SLO Botanical Garden Deck

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May 18th, 2023

Architectural Engineering

California Polytechnic State University
San Luis Obispo, CA

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Project Scope and Status

The scope of this project consisted of the design and construction of an outdoor-use deck. This deck is to be located in the NE corner of the Sage Meadow at the San Luis Obispo Botanical Garden at 3450 Dairy Creek Rd, San Luis Obispo, CA 93405. Per the facilities manager at the Botanical Garden, Chenda, this deck's intended use is as a gathering area for people to congregate. Originally, the ideal deck area was proposed as 700+ square feet, but with further site and project limitations the final design was ~480 square feet. This deck has not been constructed.

Initial Project Information

- 720 square foot deck for assembly of people
- Preference for composite decking material and low maintenance materials
- Weather and insect resistant
- Potential use of stairs, railing, ADA compliant ramp

The Site

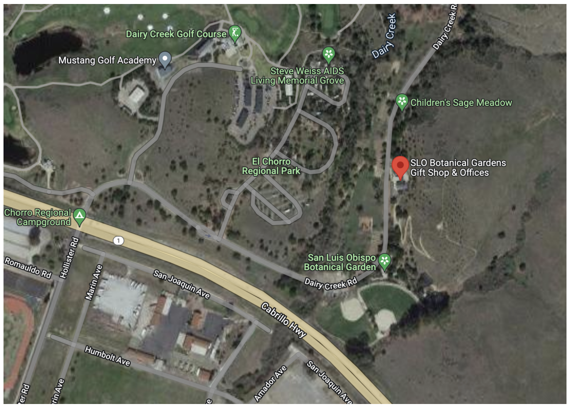


Figure 1: Map Location of Site

Figure 2: Proposed Deck Area

The site for the deck is in close proximity to various other projects in the Sage Meadow area. Most projects are directly off of the gravel foot path through the meadow. For ease of accessibility to the deck, the entrance location of the deck in respect to the foot path was considered.

The Team

The group focusing on this project consisted of four students. Three students, Troy Kauffman, Dakota Reynolds, and Jonah Kirmse from the Construction Management program at Cal Poly, SLO, and one student, Noah Demer (myself) from the Architectural Engineering department at Cal Poly, SLO.

The responsibilities of each team member varied. For simplicity, the responsibilities are divided into two sections: Construction Management and Architectural Engineering. See *Table 1: Team Member Responsibilities.*

Team Member Responsibilities	
Construction Management	**Architectural Engineering**
Cost Analysis	Structural Design
Fundraising	Permitting Process
Construction	Construction
	Architect

Table 1: Team Member Responsibilities

The Budget

Funding for this project stemmed from a couple sponsors. The scope of this report does not focus on the funding aspects of the project, but a brief summary of the basic funding information will be provided since it is a vital component for any project. CMAC, the Construction Management Advisory Council, granted $3,000 for this project. CMAC is an important body within the Construction Management department that connects students with alumni professionals. SLO Botanical Garden,whish is a non-profit organization, granted $2,000 towards the project. The Alliance, an upcoming council within Cal Poly that aims to support interdisciplinary student projects (ARCE + CM in this case), donated an additional $3,000 towards this project. Finally, and very important, was the Azek Company, which provided support for decking and railing supplies. This would cover the most expensive thing: Decking.

Weather resistant low maintenance decking would cost over $8/SF, which amounts to $4,000 across a deck of 500 SF. The next most expensive category was the lumber required for the deck structure. Because the deck would be outside, preservative treated, water resistant lumber was required, which came with additional cost compared to indoor lumber. The structural framing amounted to $2,500 just in lumber and not including fasteners or hardware. In total, the budget came out to $8,000, which was feasible depending on the deck size.

The Design

The design process for this deck, like many construciton projects, had many changes throughout the process. Most of these changes stemmed from limitations with the project budget, or limitations of the site land, and common sense. The initial plan-design of the deck was non-orthogonal and would require more lumber and labor to construct compared to a rectangular design. See *Figure 3: Initial Deck Design.*

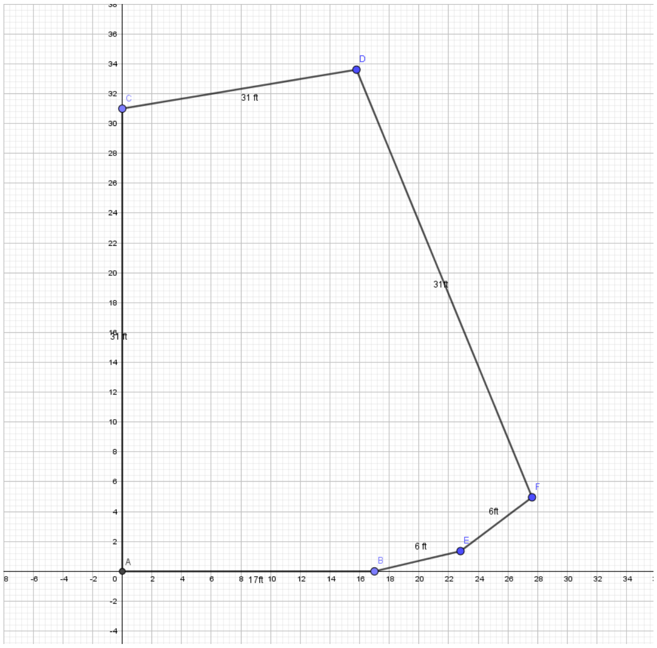


Figure 3: Initial Deck Design.

Very early in the design process it was realized that maximizing square feet with the budget was an effective objective. As a result, the team came up with a more cost-effective design that still wasn't as boring as a simple rectangle. See *Figure 4: Revised Initial Deck Design.*

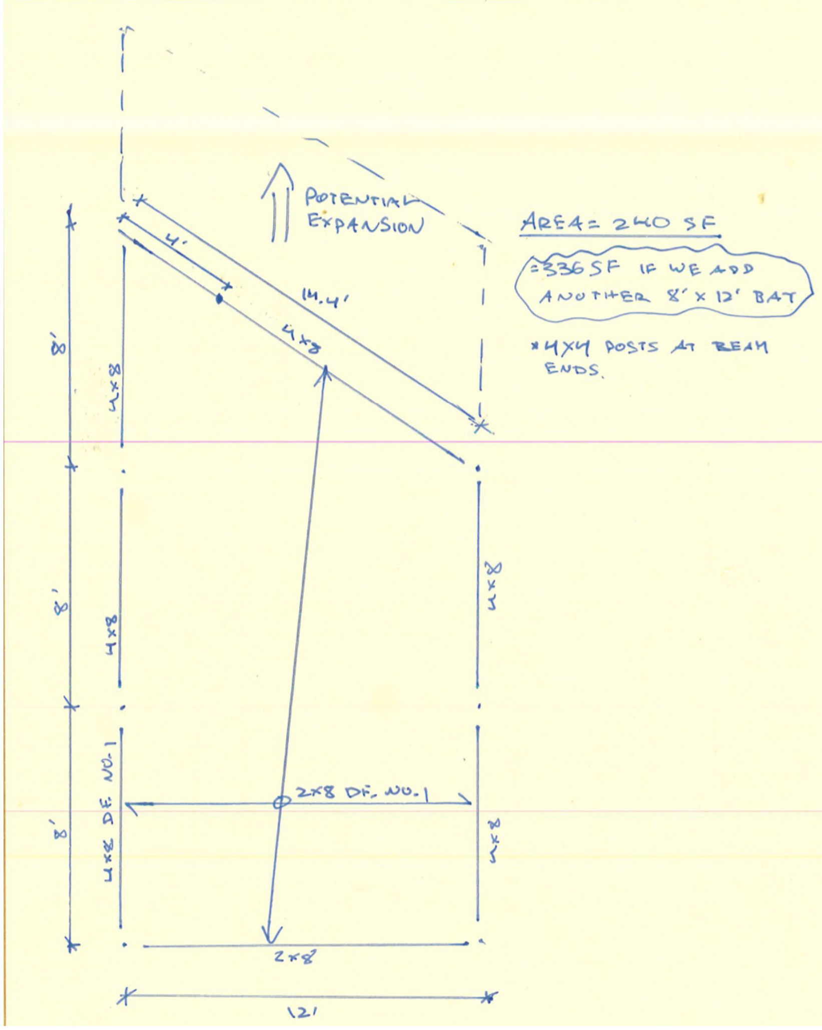


Figure 4: Revised Initial Deck Design

This revised design was a strong design that could be adjusted depending on the budget use and if costs were determined accurately. This can be seen in *Figure 4* with the “potential expansion” designation towards the top of the figure. Structurally, this expansion requires no extra design work, since it just replicates and copies the existing bays of framing. As a group, it was decided that this was a great design to push forward since it was easy to adjust and wasn’t too expensive on the project budget. To get a good understanding of how this design stacks up in reality with the site, the deck plan was staked exactly where the deck would reside. See *Figure 5: Staked Deck Layout.*

Figure 5: Staked Deck Layout

Figure 6: Architectural Site Plan

Troy and Noah were the ones who staked this deck plan. This process opened the team's eyes to some new ideas that could be implemented to the project, as well as some issues.

One of the issues was the tree adjacent to the deck seen on the right side of *Figure 5.* If one were to stand on that edge of the deck, they would likely hit their head on leaves and branches unless they were less than 4' tall, so maybe not a problem for children but absolutely a hazard. This tree can be seen on the initial site plan drawing seen in *Figure 6: Architectural Site Plan.* It wasn't until staking the deck layout that the team understood how the low hanging branches affect the deck use.

Another concern with the tree was the roots, and if they would impede on the foundation system. Since it was planned to have pad footings with posts, this wasn't a huge issue, but a root could still impede on the locations of the small footings, but this was unlikely. If the project consisted of pouring strip footings it could be a different story and the issue would need more consideration.

From this staking process, Noah (engineer) immediately saw the potential for something many engineers and architects fancy: a cantilever beam. At the acute corner of the deck seen as the far left stake in *Figure 5*, the height of the deck above earth is at its greatest. Noah saw this as the perfect opportunity for a beam to cantilever, giving the aesthetic of a floating beam/deck over earth unsupported, all while where the deck seems to be its highest. This location was also ideal for visual pizazz since the longest side of the deck is somewhat parallel to the adjacent foot path, meaning that this "floating" feature would be viewable to anyone walking the footpath and not go underappreciated.

This cantilever would eliminate the need for a post at the acute corner. In most senses, the post with the most axial load is the worst case. However, a post at the acute corner, while not taking much load compared to other posts, is indeed a "worst case". This is because a post at this location must be taller than the other posts due to the top of the deck to earth distance is greatest at this location. Typically, when posts for decks span more than three or four feet from earth to structure the post requires lateral bracing. This cantilever beam would eliminate the nead for an ugly braced post at the acute corner. See *Figure 7: Typical Post Bracing* for an example of the bracing required for posts more than 36".

