CENE 486C NAU Pottery Ramada

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November 13th, 2020

Photo provided by Kayla Cross

Project Introduction

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Photo provided by Kayla Cross

A kiln located at Northern Arizona University's Pottery Complex needs a ramada to protect students from inclement weather conditions.

Client: Jason Hess
Professor, School of Art

Project Location

Photo provided by Google Maps

Project Location

Photo provided by Google Maps

Project Constraints

- Ramada needs to look aesthetically similar to other existing ramadas by using similar material types
- Limited space to place foundations due to existing structures
- Client would like to keep the budget near $10,000 but can be flexible

  (this only includes cost of materials)

Photo provided by Kayla Cross

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Analysis of Existing Site

Photo provided by Madison Kaltschnee

Topographic Site Map

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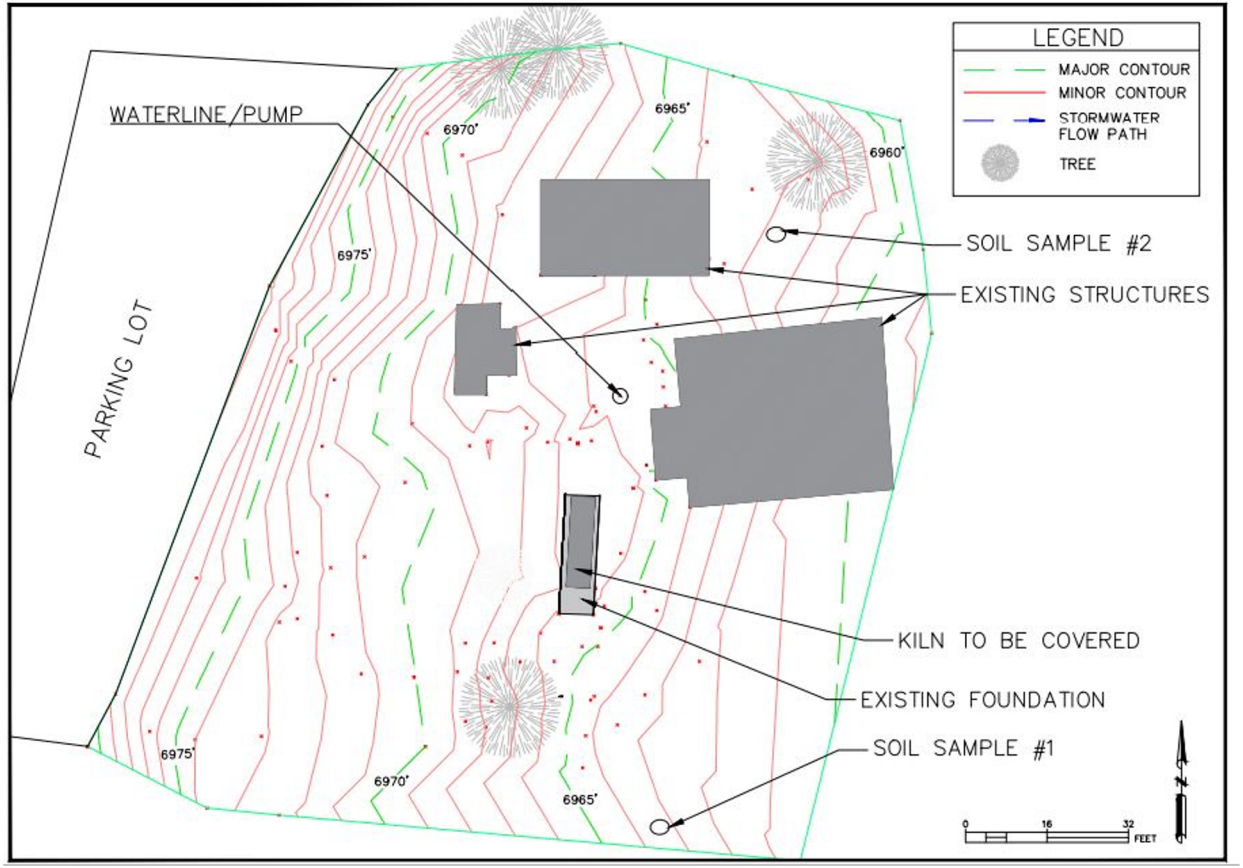

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Geotechnical Analysis

Photo provided by Madison Kaltschnee

Tests Conducted

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1. **Particle Size Distribution** Using the Sedimentations (ASTM D7928-17)
2. **Atterberg Limits** (ASTM D4318)
3. **Standard Test Method for Direct Shear Test of Soils Under Consolidated Drained Conditions** (ASTM D3080/D3080M-11)*

*Planned to conduct this test but direct shear machine was out-of-use

*Used allowable soil bearing pressure and lateral soil pressure values from Speedie Geotech Report

Photo provided by Kayla Cross

Soil Classification

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AASHTO ⇾ A-1-b Stone fragments; gravel and sand

USCS ⇾ SP-SM poorly graded sand with silt

When digging, we also found limestone 2-2.5' deep down and had to use a drill to get to soil

These Items matched what was written in the Speedie Geotech Report

Photo provided by Madison Kaltschnee

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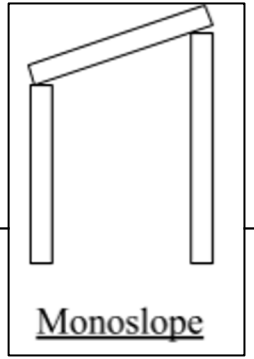
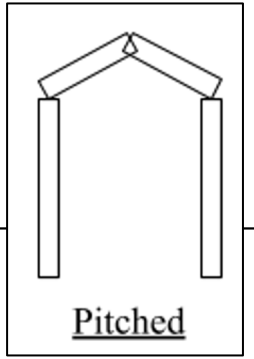
Structural Analysis

