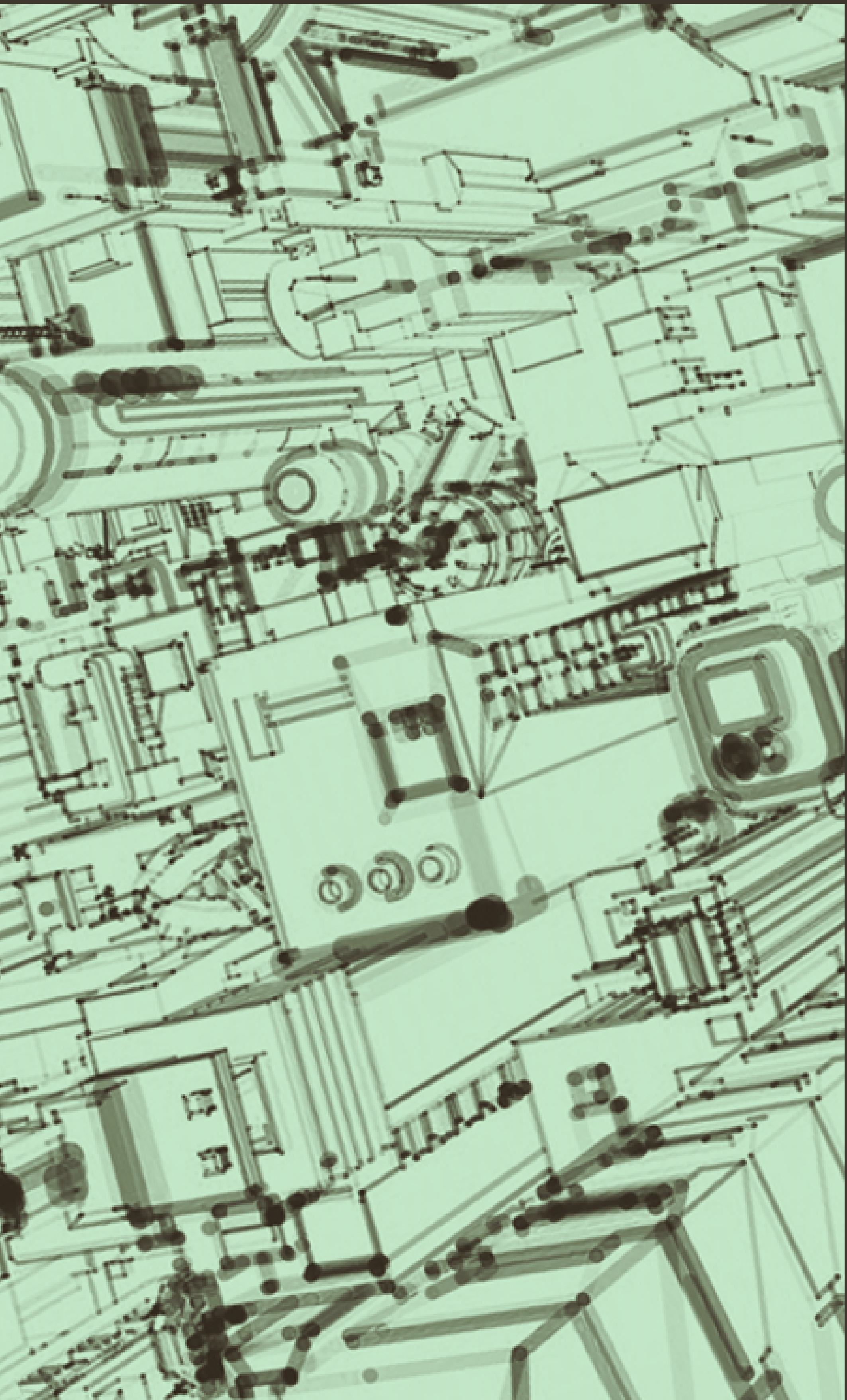
Evaluation of Structural Retrofit of a Hillside Home



ARCE 453-01:
Independent Senior Project

Fall Quarter, 2023

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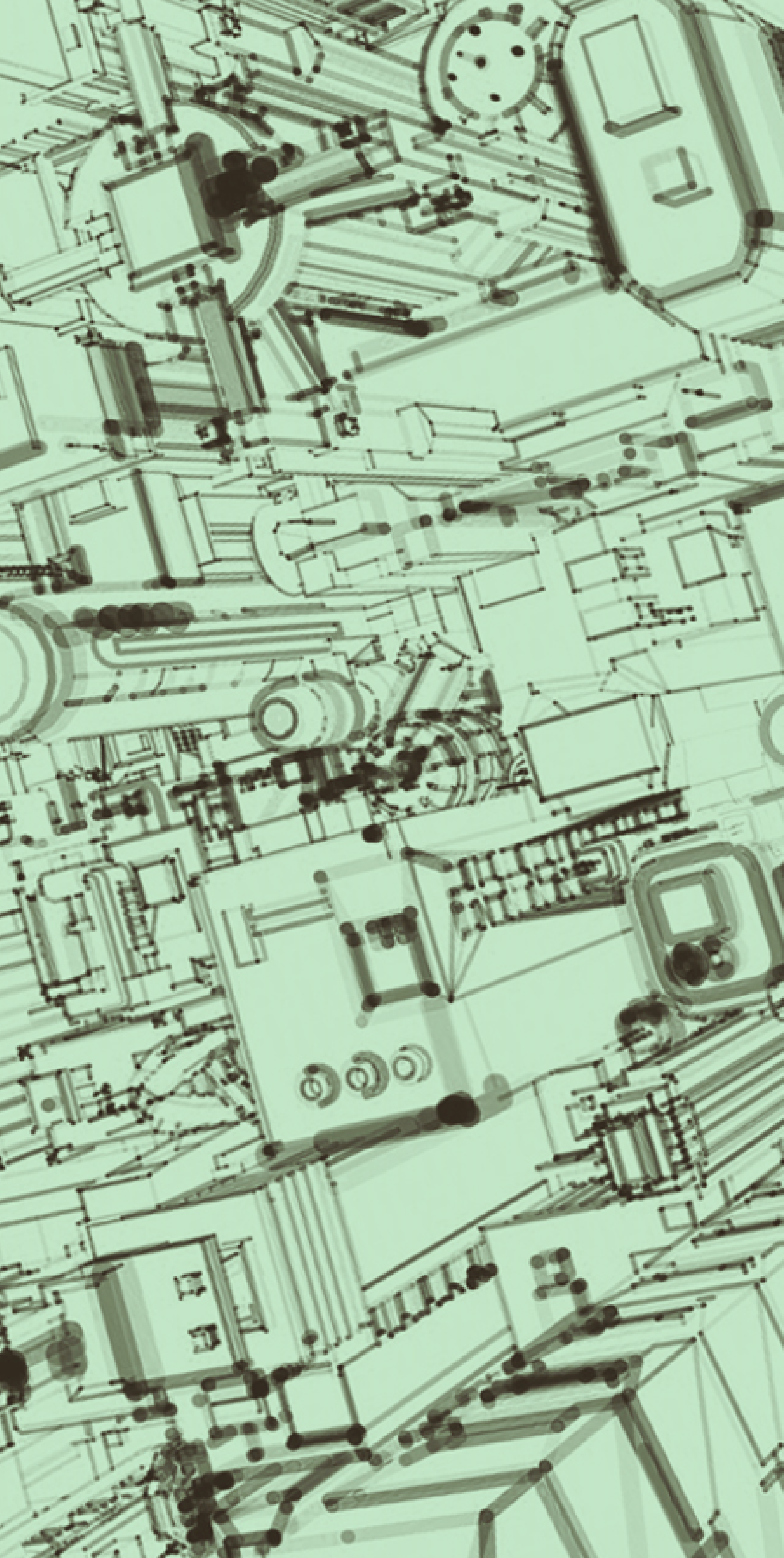


Design Evaluations and Research Commentary

Design Evaluation and Research Commentary

Owner Story

On November 24, 2021 after months of initial planning, the project owner received approval from the San Luis Obispo Planning and Building Department for initial work on a residential remodeling submission. This approval including a grading permit and other initial site work to begin renovation of the owner's hillside residential property.

The owner was looking to retrofit their current residence, remodeling the house to create new rooms and enlarge the living space, adding significantly to the existing square footage. The overall plan focused on extending the existing concrete slab foundation on grade out over an adjacent downhill slope. This would open a new garage space underneath the existing patio and residential structure. In early December of 2022 the owner desired that the design and calculation packages be submitted to the County Planning Department, and subsequently determined that should be done no later than December 22nd. In the owner's view that allowed a few days for processing and review before new 2022 California Building Codes would become effective on January 01, 2023.

This December 22, 2022 date was not to be extended since all structural projects, including existing structure retrofits and remodels, submitted for plan review before January 01, 2023 would only be required to satisfy design codes utilizing 2018 California Building Code requirements. If the project was not submitted for plan review before January 01, 2023, all design calculation package specifications and subsequent design factors would be required to meet the new 2022 California Building Code standards.

Even if design changes were minimal or there were no changes to the initial retrofit design, design plans and engineering calculations would need to meet the new code standard if submitted after January 1st. This would result in extra time and added costs to account for the additional hours for engineers to ensure all new code standards were reflected in both overall structural plans and the calculation package.

For the owner in this case, time was in fact money. If the structural design process was set back for any reason in late 2022, the subsequent late submission of a structural package for review by the County of San Luis Obispo Planning & Building Department would have resulted in additional delays, and exceeding the owner's original project timeline. The original project schedule had included some extra time for structural design revisions as requested from engineering assessment, design changes requested by the owners due to changing their mind on the final structure, or focused points-of-interest from plan reviewers. Not all potential delays could however have been anticipated.

Typically project timeframes plan and scheduled to account for design changes from engineering evaluations and/or post-plan submission reviews. Yet the owner could not them self have predicted the remodeling being delayed due to an in-development design needing a comprehensive rework at the eleventh hour because of new building codes. An unaccounted delay in the development phase just before submitting plans adds expenses for the owner as well. It was simply chance timing for the owner that the remodeling project was moving forward in the same period of time the architectural engineering industry was to be subject to new code standards. Updates to standards occur approximately every three years, but timing can vary.

The owner, not wanting to overly delay the project and pay unplanned expenses, called upon the head engineer, head contractor, architect, head mechanical contractor, and civil engineer to a quick succession of coordinated, last minute meetings. Within these last-minute, cramped design sessions they collaborated on a finalized submission package in time for December 22 submission date. Afterwards adjustments and revisions could occur after the Planning & Building Department began reviewing the plans. Follow-up with major design revisions that would legally be satisfied utilizing the 2018 California Codes, and not be required to revise the overall structural pack to reflect the new codes.

From conceptual-rough drafts to the finalized design, different depictions were communicated within the engineering team. The earliest rough-draft sketches depicted a singular concrete slab supported underneath by wooden joists and large glue laminated beams [GLB's]. The design was rapidly altered, refined till the finalized calculation package was formed. The engineers found this retrofit to be quite difficult, impacted by the limited time available. The final designing showed signs of the "on the spot" compromises generated in those rapid design sessions. In particular, the garage space overhead framing.

Thought Process of Engineer Team as Starting Point

Original Design Timeline in Summary:

During this retrofit in the Central Coast, the owner and architect wanted a patio with concrete. This encouraged structural engineers to consider making the entire floor addition all concrete at the patio and residence addition as it then match the existing concrete slab on grade. However, a monolithic concrete slab and formwork would be expensive, so metal deck was then considered. To use concrete on metal decking an initial 3.5" of concrete over the top of the residential decking would be necessary for fire separation (1 hour minimum). The originally rough draft sketches depicted this system would be supported on engineered lumber, such as glue-laminated beams. Another approach considered was the system could have been changed to framing entirely using all concrete over metal deck over steel framing. This design was a more robust option though too much for typical residential design.

These early designs of structural steel or engineered lumber beams were eventually found to be problematic to both design and draft details for within the limited time frame. Thus, these designs were quickly abandoned. For the owner and contractor, these ideas were further dismissed due to the metal deck with structural concrete fill adding a new subcontractor to the mix. Other concerns included the attaching metal deck to wood framing, or how the concrete was to have a stamped pattern and compromise the concrete's structural integrity. On the other hand, the idea of using steel structural members within wood framing was investigated for potential applications in the framing design. All these designs were seen as being ineffective to account for all the structural challenges being experienced within such a limited time frame. Therefore, a new decision was made to finalize a design with concrete finish (1.5" to 6.5" thick) on plywood sheathing. Supported by engineered wood joist and beams, with the inclusion of a custom steel girder in wood design. To account for fire separation between the garage and the residential space framing, selected an addition of 5/8” Type X gypsum wallboard to be applied. To account for concrete on the plywood sheathing the engineers detailed that moisture barrier is required to prevent rotting.

To evaluate the finalized “rush-job”, two alternative designs will be based on some of the rough draft concepts that were discussed. Developing them to show solutions to the structural challenges that made this project unique in its structural system. Looking at the pros and cons that each design has, such as concerns about creep over time causing permanent deflection. Determine if the existing design or the alternative designs, even if radically different, satisfy the conditions of being structurally efficiency, economic efficiency, factoring in constructability, and satisfying architectural aesthetics.

Architectural Influence on the Structural Design

A starting point for structural engineers on a project is referencing the architectural plans of a given project. Presenting a picture to the engineer(s) of the style, dimensions, and important building characteristics that will factor into how structural members are designed. For this retrofit, the owner wants to expand the existing residence both on what currently exist on grade and expand onto a newly constructed garage space. As examined by Arthur H. Levin in his publication of “*Hillside Building: Design and Construction*”, the architect will assign design priorities to the project differently than the structural engineer will. For example, former structural engineer and architect Aurthur Levin explains how the architect and engineer look at designing a residential structure along a hillside.

For Downhill sites, where the lot is on downhill side of a street, (Levin, pg. 7):

- Advantages:

  Buildings being easier to construct than uphill lots as building materials are carried down rather than up, view is generally better and not blocked by other buildings, less need for grading - shoring - and retaining walls.

- Disadvantage:

  Foundation system if more complicated than that used for uphill lots.

For Uphill sites, where the lot is on uphill side of a street, (Levin, pg. 7-8):

- Advantages:

  Easy to provide patio facilities in the clear space generally required behind the building.

- Disadvantages:

  - Earth slides (particularly after a fire has denuded the hill above) and rockslides can damage or destroy buildings,
  - High retaining walls and shoring are frequently required, and cost can increase dramatically,

- Some authorities require regarding a steep slope adjacent to a street to a maximum angle of 45 degrees - this can be an unexpected cost, if the required grading is high above the street level,
- The authorities may also require you to install many drainage devices - another unexpected cost.

Garage Access, Decking, & Underfloor

“On a sloping street, the garage or carport should be placed at the highest elevation of the lot next to the street (fig. 18). It is generally best to have the garage floor and the dwelling floor leading to it at the same elevation; if you were instead to put the garage at the lower elevation along the street (fig. 19), a portion of the house would be below street level and would require retaining walls. This could also cause drainage problems in the area between the dwelling and the street. If the street is so narrow that a 90-degree turn from it into the driveaway is not possible, then the garage must be turned at an angle to the street, be set back from the street, or have a wide driveway. When possible, to avoid water from the street running into the garage, make the garage floor at least 12 inches above the street at the high side of the driveway.” (Levin, pg. 48-49).

Figure 18

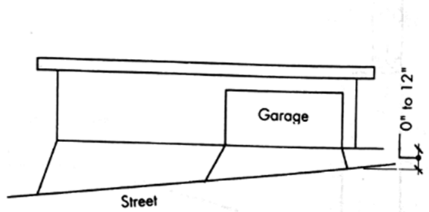
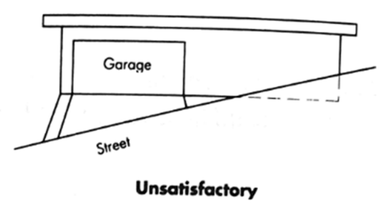


Figure 19



Under flooring within architectural terms as Arthur entails, “Another necessary decision is whether to leave open or enclose the area under the building. If the area is to be open, the structural system could involve: Wood poles, tapered steel or standard steel beams, glue-laminated beams, trusses, an arch. Two disadvantages of the open design are the need for special fire-proofing in some jurisdictions and its reduced salability. Many people think (erroneously) that a cantilevered building is less safe than buildings that are enclosed with stud walls.” (pg. 73)

Except for building failures, deflection is the item that brings the most criticism to engineers. Since, “Sagging cantilever beams and floors that feel “bouncy” are not acceptable even though their design may meet the minimum requirements of the applicable building code” (Levin, pg. 123). The garage space within this retrofit design for the owner was wanting to accommodate as much occupation space below concrete decking. For the engineer, whether a concrete slab or 4” average finish is applied, concrete dead and live loads over time behave and loading can be more significant to wood member design when compared to steel. A concern for the structural engineer is to account for creep. For example, if major creep occurs within long clear span structural members it translates not only to deflection but also cracks in the concrete. Thus, as the engineer designed a wood framed design it’s reasonable that engineered lumber, such as TJI joist, will be selected as they are less susceptible to long-term deflection.

Little Things that Started to Create Structural Challenges

The structural engineer for this renovation has a clear set of goals to achieve. Working in new vertical and lateral structural members into the existing architectural plans that were provided. Balancing the efficiency in both structural stability and the construction cost for the structure to be built within budget. Finally, when finished with designing the structural framing to be effectively communicating the "Lego-set" instructions to contractors. Yet on this project, little things that structural engineers do not upfront think about started to create structural challenges. Two of the most influential variables being drainage and fire.

1. Drainage: A Framing Challenge Reveals Itself

Why do structural engineers need to think about drainage when designing a house? An up-front answer would state that the California Building Code requires a ¼"/ft slope minimum to prevent water built up. Yet when narrowing down on the details, structural challenges begin to appear. What makes this project unique is how the little things in drainage started to create structural challenges. For instance, to account for exterior drainage the building plans present the exterior patio over an occupied space to be lower than the interior flooring. From there the structural engineer looks at how much slope the exterior concrete will have to be, and the concrete's total thickness? How is the slope going to being accounted for? The interaction of bearing loads from the exterior wall and two floor frames. How are structural members and hardware interacting? Communicating the design to the contractor?

1.1. Accounting Finished Floor Framing Gap

The owner and architect wanted a finished floor to drop between the interior residential floor and the top of the exterior patio to account for the slope needed for drainage. As shown in Figure 1, the architect reflects in their elevations that each floor was separately: (a) Interior floor based on Slab on Grade (S.O.G) and (b) Exterior patio based on new garage foundation (FND). The engineers had to self-check and measure the actual drop of 6" and that the drop accounted for minimum slope over entire patio span, since it was not directly stated on architect plans.

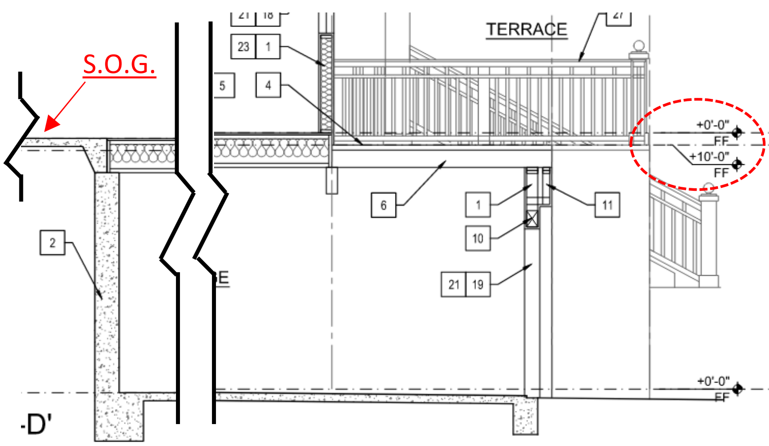


Fig. 1: Section Elevation via Architectural Plans

1.2. Where to determine patio slope for drainage?

The first place to check was to see if the architects' plans had any notations or references list that would of include notes on the slope. In the list of provided plans it referred to the Civil Engineer - Grading & Drainage Plan [Fig. 2] as best place to look. Yet when the engineers found the plans too much being communicated in one plan. They found the slope noted slopes of 1.7-2.0% grade yet was not simple to find due to the issues like the existing, removed, and infill soils all represented by same line type.

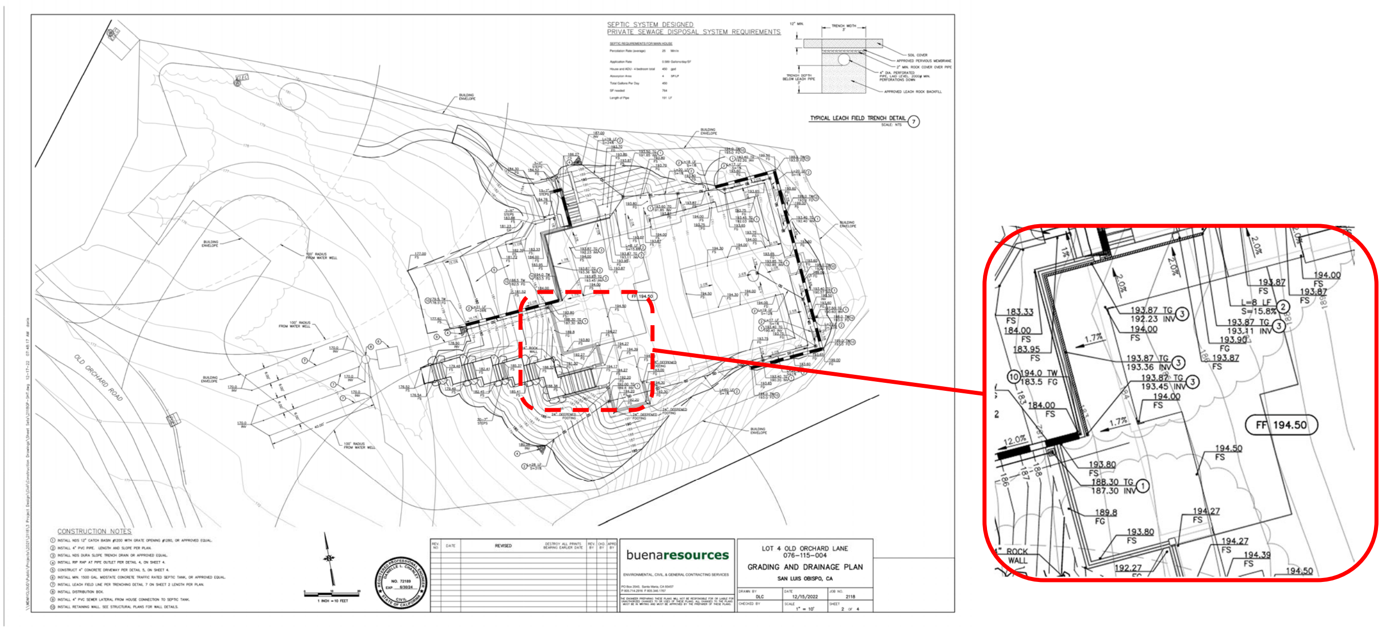
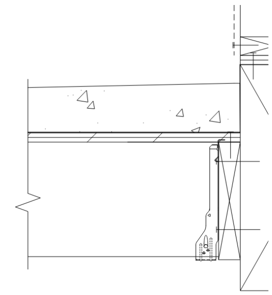


Fig. 2: Civil Engineer Grading & Drainage Plan

1.3. <u>How to Account for Slope?</u>

To account for the slope the structural engineers have to possible forms of wood framing the can be selected. Both coming with pros and cons that factor into selecting how the structural system will occur:

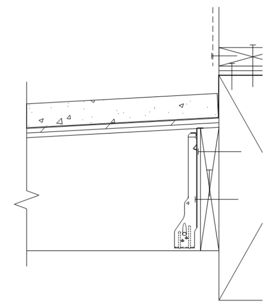


Dropped Frame Visual

A. <u>Dropped Framing</u>

- *Pros:* Flat Framing with Concrete Accounting for Slope, Repetitive Installation & Hardware

- *Cons:* More Concrete Thickness = More Weight



Ripped Frame Visual

B. <u>Ripped Framing</u>

- *Pros:* Constant Concrete Thickness, Joist can Account for Extra Weight

- *Cons:* More Cost from oversizing members, Installation & Hardware Differs at each Joist End

1.4. <u>Where Does the Gutter Go?</u>

Additionally, the placement of the gutter is a factor to consider when expectations differs between the architect, civil engineer, owner, and the structural engineer. Issues such as gutter placement are where cooperate, discussion, and effectively communication to resolve. In particular, the structural engineer compromising when large mechanical, electricity, and plumbing are predicted to cut through structural members. As shown in Fig. 3, the patio gutter would cut into the joist supporting the exterior patio.

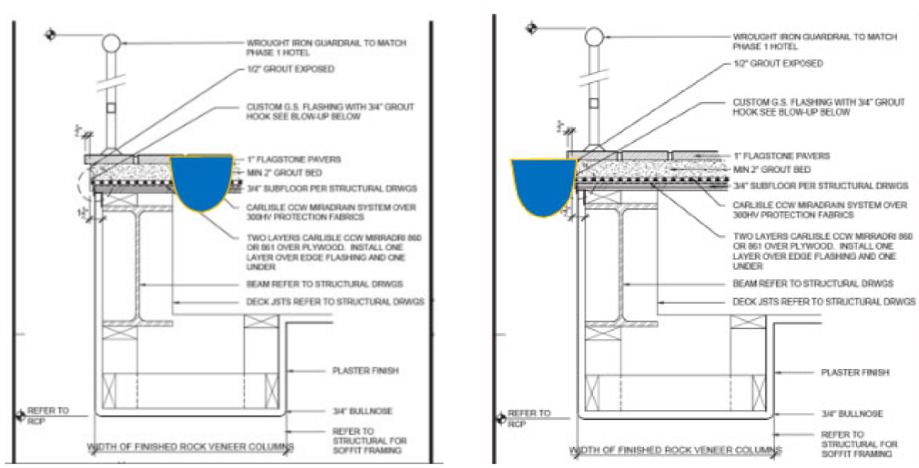


Fig. 3: Architect, Civil Eng., & Owner vs Structural Eng. Expectation

1.5. <u>Drainage Causing Structural Issues</u>

As these little things have built up to become the structural challenges this retrofit they influential to how the structural engineer will address these issues. Addressing the drainage with two levels of framing interacting at an exterior wall over the garage space and selecting a style of framing. The framing design will need to account for loads beyond the columns with large spans. Other factors for the engineer to account also include the exterior wall sheathing needing to have at least 2” gap from bottom of sheathing to the top of patio finish. Applying a 2” gap between the plywood sheathing from a wet surface to avoid rotting.

2. Fire: Effects on Adjacent Interior, Residential Framing

Buildings within a High Fire-Zone by the Building Code (Fig. 5) requirement to meet a residential flooring criteria, having occupied space barriers meet a 1-hour fire rating minimum. For this project, this requirement effects the strucutral engineers choices in how to address the floor deisgn. Depending on the selected floor framing, the fire rating is accounting for by:

- If monolithic concrete slab → 3.5” minimum thickness
- If concrete on metal deck → 3.5” min. of concrete + thickness of deck
  - Manufacturer can directly state their products rating (Fig. 4)
- For all wood framing, including concrete finished → Ceiling needing 5/8” Gyp. Board installed

Fire-Rated Composite Slabs

Table 1: Unprotected Fire Resistance Rating Concrete Thickness over FORMLOK Deck

Restrained Assembly Rating	Normal Weight (in.)	Light Weight (in.)
1 Hour	3½	2½
2 Hour	4½	3¼
3 Hour	5¼	4¾

Fig. 4: Verco Decking Catalog; VF5-Catalog-080818-1 Fire Rating Chart

TABLE 601 FIRE-RESISTANCE RATING REQUIREMENTS FOR BUILDING ELEMENTS (HOURS)

BUILDING ELEMENT	TYPE I		TYPE II		TYPE III		TYPE IV				TYPE V	
	A	B	A	B	A	B	A	B	C	HT	A	B
Primary structural frame[f] (see Section 202)	3[a, b]	2[a, b, c]	1[b, c]	0[c]	1[b, c]	0	3[a]	2[a]	2[a]	HT	1[b, c]	0
Bearing walls												
Exterior[e, f]	3	2	1	0	2	2	3	2	2	2	1	0
Interior	3[a]	2[a]	1	0	1	0	3	2	2	1/HT[g]	1	0
Nonbearing walls and partitions Exterior	See Table 705.5											
Nonbearing walls and partitions Interior[d]	0	0	0	0	0	0	0	0	0	See Section 2304.11.2	0	0
Floor construction and associated secondary structural members (see Section 202)	2	2	1	0	1	0	2	2	2	HT	1	0
Roof construction and associated secondary structural members (see Section 202)	$1^1/_2$[b]	1[b,c]	1[b,c]	0[c]	1[b,c]	0	$1^1/_2$	1	1	HT	1[b,c]	0

For SI: 1 foot = 304.8 mm.

a. Roof supports: Fire-resistance ratings of primary structural frame and bearing walls are permitted to be reduced by 1 hour where supporting a roof only.
b. Except in Group F-1, H, M and S-1 occupancies, fire protection of structural members in roof construction shall not be required, including protection of primary structural frame members, roof framing and decking where every part of the roof construction is 20 feet or more above any floor immediately below. Fire-retardant-treated wood members shall be allowed to be used for such unprotected members.
c. In all occupancies, heavy timber complying with Section 2304.11 shall be allowed for roof construction, including primary structural frame members, where a 1-hour or less fire-resistance rating is required.
d. Not less than the fire-resistance rating required by other sections of this code.
e. Not less than the fire-resistance rating based on fire separation distance (see Table 705.5).
f. Not less than the fire-resistance rating as referenced in Section 704.10.
g. Heavy timber bearing walls supporting more than two floors or more than a floor and a roof shall have a fire resistance rating of not less than 1 hour.

Fig. 5: International Code Council. “2021 International Building Codes (IBC) - Chapter 6, Table 601

2.1. <u>High Fire Zone Effects on Lateral</u>

Under the owners' request, fiberglass-wood side paneling is to be installed on as many of the exterior walls. The paneling company had tested their product and provided the report to structural engineers for reference. On the other hand, a new framing challenge revealed itself. (Fig. 6)

Since the testing did not account for structural plywood shear wall sheathing behind fiberglass composite it causes the head engineer to have a lack in confidence. Therefore, the head engineer made the call to use strong walls wherever possible since it fits between exterior and interior sheathings. This decision also accounted for the limited wall lengths to utilize plywood sheathing for interior walls in given cases.

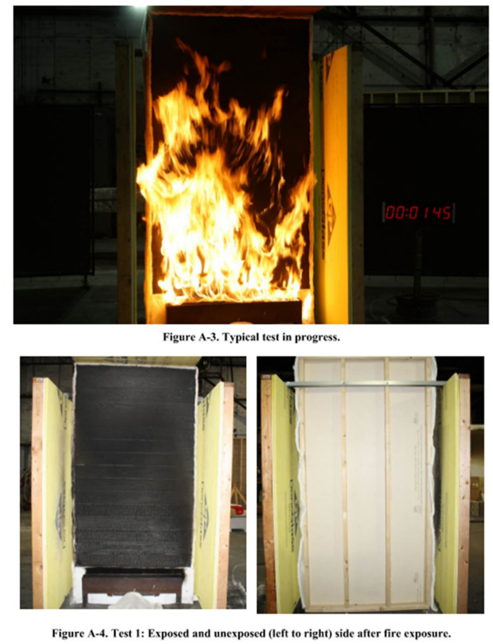


Fig. 6: Delta Millworks Testing Reports

Evaluation of Three Possible Designs

As an evaluation of the structural design that was submitted in the calculation package, will examine three possible flooring designs over the garage space. Ranging from the current design, original rough sketches, to a radically different steel alternative. Looking at how they address the challenges of drainage and fire previously presented:

- Concrete finish on wood framing with plywood sheathing
- Non-Structural concrete on engineered lumber framing with shallow Vercor deck
- Structural concrete on steel framing with Verco deck

An area of key point of interest that can be examined for how challenging it influenced the overall design. Looking at how the beam(s) underneath the exterior wall (Fig. 7)presents a visual summary for how each framing tackles the structural challenges and subsequent solutions.

<u>Challenges for this Structural Member</u>

- Main structural member governed by surrounding beams & joist
- Supports exterior wall from above
- Two levels of floor framing
- Large span over garage space, limiting number of columns

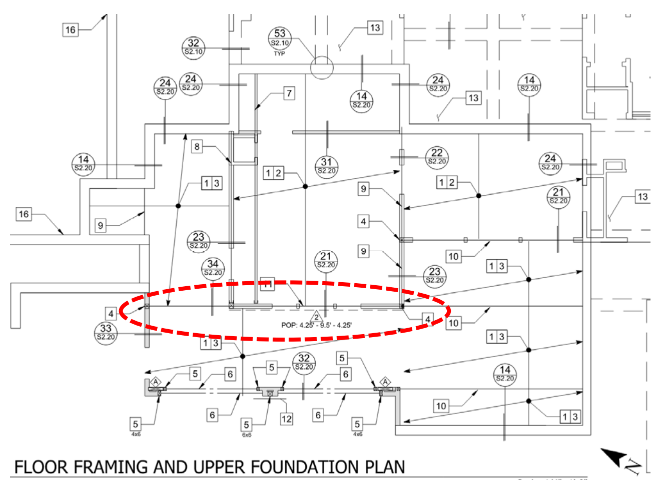


Fig. 7: Point of Interest to Focus Evaluaiton of all 3 Designs

Design: Concrete Finish on Wood w/ Plywood Sheathing

In general, this design reflects the most up-to-date version of the project originally designed in December of 2022. The owner rather than having a wooden porch decided to have a concrete finish porch. Some of the existing slab on grade foundation and retaining walls were being reused in retrofit as the back wall to the new garage. Therefore, the owner requested a concrete finish for the interior flooring instead of exposed wood flooring to match the existing house flooring. In terms of framing, underneath the moisture barrier and plywood sheathing would be TJI joist that attached to the concrete retaining walls via metal hangers.

While different thicknesses of concrete finish are occurring above, flush framing was used so the ceiling can mostly be flat underneath the residential space. This allows easy installation of continual 5/8” Gyp. Board for fire barrier separation between residential space and the garage. Structural members supporting the exterior patio in most current designs were left exposed but left flush if the owner later wanted them hidden.

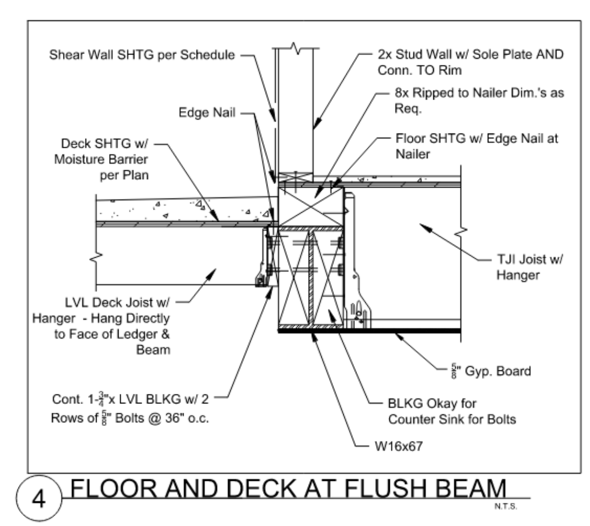


Fig. 8: Conc. Finish on Wood Visual

<u>How it Addresses the Structural Challenges?</u>

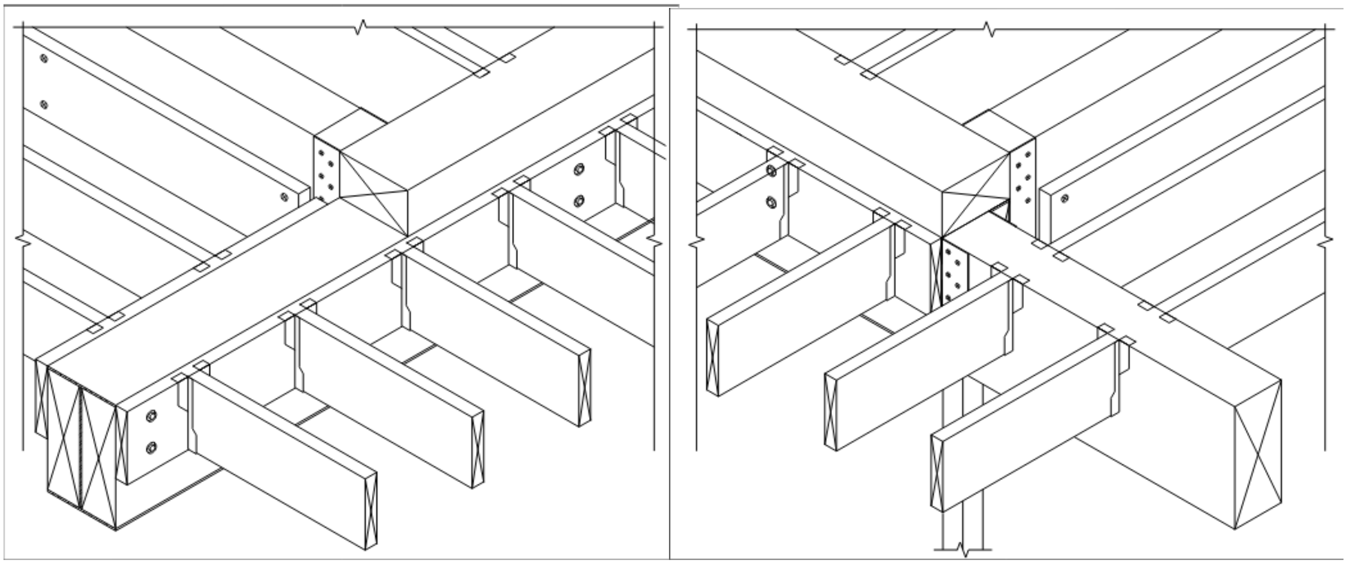
As shown in Fig. 8, the main structural member selected was a W16x67. While an inefficient W-Shape beam in selection, it matches the ceiling height and able to clear span from one column to the exterior wall. Along with being flush framed to exterior patio sheathing.

To accounting for the interior floor and hardware from above, a ripped nailer and ledgers are bolted to the W16x67 to minimize face hanger. These ledgers help save cost in hardware selection.

<u>Communicating Design via Isometric</u>

Below are isometric views of the corner ends of the exterior wall above the garage (can also reference Framing Plan & Section Detail Sheets). While isometric drawings are atypical to structural engineers drafting on projects, they are helpful within design teams to help communicate and visualize what is occurring. Especially when isometrics can present what two or more section details in the two-dimensional perspectives are all communicating.

Communicating Design via Isometric (cont.)



Pros & Cons to this Design?

Pro:

- Most Economical design in material cost
    - Specifics like one steel beam are acceptable to owner
- Flexible design to account for revisions
    - Such as converting to ripped framing
- W-Shape beam just needing one column within Garage space

Cons:

- Overtime wood is susceptible to creep
- If openings moisture barrier → Rotting
- Ripped Nailer needs start as 8x member minimum
- W16x67 is not a efficient member based on carrying capacity to cost
- W-Shape for floor and exterior member connections need:
    - ledgers, web nailers, and top ripped nailer
- Section Details can easily get too cluttered
- Due the “rush job” adjacent members possible don’t account for elements such as ridge beam

Design: Non-Structural Concrete on Engineered Timber w/ Shallow Vercor Deck

How it Addresses the Structural Challenges?

Much of the design is similar to the previous one, the key differences are that it continues the rough draft design of using a glue laminated beam with non-structural concrete on metal decking. Utilizing Engineered Wood. (Fig. 9) The structural members are girders sized to account for both floor framings and perpendicular beams interacting at the corners. The sizing of the girder and TJI joist together helps minimize face hangers wherever possible, saving cost in hardware selection. To account for the adjacent exterior patio framing, beams attached to the girders with hardware act like cantilever beams. There are two columns that fit within the garage supporting the girder; one underneath the corner of the exterior wall, while the other is offset from the corner to fit in between parking spots.

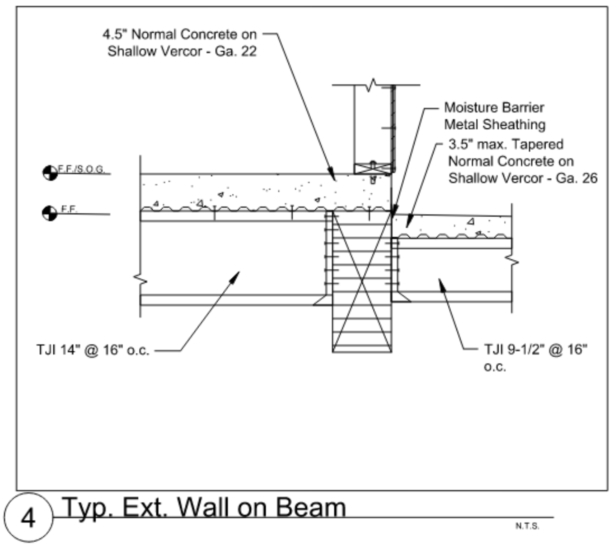
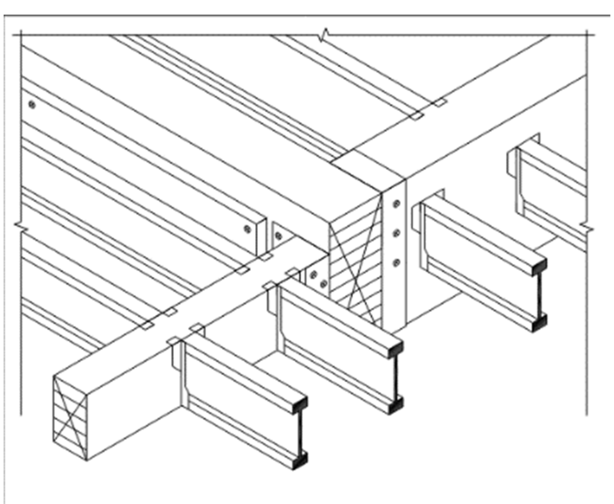
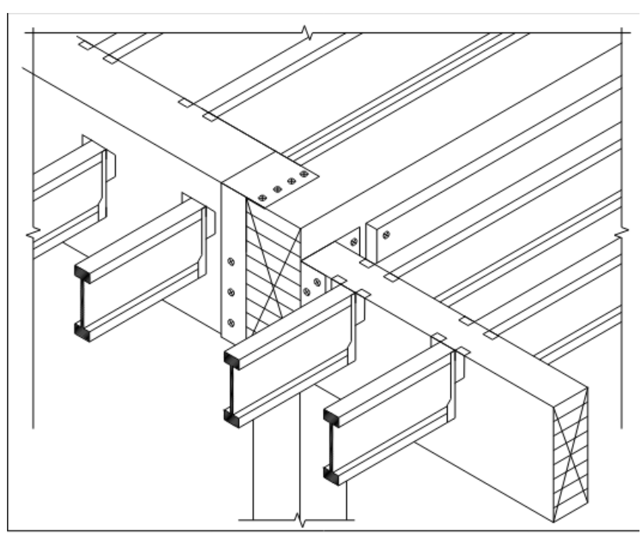


Fig. 9: Non-Struc. Conc. on Wood w/ Decking Visual

For the Shallow Verco Deck or equivalent, the total thickness = 3.5” concrete + deck thickness. From there the type and gauge is governed by both the total thickness and the clear span without shoring. Without shoring is a notable factor as shore framing adds extra cost and materials to the construction phase.

Communicating Design via Isometric





Pros & Cons to this Design?

Pro:

- By using Shallow Vercor:
  - Easy Instillation for contractor
  - Steel acts in tensile well with concrete in compression if bending loads occur
  - Acts as the moisture barrier
- Engineered TJI joist
  - Provides high resistance to deflection
  - Repetitive hardware and installation for contractor

Cons:

- At Ext. Corners with Girder Ends
  - Can be communicating a lot in small area
  - Intricate hardware instillation
- 4.5” Conc → Satisfies Residential Fire Resistance Rating on top
  - What about the Framing? → need fire barrier on underside
- GLB Beams and Girders having large 18’ maximum span
  - Large sized due to bending load , bearing load, & deflection

Design: Structural Conc. on Steel Beams w/ Verco Deck

How it Addresses the Structural Challenges?