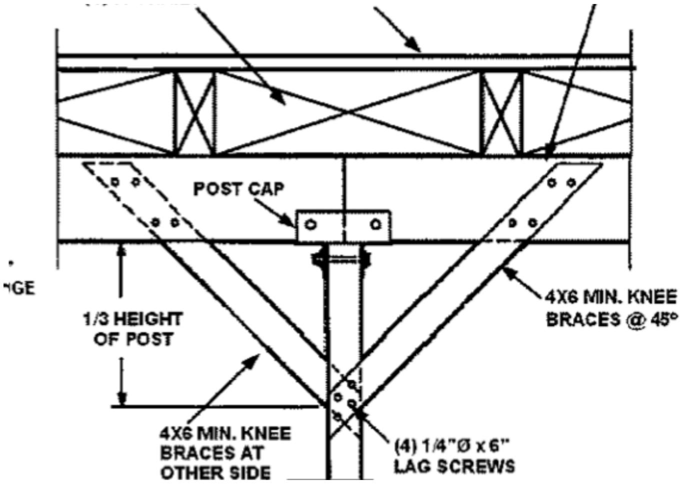


Figure 7: Typical Post Bracing

Unfortunately, the final design of this deck did not include a cantilever. The main reason being that more usable surface area on the deck was needed to meet the needs of SLO Botanical Garden. After a review meeting with Chenda it was requested that the deck be at least 16’ wide. This posed some new issues.

Firstly, the tree, already impeding on the deck, meant that the deck would need to widen only on the other side to achieve 16’ total deck width, further increasing the earth elevation differential from one side of the deck to the other, which could possibly lead to additional post bracing being required in numerous post locations.

Secondly, the design up until this point consisted of joists spanning just 12’, and 2x8 joists sufficed for this span. Widening the deck meant that a deeper joist, or more closely spaced joists to fulfil the structural requirements of the jois were neededt. Tightening the joist spacing did not seem feasible since 12” spacing was already used due to span requirements of composite decking. Composite decking is more flexible than traditional decking, which can span 16” or 24” between joists, but composite is very weather resistant which was important for the longevity and maintenance of the project. Tightening to 8” or 9” spacing did not seam feasible because it increases the lumber and hardware costs and labor necessary to construct the deck. Deepening the joist to a 2x10 or 2x12 was an option, but the prices of these joists was much more than a 2x8, again leading to a budget issue.

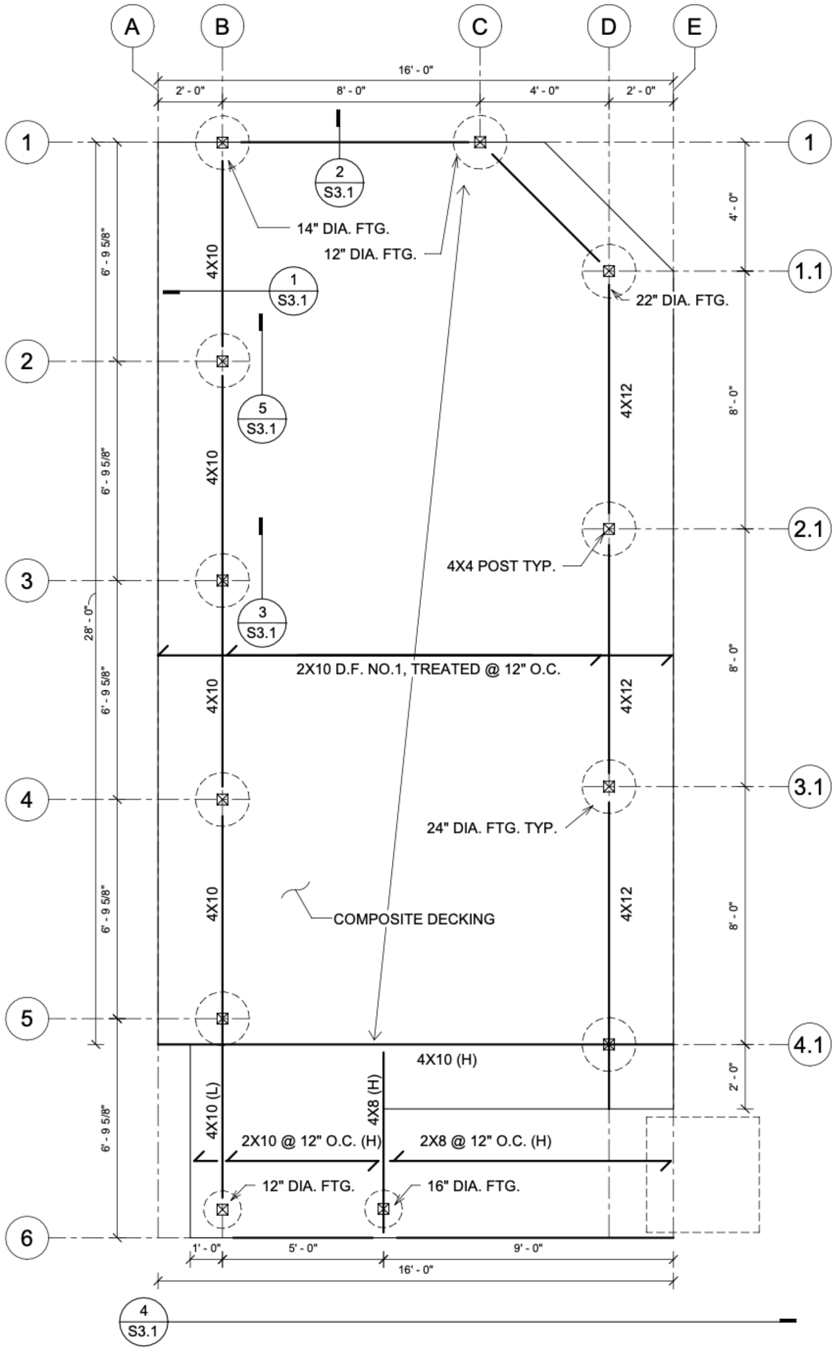
Thus, it was decided that in order to maximize the usable area of the deck with the budget, utilizing a stack-framed system (joist bearing on beam) instead of a flush-framed system (joist hang from beam) made logical sense. Stacking the joists posed many benefits.

One being that the joists could overhang 2’ on each side, achieving 16’ total joist/deck length with a 12’ main span. Framing the joists this way actually benefited the performance of the joists, since the main span bending moment and deflection demands are decreased as a result of the overhangs on each side. See the max moment with and without overhangs in calcs 1 and 2 in the appendix.

Stacking the joists also meant that the team would not need to install metal hanger hardware, reducing the overall hardware costs of the project

Another benefit was that the posts did not need to be pushed out further, which would have increased the earth elevation differential and the potential need for post bracing. The posts simply would stay in their original locations but the deck would extend 2’ past the posts rather than the posts aligning with the boundary of the deck surface as with a flush-framed system.

These benefits were clear and it was obviously the right decision for the project goals. This stack framed decision did pose some other issues. The tree wasn’t moving, so the 2’ overhang actually exacerbated the unavoidable tree issue. Another downside was if a railing were to be installed, a post could no longer extend a upwards through the decking to simultaneously act as vertical railing support and a beam support. A railing 2’ into the deck would defeat the purpose of the 16’ wide usable deck space objective. Lastly, and most unfortunate, the stack-framed system defeated the use of a cantilever. This is because while a 2’ overhang might suffice for a 12’ mainspan, it would not for smaller mainspans. Where the joists narrow to the acute corner, the joists gradually decrease in mainspan from 12’ to 2’. A 2’ cantilever on each side of a 2’ mainspan is not structurally adequate. Utilizing a stack frame system, the the framing plan was revised. See *Figure 8: Revised Framing Plan.* Note that there is no acute corner, and that the smallest joist main span is 8’.



① Framing Plan
3/8" = 1'-0"

Figure 8: Revised Framing Plan

Loading Changes

One of the biggest challenges that came later in this project was the loading. Initially, the team decided that 40 PSF of live load, and 10 PSF of dead load was adequate for this free-standing deck design. These numbers determined the 2x8 joists at 12” spacing was safe. Unfortunately, due to deck collapses in recent history, the design live load for decks has been increased from 40 PSF to 60 PSF, or 1.5*40. Even worse, since the use for this free standing platform was for “assembly”, it could be argued that the design live load could be greater than 60 PSF, and actually require 100 PSF design live loading. See *Figure 9: Prescribed Design Loads.* 60 PSF deck loading is derived from the 1.5*Load recommended, with 40 PSF as the the load.

