footing Shear @ Heel	=	1.1	psi OK
Allowable	=	82.2	psi

Sliding Calcs

Lateral Sliding Force	=	437.5	lbs
less 100% Passive Force	-	0.0	lbs
less 100% Friction Force	-	712.7	lbs
Added Force Req'd	=	0.0	lbs OK
....for 1.5 Stability	=	0.0	lbs OK

Vertical component of active lateral soil pressure IS NOT considered in the calculation of soil bearing

Load Factors

Building Code	
Dead Load	1.200
Live Load	1.600
Earth, H	1.600
Wind, W	1.600
Seismic, E	1.000

Stem Construction

		Bottom		
		Stem OK		
Design Height Above Ftg	ft =	0.00		
Wall Material Above "Ht"	=	Concrete		
Design Method	=	SD	SD	SD
Thickness	=	8.00		
Rebar Size	=	# 4		
Rebar Spacing	=	12.00		
Rebar Placed at	=	Center		
Design Data				
fb/FB + fa/Fa	=	**0.174**		
Total Force @ Section				
Service Level	lbs =			
Strength Level	lbs =	448.0		
Moment....Actual				
Service Level	ft-# =			
Strength Level	ft-# =	597.3		
Moment.....Allowable	=	3,423.0		
Shear.....Actual				
Service Level	psi =			
Strength Level	psi =	9.3		
Shear.....Allowable	psi =	82.2		
Anet (Masonry)	in2 =			
Wall Weight	psf =	100.0		
Rebar Depth 'd'	in =	4.00		

Masonry Data

f'm	psi =	
Fs	psi =	
Solid Grouting	=	
Modular Ratio 'n'	=	
Equiv. Solid Thick.	=	
Masonry Block Type	=	
Masonry Design Method	=	ASD

Concrete Data

f'c	psi =	3,000.0
Fy	psi =	60,000.0

Project Title:
Engineer:
Project ID:
Project Descr:

Cantilevered Retaining Wall

Project File: storm shelter.ec6

DESCRIPTION: STAIR WALL 4'-0"

Concrete Stem Rebar Area Details

Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing	
As (based on applied moment) :	0.0361 in2/ft		
(4/3) * As :	0.0481 in2/ft	Min Stem T&S Reinf Area 0.864 in2	
200bd/fy : 200(12)(4)/60000 :	0.16 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.192 in2/ft	
0.0018bh : 0.0018(12)(8) :	0.1728 in2/ft	Horizontal Reinforcing Options :	
	==========	One layer of :	Two layers of :
Required Area :	0.1728 in2/ft	#4@ 12.50 in	#4@ 25.00 in
Provided Area :	0.2 in2/ft	#5@ 19.38 in	#5@ 38.75 in
Maximum Area :	0.6503 in2/ft	#6@ 27.50 in	#6@ 55.00 in

Footing Data

Toe Width	=	1.00 ft
Heel Width	=	2.50
Total Footing Width	=	3.50
Footing Thickness	=	12.00 in
Key Width	=	0.00 in
Key Depth	=	0.00 in
Key Distance from Toe	=	2.83 ft

f'c = 3,000 psi Fy = 60,000 psi
Footing Concrete Density = 150.00 pcf
Min. As % = 0.0018
Cover @ Top 3.00 @ Btm.= 3.00 in

Footing Design Results

		Toe	Heel	
Factored Pressure	=	880	545	psf
Mu' : Upward	=	424	1,014	ft-#
Mu' : Downward	=	90	1,190	ft-#
Mu: Design	=	334 OK	175	ft-# OK
phiMn	=	2,739	2,739	ft-#
Actual 1-Way Shear	=	1.67	1.15	psi
Allow 1-Way Shear	=	43.82	43.82	psi
Toe Reinforcing	=	None Spec'd		
Heel Reinforcing	=	None Spec'd		
Key Reinforcing	=	None Spec'd		
Footing Torsion, Tu	=	0.00		ft-lbs
Footing Allow. Torsion, phi Tu	=	0.00		ft-lbs

If torsion exceeds allowable, provide supplemental design for footing torsion.