Google SketchUp Model Drawn by Luis Corral

Ramada Geometry



Monoslope



Pitched

Decision Matrix - Roof Design Type					
Criteria	**Weight**	**Score***	**Weighted Score**	**Score***	**Weighted Score**
Shed water away from other kilns	0.2	9	1.8	5	1
Design difficulty	0.1	6	0.6	6	0.6
Construction feasibility	0.3	7	2.1	4	1.2
Client preference	0.1	9	0.9	6	0.8
Cost of materials	0.25	10	2.5	7	1.75
Aesthetics	0.05	5	0.25	10	0.5
Allowable design height to fit chimney	0.1	7.5	0.75	4	0.4
Total	1	N/A	8.9	N/A	6.05
*Based on a scale of 1-10 (1 being the lowest score, 10 being the highest score)					

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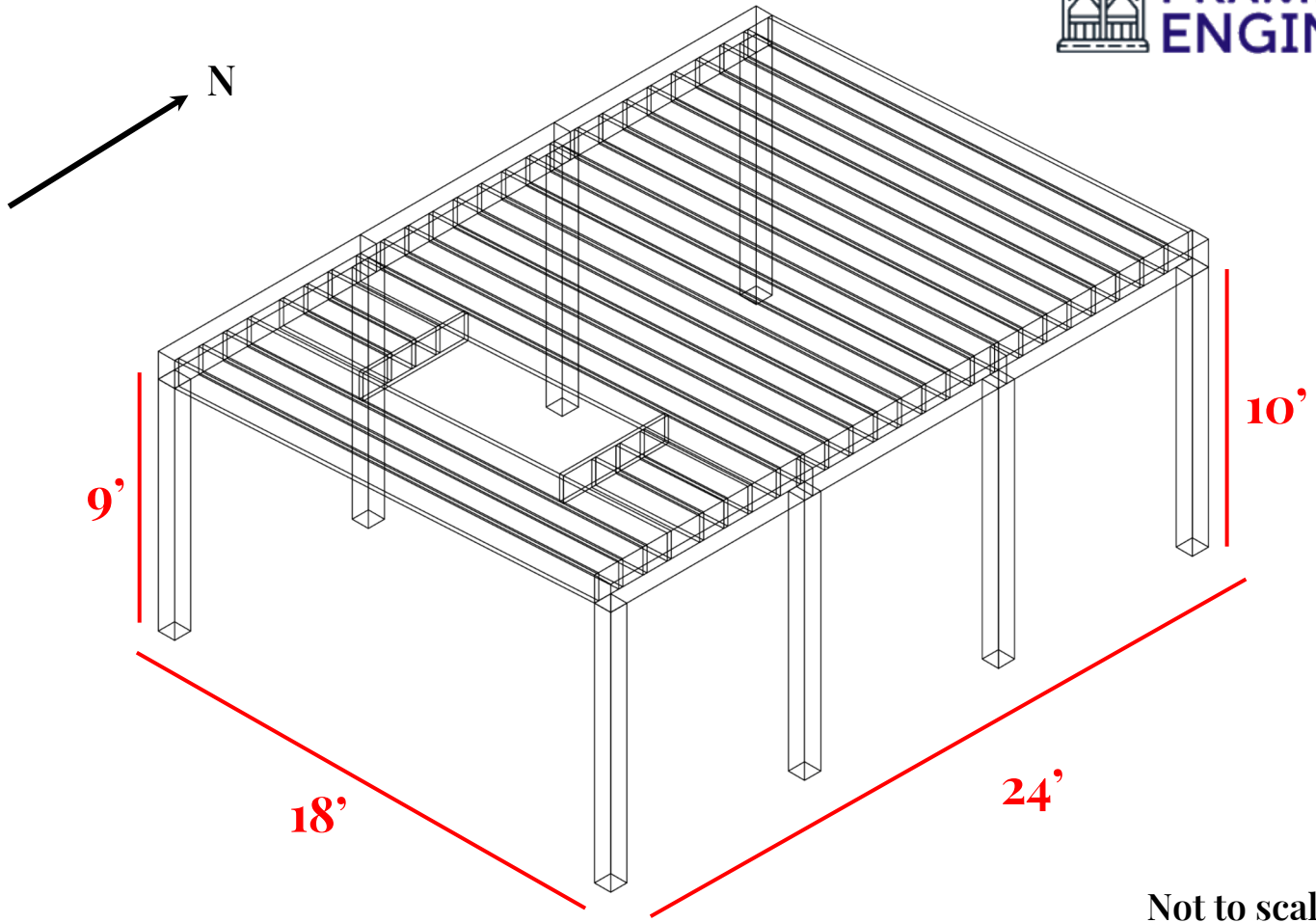

Not to scale

Design Loads

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Per ASCE 7-16: Minimum Design Loads and Associated Criteria for Buildings and Other Structures