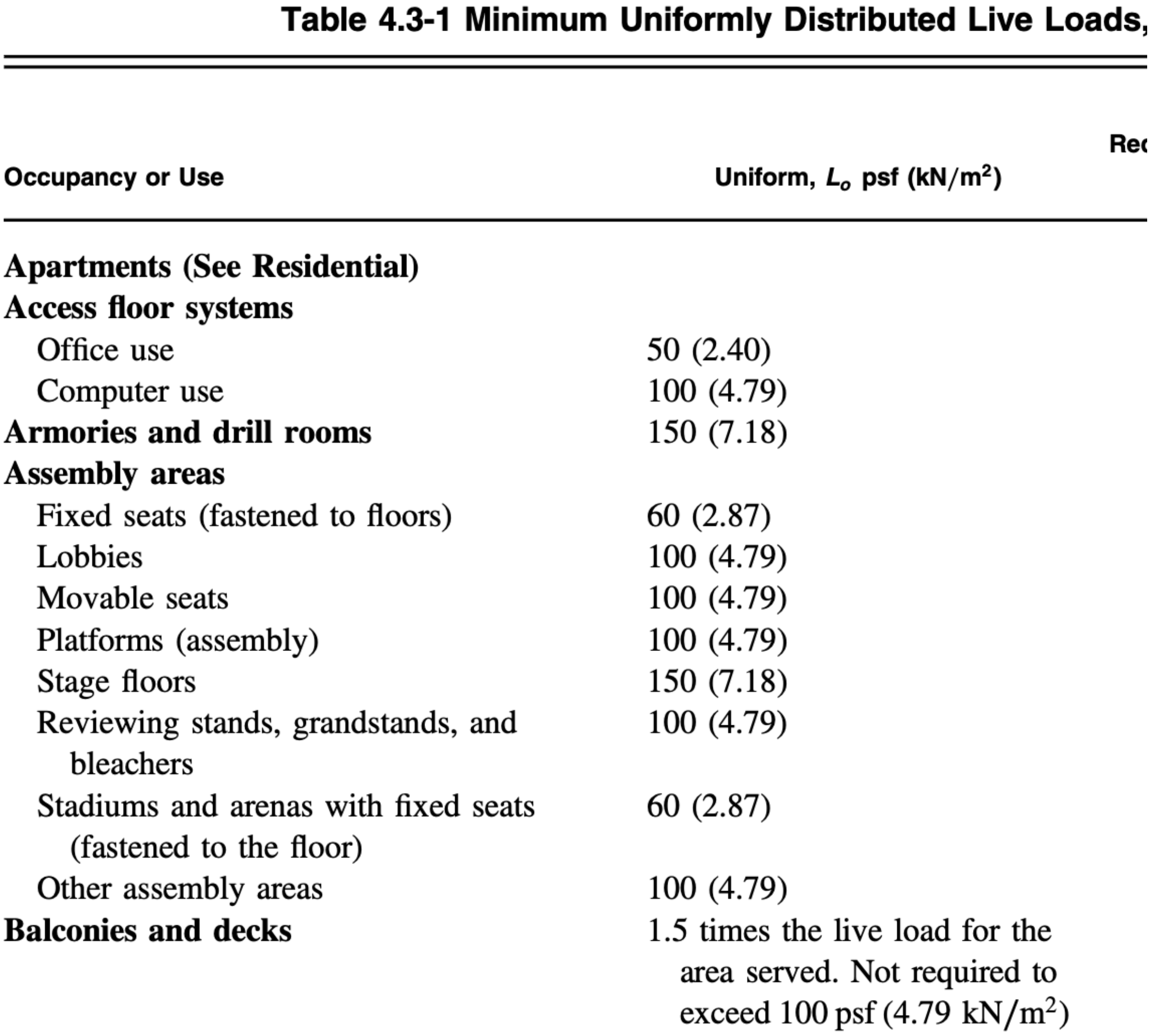


Table 4.3-1 Minimum Uniformly Distributed Live Loads,

Occupancy or Use	Uniform, L_o psf (kN/m^2)	Re
Apartments (See Residential)		
Access floor systems		
Office use	50 (2.40)	
Computer use	100 (4.79)	
Armories and drill rooms	150 (7.18)	
Assembly areas		
Fixed seats (fastened to floors)	60 (2.87)	
Lobbies	100 (4.79)	
Movable seats	100 (4.79)	
Platforms (assembly)	100 (4.79)	
Stage floors	150 (7.18)	
Reviewing stands, grandstands, and bleachers	100 (4.79)	
Stadiums and arenas with fixed seats (fastened to the floor)	60 (2.87)	
Other assembly areas	100 (4.79)	
Balconies and decks	1.5 times the live load for the area served. Not required to exceed 100 psf (4.79 kN/m^2)	

Figure 9: Prescribed Design Loads

This increased loading of 60 PSF minimum, and maybe 100 PSF, required the joists and beams to increase in size from the 2x8 and 4x8 showin in the initial designs. The member sizes shown in *Figure 8* are for 60 PSF live load.

ADA Access

This increased loading put a big dent in the budget, but there was another consideration required that would also add stress to the project budget. This consideration was ADA compliance. The deck would need an access ramp, and access to the ramp from the ADA parking spot. The team would need to ensure that an ADA compliant path exists for the entire route to the deck. This path can be seen in *Figure 9: ADA Access Path.*

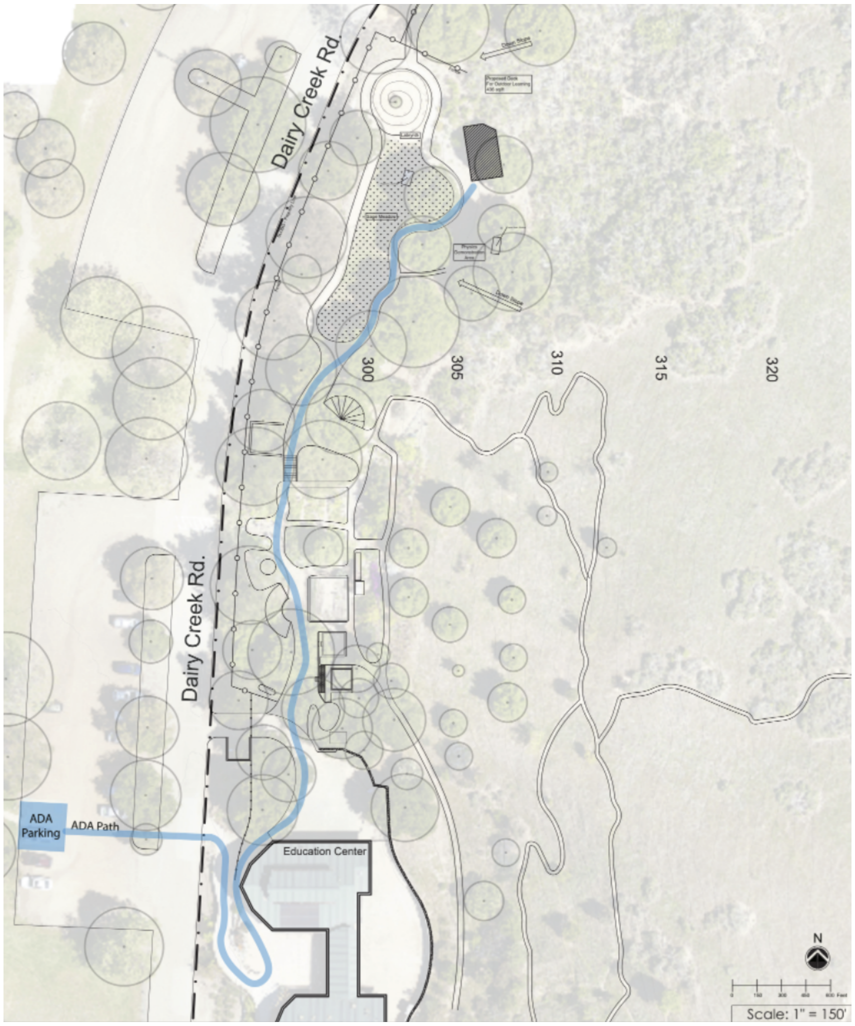


Figure 9: ADA Access Path.

Structural Details

Noah created structural details to assist with constructability and fastener specifications. These details can be seen in the drawings appendix, Appendix A.

Structural Calculations

Numerous calculations were performed by Noah throughout the design process. While not all of the calculations specifically refer to the final design, each one played a role in the design and revise process. These can be seen in Appendix B.

Conclusions

This project was this team's largest to date. The team and I learned lots about the process for constructing a structure. The main outcomes for me was consistent and efficient communication. For example, I spent a great amount of time designing a 12' wide deck in its entirety. It wasn't until later in the project that I learned about 16' being the minimum width the garden required. Another learning outcome was was the budget. More funding would have decreased the pressure to dial in a perfectly-efficient design, and perhaps the design process could have gone quicker, and the live loading increase would have had less of an effect on the timeline. Overal, I had a lot of fun working on this project and seeing what its like to manage a project start to finish.

Factors of Engineering Involvement

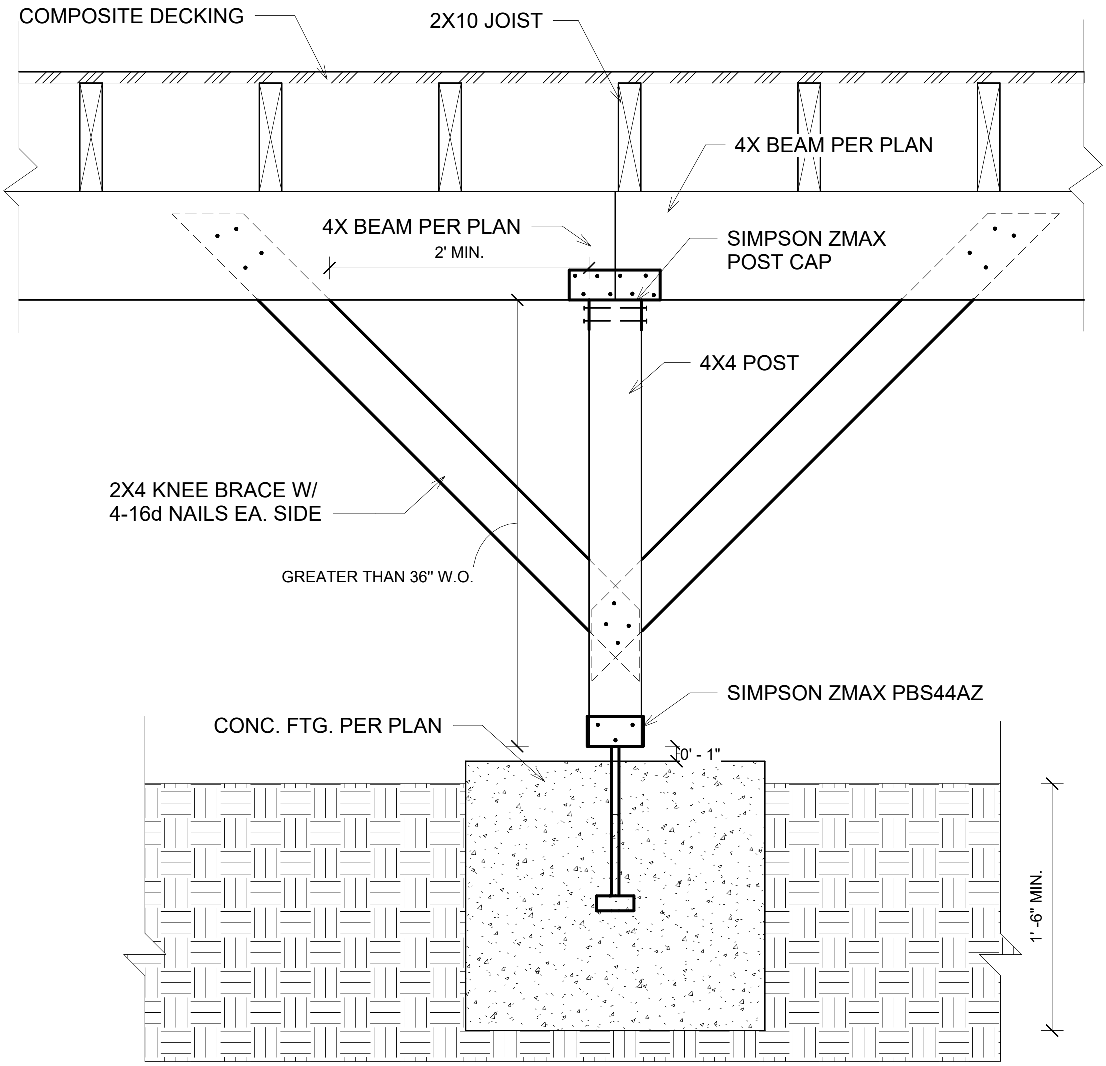
This project inspired ways of thinking that normally would not be a piece of the puzzle for say, engineering homework problems. The SLO Botanical Garden Deck project challenged all team members to think outside the box.