Other Acceptable Sizes & Spacings

Toe: phiMn = phi*5*lambda*sqrt(fc)*Sm

Heel: phiMn = phi*5*lambda*sqrt(fc)*Sm

Key: No key defined

Min footing T&S reinf Area	0.91	in2
Min footing T&S reinf Area per foot	0.26	in2 /ft

If one layer of horizontal bars:	If two layers of horizontal bars:
#4@ 9.26 in	#4@ 18.52 in
#5@ 14.35 in	#5@ 28.70 in
#6@ 20.37 in	#6@ 40.74 in

Project Title:
Engineer:
Project ID:
Project Descr:

Cantilevered Retaining Wall

Project File: storm shelter.ec6

DESCRIPTION: STAIR WALL 4'-0"

Summary of Overturning & Resisting Forces & Moments

Item	.....OVERTURNING..... Force lbs	Distance ft	Moment ft-#	.....RESISTING..... Force lbs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl)	437.5	1.67	729.2	Soil Over HL (ab. water tbl)	806.7	2.58	2,083.9
HL Act Pres (be water tbl)				Soil Over HL (bel. water tbl)		2.58	2,083.9
Hydrostatic Force				Water Table			
Buoyant Force =				Sloped Soil Over Heel =			
Surcharge over Heel =				Surcharge Over Heel =			
Surcharge Over Toe =				Adjacent Footing Load =			
Adjacent Footing Load =				Axial Dead Load on Stem =			
Added Lateral Load =				* Axial Live Load on Stem =			
Load @ Stem Above Soil =				Soil Over Toe =			
=				Surcharge Over Toe =			
				Stem Weight(s) =	450.0	1.33	600.0
				Earth @ Stem Transitions =			
				Footing Weight =	525.0	1.75	918.8
				Key Weight =		2.83	
				Vert. Component =			
Total =	437.5	**O.T.M.** =	729.2	**Total =**	1,781.7 lbs	**R.M.=**	3,602.6

Resisting/Overturning Ratio = **4.94**

Vertical Loads used for Soil Pressure = 1,974.8 lbs

* Axial live load NOT included in total displayed, or used for overturning resistance, but is included for soil pressure calculation.

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Sliding Resistance.

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Overturning Resistance.

Tilt

Horizontal Deflection at Top of Wall due to settlement of soil

(Deflection due to wall bending not considered)

Soil Spring Reaction Modulus	250.0	pci
Horizontal Defl @ Top of Wall (approximate only)	0.022	in

The above calculation is not valid if the heel soil bearing pressure exceeds that of the toe, because the wall would then tend to rotate into the retained soil.

Project Title:
Engineer:
Project ID:
Project Descr:

Cantilevered Retaining Wall

Project File: storm shelter.ec6

DESCRIPTION: STAIR WALL 4'-0"