-Dead load: 6 psf

-Roof live load: 20 psf

-Snow load: 51 psf

-Downward wind load: 30 psf

-Upward wind load: 37 psf

-Lateral wind load: 16 psf

-Horizontal seismic load: 3.5 psf

-Vertical seismic load: 1.04 psf

Roof

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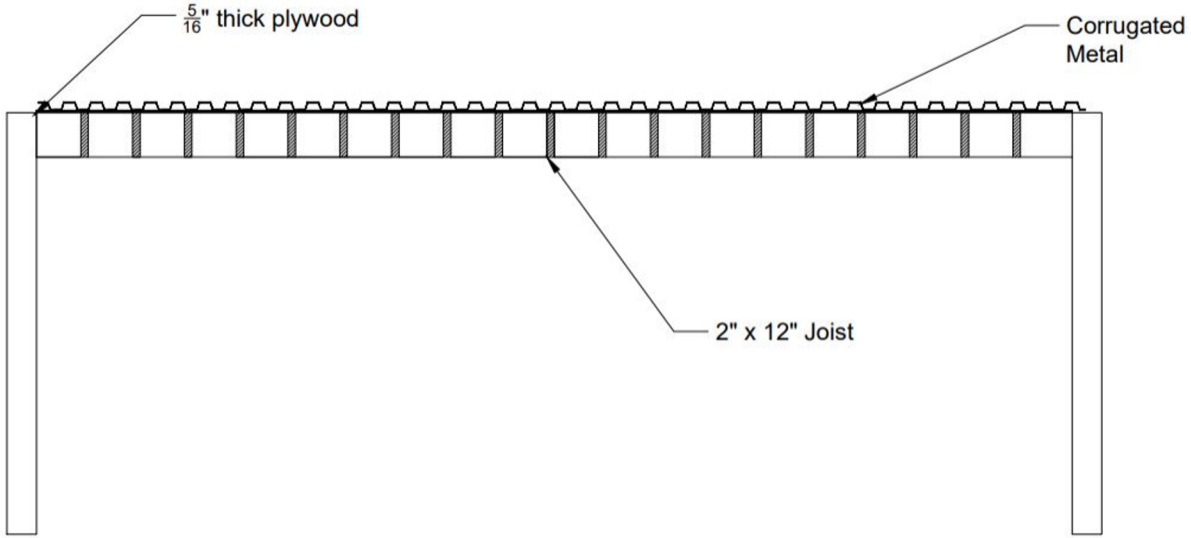
-Corrugated metal roof (Gauge 20)

-5/16” plywood



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Analysis of Wood Elements

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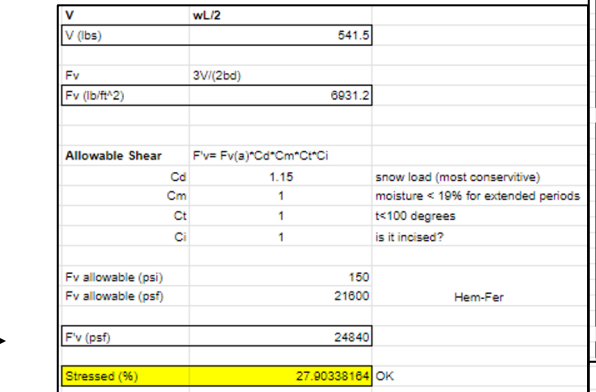
Members must pass the following checks:

-Bending capacity

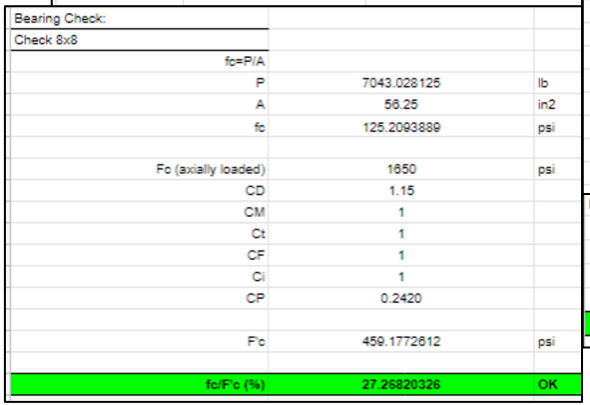
-Shear capacity

-Deflection capacity

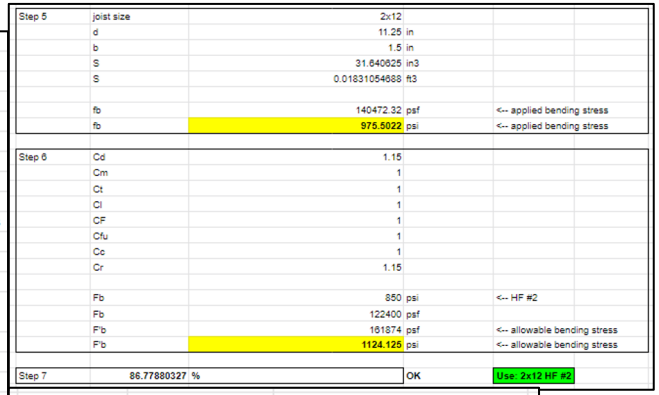
Samples of Calculations:



V	wL/2	
V (lbs)	541.5	
Fv	3V/(2bd)	
Fv (lb/ft^2)	6931.2	
Allowable Shear	F'v= Fv(a)*Cd*Cm*Ct*Ci	
Cd	1.15	snow load (most conservitive)
Cm	1	moisture < 19% for extended periods
Ct	1	t<100 degrees
Ci	1	is it incised?
Fv allowable (psi)	150	
Fv allowable (psf)	21600	Hem-Fer
F'v (psf)	24840	
Stressed (%)	27.90338164	OK