This design as shown in Fig. 10, selected W-Shape beams & girders that are sized to be optimized for efficiency of loading capacity vs cost. To account for the drop patio decking, a welded L-Shape member acts as a ledger for decking to rest on and transfer gravity loads to the structural beams. The steel girder carries the cantilever beam ends, to account for flush, adjacent decking beams. Perpendicular beams duplicate the selected girder size to provide adequate surface area for prefabricated weld-bolt connections. This is done so the total strength of the connectors, for shear or lateral loadings, is optimized to be stronger than the steel beams themselves. two columns are fit within the garage as well; one underneath the corner of the exterior wall, while the other is offset from the corner to fit in between parking spots.

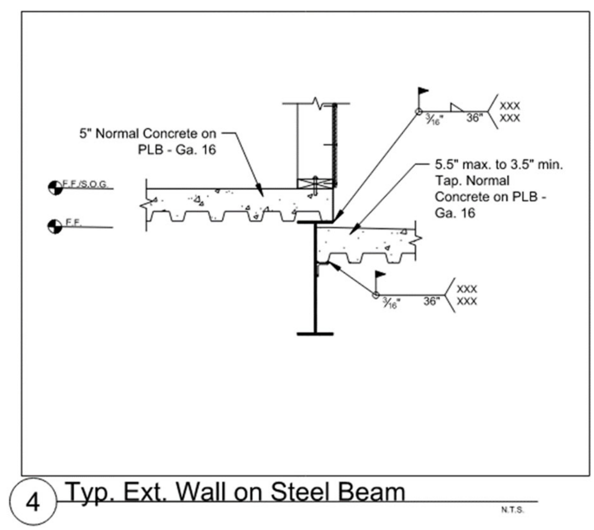
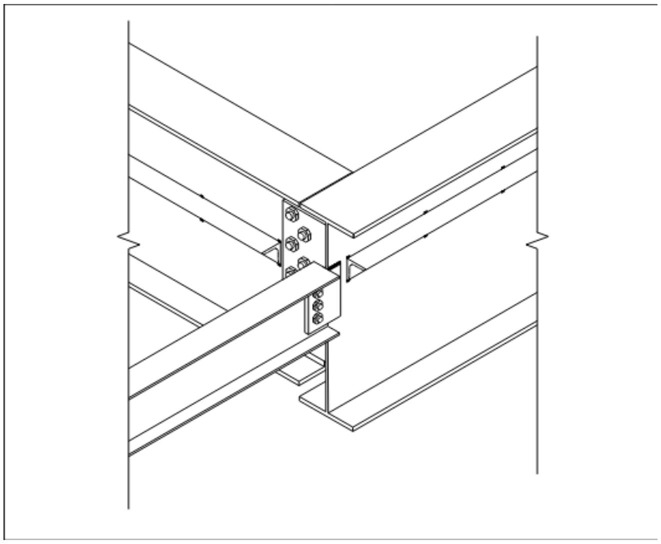
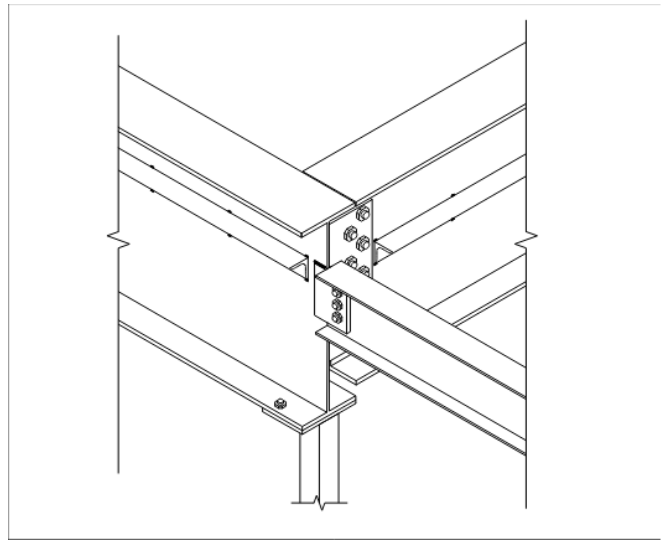


Fig. 10: Struc. Conc. on Steel w/ Decking Visual

For the Verco Deck or equivalent, total thickness = 3.5” concrete + deck thickness. From there the type and gauge are governed by total thickness and clear span without shoring. Without shoring is a notable factor as shore framing adds extra cost and materials to the construction phase. A benefit of using structural concrete on metal deck is that it self-supporting. So less structural members are needed to carry floor loads. Furthermore, it allows the concrete and steel when experiencing loading forces to behave in their most efficient behaviors of each material. For instance, concrete best works when in compression (the floor slab), while both the steel deck and mesh are best suited for tensile forces.

Communicating Design via Isometric





Pros & Cons to this Design?

Pros:

- Most robust design
- Structural Concrete can self support over clear span
  - Less Structural Members needed
- Prefabrication → Less Time and Cost for Installation for Contractor
- For Residential Space, framing doesn't need gyp. Board ceiling
- Exterior Structural Slab can transfer lateral forces
  - Can utilize Retaining Wall FND with a shear wall → Less Strong Walls needed

Cons:

- Most Expensive
- Most steel and concrete used between all three designs
- Anchor Points into the Concrete Retaining Wall FND have small error tolerance
- Each In-Field Weld add cost rapidly
- For architect not as aesthetically pleasing for a residence without hanging ceiling

Evaluation Closure

Is there a correct answer or is this a trick question? There is no "correct" answer because it involves the right balancing of different priorities within a given project. Structural Engineer tailors building designs based on factors such as: Robustness, Cost, Aesthetics, Building within constraints, Resistance to Rot, Stiffness, Constructability, and others. An owner, architect, structural engineer, and contractor each assign different relative, important factors to what governs a design. Thus, compromises are where discussions with effective communication between everyone to produce a satisfactory, finalized calculation package. As structural engineers, we tailor the structural systems based on the conditions of each design project.

Big Picture Discussion

Influence by Global Issues

As structural engineers, we are entrusted with the fulfillment of our professional duties. Carefully considering the safety, health, and welfare of the general public. Through technical knowledge and sharing ever developing techniques, engineers can lead to improving residential and commercial efficiency. On the other hand, little factors like greenhouse gas over recent years continue to become a growing concern to owners of future developments. Being mindful in the design phase to address these special requests, we adapt structural systems to account for the special needs of owners, such as solar panel installation. On the other hand, we strive to decrease the carbon footprint that a structure produces when it is being constructed, operations and maintenance across its life expectancy, and as much can be recycled when demolition occurs.

Influence by Cultural

The culture of structural engineers is that we directly affect those we serve. Using our creativity, technical knowledge, and engineering practices to improve the quality of life of the owners of residential retrofits or commercial developments. Providing structural systems with a focus on ensuring the safety of the occupants who will reside within the projects we work on. Our contributions enable society, which entrust us as engineers, is to helps address the needs of the general public with housing developments and critical infrastructure to keep daily lifestyles thriving. Furthermore, with this project being built in a high-fire zone, we are expected to account for the fire-resistance of the structure, providing safety to the local residence. Especially when public investment into fire-resistance develops due to recent events like the Maui wildfires in August 2023, Camp Fire in November 2018, or I-10 roadway fire in November 2023.

Meeting Social Needs

Residential projects are more personal investments than a commercial or infrastructure project. Structural engineers are interacting with the owners of the house, whether it is a new house being built or a retrofit. In discussion between the engineer and owner, we are expected to behave professionally but leave room to be interactive and social with the client. To them this is an investment in where they will be living, so we want to create a friendly environment. Entrusting our client to be open for discussion in cooperation to delivering a project that satisfies their need with neighborly attitudes.

Influenced by Environmental Issues

When thinking about the materials invested into residential housing such as lumber, steel, and concrete we should be mindful to what is required to erect structure and what is excess waste. Using our structural knowledge and creativity, we are motivated to not only calculate the most economical designs but using as minimum raw materials. For all materials on a project have a production and transportation system that produces greenhouse gases to produce a usable structural member at the construction site. As engineers we participate in decreasing the waste of resources and greenhouse gases with implementation of integrating environmentally friendly solutions into our project designs.

Meeting Needs of Economic

In the selection of connectors and hardware for a given project design, cost is a key factor to continually account for. The owner and contractor are the most invested into the cost out of all the members of the project team. As structural engineers, we strive to balance the structural stability of the framing while being as cost effective as possible. With the general economy effecting prices of structural members, such as plywood, hangers, or holdowns, we are expected to be selective in what our design requires to function. Minimizing excessive cost whenever possible so the owner receives a cost-efficient structural system that is tailored to their needs.

Lifelong Learning Experience

The biggest take away from work on this project is learning that design options for even a residential remodeling project are difficult to consider if a schedule crunch occurs. This project evaluated alternative designs that could have been considered by the home owner and collaborative engineering team if sufficient time had been available prior to the owner's December 2022 deadline for package submittal to the County Planning Department. Final building difficulty and costs may have been reduced and overall owner satisfaction with the remodeling enhanced, if the alternative designs could have been considered and evaluated.

Additionally, from experience working on this project I have learned that residential remodeling is not repetitive or mundane, each case is unique. Essentially no two projects in residential design are directly comparable in many respects. Currently, I am planning to continue working with Wethington Engineering, Inc. that was a key participant in the collaborative team that completed and submitted the design package for the residential remodel that was subject of this project. The alternative designs developed and evaluated were compared to that original design. I am looking forward to working on similar projects in the future that I anticipate will be both challenging and unique experiences as a structural engineer.

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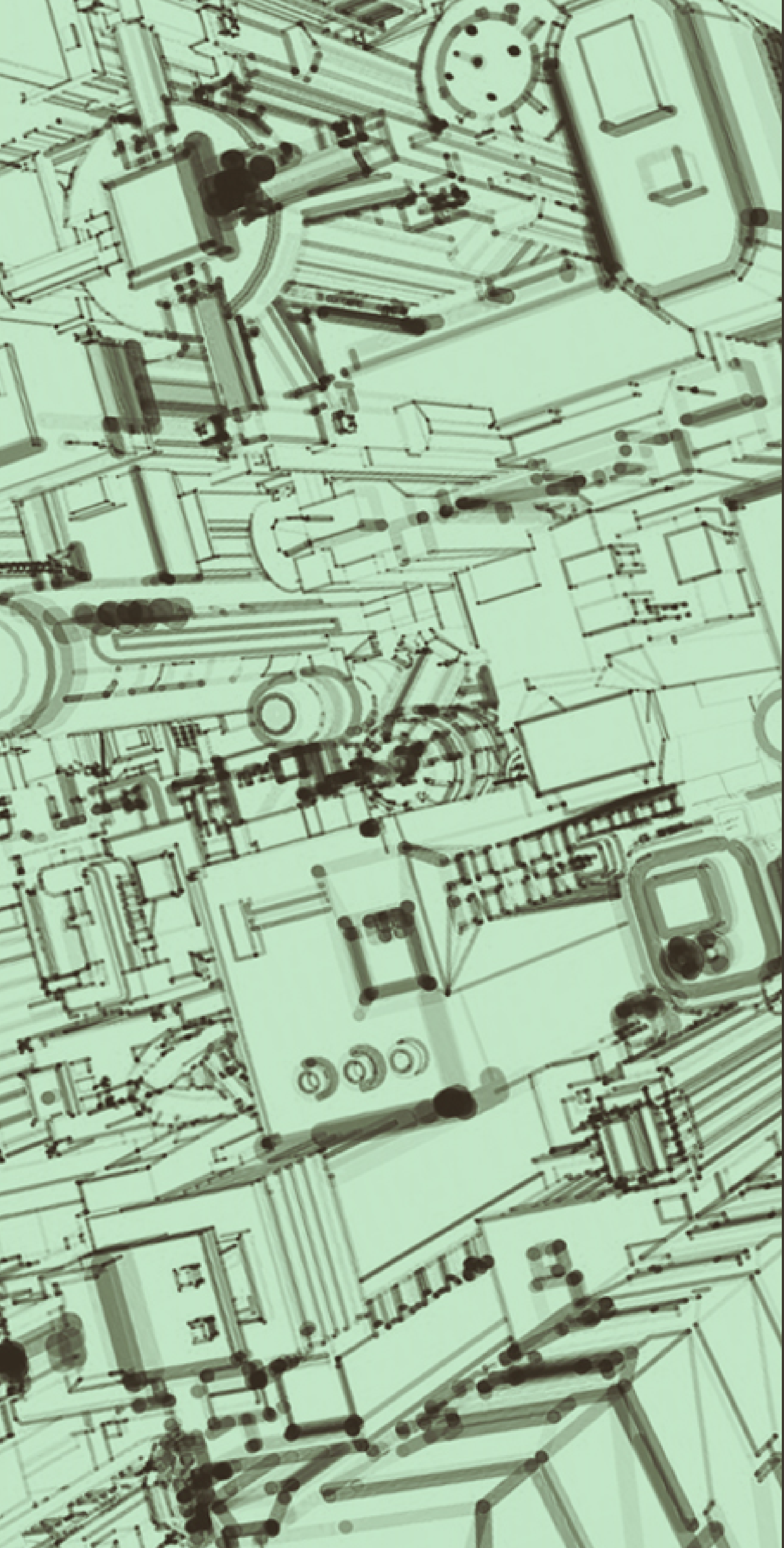


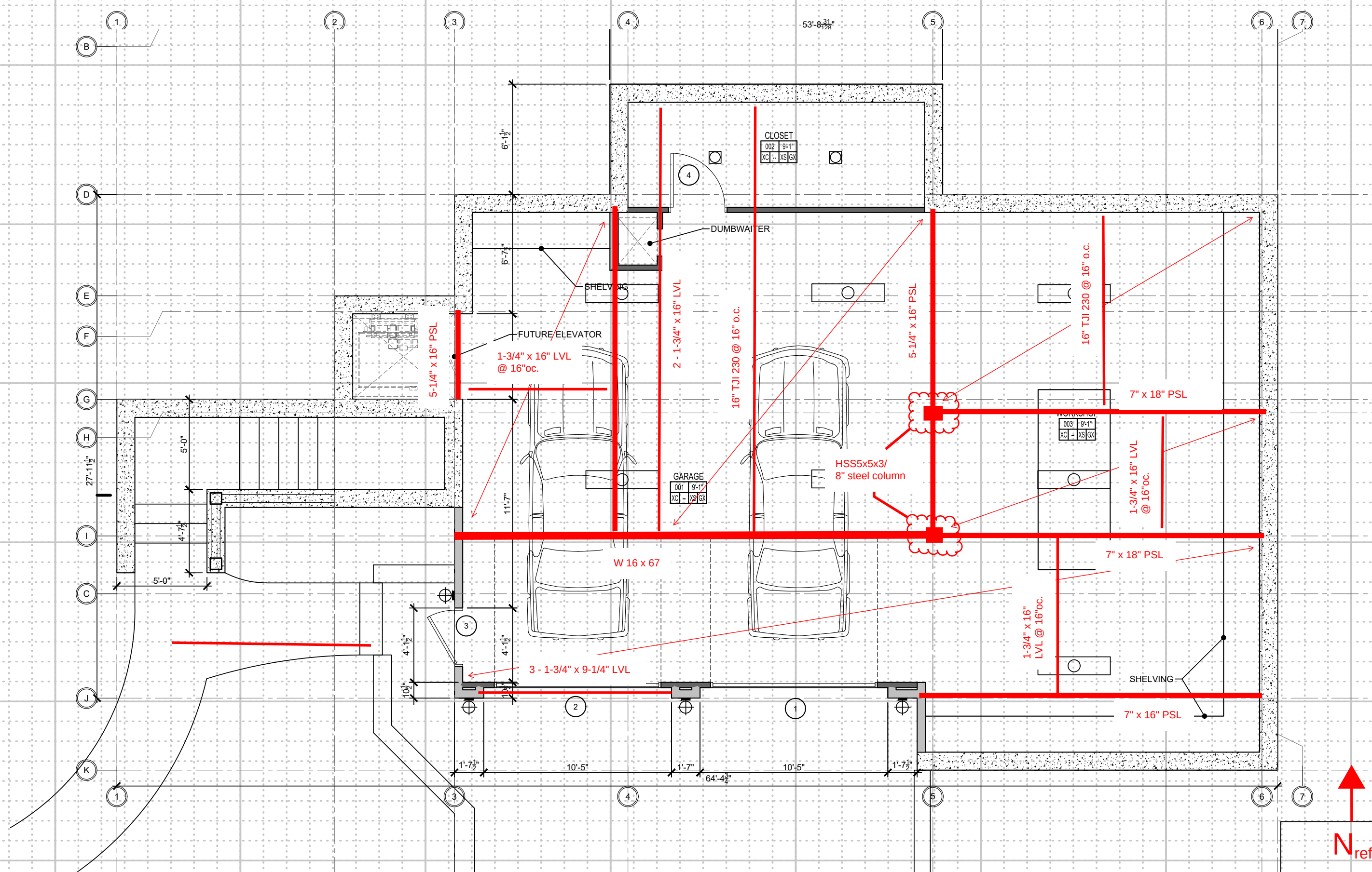
Vertical Design

Concrete Finish on Wood w/ Ply. Sheathing [Original Design]

Date: ____________ By: ___________ Project: ______________________________

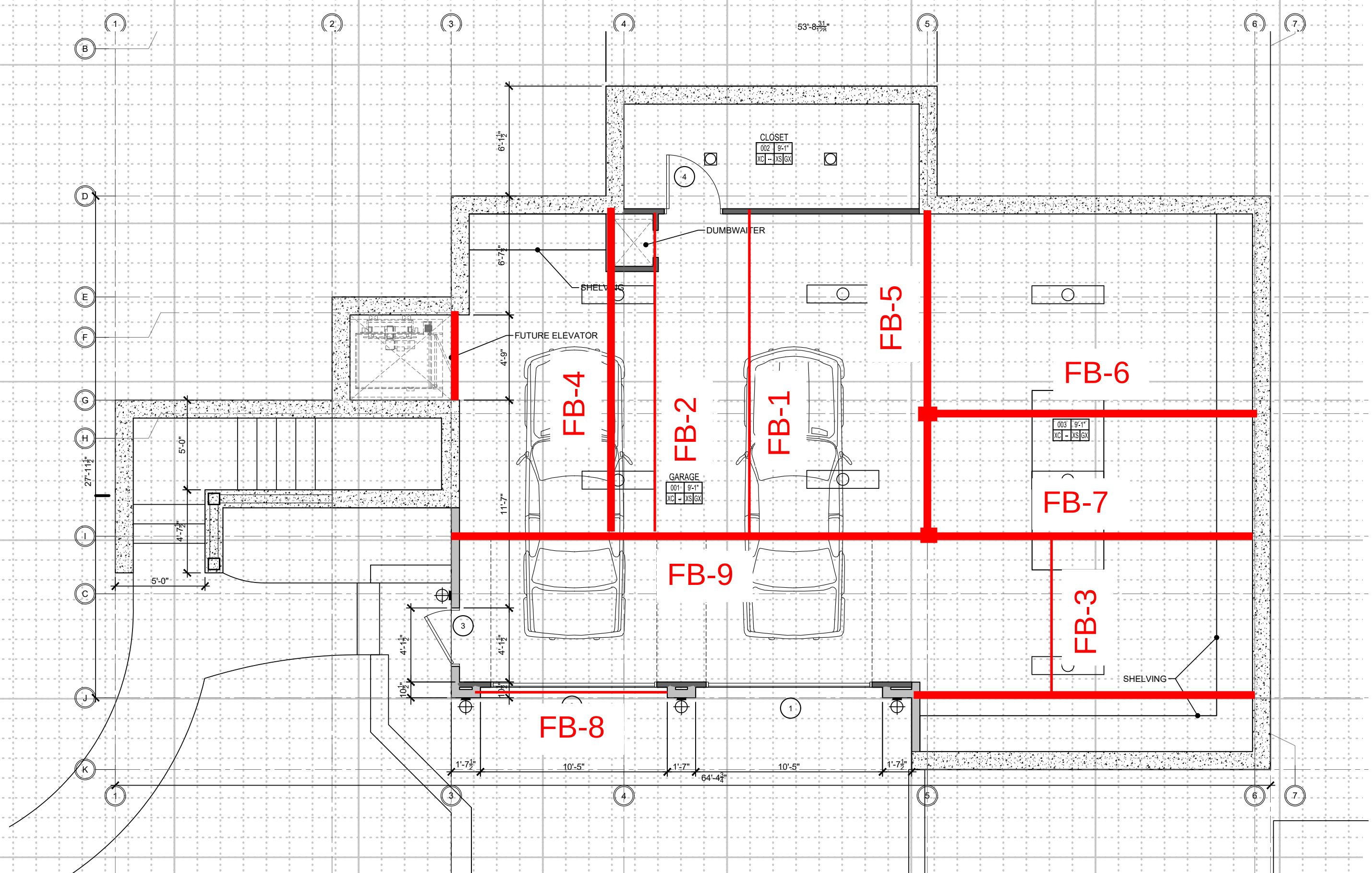
Current Design: Key Structural Plan

Vertical Key Plan
Floor



Date: ____________ By: ___________ Project: ______________________________

Vertical Key Plan
Floor



WETHINGTON
ENGINEERING, INC

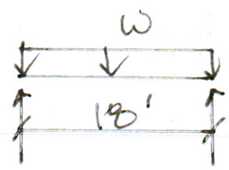
Date: 11/22 By: HW Project: 2022-024 Knuggel

(FB-1) Typ Floor Joist

FLOOR (w)

Trib = 1'

* spacing determined in analysis program



16" TJI 230 @ 16" OC
w/ IUS 2.37/16 hanger

(FB-2) Floor beam @ dumbwaiter opening

FLOOR (w)

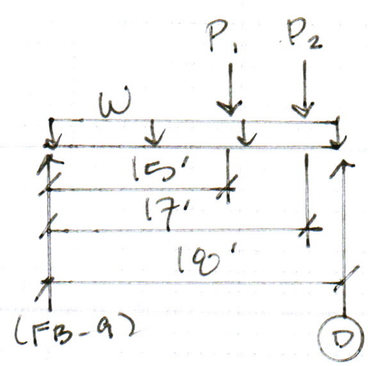
TRIB = 2'

RB-14 (P1)

TRIB = R1

RB-14 (P2)

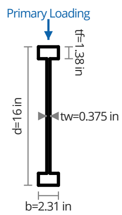
TRIB = R2

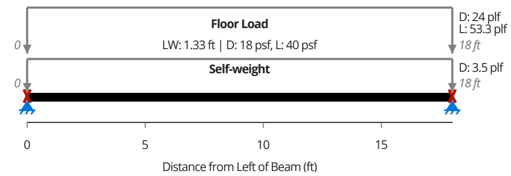


2 - 1 3/4" x 16" LVL w/
IUS 3.56/16 hanger

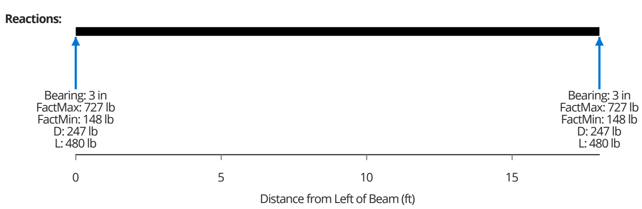
Client:		**Date:**	Dec 9, 2022
Author:	Heather Wethington	**Job #:**	2022-024
Project:	Kruggel	**Subject:**	**FB-1** PASS
References:	NDS 2018 (ASD)		

Summary





	Member		16" TJI 230
57%	Moment Utilization	$M/M' =$	3270 lb*ft / 5710 lb*ft
33%	Shear Utilization	$V/V' =$	727 lb / 2190 lb
53%	Bearing Utilization	$R/R' =$	727 lb / 1360 lb
61%	Governing Live / Short-Term Deflection	$\delta_{ST} =$	-0.219 in (L/989)
30%	Governing Long-Term Deflection	$\delta_{LT} =$	-0.266 in (L/814)
	Governing Long-Term Deflection	$\delta_{LT} =$	-0.266 in



Key Properties

Beam Plan Length	$L_X =$	18 ft

Loads

Design Conditions

Design Code for Load Combinations	International Building Code (IBC) 2018

Member Properties

Base Allowable Moment	$M_r =$	5710 lb · ft
Base Allowable Shear	$V_r =$	2190 lb
Base Perpendicular Compression Allowable Stress	$F_{c\perp} =$	0 psi

Section Bending (NDS 2018 2.3)

Governing Duration Factor in Bending	$C_{D,b} =$	1
Beam Stability Factor	$C_L =$	1
Adjusted Allowable Moment	$M_r' =$	5710 lb · ft

Shear Design (NDS 2018 3.4)

Governing Duration Factor	$C_D =$	1
Adjusted Allowable Shear	$V_r' =$	2190 lb

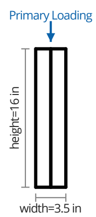
Bearing (NDS 2018 3.10)

Base Bearing Strength	$F_{c\perp}'/C_b =$	0 psi

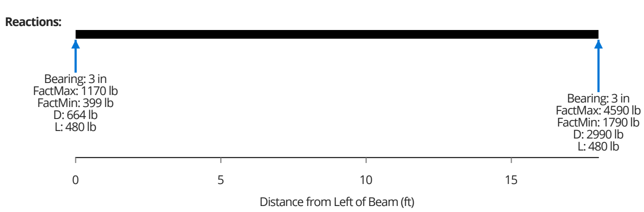
Comments

Client:		**Date:**	Dec 9, 2022
Author:	Cameron Cunningham	**Job #:**	2022-024
Project:	Kruggel	**Subject:**	**FB-2** PASS
References:	NDS 2018 (ASD)		

Summary



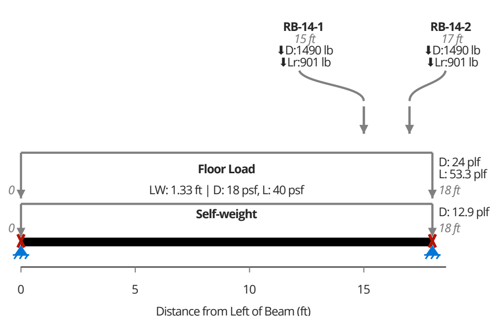
	Member		2 plies - 1-3/4x16 Microllam LVL 2.0E-2600Fb
22%	Moment Utilization	$M/M' =$	7260 lb*ft / 32 400 lb*ft
35%	Shear Utilization	$V/V' =$	4590 lb / 13 300 lb
58%	Bearing Utilization	$R/R' =$	4590 lb / 7870 lb
	Minimum Bearing Length (End Supports)	$\ell_{b,min,end} =$	1.75 in
33%	Governing Live / Short-Term Deflection	$\delta_{ST} =$	-0.119 in (L/1810)
20%	Governing Long-Term Deflection	$\delta_{LT} =$	-0.181 in (L/1200)
	Governing Long-Term Deflection	$\delta_{LT} =$	-0.181 in



Key Properties

Beam Plan Length	$L_X =$	18 ft
Continuous Bracing for Lateral Torsional Buckling		Top Braced

Loads



Design Conditions

Design Code for Load Combinations		International Building Code (IBC) 2018

Member Properties

Cross-Sectional Area	$A =$	56 in²
Strong Axis Moment of Inertia	$I_{xx} =$	1190 in⁴
Section Modulus	$S =$	149 in³
Base Allowable Bending Stress	$F_b =$	2600 psi
Base Allowable Shear Stress	$F_v =$	285 psi
Base Perpendicular Compression Allowable Stress	$F_{c\perp} =$	750 psi
True Modulus of Elasticity	$E_{true} =$	$2\,000\,000$ psi
Apparent Modulus of Elasticity	$E_{app} =$	NaN psi
Modulus of Elasticity for Deflections	$E =$	$2\,000\,000$ psi

Elastic Modulus (NDS 2018 2.3)

Adjusted Modulus of Elasticity	$E' =$	$2\,000\,000$ psi
Adjusted Shear Modulus	$G' =$	$125\,000$ psi

Section Bending (NDS 2018 2.3)

Volume Factor	$C_V =$	0.962

Positive Bending (NDS 2018 2.3)

Governing Duration Factor - Positive Bending	$C_{D,b}^{+} =$	1
Governing Beam Stability Factor - Positive Bending	$C_L^{+} =$	1
Adjusted Bending Strength - Positive Bending	$F_b'^{+} =$	2600 psi

Negative Bending (NDS 2018 2.3)

Governing Duration Factor - Negative Bending	$C_{D,b}^{-} =$	0.9
Governing Beam Stability Factor - Negative Bending	$C_L^{-} =$	0.83
Adjusted Bending Strength - Negative Bending	$F_b'^{-} =$	2020 psi

Shear Design (NDS 2018 3.4)

Governing Duration Factor	$C_D =$	1.25
Adjusted Shear Strength	$F_v' =$	356 psi

Bearing (NDS 2018 3.10)

Base Bearing Strength	$F_{c\perp}'/C_b =$	750 psi

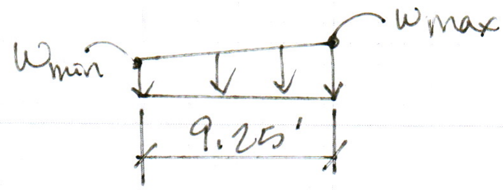
Comments

Date: 11/22 By: HW Project: 2022·024 Kruggel

(FB-3) Typ Deck Joist

Deck (Wmin/Wmax)

TRIB = 1' / 1.33'



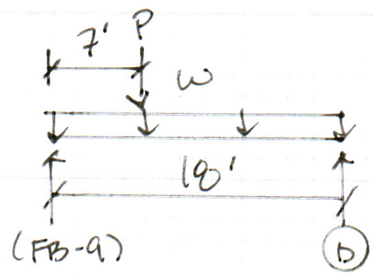
1 3/4" x 9 1/4" LVL @ 16" oc
w/ MIU 1.81/9 hanger

(FB-4) Floor Beam @ Grid 4

	TRUSS ROOF	+ EXT WALL	+ FLOOR	+ DECK	(w)
TRIB =	2'	10'	1'	4'	

PORCH ROOF (P)

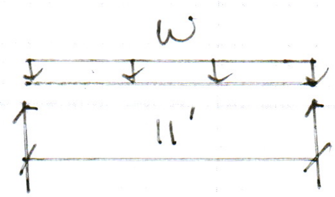
TRIB = 27.6 SF



7" x 16" PSL w/
HGU 7.25-SDS hanger

(FB-5) Floor Beam @ Grid 5

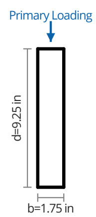
	TRUSS ROOF	+ STICK ROOF	+ INT WALL	+ FLOOR	+ DECK	(w)
TRIB =	2'	4.5'	10'	1'	1'	



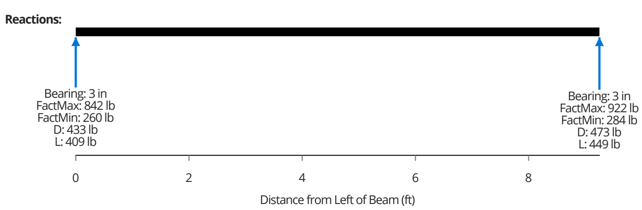
5 1/4" x 16" PSL w/
MGU5.50-SDS hanger

Client:		**Date:**	Dec 9, 2022
Author:	Heather Wethington	**Job #:**	2022-024
Project:	Kruggel	**Subject:**	**FB-3** PASS
References:	NDS 2018 (ASD)		

Summary



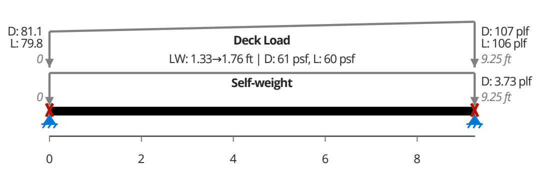
	Member		1-3/4x9-1/4 Microllam LVL 2.0E-2600Fb
35%	Moment Utilization	$M/M' =$	2040 lb*ft / 5830 lb*ft
30%	Shear Utilization	$V/V' =$	922 lb / 3080 lb
23%	Bearing Utilization	$R/R' =$	922 lb / 3940 lb
	Minimum Bearing Length (End Supports)	$\ell_{b,min,end} =$	0.702 in
42%	Governing Live / Short-Term Deflection	$\delta_{ST} =$	-0.0769 in (L/1440)
24%	Governing Long-Term Deflection	$\delta_{LT} =$	-0.112 in (L/992)
	Governing Long-Term Deflection	$\delta_{LT} =$	-0.112 in



Key Properties

Beam Plan Length	$L_X =$	9.25 ft
Continuous Bracing for Lateral Torsional Buckling		Top Braced

Loads



Design Conditions

Design Code for Load Combinations	International Building Code (IBC) 2018

Member Properties

Cross-Sectional Area	$A =$	16.2 in^2
Strong Axis Moment of Inertia	$I_{xx} =$	115 in^4
Section Modulus	$S =$	25 in^3
Base Allowable Bending Stress	$F_b =$	2600 psi
Base Allowable Shear Stress	$F_v =$	285 psi
Base Perpendicular Compression Allowable Stress	$F_{c\perp} =$	750 psi
True Modulus of Elasticity	$E_{true} =$	$2\,000\,000$ psi
Apparent Modulus of Elasticity	$E_{app} =$	NaN psi
Modulus of Elasticity for Deflections	$E =$	$2\,000\,000$ psi

Elastic Modulus (NDS 2018 2.3)

Adjusted Modulus of Elasticity	$E' =$	$2\,000\,000$ psi
Adjusted Shear Modulus	$G' =$	$125\,000$ psi

Section Bending (NDS 2018 2.3)

Volume Factor	$C_V =$	1.04

Positive Bending (NDS 2018 2.3)

Governing Duration Factor - Positive Bending	$C_{D,b}^{+} =$	1
Governing Beam Stability Factor - Positive Bending	$C_L^{+} =$	1
Adjusted Bending Strength - Positive Bending	$F_b'^{+} =$	2800 psi

Negative Bending (NDS 2018 2.3)

Governing Duration Factor - Negative Bending	$C_{D,b}^{-} =$	0.9
Governing Beam Stability Factor - Negative Bending	$C_L^{-} =$	0.67
Adjusted Bending Strength - Negative Bending	$F_b'^{-} =$	1690 psi

Shear Design (NDS 2018 3.4)

Governing Duration Factor	$C_D =$	1
Adjusted Shear Strength	$F_v' =$	285 psi

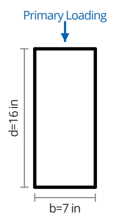
Bearing (NDS 2018 3.10)

Base Bearing Strength	$F_{c\perp}'/C_b =$	750 psi

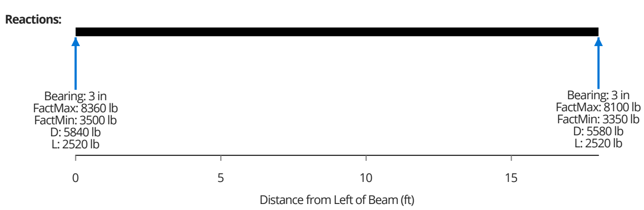
Comments

Client:		Date:	Dec 9, 2022
Author:	Cameron Cunningham	Job #:	2022-024
Project:	Kruggel	Subject:	FB-4 PASS
References:	NDS 2018 (ASD)		

Summary



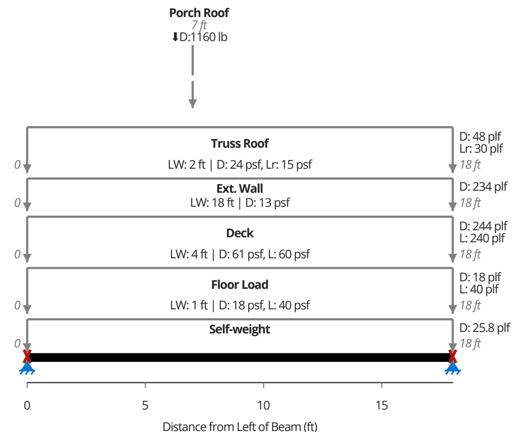
	Member		7x16 Parallam PSL 2.0E-2900Fb
53%	Moment Utilization	$M/M' =$	38 600 lb*ft / 72 700 lb*ft
39%	Shear Utilization	$V/V' =$	8360 lb / 21 700 lb
64%	Bearing Utilization	$R/R' =$	8360 lb / 13 100 lb
	Minimum Bearing Length (End Supports)	$\ell_{b,min,end} =$	1.91 in
50%	Governing Live / Short-Term Deflection	$\delta_{ST} =$	-0.18 in (L/1200)
38%	Governing Long-Term Deflection	$\delta_{LT} =$	-0.345 in (L/627)
	Governing Long-Term Deflection	$\delta_{LT} =$	-0.345 in



Key Properties

PSL is Treated / Wolmanized?		No
Beam Plan Length	$L_X =$	18 ft
Continuous Bracing for Lateral Torsional Buckling		Top Braced

Loads



Design Conditions

Design Code for Load Combinations	International Building Code (IBC) 2018

Member Properties

Cross-Sectional Area	$A =$	112 in²
Strong Axis Moment of Inertia	$I_{xx} =$	2390 in⁴
Section Modulus	$S =$	299 in³
Base Allowable Bending Stress	$F_b =$	2900 psi
Base Allowable Shear Stress	$F_v =$	290 psi
Base Perpendicular Compression Allowable Stress	$F_{c\perp} =$	625 psi
True Modulus of Elasticity	$E_{true} =$	$2\,000\,000$ psi
Apparent Modulus of Elasticity	$E_{app} =$	NaN psi
Modulus of Elasticity for Deflections	$E =$	$2\,000\,000$ psi

Elastic Modulus (NDS 2018 2.3)

Adjusted Modulus of Elasticity	$E' =$	$2\,000\,000$ psi
Adjusted Shear Modulus	$G' =$	$125\,000$ psi

Section Bending (NDS 2018 2.3)

Volume Factor	$C_V =$	0.969

Positive Bending (NDS 2018 2.3)

Governing Duration Factor - Positive Bending	$C_{D,b}^{+} =$	1
Governing Beam Stability Factor - Positive Bending	$C_L^{+} =$	1
Adjusted Bending Strength - Positive Bending	$F_b'^{+} =$	2920 psi

Negative Bending (NDS 2018 2.3)

Governing Duration Factor - Negative Bending	$C_{D,b}^{-} =$	0.9
Governing Beam Stability Factor - Negative Bending	$C_L^{-} =$	0.98
	$F_b'^{-} =$	2630 psi

Adjusted Bending Strength - Negative Bending

Shear Design (NDS 2018 3.4)

Governing Duration Factor $C_D = 1$

Adjusted Shear Strength $F'_v = 290\ \mathrm{psi}$

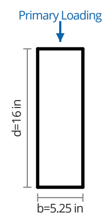
Bearing (NDS 2018 3.10)

Base Bearing Strength $F'_{c\perp}/C_b = 625\ \mathrm{psi}$

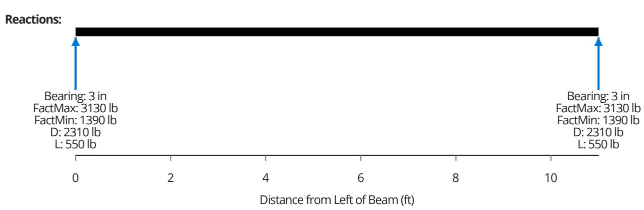
Comments

Client:		**Date:**	Dec 9, 2022
Author:	Cameron Cunningham	**Job #:**	2022-024
Project:	Kruggel	**Subject:**	**FB-5** PASS
References:	NDS 2018 (ASD)		

Summary



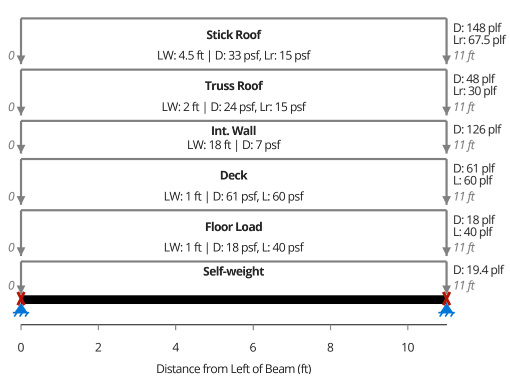
	Member		5-1/4x16 Parallam PSL 2.0E-2900Fb
14%	Moment Utilization	$M/M' =$	7880 lb*ft / 54 500 lb*ft
18%	Shear Utilization	$V/V' =$	2860 lb / 16 200 lb
32%	Bearing Utilization	$R/R' =$	3130 lb / 9840 lb
	Minimum Bearing Length (End Supports)	$\ell_{b,min,end} =$	0.954 in
12%	Governing Live / Short-Term Deflection	$\delta_{ST} =$	-0.0266 in (L/4960)
8%	Governing Long-Term Deflection	$\delta_{LT} =$	-0.046 in (L/2870)
	Governing Long-Term Deflection	$\delta_{LT} =$	-0.046 in



Key Properties

PSL is Treated / Wolmanized?		No
Beam Plan Length	$L_X =$	11 ft
Continuous Bracing for Lateral Torsional Buckling		Top Braced

Loads



Design Conditions

Design Code for Load Combinations		International Building Code (IBC) 2018

Member Properties

Cross-Sectional Area	$A =$	84 in²
Strong Axis Moment of Inertia	$I_{xx} =$	1790 in⁴
Section Modulus	$S =$	224 in³
Base Allowable Bending Stress	$F_b =$	2900 psi
Base Allowable Shear Stress	$F_v =$	290 psi
Base Perpendicular Compression Allowable Stress	$F_{c\perp} =$	625 psi
True Modulus of Elasticity	$E_{true} =$	$2\,000\,000$ psi
Apparent Modulus of Elasticity	$E_{app} =$	NaN psi
Modulus of Elasticity for Deflections	$E =$	$2\,000\,000$ psi

Elastic Modulus (NDS 2018 2.3)

Adjusted Modulus of Elasticity	$E' =$	$2\,000\,000$ psi
Adjusted Shear Modulus	$G' =$	$125\,000$ psi

Section Bending (NDS 2018 2.3)

Volume Factor	$C_V =$	0.969

Positive Bending (NDS 2018 2.3)

Governing Duration Factor - Positive Bending	$C_{D,b}^{+} =$	1
Governing Beam Stability Factor - Positive Bending	$C_L^{+} =$	1
Adjusted Bending Strength - Positive Bending	$F_b'^{+} =$	2920 psi

Negative Bending (NDS 2018 2.3)

Governing Duration Factor - Negative Bending	$C_{D,b}^{-} =$	0.9
Governing Beam Stability Factor - Negative Bending	$C_L^{-} =$	0.973
Adjusted Bending Strength - Negative Bending	$F_b'^{-} =$	2630 psi

Shear Design (NDS 2018 3.4)

Governing Duration Factor	$C_D =$	1
Adjusted Shear Strength	$F_v' =$	290 psi

Bearing (NDS 2018 3.10)

Base Bearing Strength	$F_{c\perp}'/C_b =$	625 psi

Comments

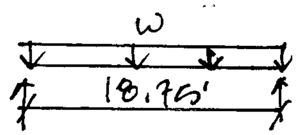
WETHINGTON
ENGINEERING, INC.