The design required more than beams that are sufficiently sized. It required the team to consider how the deck would be used, serviced, and appreciated, and how the design could meet the expectations of SLO Botanical Garden’s intentions. For example, a railing, if designed and installed correctly, would increase the safety of the project. Since the deck resides in the “Childrens Meadow” it is likely that children would use the deck. Due to the varying elevation, a child might jump off the deck one time successfully, but the next time they jump could be dangerous without them realizing. A railing would mitigate this safety risk, and it was considered.

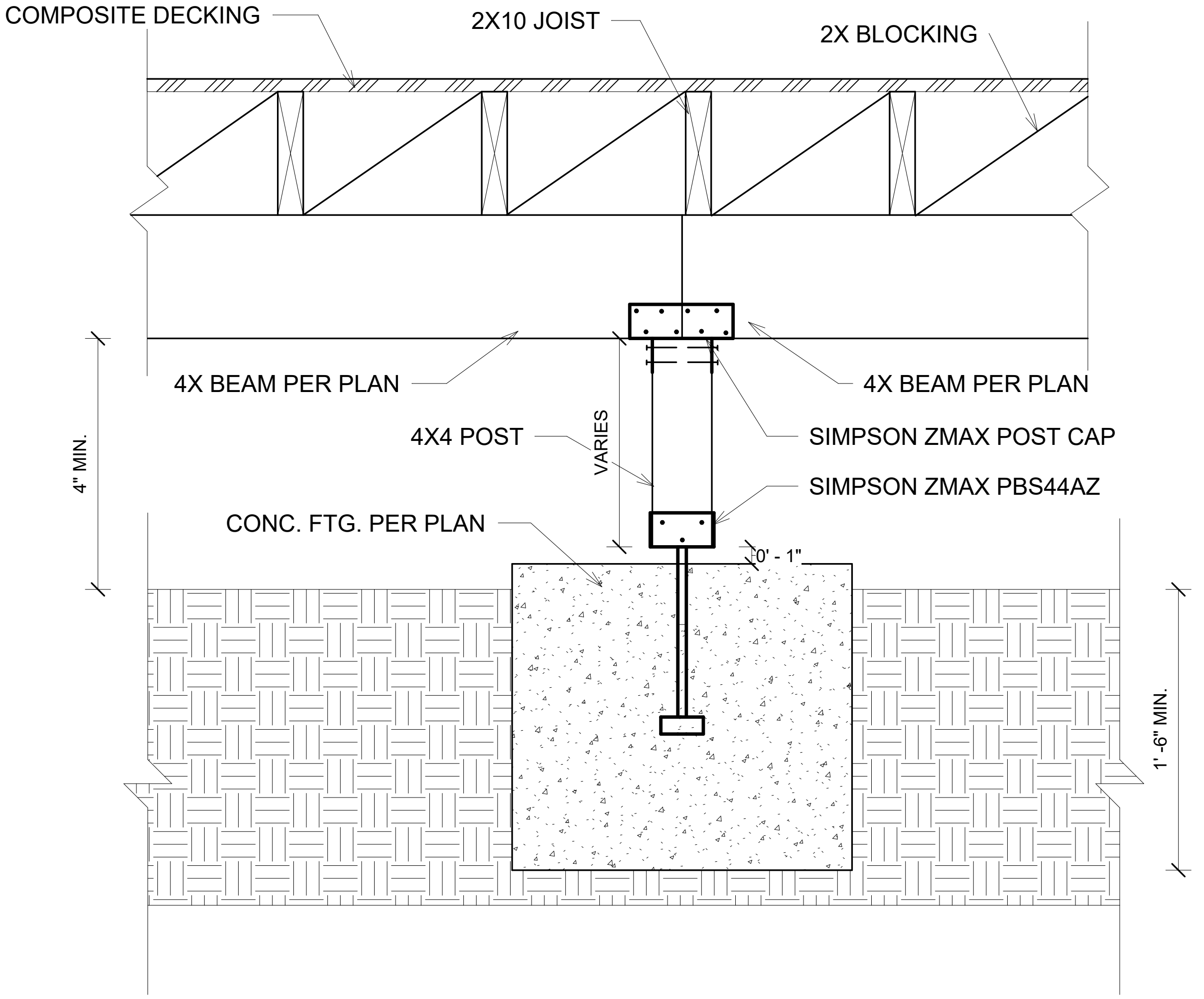
For the usage of the deck to be appreciated the greatest, it was requested that the deck become wider than 12’. Considering a wider deck could make a more welcoming gathering place, since that is one of the uses of the deck. The social impact of the deck was optimized via decisions like widening the deck, and creating an ADA compliant pathway to the deck. Furthermore, the exact width of the deck of 16’ meant that lumber waste could be reduced, since 16’ length is a commonly stocked item. This decision reduced the cost and material waste - a win for the environment. Similarly, the aethetics of the deck were considered carefully to match the goals of the project. There are various projects within the Childrens Meadow with no apparent theme or consistent colorways, so exposed pressure treated lumber beams were not frowned on. Combining this idea with the importance of a sustainable and easily maintained design, composite decking and weather-treated lumber was specified, mitigating the future time, attention, and money required by the garden staff and volunteers. Along the same lines, pressure treated posts on an elevated base would protect the wood from ground moisture, thus increase the lifespan of the significantly important structural elements.

Appendix A: Drawings

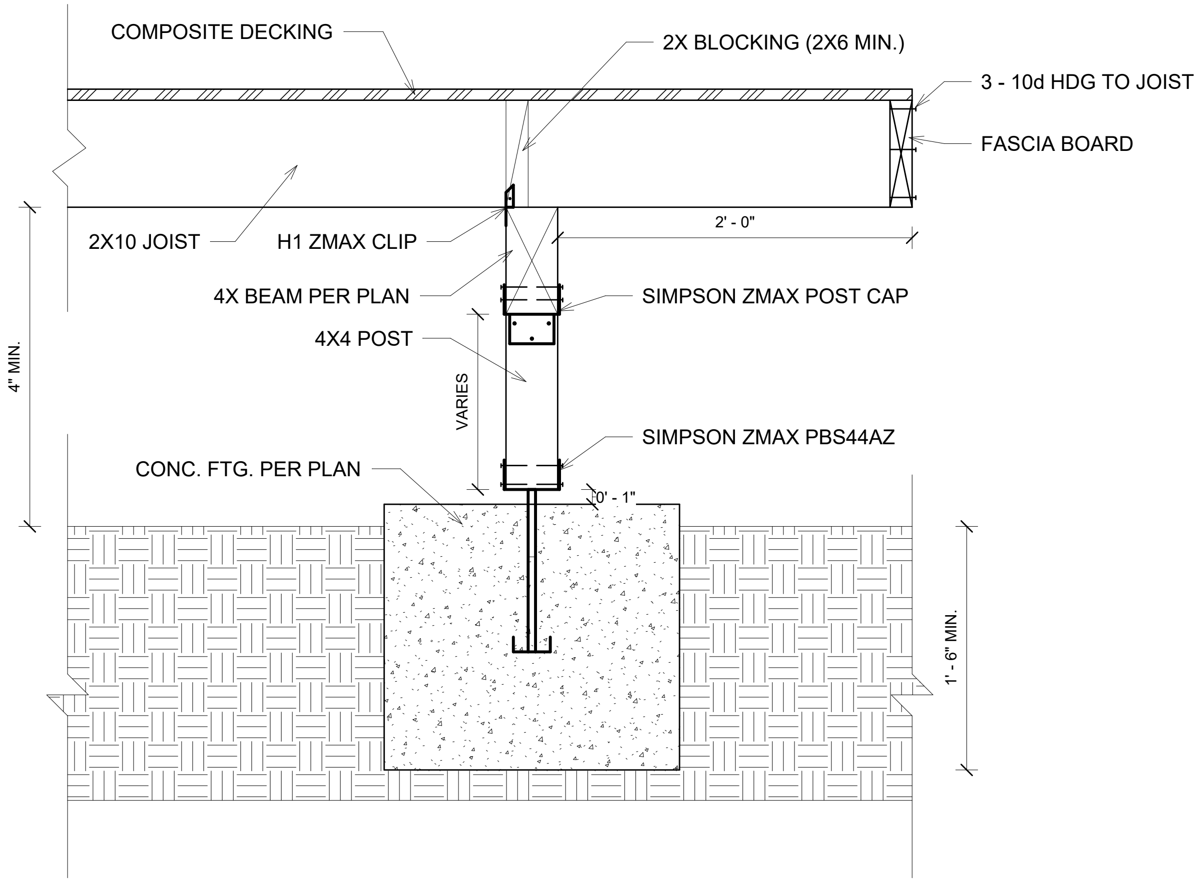
Details



5 ⑤ Post Bracing
1 1/2" = 1'-0"