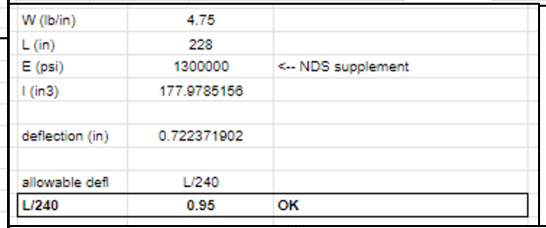
Bearing Check:		
Check 8x8		
fc=P/A		
P	7043.028125	lb
A	56.25	in2
fc	125.2093889	psi
Fc (axially loaded)	1650	psi
CD	1.15	
CM	1	
Ct	1	
CF	1	
Ci	1	
CP	0.2420	
F'c	459.1772612	psi
fc/F'c (%)	27.26820326	OK



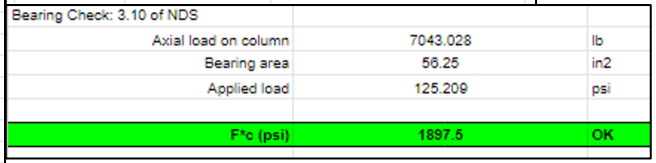
Step 5	joist size	2x12		
	d	11.25	in	
	b	1.5	in	
	S	31.640625	in3	
	S	0.01831054688	ft3	
	fb	140472.32	psf	<-- applied bending stress
	fb	975.5022	psi	<-- applied bending stress

Step 6	Cd	1.15		
	Cm	1		
	Ct	1		
	Ci	1		
	CF	1		
	Cfu	1		
	Cc	1		
	Cr	1.15		
	Fb	850	psi	<-- HF #2
	Fb	122400	psf	
	F'b	161874	psf	<-- allowable bending stress
	F'b	1124.125	psi	<-- allowable bending stress

Step 7	86.77880327	%	OK	Use: 2x12 HF #2



W (lb/in)	4.75	
L (in)	228	
E (psi)	1300000	<-- NDS supplement
I (in3)	177.9785156	
deflection (in)	0.722371902	
allowable defl	L/240	
L/240	0.95	OK



Bearing Check: 3.10 of NDS		
Axial load on column	7043.028	lb
Bearing area	56.25	in2
Applied load	125.209	psi
F*c (psi)	1897.5	OK

Joists and Beams

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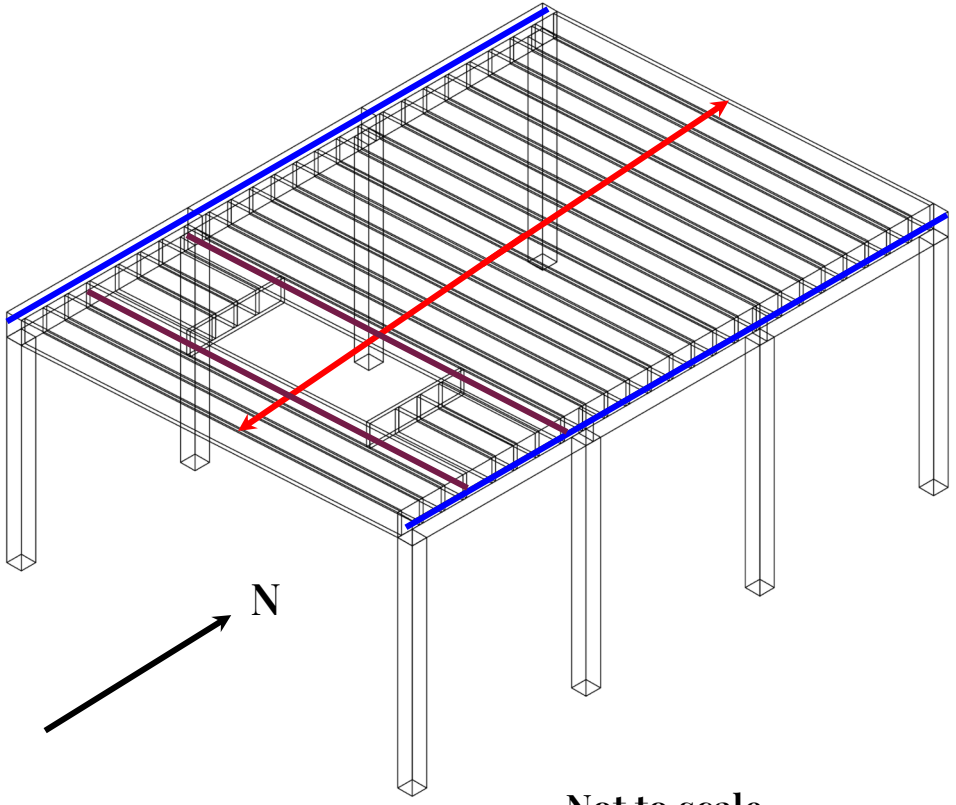
-Joists ↠ 2x12 members, 19’

-Joists adjacent to chimney ↠ (3) 2x12 members, 19’

-Beams ↠ 8x12 members, 8’