Date: 11/22 By: HW Project: 2022-024 Kruggel

(FB-6) Floor Beam @ Grid H

STICK ROOF	+ EXT WALL	+ FLOOR	+ DECK
TRIB = 2'	14.1'	6'	4.6'

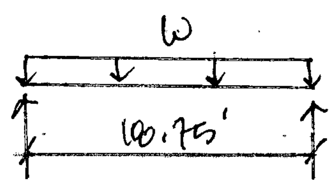
↑ increased trib to account for thicker conc @ deck



7"x18" PSL

(FB-7) Floor Beam on Grid I bet. 5 & 6

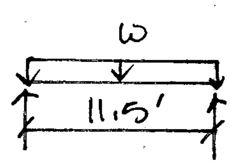
DECK
TRIB = 10'



7"x18" PSL

(FB-8) Garage Header

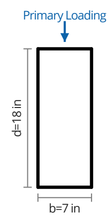
DECK
TRIB = 4.7'



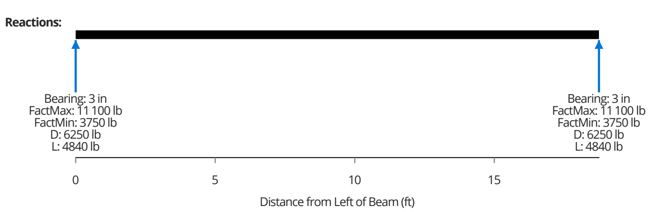
3-1 3/4" x 9 1/4" LVL

Client:		**Date:**	Dec 9, 2022	
Author:	Cameron Cunningham	**Job #:**	2022-024	
Project:	Kruggel	**Subject:**	**FB-6**	PASS
References:	NDS 2018 (ASD)			

Summary



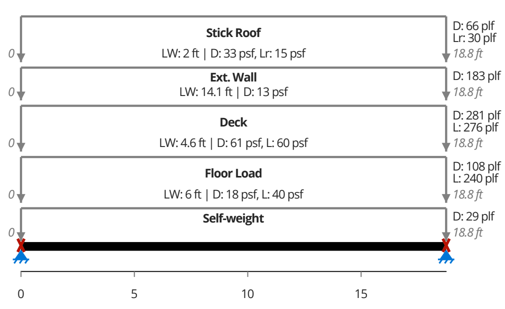
	Member		7x18 Parallam PSL 2.0E-2900Fb
57%	Moment Utilization	$M/M' =$	52 000 lb*ft / 90 800 lb*ft
46%	Shear Utilization	$V/V' =$	11 100 lb / 24 400 lb
84%	Bearing Utilization	$R/R' =$	11 100 lb / 13 100 lb
	Minimum Bearing Length (End Supports)	$\ell_{b,min,end} =$	2.53 in
69%	Governing Live / Short-Term Deflection	$\delta_{ST} =$	-0.258 in (L/870)
42%	Governing Long-Term Deflection	$\delta_{LT} =$	-0.395 in (L/570)
	Governing Long-Term Deflection	$\delta_{LT} =$	-0.395 in



Key Properties

PSL is Treated / Wolmanized?		No
Beam Plan Length	$L_X =$	18.8 ft
Continuous Bracing for Lateral Torsional Buckling		Top Braced

Loads



Design Conditions

Design Code for Load Combinations		International Building Code (IBC) 2018

Member Properties

Cross-Sectional Area	$A =$	126 in^2
Strong Axis Moment of Inertia	$I_{xx} =$	3400 in^4
Section Modulus	$S =$	378 in^3
Base Allowable Bending Stress	$F_b =$	2900 psi
Base Allowable Shear Stress	$F_v =$	290 psi
Base Perpendicular Compression Allowable Stress	$F_{c\perp} =$	625 psi
True Modulus of Elasticity	$E_{true} =$	$2\,000\,000$ psi
Apparent Modulus of Elasticity	$E_{app} =$	NaN psi
Modulus of Elasticity for Deflections	$E =$	$2\,000\,000$ psi

Elastic Modulus (NDS 2018 2.3)

Adjusted Modulus of Elasticity	$E' =$	$2\,000\,000$ psi
Adjusted Shear Modulus	$G' =$	$125\,000$ psi

Section Bending (NDS 2018 2.3)

Volume Factor	$C_V =$	0.956

Positive Bending (NDS 2018 2.3)

Governing Duration Factor - Positive Bending	$C^+_{D,b} =$	1
Governing Beam Stability Factor - Positive Bending	$C^+_L =$	1
Adjusted Bending Strength - Positive Bending	$F'^+_b =$	2880 psi

Negative Bending (NDS 2018 2.3)

Governing Duration Factor - Negative Bending	$C^-_{D,b} =$	0.9
Governing Beam Stability Factor - Negative Bending	$C^-_L =$	0.974
Adjusted Bending Strength - Negative Bending	$F'^-_b =$	2590 psi

Shear Design (NDS 2018 3.4)

Governing Duration Factor	$C_D =$	1
Adjusted Shear Strength	$F'_v =$	290 psi

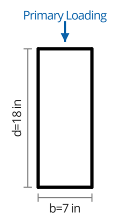
Bearing (NDS 2018 3.10)

Base Bearing Strength	$F'_{c\perp}/C_b =$	625 psi

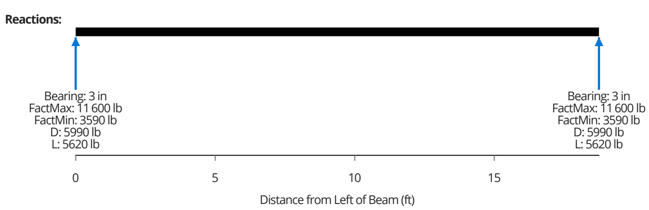
Comments

Client:		Date:	Dec 9, 2022
Author:	Cameron Cunningham	Job #:	2022-024
Project:	Kruggel	Subject:	FB-7 PASS
References:	NDS 2018 (ASD)		

Summary



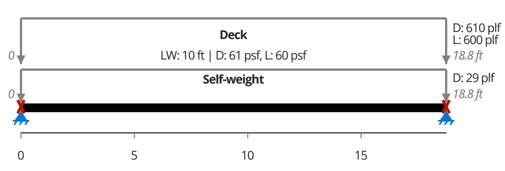
	Member		7x18 Parallam PSL 2.0E-2900Fb
60%	Moment Utilization	$M/M' =$	54 400 lb*ft / 90 800 lb*ft
48%	Shear Utilization	$V/V' =$	11 600 lb / 24 400 lb
89%	Bearing Utilization	$R/R' =$	11 600 lb / 13 100 lb
	Minimum Bearing Length (End Supports)	$\ell_{b,min,end} =$	2.66 in
75%	Governing Live / Short-Term Deflection	$\delta_{ST} =$	-0.282 in (L/797)
44%	Governing Long-Term Deflection	$\delta_{LT} =$	-0.413 in (L/545)
	Governing Long-Term Deflection	$\delta_{LT} =$	-0.413 in



Key Properties

PSL is Treated / Wolmanized?		No
Beam Plan Length	$L_X =$	18.8 ft
Continuous Bracing for Lateral Torsional Buckling		Top Braced

Loads



Design Conditions

Design Code for Load Combinations	International Building Code (IBC) 2018

Member Properties

Cross-Sectional Area	$A =$	126 in²
Strong Axis Moment of Inertia	$I_{xx} =$	3400 in⁴
Section Modulus	$S =$	378 in³
Base Allowable Bending Stress	$F_b =$	2900 psi
Base Allowable Shear Stress	$F_v =$	290 psi
Base Perpendicular Compression Allowable Stress	$F_{c\perp} =$	625 psi
True Modulus of Elasticity	$E_{true} =$	$2\,000\,000$ psi
Apparent Modulus of Elasticity	$E_{app} =$	NaN psi
Modulus of Elasticity for Deflections	$E =$	$2\,000\,000$ psi

Elastic Modulus (NDS 2018 2.3)

Adjusted Modulus of Elasticity	$E' =$	$2\,000\,000$ psi
Adjusted Shear Modulus	$G' =$	$125\,000$ psi

Section Bending (NDS 2018 2.3)

Volume Factor	$C_V =$	0.956

Positive Bending (NDS 2018 2.3)

Governing Duration Factor - Positive Bending	$C_{D,b}^{+} =$	1
Governing Beam Stability Factor - Positive Bending	$C_L^{+} =$	1
Adjusted Bending Strength - Positive Bending	$F_b'^{+} =$	2880 psi

Negative Bending (NDS 2018 2.3)

Governing Duration Factor - Negative Bending	$C_{D,b}^{-} =$	0.9
Governing Beam Stability Factor - Negative Bending	$C_L^{-} =$	0.974
Adjusted Bending Strength - Negative Bending	$F_b'^{-} =$	2590 psi

Shear Design (NDS 2018 3.4)

Governing Duration Factor	$C_D =$	1
Adjusted Shear Strength	$F_v' =$	290 psi

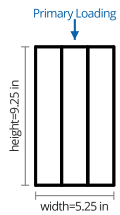
Bearing (NDS 2018 3.10)

Base Bearing Strength	$F_{c\perp}'/C_b =$	625 psi

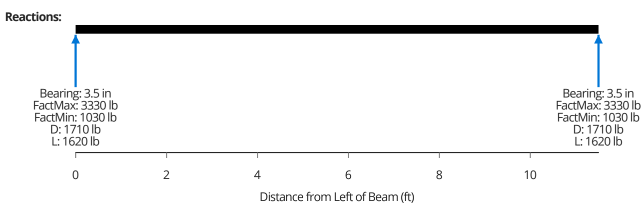
Comments

Client:		**Date:**	Dec 9, 2022
Author:	Heather Wethington	**Job #:**	2022-024
Project:	Kruggel	**Subject:**	**FB-8** PASS
References:	NDS 2018 (ASD)		

Summary



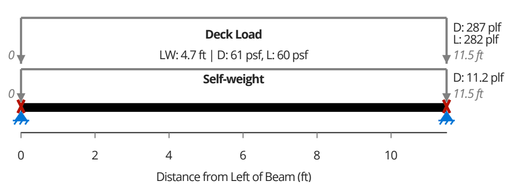
	Member		3 plies - 1-3/4x9-1/4 Microllam LVL 2.0E-2600Fb
56%	Moment Utilization	$M/M' =$	9590 lb*ft / 17 300 lb*ft
36%	Shear Utilization	$V/V' =$	3330 lb / 9230 lb
24%	Bearing Utilization	$R/R' =$	3330 lb / 13 800 lb
	Minimum Bearing Length (End Supports)	$\ell_{b,min,end} =$	0.847 in
77%	Governing Live / Short-Term Deflection	$\delta_{ST} =$	-0.177 in (L/779)
46%	Governing Long-Term Deflection	$\delta_{LT} =$	-0.262 in (L/527)
	Governing Long-Term Deflection	$\delta_{LT} =$	-0.262 in



Key Properties

Beam Plan Length	$L_X =$	11.5 ft
Continuous Bracing for Lateral Torsional Buckling		No Continuous Bracing

Loads



Design Conditions

Design Code for Load Combinations	International Building Code (IBC) 2018

Member Properties

Cross-Sectional Area	$A =$	48.6 in²
Strong Axis Moment of Inertia	$I_{xx} =$	346 in⁴
Section Modulus	$S =$	74.9 in³
Base Allowable Bending Stress	$F_b =$	2600 psi
Base Allowable Shear Stress	$F_v =$	285 psi
Base Perpendicular Compression Allowable Stress	$F_{c\perp} =$	750 psi
True Modulus of Elasticity	$E_{true} =$	$2\,000\,000$ psi
Apparent Modulus of Elasticity	$E_{app} =$	NaN psi
Modulus of Elasticity for Deflections	$E =$	$2\,000\,000$ psi

Elastic Modulus (NDS 2018 2.3)

Adjusted Modulus of Elasticity	$E' =$	$2\,000\,000$ psi
Adjusted Shear Modulus	$G' =$	$125\,000$ psi

Section Bending (NDS 2018 2.3)

Volume Factor	$C_V =$	1.04

Positive Bending (NDS 2018 2.3)

Governing Duration Factor - Positive Bending	$C_{D,b}^{+} =$	1
Governing Beam Stability Factor - Positive Bending	$C_L^{+} =$	0.988
Adjusted Bending Strength - Positive Bending	$F_b'^{+} =$	2770 psi

Negative Bending (NDS 2018 2.3)

Governing Duration Factor - Negative Bending	$C_{D,b}^{-} =$	0.9
Governing Beam Stability Factor - Negative Bending	$C_L^{-} =$	0.989
Adjusted Bending Strength - Negative Bending	$F_b'^{-} =$	2490 psi

Shear Design (NDS 2018 3.4)

Governing Duration Factor	$C_D =$	1
Adjusted Shear Strength	$F_v' =$	285 psi

Bearing (NDS 2018 3.10)

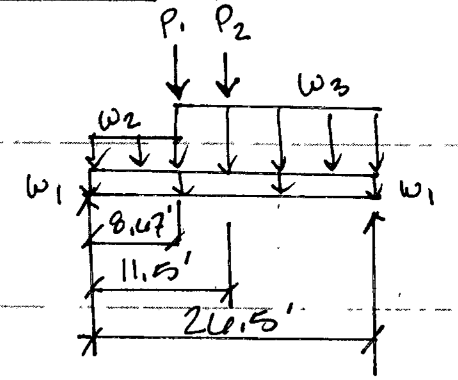
Base Bearing Strength	$F_{c\perp}'/C_b =$	750 psi

Comments

WETHINGTON
ENGINEERING, INC.

Date: 11/22 By: HW Project: 2022-024 Kruggel

(FB-9) Floor Beam on Grid I bet. 4&5



DECK (W1)
TRIB = 4.5'

DECK (W2)
TRIB = 1.33'

TRUSS ROOF + EXT WALL + FLOOR (W3)
TRIB = 90' 9' 9'

FB-4 (P1)
TRIB = R1

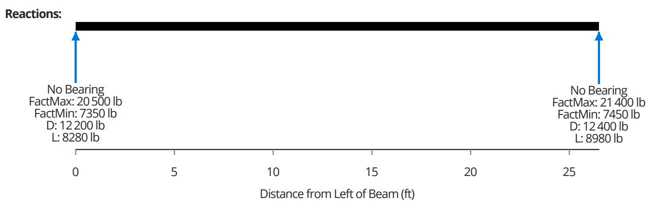
FB-2 (P2)
TRIB = R1

W16x67

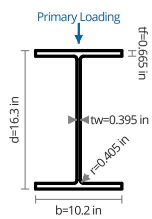
Client:		**Date:**	Dec 9, 2022
Author:	Cameron Cunningham	**Job #:**	2022-024
Project:	Kruggel	**Subject:**	**FB-9** PASS
References:	AISC 360-16 (ASD)		

Summary

69%	Allowable Bending Moment Strength	$M_n/\Omega =$	$231\,000$ lb · ft
17%	Allowable Shear Strength	$V_n/\Omega =$	$129\,000$ lb
63%	Critical Deflection	$\delta_{gov} =$	-0.335 in
	Critical Deflection Ratio	$L/ =$	948
	Dead Load Deflection	$\delta_D =$	-0.423 in

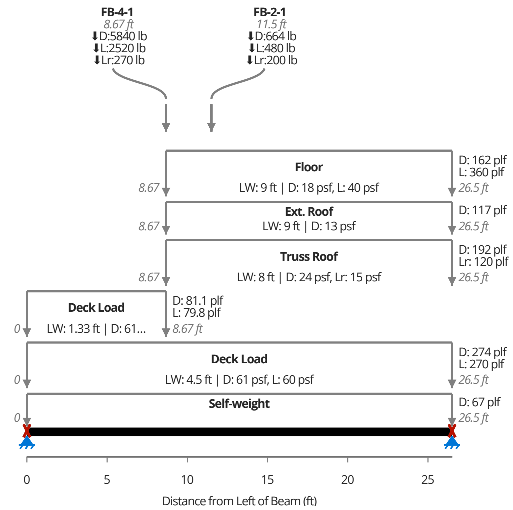


Key Properties



Designation		W16X67
Yield Strength	$F_y =$	$50\,000$ psi
Beam Plan Length	$L_X =$	26.5 ft
Continuous Bracing for Lateral Torsional Buckling		No continuous bracing

Loads



Design Criteria

Design Code for Load Combinations	$\text{Code} =$	International Building Code (IBC) 2018

Member Properties

Gross Area	$A_g =$	19.6 in²
Moment of Inertia	$I =$	954 in⁴
Section Modulus	$S =$	117 in³
Fully Plastic Length	$L_p =$	8 ft, 8.3 in
Elastic Global Buckling Length	$L_r =$	26 ft, 1 in

Section Classification (AISC 360-16 B4)

Section Classification - Flanges	Compact
Section Classification - Web	Compact

Section Flexural Capacity (AISC 360-16, Chapter F)

Plastic Moment Resistance	$M_p =$	$542\,000$ lb · ft
Nominal Cross-Section Bending Resistance	$M_{sxn} =$	$542\,000$ lb · ft

Flexural Capacity - Positive Bending (AISC 360-16, Chapter F)

Longest Unbraced Segment - Positive Bending	$L^+_{umax} =$	26 ft, 6 in
Lateral-Torsional Buckling Governs? - Positive Bending	$LTB^+_{flag} =$	Yes
Governing LTB Resistance - Positive Bending	$M^+_{LTB} =$	$386\,000$ lb · ft

Flexural Capacity - Negative Bending (AISC 360-16, Chapter F)

Lateral-Torsional Buckling Governs? - Negative Bending	$LTB^-_{flag} =$	No

Shear Capacity (AISC 360-16, Chapter G)

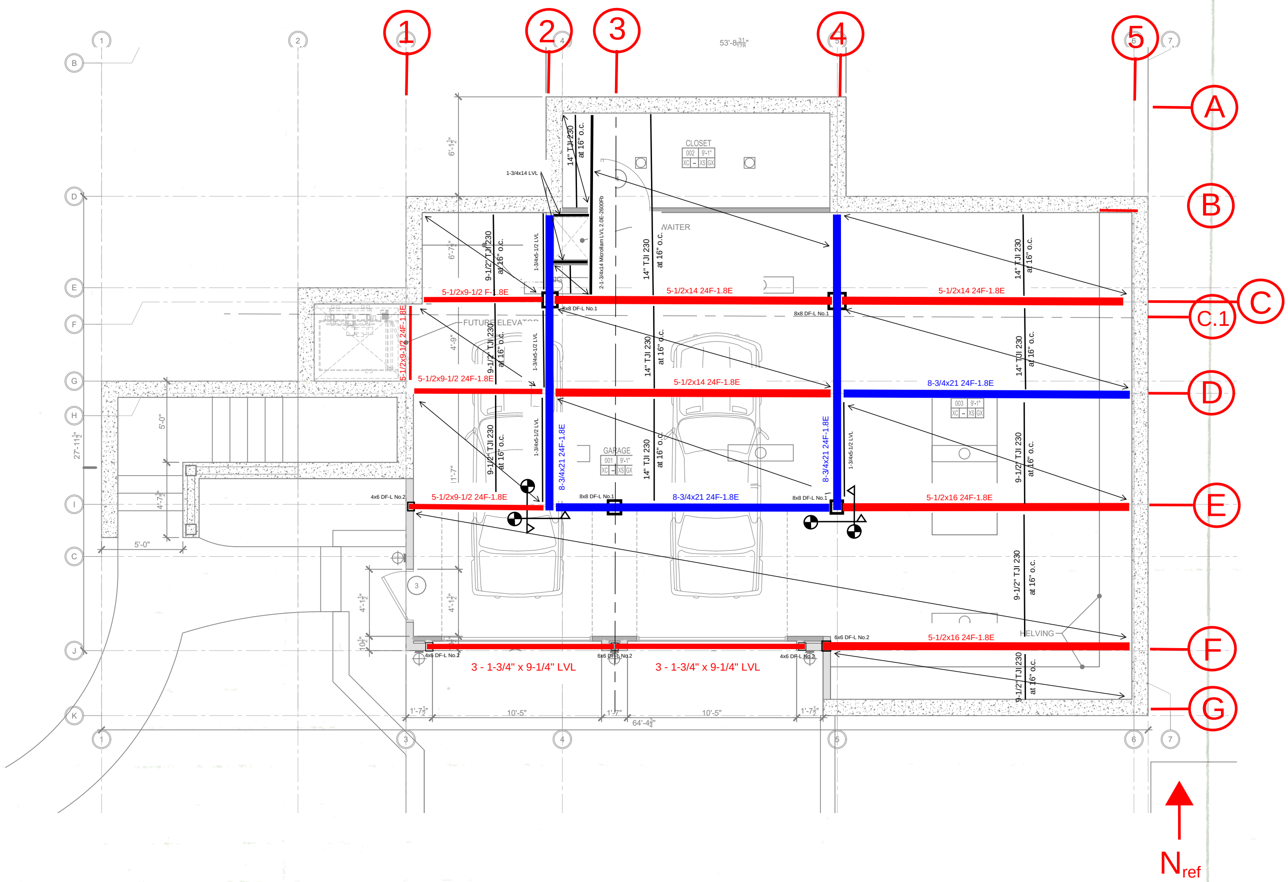
Shear Slenderness	$h/t_w =$	35.9
Web Shear Strength Coefficient	$C_{v1} =$	1

Nominal Shear Capacity	$V_n = 193\,000\ \mathrm{lb}$	Comments

Non-Structural Concrete on Wood w/ Shallow Vercor

Prior Consideration:
Strucutral, Verco decking with Wood/GLB Framing

Key Plan

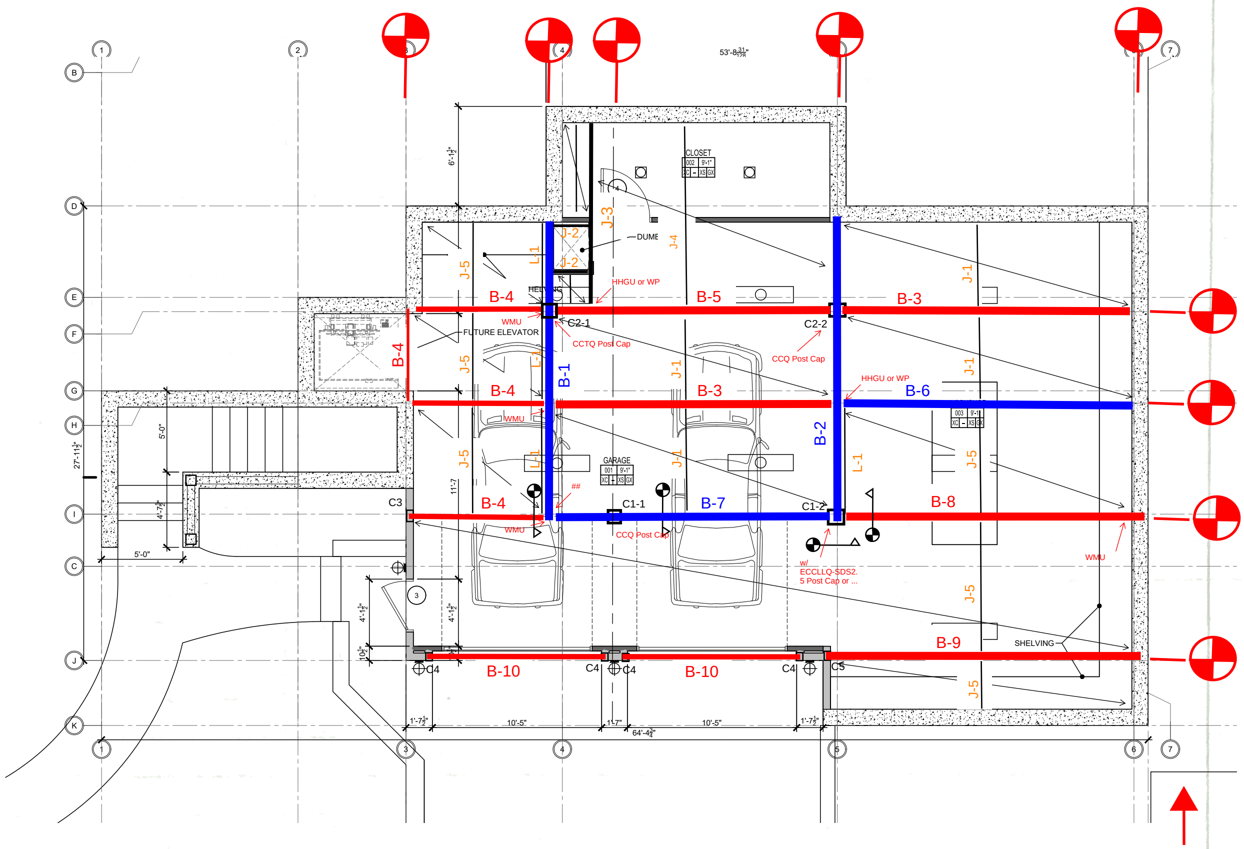


Prior Consideration:

<u>Strucutral, Verco decking with Wood/GLB Framing</u>

Note: to help with constructibility, oversize specific beams to as many connection points are flush. along grid-lines, size most loaded-largest beam, reuse size for continuing members. Primarily do separate calc's to account for differing loading cases.

Design Key Plan



Note: for B-9, since B-9 has 2" deeper depth than B-6/8 --> utilize HHGU hanger for connection at column end

<u>Refer to Clear Calc. Reports for design member choices</u>

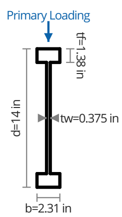
Being conservative with using maximum of height of 9' for all columns for worst cases

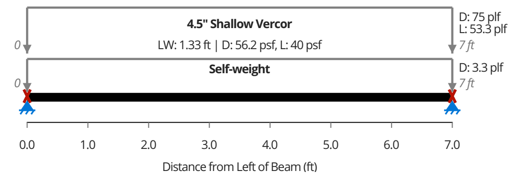
Client:	John Lawson	**Date:**	Oct 14, 2023
Author:	Cameron Cunningham	**Job #:**	ARCE 453-01
Project:	C.S.P. - Prior Consideration Design	**Subject:**	**Member Schedule**

	Calculation	Member	Quantity	Comments
34%	**J-1**	14" TJI 230	7 ft	
10%	**J-2**	1-3/4x14 Microllam LVL 2.0E-2600Fb	2.33 ft	
38%	**J-3**	2 - 1-3/4x14 Microllam LVL 2.0E-2600Fb	11.3 ft	
33%	**J-4**	14" TJI 230	11.3 ft	
51%	**J-5**	9-1/2" TJI 230	9 ft	
14%	**L-1**	1-3/4x5-1/2 Microllam LVL 2.0E-2600Fb	9 ft	
60%	**B-1**	8-3/4x21 24F-1.8E	18 ft	
88%	**B-2**	8-3/4x21 24F-1.8E	18 ft	
62%	**B-3**	5-1/2x14 24F-1.8E	18.5 ft	
53%	**B-4**	5-1/2x9-1/2 24F-1.8E	8.5 ft	
86%	**B-5**	5-1/2x14 24F-1.8E	18 ft	
61%	**B-6**	8-3/4x21 24F-1.8E	18.8 ft	
67%	**B-7**	8-3/4x21 24F-1.8E	18 ft	
95%	**B-8**	5-1/2x16 24F-1.8E	18.8 ft	
95%	**B-9**	5-1/2x16 24F-1.8E	18.8 ft	
45%	**B-10**	3 - 1-3/4x9-1/2 Microllam LVL 2.0E-2600Fb	11.5 ft	
49%	**C1-1**	8x8 D.Fir-L No. 1	9 ft	
13%	**C1-2**	8x8 D.Fir-L No. 2	9 ft	
44%	**C2-1**	8x8 D.Fir-L No. 1	9 ft	
56%	**C2-2**	8x8 D.Fir-L No. 1	9 ft	
25%	**C3**	6x6 D.Fir-L No. 2	9 ft	
54%	**C4**	6x6 D.Fir-L No. 2	9 ft	
32%	**C5**	4x6 D.Fir-L No. 2	9 ft	
19%	**Typ. Ext. Bearing Wall**	2x6 D.Fir-L No. 2	9 ft	
90%	**HDR-1**	4x6 D.Fir-L No. 2	3.75 ft	

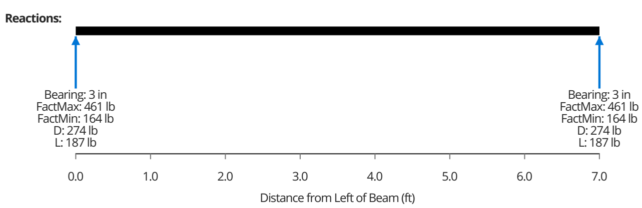
Client:	John Lawson	**Date:**	Oct 14, 2023
Author:	Cameron Cunningham	**Job #:**	ARCE 453-01
Project:	C.S.P. - Prior Consideration Design	**Subject:**	J-1 PASS
References:	NDS 2018 (ASD)		

Summary





	Member		14" TJI 230
16%	Moment Utilization	$M/M' =$	806 lb*ft / 4990 lb*ft
24%	Shear Utilization	$V/V' =$	461 lb / 1950 lb
34%	Bearing Utilization	$R/R' =$	461 lb / 1360 lb
6%	Governing Live / Short-Term Deflection	$\delta_{ST} =$	-0.0143 in (L/5880)
5%	Governing Long-Term Deflection	$\delta_{LT} =$	-0.0184 in (L/4550)
	Governing Long-Term Deflection	$\delta_{LT} =$	-0.0184 in



Key Properties

Beam Plan Length	$L_X =$	7 ft

Loads

Design Conditions

Design Code for Load Combinations	International Building Code (IBC) 2018

Member Properties

Base Allowable Moment	$M_r =$	4990 lb · ft
Base Allowable Shear	$V_r =$	1950 lb
Base Perpendicular Compression Allowable Stress	$F_{c\perp} =$	0 psi

Section Bending (NDS 2018 2.3)

Governing Duration Factor in Bending	$C_{D,b} =$	1
Beam Stability Factor	$C_L =$	1
Adjusted Allowable Moment	$M_r' =$	4990 lb · ft

Shear Design (NDS 2018 3.4)

Governing Duration Factor	$C_D =$	1
Adjusted Allowable Shear	$V_r' =$	1950 lb

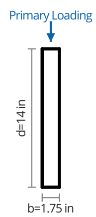
Bearing (NDS 2018 3.10)

Base Bearing Strength	$F'_{c\perp}/C_b =$	0 psi

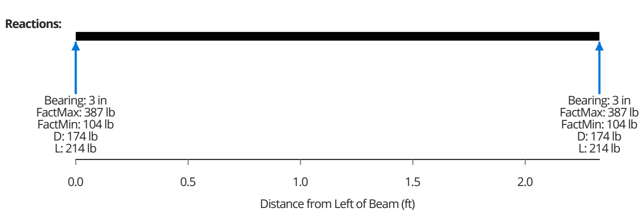
Comments

Client:	John Lawson	**Date:**	Oct 14, 2023
Author:	Cameron Cunningham	**Job #:**	ARCE 453-01
Project:	C.S.P. - Prior Consideration Design	**Subject:**	J-2 PASS
References:	NDS 2018 (ASD)		

Summary



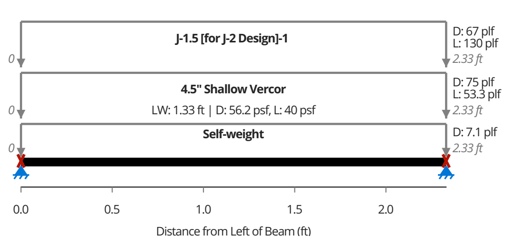
	Member		1-3/4x14 Microllam LVL 2.0E-2600Fb
2%	Moment Utilization	$M/M' =$	226 lb*ft / 12 600 lb*ft
8%	Shear Utilization	$V/V' =$	387 lb / 4650 lb
10%	Bearing Utilization	$R/R' =$	387 lb / 3940 lb
	Minimum Bearing Length (End Supports)	$\ell_{b,min,end} =$	0.295 in
1%	Governing Live / Short-Term Deflection	$\delta_{ST} =$	-0.000975 in (L/28 700)
1%	Governing Long-Term Deflection	$\delta_{LT} =$	-0.00104 in (L/27 000)
	Governing Long-Term Deflection	$\delta_{LT} =$	-0.00104 in



Key Properties

Beam Plan Length	$L_X =$	2.33 ft
Continuous Bracing for Lateral Torsional Buckling		Top Braced

Loads



Design Conditions

Design Code for Load Combinations	International Building Code (IBC) 2018

Member Properties

Cross-Sectional Area	$A =$	24.5 in²
Strong Axis Moment of Inertia	$I_{xx} =$	400 in⁴
Section Modulus	$S =$	57.2 in³
Base Allowable Bending Stress	$F_b =$	2600 psi
Base Allowable Shear Stress	$F_v =$	285 psi
Base Perpendicular Compression Allowable Stress	$F_{c\perp} =$	750 psi
True Modulus of Elasticity	$E_{true} =$	$2\,000\,000$ psi
Apparent Modulus of Elasticity	$E_{app} =$	NaN psi
Modulus of Elasticity for Deflections	$E =$	$2\,000\,000$ psi

Elastic Modulus (NDS 2018 2.3)

Adjusted Modulus of Elasticity	$E' =$	$2\,000\,000$ psi
Adjusted Shear Modulus	$G' =$	$125\,000$ psi

Section Bending (NDS 2018 2.3)

Volume Factor	$C_V =$	0.979

Positive Bending (NDS 2018 2.3)

Governing Duration Factor - Positive Bending	$C_{D,b}^{+} =$	1
Governing Beam Stability Factor - Positive Bending	$C_L^{+} =$	1
Adjusted Bending Strength - Positive Bending	$F_b'^{+} =$	2650 psi

Negative Bending (NDS 2018 2.3)

Governing Duration Factor - Negative Bending	$C_{D,b}^{-} =$	0.9
Governing Beam Stability Factor - Negative Bending	$C_L^{-} =$	0.782
Adjusted Bending Strength - Negative Bending	$F_b'^{-} =$	1900 psi

Shear Design (NDS 2018 3.4)

Governing Duration Factor	$C_D =$	1
Adjusted Shear Strength	$F_v' =$	285 psi

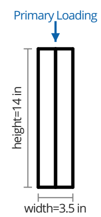
Bearing (NDS 2018 3.10)

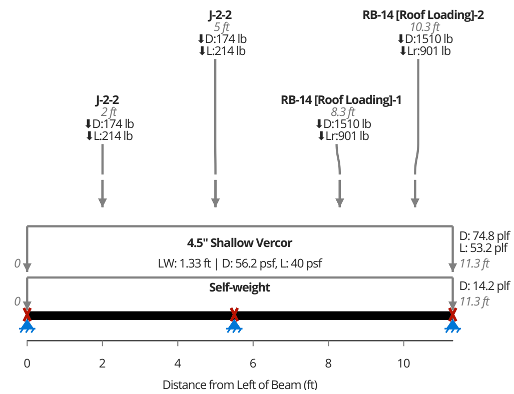
Base Bearing Strength	$F_{c\perp}'/C_b =$	750 psi

Comments

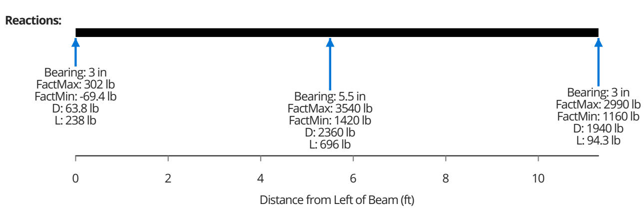
Client:	John Lawson	**Date:**	Oct 14, 2023
Author:	Cameron Cunningham	**Job #:**	ARCE 453-01
Project:	C.S.P. - Prior Consideration Design	**Subject:**	J-3 PASS
References:	NDS 2018 (ASD)		

Summary





	Member		2 plies - 1-3/4x14 Microllam LVL 2.0E-2600Fb
13%	Moment Utilization	$M/M' =$	3770 lb*ft / 29 700 lb*ft
26%	Shear Utilization	$V/V' =$	2990 lb / 11 600 lb
38%	Bearing Utilization	$R/R' =$	2990 lb / 7870 lb
	Minimum Bearing Length (End Supports)	$\ell_{b,min,end} =$	1.14 in
	Minimum Bearing Length (Int Supports)	$\ell_{b,min,int} =$	1.26 in
5%	Governing Live / Short-Term Deflection	$\delta_{ST} =$	-0.0105 in (L/6630)
5%	Governing Long-Term Deflection	$\delta_{LT} =$	-0.0143 in (L/4870)
	Governing Long-Term Deflection	$\delta_{LT} =$	-0.0143 in



Key Properties

Beam Plan Length	$L_X =$	11.3 ft
Continuous Bracing for Lateral Torsional Buckling		No Continuous Bracing

Loads

Design Conditions

Design Code for Load Combinations	International Building Code (IBC) 2018

Member Properties

Cross-Sectional Area	$A =$	49 in²
Strong Axis Moment of Inertia	$I_{xx} =$	800 in⁴
Section Modulus	$S =$	114 in³
Base Allowable Bending Stress	$F_b =$	2600 psi
Base Allowable Shear Stress	$F_v =$	285 psi
Base Perpendicular Compression Allowable Stress	$F_{c\perp} =$	750 psi
True Modulus of Elasticity	$E_{true} =$	$2\,000\,000$ psi
Apparent Modulus of Elasticity	$E_{app} =$	NaN psi
Modulus of Elasticity for Deflections	$E =$	$2\,000\,000$ psi

Elastic Modulus (NDS 2018 2.3)

Adjusted Modulus of Elasticity	$E' =$	$2\,000\,000$ psi
Adjusted Shear Modulus	$G' =$	$125\,000$ psi

Section Bending (NDS 2018 2.3)

Volume Factor	$C_V =$	0.979

Positive Bending (NDS 2018 2.3)

Governing Duration Factor - Positive Bending	$C^+_{D,b} =$	1.25
Governing Beam Stability Factor - Positive Bending	$C^+_L =$	0.96
Adjusted Bending Strength - Positive Bending	$F'^+_b =$	3120 psi

Negative Bending (NDS 2018 2.3)

Governing Duration Factor - Negative Bending	$C^-_{D,b} =$	1
Governing Beam Stability Factor - Negative Bending	$C^-_L =$	0.972
Adjusted Bending Strength - Negative Bending	$F'^-_b =$	2530 psi

Shear Design (NDS 2018 3.4)

Governing Duration Factor	$C_D = 1.25$
Adjusted Shear Strength	$F'_v = 356$ psi

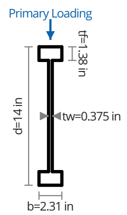
Bearing (NDS 2018 3.10)

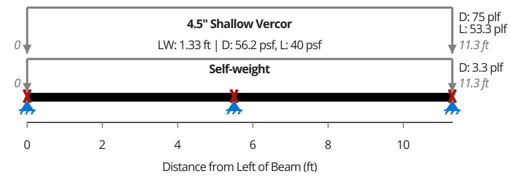
Base Bearing Strength	$F'_{c\perp}/C_b = 750$ psi

Comments

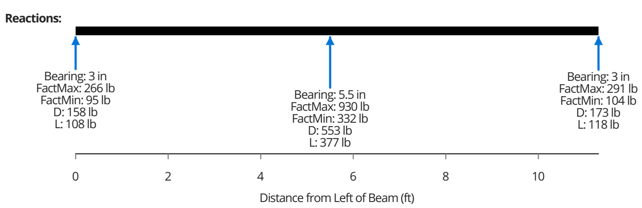
Client:	John Lawson	**Date:**	Oct 14, 2023
Author:	Cameron Cunningham	**Job #:**	ARCE 453-01
Project:	C.S.P. - Prior Consideration Design	**Subject:**	**J-4** PASS
References:	NDS 2018 (ASD)		

Summary





	Member		14" TJI 230
11%	Moment Utilization	$M/M' =$	526 lb*ft / 4990 lb*ft
24%	Shear Utilization	$V/V' =$	472 lb / 1950 lb
33%	Bearing Utilization	$R/R' =$	930 lb / 2790 lb
4%	Governing Live / Short-Term Deflection	$\delta_{ST} =$	-0.00682 in (L/10 200)
3%	Governing Long-Term Deflection	$\delta_{LT} =$	-0.00769 in (L/9060)
	Governing Long-Term Deflection	$\delta_{LT} =$	-0.00769 in



Key Properties

Beam Plan Length	$L_X =$	11.3 ft

Loads

Design Conditions

Design Code for Load Combinations	International Building Code (IBC) 2018

Member Properties

Base Allowable Moment	$M_r =$	4990 lb · ft
Base Allowable Shear	$V_r =$	1950 lb
Base Perpendicular Compression Allowable Stress	$F_{c\perp} =$	0 psi

Section Bending (NDS 2018 2.3)

Governing Duration Factor in Bending	$C_{D,b} =$	1
Beam Stability Factor	$C_L =$	1
Adjusted Allowable Moment	$M'_r =$	4990 lb · ft

Shear Design (NDS 2018 3.4)

Governing Duration Factor	$C_D =$	1
Adjusted Allowable Shear	$V'_r =$	1950 lb

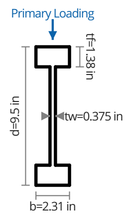
Bearing (NDS 2018 3.10)

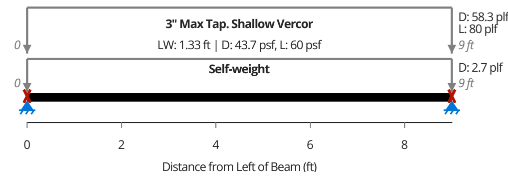
Base Bearing Strength	$F'_{c\perp}/C_b =$	0 psi

Comments

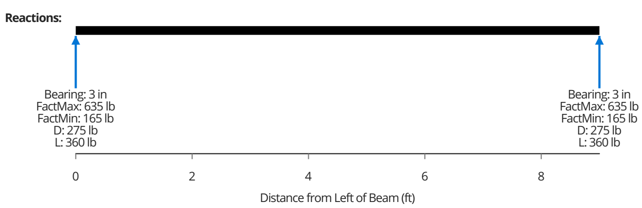
Client:	John Lawson	Date:	Oct 14, 2023
Author:	Cameron Cunningham	Job #:	ARCE 453-01
Project:	C.S.P. - Prior Consideration Design	Subject:	J-5 PASS
References:	NDS 2018 (ASD)		

Summary





	Member		9-1/2" TJI 230
43%	Moment Utilization	$M/M' =$	1430 lb*ft / 3330 lb*ft
48%	Shear Utilization	$V/V' =$	635 lb / 1330 lb
51%	Bearing Utilization	$R/R' =$	635 lb / 1250 lb
27%	Governing Live / Short-Term Deflection	$\delta_{ST} =$	-0.0825 in (L/1310)
23%	Governing Long-Term Deflection	$\delta_{LT} =$	-0.104 in (L/1040)
	Governing Long-Term Deflection	$\delta_{LT} =$	-0.104 in



Key Properties

Beam Plan Length	$L_X =$	9 ft

Loads

Design Conditions

Design Code for Load Combinations	International Building Code (IBC) 2018

Member Properties

Base Allowable Moment	$M_r =$	3330 lb · ft
Base Allowable Shear	$V_r =$	1330 lb
Base Perpendicular Compression Allowable Stress	$F_{c\perp} =$	0 psi

Section Bending (NDS 2018 2.3)

Governing Duration Factor in Bending	$C_{D,b} =$	1
Beam Stability Factor	$C_L =$	1
Adjusted Allowable Moment	$M'_r =$	3330 lb · ft

Shear Design (NDS 2018 3.4)

Governing Duration Factor	$C_D =$	1
Adjusted Allowable Shear	$V'_r =$	1330 lb

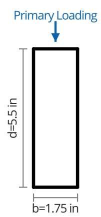
Bearing (NDS 2018 3.10)

Base Bearing Strength	$F'_{c\perp}/C_b =$	0 psi

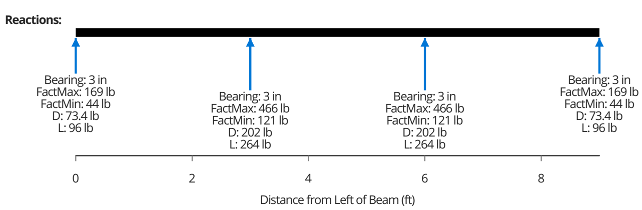
Comments

Client:	John Lawson	**Date:**	Oct 14, 2023
Author:	Cameron Cunningham	**Job #:**	ARCE 453-01
Project:	C.S.P. - Prior Consideration Design	**Subject:**	**L-1** PASS
References:	NDS 2018 (ASD)		

Summary



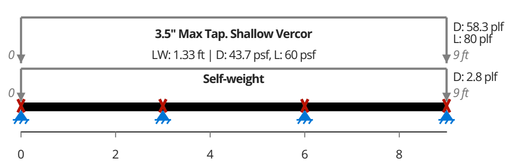
	Member		1-3/4x5-1/2 Microllam LVL 2.0E-2600Fb
6%	Moment Utilization	$M/M' =$	-127 lb*ft / 2170 lb*ft
14%	Shear Utilization	$V/V' =$	254 lb / 1830 lb
11%	Bearing Utilization	$R/R' =$	466 lb / 4430 lb
	Minimum Bearing Length (End Supports)	$\ell_{b,min,end} =$	0.129 in
	Minimum Bearing Length (Int Supports)	$\ell_{b,min,int} =$	0.315 in
3%	Governing Live / Short-Term Deflection	$\delta_{ST} =$	-0.00278 in (L/13 000)
2%	Governing Long-Term Deflection	$\delta_{LT} =$	-0.00339 in (L/10 600)
	Governing Long-Term Deflection	$\delta_{LT} =$	-0.00339 in



Key Properties

Beam Plan Length	$L_X =$	9 ft
Continuous Bracing for Lateral Torsional Buckling		Top Braced