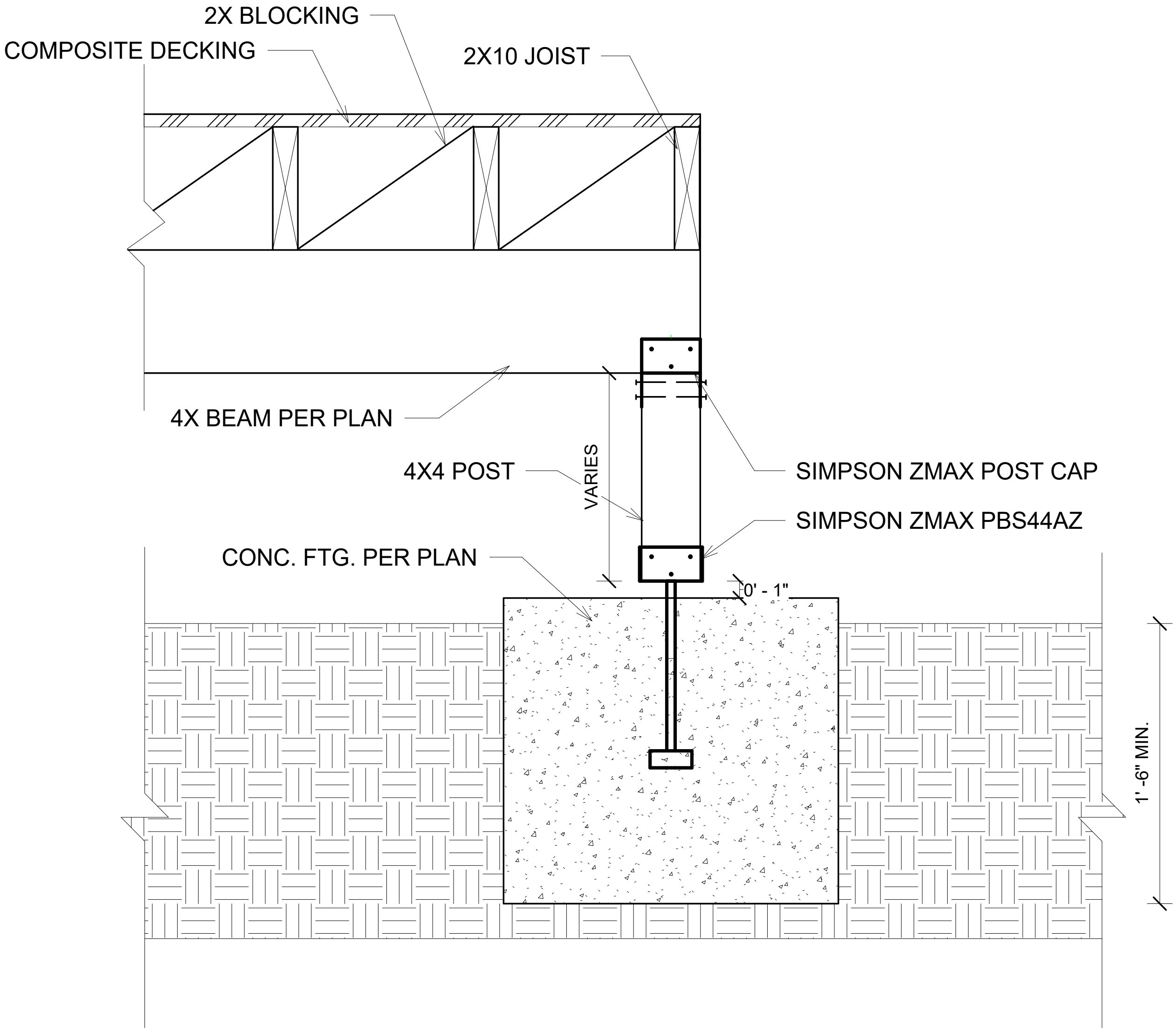


3 ③ Gravity Detail 3
1 1/2" = 1'-0"



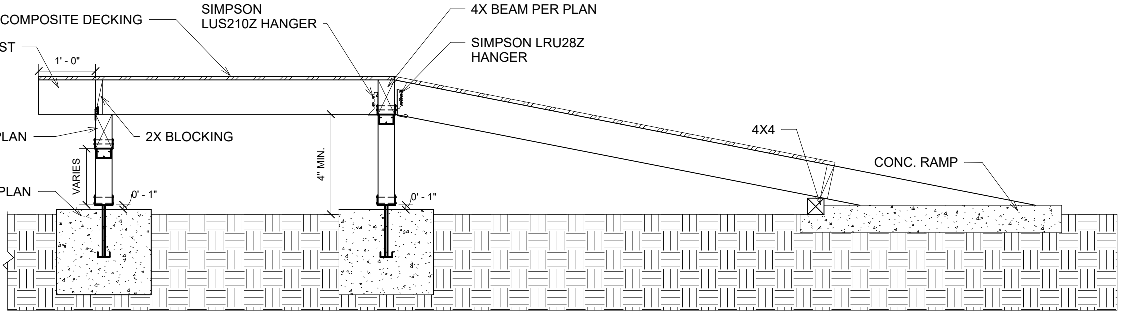
1

① Gravity Detail 1
1 1/2" = 1'-0"



② Gravity Detail 2
1 1/2" = 1'-0"

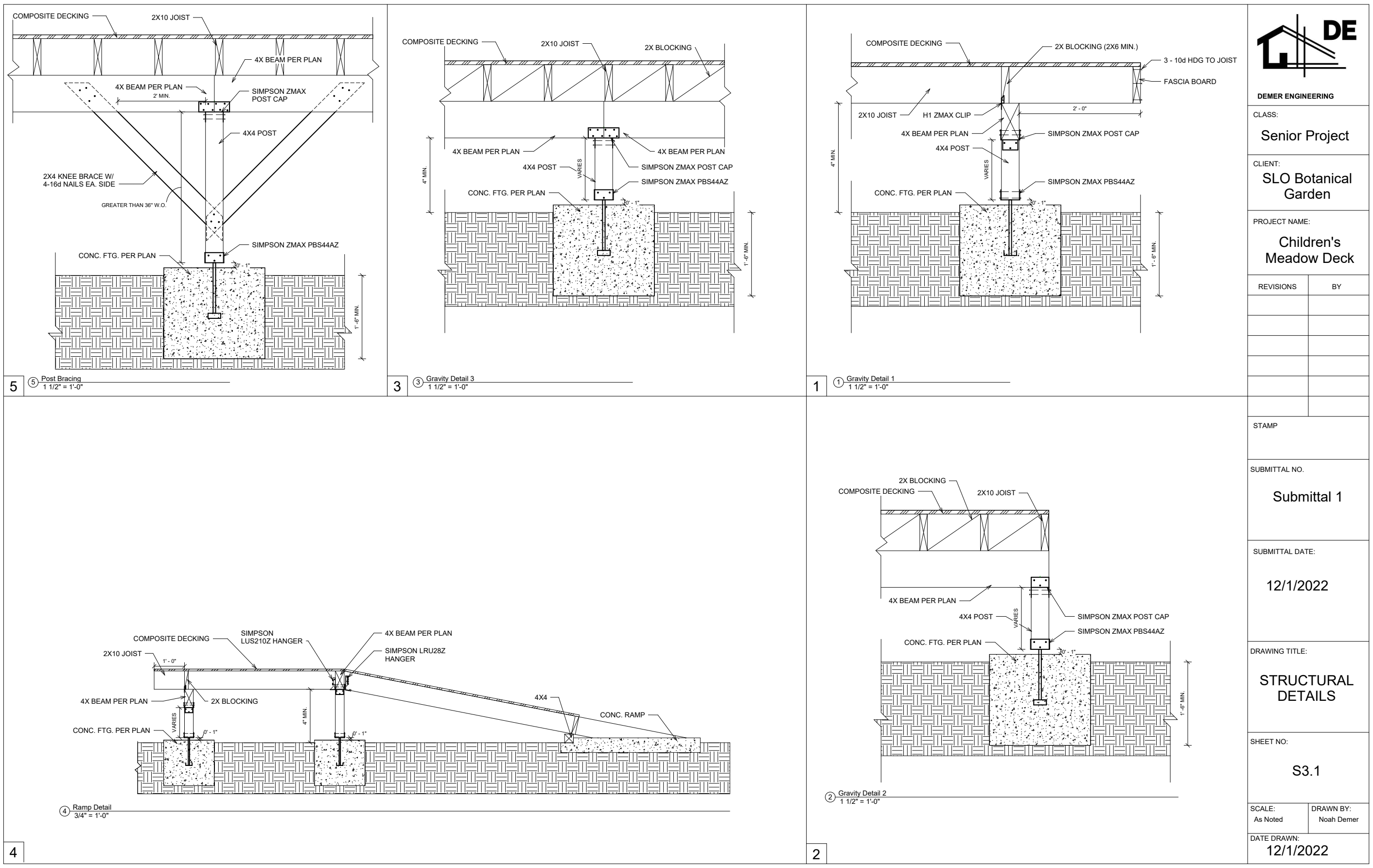
2



④ Ramp Detail
3/4" = 1'-0"

4

Detail Sheet

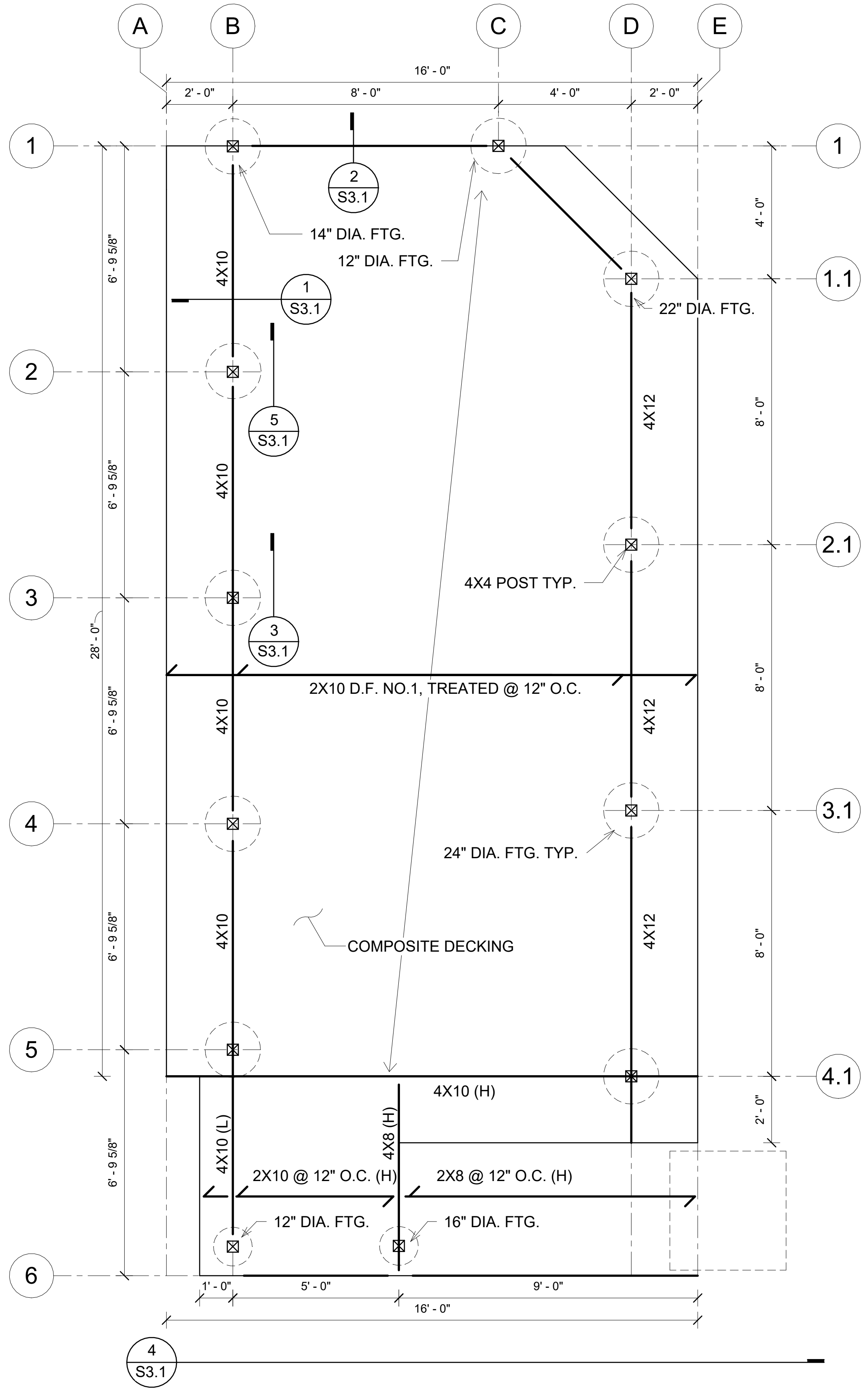


CLASS: Senior Project
CLIENT: SLO Botanical Garden
PROJECT NAME: Children's Meadow Deck