Rebar Lap & Embedment Lengths Information

Stem Design Segment: Bottom
Stem Design Height: 0.00 ft above top of footing

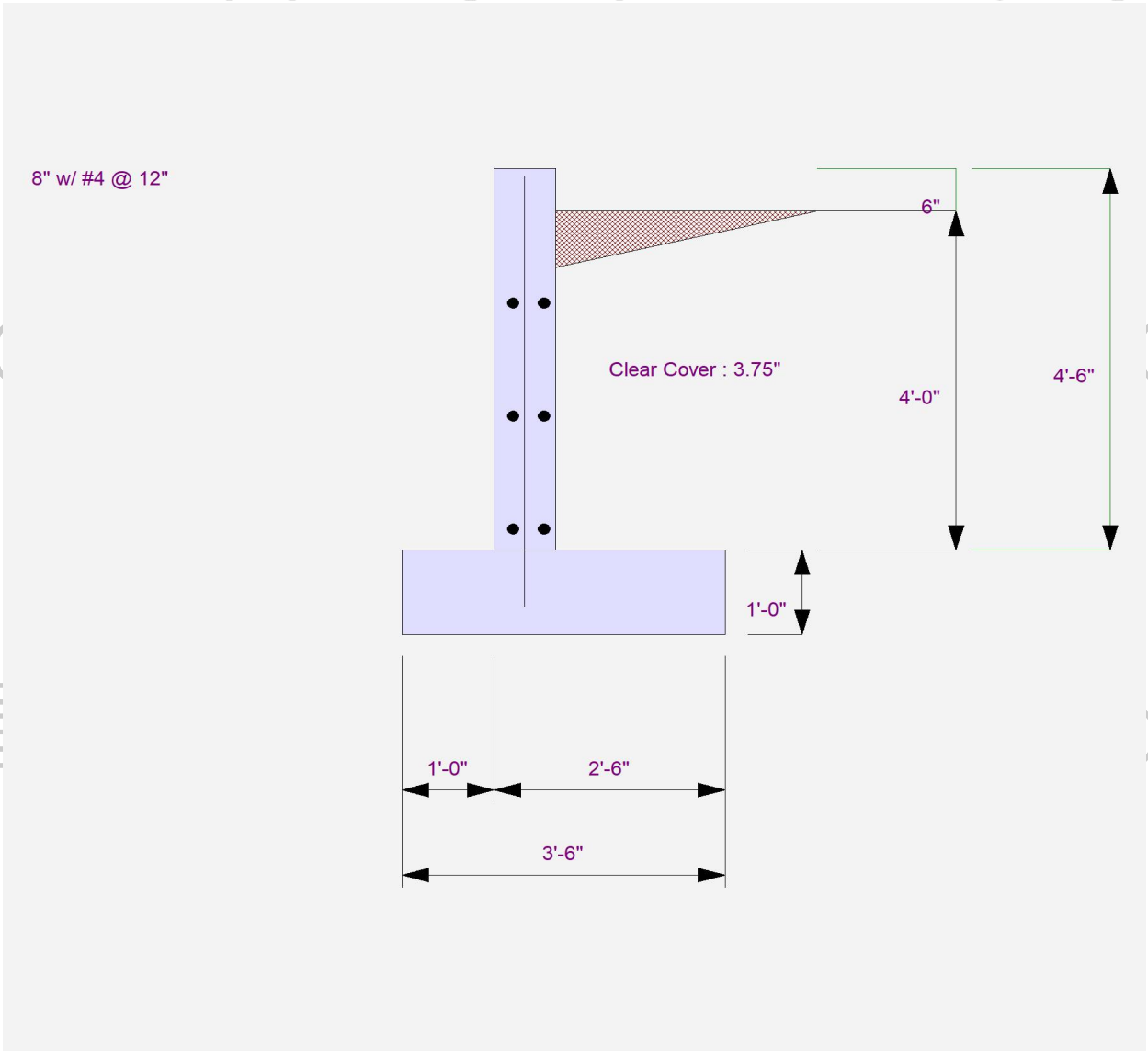
Lap Splice length for #4 bar specified in this stem design segment (25.4.2.3a) =	17.09 in
Development length for #4 bar specified in this stem design segment =	13.15 in
Hooked embedment length into footing for #4 bar specified in this stem design segment =	7.67 in
As Provided =	0.2000 in2/ft
As Required =	0.1728 in2/ft

Project Title:
Engineer:
Project ID:
Project Descr:

Cantilevered Retaining Wall

Project File: storm shelter.ec6

DESCRIPTION: STAIR WALL 4'-0"