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Columns

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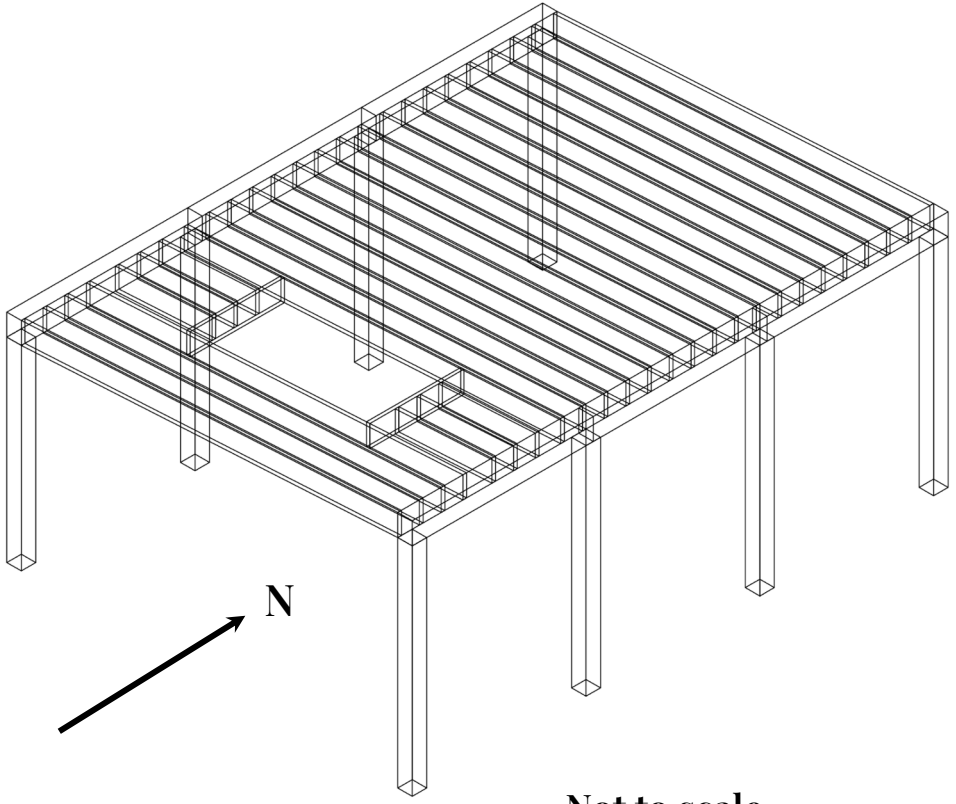
-Lateral force resisting system: cantilever columns

-8x8 members, (4) 10’ and (4) 9’



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Foundations

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CALCULATIONS: Using Terzaghi's Bearing Capacity Equation for Circular Foundations

$$q_u = 1.3c'N_c + qN_q + 0.3\gamma BN_\gamma \ (Circular\ Foundations)$$

c'= soil cohesion

γ= *unit weight of soil*

q= effective stress at the bottom of the foundation

N_c, N_q, N_γ= *Bearing Capacity Factors*

B= Diameter of Foundation

RESULTS:

- 2'-0" diameter circular shallow foundations
- 30" with 6" above soil surface (36" total)

Foundation Rebar

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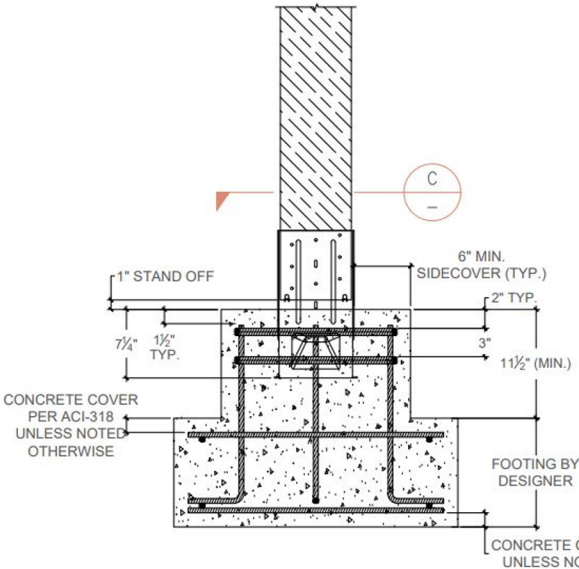
Rebar required by connection:

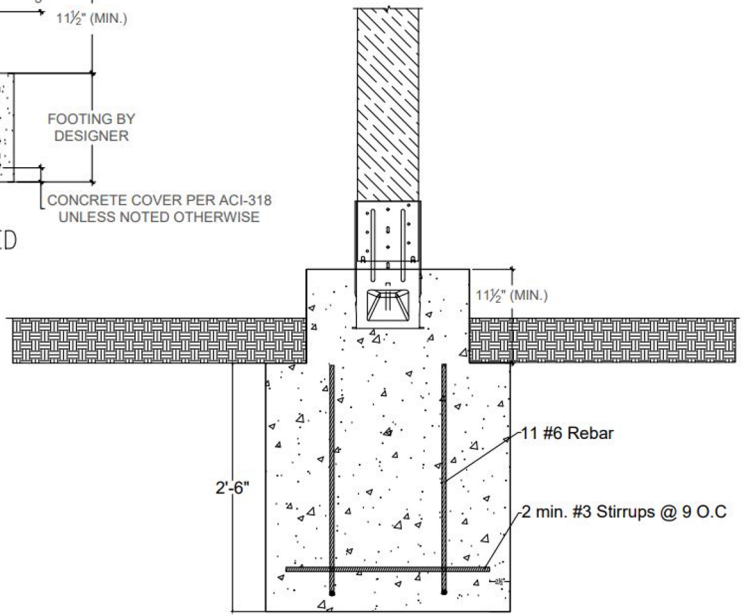
- Vertical Reinforcement: 8 #5 @ 8” o.c.
- Shear Reinforcement: #4 stirrups @ 3” o.c.

Design rebar:

- Vertical Reinforcement: 11 #6 spaced @ 1” o.c. min.
- Shear Reinforcement: 2 #3 stirrups spaced @ 9” o.c.