REVISIONS	BY

STAMP
SUBMITTAL NO. Submittal 1
SUBMITTAL DATE: 12/1/2022
DRAWING TITLE: STRUCTURAL DETAILS
SHEET NO: S3.1
SCALE: As Noted
DRAWN BY: Noah Demer
DATE DRAWN: 12/1/2022

Structural Plan



1 Framing Plan
3/8" = 1'-0"

NOTES:

Composite decking shall be manufactured by TimberTech

Site shall be graded such that the elevation of the deck surface will not exceed 30"

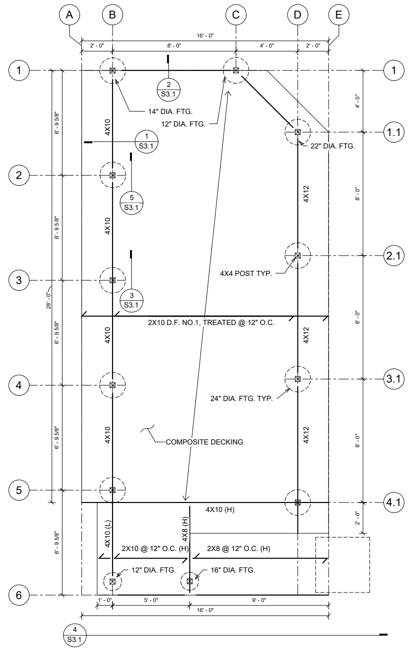
All lumber shall be preservative-treated

All beams/joists shall be Douglas Fir No. 1 Grade

Fasteners, including nuts and washers, for preservative-treated wood shall be of hot-dipped, zinc-coated galvanized steel, stainless steel, silicon bronze or copper.

(H) indicates the "high" stack-framed member
(L) indicates "low" stack-framed member

Structural Plan Sheet



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DE
DEMER ENGINEERING

CLASS:
Senior Project

CLIENT:
SLO Botanical Garden

PROJECT NAME:
Children's Meadow Deck

REVISIONS	BY

STAMP

SUBMITTAL NO.
Submittal 1

SUBMITTAL DATE:
12/1/2022

DRAWING TITLE:
STRUCURAL FRAMING PLAN

SHEET NO:
S2.1

SCALE:
As Noted

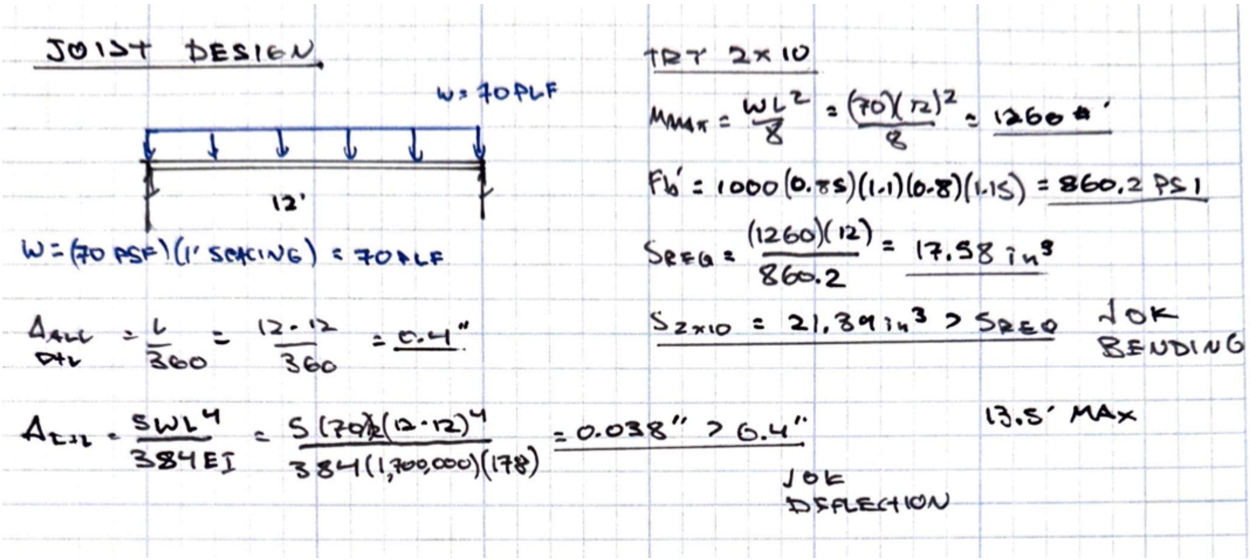
DRAWN BY:
Noah Demer

DATE DRAWN:
12/1/2022

Appendix B: Calculations

Appendix

Calc 1 - Simple Span Joist



JOIST DESIGN

$w = (70\ \text{PSF})(1'\ \text{SPACING}) = 70\ \text{PLF}$

$\Delta_{ALL\ D+L} = \frac{L}{360} = \frac{12 \cdot 12}{360} = \underline{0.4''}$

$\Delta_{D+L} = \frac{5wL^4}{384EI} = \frac{5(70/12)(12 \cdot 12)^4}{384(1{,}700{,}000)(178)} = \underline{0.038'' > 0.4''}$

✓OK DEFLECTION

TRY 2x10

$M_{MAX} = \frac{wL^2}{8} = \frac{(70)(12)^2}{8} = \underline{1260\ \#'}$

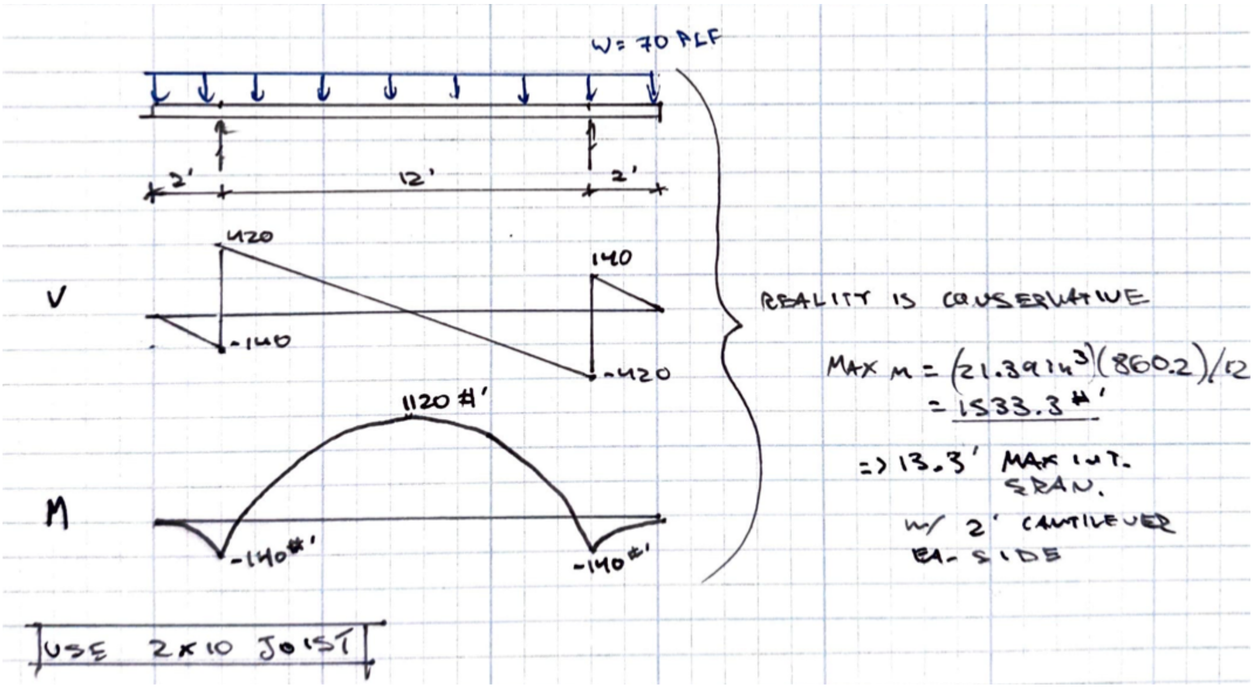
$F_b' = 1000(0.85)(1.1)(0.8)(1.15) = \underline{860.2\ \text{PSI}}$

$S_{REQ} = \frac{(1260)(12)}{860.2} = \underline{17.58\ in^3}$

$\underline{S_{2x10} = 21.39\ in^3 > S_{REQ}}$ ✓OK BENDING

13.5' MAX

Calc 2 - Simple Span Joist with Overhang Each Side



REALITY IS CONSERVATIVE

$\text{MAX } M = (21.39\ in^3)(860.2)/12$
$= \underline{1533.3\ \#'}$

=> 13.3' MAX INT. SPAN.

w/ 2' CANTILEVER EA. SIDE

USE 2x10 JOIST

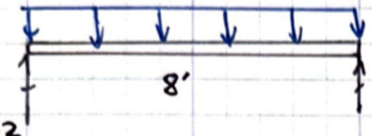
Calc 3 - Beam Long

GRID "B" TYP.