Loads



Design Conditions

Design Code for Load Combinations	International Building Code (IBC) 2018

Member Properties

Cross-Sectional Area	$A =$	9.62 in²
Strong Axis Moment of Inertia	$I_{xx} =$	24.3 in⁴
Section Modulus	$S =$	8.82 in³
Base Allowable Bending Stress	$F_b =$	2600 psi
Base Allowable Shear Stress	$F_v =$	285 psi
Base Perpendicular Compression Allowable Stress	$F_{c\perp} =$	750 psi
True Modulus of Elasticity	$E_{true} =$	$2\,000\,000$ psi
Apparent Modulus of Elasticity	$E_{app} =$	NaN psi
Modulus of Elasticity for Deflections	$E =$	$2\,000\,000$ psi

Elastic Modulus (NDS 2018 2.3)

Adjusted Modulus of Elasticity	$E' =$	$2\,000\,000$ psi
Adjusted Shear Modulus	$G' =$	$125\,000$ psi

Section Bending (NDS 2018 2.3)

Volume Factor	$C_V =$	1.11

Positive Bending (NDS 2018 2.3)

Governing Duration Factor - Positive Bending	$C^+_{D,b} =$	1
Governing Beam Stability Factor - Positive Bending	$C^+_L =$	1
Adjusted Bending Strength - Positive Bending	$F'^+_b =$	3010 psi

Negative Bending (NDS 2018 2.3)

Governing Duration Factor - Negative Bending	$C^-_{D,b} =$	1
Governing Beam Stability Factor - Negative Bending	$C^-_L =$	0.983
Adjusted Bending Strength - Negative Bending	$F'^-_b =$	2950 psi

Shear Design (NDS 2018 3.4)

Governing Duration Factor	$C_D =$	1
Adjusted Shear Strength	$F'_v =$	285 psi

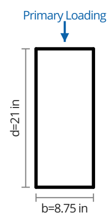
Bearing (NDS 2018 3.10)

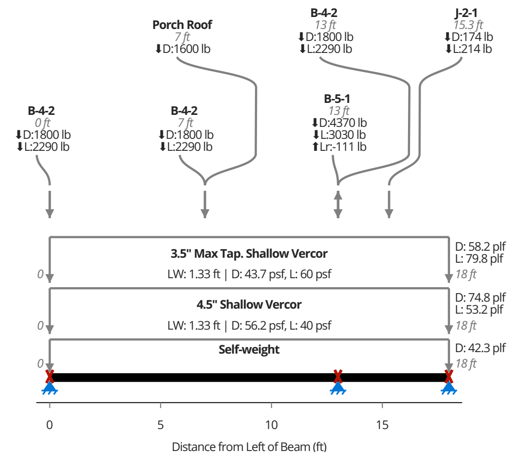
Base Bearing Strength	$F'_{c\perp}/C_b =$	750 psi

Comments

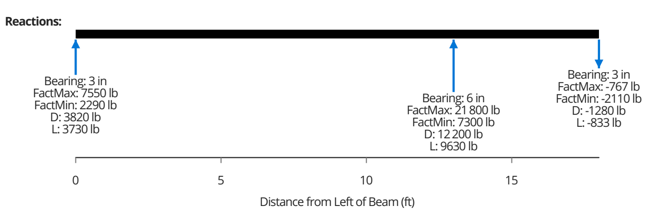
Client:	John Lawson	**Date:**	Oct 14, 2023
Author:	Cameron Cunningham	**Job #:**	ARCE 453-01
Project:	C.S.P. - Prior Consideration Design	**Subject:**	B-1 PASS
References:	NDS 2018 (ASD)		

Summary





	Member		8-3/4x21 24F-1.8E
20%	Moment Utilization	$M/M' =$	-15 300 lb*ft / 74 800 lb*ft
19%	Shear Utilization	$V/V' =$	6250 lb / 32 500 lb
60%	Bearing Utilization	$R/R' =$	21 800 lb / 36 300 lb
	Minimum Bearing Length (End Supports)	$\ell_{b,min,end} =$	1.33 in
	Minimum Bearing Length (Int Supports)	$\ell_{b,min,int} =$	3.61 in
3%	Governing Live / Short-Term Deflection	$\delta_{ST} =$	-0.0124 in (L/12 600)
3%	Governing Long-Term Deflection	$\delta_{LT} =$	-0.0213 in (L/7320)
	Governing Long-Term Deflection	$\delta_{LT} =$	-0.0213 in



Key Properties

Beam Plan Length	$L_X =$	18 ft
Continuous Bracing for Lateral Torsional Buckling		Top Braced

Loads

Design Conditions

Design Code for Load Combinations		International Building Code (IBC) 2018

Member Properties

Cross-Sectional Area	$A =$	184 in²
Strong Axis Moment of Inertia	$I_{xx} =$	6750 in⁴
Section Modulus	$S =$	643 in³
Base Allowable Bending Stress	$F_b =$	2400 psi
Base Allowable Shear Stress	$F_v =$	265 psi
Base Perpendicular Compression Allowable Stress	$F_{c\perp} =$	650 psi
True Modulus of Elasticity	$E_{true} =$	$1\,900\,000$ psi
Apparent Modulus of Elasticity	$E_{app} =$	$1\,800\,000$ psi
Modulus of Elasticity for Deflections	$E =$	$1\,800\,000$ psi

Elastic Modulus (NDS 2018 2.3)

Adjusted Modulus of Elasticity	$E' =$	$1\,800\,000$ psi

Section Bending (NDS 2018 2.3)

Volume Factor	$C_V =$	0.962

Positive Bending (NDS 2018 2.3)

Governing Duration Factor - Positive Bending	$C^+_{D,b} =$	1
Governing Beam Stability Factor - Positive Bending	$C^+_L =$	1
Adjusted Bending Strength - Positive Bending	$F'^+_b =$	2310 psi

Negative Bending (NDS 2018 2.3)

Governing Duration Factor - Negative Bending	$C^-_{D,b} =$	1
Governing Beam Stability Factor - Negative Bending	$C^-_L =$	0.995
	$F'^-_b =$	1390 psi

Adjusted Bending Strength - Negative Bending

Shear Design (NDS 2018 3.4)

Governing Duration Factor	$C_D = 1$
Adjusted Shear Strength	$F'_v = 265$ psi

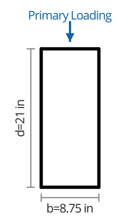
Bearing (NDS 2018 3.10)

Base Bearing Strength	$F'_{c\perp}/C_b = 650$ psi

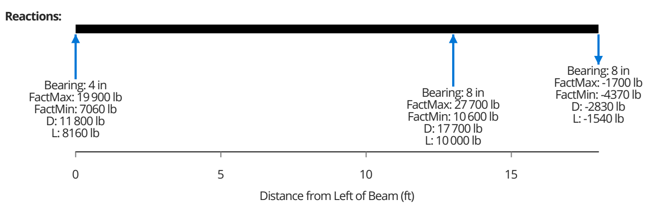
Comments

Client:	John Lawson	**Date:**	Oct 14, 2023
Author:	Cameron Cunningham	**Job #:**	ARCE 453-01
Project:	C.S.P. - Prior Consideration Design	**Subject:**	B-2 PASS
References:	NDS 2018 (ASD)		

Summary



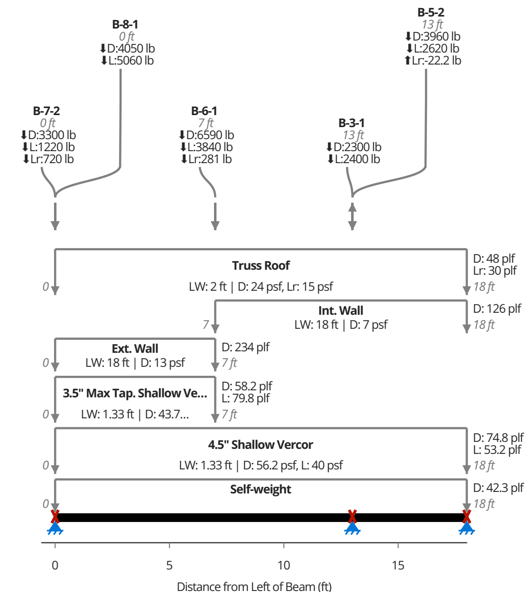
	Member		8-3/4x21 24F-1.8E
35%	Moment Utilization	$M/M' =$	-26 100 lb*ft / 74 700 lb*ft
32%	Shear Utilization	$V/V' =$	10 300 lb / 32 500 lb
88%	Bearing Utilization	$R/R' =$	19 900 lb / 22 700 lb
	Minimum Bearing Length (End Supports)	$\ell_{b,min,end} =$	3.51 in
	Minimum Bearing Length (Int Supports)	$\ell_{b,min,int} =$	4.87 in
4%	Governing Live / Short-Term Deflection	$\delta_{ST} =$	-0.0194 in (L/8030)
6%	Governing Long-Term Deflection	$\delta_{LT} =$	-0.0376 in (L/4150)
	Governing Long-Term Deflection	$\delta_{LT} =$	-0.0376 in



Key Properties

Beam Plan Length	$L_X =$	18 ft
Continuous Bracing for Lateral Torsional Buckling		Top Braced

Loads



Design Conditions

Design Code for Load Combinations	International Building Code (IBC) 2018

Member Properties

Cross-Sectional Area	$A =$	184 in²
Strong Axis Moment of Inertia	$I_{xx} =$	6750 in⁴
Section Modulus	$S =$	643 in³
Base Allowable Bending Stress	$F_b =$	2400 psi
Base Allowable Shear Stress	$F_v =$	265 psi
Base Perpendicular Compression Allowable Stress	$F_{c\perp} =$	650 psi
True Modulus of Elasticity	$E_{true} =$	$1\,900\,000$ psi
Apparent Modulus of Elasticity	$E_{app} =$	$1\,800\,000$ psi
Modulus of Elasticity for Deflections	$E =$	$1\,800\,000$ psi

Elastic Modulus (NDS 2018 2.3)

Adjusted Modulus of Elasticity	$E' =$	$1\,800\,000$ psi

Section Bending (NDS 2018 2.3)

Volume Factor	$C_V =$	0.962

Positive Bending (NDS 2018 2.3)

Governing Duration Factor - Positive Bending	$C_{D,b}^{+} =$	1
Governing Beam Stability Factor - Positive Bending	$C_L^{+} =$	1
Adjusted Bending Strength - Positive Bending	$F_b'^{+} =$	2310 psi

Negative Bending (NDS 2018 2.3)

Governing Duration Factor - Negative Bending	$C_{D,b}^{-} = 1$
Governing Beam Stability Factor - Negative Bending	$C_L^{-} = 0.995$
Adjusted Bending Strength - Negative Bending	$F_b'^{-} = 1390 \text{ psi}$

Shear Design (NDS 2018 3.4)

Governing Duration Factor	$C_D = 1$
Adjusted Shear Strength	$F_v' = 265 \text{ psi}$

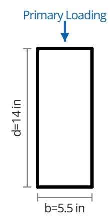
Bearing (NDS 2018 3.10)

Base Bearing Strength	$F_{c\perp}'/C_b = 650 \text{ psi}$

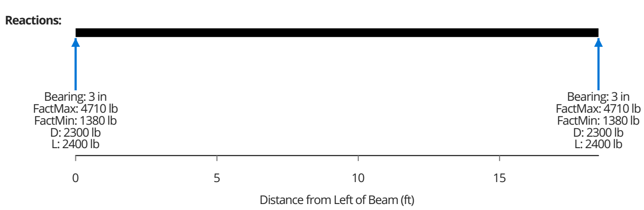
Comments

Client:	John Lawson	**Date:**	Oct 14, 2023
Author:	Cameron Cunningham	**Job #:**	ARCE 453-01
Project:	C.S.P. - Prior Consideration Design	**Subject:**	B-3 PASS
References:	NDS 2018 (ASD)		

Summary



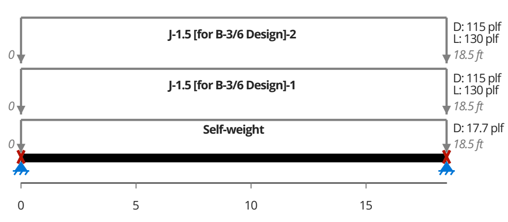
	Member		5-1/2x14 24F-1.8E
62%	Moment Utilization	$M/M' =$	21 800 lb*ft / 34 800 lb*ft
35%	Shear Utilization	$V/V' =$	4710 lb / 13 600 lb
44%	Bearing Utilization	$R/R' =$	4710 lb / 10 700 lb
	Minimum Bearing Length (End Supports)	$\ell_{b,min,end} =$	1.32 in
49%	Governing Live / Short-Term Deflection	$\delta_{ST} =$	-0.303 in (L/733)
48%	Governing Long-Term Deflection	$\delta_{LT} =$	-0.447 in (L/496)
	Governing Long-Term Deflection	$\delta_{LT} =$	-0.447 in



Key Properties

Beam Plan Length	$L_X =$	18.5 ft
Continuous Bracing for Lateral Torsional Buckling		No Continuous Bracing

Loads



Design Conditions

Design Code for Load Combinations	International Building Code (IBC) 2018

Member Properties

Cross-Sectional Area	$A =$	77 in^2
Strong Axis Moment of Inertia	$I_{xx} =$	1260 in^4
Section Modulus	$S =$	180 in^3
Base Allowable Bending Stress	$F_b =$	2400 psi
Base Allowable Shear Stress	$F_v =$	265 psi
Base Perpendicular Compression Allowable Stress	$F_{c\perp} =$	650 psi
True Modulus of Elasticity	$E_{true} =$	$1\,900\,000$ psi
Apparent Modulus of Elasticity	$E_{app} =$	$1\,800\,000$ psi
Modulus of Elasticity for Deflections	$E =$	$1\,800\,000$ psi

Elastic Modulus (NDS 2018 2.3)

Adjusted Modulus of Elasticity	$E' =$	$1\,800\,000$ psi

Section Bending (NDS 2018 2.3)

Volume Factor	$C_V =$	0.991

Positive Bending (NDS 2018 2.3)

Governing Duration Factor - Positive Bending	$C^+_{D,b} =$	1
Governing Beam Stability Factor - Positive Bending	$C^+_L =$	0.969
Adjusted Bending Strength - Positive Bending	$F'^+_b =$	2330 psi

Negative Bending (NDS 2018 2.3)

Governing Duration Factor - Negative Bending	$C^-_{D,b} =$	0.9
Governing Beam Stability Factor - Negative Bending	$C^-_L =$	0.986
Adjusted Bending Strength - Negative Bending	$F'^-_b =$	1290 psi

Shear Design (NDS 2018 3.4)

Governing Duration Factor	$C_D =$	1
Adjusted Shear Strength	$F'_v =$	265 psi

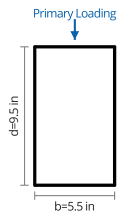
Bearing (NDS 2018 3.10)

Base Bearing Strength	$F'_{c\perp}/C_b =$	650 psi

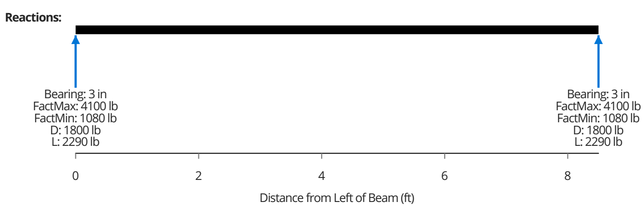
Comments

Client:	John Lawson	**Date:**	Oct 14, 2023
Author:	Cameron Cunningham	**Job #:**	ARCE 453-01
Project:	C.S.P. - Prior Consideration Design	**Subject:**	B-4 PASS
References:	NDS 2018 (ASD)		

Summary



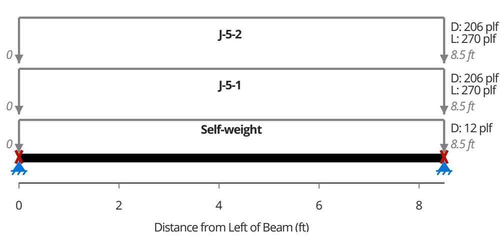
	Member		5-1/2x9-1/2 24F-1.8E
53%	Moment Utilization	$M/M' =$	8710 lb*ft / 16 500 lb*ft
44%	Shear Utilization	$V/V' =$	4100 lb / 9230 lb
38%	Bearing Utilization	$R/R' =$	4100 lb / 10 700 lb
	Minimum Bearing Length (End Supports)	$\ell_{b,min,end} =$	1.15 in
32%	Governing Live / Short-Term Deflection	$\delta_{ST} =$	-0.0897 in (L/1140)
29%	Governing Long-Term Deflection	$\delta_{LT} =$	-0.125 in (L/817)
	Governing Long-Term Deflection	$\delta_{LT} =$	-0.125 in



Key Properties

Beam Plan Length	$L_X =$	8.5 ft
Continuous Bracing for Lateral Torsional Buckling		Top Braced

Loads



Design Conditions

Design Code for Load Combinations		International Building Code (IBC) 2018

Member Properties

Cross-Sectional Area	$A =$	52.2 in²
Strong Axis Moment of Inertia	$I_{xx} =$	393 in⁴
Section Modulus	$S =$	82.7 in³
Base Allowable Bending Stress	$F_b =$	2400 psi
Base Allowable Shear Stress	$F_v =$	265 psi
Base Perpendicular Compression Allowable Stress	$F_{c\perp} =$	650 psi
True Modulus of Elasticity	$E_{true} =$	$1\,900\,000$ psi
Apparent Modulus of Elasticity	$E_{app} =$	$1\,800\,000$ psi
Modulus of Elasticity for Deflections	$E =$	$1\,800\,000$ psi

Elastic Modulus (NDS 2018 2.3)

Adjusted Modulus of Elasticity	$E' =$	$1\,800\,000$ psi

Section Bending (NDS 2018 2.3)

Volume Factor	$C_V =$	1

Positive Bending (NDS 2018 2.3)

Governing Duration Factor - Positive Bending	$C_{D,b}^{+} =$	1
Governing Beam Stability Factor - Positive Bending	$C_L^{+} =$	1
Adjusted Bending Strength - Positive Bending	$F_b'^{+} =$	2400 psi

Negative Bending (NDS 2018 2.3)

Governing Duration Factor - Negative Bending	$C_{D,b}^{-} =$	0.9
Governing Beam Stability Factor - Negative Bending	$C_L^{-} =$	0.996
Adjusted Bending Strength - Negative Bending	$F_b'^{-} =$	1300 psi

Shear Design (NDS 2018 3.4)

Governing Duration Factor	$C_D =$	1
Adjusted Shear Strength	$F_v' =$	265 psi

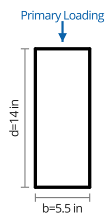
Bearing (NDS 2018 3.10)

Base Bearing Strength	$F_{c\perp}'/C_b =$	650 psi

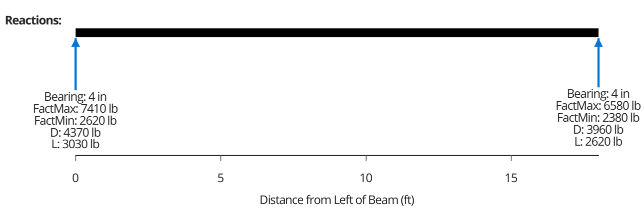
Comments

Client:	John Lawson	**Date:**	Oct 14, 2023
Author:	Cameron Cunningham	**Job #:**	ARCE 453-01
Project:	C.S.P. - Prior Consideration Design	**Subject:**	B-5 PASS
References:	NDS 2018 (ASD)		

Summary



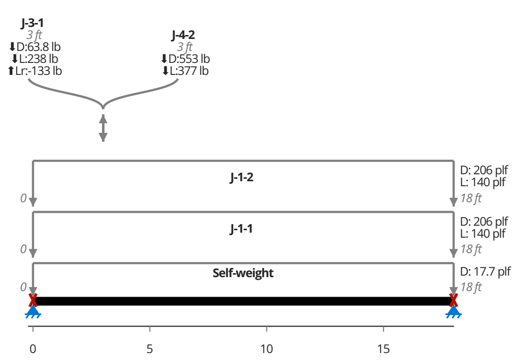
	Member		5-1/2x14 24F-1.8E
86%	Moment Utilization	$M/M' =$	30 600 lb*ft / 35 700 lb*ft
54%	Shear Utilization	$V/V' =$	7410 lb / 13 600 lb
52%	Bearing Utilization	$R/R' =$	7410 lb / 14 300 lb
	Minimum Bearing Length (End Supports)	$\ell_{b,min,end} =$	2.07 in
52%	Governing Live / Short-Term Deflection	$\delta_{ST} =$	-0.314 in (L/689)
61%	Governing Long-Term Deflection	$\delta_{LT} =$	-0.551 in (L/392)
	Governing Long-Term Deflection	$\delta_{LT} =$	-0.551 in



Key Properties

Beam Plan Length	$L_X =$	18 ft
Continuous Bracing for Lateral Torsional Buckling		Top Braced

Loads



Design Conditions

Design Code for Load Combinations		International Building Code (IBC) 2018

Member Properties

Cross-Sectional Area	$A =$	77 in²
Strong Axis Moment of Inertia	$I_{xx} =$	1260 in⁴
Section Modulus	$S =$	180 in³
Base Allowable Bending Stress	$F_b =$	2400 psi
Base Allowable Shear Stress	$F_v =$	265 psi
Base Perpendicular Compression Allowable Stress	$F_{c\perp} =$	650 psi
True Modulus of Elasticity	$E_{true} =$	$1\,900\,000$ psi
Apparent Modulus of Elasticity	$E_{app} =$	$1\,800\,000$ psi
Modulus of Elasticity for Deflections	$E =$	$1\,800\,000$ psi

Elastic Modulus (NDS 2018 2.3)

Adjusted Modulus of Elasticity	$E' =$	$1\,800\,000$ psi

Section Bending (NDS 2018 2.3)

Volume Factor	$C_V =$	0.993

Positive Bending (NDS 2018 2.3)

Governing Duration Factor - Positive Bending	$C^+_{D,b} =$	1
Governing Beam Stability Factor - Positive Bending	$C^+_L =$	1
Adjusted Bending Strength - Positive Bending	$F'^+_b =$	2380 psi

Negative Bending (NDS 2018 2.3)

Governing Duration Factor - Negative Bending	$C^-_{D,b} =$	0.9
Governing Beam Stability Factor - Negative Bending	$C^-_L =$	0.987
Adjusted Bending Strength - Negative Bending	$F'^-_b =$	1290 psi

Shear Design (NDS 2018 3.4)

Governing Duration Factor	$C_D =$	1
Adjusted Shear Strength	$F'_v =$	265 psi

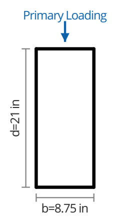
Bearing (NDS 2018 3.10)

Base Bearing Strength	$F'_{c\perp}/C_b =$	650 psi

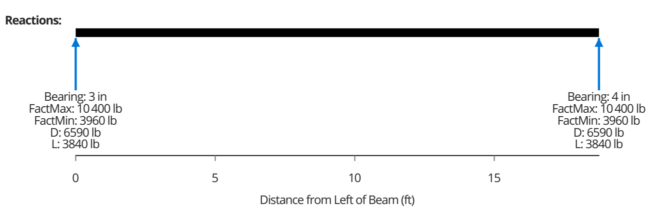
Comments

Client:	John Lawson	**Date:**	Oct 14, 2023
Author:	Cameron Cunningham	**Job #:**	ARCE 453-01
Project:	C.S.P. - Prior Consideration Design	**Subject:**	B-6 PASS
References:	NDS 2018 (ASD)		

Summary



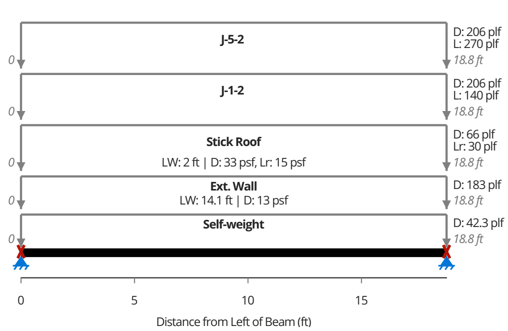
	Member		8-3/4x21 24F-1.8E
42%	Moment Utilization	$M/M' =$	48 900 lb*ft / 117 000 lb*ft
32%	Shear Utilization	$V/V' =$	10 400 lb / 32 500 lb
61%	Bearing Utilization	$R/R' =$	10 400 lb / 17 100 lb
	Minimum Bearing Length (End Supports)	$\ell_{b,min,end} =$	1.83 in
16%	Governing Live / Short-Term Deflection	$\delta_{ST} =$	-0.101 in (L/2240)
19%	Governing Long-Term Deflection	$\delta_{LT} =$	-0.181 in (L/1240)
	Governing Long-Term Deflection	$\delta_{LT} =$	-0.181 in



Key Properties

Beam Plan Length	$L_X =$	18.8 ft
Continuous Bracing for Lateral Torsional Buckling		Top Braced

Loads



Design Conditions

Design Code for Load Combinations		International Building Code (IBC) 2018

Member Properties

Cross-Sectional Area	$A =$	184 in²
Strong Axis Moment of Inertia	$I_{xx} =$	6750 in⁴
Section Modulus	$S =$	643 in³
Base Allowable Bending Stress	$F_b =$	2400 psi
Base Allowable Shear Stress	$F_v =$	265 psi
Base Perpendicular Compression Allowable Stress	$F_{c\perp} =$	650 psi
True Modulus of Elasticity	$E_{true} =$	$1\,900\,000$ psi
Apparent Modulus of Elasticity	$E_{app} =$	$1\,800\,000$ psi
Modulus of Elasticity for Deflections	$E =$	$1\,800\,000$ psi

Elastic Modulus (NDS 2018 2.3)

Adjusted Modulus of Elasticity	$E' =$	$1\,800\,000$ psi

Section Bending (NDS 2018 2.3)

Volume Factor	$C_V =$	0.907

Positive Bending (NDS 2018 2.3)

Governing Duration Factor - Positive Bending	$C_{D,b}^{+} =$	1
Governing Beam Stability Factor - Positive Bending	$C_L^{+} =$	1
Adjusted Bending Strength - Positive Bending	$F_b'^{+} =$	2180 psi

Negative Bending (NDS 2018 2.3)

Governing Duration Factor - Negative Bending	$C_{D,b}^{-} =$	0.9
Governing Beam Stability Factor - Negative Bending	$C_L^{-} =$	0.992
Adjusted Bending Strength - Negative Bending	$F_b'^{-} =$	1180 psi

Shear Design (NDS 2018 3.4)

Governing Duration Factor	$C_D =$	1
Adjusted Shear Strength	$F_v' =$	265 psi

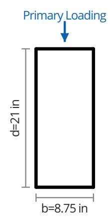
Bearing (NDS 2018 3.10)

Base Bearing Strength	$F_{c\perp}'/C_b =$	650 psi

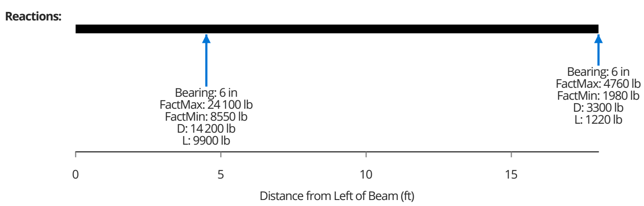
Comments

Client:	John Lawson	**Date:**	Oct 14, 2023
Author:	Cameron Cunningham	**Job #:**	ARCE 453-01
Project:	C.S.P. - Prior Consideration Design	**Subject:**	B-7 PASS
References:	NDS 2018 (ASD)		

Summary



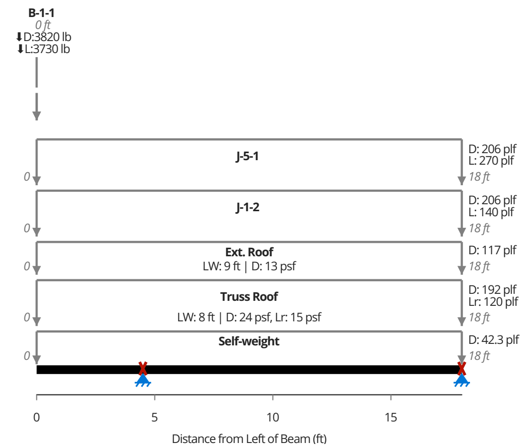
	Member		8-3/4x21 24F-1.8E
62%	Moment Utilization	$M/M' =$	-45 900 lb*ft / 73 700 lb*ft
40%	Shear Utilization	$V/V' =$	12 800 lb / 32 500 lb
67%	Bearing Utilization	$R/R' =$	24 100 lb / 36 300 lb
	Minimum Bearing Length (End Supports)	$\ell_{b,min,end} =$	0.836 in
	Minimum Bearing Length (Int Supports)	$\ell_{b,min,int} =$	4 in
27%	Governing Live / Short-Term Deflection	$\delta_{ST} =$	-0.049 in (L/1100)
16%	Governing Long-Term Deflection	$\delta_{LT} =$	-0.0709 in (L/762)
	Governing Long-Term Deflection	$\delta_{LT} =$	-0.0709 in



Key Properties

Beam Plan Length	$L_X =$	18 ft
Continuous Bracing for Lateral Torsional Buckling		No Continuous Bracing

Loads



Design Conditions

Design Code for Load Combinations	International Building Code (IBC) 2018

Member Properties

Cross-Sectional Area	$A =$	184 in²
Strong Axis Moment of Inertia	$I_{xx} =$	6750 in⁴
Section Modulus	$S =$	643 in³
Base Allowable Bending Stress	$F_b =$	2400 psi
Base Allowable Shear Stress	$F_v =$	265 psi
Base Perpendicular Compression Allowable Stress	$F_{c\perp} =$	650 psi
True Modulus of Elasticity	$E_{true} =$	$1\,900\,000$ psi
Apparent Modulus of Elasticity	$E_{app} =$	$1\,800\,000$ psi
Modulus of Elasticity for Deflections	$E =$	$1\,800\,000$ psi

Elastic Modulus (NDS 2018 2.3)

Adjusted Modulus of Elasticity	$E' =$	$1\,800\,000$ psi

Section Bending (NDS 2018 2.3)

Volume Factor	$C_V =$	0.949

Positive Bending (NDS 2018 2.3)

Governing Duration Factor - Positive Bending	$C_{D,b}^{+} =$	1
Governing Beam Stability Factor - Positive Bending	$C_L^{+} =$	0.996
Adjusted Bending Strength - Positive Bending	$F_b'^{+} =$	2280 psi

Negative Bending (NDS 2018 2.3)

Governing Duration Factor - Negative Bending	$C_{D,b}^{-} =$	1
Governing Beam Stability Factor - Negative Bending	$C_L^{-} =$	0.997
Adjusted Bending Strength - Negative Bending	$F_b'^{-} =$	1380 psi

Shear Design (NDS 2018 3.4)

Governing Duration Factor $C_D = 1$

Adjusted Shear Strength $F_v' = 265$ psi

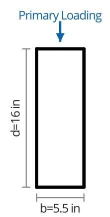
Bearing (NDS 2018 3.10)

Base Bearing Strength $F_{c\perp}'/C_b = 650$ psi

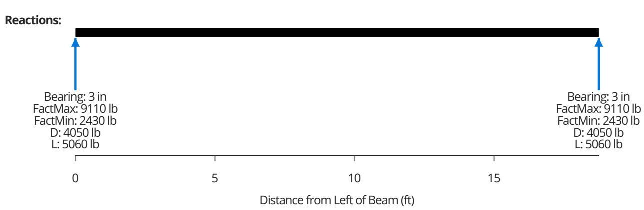
Comments

Client:	John Lawson	**Date:**	Oct 14, 2023
Author:	Cameron Cunningham	**Job #:**	ARCE 453-01
Project:	C.S.P. - Prior Consideration Design	**Subject:**	**B-8** PASS
References:	NDS 2018 (ASD)		

Summary



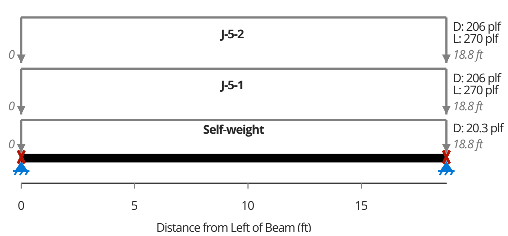
	Member		5-1/2x16 24F-1.8E
95%	Moment Utilization	$M/M' =$	42 700 lb*ft / 45 000 lb*ft
59%	Shear Utilization	$V/V' =$	9110 lb / 15 500 lb
85%	Bearing Utilization	$R/R' =$	9110 lb / 10 700 lb
	Minimum Bearing Length (End Supports)	$\ell_{b,min,end} =$	2.55 in
71%	Governing Live / Short-Term Deflection	$\delta_{ST} =$	-0.444 in (L/506)
66%	Governing Long-Term Deflection	$\delta_{LT} =$	-0.622 in (L/362)
	Governing Long-Term Deflection	$\delta_{LT} =$	-0.622 in



Key Properties

Beam Plan Length	$L_X =$	18.8 ft
Continuous Bracing for Lateral Torsional Buckling		No Continuous Bracing

Loads



Design Conditions

Design Code for Load Combinations		International Building Code (IBC) 2018

Member Properties

Cross-Sectional Area	$A =$	88 in^2
Strong Axis Moment of Inertia	$I_{xx} =$	1880 in^4
Section Modulus	$S =$	235 in^3
Base Allowable Bending Stress	$F_b =$	2400 psi
Base Allowable Shear Stress	$F_v =$	265 psi
Base Perpendicular Compression Allowable Stress	$F_{c\perp} =$	650 psi
True Modulus of Elasticity	$E_{true} =$	$1\,900\,000$ psi
Apparent Modulus of Elasticity	$E_{app} =$	$1\,800\,000$ psi
Modulus of Elasticity for Deflections	$E =$	$1\,800\,000$ psi

Elastic Modulus (NDS 2018 2.3)

Adjusted Modulus of Elasticity	$E' =$	$1\,800\,000$ psi

Section Bending (NDS 2018 2.3)

Volume Factor	$C_V =$	0.976

Positive Bending (NDS 2018 2.3)

Governing Duration Factor - Positive Bending	$C_{D,b}^{+} =$	1
Governing Beam Stability Factor - Positive Bending	$C_L^{+} =$	0.959
Adjusted Bending Strength - Positive Bending	$F_b'^{+} =$	2300 psi

Negative Bending (NDS 2018 2.3)

Governing Duration Factor - Negative Bending	$C_{D,b}^{-} =$	0.9
Governing Beam Stability Factor - Negative Bending	$C_L^{-} =$	0.983
Adjusted Bending Strength - Negative Bending	$F_b'^{-} =$	1270 psi

Shear Design (NDS 2018 3.4)

Governing Duration Factor	$C_D =$	1
Adjusted Shear Strength	$F_v' =$	265 psi

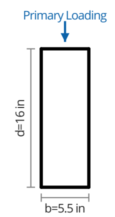
Bearing (NDS 2018 3.10)

Base Bearing Strength	$F_{c\perp}'/C_b =$	650 psi

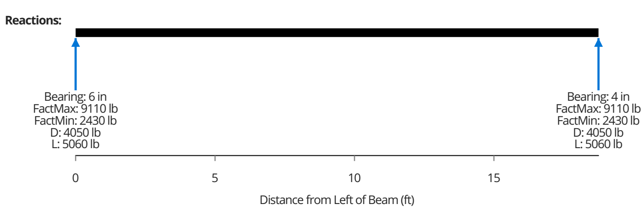
Comments

Client:	John Lawson	**Date:**	Oct 14, 2023
Author:	Cameron Cunningham	**Job #:**	ARCE 453-01
Project:	C.S.P. - Prior Consideration Design	**Subject:**	B-9 PASS
References:	NDS 2018 (ASD)		

Summary



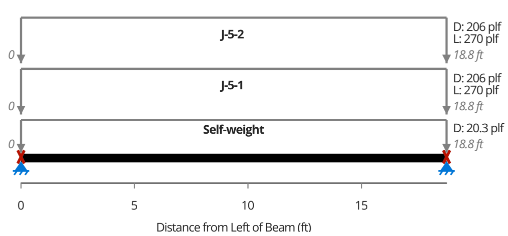
	Member		5-1/2x16 24F-1.8E
95%	Moment Utilization	$M/M' =$	42 700 lb*ft / 45 000 lb*ft
59%	Shear Utilization	$V/V' =$	9110 lb / 15 500 lb
64%	Bearing Utilization	$R/R' =$	9110 lb / 14 300 lb
	Minimum Bearing Length (End Supports)	$\ell_{b,min,end} =$	2.55 in
71%	Governing Live / Short-Term Deflection	$\delta_{ST} =$	-0.444 in (L/506)
66%	Governing Long-Term Deflection	$\delta_{LT} =$	-0.622 in (L/362)
	Governing Long-Term Deflection	$\delta_{LT} =$	-0.622 in



Key Properties

Beam Plan Length	$L_X =$	18.8 ft
Continuous Bracing for Lateral Torsional Buckling		No Continuous Bracing

Loads



Design Conditions

Design Code for Load Combinations	International Building Code (IBC) 2018

Member Properties

Cross-Sectional Area	$A =$	88 in²
Strong Axis Moment of Inertia	$I_{xx} =$	1880 in⁴
Section Modulus	$S =$	235 in³
Base Allowable Bending Stress	$F_b =$	2400 psi
Base Allowable Shear Stress	$F_v =$	265 psi
Base Perpendicular Compression Allowable Stress	$F_{c\perp} =$	650 psi
True Modulus of Elasticity	$E_{true} =$	$1\,900\,000$ psi
Apparent Modulus of Elasticity	$E_{app} =$	$1\,800\,000$ psi
Modulus of Elasticity for Deflections	$E =$	$1\,800\,000$ psi

Elastic Modulus (NDS 2018 2.3)

Adjusted Modulus of Elasticity	$E' =$	$1\,800\,000$ psi

Section Bending (NDS 2018 2.3)

Volume Factor	$C_V =$	0.976

Positive Bending (NDS 2018 2.3)

Governing Duration Factor - Positive Bending	$C_{D,b}^{+} =$	1
Governing Beam Stability Factor - Positive Bending	$C_L^{+} =$	0.959
Adjusted Bending Strength - Positive Bending	$F_b'^{+} =$	2300 psi

Negative Bending (NDS 2018 2.3)

Governing Duration Factor - Negative Bending	$C_{D,b}^{-} =$	0.9
Governing Beam Stability Factor - Negative Bending	$C_L^{-} =$	0.983
Adjusted Bending Strength - Negative Bending	$F_b'^{-} =$	1270 psi

Shear Design (NDS 2018 3.4)

Governing Duration Factor	$C_D =$	1
Adjusted Shear Strength	$F_v' =$	265 psi

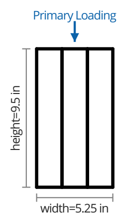
Bearing (NDS 2018 3.10)

Base Bearing Strength	$F_{c\perp}'/C_b =$	650 psi

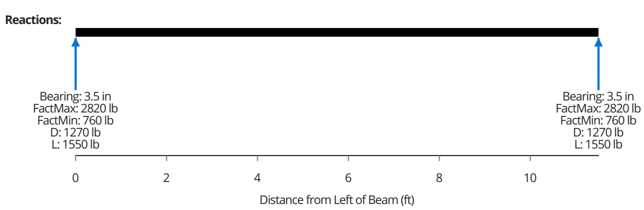
Comments

Client:	John Lawson	**Date:**	Oct 14, 2023
Author:	Cameron Cunningham	**Job #:**	ARCE 453-01
Project:	C.S.P. - Prior Consideration Design	**Subject:**	**B-10** PASS
References:	NDS 2018 (ASD)		

Summary



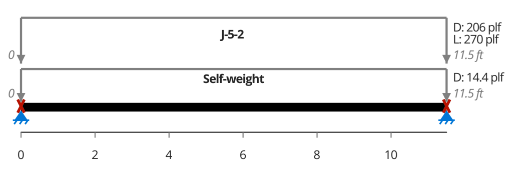
	Member		3 plies - 1-3/4x9-1/2 Microllam LVL 2.0E-2600Fb
45%	Moment Utilization	$M/M' =$	8110 lb*ft / 18 100 lb*ft
30%	Shear Utilization	$V/V' =$	2820 lb / 9480 lb
20%	Bearing Utilization	$R/R' =$	2820 lb / 13 800 lb
	Minimum Bearing Length (End Supports)	$\ell_{b,min,end} =$	0.716 in
41%	Governing Live / Short-Term Deflection	$\delta_{ST} =$	-0.156 in (L/884)
37%	Governing Long-Term Deflection	$\delta_{LT} =$	-0.214 in (L/645)
	Governing Long-Term Deflection	$\delta_{LT} =$	-0.214 in



Key Properties

Beam Plan Length	$L_X =$	11.5 ft
Continuous Bracing for Lateral Torsional Buckling		No Continuous Bracing

Loads



Design Conditions

Design Code for Load Combinations	International Building Code (IBC) 2018

Member Properties

Cross-Sectional Area	$A =$	49.9 in²
Strong Axis Moment of Inertia	$I_{xx} =$	375 in⁴
Section Modulus	$S =$	79 in³
Base Allowable Bending Stress	$F_b =$	2600 psi
Base Allowable Shear Stress	$F_v =$	285 psi
Base Perpendicular Compression Allowable Stress	$F_{c\perp} =$	750 psi
True Modulus of Elasticity	$E_{true} =$	$2\,000\,000$ psi
Apparent Modulus of Elasticity	$E_{app} =$	NaN psi
Modulus of Elasticity for Deflections	$E =$	$2\,000\,000$ psi

Elastic Modulus (NDS 2018 2.3)

Adjusted Modulus of Elasticity	$E' =$	$2\,000\,000$ psi
Adjusted Shear Modulus	$G' =$	$125\,000$ psi

Section Bending (NDS 2018 2.3)

Volume Factor	$C_V =$	1.03

Positive Bending (NDS 2018 2.3)

Governing Duration Factor - Positive Bending	$C_{D,b}^{+} =$	1
Governing Beam Stability Factor - Positive Bending	$C_L^{+} =$	0.987
Adjusted Bending Strength - Positive Bending	$F_b'^{+} =$	2760 psi

Negative Bending (NDS 2018 2.3)

Governing Duration Factor - Negative Bending	$C_{D,b}^{-} =$	0.9
Governing Beam Stability Factor - Negative Bending	$C_L^{-} =$	0.989
Adjusted Bending Strength - Negative Bending	$F_b'^{-} =$	2480 psi

Shear Design (NDS 2018 3.4)

Governing Duration Factor	$C_D =$	1
Adjusted Shear Strength	$F_v' =$	285 psi

Bearing (NDS 2018 3.10)

Base Bearing Strength	$F_{c\perp}'/C_b =$	750 psi

Comments

Client:	John Lawson	**Date:**	Oct 14, 2023
Author:	Cameron Cunningham	**Job #:**	ARCE 453-01
Project:	C.S.P. - Prior Consideration Design	**Subject:**	**C1-1** PASS
References:	NDS 2018 (ASD)		

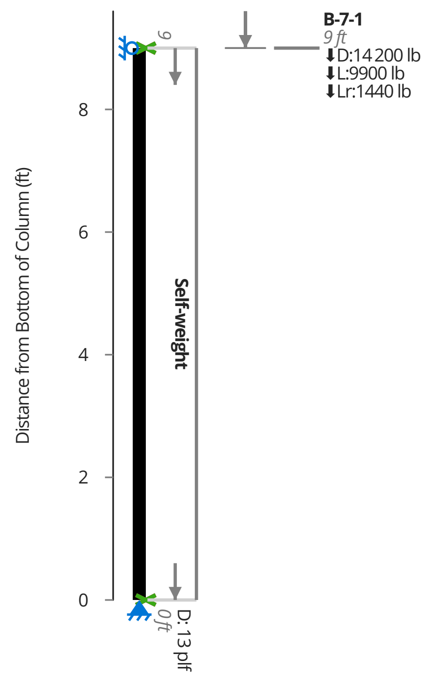
Summary

49%	Allowable Compressive Load (X-Axis Buckling)	$P'_x = 50\,000$ lb
49%	Allowable Compressive Load (Y-Axis Buckling)	$P'_y = 50\,000$ lb

Key Properties

Member	8x8 D.Fir-L No. 1
Column Height	$L = 9$ ft
Continuous Bracing for Strong Axis Buckling	No
Continuous Bracing for Weak Axis Buckling	No
Continuous Bracing for Lateral Torsional Buckling	No

Loads



Design Conditions

Design Code for Load Combinations	International Building Code (IBC) 2018

Capacity in Pure Axial Loading (NDS 2018 Section 3.7)