MPB88Z – REINFORCED CONCRETE FOOTING



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Connections

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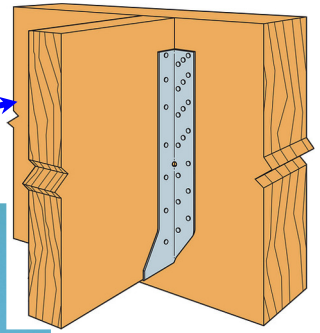
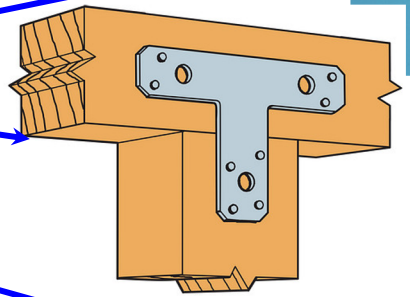
Simpson Tie Wood Construction Connectors:

Joists to beams ↠ HU212 & HU212-3



Beams to columns ↠ 1616HT & LCE4



Columns to foundations ↠ MPB88Z

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Material Specifications

Photo provided by Kayla Cross

Material Types

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Joists ⇾ Hem Fir #2 wood

Beams ⇾ Douglas Fir #2 wood

Columns ⇾ Glue-Laminated Douglas Fir (DF/DF 24F-V4)

Plywood ⇾ 5/16” thick of any type of wood

Metal decking ⇾ 20 Gauge with corrugated ridges for water runoff

Foundations ⇾ 4000 psi concrete

Rebar -> yield strength of 60 ksi

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Site Design

Photo provided by Madison Kaltschnee

Existing Drainage Analysis

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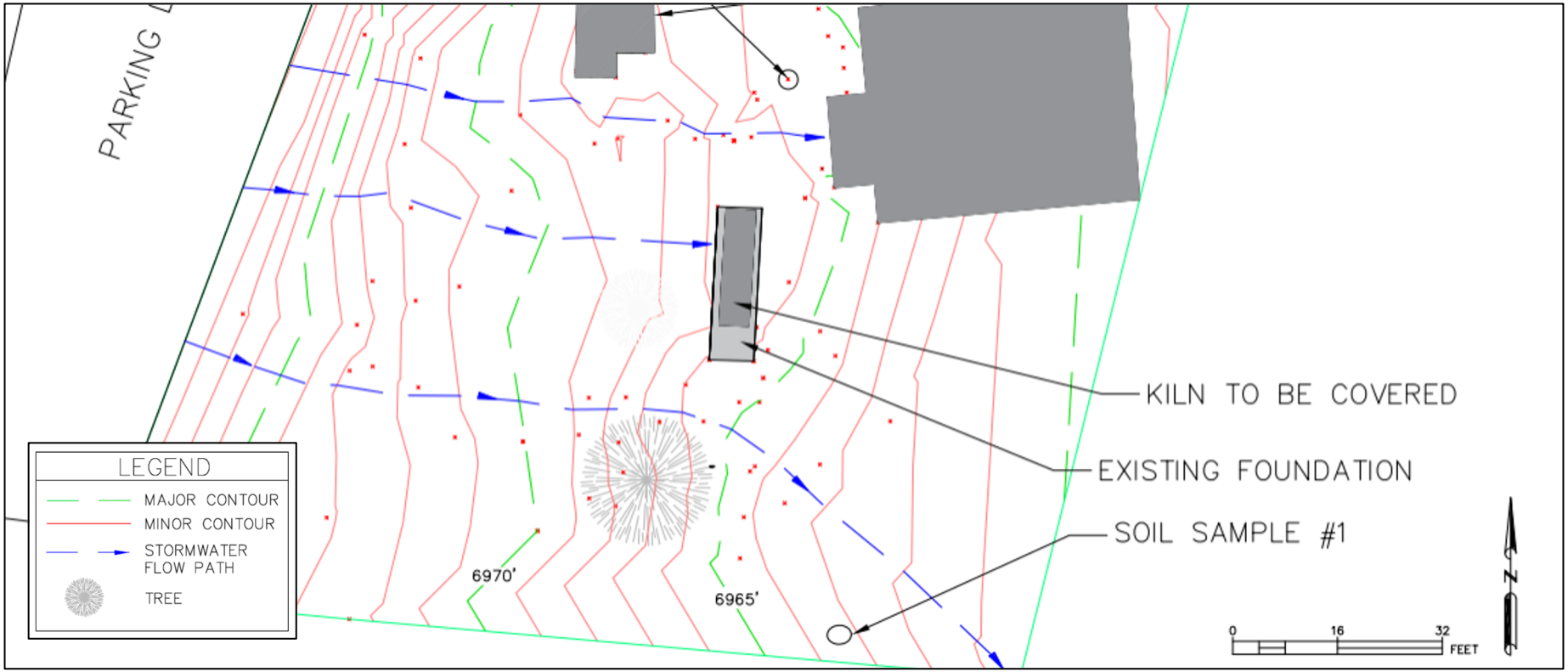