$W = (70\,PSF)(8')$
$= 560\,PLF$

$M_{MAX} = \frac{wL^2}{8}$

$= \frac{(560)(8)^2}{8} = 4{,}480\ \#'$



TRT 4X12

$F_b' = F_b C_M C_F C_i = (1000)(1.0)(1.1)(0.8)$
$= \underline{880\ PSI}$

$S_{REQ} = \frac{M}{F_b'} = \frac{(4480)(12)}{880} = \underline{61.09\ in^3\ REQ < S_{4x12} = 73.83}$ ✓ OK BENDING 4x12

$\Delta_{ALL\ D+L} = \frac{L}{360} = \frac{8 \cdot 12}{360} = \underline{0.2667''}$

$\Delta_{D+L} = \frac{5wL^4}{384EI} = \frac{5(560/12)(8 \cdot 12)^4}{384(1{,}700{,}000)(415.3)} = \underline{0.0731''}$

$0.0731 < 0.266$ ✓ OK DEFLECTION
$\Delta < \Delta_{ALL}$

$\boxed{\text{USE 4x12}}$

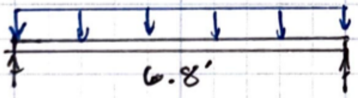
9' MAX FOR 4x12

Calc 4 - Beam Short

GRID "D" TYPE

$W = 560\,PLF$

$M_{MAX} = \frac{wL^2}{8} = \frac{(560)(6.55^2)}{8}$
$= \underline{3003.2\ \#'}$



CLEAR SPAN = $(6.8')(12) - 2(1.5'') = 6.55'$
TRT 4X10
$F_b' = (1000)(0.85)(1.2)(0.8) = \underline{816\ PSI}$

$S_{REQ} = \frac{M}{F_b'} = \frac{(3003.2)(12)}{816} = \underline{44.16\ in^3 < S_{4x10} = 49.91}$ ✓ OK BENDING

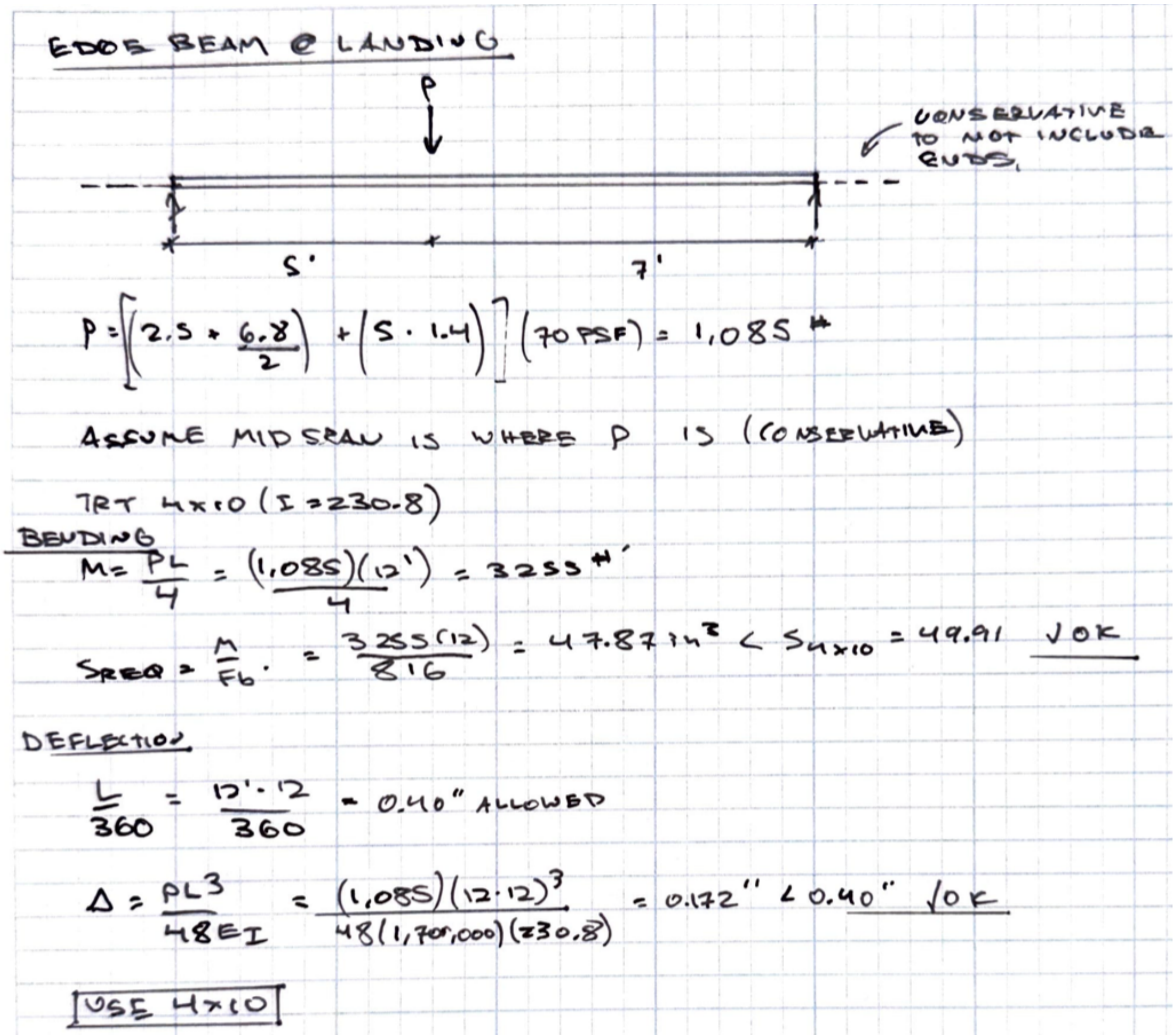
$\Delta_{ALL\ D+L} = \frac{L}{360} = \frac{6.8(12)}{360} = \underline{0.226''}$

7.2' MAX 4x10

$\Delta_{D+L} = \frac{5wL^4}{384EI} = \frac{5 \cdot (560/12)(6.8 \cdot 12)^4}{384(1{,}700{,}000)(230.8)} = \underline{0.0686'' < 0.226''}$ ✓ OK DEFLECTION

$\boxed{\text{USE 4x10}}$

Calc 5 - Beam at Landing



EDGE BEAM @ LANDING

CONSERVATIVE TO NOT INCLUDE ENDS.

$$P = \left[\left(2.5 \cdot \frac{6.8}{2}\right) + \left(5 \cdot 1.4\right)\right](70\text{ PSF}) = 1{,}085^{\#}$$

ASSUME MIDSPAN IS WHERE P IS (CONSERVATIVE)

TRY 4x10 $(I = 230.8)$

BENDING

$$M = \frac{PL}{4} = \frac{(1{,}085)(12')}{4} = 3255^{\#'}$$

$$S_{REQ} = \frac{M}{F_b} = \frac{3255(12)}{816} = 47.87\ in^3 < S_{4x10} = 49.91 \quad \checkmark OK$$

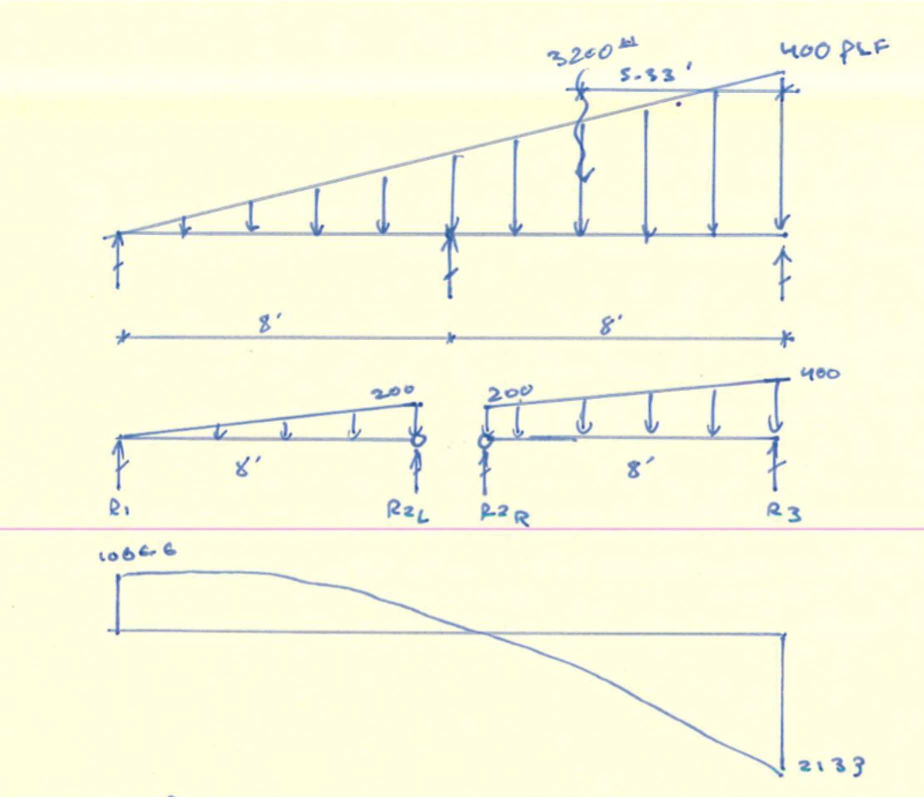
DEFLECTION

$$\frac{L}{360} = \frac{12' \cdot 12}{360} = 0.40''\ \text{ALLOWED}$$

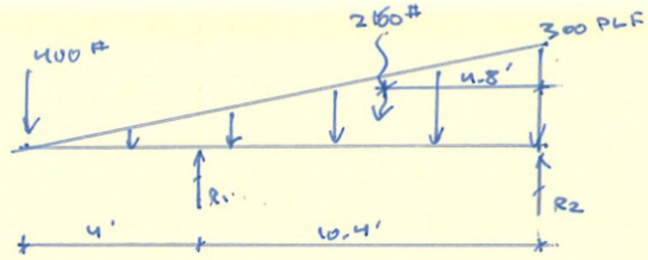
$$\Delta = \frac{PL^3}{48EI} = \frac{(1{,}085)(12 \cdot 12)^3}{48(1{,}700{,}000)(230.8)} = 0.172'' < 0.40'' \quad \checkmark OK$$

$$\boxed{\text{USE } 4x10}$$

Calc 6 - Cantilever Beam Hand Calcs (3 images)



CANTILEVER 14.4' BEAM

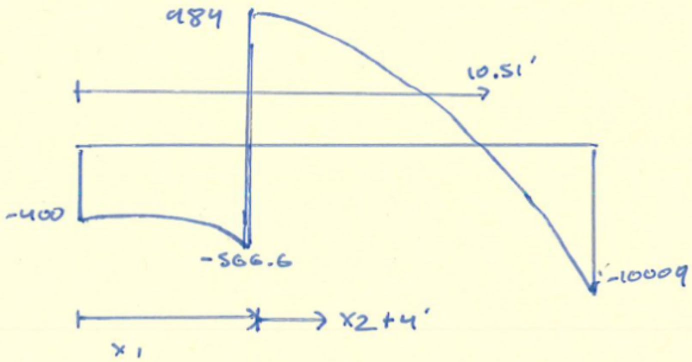


$$\overset{\curvearrowleft}{\Sigma M_{R_1}} = (400)(4) + (10.4')(R2) - \frac{300(14.4)}{2}(10.4-4.8) = 0$$

$R2 = 1{,}009\ \#$

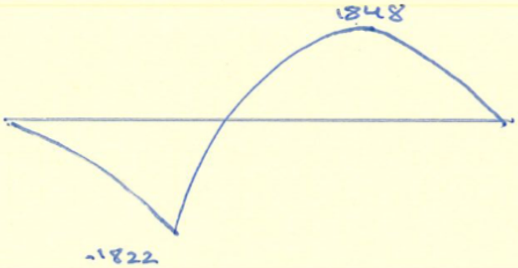
$\Sigma F_y = -400 + 1{,}009 - 2{,}160 + R_1 = 0$

$R_1 = 1{,}551\ \#$



$$V_{(x_1)} = -400 - \frac{20.83x^2}{2} \Rightarrow M = -400(x) - \frac{20.83(x)^3}{6}$$