Fully Braced Compression Strength - Pure Axial Loading	$F_c^* = 1000$ psi
Governing Slenderness - X-axis	$(\ell_e/d) = 14.4$
Governing Slenderness - Y-axis	$(\ell_e/b) = 14.4$
Adjusted Compression Strength (X-axis)	$F'_{c,x} = 888$ psi
Adjusted Compression Strength (Y-axis)	$F'_{c,y} = 888$ psi

Comments

Client:	John Lawson	**Date:**	Oct 14, 2023
Author:	Cameron Cunningham	**Job #:**	ARCE 453-01
Project:	C.S.P. - Prior Consideration Design	**Subject:**	**C1-2** PASS
References:	NDS 2018 (ASD)		

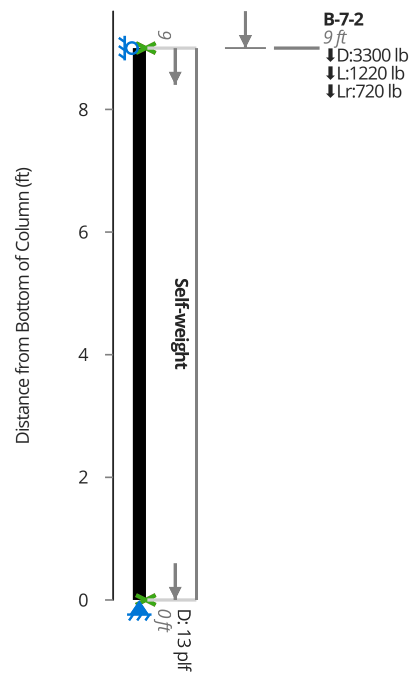
Summary

13%	Allowable Compressive Load (X-Axis Buckling)	$P'_x = 35\,700$ lb
13%	Allowable Compressive Load (Y-Axis Buckling)	$P'_y = 35\,700$ lb

Key Properties

Member	8x8 D.Fir-L No. 2
Column Height	$L = 9$ ft
Continuous Bracing for Strong Axis Buckling	No
Continuous Bracing for Weak Axis Buckling	No
Continuous Bracing for Lateral Torsional Buckling	No

Loads



Design Conditions

Design Code for Load Combinations	International Building Code (IBC) 2018

Capacity in Pure Axial Loading (NDS 2018 Section 3.7)

Fully Braced Compression Strength - Pure Axial Loading	$F_c^* = 700$ psi
Governing Slenderness - X-axis	$(\ell_e/d) = 14.4$
Governing Slenderness - Y-axis	$(\ell_e/b) = 14.4$
Adjusted Compression Strength (X-axis)	$F'_{c,x} = 634$ psi
Adjusted Compression Strength (Y-axis)	$F'_{c,y} = 634$ psi

Comments

Client:	John Lawson	**Date:**	Oct 14, 2023
Author:	Cameron Cunningham	**Job #:**	ARCE 453-01
Project:	C.S.P. - Prior Consideration Design	**Subject:**	**C2-1** PASS
References:	NDS 2018 (ASD)		

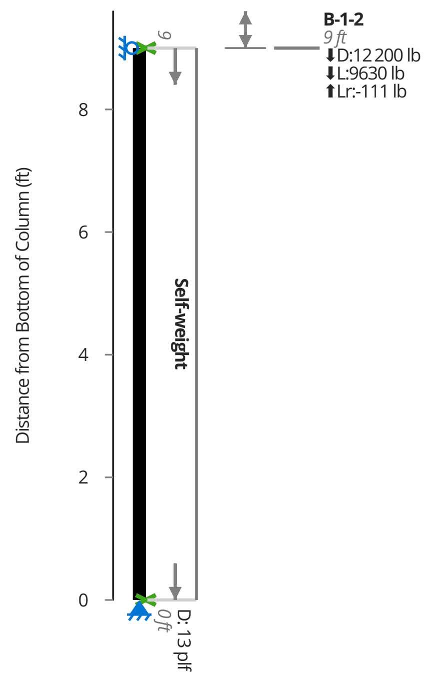
Summary

44%	Allowable Compressive Load (X-Axis Buckling)	$P'_x = 50\,000 \text{ lb}$
44%	Allowable Compressive Load (Y-Axis Buckling)	$P'_y = 50\,000 \text{ lb}$

Key Properties

Member	8x8 D.Fir-L No. 1
Column Height	$L = 9 \text{ ft}$
Continuous Bracing for Strong Axis Buckling	No
Continuous Bracing for Weak Axis Buckling	No
Continuous Bracing for Lateral Torsional Buckling	No

Loads



Design Conditions

Design Code for Load Combinations	International Building Code (IBC) 2018

Capacity in Pure Axial Loading (NDS 2018 Section 3.7)

Fully Braced Compression Strength - Pure Axial Loading	$F_c^* = 1000 \text{ psi}$
Governing Slenderness - X-axis	$(\ell_e/d) = 14.4$
Governing Slenderness - Y-axis	$(\ell_e/b) = 14.4$
Adjusted Compression Strength (X-axis)	$F'_{c,x} = 888 \text{ psi}$
Adjusted Compression Strength (Y-axis)	$F'_{c,y} = 888 \text{ psi}$

Comments

Client:	John Lawson	**Date:**	Oct 14, 2023
Author:	Cameron Cunningham	**Job #:**	ARCE 453-01
Project:	C.S.P. - Prior Consideration Design	**Subject:**	**C2-2** PASS
References:	NDS 2018 (ASD)		

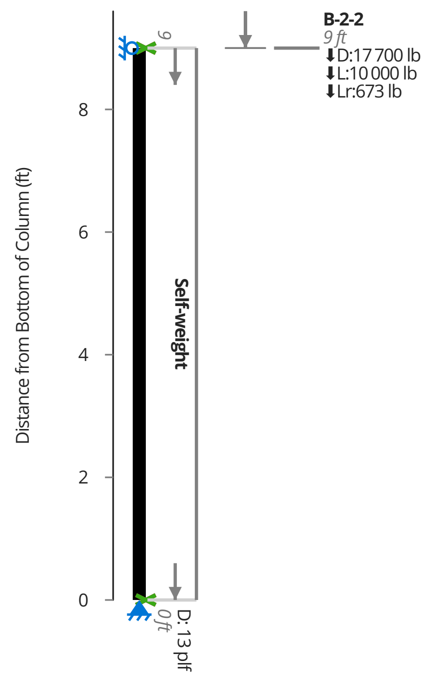
Summary

56%	Allowable Compressive Load (X-Axis Buckling)	$P'_x = 50\,000$ lb
56%	Allowable Compressive Load (Y-Axis Buckling)	$P'_y = 50\,000$ lb

Key Properties

Member	8x8 D.Fir-L No. 1
Column Height	$L = 9$ ft
Continuous Bracing for Strong Axis Buckling	No
Continuous Bracing for Weak Axis Buckling	No
Continuous Bracing for Lateral Torsional Buckling	No

Loads



Design Conditions

Design Code for Load Combinations	International Building Code (IBC) 2018

Capacity in Pure Axial Loading (NDS 2018 Section 3.7)

Fully Braced Compression Strength - Pure Axial Loading	$F_c^* = 1000$ psi
Governing Slenderness - X-axis	$(\ell_e/d) = 14.4$
Governing Slenderness - Y-axis	$(\ell_e/b) = 14.4$
Adjusted Compression Strength (X-axis)	$F'_{c,x} = 888$ psi
Adjusted Compression Strength (Y-axis)	$F'_{c,y} = 888$ psi

Comments

Client:	John Lawson	Date:	Oct 14, 2023
Author:	Cameron Cunningham	Job #:	ARCE 453-01
Project:	C.S.P. - Prior Consideration Design	Subject:	C3 PASS
References:	NDS 2018 (ASD)		

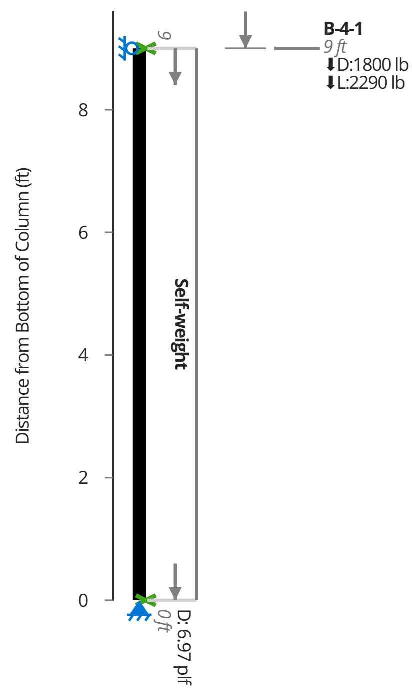
Summary

25%	Allowable Compressive Load (X-Axis Buckling)	$P'_x =$	$16\,900$ lb
25%	Allowable Compressive Load (Y-Axis Buckling)	$P'_y =$	$16\,900$ lb

Key Properties

Member		6x6 D.Fir-L No. 2
Column Height	$L =$	9 ft
Continuous Bracing for Strong Axis Buckling		No
Continuous Bracing for Weak Axis Buckling		No
Continuous Bracing for Lateral Torsional Buckling		No

Loads



Design Conditions

Design Code for Load Combinations	International Building Code (IBC) 2018

Capacity in Pure Axial Loading (NDS 2018 Section 3.7)

Fully Braced Compression Strength - Pure Axial Loading	$F_c^* =$	700 psi
Governing Slenderness - X-axis	$(\ell_e/d) =$	19.6
Governing Slenderness - Y-axis	$(\ell_e/b) =$	19.6
Adjusted Compression Strength (X-axis)	$F'_{c,x} =$	559 psi
Adjusted Compression Strength (Y-axis)	$F'_{c,y} =$	559 psi

Comments

Client:	John Lawson	**Date:**	Oct 14, 2023
Author:	Cameron Cunningham	**Job #:**	ARCE 453-01
Project:	C.S.P. - Prior Consideration Design	**Subject:**	**C4** PASS
References:	NDS 2018 (ASD)		

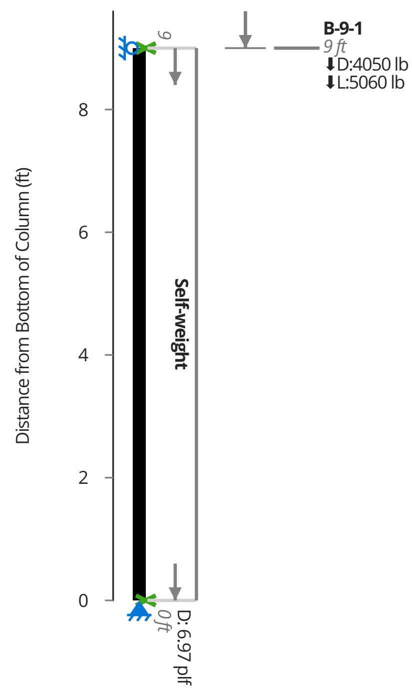
Summary

54%	Allowable Compressive Load (X-Axis Buckling)	$P'_x =$	$16\,900$ lb
54%	Allowable Compressive Load (Y-Axis Buckling)	$P'_y =$	$16\,900$ lb

Key Properties

Member		6x6 D.Fir-L No. 2
Column Height	$L =$	9 ft
Continuous Bracing for Strong Axis Buckling		No
Continuous Bracing for Weak Axis Buckling		No
Continuous Bracing for Lateral Torsional Buckling		No

Loads



Design Conditions

Design Code for Load Combinations	International Building Code (IBC) 2018

Capacity in Pure Axial Loading (NDS 2018 Section 3.7)

Fully Braced Compression Strength - Pure Axial Loading	$F_c^* =$	700 psi
Governing Slenderness - X-axis	$(\ell_e/d) =$	19.6
Governing Slenderness - Y-axis	$(\ell_e/b) =$	19.6
Adjusted Compression Strength (X-axis)	$F'_{c,x} =$	559 psi
Adjusted Compression Strength (Y-axis)	$F'_{c,y} =$	559 psi

Comments

Client:	John Lawson	Date:	Oct 14, 2023
Author:	Cameron Cunningham	Job #:	ARCE 453-01
Project:	C.S.P. - Prior Consideration Design	Subject:	C5 PASS
References:	NDS 2018 (ASD)		

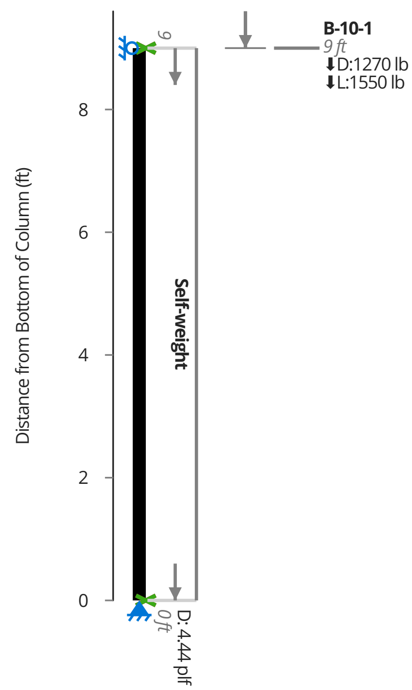
Summary

10%	Allowable Compressive Load (X-Axis Buckling)	$P'_x =$	$28\,600$ lb
32%	Allowable Compressive Load (Y-Axis Buckling)	$P'_y =$	8850 lb

Key Properties

Member		4x6 D.Fir-L No. 2
Column Height	$L =$	9 ft
Continuous Bracing for Strong Axis Buckling		Yes
Continuous Bracing for Weak Axis Buckling		No
Continuous Bracing for Lateral Torsional Buckling		No

Loads



Design Conditions

Design Code for Load Combinations	International Building Code (IBC) 2018

Capacity in Pure Axial Loading (NDS 2018 Section 3.7)

Fully Braced Compression Strength - Pure Axial Loading	$F_c^* =$	1490 psi
Governing Slenderness - X-axis	$(\ell_e/d) =$	0
Governing Slenderness - Y-axis	$(\ell_e/b) =$	30.9
Adjusted Compression Strength (X-axis)	$F'_{c,x} =$	1480 psi
Adjusted Compression Strength (Y-axis)	$F'_{c,y} =$	460 psi

Comments

Client:	John Lawson	**Date:**	Oct 14, 2023	
Author:	Cameron Cunningham	**Job #:**	ARCE 453-01	
Project:	C.S.P. - Prior Consideration Design	**Subject:**	**Typ. Ext. Bearing Wall**	PASS
References:	NDS 2018 (ASD)			

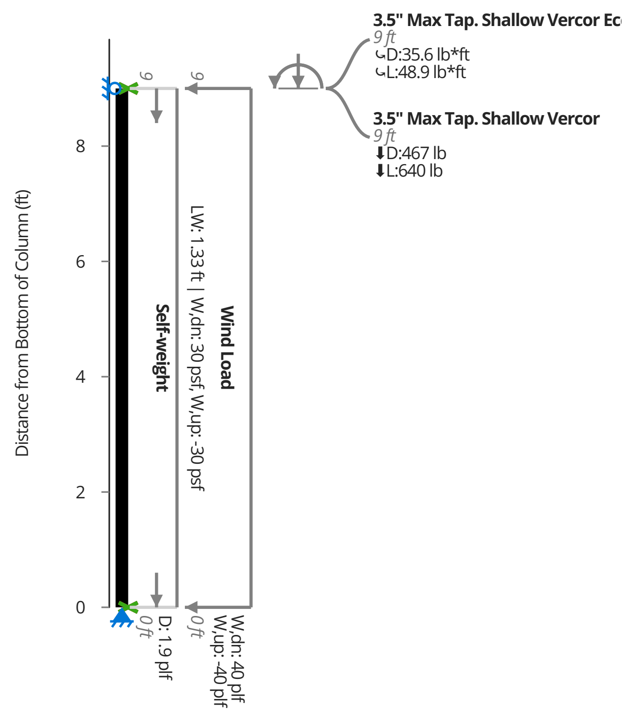
Summary

15%	Allowable Compressive Load (X-Axis Buckling)	$P'_x =$	7650 lb
9%	Allowable Compressive Load (Y-Axis Buckling)	$P'_y =$	$12\,300$ lb
19%	Allowable X-Axis Moment	$M'_x =$	1360 lb · ft
19%	Combined Compression / Bending	$\text{Int}_C =$	0.194
17%	Governing Live / Short-Term X-Axis Deflection	$\delta_{x,ST} =$	0.0745 in
	Critical Live / Short-Term X-Axis Deflection Ratio	$(L/)_{x,ST} =$	1450
2%	Governing Long-Term X-Axis Deflection	$\delta_{x,LT} =$	0.018 in
	Critical Long-Term X-Axis Deflection Ratio	$(L/)_{x,LT} =$	6000

Key Properties

Member		2x6 D.Fir-L No. 2
Column Height	$L =$	9 ft
Continuous Bracing for Strong Axis Buckling		No
Continuous Bracing for Weak Axis Buckling		Yes
Continuous Bracing for Lateral Torsional Buckling		Yes

Loads



Design Conditions

Design Code for Load Combinations	International Building Code (IBC) 2018

Capacity in Pure Axial Loading (NDS 2018 Section 3.7)

Fully Braced Compression Strength - Pure Axial Loading	$F^*_c =$	1490 psi
Governing Slenderness - X-axis	$(\ell_e/d) =$	19.6
Governing Slenderness - Y-axis	$(\ell_e/b) =$	0
Adjusted Compression Strength (X-axis)	$F'_{c,x} =$	928 psi
Adjusted Compression Strength (Y-axis)	$F'_{c,y} =$	1480 psi

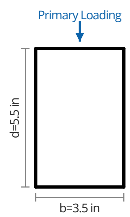
Shear Design (NDS 2018 3.4)

7%	Shear Capacity (X-axis)	$V'_{nx} =$	1580 lb

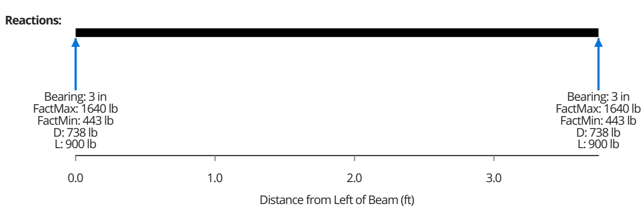
Comments

Client:	John Lawson	**Date:**	Oct 14, 2023
Author:	Cameron Cunningham	**Job #:**	ARCE 453-01
Project:	C.S.P. - Prior Consideration Design	**Subject:**	**HDR-1** PASS
References:	NDS 2018 (ASD)		

Summary



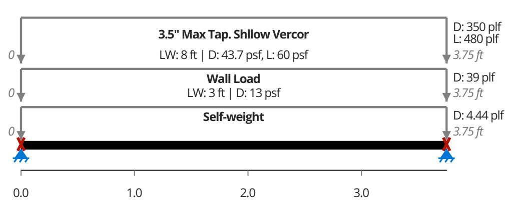
	Member		4x6 D.Fir-L No. 2
90%	Moment Utilization	$M/M' =$	1540 lb*ft / 1710 lb*ft
71%	Shear Utilization	$V/V' =$	1640 lb / 2310 lb
25%	Bearing Utilization	$R/R' =$	1640 lb / 6560 lb
	Minimum Bearing Length (End Supports)	$\ell_{b,min,end} =$	0.749 in
22%	Governing Live / Short-Term Deflection	$\delta_{ST} =$	-0.0275 in (L/1640)
21%	Governing Long-Term Deflection	$\delta_{LT} =$	-0.0388 in (L/1160)
	Governing Long-Term Deflection	$\delta_{LT} =$	-0.0388 in



Key Properties

Beam Plan Length	$L_X =$	3.75 ft
Continuous Bracing for Lateral Torsional Buckling		No Continuous Bracing

Loads



Design Conditions

Design Code for Load Combinations	International Building Code (IBC) 2018

Member Properties

Cross-Sectional Area	$A =$	19.2 in^2
Strong Axis Moment of Inertia	$I_{xx} =$	48.5 in^4
Section Modulus	$S =$	17.6 in^3
Base Allowable Bending Stress	$F_b =$	900 psi
Base Allowable Shear Stress	$F_v =$	180 psi
Base Perpendicular Compression Allowable Stress	$F_{c\perp} =$	625 psi
True Modulus of Elasticity	$E_{true} =$	$1\,600\,000$ psi
Apparent Modulus of Elasticity	$E_{app} =$	$1\,600\,000$ psi
Modulus of Elasticity for Deflections	$E =$	$1\,600\,000$ psi

Elastic Modulus (NDS 2018 2.3)

Adjusted Modulus of Elasticity	$E' =$	$1\,600\,000$ psi

Section Bending (NDS 2018 2.3)

Size Factor	$C_{F,b} =$	1.3
Incising Factor	$C_{i,b} =$	1

Positive Bending (NDS 2018 2.3)

Governing Duration Factor - Positive Bending	$C_{D,b}^{+} =$	1
Governing Beam Stability Factor - Positive Bending	$C_L^{+} =$	0.996
Adjusted Bending Strength - Positive Bending	$F_b'^{+} =$	1170 psi

Negative Bending (NDS 2018 2.3)

Governing Duration Factor - Negative Bending	$C_{D,b}^{-} =$	0.9
Governing Beam Stability Factor - Negative Bending	$C_L^{-} =$	0.997
Adjusted Bending Strength - Negative Bending	$F_b'^{-} =$	1050 psi

Shear Design (NDS 2018 3.4)

Governing Duration Factor	$C_D =$	1
Adjusted Shear Strength	$F_v' =$	180 psi

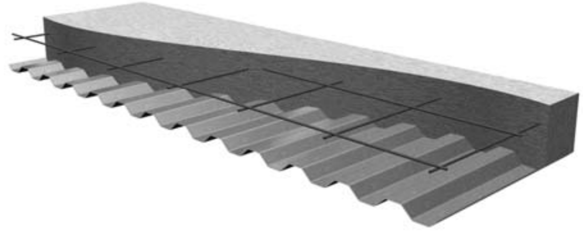
Bearing (NDS 2018 3.10)

Base Bearing Strength	$F_{c\perp}'/C_b =$	625 psi

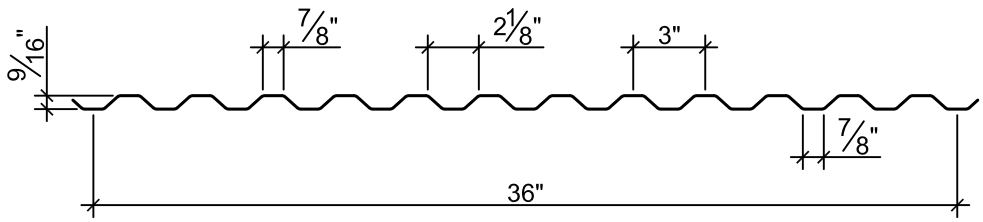
Comments

Shallow VERCOR™

- 9⁄16" Deep Deck
- Galvanized



Dimensions



Shallow VERCOR

Standard Overlapping Sidelap

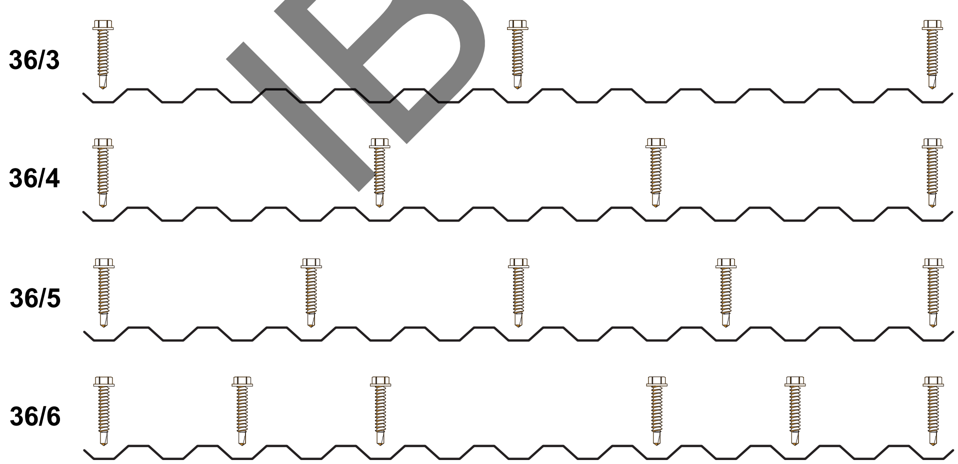
Deck Weight and Section Properties

Gage	Weight	I_d for Deflection		Moment		Allowable Reactions per ft of Width (lb) due to Web Crippling: One Flange Loading				Two Flange Loading			
	Galv	Single Span	Multi Span	$+S_{eff}$	$-S_{eff}$	End Bearing Length		Interior Bearing Length		End Bearing Length		Interior Bearing Length	
	(psf)	(in.^{4}/ft)	(in.^{4}/ft)	(in.^{3}/ft)	(in.^{3}/ft)	1 1/2"	2"	1 1/2"	2"	1 1/2"	2"	1 1/2"	2"
26	1.0	0.013	0.013	0.041	0.043	581	644	788	862	536	582	963	1061
24	1.3	0.018	0.018	0.059	0.059	980	1081	1375	1497	999	1080	1709	1875
22	1.6	0.022	0.022	0.073	0.073	1466	1611	2105	2283	1598	1721	2645	2889

Notes:

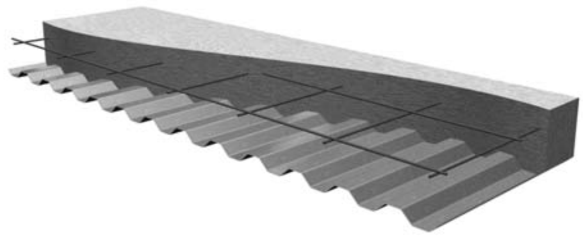
1. Section properties are based on F_y = 60,000 psi (specified minimum F_y = 80,000 psi).
2. I_d is for deflection due to uniform loads.
3. S_{eff} (+ or -) is the effective section modulus.
4. Allowable (ASD) reactions are based on web crippling, per AISI S100 Section C3.4, where Ω_w = 1.70 for end bearing and 1.75 for interior bearing. Nominal reactions may be determined by multiplying the table values by Ω_w. LRFD reactions may be determined by multiplying nominal reactions by ϕ_w = 0.9 for end reactions and 0.85 for interior reactions.

Attachment Patterns to Supports



Shallow VERCOR™

- ≥ 3 in. Total Slab Depth
- Normal Weight Concrete



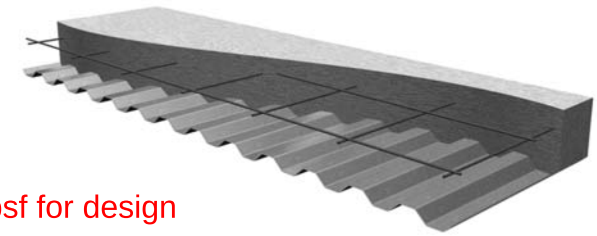
Allowable Interior Diaphragm Shear Strengths, q (plf) and Flexibility Factors, F (in./lb. x 10^6)

Deck Gage	Total Slab Thickness	Attachment Pattern	2'-0"	2'-6"	3'-0"	3'-6"	4'-0"	4'-6"	5'-0"	5'-6"	6'-0"
Ext. Patio 26	3.0"	q - 3 screws	1629	1600	1582	1566	1559	1549	1541	1535	1529
		q - 4 screws	1642	1611	1591	1574	1566	1555	1547	1540	1534
		q - 5 screws	1658	1624	1603	1584	1575	1564	1554	1547	1541
		q - 6 screws	1694	1653	1628	1606	1595	1582	1571	1562	1554
	Thickness ≥ 3.5"	q - 3 screws	1931	1902	1884	1868	1860	1851	1843	1837	1831
24	3.0"	q - 3 screws	1691	1651	1625	1603	1592	1579	1568	1559	1552
		q - 4 screws	1708	1665	1637	1614	1602	1588	1576	1566	1558
		q - 5 screws	1730	1682	1653	1627	1614	1598	1586	1575	1567
		q - 6 screws	1777	1721	1687	1656	1641	1623	1607	1595	1585
	3.5"	q - 3 screws	1993	1952	1927	1905	1894	1881	1870	1861	1854
		q - 4 screws	2010	1967	1939	1915	1904	1889	1878	1868	1860
		q - 5 screws	2032	1984	1955	1929	1916	1900	1888	1877	1868
		q - 6 screws	2079	2023	1988	1958	1943	1924	1909	1897	1887
	Thickness ≥ 4.0"	q - 3 screws	2295	2254	2229	2207	2196	2182	2172	2163	2155
22	3.0"	q - 3 screws	1756	1703	1670	1642	1627	1610	1596	1585	1575
		q - 4 screws	1777	1721	1685	1655	1640	1621	1606	1594	1584
		q - 5 screws	1804	1743	1705	1671	1655	1635	1618	1605	1594
		q - 6 screws	1863	1792	1747	1708	1689	1665	1645	1630	1616
	3.5"	q - 3 screws	2057	2005	1972	1943	1929	1912	1898	1887	1877
		q - 4 screws	2079	2023	1987	1957	1941	1923	1908	1896	1885
		q - 5 screws	2106	2045	2007	1973	1957	1936	1920	1907	1896
		q - 6 screws	2165	2094	2049	2009	1991	1967	1947	1931	1918
	4.0"	q - 3 screws	2359	2307	2274	2245	2231	2214	2200	2188	2179
		q - 4 screws	2381	2325	2289	2258	2243	2225	2210	2197	2187
		q - 5 screws	2408	2347	2308	2275	2259	2238	2222	2209	2197
		q - 6 screws	2467	2396	2351	2311	2293	2268	2249	2233	2220
Int. Flooring	Thickness ≥ 4.5"	q - 3 screws	2661	2609	2576	2547	2533	2515	2502	2490	2481

See footnotes on page 135. See page 131 for vertical loads footnotes.

Shallow VERCOR™

- ≥ 3 in. Total Slab Depth
- Normal Weight Concrete



for 4.5" - will use Avg. of 56.25 psf for design

for 5.5" - will use 69.1psf for design

Concrete Properties

Density (pcf)	Uniform Weight (psf)	Uniform Volume (yd³/100 ft²)	Compressive Strength, f'_c (psi)
145	32.9 to 69.1	0.839 to 1.852	3000

Notes:
1. Volumes and weights do not include allowance for deflection.
2. Weights are for concrete only and do not include weight of steel deck.
3. Total slab depth is nominal depth from top of concrete to bottom of steel deck.
4. Uniform and weight volume depend on slab thickness selected. See pages 20-21 for further information.

Footnotes for Maximum Unshored Clear Span and Allowable Diaphragm Shear Strength Tables

1. Interior connections may be #12, #14 or Shearflex® screws.
2. Connections at diaphragm perimeter or other collector elements are to be based on the actual shear to be transferred and the capacity of the connections used.

Allowable Shear Capacity per Connection (lbs)	Fastener Type	9/16" SV - Deck Gage		
		26	24	22
	#12 Screw	199 lbs	266 lbs	333 lbs
	#14 Screw or Shearflex®	230 lbs	308 lbs	385 lbs

3. If higher shear values than those shown are required, please contact Verco Engineering Dept.
4. Total slab depth is nominal depth from top of concrete to bottom of steel deck.
5. Concrete fill to be normal weight (145 pcf) and have minimum compressive strength f'_c = 3,000 psi.
6. SV decks with structural concrete fill have a Flexibility Factor of F <1.
7. Sidelap connections - minimum 1 - #10 screw per span, maximum 36" oc spacing.
8. A continuous 3 span condition is assumed for all span lengths 4 ft and greater. For span lengths less than 4 ft, a 12 ft long sheet is assumed, with a maximum of 7 continuous spans.
9. To convert to nominal values multiply by Ω_d (ASD) = 3.25. To convert to LRFD multiple nominal value by Φ_d = .5

Maximum Unshored Clear Span (ft-in.)

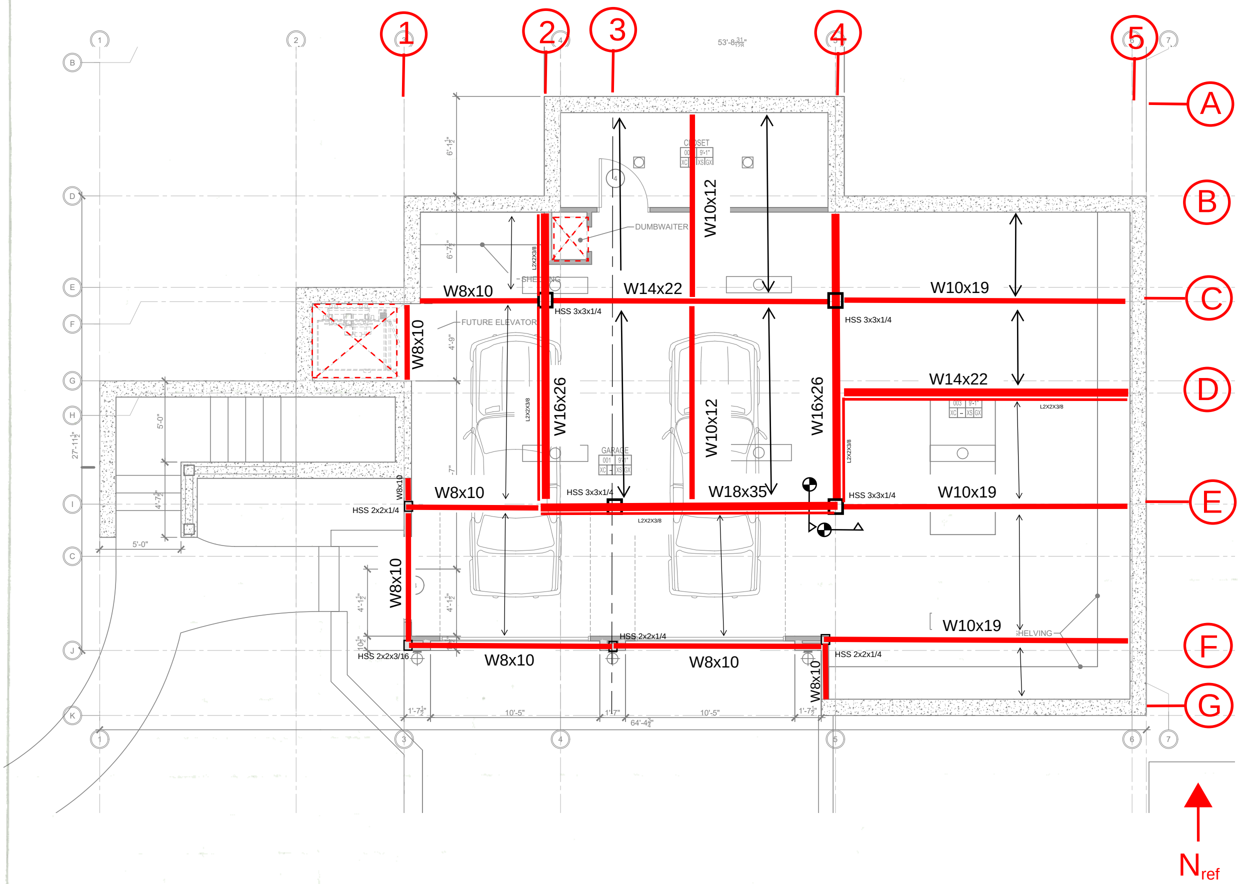
Gage	Span	Total Slab Depth Normal Weight Conc. (145 pcf)						
		3.0" NW	3.5" NW	4.0" NW	4.5" NW	5.0" NW	5.5" NW	6.0" NW
26	1	2'-5"	2'-5"	2'-4"	2'-3"	2'-2"	2'-2"	2'-1"
	2	2'-11"	2'-10"	2'-9"	2'-8"	2'-7"	2'-7"	2'-6"
	3	3'-0"	2'-11"	2'-9"	2'-9"	2'-8"	2'-7"	2'-6"
24	1	3'-3"	3'-2"	3'-1"	3'-0"	2'-11"	2'-10"	2'-9"
	2	3'-11"	3'-9"	3'-8"	3'-6"	3'-5"	3'-4"	3'-3"
	3	3'-11"	3'-10"	3'-8"	3'-7"	3'-6"	3-4"	3'-3"
22	1	3'-8"	3'-6"	3'-4"	3'-2"	3'-1"	3'-0"	2'-11"
	2	4'-7"	4'-5"	4'-3"	4'-1"	4'-0"	3'-10"	3'-9"
	3	4'-6"	4'-3"	4'-1"	3'-11"	3'-10"	3'-8"	3'-7"

1. Shoring calculations based on the following:
   - Deck supporting dead load of concrete plus 20 psf uniform construction load or 150 pound concentrated construction live load for flexure.
   - Dead load deflection limited to L/180 of span length, not to exceed 3/4".
   - Allowable reactions based on maximum bearing length permitted by AISI S100. Support reactions for unshored spans due to dead loads and uniform construction live loads must be evaluated based on the allowable reactions set forth on page 128.
2. Shoring is required at midspan for spans greater than those shown.

Structural Concrete on Steel w/ Verco

Alternative Steel Design:
Structural, Verco Decking with all Steel Framing

Key Plan

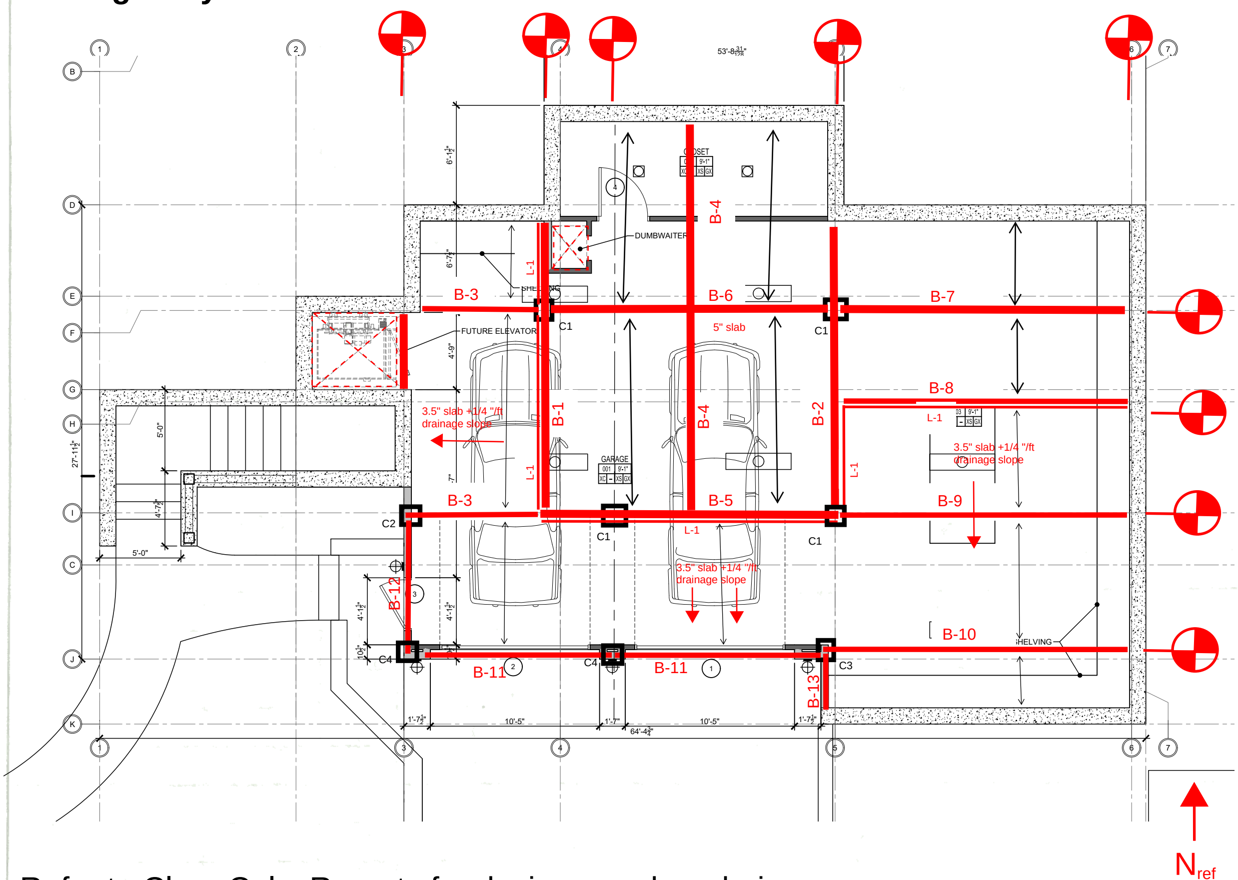


Alternative Steel Design:

Structural, Verco Decking with all Steel Framing

Note: to help with constructibility, oversize specific beams to as many connection points are flush. along grid-lines, size most loaded-largest beam, reuse size for continuing members. Primarily do separate calc's to account for differing loading cases.