Drainage Analysis

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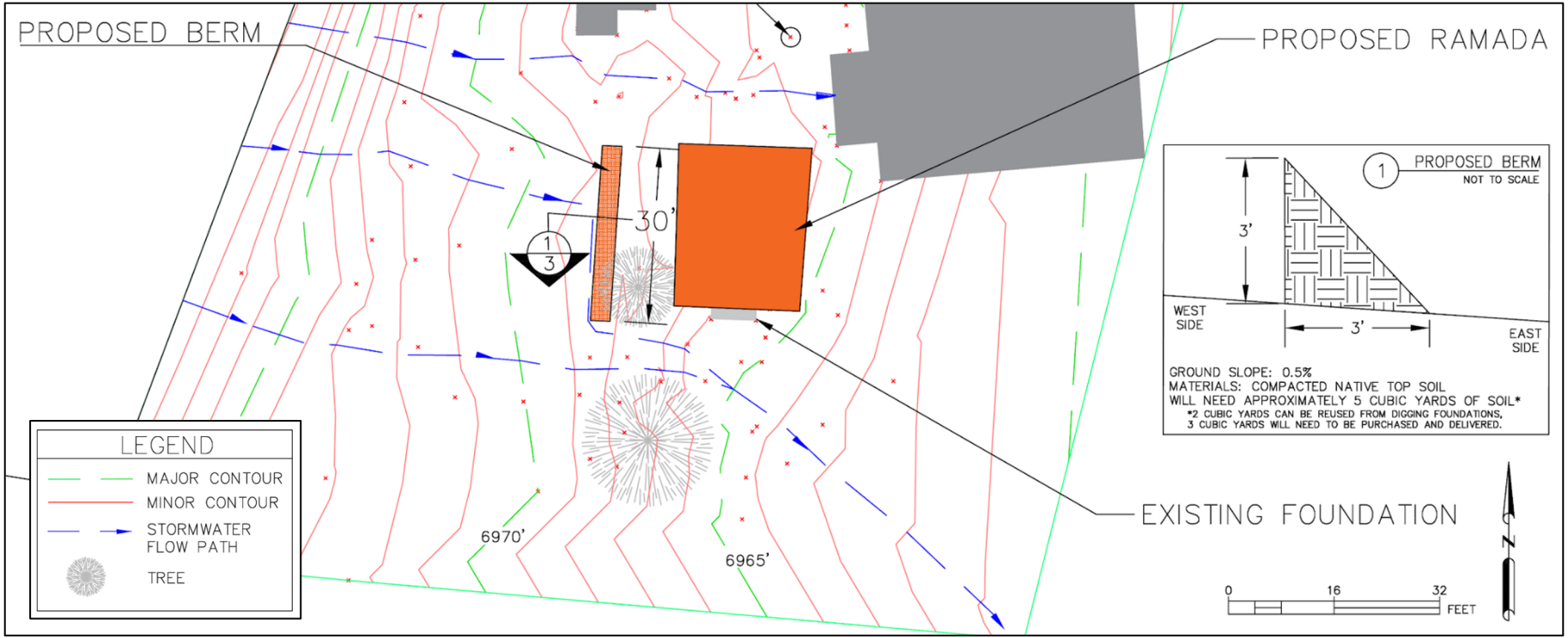
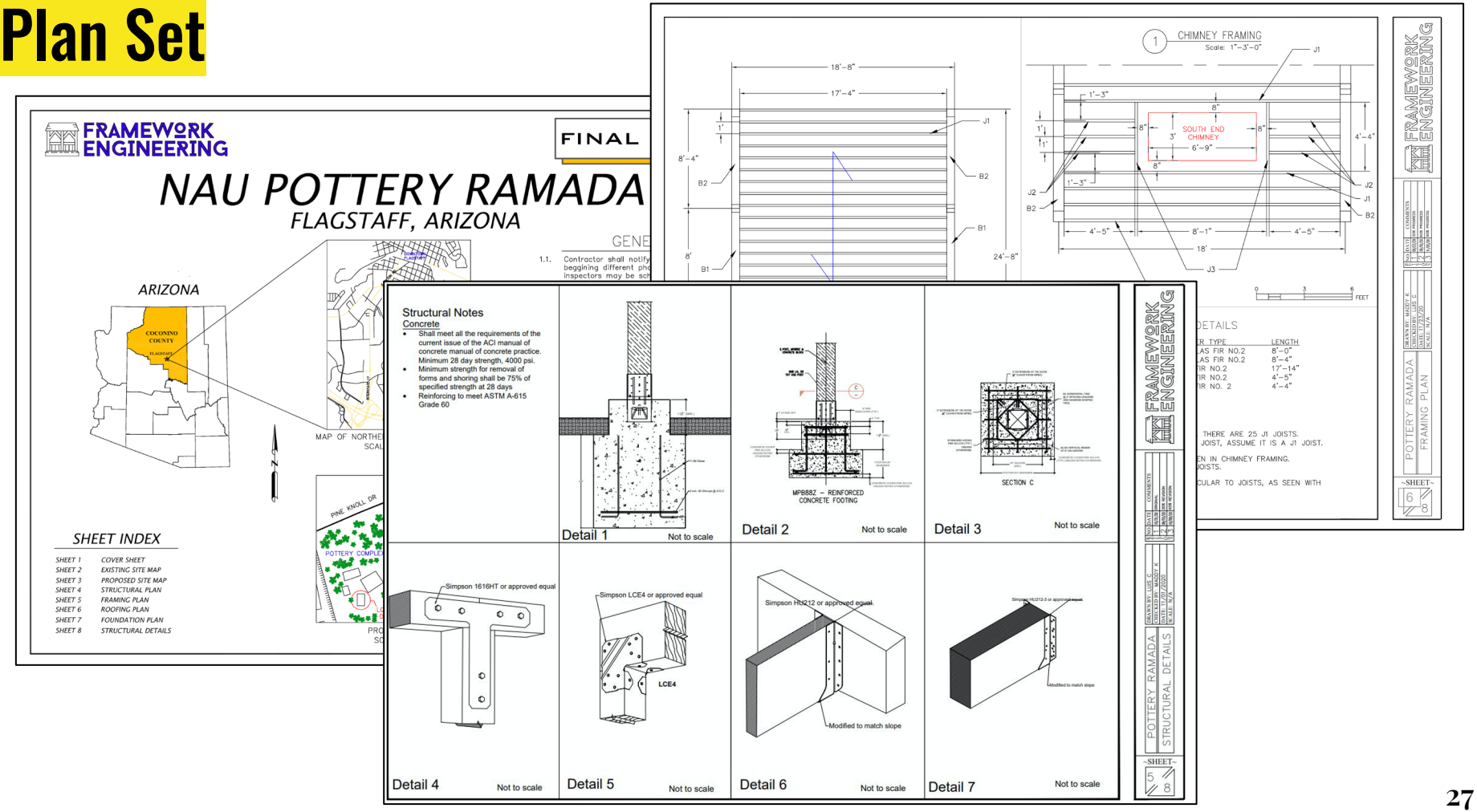