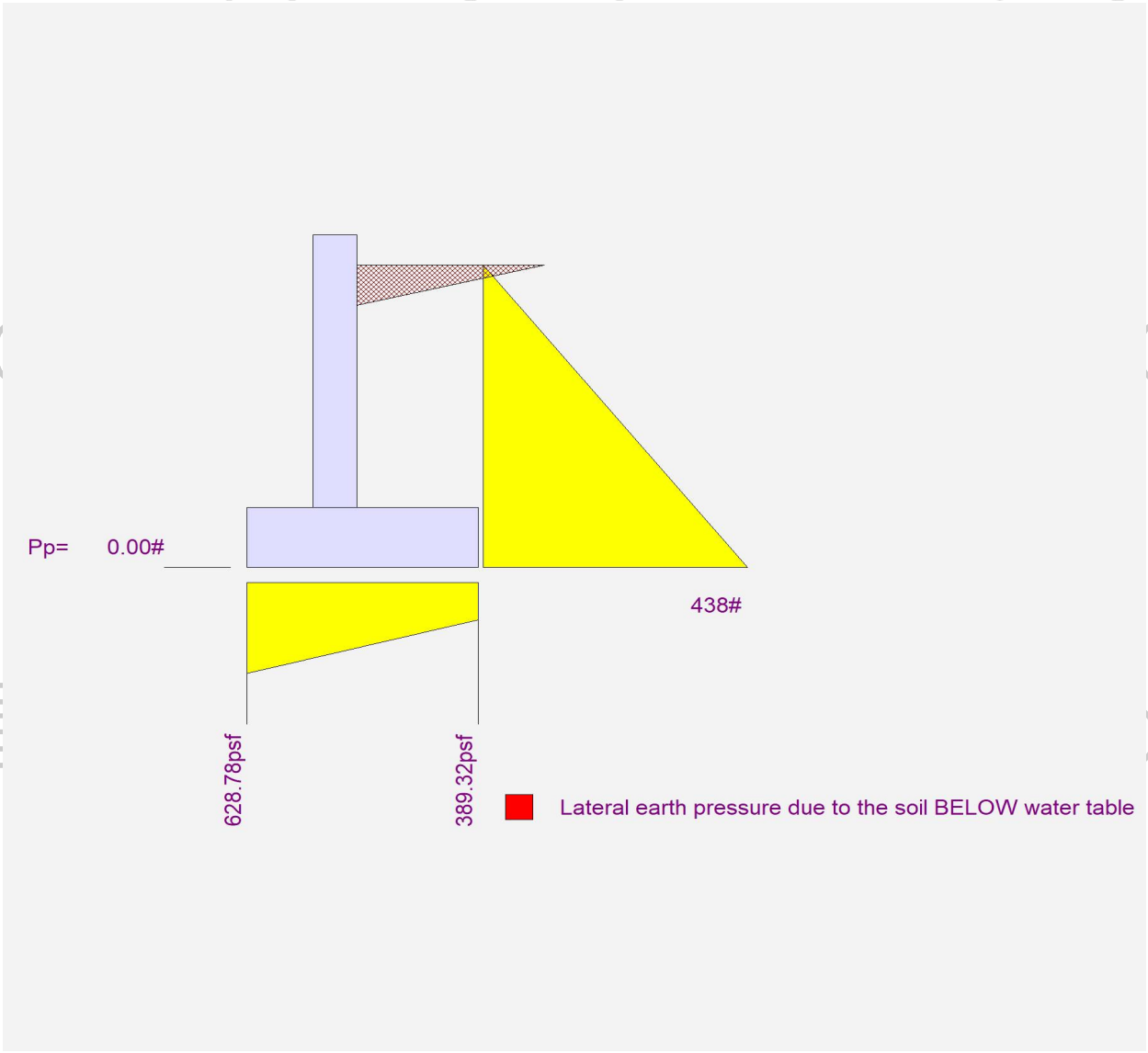


Project Title:
Engineer:
Project ID:
Project Descr:

Cantilevered Retaining Wall

Project File: storm shelter.ec6

DESCRIPTION: STAIR WALL 4'-0"



Appendix B

Joshua Sweeten

(385) 368-6935 · 17jsweeten1@gmail.com · Provo, Ut · linkedin.com/in/joshuasweeten/

EDUCATION

Brigham Young University, Ira A. Fulton College of Engineering April 2024
BS, Civil Engineering Provo, UT

- Cumulative GPA 3.54
- Thomas S. Monson Scholarship (4-year 150% tuition, top 0.04% of incoming class)
- Regents' Exemplary Scholarship (2-year 50% tuition)

EXPERIENCE

Career Mentor January 2023 – June 2023
BYU Career Services Provo, UT

- Delivered personalized 1-on-1 resume coaching to students, optimizing their job search strategies
- Guided students in exploring potential career paths by leveraging platforms like LinkedIn and Handshake
- Conducted engaging career development classes for groups of 25+ students, fostering professional growth

Engineering Intern May 2022 – August 2022
Advanced Engineering and Environmental Services (AE2S) Lehi, UT

- Acted as on-site representative for the construction of new $10 million booster pump station
- Utilized Python to extract and analyze national soil moisture data, advancing drought mitigation efforts
- Cut task time from 40 minutes to 4 by automating asset management task in ArcGIS with Python script
- Researched the 8 tribal nations of Utah, culminating in a report identifying areas for improved water services

Team Lead June 2021 – August 2021
Olympus Fireworks Layton, UT

- Led top performing tent team in dissembling and storing 30+ firework tents in 5 days
- Reduced task time from 45 minutes to 30 by minimizing down time and establishing team goals

Asset Management Intern August 2020 – April 2021
Central Utah Water Conservancy District Orem, UT

- Revised and successfully guided 5 technical operation and maintenance documents through approval
- Collaborated with a team of GIS staff to create a spatial service with detailed geographical information encompassing 4 facilities
- Reviewed and updated over 500 assets in a registry database
- Led 7 out of 8 other interns in key performance indicator (KPI) efficiency

VOLUNTEER EXPERIENCE

Vice President May 2022 – April 2023
BYU Civil Engineering Student Chapter Provo, UT

- Oversaw and led weekly seminars of 180+ students
- Customized presentations to address student interests, leading to 20% attendance increase
- Corresponded between club presidencies and ASCE officers to increase activity publicity and attendance

Full-time Representative July 2017 – July 2019
The Church of Jesus Christ of Latter-day Saints Taichung, Taiwan

- Generated 33% increase in interested target audience through improved finding techniques
- Trained 25+ full-time representatives through weekly and monthly development meetings
- Committed 1500+ Chinese characters to memory