Design Key Plan



Refer to Clear Calc. Reports for design member choices

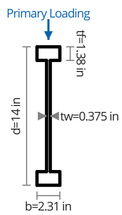
Being conservative with using maximum of height of 9' for all columns for worst cases

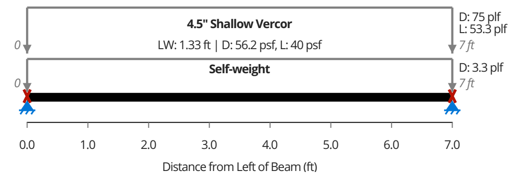
Client:	John Lawson	**Date:**	Oct 14, 2023
Author:	Cameron Cunningham	**Job #:**	ARCE 453-01
Project:	C.S.P. - Prior Consideration Design	**Subject:**	**Member Schedule**

	Calculation	Member	Quantity	Comments
34%	**J-1**	14" TJI 230	7 ft	
10%	**J-2**	1-3/4x14 Microllam LVL 2.0E-2600Fb	2.33 ft	
38%	**J-3**	2 - 1-3/4x14 Microllam LVL 2.0E-2600Fb	11.3 ft	
33%	**J-4**	14" TJI 230	11.3 ft	
51%	**J-5**	9-1/2" TJI 230	9 ft	
14%	**L-1**	1-3/4x5-1/2 Microllam LVL 2.0E-2600Fb	9 ft	
60%	**B-1**	8-3/4x21 24F-1.8E	18 ft	
88%	**B-2**	8-3/4x21 24F-1.8E	18 ft	
62%	**B-3**	5-1/2x14 24F-1.8E	18.5 ft	
53%	**B-4**	5-1/2x9-1/2 24F-1.8E	8.5 ft	
86%	**B-5**	5-1/2x14 24F-1.8E	18 ft	
61%	**B-6**	8-3/4x21 24F-1.8E	18.8 ft	
67%	**B-7**	8-3/4x21 24F-1.8E	18 ft	
95%	**B-8**	5-1/2x16 24F-1.8E	18.8 ft	
95%	**B-9**	5-1/2x16 24F-1.8E	18.8 ft	
45%	**B-10**	3 - 1-3/4x9-1/2 Microllam LVL 2.0E-2600Fb	11.5 ft	
49%	**C1-1**	8x8 D.Fir-L No. 1	9 ft	
13%	**C1-2**	8x8 D.Fir-L No. 2	9 ft	
44%	**C2-1**	8x8 D.Fir-L No. 1	9 ft	
56%	**C2-2**	8x8 D.Fir-L No. 1	9 ft	
25%	**C3**	6x6 D.Fir-L No. 2	9 ft	
54%	**C4**	6x6 D.Fir-L No. 2	9 ft	
32%	**C5**	4x6 D.Fir-L No. 2	9 ft	
19%	**Typ. Ext. Bearing Wall**	2x6 D.Fir-L No. 2	9 ft	
90%	**HDR-1**	4x6 D.Fir-L No. 2	3.75 ft	

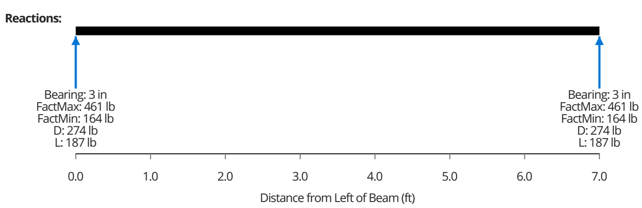
Client:	John Lawson	**Date:**	Oct 14, 2023
Author:	Cameron Cunningham	**Job #:**	ARCE 453-01
Project:	C.S.P. - Prior Consideration Design	**Subject:**	J-1 PASS
References:	NDS 2018 (ASD)		

Summary





	Member		14" TJI 230
16%	Moment Utilization	$M/M' =$	806 lb*ft / 4990 lb*ft
24%	Shear Utilization	$V/V' =$	461 lb / 1950 lb
34%	Bearing Utilization	$R/R' =$	461 lb / 1360 lb
6%	Governing Live / Short-Term Deflection	$\delta_{ST} =$	-0.0143 in (L/5880)
5%	Governing Long-Term Deflection	$\delta_{LT} =$	-0.0184 in (L/4550)
	Governing Long-Term Deflection	$\delta_{LT} =$	-0.0184 in



Key Properties

Beam Plan Length	$L_X =$	7 ft

Loads

Design Conditions

Design Code for Load Combinations	International Building Code (IBC) 2018

Member Properties

Base Allowable Moment	$M_r =$	4990 lb · ft
Base Allowable Shear	$V_r =$	1950 lb
Base Perpendicular Compression Allowable Stress	$F_{c\perp} =$	0 psi

Section Bending (NDS 2018 2.3)

Governing Duration Factor in Bending	$C_{D,b} =$	1
Beam Stability Factor	$C_L =$	1
Adjusted Allowable Moment	$M_r' =$	4990 lb · ft

Shear Design (NDS 2018 3.4)

Governing Duration Factor	$C_D =$	1
Adjusted Allowable Shear	$V_r' =$	1950 lb

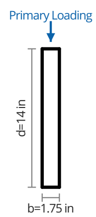
Bearing (NDS 2018 3.10)

Base Bearing Strength	$F_{c\perp}'/C_b =$	0 psi

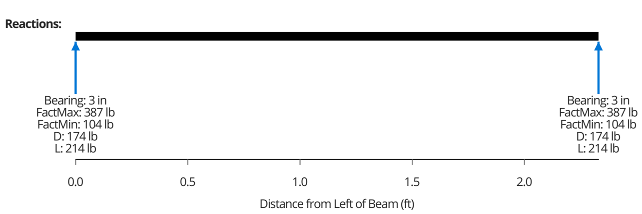
Comments

Client:	John Lawson	**Date:**	Oct 14, 2023
Author:	Cameron Cunningham	**Job #:**	ARCE 453-01
Project:	C.S.P. - Prior Consideration Design	**Subject:**	J-2 PASS
References:	NDS 2018 (ASD)		

Summary



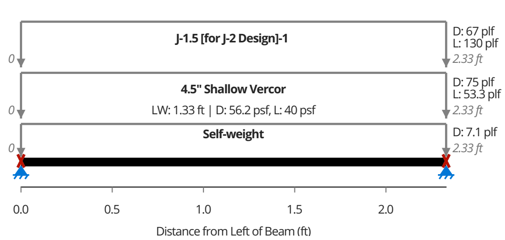
	Member		1-3/4x14 Microllam LVL 2.0E-2600Fb
2%	Moment Utilization	$M/M' =$	226 lb*ft / 12 600 lb*ft
8%	Shear Utilization	$V/V' =$	387 lb / 4650 lb
10%	Bearing Utilization	$R/R' =$	387 lb / 3940 lb
	Minimum Bearing Length (End Supports)	$\ell_{b,min,end} =$	0.295 in
1%	Governing Live / Short-Term Deflection	$\delta_{ST} =$	-0.000975 in (L/28 700)
1%	Governing Long-Term Deflection	$\delta_{LT} =$	-0.00104 in (L/27 000)
	Governing Long-Term Deflection	$\delta_{LT} =$	-0.00104 in



Key Properties

Beam Plan Length	$L_X =$	2.33 ft
Continuous Bracing for Lateral Torsional Buckling		Top Braced

Loads



Design Conditions

Design Code for Load Combinations	International Building Code (IBC) 2018

Member Properties

Cross-Sectional Area	$A =$	24.5 in²
Strong Axis Moment of Inertia	$I_{xx} =$	400 in⁴
Section Modulus	$S =$	57.2 in³
Base Allowable Bending Stress	$F_b =$	2600 psi
Base Allowable Shear Stress	$F_v =$	285 psi
Base Perpendicular Compression Allowable Stress	$F_{c\perp} =$	750 psi
True Modulus of Elasticity	$E_{true} =$	$2\,000\,000$ psi
Apparent Modulus of Elasticity	$E_{app} =$	NaN psi
Modulus of Elasticity for Deflections	$E =$	$2\,000\,000$ psi

Elastic Modulus (NDS 2018 2.3)

Adjusted Modulus of Elasticity	$E' =$	$2\,000\,000$ psi
Adjusted Shear Modulus	$G' =$	$125\,000$ psi

Section Bending (NDS 2018 2.3)

Volume Factor	$C_V =$	0.979

Positive Bending (NDS 2018 2.3)

Governing Duration Factor - Positive Bending	$C_{D,b}^{+} =$	1
Governing Beam Stability Factor - Positive Bending	$C_L^{+} =$	1
Adjusted Bending Strength - Positive Bending	$F_b'^{+} =$	2650 psi

Negative Bending (NDS 2018 2.3)

Governing Duration Factor - Negative Bending	$C_{D,b}^{-} =$	0.9
Governing Beam Stability Factor - Negative Bending	$C_L^{-} =$	0.782
Adjusted Bending Strength - Negative Bending	$F_b'^{-} =$	1900 psi

Shear Design (NDS 2018 3.4)

Governing Duration Factor	$C_D =$	1
Adjusted Shear Strength	$F_v' =$	285 psi

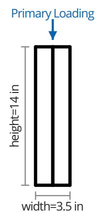
Bearing (NDS 2018 3.10)

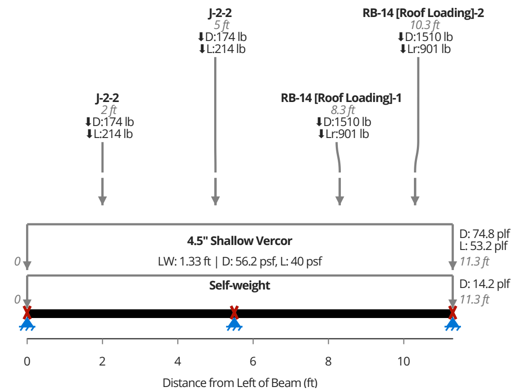
Base Bearing Strength	$F_{c\perp}'/C_b =$	750 psi

Comments

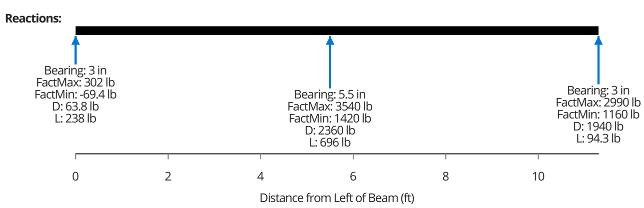
Client:	John Lawson	**Date:**	Oct 14, 2023
Author:	Cameron Cunningham	**Job #:**	ARCE 453-01
Project:	C.S.P. - Prior Consideration Design	**Subject:**	J-3 PASS
References:	NDS 2018 (ASD)		

Summary





	Member		2 plies - 1-3/4x14 Microllam LVL 2.0E-2600Fb
13%	Moment Utilization	$M/M' =$	3770 lb*ft / 29 700 lb*ft
26%	Shear Utilization	$V/V' =$	2990 lb / 11 600 lb
38%	Bearing Utilization	$R/R' =$	2990 lb / 7870 lb
	Minimum Bearing Length (End Supports)	$\ell_{b,min,end} =$	1.14 in
	Minimum Bearing Length (Int Supports)	$\ell_{b,min,int} =$	1.26 in
5%	Governing Live / Short-Term Deflection	$\delta_{ST} =$	-0.0105 in (L/6630)
5%	Governing Long-Term Deflection	$\delta_{LT} =$	-0.0143 in (L/4870)
	Governing Long-Term Deflection	$\delta_{LT} =$	-0.0143 in



Key Properties

Beam Plan Length	$L_X =$	11.3 ft
Continuous Bracing for Lateral Torsional Buckling		No Continuous Bracing

Loads

Design Conditions

Design Code for Load Combinations	International Building Code (IBC) 2018

Member Properties

Cross-Sectional Area	$A =$	49 in²
Strong Axis Moment of Inertia	$I_{xx} =$	800 in⁴
Section Modulus	$S =$	114 in³
Base Allowable Bending Stress	$F_b =$	2600 psi
Base Allowable Shear Stress	$F_v =$	285 psi
Base Perpendicular Compression Allowable Stress	$F_{c\perp} =$	750 psi
True Modulus of Elasticity	$E_{true} =$	$2\,000\,000$ psi
Apparent Modulus of Elasticity	$E_{app} =$	NaN psi
Modulus of Elasticity for Deflections	$E =$	$2\,000\,000$ psi

Elastic Modulus (NDS 2018 2.3)

Adjusted Modulus of Elasticity	$E' =$	$2\,000\,000$ psi
Adjusted Shear Modulus	$G' =$	$125\,000$ psi

Section Bending (NDS 2018 2.3)

Volume Factor	$C_V =$	0.979

Positive Bending (NDS 2018 2.3)

Governing Duration Factor - Positive Bending	$C_{D,b}^{+} =$	1.25
Governing Beam Stability Factor - Positive Bending	$C_L^{+} =$	0.96
Adjusted Bending Strength - Positive Bending	$F_b'^{+} =$	3120 psi

Negative Bending (NDS 2018 2.3)

Governing Duration Factor - Negative Bending	$C_{D,b}^{-} =$	1
Governing Beam Stability Factor - Negative Bending	$C_L^{-} =$	0.972
Adjusted Bending Strength - Negative Bending	$F_b'^{-} =$	2530 psi

Shear Design (NDS 2018 3.4)

Governing Duration Factor	$C_D = 1.25$
Adjusted Shear Strength	$F'_v = 356 \text{ psi}$

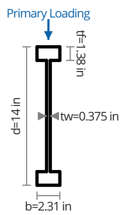
Bearing (NDS 2018 3.10)

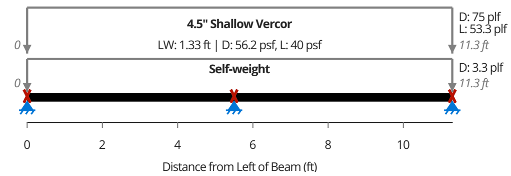
Base Bearing Strength	$F'_{c\perp}/C_b = 750 \text{ psi}$

Comments

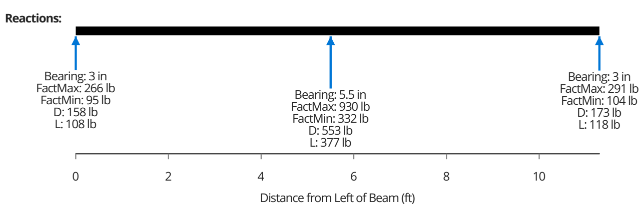
Client:	John Lawson	**Date:**	Oct 14, 2023
Author:	Cameron Cunningham	**Job #:**	ARCE 453-01
Project:	C.S.P. - Prior Consideration Design	**Subject:**	J-4 PASS
References:	NDS 2018 (ASD)		

Summary





	Member		14" TJI 230
11%	Moment Utilization	$M/M' =$	526 lb*ft / 4990 lb*ft
24%	Shear Utilization	$V/V' =$	472 lb / 1950 lb
33%	Bearing Utilization	$R/R' =$	930 lb / 2790 lb
4%	Governing Live / Short-Term Deflection	$\delta_{ST} =$	-0.00682 in (L/10 200)
3%	Governing Long-Term Deflection	$\delta_{LT} =$	-0.00769 in (L/9060)
	Governing Long-Term Deflection	$\delta_{LT} =$	-0.00769 in



Key Properties

Beam Plan Length	$L_X =$	11.3 ft

Loads

Design Conditions

Design Code for Load Combinations	International Building Code (IBC) 2018

Member Properties

Base Allowable Moment	$M_r =$	4990 lb · ft
Base Allowable Shear	$V_r =$	1950 lb
Base Perpendicular Compression Allowable Stress	$F_{c\perp} =$	0 psi

Section Bending (NDS 2018 2.3)

Governing Duration Factor in Bending	$C_{D,b} =$	1
Beam Stability Factor	$C_L =$	1
Adjusted Allowable Moment	$M_r' =$	4990 lb · ft

Shear Design (NDS 2018 3.4)

Governing Duration Factor	$C_D =$	1
Adjusted Allowable Shear	$V_r' =$	1950 lb

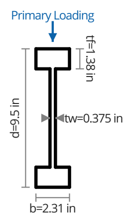
Bearing (NDS 2018 3.10)

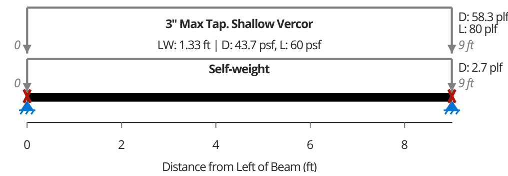
Base Bearing Strength	$F_{c\perp}'/C_b =$	0 psi

Comments

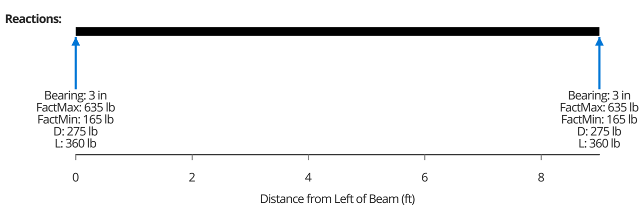
Client:	John Lawson	**Date:**	Oct 14, 2023
Author:	Cameron Cunningham	**Job #:**	ARCE 453-01
Project:	C.S.P. - Prior Consideration Design	**Subject:**	J-5 PASS
References:	NDS 2018 (ASD)		

Summary





	Member		9-1/2" TJI 230
43%	Moment Utilization	$M/M' =$	1430 lb*ft / 3330 lb*ft
48%	Shear Utilization	$V/V' =$	635 lb / 1330 lb
51%	Bearing Utilization	$R/R' =$	635 lb / 1250 lb
27%	Governing Live / Short-Term Deflection	$\delta_{ST} =$	-0.0825 in (L/1310)
23%	Governing Long-Term Deflection	$\delta_{LT} =$	-0.104 in (L/1040)
	Governing Long-Term Deflection	$\delta_{LT} =$	-0.104 in



Key Properties

Beam Plan Length	$L_X =$	9 ft

Loads

Design Conditions

Design Code for Load Combinations	International Building Code (IBC) 2018

Member Properties

Base Allowable Moment	$M_r =$	3330 lb · ft
Base Allowable Shear	$V_r =$	1330 lb
Base Perpendicular Compression Allowable Stress	$F_{c\perp} =$	0 psi

Section Bending (NDS 2018 2.3)

Governing Duration Factor in Bending	$C_{D,b} =$	1
Beam Stability Factor	$C_L =$	1
Adjusted Allowable Moment	$M'_r =$	3330 lb · ft

Shear Design (NDS 2018 3.4)

Governing Duration Factor	$C_D =$	1
Adjusted Allowable Shear	$V'_r =$	1330 lb

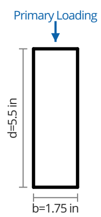
Bearing (NDS 2018 3.10)

Base Bearing Strength	$F'_{c\perp}/C_b =$	0 psi

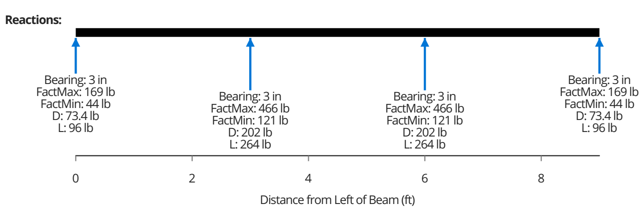
Comments

Client:	John Lawson	**Date:**	Oct 14, 2023
Author:	Cameron Cunningham	**Job #:**	ARCE 453-01
Project:	C.S.P. - Prior Consideration Design	**Subject:**	**L-1** PASS
References:	NDS 2018 (ASD)		

Summary



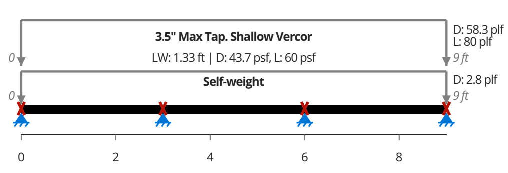
	Member		1-3/4x5-1/2 Microllam LVL 2.0E-2600Fb
6%	Moment Utilization	$M/M' =$	-127 lb*ft / 2170 lb*ft
14%	Shear Utilization	$V/V' =$	254 lb / 1830 lb
11%	Bearing Utilization	$R/R' =$	466 lb / 4430 lb
	Minimum Bearing Length (End Supports)	$\ell_{b,min,end} =$	0.129 in
	Minimum Bearing Length (Int Supports)	$\ell_{b,min,int} =$	0.315 in
3%	Governing Live / Short-Term Deflection	$\delta_{ST} =$	-0.00278 in (L/13 000)
2%	Governing Long-Term Deflection	$\delta_{LT} =$	-0.00339 in (L/10 600)
	Governing Long-Term Deflection	$\delta_{LT} =$	-0.00339 in



Key Properties

Beam Plan Length	$L_X =$	9 ft
Continuous Bracing for Lateral Torsional Buckling		Top Braced

Loads



Design Conditions

Design Code for Load Combinations	International Building Code (IBC) 2018

Member Properties

Cross-Sectional Area	$A =$	9.62 in²
Strong Axis Moment of Inertia	$I_{xx} =$	24.3 in⁴
Section Modulus	$S =$	8.82 in³
Base Allowable Bending Stress	$F_b =$	2600 psi
Base Allowable Shear Stress	$F_v =$	285 psi
Base Perpendicular Compression Allowable Stress	$F_{c\perp} =$	750 psi
True Modulus of Elasticity	$E_{true} =$	$2\,000\,000$ psi
Apparent Modulus of Elasticity	$E_{app} =$	NaN psi
Modulus of Elasticity for Deflections	$E =$	$2\,000\,000$ psi

Elastic Modulus (NDS 2018 2.3)

Adjusted Modulus of Elasticity	$E' =$	$2\,000\,000$ psi
Adjusted Shear Modulus	$G' =$	$125\,000$ psi

Section Bending (NDS 2018 2.3)

Volume Factor	$C_V =$	1.11

Positive Bending (NDS 2018 2.3)

Governing Duration Factor - Positive Bending	$C_{D,b}^{+} =$	1
Governing Beam Stability Factor - Positive Bending	$C_L^{+} =$	1
Adjusted Bending Strength - Positive Bending	$F_b'^{+} =$	3010 psi

Negative Bending (NDS 2018 2.3)

Governing Duration Factor - Negative Bending	$C_{D,b}^{-} =$	1
Governing Beam Stability Factor - Negative Bending	$C_L^{-} =$	0.983
Adjusted Bending Strength - Negative Bending	$F_b'^{-} =$	2950 psi

Shear Design (NDS 2018 3.4)

Governing Duration Factor	$C_D =$	1
Adjusted Shear Strength	$F_v' =$	285 psi

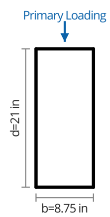
Bearing (NDS 2018 3.10)

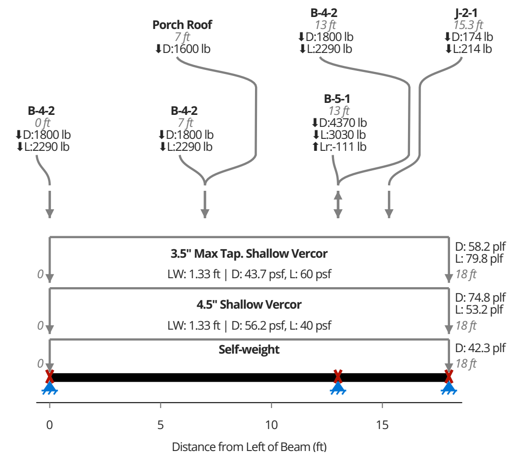
Base Bearing Strength	$F_{c\perp}'/C_b =$	750 psi

Comments

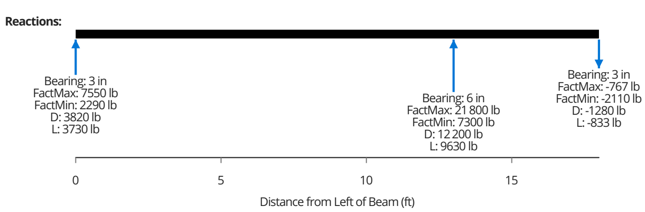
Client:	John Lawson	**Date:**	Oct 14, 2023
Author:	Cameron Cunningham	**Job #:**	ARCE 453-01
Project:	C.S.P. - Prior Consideration Design	**Subject:**	**B-1** PASS
References:	NDS 2018 (ASD)		

Summary





	Member		8-3/4x21 24F-1.8E
20%	Moment Utilization	$M/M' =$	-15 300 lb*ft / 74 800 lb*ft
19%	Shear Utilization	$V/V' =$	6250 lb / 32 500 lb
60%	Bearing Utilization	$R/R' =$	21 800 lb / 36 300 lb
	Minimum Bearing Length (End Supports)	$\ell_{b,min,end} =$	1.33 in
	Minimum Bearing Length (Int Supports)	$\ell_{b,min,int} =$	3.61 in
3%	Governing Live / Short-Term Deflection	$\delta_{ST} =$	-0.0124 in (L/12 600)
3%	Governing Long-Term Deflection	$\delta_{LT} =$	-0.0213 in (L/7320)
	Governing Long-Term Deflection	$\delta_{LT} =$	-0.0213 in



Key Properties

Beam Plan Length	$L_X =$	18 ft
Continuous Bracing for Lateral Torsional Buckling		Top Braced

Loads

Design Conditions

Design Code for Load Combinations	International Building Code (IBC) 2018

Member Properties

Cross-Sectional Area	$A =$	184 in²
Strong Axis Moment of Inertia	$I_{xx} =$	6750 in⁴
Section Modulus	$S =$	643 in³
Base Allowable Bending Stress	$F_b =$	2400 psi
Base Allowable Shear Stress	$F_v =$	265 psi
Base Perpendicular Compression Allowable Stress	$F_{c\perp} =$	650 psi
True Modulus of Elasticity	$E_{true} =$	$1\,900\,000$ psi
Apparent Modulus of Elasticity	$E_{app} =$	$1\,800\,000$ psi
Modulus of Elasticity for Deflections	$E =$	$1\,800\,000$ psi

Elastic Modulus (NDS 2018 2.3)

Adjusted Modulus of Elasticity	$E' =$	$1\,800\,000$ psi

Section Bending (NDS 2018 2.3)

Volume Factor	$C_V =$	0.962

Positive Bending (NDS 2018 2.3)

Governing Duration Factor - Positive Bending	$C_{D,b}^{+} =$	1
Governing Beam Stability Factor - Positive Bending	$C_L^{+} =$	1
Adjusted Bending Strength - Positive Bending	$F_b'^{+} =$	2310 psi

Negative Bending (NDS 2018 2.3)

Governing Duration Factor - Negative Bending	$C_{D,b}^{-} =$	1
Governing Beam Stability Factor - Negative Bending	$C_L^{-} =$	0.995
	$F_b'^{-} =$	1390 psi

Adjusted Bending Strength - Negative Bending

Shear Design (NDS 2018 3.4)

Governing Duration Factor $C_D = 1$

Adjusted Shear Strength $F'_v = 265 \text{ psi}$

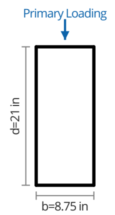
Bearing (NDS 2018 3.10)

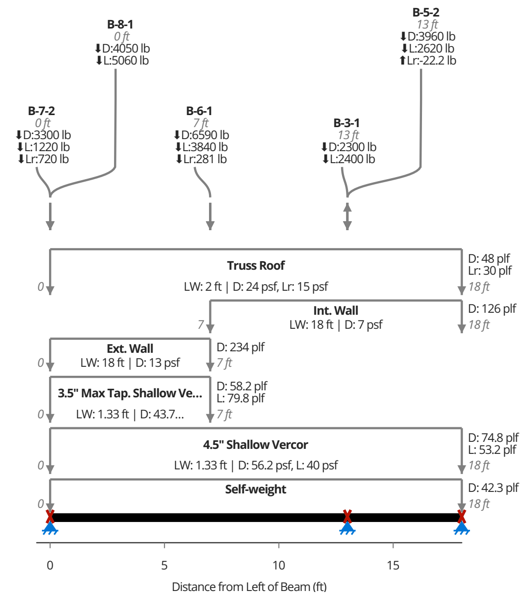
Base Bearing Strength $F'_{c\perp}/C_b = 650 \text{ psi}$

Comments

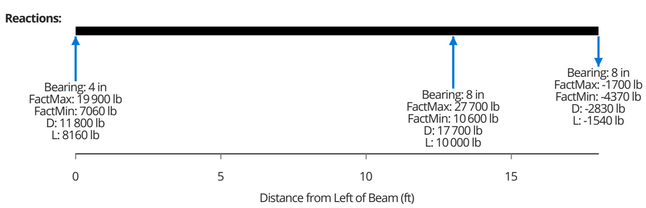
Client:	John Lawson	**Date:**	Oct 14, 2023
Author:	Cameron Cunningham	**Job #:**	ARCE 453-01
Project:	C.S.P. - Prior Consideration Design	**Subject:**	B-2 PASS
References:	NDS 2018 (ASD)		

Summary





	Member		8-3/4x21 24F-1.8E
35%	Moment Utilization	$M/M' =$	-26 100 lb*ft / 74 700 lb*ft
32%	Shear Utilization	$V/V' =$	10 300 lb / 32 500 lb
88%	Bearing Utilization	$R/R' =$	19 900 lb / 22 700 lb
	Minimum Bearing Length (End Supports)	$\ell_{b,min,end} =$	3.51 in
	Minimum Bearing Length (Int Supports)	$\ell_{b,min,int} =$	4.87 in
4%	Governing Live / Short-Term Deflection	$\delta_{ST} =$	-0.0194 in (L/8030)
6%	Governing Long-Term Deflection	$\delta_{LT} =$	-0.0376 in (L/4150)
	Governing Long-Term Deflection	$\delta_{LT} =$	-0.0376 in



Key Properties

Beam Plan Length	$L_X =$	18 ft
Continuous Bracing for Lateral Torsional Buckling		Top Braced

Loads

Design Conditions

Design Code for Load Combinations	International Building Code (IBC) 2018

Member Properties

Cross-Sectional Area	$A =$	184 in²
Strong Axis Moment of Inertia	$I_{xx} =$	6750 in⁴
Section Modulus	$S =$	643 in³
Base Allowable Bending Stress	$F_b =$	2400 psi
Base Allowable Shear Stress	$F_v =$	265 psi
Base Perpendicular Compression Allowable Stress	$F_{c\perp} =$	650 psi
True Modulus of Elasticity	$E_{true} =$	$1\,900\,000$ psi
Apparent Modulus of Elasticity	$E_{app} =$	$1\,800\,000$ psi
Modulus of Elasticity for Deflections	$E =$	$1\,800\,000$ psi

Elastic Modulus (NDS 2018 2.3)

Adjusted Modulus of Elasticity	$E' =$	$1\,800\,000$ psi

Section Bending (NDS 2018 2.3)

Volume Factor	$C_V =$	0.962

Positive Bending (NDS 2018 2.3)

Governing Duration Factor - Positive Bending	$C_{D,b}^{+} =$	1
Governing Beam Stability Factor - Positive Bending	$C_L^{+} =$	1
Adjusted Bending Strength - Positive Bending	$F_b'^{+} =$	2310 psi

Negative Bending (NDS 2018 2.3)

Governing Duration Factor - Negative Bending	$C^{-}_{D,b} =$	1
Governing Beam Stability Factor - Negative Bending	$C^{-}_{L} =$	0.995
Adjusted Bending Strength - Negative Bending	$F'^{-}_{b} =$	1390 psi

Shear Design (NDS 2018 3.4)

Governing Duration Factor	$C_D =$	1
Adjusted Shear Strength	$F'_v =$	265 psi

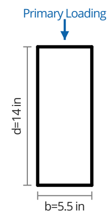
Bearing (NDS 2018 3.10)

Base Bearing Strength	$F'_{c\perp}/C_b =$	650 psi

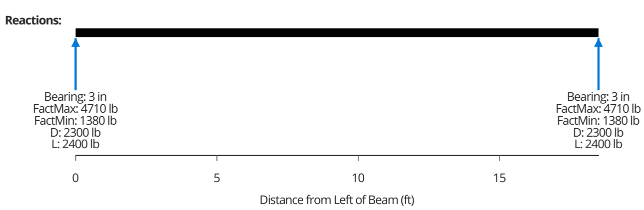
Comments

Client:	John Lawson	**Date:**	Oct 14, 2023
Author:	Cameron Cunningham	**Job #:**	ARCE 453-01
Project:	C.S.P. - Prior Consideration Design	**Subject:**	B-3 PASS
References:	NDS 2018 (ASD)		

Summary



	Member		5-1/2x14 24F-1.8E
62%	Moment Utilization	$M/M' =$	21 800 lb*ft / 34 800 lb*ft
35%	Shear Utilization	$V/V' =$	4710 lb / 13 600 lb
44%	Bearing Utilization	$R/R' =$	4710 lb / 10 700 lb
	Minimum Bearing Length (End Supports)	$\ell_{b,min,end} =$	1.32 in
49%	Governing Live / Short-Term Deflection	$\delta_{ST} =$	-0.303 in (L/733)
48%	Governing Long-Term Deflection	$\delta_{LT} =$	-0.447 in (L/496)
	Governing Long-Term Deflection	$\delta_{LT} =$	-0.447 in



Key Properties

Beam Plan Length	$L_X =$	18.5 ft
Continuous Bracing for Lateral Torsional Buckling		No Continuous Bracing

Loads

Design Conditions

Design Code for Load Combinations		International Building Code (IBC) 2018

Member Properties

Cross-Sectional Area	$A =$	77 in²
Strong Axis Moment of Inertia	$I_{xx} =$	1260 in⁴
Section Modulus	$S =$	180 in³
Base Allowable Bending Stress	$F_b =$	2400 psi
Base Allowable Shear Stress	$F_v =$	265 psi
Base Perpendicular Compression Allowable Stress	$F_{c\perp} =$	650 psi
True Modulus of Elasticity	$E_{true} =$	$1\,900\,000$ psi
Apparent Modulus of Elasticity	$E_{app} =$	$1\,800\,000$ psi
Modulus of Elasticity for Deflections	$E =$	$1\,800\,000$ psi

Elastic Modulus (NDS 2018 2.3)

Adjusted Modulus of Elasticity	$E' =$	$1\,800\,000$ psi

Section Bending (NDS 2018 2.3)

Volume Factor	$C_V =$	0.991

Positive Bending (NDS 2018 2.3)

Governing Duration Factor - Positive Bending	$C_{D,b}^{+} =$	1
Governing Beam Stability Factor - Positive Bending	$C_L^{+} =$	0.969
Adjusted Bending Strength - Positive Bending	$F_b'^{+} =$	2330 psi

Negative Bending (NDS 2018 2.3)

Governing Duration Factor - Negative Bending	$C_{D,b}^{-} =$	0.9
Governing Beam Stability Factor - Negative Bending	$C_L^{-} =$	0.986
Adjusted Bending Strength - Negative Bending	$F_b'^{-} =$	1290 psi

Shear Design (NDS 2018 3.4)

Governing Duration Factor	$C_D =$	1
Adjusted Shear Strength	$F_v' =$	265 psi

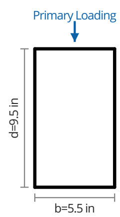
Bearing (NDS 2018 3.10)

Base Bearing Strength	$F_{c\perp}'/C_b =$	650 psi

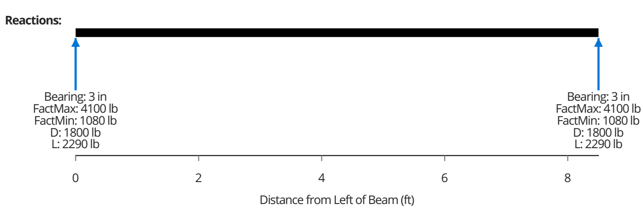
Comments

Client:	John Lawson	Date:	Oct 14, 2023
Author:	Cameron Cunningham	Job #:	ARCE 453-01
Project:	C.S.P. - Prior Consideration Design	Subject:	B-4 PASS
References:	NDS 2018 (ASD)		

Summary



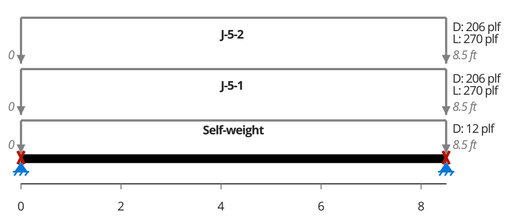
	Member		5-1/2x9-1/2 24F-1.8E
53%	Moment Utilization	$M/M' =$	8710 lb*ft / 16 500 lb*ft
44%	Shear Utilization	$V/V' =$	4100 lb / 9230 lb
38%	Bearing Utilization	$R/R' =$	4100 lb / 10 700 lb
	Minimum Bearing Length (End Supports)	$\ell_{b,min,end} =$	1.15 in
32%	Governing Live / Short-Term Deflection	$\delta_{ST} =$	-0.0897 in (L/1140)
29%	Governing Long-Term Deflection	$\delta_{LT} =$	-0.125 in (L/817)
	Governing Long-Term Deflection	$\delta_{LT} =$	-0.125 in



Key Properties

Beam Plan Length	$L_X =$	8.5 ft
Continuous Bracing for Lateral Torsional Buckling		Top Braced

Loads



Design Conditions

Design Code for Load Combinations		International Building Code (IBC) 2018

Member Properties

Cross-Sectional Area	$A =$	52.2 in²
Strong Axis Moment of Inertia	$I_{xx} =$	393 in⁴
Section Modulus	$S =$	82.7 in³
Base Allowable Bending Stress	$F_b =$	2400 psi
Base Allowable Shear Stress	$F_v =$	265 psi
Base Perpendicular Compression Allowable Stress	$F_{c\perp} =$	650 psi
True Modulus of Elasticity	$E_{true} =$	$1\,900\,000$ psi
Apparent Modulus of Elasticity	$E_{app} =$	$1\,800\,000$ psi
Modulus of Elasticity for Deflections	$E =$	$1\,800\,000$ psi

Elastic Modulus (NDS 2018 2.3)

Adjusted Modulus of Elasticity	$E' =$	$1\,800\,000$ psi

Section Bending (NDS 2018 2.3)

Volume Factor	$C_V =$	1

Positive Bending (NDS 2018 2.3)

Governing Duration Factor - Positive Bending	$C^+_{D,b} =$	1
Governing Beam Stability Factor - Positive Bending	$C^+_L =$	1
Adjusted Bending Strength - Positive Bending	$F'^+_b =$	2400 psi

Negative Bending (NDS 2018 2.3)

Governing Duration Factor - Negative Bending	$C^-_{D,b} =$	0.9
Governing Beam Stability Factor - Negative Bending	$C^-_L =$	0.996
Adjusted Bending Strength - Negative Bending	$F'^-_b =$	1300 psi

Shear Design (NDS 2018 3.4)

Governing Duration Factor	$C_D =$	1
Adjusted Shear Strength	$F'_v =$	265 psi

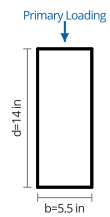
Bearing (NDS 2018 3.10)

Base Bearing Strength	$F'_{c\perp}/C_b =$	650 psi

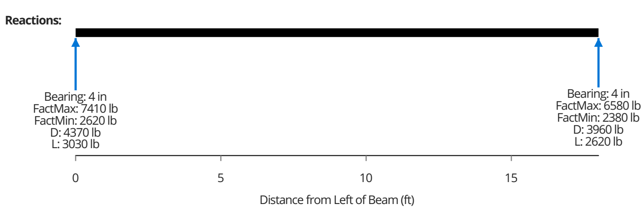
Comments

Client:	John Lawson	**Date:**	Oct 14, 2023
Author:	Cameron Cunningham	**Job #:**	ARCE 453-01
Project:	C.S.P. - Prior Consideration Design	**Subject:**	B-5 PASS
References:	NDS 2018 (ASD)		

Summary



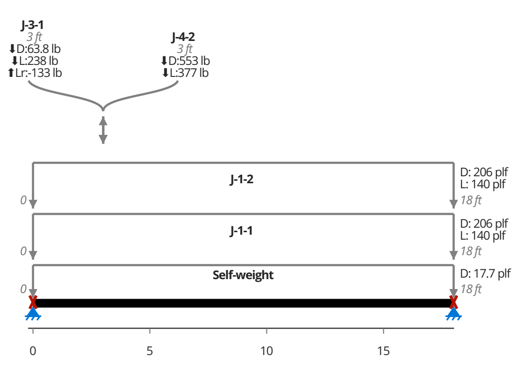
	Member		5-1/2x14 24F-1.8E
86%	Moment Utilization	$M/M' =$	30 600 lb*ft / 35 700 lb*ft
54%	Shear Utilization	$V/V' =$	7410 lb / 13 600 lb
52%	Bearing Utilization	$R/R' =$	7410 lb / 14 300 lb
	Minimum Bearing Length (End Supports)	$\ell_{b,min,end} =$	2.07 in
52%	Governing Live / Short-Term Deflection	$\delta_{ST} =$	-0.314 in (L/689)
61%	Governing Long-Term Deflection	$\delta_{LT} =$	-0.551 in (L/392)
	Governing Long-Term Deflection	$\delta_{LT} =$	-0.551 in



Key Properties

Beam Plan Length	$L_X =$	18 ft
Continuous Bracing for Lateral Torsional Buckling		Top Braced

Loads



Design Conditions

Design Code for Load Combinations	International Building Code (IBC) 2018

Member Properties

Cross-Sectional Area	$A =$	77 in²
Strong Axis Moment of Inertia	$I_{xx} =$	1260 in⁴
Section Modulus	$S =$	180 in³
Base Allowable Bending Stress	$F_b =$	2400 psi
Base Allowable Shear Stress	$F_v =$	265 psi
Base Perpendicular Compression Allowable Stress	$F_{c\perp} =$	650 psi
True Modulus of Elasticity	$E_{true} =$	$1\,900\,000$ psi
Apparent Modulus of Elasticity	$E_{app} =$	$1\,800\,000$ psi
Modulus of Elasticity for Deflections	$E =$	$1\,800\,000$ psi

Elastic Modulus (NDS 2018 2.3)

Adjusted Modulus of Elasticity	$E' =$	$1\,800\,000$ psi

Section Bending (NDS 2018 2.3)

Volume Factor	$C_V =$	0.993

Positive Bending (NDS 2018 2.3)

Governing Duration Factor - Positive Bending	$C_{D,b}^{+} =$	1
Governing Beam Stability Factor - Positive Bending	$C_L^{+} =$	1
Adjusted Bending Strength - Positive Bending	$F_b'^{+} =$	2380 psi

Negative Bending (NDS 2018 2.3)

Governing Duration Factor - Negative Bending	$C_{D,b}^{-} =$	0.9
Governing Beam Stability Factor - Negative Bending	$C_L^{-} =$	0.987
Adjusted Bending Strength - Negative Bending	$F_b'^{-} =$	1290 psi

Shear Design (NDS 2018 3.4)

Governing Duration Factor	$C_D =$	1
Adjusted Shear Strength	$F_v' =$	265 psi

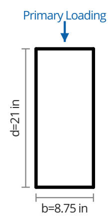
Bearing (NDS 2018 3.10)

Base Bearing Strength	$F_{c\perp}'/C_b =$	650 psi

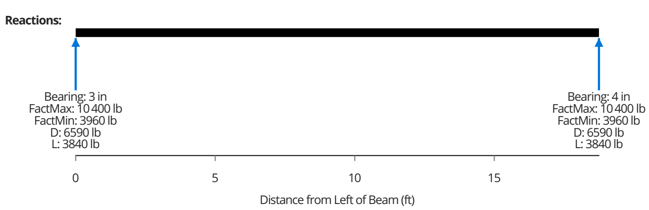
Comments

Client:	John Lawson	**Date:**	Oct 14, 2023
Author:	Cameron Cunningham	**Job #:**	ARCE 453-01
Project:	C.S.P. - Prior Consideration Design	**Subject:**	B-6 PASS
References:	NDS 2018 (ASD)		

Summary



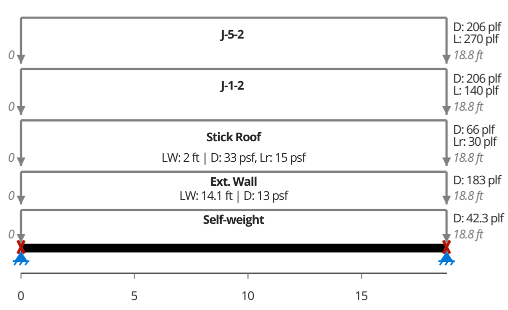
	Member		8-3/4x21 24F-1.8E
42%	Moment Utilization	$M/M' =$	48 900 lb*ft / 117 000 lb*ft
32%	Shear Utilization	$V/V' =$	10 400 lb / 32 500 lb
61%	Bearing Utilization	$R/R' =$	10 400 lb / 17 100 lb
	Minimum Bearing Length (End Supports)	$\ell_{b,min,end} =$	1.83 in
16%	Governing Live / Short-Term Deflection	$\delta_{ST} =$	-0.101 in (L/2240)
19%	Governing Long-Term Deflection	$\delta_{LT} =$	-0.181 in (L/1240)
	Governing Long-Term Deflection	$\delta_{LT} =$	-0.181 in



Key Properties

Beam Plan Length	$L_X =$	18.8 ft
Continuous Bracing for Lateral Torsional Buckling		Top Braced

Loads



Design Conditions

Design Code for Load Combinations	International Building Code (IBC) 2018

Member Properties

Cross-Sectional Area	$A =$	184 in²
Strong Axis Moment of Inertia	$I_{xx} =$	6750 in⁴
Section Modulus	$S =$	643 in³
Base Allowable Bending Stress	$F_b =$	2400 psi
Base Allowable Shear Stress	$F_v =$	265 psi
Base Perpendicular Compression Allowable Stress	$F_{c\perp} =$	650 psi
True Modulus of Elasticity	$E_{true} =$	$1\,900\,000$ psi
Apparent Modulus of Elasticity	$E_{app} =$	$1\,800\,000$ psi
Modulus of Elasticity for Deflections	$E =$	$1\,800\,000$ psi

Elastic Modulus (NDS 2018 2.3)

Adjusted Modulus of Elasticity	$E' =$	$1\,800\,000$ psi

Section Bending (NDS 2018 2.3)

Volume Factor	$C_V =$	0.907

Positive Bending (NDS 2018 2.3)

Governing Duration Factor - Positive Bending	$C_{D,b}^{+} =$	1
Governing Beam Stability Factor - Positive Bending	$C_L^{+} =$	1
Adjusted Bending Strength - Positive Bending	$F_b'^{+} =$	2180 psi

Negative Bending (NDS 2018 2.3)

Governing Duration Factor - Negative Bending	$C_{D,b}^{-} =$	0.9
Governing Beam Stability Factor - Negative Bending	$C_L^{-} =$	0.992
Adjusted Bending Strength - Negative Bending	$F_b'^{-} =$	1180 psi

Shear Design (NDS 2018 3.4)

Governing Duration Factor	$C_D =$	1
Adjusted Shear Strength	$F_v' =$	265 psi

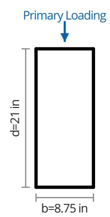
Bearing (NDS 2018 3.10)

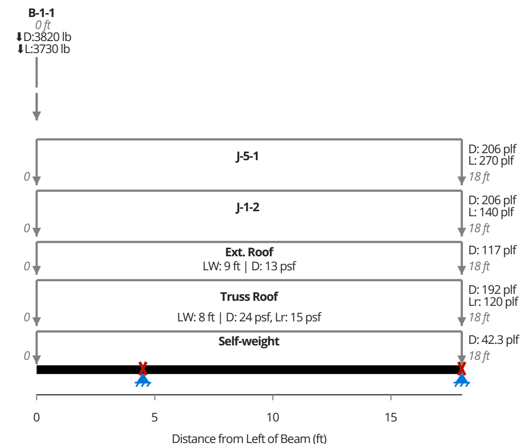
Base Bearing Strength	$F_{c\perp}'/C_b =$	650 psi

Comments

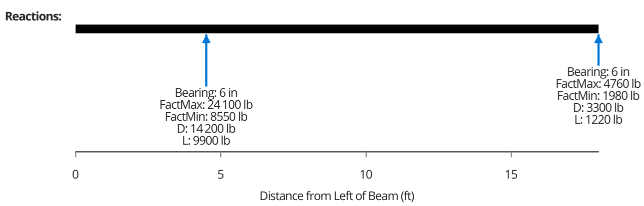
Client:	John Lawson	**Date:**	Oct 14, 2023
Author:	Cameron Cunningham	**Job #:**	ARCE 453-01
Project:	C.S.P. - Prior Consideration Design	**Subject:**	B-7 PASS
References:	NDS 2018 (ASD)		