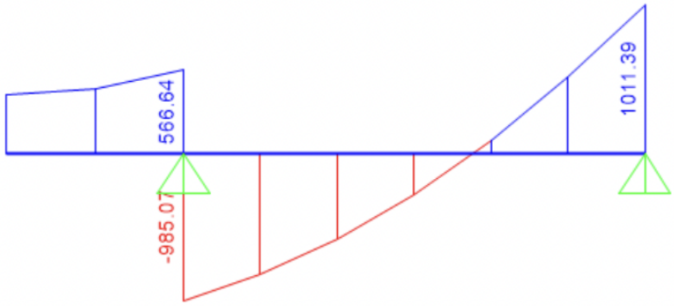
$$V_{(x_2)} = 1151 - \frac{20.83x^2}{2} \Rightarrow M = 1151(x) - \frac{20.83(x)^3}{6}$$

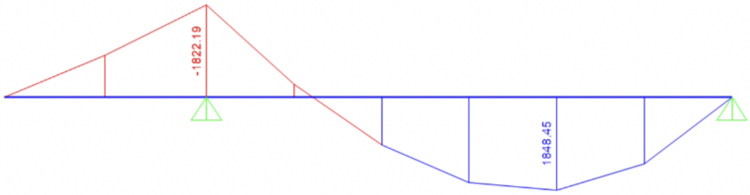


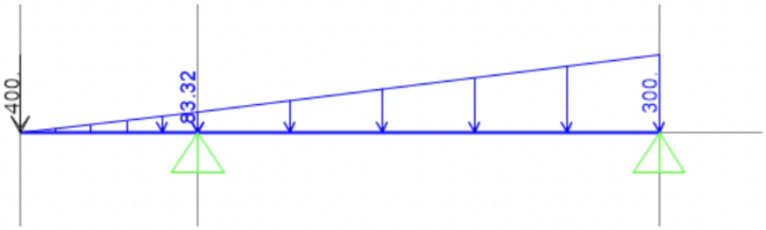
$$\frac{M}{F_b} = S_{REQ} = \frac{1848(12)}{1000} = 22.8\ \text{in}^3$$

$\Delta_{SAP} = 0.149''$
4'-CANTILEVER

Calc 7 - Cantilever Beam Output







Calc 8 - Initial Beam Design

BEAM DESIGN

$8' \Rightarrow I_{REQ} (L/360 \; D+L) = 60.9 \text{ in}^4 \Rightarrow$ 2x12 $S = 31.64$

$S_{REQ} (M/F_b) = 28.8 \text{ in}^3$ $I = 178$

4x8 $S = 30.66$

$I = 111.1$

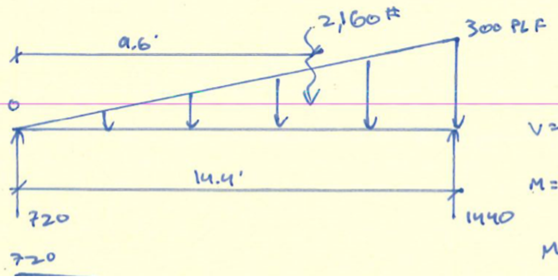
$16' \Rightarrow I_{REQ} (L/360 \; D+L) = 487.9 \text{ in}^4$

$(L/240 \; D+L)\; 325.3 \text{ in}^4$

$S_{REQ} (M/F_b) = 115.2 \text{ in}^4$ X

NOT WORTH ⇒ USE 8' BM

14.4' (DIAGONAL EDGE) = TRIANGLE LOAD



$m = 300/14.4$

$= 20.83 \;\#/\text{FT}^2$

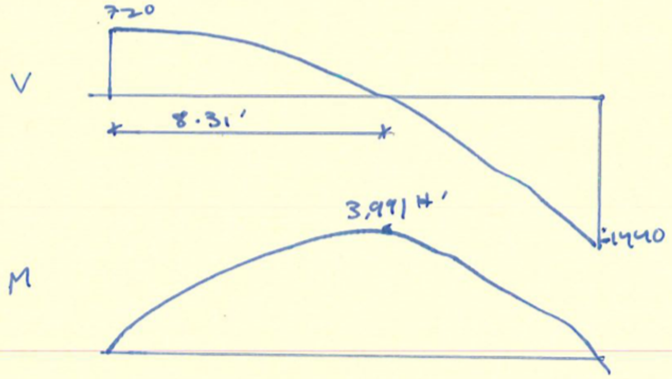
$Y = -20.83x$

$V = \int = -\dfrac{20.83x^2}{2} + 720$

$M = \int = -\dfrac{20.83x^3}{6} + 720x$

$M(8.31) = 3491 \;\#'$

$M(8.31) = 3491 \;\#'$



$\dfrac{M}{F_b} = S_{REQ} = \underline{47.9 \text{ in}^3}$

$\Delta = 0.0130 wL^3/EI = \dfrac{(0.0130)(2160)(14.4 \cdot 12)^3}{1{,}700{,}000 \; (I_{REQ})} < \dfrac{L}{360} = 0.48''$

I_{REQ} $\underline{177.5 \text{ in}^4}$

⇒ 4x10 $S = 49.9$

$I = 230.8$

3x12

6x8

8' W/ TRIANGLE LOAD

$I_{REQ} = 30.466$

$S_{REQ} = 14.73$

= 2x10 (21.39, 98)

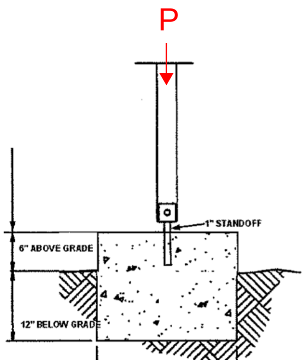
4x6

4x8

Calc 9 - Post Point Load Comparison with Different Live Load Requirements

P = 3,200#

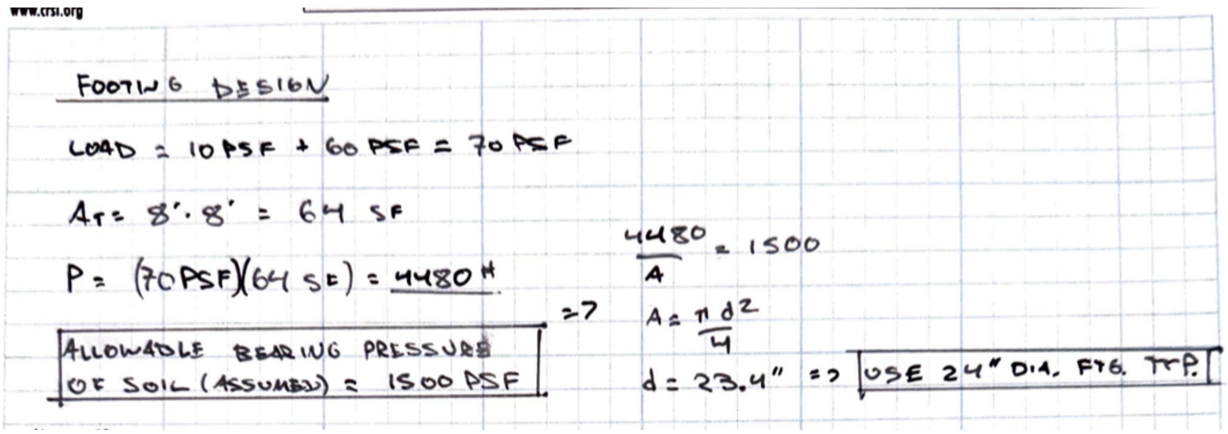
40 PSF Live



P = 4,500#

60 PSF Live

Calc 10 - Footing Size



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FOOTING DESIGN

LOAD = 10 PSF + 60 PSF = 70 PSF

$A_T = 8' \cdot 8' = 64$ SF

P = (70 PSF)(64 SF) = 4480#

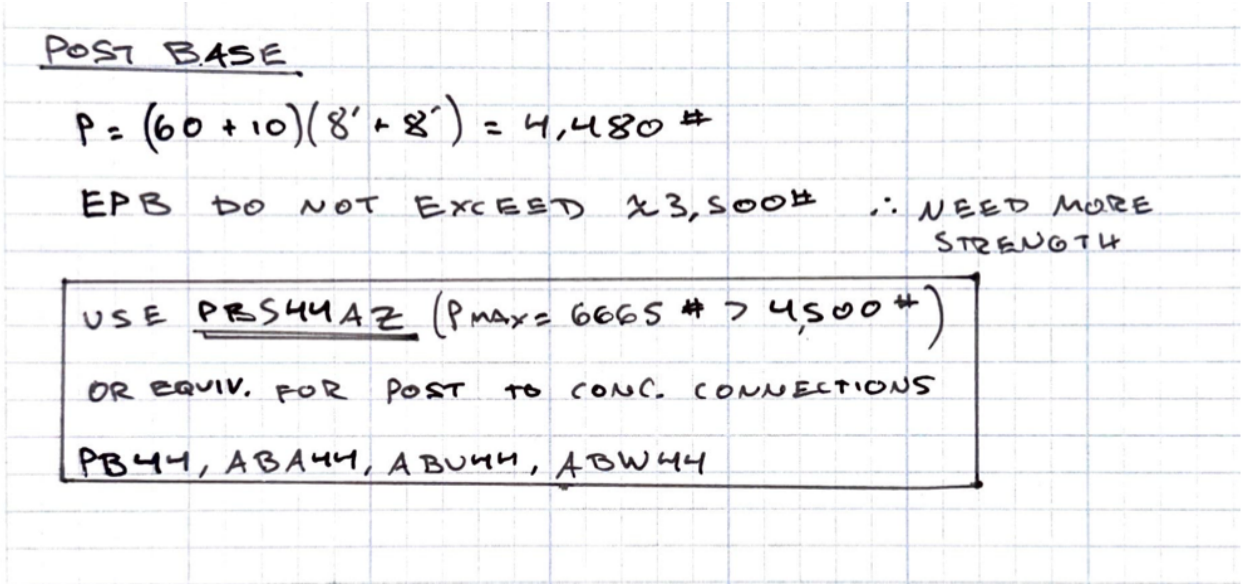
ALLOWABLE BEARING PRESSURE OF SOIL (ASSUMED) = 1500 PSF

=> $\frac{4480}{A} = 1500$

$A = \frac{\pi d^2}{4}$

d = 23.4" => USE 24" DIA. FTG. TYP.

Calc 11 - Post Base Determination



POST BASE

P = (60 + 10)(8' · 8') = 4,480#

EPB DO NOT EXCEED ≈ 3,500# ∴ NEED MORE STRENGTH

USE PBS44AZ (P_{MAX} = 6665# > 4,500#)

OR EQUIV. FOR POST TO CONC. CONNECTIONS

PB44, ABA44, ABU44, ABW44