Plan Set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FINAL
NAU POTTERY RAMADA
FLAGSTAFF, ARIZONA
ARIZONA
COCONINO COUNTY
FLAGSTAFF
SHEET INDEX
SHEET 1 COVER SHEET
SHEET 2 EXISTING SITE MAP
SHEET 3 PROPOSED SITE MAP
SHEET 4 STRUCTURAL PLAN
SHEET 5 FRAMING PLAN
SHEET 6 ROOFING PLAN
SHEET 7 FOUNDATION PLAN
SHEET 8 STRUCTURAL DETAILS
1 CHIMNEY FRAMING
Scale: 1"–3"–0"
SOUTH END CHIMNEY
18'–8"
17'–4"
24'–8"
Structural Notes
Concrete
Shall meet all the requirements of the current issue of the ACI manual of concrete practice.
Minimum 28 day strength, 4000 psi.
Minimum strength for removal of forms and shoring shall be 75% of specified strength at 28 days
Reinforcing to meet ASTM A-615 Grade 60
Detail 1 Not to scale
Detail 2 Not to scale
MPB88Z – REINFORCED CONCRETE FOOTING
Detail 3 Not to scale
SECTION C
Simpson 1616HT or approved equal
Detail 4 Not to scale
Simpson LCE4 or approved equal
LCE4
Detail 5 Not to scale
Simpson HU212 or approved equal
Modified to match slope
Detail 6 Not to scale
Detail 7 Not to scale
POTTERY RAMADA
STRUCTURAL DETAILS
FRAMING PLAN

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Photo provided by Kayla Cross

Project Management

Cost Estimate of Materials

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Original Budget: ~$10,000

Over budget by: $4,795

Possible Reasons:

- Retail pricing
  - Construction company may be able to obtain contractor discounts
- Availability
  - Some materials are easier to obtain than others
- Delivery Fees

Section	Material	Quantity	Cost
Framing	2x12 Joists	26	$489.00
	8x12 Beams	6	$4,684.00
	8x8 Columns	8	$3,803.00
Roofing	Plywood	456 square feet	$450.00
	Metal Roofing	456 square feet	$1,350.00
	Philip Flat Head Sheet Metal Stainless Steel Screws	300 screws	$30.00
Pier Foundations	Concrete	10 cubic feet per pier	$520.00
	Rebar	52 feet per pier	$420.00
Connections	HU212	52	$468.00
	HU212-3	4	$188.00
	1616HT	8	$320.00
	LCE4	8	$64.00
	MBP88Z	8	$1,760.00
Berm	Native Top Soil	3 cubic yards	$249.00
		Total cost	**$14,795.00**

Hours Log

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Original Estimate: ~20 weeks

Actual: ~16 weeks

Proposed Hours		
Role	**Hours**	**Days**
Senior Engineer	72	9
Engineer	183.5	22
Engineer in Training	321.5	40
Lab Technician	10	1
Engineering Intern	129	16
Administrative Assistant	70	8
Total	**786**	98

Actual Hours		
Role	**Hours**	**Days**
Senior Engineer	65.75	8
Engineer	200	25
Engineer in Training	175.5	21
Lab Technician	20	2
Engineering Intern	115	14
Administrative Assistant	45	5
Total	**621.25**	77

Reasons behind shortened project length:

- COVID-19 pandemic - affected ability to reserve survey equipment and lab time in the summer months
- Planset - allocated more time than needed
- Geotechnical analysis testing - not able to perform direct shear testing
- Drainage analysis - scope of analysis was decreased from original plan

Project Impacts

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Economic

- Less maintenance, repairs, or replacements
- Extended lifetime
- Increase student enrollment in ceramic classes
- Increase in property value

Social

- Better aesthetics within pottery complex
- Increased campus pride
- Happier students and faculty

Environmental

- Improved stormwater drainage control
- Less flooding near Kilns
- Increased CO_2 levels due to more use

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Thank you for listening.
Any questions?

For more information about our project, please visit our website at:

https://www.ceias.nau.edu/capstone/projects/CENE/2020/NAUPotteryRamada/

Recorded Presentation Zoom Link

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- https://nau.zoom.us/rec/play/ZqhBPbV2WoFYOpyn95PwSfHyzk_tHo-rHho4-BToQ8_M99IKPpT9dnic9-CdkkTW_LRImZKltRZoPkqP.fs8KRTbqlN5xBYWg?continueMode=true&_x_zm_rtaid=jllRtQtnQyy24MwFmZLMlg.1605725666342.3ea70ba62a8999cd3c27edaa02cc6b5e&_x_zm_rhtaid=687

- Ramada Presentation: 50:00:00 – 1:14:35