Summary





	Member		8-3/4x21 24F-1.8E
62%	Moment Utilization	$M/M' =$	-45 900 lb*ft / 73 700 lb*ft
40%	Shear Utilization	$V/V' =$	12 800 lb / 32 500 lb
67%	Bearing Utilization	$R/R' =$	24 100 lb / 36 300 lb
	Minimum Bearing Length (End Supports)	$\ell_{b,min,end} =$	0.836 in
	Minimum Bearing Length (Int Supports)	$\ell_{b,min,int} =$	4 in
27%	Governing Live / Short-Term Deflection	$\delta_{ST} =$	-0.049 in (L/1100)
16%	Governing Long-Term Deflection	$\delta_{LT} =$	-0.0709 in (L/762)
	Governing Long-Term Deflection	$\delta_{LT} =$	-0.0709 in



Key Properties

Beam Plan Length	$L_X =$	18 ft
Continuous Bracing for Lateral Torsional Buckling		No Continuous Bracing

Loads

Design Conditions

Design Code for Load Combinations	International Building Code (IBC) 2018

Member Properties

Cross-Sectional Area	$A =$	184 in²
Strong Axis Moment of Inertia	$I_{xx} =$	6750 in⁴
Section Modulus	$S =$	643 in³
Base Allowable Bending Stress	$F_b =$	2400 psi
Base Allowable Shear Stress	$F_v =$	265 psi
Base Perpendicular Compression Allowable Stress	$F_{c\perp} =$	650 psi
True Modulus of Elasticity	$E_{true} =$	$1\,900\,000$ psi
Apparent Modulus of Elasticity	$E_{app} =$	$1\,800\,000$ psi
Modulus of Elasticity for Deflections	$E =$	$1\,800\,000$ psi

Elastic Modulus (NDS 2018 2.3)

Adjusted Modulus of Elasticity	$E' =$	$1\,800\,000$ psi

Section Bending (NDS 2018 2.3)

Volume Factor	$C_V =$	0.949

Positive Bending (NDS 2018 2.3)

Governing Duration Factor - Positive Bending	$C^+_{D,b} =$	1
Governing Beam Stability Factor - Positive Bending	$C^+_L =$	0.996
Adjusted Bending Strength - Positive Bending	$F'^+_b =$	2280 psi

Negative Bending (NDS 2018 2.3)

Governing Duration Factor - Negative Bending	$C^-_{D,b} =$	1
Governing Beam Stability Factor - Negative Bending	$C^-_L =$	0.997
Adjusted Bending Strength - Negative Bending	$F'^-_b =$	1380 psi

Shear Design (NDS 2018 3.4)

Governing Duration Factor	$C_D = 1$
Adjusted Shear Strength	$F'_v = 265$ psi

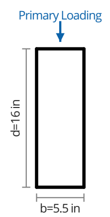
Bearing (NDS 2018 3.10)

Base Bearing Strength	$F'_{c\perp}/C_b = 650$ psi

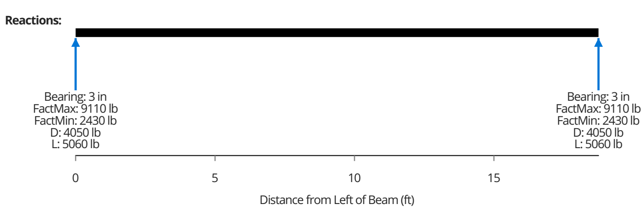
Comments

Client:	John Lawson	**Date:**	Oct 14, 2023
Author:	Cameron Cunningham	**Job #:**	ARCE 453-01
Project:	C.S.P. - Prior Consideration Design	**Subject:**	B-8 PASS
References:	NDS 2018 (ASD)		

Summary



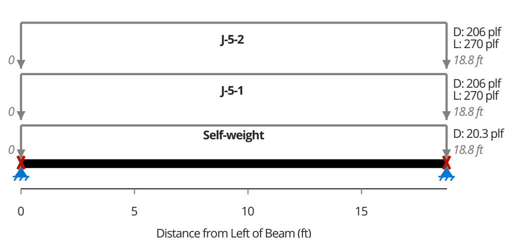
	Member		5-1/2x16 24F-1.8E
95%	Moment Utilization	$M/M' =$	42 700 lb*ft / 45 000 lb*ft
59%	Shear Utilization	$V/V' =$	9110 lb / 15 500 lb
85%	Bearing Utilization	$R/R' =$	9110 lb / 10 700 lb
	Minimum Bearing Length (End Supports)	$\ell_{b,min,end} =$	2.55 in
71%	Governing Live / Short-Term Deflection	$\delta_{ST} =$	-0.444 in (L/506)
66%	Governing Long-Term Deflection	$\delta_{LT} =$	-0.622 in (L/362)
	Governing Long-Term Deflection	$\delta_{LT} =$	-0.622 in



Key Properties

Beam Plan Length	$L_X =$	18.8 ft
Continuous Bracing for Lateral Torsional Buckling		No Continuous Bracing

Loads



Design Conditions

Design Code for Load Combinations	International Building Code (IBC) 2018

Member Properties

Cross-Sectional Area	$A =$	88 in²
Strong Axis Moment of Inertia	$I_{xx} =$	1880 in⁴
Section Modulus	$S =$	235 in³
Base Allowable Bending Stress	$F_b =$	2400 psi
Base Allowable Shear Stress	$F_v =$	265 psi
Base Perpendicular Compression Allowable Stress	$F_{c\perp} =$	650 psi
True Modulus of Elasticity	$E_{true} =$	$1\,900\,000$ psi
Apparent Modulus of Elasticity	$E_{app} =$	$1\,800\,000$ psi
Modulus of Elasticity for Deflections	$E =$	$1\,800\,000$ psi

Elastic Modulus (NDS 2018 2.3)

Adjusted Modulus of Elasticity	$E' =$	$1\,800\,000$ psi

Section Bending (NDS 2018 2.3)

Volume Factor	$C_V =$	0.976

Positive Bending (NDS 2018 2.3)

Governing Duration Factor - Positive Bending	$C_{D,b}^{+} =$	1
Governing Beam Stability Factor - Positive Bending	$C_L^{+} =$	0.959
Adjusted Bending Strength - Positive Bending	$F_b'^{+} =$	2300 psi

Negative Bending (NDS 2018 2.3)

Governing Duration Factor - Negative Bending	$C_{D,b}^{-} =$	0.9
Governing Beam Stability Factor - Negative Bending	$C_L^{-} =$	0.983
Adjusted Bending Strength - Negative Bending	$F_b'^{-} =$	1270 psi

Shear Design (NDS 2018 3.4)

Governing Duration Factor	$C_D =$	1
Adjusted Shear Strength	$F_v' =$	265 psi

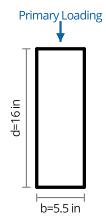
Bearing (NDS 2018 3.10)

Base Bearing Strength	$F_{c\perp}'/C_b =$	650 psi

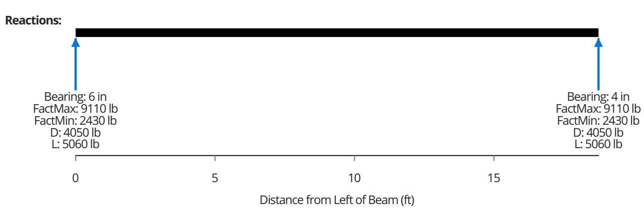
Comments

Client:	John Lawson	**Date:**	Oct 14, 2023	
Author:	Cameron Cunningham	**Job #:**	ARCE 453-01	
Project:	C.S.P. - Prior Consideration Design	**Subject:**	B-9	PASS
References:	NDS 2018 (ASD)			

Summary



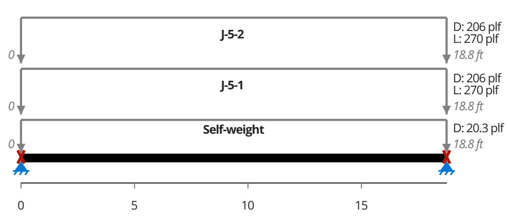
	Member		5-1/2x16 24F-1.8E
95%	Moment Utilization	$M/M' =$	42 700 lb*ft / 45 000 lb*ft
59%	Shear Utilization	$V/V' =$	9110 lb / 15 500 lb
64%	Bearing Utilization	$R/R' =$	9110 lb / 14 300 lb
	Minimum Bearing Length (End Supports)	$\ell_{b,min,end} =$	2.55 in
71%	Governing Live / Short-Term Deflection	$\delta_{ST} =$	-0.444 in (L/506)
66%	Governing Long-Term Deflection	$\delta_{LT} =$	-0.622 in (L/362)
	Governing Long-Term Deflection	$\delta_{LT} =$	-0.622 in



Key Properties

Beam Plan Length	$L_X =$	18.8 ft
Continuous Bracing for Lateral Torsional Buckling		No Continuous Bracing

Loads



Design Conditions

Design Code for Load Combinations	International Building Code (IBC) 2018

Member Properties

Cross-Sectional Area	$A =$	88 in^2
Strong Axis Moment of Inertia	$I_{xx} =$	1880 in^4
Section Modulus	$S =$	235 in^3
Base Allowable Bending Stress	$F_b =$	2400 psi
Base Allowable Shear Stress	$F_v =$	265 psi
Base Perpendicular Compression Allowable Stress	$F_{c\perp} =$	650 psi
True Modulus of Elasticity	$E_{true} =$	$1\,900\,000$ psi
Apparent Modulus of Elasticity	$E_{app} =$	$1\,800\,000$ psi
Modulus of Elasticity for Deflections	$E =$	$1\,800\,000$ psi

Elastic Modulus (NDS 2018 2.3)

Adjusted Modulus of Elasticity	$E' =$	$1\,800\,000$ psi

Section Bending (NDS 2018 2.3)

Volume Factor	$C_V =$	0.976

Positive Bending (NDS 2018 2.3)

Governing Duration Factor - Positive Bending	$C_{D,b}^{+} =$	1
Governing Beam Stability Factor - Positive Bending	$C_L^{+} =$	0.959
Adjusted Bending Strength - Positive Bending	$F_b'^{+} =$	2300 psi

Negative Bending (NDS 2018 2.3)

Governing Duration Factor - Negative Bending	$C_{D,b}^{-} =$	0.9
Governing Beam Stability Factor - Negative Bending	$C_L^{-} =$	0.983
Adjusted Bending Strength - Negative Bending	$F_b'^{-} =$	1270 psi

Shear Design (NDS 2018 3.4)

Governing Duration Factor	$C_D =$	1
Adjusted Shear Strength	$F_v' =$	265 psi

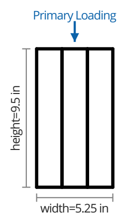
Bearing (NDS 2018 3.10)

Base Bearing Strength	$F_{c\perp}'/C_b =$	650 psi

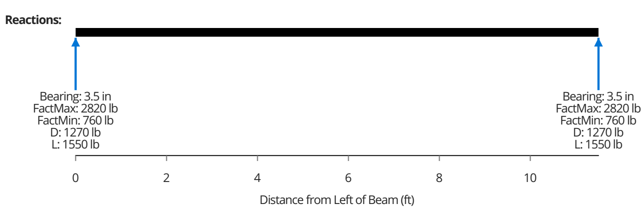
Comments

Client:	John Lawson	**Date:**	Oct 14, 2023
Author:	Cameron Cunningham	**Job #:**	ARCE 453-01
Project:	C.S.P. - Prior Consideration Design	**Subject:**	**B-10** PASS
References:	NDS 2018 (ASD)		

Summary



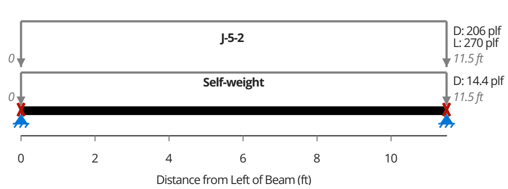
	Member		3 plies - 1-3/4x9-1/2 Microllam LVL 2.0E-2600Fb
45%	Moment Utilization	$M/M' =$	8110 lb*ft / 18 100 lb*ft
30%	Shear Utilization	$V/V' =$	2820 lb / 9480 lb
20%	Bearing Utilization	$R/R' =$	2820 lb / 13 800 lb
	Minimum Bearing Length (End Supports)	$\ell_{b,min,end} =$	0.716 in
41%	Governing Live / Short-Term Deflection	$\delta_{ST} =$	-0.156 in (L/884)
37%	Governing Long-Term Deflection	$\delta_{LT} =$	-0.214 in (L/645)
	Governing Long-Term Deflection	$\delta_{LT} =$	-0.214 in



Key Properties

Beam Plan Length	$L_X =$	11.5 ft
Continuous Bracing for Lateral Torsional Buckling		No Continuous Bracing

Loads



Design Conditions

Design Code for Load Combinations	International Building Code (IBC) 2018

Member Properties

Cross-Sectional Area	$A =$	49.9 in²
Strong Axis Moment of Inertia	$I_{xx} =$	375 in⁴
Section Modulus	$S =$	79 in³
Base Allowable Bending Stress	$F_b =$	2600 psi
Base Allowable Shear Stress	$F_v =$	285 psi
Base Perpendicular Compression Allowable Stress	$F_{c\perp} =$	750 psi
True Modulus of Elasticity	$E_{true} =$	$2\,000\,000$ psi
Apparent Modulus of Elasticity	$E_{app} =$	NaN psi
Modulus of Elasticity for Deflections	$E =$	$2\,000\,000$ psi

Elastic Modulus (NDS 2018 2.3)

Adjusted Modulus of Elasticity	$E' =$	$2\,000\,000$ psi
Adjusted Shear Modulus	$G' =$	$125\,000$ psi

Section Bending (NDS 2018 2.3)

Volume Factor	$C_V =$	1.03

Positive Bending (NDS 2018 2.3)

Governing Duration Factor - Positive Bending	$C_{D,b}^{+} =$	1
Governing Beam Stability Factor - Positive Bending	$C_L^{+} =$	0.987
Adjusted Bending Strength - Positive Bending	$F_b^{\prime +} =$	2760 psi

Negative Bending (NDS 2018 2.3)

Governing Duration Factor - Negative Bending	$C_{D,b}^{-} =$	0.9
Governing Beam Stability Factor - Negative Bending	$C_L^{-} =$	0.989
Adjusted Bending Strength - Negative Bending	$F_b^{\prime -} =$	2480 psi

Shear Design (NDS 2018 3.4)

Governing Duration Factor	$C_D =$	1
Adjusted Shear Strength	$F_v' =$	285 psi

Bearing (NDS 2018 3.10)

Base Bearing Strength	$F_{c\perp}'/C_b =$	750 psi

Comments

Client:	John Lawson	Date:	Oct 14, 2023
Author:	Cameron Cunningham	Job #:	ARCE 453-01
Project:	C.S.P. - Prior Consideration Design	Subject:	C1-1 PASS
References:	NDS 2018 (ASD)		

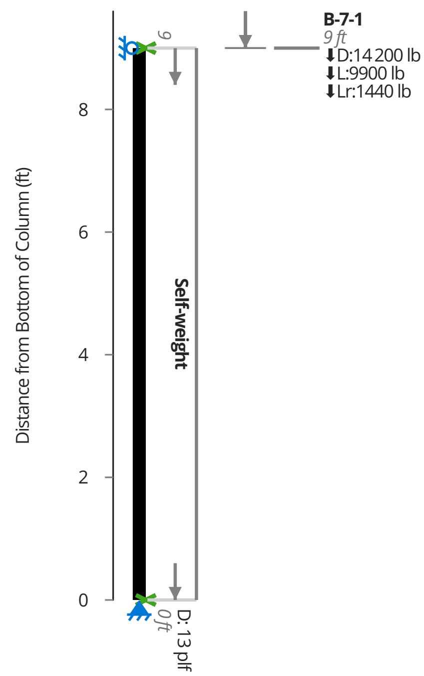
Summary

49%	Allowable Compressive Load (X-Axis Buckling)	$P'_x =$	$50\,000$ lb
49%	Allowable Compressive Load (Y-Axis Buckling)	$P'_y =$	$50\,000$ lb

Key Properties

Member		8x8 D.Fir-L No. 1
Column Height	$L =$	9 ft
Continuous Bracing for Strong Axis Buckling		No
Continuous Bracing for Weak Axis Buckling		No
Continuous Bracing for Lateral Torsional Buckling		No

Loads



Design Conditions

Design Code for Load Combinations	International Building Code (IBC) 2018

Capacity in Pure Axial Loading (NDS 2018 Section 3.7)

Fully Braced Compression Strength - Pure Axial Loading	$F_c^* =$	1000 psi
Governing Slenderness - X-axis	$(\ell_e/d) =$	14.4
Governing Slenderness - Y-axis	$(\ell_e/b) =$	14.4
Adjusted Compression Strength (X-axis)	$F'_{c,x} =$	888 psi
Adjusted Compression Strength (Y-axis)	$F'_{c,y} =$	888 psi

Comments

Client:	John Lawson	**Date:**	Oct 14, 2023
Author:	Cameron Cunningham	**Job #:**	ARCE 453-01
Project:	C.S.P. - Prior Consideration Design	**Subject:**	**C1-2** PASS
References:	NDS 2018 (ASD)		

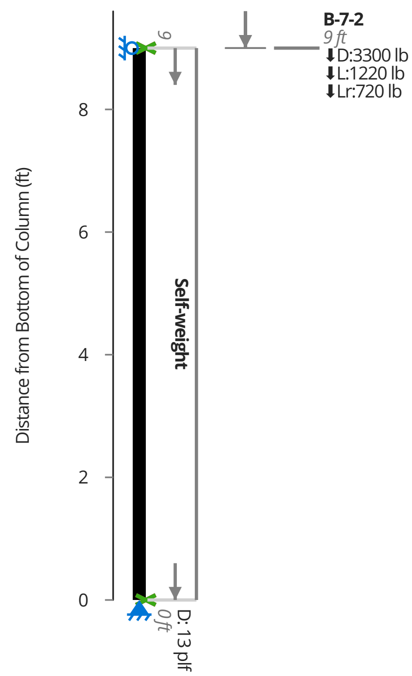
Summary

13%	Allowable Compressive Load (X-Axis Buckling)	$P'_x = 35\,700$ lb
13%	Allowable Compressive Load (Y-Axis Buckling)	$P'_y = 35\,700$ lb

Key Properties

Member	8x8 D.Fir-L No. 2
Column Height	$L = 9$ ft
Continuous Bracing for Strong Axis Buckling	No
Continuous Bracing for Weak Axis Buckling	No
Continuous Bracing for Lateral Torsional Buckling	No

Loads



Design Conditions

Design Code for Load Combinations	International Building Code (IBC) 2018

Capacity in Pure Axial Loading (NDS 2018 Section 3.7)

Fully Braced Compression Strength - Pure Axial Loading	$F_c^* = 700$ psi
Governing Slenderness - X-axis	$(\ell_e/d) = 14.4$
Governing Slenderness - Y-axis	$(\ell_e/b) = 14.4$
Adjusted Compression Strength (X-axis)	$F'_{c,x} = 634$ psi
Adjusted Compression Strength (Y-axis)	$F'_{c,y} = 634$ psi

Comments

Client:	John Lawson	**Date:**	Oct 14, 2023
Author:	Cameron Cunningham	**Job #:**	ARCE 453-01
Project:	C.S.P. - Prior Consideration Design	**Subject:**	**C2-1** PASS
References:	NDS 2018 (ASD)		

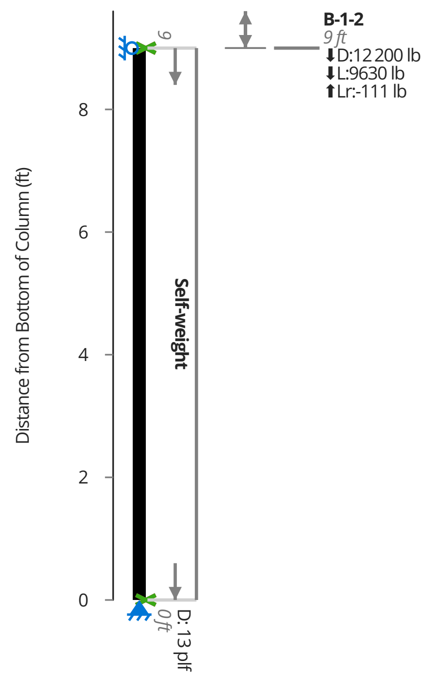
Summary

44%	Allowable Compressive Load (X-Axis Buckling)	$P'_x = 50\,000$ lb
44%	Allowable Compressive Load (Y-Axis Buckling)	$P'_y = 50\,000$ lb

Key Properties

Member	8x8 D.Fir-L No. 1
Column Height	$L = 9$ ft
Continuous Bracing for Strong Axis Buckling	No
Continuous Bracing for Weak Axis Buckling	No
Continuous Bracing for Lateral Torsional Buckling	No

Loads



Design Conditions

Design Code for Load Combinations	International Building Code (IBC) 2018

Capacity in Pure Axial Loading (NDS 2018 Section 3.7)

Fully Braced Compression Strength - Pure Axial Loading	$F_c^* = 1000$ psi
Governing Slenderness - X-axis	$(\ell_e/d) = 14.4$
Governing Slenderness - Y-axis	$(\ell_e/b) = 14.4$
Adjusted Compression Strength (X-axis)	$F'_{c,x} = 888$ psi
Adjusted Compression Strength (Y-axis)	$F'_{c,y} = 888$ psi

Comments

Client:	John Lawson	**Date:**	Oct 14, 2023
Author:	Cameron Cunningham	**Job #:**	ARCE 453-01
Project:	C.S.P. - Prior Consideration Design	**Subject:**	**C2-2** PASS
References:	NDS 2018 (ASD)		

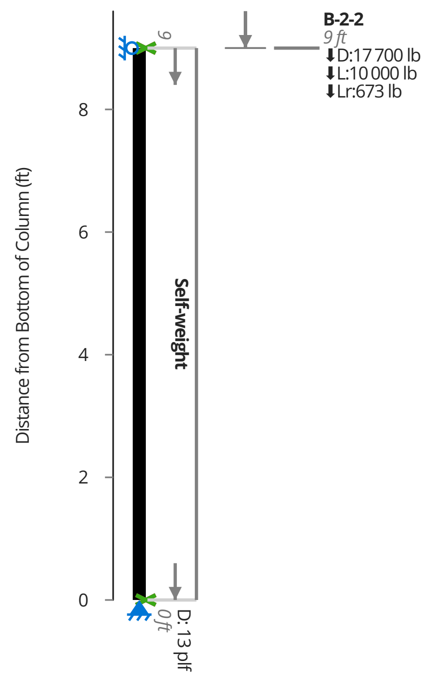
Summary

56%	Allowable Compressive Load (X-Axis Buckling)	$P'_x =$	$50\,000$ lb
56%	Allowable Compressive Load (Y-Axis Buckling)	$P'_y =$	$50\,000$ lb

Key Properties

Member		8x8 D.Fir-L No. 1
Column Height	$L =$	9 ft
Continuous Bracing for Strong Axis Buckling		No
Continuous Bracing for Weak Axis Buckling		No
Continuous Bracing for Lateral Torsional Buckling		No

Loads



Design Conditions

Design Code for Load Combinations	International Building Code (IBC) 2018

Capacity in Pure Axial Loading (NDS 2018 Section 3.7)

Fully Braced Compression Strength - Pure Axial Loading	$F_c^* =$	1000 psi
Governing Slenderness - X-axis	$(\ell_e/d) =$	14.4
Governing Slenderness - Y-axis	$(\ell_e/b) =$	14.4
Adjusted Compression Strength (X-axis)	$F'_{c,x} =$	888 psi
Adjusted Compression Strength (Y-axis)	$F'_{c,y} =$	888 psi

Comments

Client:	John Lawson	**Date:**	Oct 14, 2023
Author:	Cameron Cunningham	**Job #:**	ARCE 453-01
Project:	C.S.P. - Prior Consideration Design	**Subject:**	C3 PASS
References:	NDS 2018 (ASD)		

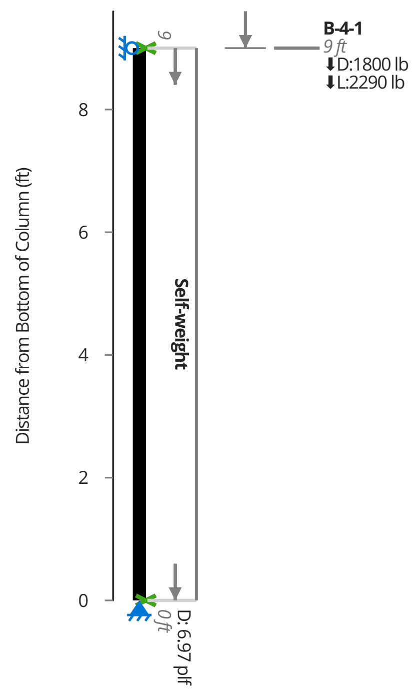
Summary

25%	Allowable Compressive Load (X-Axis Buckling)	$P'_x = 16\,900$ lb
25%	Allowable Compressive Load (Y-Axis Buckling)	$P'_y = 16\,900$ lb

Key Properties

Member	6x6 D.Fir-L No. 2
Column Height	$L = 9$ ft
Continuous Bracing for Strong Axis Buckling	No
Continuous Bracing for Weak Axis Buckling	No
Continuous Bracing for Lateral Torsional Buckling	No

Loads



Design Conditions

Design Code for Load Combinations	International Building Code (IBC) 2018

Capacity in Pure Axial Loading (NDS 2018 Section 3.7)

Fully Braced Compression Strength - Pure Axial Loading	$F_c^* = 700$ psi
Governing Slenderness - X-axis	$(\ell_e/d) = 19.6$
Governing Slenderness - Y-axis	$(\ell_e/b) = 19.6$
Adjusted Compression Strength (X-axis)	$F'_{c,x} = 559$ psi
Adjusted Compression Strength (Y-axis)	$F'_{c,y} = 559$ psi

Comments

Client:	John Lawson	**Date:**	Oct 14, 2023
Author:	Cameron Cunningham	**Job #:**	ARCE 453-01
Project:	C.S.P. - Prior Consideration Design	**Subject:**	**C4** PASS
References:	NDS 2018 (ASD)		

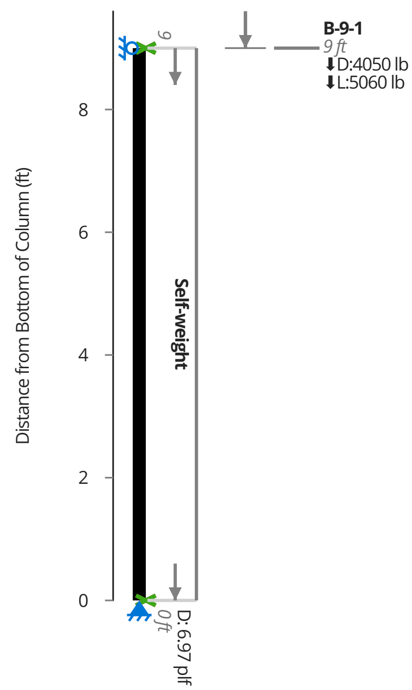
Summary

54%	Allowable Compressive Load (X-Axis Buckling)	$P'_x = 16\,900$ lb
54%	Allowable Compressive Load (Y-Axis Buckling)	$P'_y = 16\,900$ lb

Key Properties

Member	6x6 D.Fir-L No. 2
Column Height	$L = 9$ ft
Continuous Bracing for Strong Axis Buckling	No
Continuous Bracing for Weak Axis Buckling	No
Continuous Bracing for Lateral Torsional Buckling	No

Loads



Design Conditions

Design Code for Load Combinations	International Building Code (IBC) 2018

Capacity in Pure Axial Loading (NDS 2018 Section 3.7)

Fully Braced Compression Strength - Pure Axial Loading	$F_c^* = 700$ psi
Governing Slenderness - X-axis	$(\ell_e/d) = 19.6$
Governing Slenderness - Y-axis	$(\ell_e/b) = 19.6$
Adjusted Compression Strength (X-axis)	$F'_{c,x} = 559$ psi
Adjusted Compression Strength (Y-axis)	$F'_{c,y} = 559$ psi

Comments

Client:	John Lawson	**Date:**	Oct 14, 2023
Author:	Cameron Cunningham	**Job #:**	ARCE 453-01
Project:	C.S.P. - Prior Consideration Design	**Subject:**	**C5** PASS
References:	NDS 2018 (ASD)		

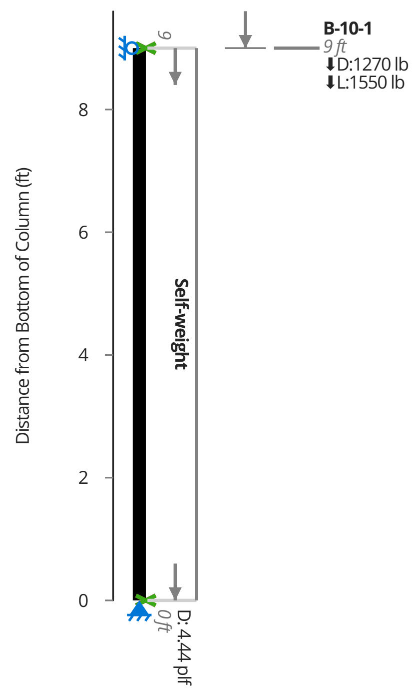
Summary

10%	Allowable Compressive Load (X-Axis Buckling)	$P'_x = 28\,600$ lb
32%	Allowable Compressive Load (Y-Axis Buckling)	$P'_y = 8850$ lb

Key Properties

Member	4x6 D.Fir-L No. 2
Column Height	$L = 9$ ft
Continuous Bracing for Strong Axis Buckling	Yes
Continuous Bracing for Weak Axis Buckling	No
Continuous Bracing for Lateral Torsional Buckling	No

Loads



Design Conditions

Design Code for Load Combinations	International Building Code (IBC) 2018

Capacity in Pure Axial Loading (NDS 2018 Section 3.7)

Fully Braced Compression Strength - Pure Axial Loading	$F_c^* = 1490$ psi
Governing Slenderness - X-axis	$(\ell_e/d) = 0$
Governing Slenderness - Y-axis	$(\ell_e/b) = 30.9$
Adjusted Compression Strength (X-axis)	$F'_{c,x} = 1480$ psi
Adjusted Compression Strength (Y-axis)	$F'_{c,y} = 460$ psi

Comments

Client:	John Lawson	**Date:**	Oct 14, 2023
Author:	Cameron Cunningham	**Job #:**	ARCE 453-01
Project:	C.S.P. - Prior Consideration Design	**Subject:**	**Typ. Ext. Bearing Wall** PASS
References:	NDS 2018 (ASD)		

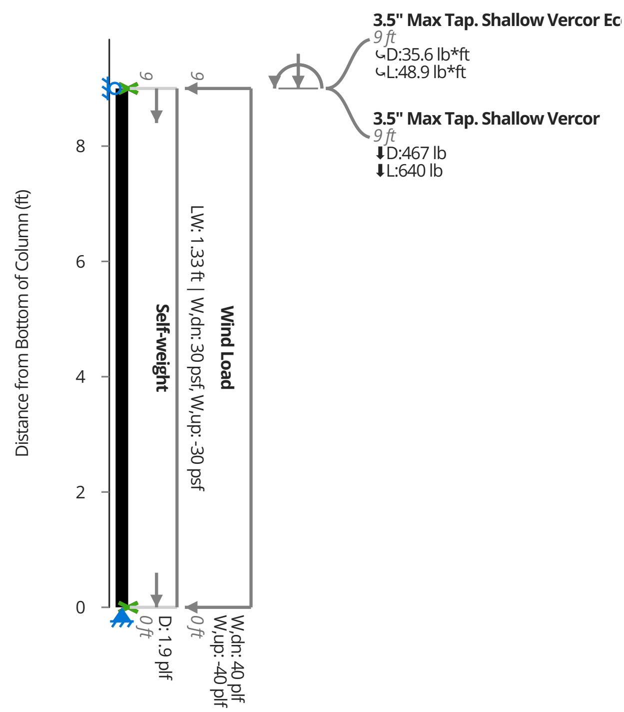
Summary

15%	Allowable Compressive Load (X-Axis Buckling)	$P'_x =$	7650 lb
9%	Allowable Compressive Load (Y-Axis Buckling)	$P'_y =$	12 300 lb
19%	Allowable X-Axis Moment	$M'_x =$	1360 lb · ft
19%	Combined Compression / Bending	$\text{Int}_C =$	0.194
17%	Governing Live / Short-Term X-Axis Deflection	$\delta_{x,ST} =$	0.0745 in
	Critical Live / Short-Term X-Axis Deflection Ratio	$(L/)_{x,ST} =$	1450
2%	Governing Long-Term X-Axis Deflection	$\delta_{x,LT} =$	0.018 in
	Critical Long-Term X-Axis Deflection Ratio	$(L/)_{x,LT} =$	6000

Key Properties

Member		2x6 D.Fir-L No. 2
Column Height	$L =$	9 ft
Continuous Bracing for Strong Axis Buckling		No
Continuous Bracing for Weak Axis Buckling		Yes
Continuous Bracing for Lateral Torsional Buckling		Yes

Loads



Design Conditions

Design Code for Load Combinations		International Building Code (IBC) 2018

Capacity in Pure Axial Loading (NDS 2018 Section 3.7)

Fully Braced Compression Strength - Pure Axial Loading	$F_c^* =$	1490 psi
Governing Slenderness - X-axis	$(\ell_e/d) =$	19.6
Governing Slenderness - Y-axis	$(\ell_e/b) =$	0
Adjusted Compression Strength (X-axis)	$F'_{c,x} =$	928 psi
Adjusted Compression Strength (Y-axis)	$F'_{c,y} =$	1480 psi

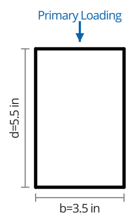
Shear Design (NDS 2018 3.4)

7%	Shear Capacity (X-axis)	$V'_{nx} =$	1580 lb

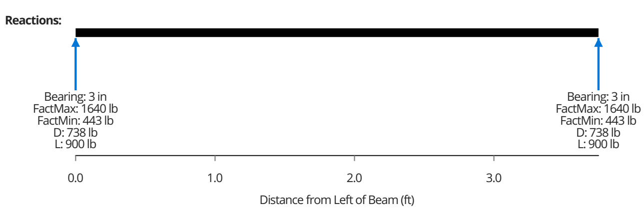
Comments

Client:	John Lawson	**Date:**	Oct 14, 2023
Author:	Cameron Cunningham	**Job #:**	ARCE 453-01
Project:	C.S.P. - Prior Consideration Design	**Subject:**	**HDR-1** PASS
References:	NDS 2018 (ASD)		

Summary



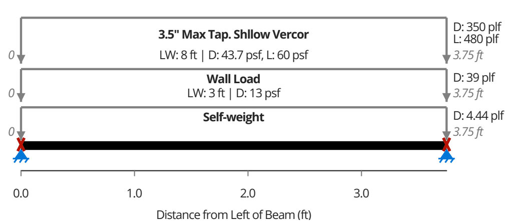
	Member		4x6 D.Fir-L No. 2
90%	Moment Utilization	$M/M' =$	1540 lb*ft / 1710 lb*ft
71%	Shear Utilization	$V/V' =$	1640 lb / 2310 lb
25%	Bearing Utilization	$R/R' =$	1640 lb / 6560 lb
	Minimum Bearing Length (End Supports)	$\ell_{b,min,end} =$	0.749 in
22%	Governing Live / Short-Term Deflection	$\delta_{ST} =$	-0.0275 in (L/1640)
21%	Governing Long-Term Deflection	$\delta_{LT} =$	-0.0388 in (L/1160)
	Governing Long-Term Deflection	$\delta_{LT} =$	-0.0388 in



Key Properties

Beam Plan Length	$L_X =$	3.75 ft
Continuous Bracing for Lateral Torsional Buckling		No Continuous Bracing

Loads



Design Conditions

Design Code for Load Combinations	International Building Code (IBC) 2018

Member Properties

Cross-Sectional Area	$A =$	19.2 in²
Strong Axis Moment of Inertia	$I_{xx} =$	48.5 in⁴
Section Modulus	$S =$	17.6 in³
Base Allowable Bending Stress	$F_b =$	900 psi
Base Allowable Shear Stress	$F_v =$	180 psi
Base Perpendicular Compression Allowable Stress	$F_{c\perp} =$	625 psi
True Modulus of Elasticity	$E_{true} =$	$1\,600\,000$ psi
Apparent Modulus of Elasticity	$E_{app} =$	$1\,600\,000$ psi
Modulus of Elasticity for Deflections	$E =$	$1\,600\,000$ psi

Elastic Modulus (NDS 2018 2.3)

Adjusted Modulus of Elasticity	$E' =$	$1\,600\,000$ psi

Section Bending (NDS 2018 2.3)

Size Factor	$C_{F,b} =$	1.3
Incising Factor	$C_{i,b} =$	1

Positive Bending (NDS 2018 2.3)

Governing Duration Factor - Positive Bending	$C^+_{D,b} =$	1
Governing Beam Stability Factor - Positive Bending	$C^+_L =$	0.996
Adjusted Bending Strength - Positive Bending	$F'^+_b =$	1170 psi

Negative Bending (NDS 2018 2.3)

Governing Duration Factor - Negative Bending	$C^-_{D,b} =$	0.9
Governing Beam Stability Factor - Negative Bending	$C^-_L =$	0.997
Adjusted Bending Strength - Negative Bending	$F'^-_b =$	1050 psi

Shear Design (NDS 2018 3.4)

Governing Duration Factor	$C_D =$	1
Adjusted Shear Strength	$F'_v =$	180 psi

Bearing (NDS 2018 3.10)

Base Bearing Strength	$F'_{c\perp}/C_b =$	625 psi

Comments

Z_x

Table 3-2 (continued)
W-Shapes
Selection by Z_x

F_y = 50 ksi

Shape	Z_x	M_{px}/Ω_b	$\phi_b M_{px}$	M_{rx}/Ω_b	$\phi_b M_{rx}$	BF/Ω_b	$\phi_b BF$	L_p	L_r	I_x	V_{nx}/Ω_v	$\phi_v V_{nx}$
		kip-ft	kip-ft	kip-ft	kip-ft	kips	kips				kips	kips
	in.^{3}	ASD	LRFD	ASD	LRFD	ASD	LRFD	ft	ft	in.^{4}	ASD	LRFD
W21×44	**95.4**	**238**	**358**	**143**	**214**	**11.1**	**16.8**	**4.45**	**13.0**	**843**	**145**	**217**
W16×50	92.0	230	345	141	213	7.69	11.4	5.62	17.2	659	124	186
W18×46	90.7	226	340	138	207	9.63	14.6	4.56	13.7	712	130	195
W14×53	87.1	217	327	136	204	5.22	7.93	6.78	22.3	541	103	154
W12×58	86.4	216	324	136	205	3.82	5.69	8.87	29.8	475	87.8	132
W10×68	85.3	213	320	132	199	2.58	3.85	9.15	40.6	394	97.8	147
W16×45	82.3	205	309	127	191	7.12	10.8	5.55	16.5	586	111	167
W18×40	**78.4**	**196**	**294**	**119**	**180**	**8.94**	**13.2**	**4.49**	**13.1**	**612**	**113**	**169**
W14×48	78.4	196	294	123	184	5.09	7.67	6.75	21.1	484	93.8	141
W12×53	77.9	194	292	123	185	3.65	5.50	8.76	28.2	425	83.5	125
W10×60	74.6	186	280	116	175	2.54	3.82	9.08	36.6	341	85.7	129
W16×40	**73.0**	**182**	**274**	**113**	**170**	**6.67**	**10.0**	**5.55**	**15.9**	**518**	**97.6**	**146**
W12×50	71.9	179	270	112	169	3.97	5.98	6.92	23.8	391	90.3	135
W8×67	70.1	175	263	105	159	1.75	2.59	7.49	47.6	272	103	154
W14×43	69.6	174	261	109	164	4.88	7.28	6.68	20.0	428	83.6	125
W10×54	66.6	166	250	105	158	2.48	3.75	9.04	33.6	303	74.7	112
W18×35	**66.5**	**166**	**249**	**101**	**151**	**8.14**	**12.3**	**4.31**	**12.3**	**510**	**106**	**159**
W12×45	64.2	160	241	101	151	3.80	5.80	6.89	22.4	348	81.1	122
W16×36	64.0	160	240	98.7	148	6.24	9.36	5.37	15.2	448	93.8	141
W14×38	61.5	153	231	95.4	143	5.37	8.20	5.47	16.2	385	87.4	131
W10×49	60.4	151	227	95.4	143	2.46	3.71	8.97	31.6	272	68.0	102
W8×58	59.8	149	224	90.8	137	1.70	2.55	7.42	41.6	228	89.3	134
W12×40	57.0	142	214	89.9	135	3.66	5.54	6.85	21.1	307	70.2	105
W10×45	54.9	137	206	85.8	129	2.59	3.89	7.10	26.9	248	70.7	106
W14×34	**54.6**	**136**	**205**	**84.9**	**128**	**5.01**	**7.55**	**5.40**	**15.6**	**340**	**79.8**	**120**
W16×31	**54.0**	**135**	**203**	**82.4**	**124**	**6.86**	**10.3**	**4.13**	**11.8**	**375**	**87.5**	**131**
W12×35	51.2	128	192	79.6	120	4.34	6.45	5.44	16.6	285	75.0	113
W8×48	49.0	122	184	75.4	113	1.67	2.55	7.35	35.2	184	68.0	102
W14×30	**47.3**	**118**	**177**	**73.4**	**110**	**4.63**	**6.95**	**5.26**	**14.9**	**291**	**74.5**	**112**
W10×39	46.8	117	176	73.5	111	2.53	3.78	6.99	24.2	209	62.5	93.7
W16×26[v]	**44.2**	**110**	**166**	**67.1**	**101**	**5.93**	**8.98**	**3.96**	**11.2**	**301**	**70.5**	**106**
W12×30	43.1	108	162	67.4	101	3.97	5.96	5.37	15.6	238	64.0	95.9

ASD	LRFD
$\Omega_b = 1.67$ $\Omega_v = 1.50$	$\phi_b = 0.90$ $\phi_v = 1.00$

[v] Shape does not meet the h/t_w limit for shear in AISC *Specification* Section G2.1(a) with $F_y = 50$ ksi; therefore, $\phi_v = 0.90$ and $\Omega_v = 1.67$.