Julianna Edington

(512) 994-8837 · julianna.edington@gmail.com · linkedin.com/in/julianna-edington

EDUCATION

Brigham Young University Dec 2024
Bachelor of Science: Civil Engineering Provo, UT
- GPA 3.97
- Academic Scholarship (Jan 2022- Dec 2023)

SKILLS

- RISA 3D
- Revit
- AutoCAD Civil 3D
- Computer Programming: VBA, HTML, RStudio
- CAD (Autodesk Inventor)
- ArcGISPro
- Agisoft Metashape
- Portuguese Proficiency
- Microsoft Office

WORK EXPERIENCE

Vector Structural Engineering Apr 2023-Aug 2023
Intern, Telecom Team Draper, UT
- Designed mount assemblies model on RISA 3D to provide mount structural analysis for four clients
- Aided professional engineers in 20+ projects by performing equipment anchorage design analysis
- Collaborated with clients to provide and receive updates for revising construction drawings

Brigham Young University Air Quality Research Group Aug 2022-Jan 2023
Research Assistant Provo, UT
- Researched with a group of eight students and one professor to study air quality in homes
- Collected ozone and particulate matter samples to compare outdoor versus indoor data
- Coded 5 plot graphs in RStudio to analyze differences in swamp cooler and central air homes

Brigham Young University Hydroinformatics Research Group Aug 2019-Apr 2020
Research Assistant Provo, UT
- Researched with a group of six students and one professor to study sediment trends
- Gathered geographic data at Starvation Reservoir with drones
- Created 3D models of lake using GIS software
- Wrote a group scientific paper for project with findings and analysis

ACTIVITIES

Member of the American Society of Civil Engineers Aug 2019-Present
- Volunteered in service projects and activities twice a month

Member of the Society of Women Engineers at BYU Aug 2019-Present
- Attended dinners with leaders of engineering companies once a semester
- Participated in engineering career learning retreat

Intramural Sports Jan 2022-Apr 2022
- Champion in 2v2 volleyball, women's team basketball, coed team volleyball

VOLUNTEER EXPERIENCE

The Church of Jesus Christ of Latter-day Saints Jul 2020-Dec 2021
Volunteer Representative Ventura, California & London, England
- Led and trained St Albans, England area of 16 volunteers (4 months)
- Presented 12 trainings on improving leadership, managerial, and interpersonal relations skills
- Analyzed and reported weekly and monthly statistics to leadership
- Served in Portuguese areas in London (5 months) and helped create a Portuguese church unit

Isaac Averett

isaac@averettfam.com | (541) 580-9898 | www.linkedin.com/in/isaac-averett

EDUCATION

BS, Civil and Environmental Engineering, Emphasis in Structures **(**December 2024)
Brigham Young University – Provo, Utah

- GPA 3.18
- Civil Engineering Practice (Capstone)
- Structural Analysis
- Engineering Drafting w/ CAD Apps

RELEVANT SKILLS

- AutoCAD Civil 3D
- Enercalc
- Risa3D
- Computer Programming: VBA & Python
- Microsoft Office

PROFESSIONAL EXPERIENCE

Structural Engineering Intern / Project Manager (April 2021 – Present)
Vector Structural Engineers – Draper, UT

- Manage residential design projects through completion
- Correspond with clients daily regarding project status, handle questions, and resolve RFIs
- Determine beam, post, foundation, lateral system, and related structural elements for residential and commercial structures
- Evaluate and provide feedback regarding truss, concrete, and steel shop calculations and related submittals
- Work closely with engineers to resolve and perform various tasks

Customer Service Representative (Sept. 2020 – April 2021)
EnerBank USA – Provo, UT

- Provide telephone support to customers and document relevant information
- Assist in account disputes and provide customer with account information, including when customer became escalated
- Process payments and provide counsel regarding payments and loan information

Order Fulfillment (June 2020 – Aug. 2020)
Stampin' Up! – Riverton, UT

- Prepared orders to be shipped to consumers in an orderly manner
- Collaborated efficiently with the team to meet and exceed demanding order volumes, consistently packaging over 90,000 products per day
- Consistently maintained a schedule of ten-hour shifts, five days a week

ACTIVITIES

Student Innovator of the Year (SIOY) (Present 2023-2024 season)

- In partnership with a colleague, engaged in the collaborative development of an application aimed at optimizing the efficiency of the structural design process

German American Partnership Program (GAPP) **(**2016 – 2017)

- Facilitated a three-week hosting experience for a German exchange student, followed by a three-month period of residing in Germany
- Attended classes and instructed a course regarding American culture over a three-week period