F_y = 50 ksi

Table 3-2 (continued)
W-Shapes
Selection by Z_x

Z_x

Shape	Z_x	M_{px}/Ω_b	$\phi_b M_{px}$	M_{rx}/Ω_b	$\phi_b M_{rx}$	BF/Ω_b	$\phi_b BF$	L_p	L_r	I_x	V_{nx}/Ω_v	$\phi_v V_{nx}$
		kip-ft	kip-ft	kip-ft	kip-ft	kips	kips				kips	kips
	in.^{3}	ASD	LRFD	ASD	LRFD	ASD	LRFD	ft	ft	in.^{4}	ASD	LRFD
W14×26	**40.2**	**100**	**151**	**61.7**	**92.7**	**5.33**	**8.11**	**3.81**	**11.0**	**245**	**70.9**	**106**
W8×40	39.8	99.3	149	62.0	93.2	1.64	2.46	7.21	29.9	146	59.4	89.1
W10×33	38.8	96.8	146	61.1	91.9	2.39	3.62	6.85	21.8	171	56.4	84.7
W12×26	**37.2**	**92.8**	**140**	**58.3**	**87.7**	**3.61**	**5.46**	**5.33**	**14.9**	**204**	**56.1**	**84.2**
W10×30	36.6	91.3	137	56.6	85.1	3.08	4.61	4.84	16.1	170	63.0	94.5
W8×35	34.7	86.6	130	54.5	81.9	1.62	2.43	7.17	27.0	127	50.3	75.5
W14×22	**33.2**	**82.8**	**125**	**50.6**	**76.1**	**4.78**	**7.27**	**3.67**	**10.4**	**199**	**63.0**	**94.5**
W10×26	31.3	78.1	117	48.7	73.2	2.91	4.34	4.80	14.9	144	53.6	80.3
W8×31[f]	30.4	75.8	114	48.0	72.2	1.58	2.37	7.18	24.8	110	45.6	68.4
W12×22	**29.3**	**73.1**	**110**	**44.4**	**66.7**	**4.68**	**7.06**	**3.00**	**9.13**	**156**	**64.0**	**95.9**
W8×28	27.2	67.9	102	42.4	63.8	1.67	2.50	5.72	21.0	98.0	45.9	68.9
W10×22	**26.0**	**64.9**	**97.5**	**40.5**	**60.9**	**2.68**	**4.02**	**4.70**	**13.8**	**118**	**49.0**	**73.4**
W12×19	**24.7**	**61.6**	**92.6**	**37.2**	**55.9**	**4.27**	**6.43**	**2.90**	**8.61**	**130**	**57.3**	**86.0**
W8×24	23.1	57.6	86.6	36.5	54.9	1.60	2.40	5.69	18.9	82.7	38.9	58.3
W10×19	**21.6**	**53.9**	**81.0**	**32.8**	**49.4**	**3.18**	**4.76**	**3.09**	**9.73**	**96.3**	**51.0**	**76.5**
W8×21	20.4	50.9	76.5	31.8	47.8	1.85	2.77	4.45	14.8	75.3	41.4	62.1
W12×16	**20.1**	**50.1**	**75.4**	**29.9**	**44.9**	**3.80**	**5.73**	**2.73**	**8.05**	**103**	**52.8**	**79.2**
W10×17	18.7	46.7	70.1	28.3	42.5	2.98	4.47	2.98	9.16	81.9	48.5	72.7
W12×14[v]	**17.4**	**43.4**	**65.3**	**26.0**	**39.1**	**3.43**	**5.17**	**2.66**	**7.73**	**88.6**	**42.8**	**64.3**
W8×18	17.0	42.4	63.8	26.5	39.9	1.74	2.61	4.34	13.5	61.9	37.4	56.2
W10×15	16.0	39.9	60.0	24.1	36.2	2.75	4.14	2.86	8.61	68.9	46.0	68.9
W8×15	13.6	33.9	51.0	20.6	31.0	1.90	2.85	3.09	10.1	48.0	39.7	59.6
W10×12[f]	**12.6**	**31.2**	**46.9**	**19.0**	**28.6**	**2.36**	**3.53**	**2.87**	**8.05**	**53.8**	**37.5**	**56.3**
W8×13	11.4	28.4	42.8	17.3	26.0	1.76	2.67	2.98	9.27	39.6	36.8	55.1
W8×10[f]	**8.87**	**21.9**	**32.9**	**13.6**	**20.5**	**1.54**	**2.30**	**3.14**	**8.52**	**30.8**	**26.8**	**40.2**

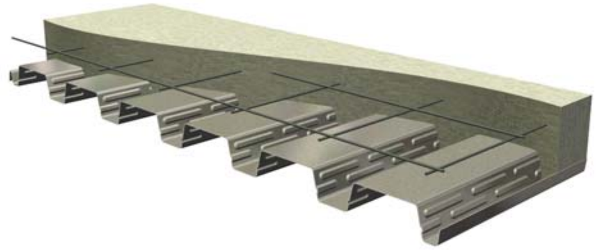
ASD	LRFD
$\Omega_b = 1.67$ $\Omega_v = 1.50$	$\phi_b = 0.90$ $\phi_v = 1.00$

[f] Shape exceeds compact limit for flexure with $F_y = 50$ ksi; tabulated values have been adjusted accordingly.

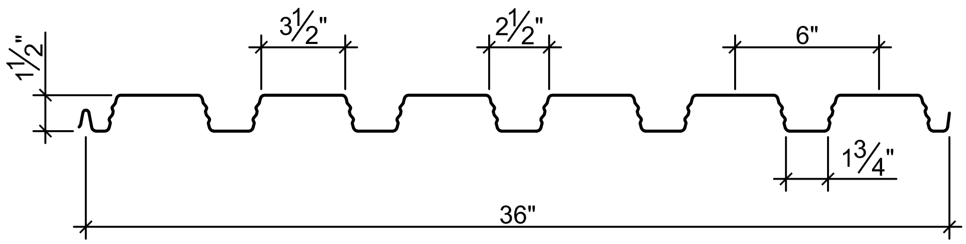
[v] Shape does not meet the h/t_w limit for shear in AISC *Specification* Section G2.1(a) with $F_y = 50$ ksi; therefore, $\phi_v = 0.90$ and $\Omega_v = 1.67$.

PLB™ or B FORMLOK™

- 1½ in. Deep FORMLOK Deck
- Phosphatized/Painted or Galvanized
- PLB FORMLOK used with PunchLok II System
- B FORMLOK used with TSWs or BPs
- B FORMLOK-SS used with Screws



Dimensions



PLB or B FORMLOK — Standard Interlocking Sidelap

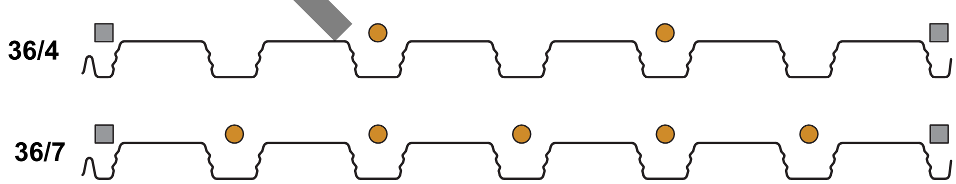
B FORMLOK-SS — Screw Fastened Sidelap

Deck Weight and Section Properties

Gage	Weight		I_d for Deflection		Moment		Allowable Reactions per ft of Width (lb) due to Web Crippling — One Flange Loading					Two Flange Loading				
	Galv	Painted	Single Span	Multi Span	$+S_{eff}$	$-S_{eff}$	End Bearing Length			Interior Bearing Length		End Bearing Length			Interior Bearing Length	
	(psf)	(psf)	(in.^{4}/ft)	(in.^{4}/ft)	(in.^{3}/ft)	(in.^{3}/ft)	2"	3"	4"	3"	4"	2"	3"	4"	3"	4"
22	1.9	1.8	0.177	0.192	0.176	0.188	935	1076	1163	1559	1671	962	1078	1150	1935	2084
20	2.3	2.2	0.219	0.231	0.230	0.237	1301	1492	1609	2190	2340	1413	1576	1675	2744	2947
18	2.9	2.8	0.302	0.306	0.314	0.331	2181	2484	2667	3714	3950	2551	2823	2987	4713	5038
16	3.5	3.4	0.381	0.381	0.399	0.410	3265	3699	3955	5607	5938	4018	4422	4660	7168	7631

Notes:
1. Section properties are based on F_y = 50,000 psi.
2. I_d is for deflection due to uniform loads.
3. S_{eff} (+ or -) is the effective section modulus.
4. Allowable (ASD) reactions are based on web crippling, per AISI S100 Section C3.4, where Ω_w = 1.70 for end bearing and 1.75 for interior bearing. Nominal reactions may be determined by multiplying the table values by Ω_w. LRFD reactions may be determined by multiplying nominal reactions by ϕ_w = 0.9 for end reactions and 0.85 for interior reactions.

Attachment Patterns to Supports



Note: ● indicates location of arc spot weld, power actuated fastener, or screw as indicated in the load tables.
■ indicates location of arc seam weld, power actuated fastener, or screw as indicated in the load tables.

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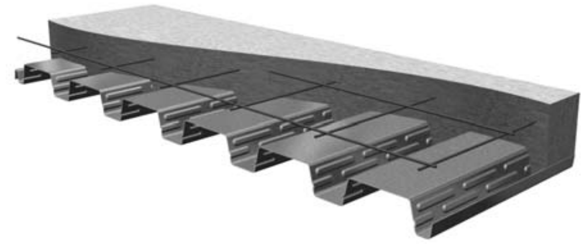


Footnotes for Maximum Unshored Clear Span, Allowable Superimposed Loads, and Allowable Diaphragm Shear Strength Tables

1. Shoring calculations are based on the following:
   - Deck supporting dead load of concrete plus 20 psf uniform construction load or 150 pound concentrated construction live load for flexure. 4 psf is added for normal weight concrete and 3 psf is added for light weight concrete to account for ponding due to deck deflection between support members.
   - Dead load deflection limited to L/180 of span length, not to exceed 3/4".
   - Minimum end and interior bearing of 2".
2. Concrete fill to have minimum 28-day compressive strength f'_c = 3,000 psi.
3. Total slab depth is nominal depth from top of concrete to bottom of steel deck.
4. Shoring is required at midspan for allowable superimposed loads in the shaded area to the right of the heavy line.
5. Nominal diaphragm shear strengths may be determined by multiplying the tabulated strengths by Ω = 3.0. LRFD diaphragm shear strength may be determined by multiplying nominal diaphragm shear strength by ϕ = 0.55.
6. To obtain allowable diaphragm shear strengths using mechanical fasteners, multiply the tabulated strengths by the appropriate adjustment factor, A_q listed in the following table.

Attachment Pattern	Adjustment Factor	Total Slab Depth (in.)								
		Normal Weight Concrete					Light Weight Concrete			
		3 1/2	4	4 1/2	5	6	3 1/2	4	4 3/4	5 3/4
36/4	A_{q4}	0.60	0.66	0.68	0.62	0.53	0.46	0.53	0.62	0.69
36/7	A_{q7}	0.49	0.57	0.62	0.66	0.72	0.38	0.44	0.52	0.61

Notes:

a. Mechanical fastener attachment patterns are to match the listed attachment patterns for welds.

b. Applicable mechanical fasteners are limited to the following: Hilti Fasteners, Pneutek Fasteners and SDI Recognized #12 or #14 Screws produced by Buildex, Elco, Hilti or Simpson Strong-Tie. Comply with minimum and maximum substrate thickness requirements for applicable mechanical fasteners. Note that these adjustment factors are based on the most conservative value for all listed connectors.

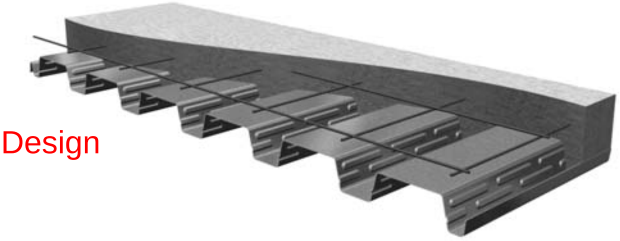
c. Nominal diaphragm shear strengths for mechanically fastened FORMLOK slabs may be determined by multiplying the adjusted tabulated strengths by Ω = 3.25. LRFD diaphragm shear strengths for mechanically fastened FORMLOK slabs may be determined by multiplying the adjusted nominal strengths by ϕ = 0.50.

d. Consult fastener manufacturer for applicable fire-resistance assembly ratings where mechanical fasteners are required.

PLB™ or B FORMLOK™

- **3½ in. TOTAL SLAB DEPTH**
- **Normal Weight Concrete**

For Tapered-Patio Decking in Both Prior & Alt. Steel Design
- span based on longest clear span distance



Maximum Unshored Clear Span (ft-in.)

Deck Gage	Number of Deck Spans 1	2	3
22	6'-6"	7'-8"	7'-9"
20	7'-9"	9'-1"	9'-3"
18	8'-10"	10'-8"	11'-0"
16	9'-6"	11'-10"	11'-7"

Shoring is required for spans greater than those shown above. See Footnote 1 on page 39 for required bearing.

Concrete Properties

To be used for Tamp. Deck in low end

Density (pcf)	Uniform Weight (psf)	Uniform Volume ($yd^3/100\ ft^2$)	Compressive Strength, f'_c (psi)
145	30.6	0.781	3000

Notes:
1. Volumes and weights do not include allowance for deflection.
2. Weights are for concrete only and do not include weight of steel deck.
3. Total slab depth is nominal depth from top of concrete to bottom of steel deck.

for design: 3.5" min. actual thickness at low end

Allowable Superimposed Loads (psf)

Deck Gage	Number of Deck Spans	4'-0"	5'-0"	6'-0"	6'-6"	7'-0"	7'-6"	8'-0"	8'-6"	9'-0"	9'-6"	10'-0"	10'-6"	11'-0"	11'-6"	12'-0"
22	1	400	353	261	228	170	148	130	115	101	90	80	71	64	57	51
	2	400	353	261	228	202	180	130	115	101	90	80	71	64	57	51
	3	400	353	261	228	202	180	130	115	101	90	80	71	64	57	51
20	1	400	372	274	240	212	189	138	122	108	96	85	76	68	61	55
	2	400	372	274	240	212	189	170	153	140	96	85	76	68	61	55
	3	400	372	274	240	212	189	170	153	140	96	85	76	68	61	55
18	1	400	400	297	260	230	205	184	166	119	106	95	85	76	68	61
	2	400	400	297	260	230	205	184	166	151	138	127	117	76	68	61
	3	400	400	297	260	230	205	184	166	151	138	127	117	108	68	61
16	1	400	400	297	260	230	205	184	166	151	138	94	84	75	68	61
	2	400	400	297	260	230	205	184	166	151	138	127	117	108	100	61
	3	400	400	297	260	230	205	184	166	151	138	127	117	108	100	61

See footnotes on page 39.

Shoring required in shaded areas to right of heavy line.

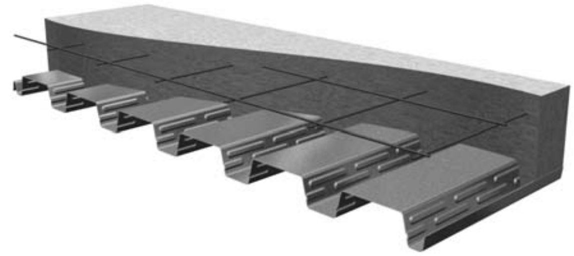
Allowable Diaphragm Shear Strengths, q (plf) and Flexibility Factors, F (in./lb. x 10^6)

Attachment Pattern	Deck Gage		4'-0"	5'-0"	6'-0"	6'-6"	7'-0"	7'-6"	8'-0"	8'-6"	9'-0"	9'-6"	10'-0"	10'-6"	11'-0"	11'-6"	12'-0"
36/4	**22**	q	2074	1925	1825	1787	1754	1726	1701	1679	1659	1642	1626	1612	1599	1587	1576
		F	0.40	0.43	0.45	0.46	0.47	0.48	0.48	0.49	0.50	0.50	0.51	0.51	0.52	0.52	0.52
	20	q	2192	2013	1893	1847	1808	1773	1743	1717	1694	1673	1654	1637	1621	1607	1594
		F	0.34	0.37	0.40	0.41	0.42	0.42	0.43	0.44	0.44	0.45	0.45	0.46	0.46	0.47	0.47
	18	q	2444	2205	2046	1985	1932	1887	1847	1812	1781	1753	1728	1705	1684	1665	1648
		F	0.27	0.30	0.32	0.33	0.34	0.35	0.35	0.36	0.37	0.37	0.38	0.38	0.39	0.39	0.40
	16	q	2713	2414	2215	2138	2073	2016	1966	1922	1883	1848	1816	1788	1762	1738	1717
		F	0.21	0.24	0.26	0.27	0.28	0.29	0.30	0.30	0.31	0.32	0.32	0.33	0.33	0.34	0.34
36/7	**22**	q	2389	2177	2035	1981	1934	1893	1858	1827	1799	1774	1752	1732	1713	1697	1681
		F	0.35	0.38	0.41	0.42	0.43	0.44	0.44	0.45	0.46	0.46	0.47	0.48	0.48	0.49	0.49
	20	q	2569	2315	2145	2079	2023	1975	1932	1895	1861	1832	1805	1780	1758	1738	1720
		F	0.29	0.33	0.35	0.36	0.37	0.38	0.39	0.40	0.40	0.41	0.42	0.42	0.43	0.43	0.44
	18	q	2947	2607	2381	2294	2219	2155	2098	2048	2004	1964	1929	1896	1867	1840	1815
		F	0.22	0.25	0.27	0.28	0.29	0.30	0.31	0.32	0.33	0.33	0.34	0.34	0.35	0.35	0.36
	16	q	3342	2917	2634	2525	2432	2351	2280	2218	2162	2113	2068	2027	1991	1957	1926
		F	0.17	0.20	0.22	0.23	0.24	0.25	0.26	0.26	0.27	0.28	0.28	0.29	0.29	0.30	0.30

See footnotes on page 39.

PLB™ or B FORMLOK™

- 5 in. TOTAL SLAB DEPTH
- Normal Weight Concrete
- 1 Hour Fire Rating



Maximum Unshored Clear Span (ft-in.)

Deck Gage	Number of Deck Spans 1	2	3
22	5'-8"	6'-8"	6'-9"
20	6'-9"	7'-11"	8'-0"
18	7'-9"	9'-4"	9'-7"
16	8'-4"	10'-4"	10'-4"

Shoring is required for spans greater than those shown above. See Footnote 1 on page 39 for required bearing.

Concrete Properties

Density (pcf)	Uniform Weight (psf)	Uniform Volume ($yd^3/100\ ft^2$)	Compressive Strength, f'_c (psi)
145	48.7	1.244	3000

Notes:
1. Volumes and weights do not include allowance for deflection.
2. Weights are for concrete only and do not include weight of steel deck.
3. Total slab depth is nominal depth from top of concrete to bottom of steel deck.

Allowable Superimposed Loads (psf)

Deck Gage	Number of Deck Spans	Span (ft-in.) 4'-0"	5'-0"	6'-0"	6'-6"	7'-0"	7'-6"	8'-0"	8'-6"	9'-0"	9'-6"	10'-0"	10'-6"	11'-0"	11'-6"	12'-0"
22	1	400	400	347	297	257	224	197	173	153	136	121	108	96	86	77
	2	400	400	393	344	257	224	197	173	153	136	121	108	96	86	77
	3	400	400	393	344	257	224	197	173	153	136	121	108	96	86	77
20	1	400	400	400	361	272	237	208	184	163	145	129	115	103	92	83
	2	400	400	400	361	319	284	208	184	163	145	129	115	103	92	83
	3	400	400	400	361	319	284	255	184	163	145	129	115	103	92	83
18	1	400	400	400	389	344	306	227	201	178	159	142	127	114	103	92
	2	400	400	400	389	344	306	275	249	226	159	142	127	114	103	92
	3	400	400	400	389	344	306	275	249	226	207	142	127	114	103	92
16	1	400	400	400	386	341	304	273	198	176	157	140	125	112	101	91
	2	400	400	400	386	341	304	273	247	224	205	188	125	112	101	91
	3	400	400	400	386	341	304	273	247	224	205	188	125	112	101	91

See footnotes on page 39.

Shoring required in shaded areas to right of heavy line.

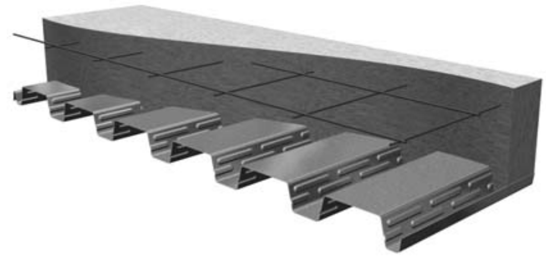
Allowable Diaphragm Shear Strengths, q (plf) and Flexibility Factors, F (in./lb. x 10^6)

Attachment Pattern	Deck Gage		Span (ft-in.) 4'-0"	5'-0"	6'-0"	6'-6"	7'-0"	7'-6"	8'-0"	8'-6"	9'-0"	9'-6"	10'-0"	10'-6"	11'-0"	11'-6"	12'-0"
36/4	22	q	2792	2642	2543	2504	2472	2443	2418	2396	2377	2359	2343	2329	2316	2304	2294
		F	0.30	0.31	0.32	0.33	0.33	0.34	0.34	0.34	0.35	0.35	0.35	0.35	0.36	0.36	0.36
	20	q	2909	2730	2610	2564	2525	2491	2461	2434	2411	2390	2371	2354	2338	2324	2311
		F	0.26	0.28	0.29	0.29	0.30	0.30	0.31	0.31	0.31	0.31	0.32	0.32	0.32	0.32	0.33
	18	q	3161	2923	2763	2702	2650	2604	2564	2529	2498	2470	2445	2422	2401	2382	2365
		F	0.21	0.22	0.24	0.24	0.25	0.25	0.25	0.26	0.26	0.26	0.27	0.27	0.27	0.27	0.28
	16	q	3430	3131	2932	2856	2790	2733	2683	2639	2600	2565	2534	2505	2479	2456	2434
		F	0.17	0.19	0.20	0.20	0.21	0.21	0.22	0.22	0.22	0.23	0.23	0.23	0.24	0.24	0.24
36/7	22	q	3106	2894	2752	2698	2651	2611	2575	2544	2516	2492	2469	2449	2431	2414	2398
		F	0.27	0.28	0.30	0.31	0.31	0.32	0.32	0.32	0.33	0.33	0.33	0.34	0.34	0.34	0.34
	20	q	3287	3032	2862	2796	2740	2692	2649	2612	2579	2549	2522	2498	2476	2455	2437
		F	0.23	0.25	0.26	0.27	0.27	0.28	0.28	0.29	0.29	0.30	0.30	0.30	0.30	0.31	0.31
	18	q	3664	3325	3098	3011	2937	2872	2816	2766	2721	2682	2646	2613	2584	2557	2533
		F	0.18	0.20	0.21	0.22	0.22	0.23	0.23	0.24	0.24	0.24	0.25	0.25	0.25	0.25	0.26
	16	q	4059	3634	3351	3242	3149	3068	2997	2935	2880	2830	2785	2745	2708	2674	2644
		F	0.14	0.16	0.17	0.18	0.19	0.19	0.19	0.20	0.20	0.21	0.21	0.21	0.22	0.22	0.22

See footnotes on page 39.

PLB™ or B FORMLOK™

- 6 in. TOTAL SLAB DEPTH
- Normal Weight Concrete
- 2 Hour Fire Rating



Maximum Unshored Clear Span (ft-in.)

Deck Gage	Number of Deck Spans 1	2	3
22	5'-4"	6'-2"	6'-3"
20	6'-3"	7'-4"	7'-5"
18	7'-3"	8'-8"	8'-11"
16	7'-10"	9'-7"	9'-8"

Shoring is required for spans greater than those shown above. See Footnote 1 on page 39 for required bearing.

Concrete Properties

To be used for Tamp. Deck in Clear Calc Report

Density (pcf)	Uniform Weight (psf)	Uniform Volume ($yd^3/100\ ft^2$)	Compressive Strength, f'_c (psi)
145	60.8	1.553	3000

Notes:
1. Volumes and weights do not include allowance for deflection.
2. Weights are for concrete only and do not include weight of steel deck.
3. Total slab depth is nominal depth from top of concrete to bottom of steel deck.

for design: 5.5" actual thickness at high end.
Design calc. use 6" max.

Allowable Superimposed Loads (psf)

Deck Gage	Number of Deck Spans	4'-0"	5'-0"	6'-0"	6'-6"	7'-0"	7'-6"	8'-0"	8'-6"	9'-0"	9'-6"	10'-0"	10'-6"	11'-0"	11'-6"	12'-0"
22	1	400	400	400	369	320	279	244	215	191	169	151	134	120	107	96
	2	400	400	400	369	320	279	244	215	191	169	151	134	120	107	96
	3	400	400	400	369	320	279	244	215	191	169	151	134	120	107	96
20	1	400	400	400	389	337	295	259	228	202	180	160	143	128	115	103
	2	400	400	400	400	395	295	259	228	202	180	160	143	128	115	103
	3	400	400	400	400	395	295	259	228	202	180	160	143	128	115	103
18	1	400	400	400	400	400	321	282	250	222	197	177	158	142	128	115
	2	400	400	400	400	400	379	340	308	222	197	177	158	142	128	115
	3	400	400	400	400	400	379	340	308	222	197	177	158	142	128	115
16	1	400	400	400	400	400	376	279	246	219	195	174	156	140	126	113
	2	400	400	400	400	400	376	337	305	277	253	174	156	140	126	113
	3	400	400	400	400	400	376	337	305	277	253	174	156	140	126	113

See footnotes on page 39.

Shoring required in shaded areas to right of heavy line.

Allowable Diaphragm Shear Strengths, q (plf) and Flexibility Factors, F (in./lb. x 10^6)

Attachment Pattern	Deck Gage		4'-0"	5'-0"	6'-0"	6'-6"	7'-0"	7'-6"	8'-0"	8'-6"	9'-0"	9'-6"	10'-0"	10'-6"	11'-0"	11'-6"	12'-0"
36/4	**22**	q	3270	3120	3021	2983	2950	2921	2896	2874	2855	2837	2822	2807	2794	2783	2772
		F	0.25	0.26	0.27	0.28	0.28	0.28	0.28	0.29	0.29	0.29	0.29	0.29	0.29	0.30	0.30
	20	q	3387	3208	3088	3042	3003	2969	2939	2912	2889	2868	2849	2832	2817	2802	2789
		F	0.22	0.23	0.24	0.25	0.25	0.25	0.26	0.26	0.26	0.26	0.26	0.27	0.27	0.27	0.27
	18	q	3640	3401	3241	3180	3128	3082	3042	3007	2976	2948	2923	2900	2880	2861	2843
		F	0.18	0.19	0.20	0.21	0.21	0.21	0.21	0.22	0.22	0.22	0.22	0.22	0.23	0.23	0.23
	16	q	3908	3610	3410	3334	3268	3211	3161	3117	3078	3043	3012	2983	2957	2934	2912
		F	0.15	0.16	0.17	0.17	0.18	0.18	0.18	0.19	0.19	0.19	0.19	0.20	0.20	0.20	0.20
36/7	**22**	q	3584	3372	3230	3176	3129	3089	3053	3022	2995	2970	2947	2927	2909	2892	2877
		F	0.23	0.24	0.26	0.26	0.26	0.27	0.27	0.27	0.28	0.28	0.28	0.28	0.28	0.29	0.29
	20	q	3765	3510	3340	3275	3219	3170	3128	3090	3057	3027	3000	2976	2954	2934	2915
		F	0.20	0.21	0.23	0.23	0.23	0.24	0.24	0.24	0.25	0.25	0.25	0.25	0.25	0.26	0.26
	18	q	4142	3803	3577	3490	3415	3350	3294	3244	3199	3160	3124	3092	3062	3035	3011
		F	0.16	0.17	0.18	0.19	0.19	0.19	0.20	0.20	0.20	0.21	0.21	0.21	0.21	0.21	0.22
	16	q	4537	4113	3829	3721	3627	3546	3476	3413	3358	3308	3263	3223	3186	3153	3122
		F	0.13	0.14	0.15	0.16	0.16	0.16	0.17	0.17	0.17	0.18	0.18	0.18	0.18	0.18	0.19

See footnotes on page 39.

OPENINGS IN FORMLOK DECKS

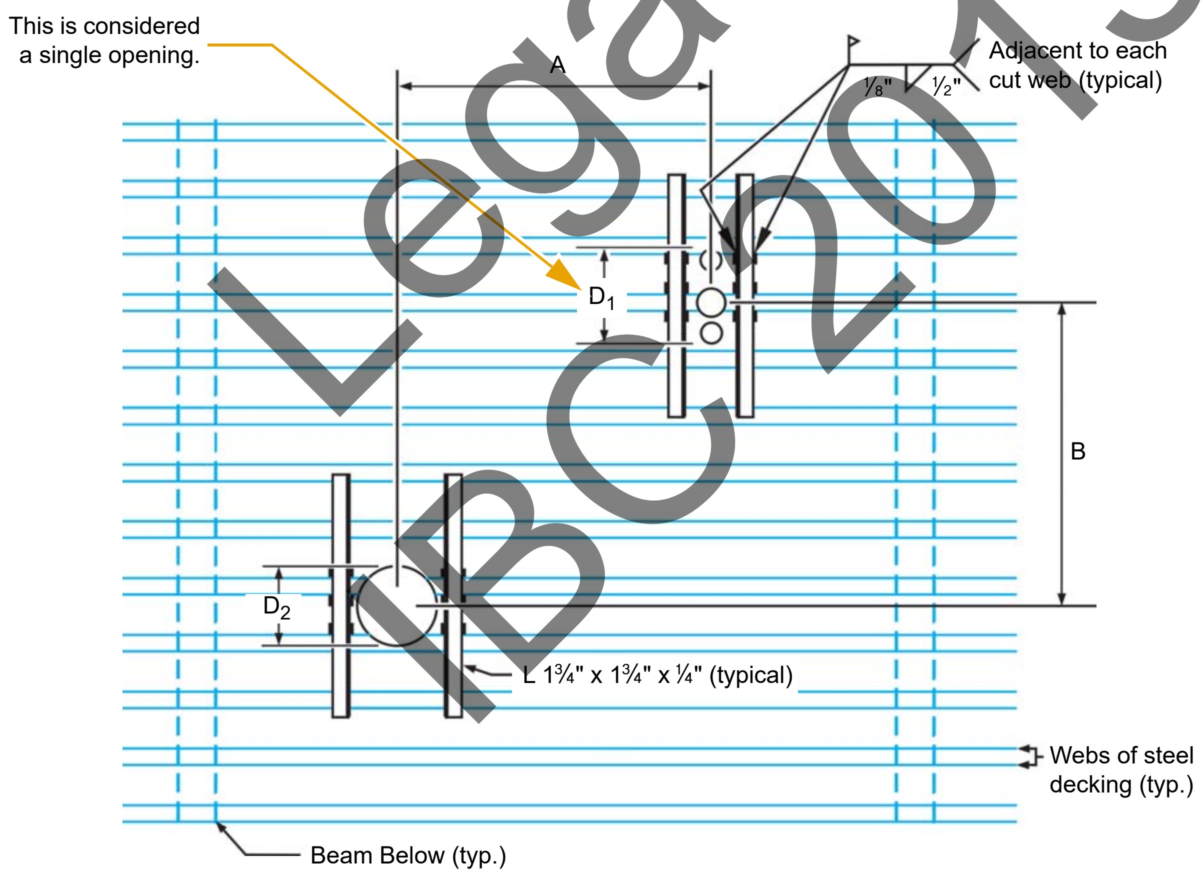
The following suggestions for openings in FORMLOK deck are intended to address support of construction loads by the deck before the concrete has fully cured and to address distribution of the reactions from superimposed loads to the adjacent composite slab. These suggestions should be evaluated based on specific project conditions by the responsible design professional.

It is suggested in all cases that the openings should be blocked out and the FORMLOK deck left intact whenever possible. After the concrete has cured, the FORMLOK deck in the area of the opening can be removed. If the deck is left intact until after the concrete has fully cured, alternative methods of reinforcing to those illustrated, such as rebar, may be used to distribute superimposed loads around the opening.

Note: Typically, individual holes less than 6 in. in diameter and cutting no more than one web need no reinforcing.

(continued on page 31)

Holes cutting no more than:
- **3 adjacent webs for 6" and 8" module deck.**
- **2 adjacent webs for 12" module deck.**



Notes:
1. Angles shall be placed on top of the FORMLOK deck.
2. Angles shall extend 3 webs past the deck opening (typical).
3. If Dimension A is >$4D_1$, $4D_2$, or 32" whichever is larger, there is no restriction on Dimension B.
4. If Dimension B is >$4D_1$, $4D_2$, or 32" whichever is larger, there is no restriction on Dimension A.
5. If Dimensions A and B are <$4D_1$, $4D_2$, or 32" whichever is larger, the opening group shall be considered as a single large hole, and shall be reinforced as required for the larger opening as shown in Figure 19.

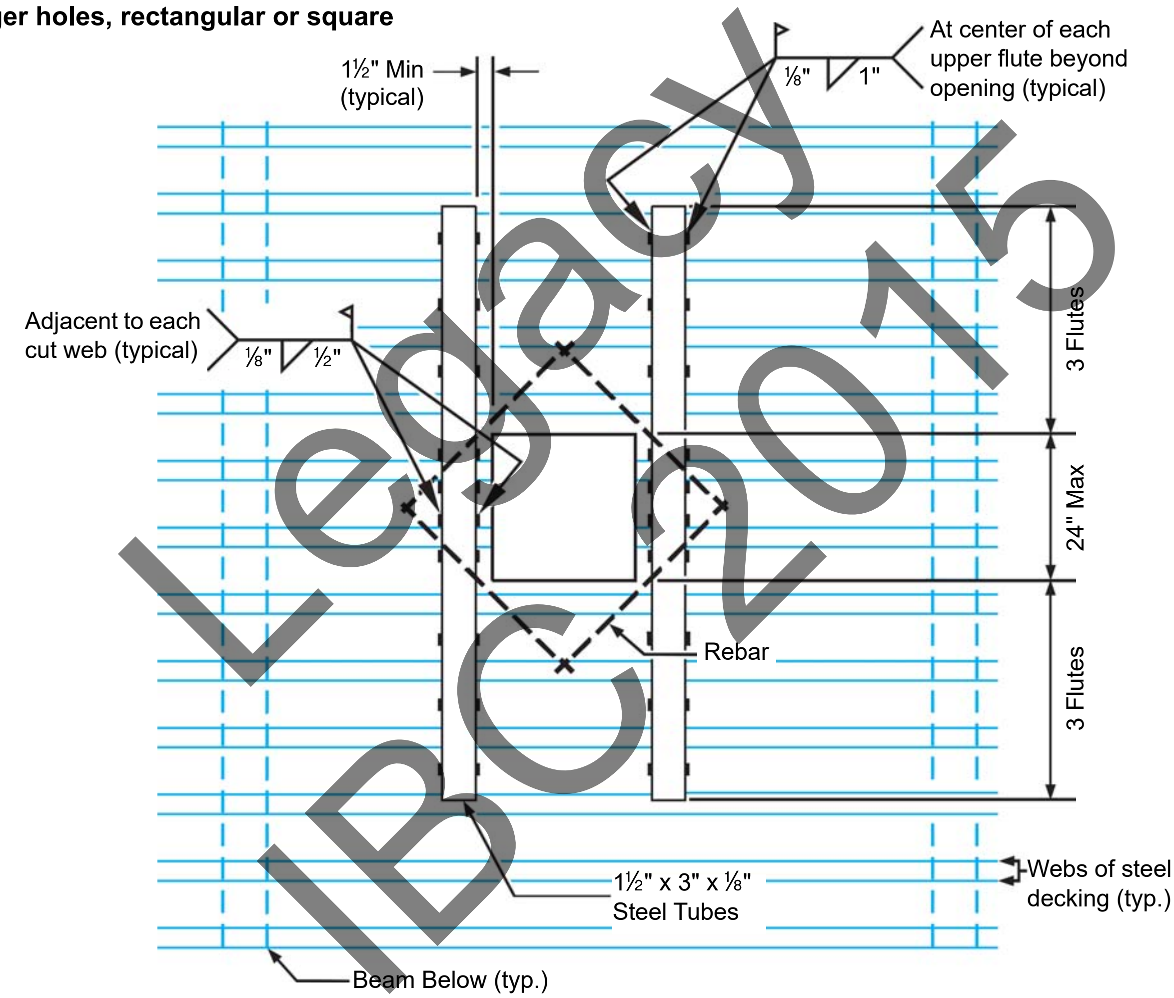
FIGURE 18

(continued from page 30)

- The diagonal bars shown at larger openings are intended to address cracking at corners and are in addition to the reinforcing required for load distribution.
- Figure 18 illustrates recommendations for holes 6 to 12 in. in diameter, those cutting more than one web, or groups of small holes.
- Figure 19 illustrates recommendations for larger openings, up to 24".
- Provide alternate means of support around openings or groups of openings larger than 24 in.

The critical dimension for an opening or groups of openings is the width measured perpendicular to the deck span as shown in Figures 18 and 19. The length of an opening or hole measured parallel to the direction of the deck span is not limited.

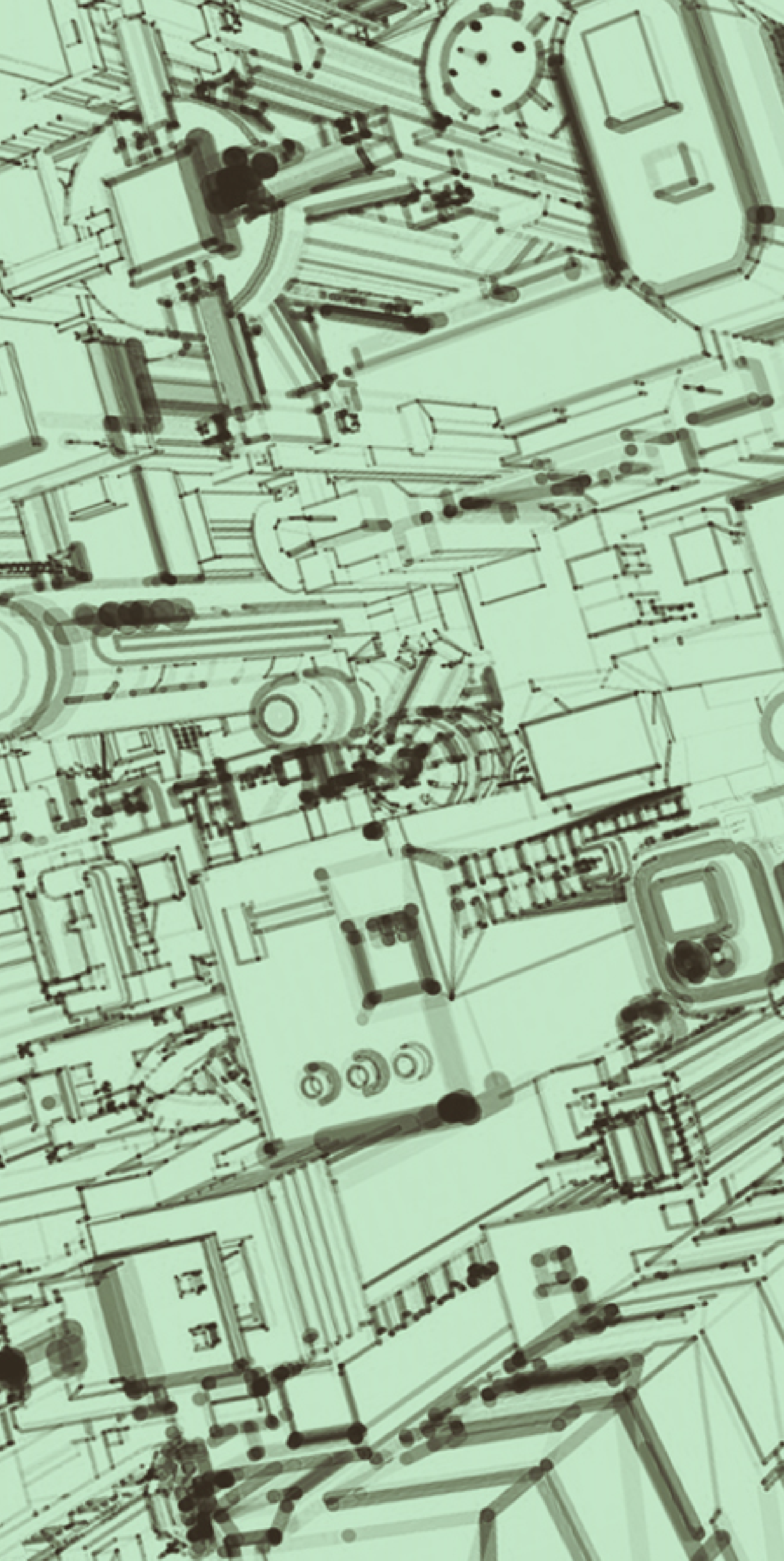
Larger holes, rectangular or square



Notes:

1. Tubes shall be placed on top of the deck. Note: Availability may suggest the use of alternate members such as channels or angles with comparable strength.
2. Add rebars at corners of opening above the tubes. Rebar size and clear cover to be determined by responsible design professional.
3. If the opening or group of openings occurs in one FORMLOK deck unit, the opening or opening group may be cut before pouring concrete, but it may be preferable to form opening with pour stops and cut the deck after concrete has cured.
4. If the opening or group of openings cuts through two FORMLOK deck units, the deck shall not be cut until concrete has been placed and cured. At the time of pouring, suitable sleeves or bulkheads shall be placed around the opening.
5. When the maximum dimension of an opening or opening group exceeds 24", provide alternate means of support.

FIGURE 19



Lateral Design

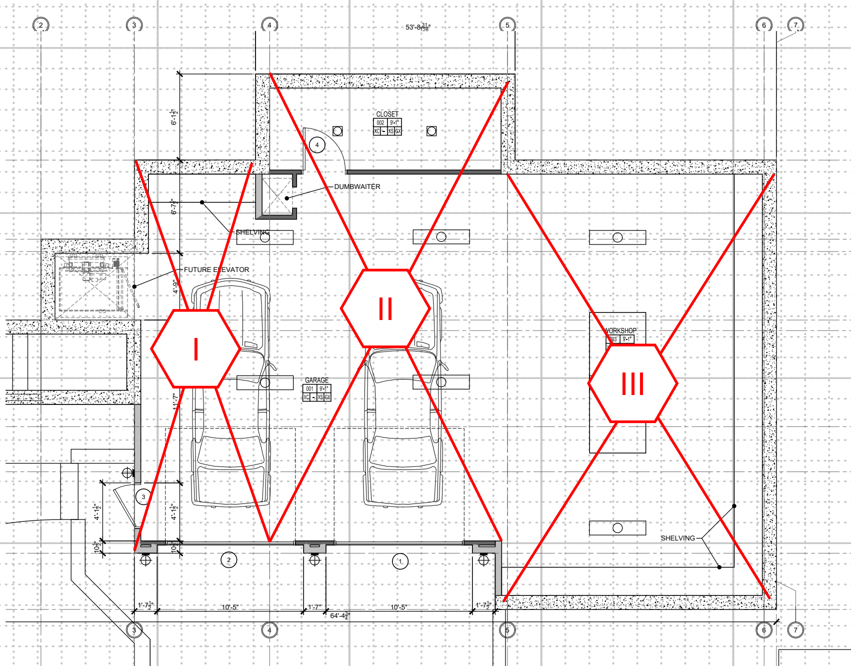
Lateral Design

Concrete Finish on Wood w/ Ply. Sheathing [Original Design]

WETHINGTON
ENGINEERING, INC.

Date: ____________ By: ___________ Project: ____

Lateral Key Plan
Floor

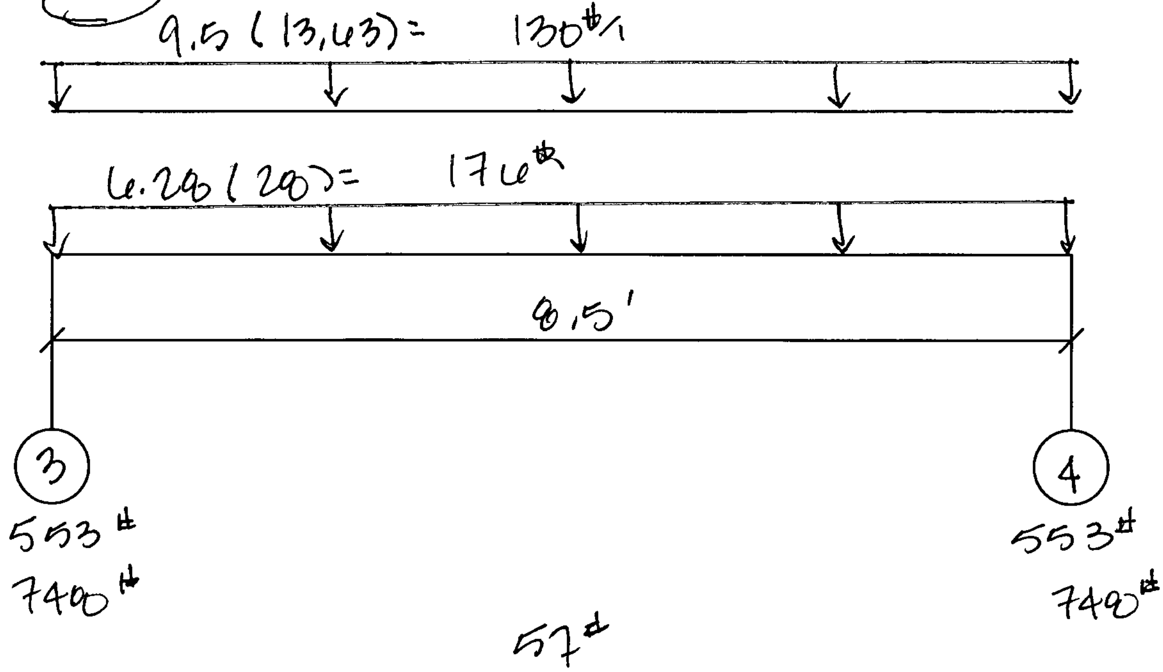


N_{ref}

WETHINGTON ENGINEERING, INC.

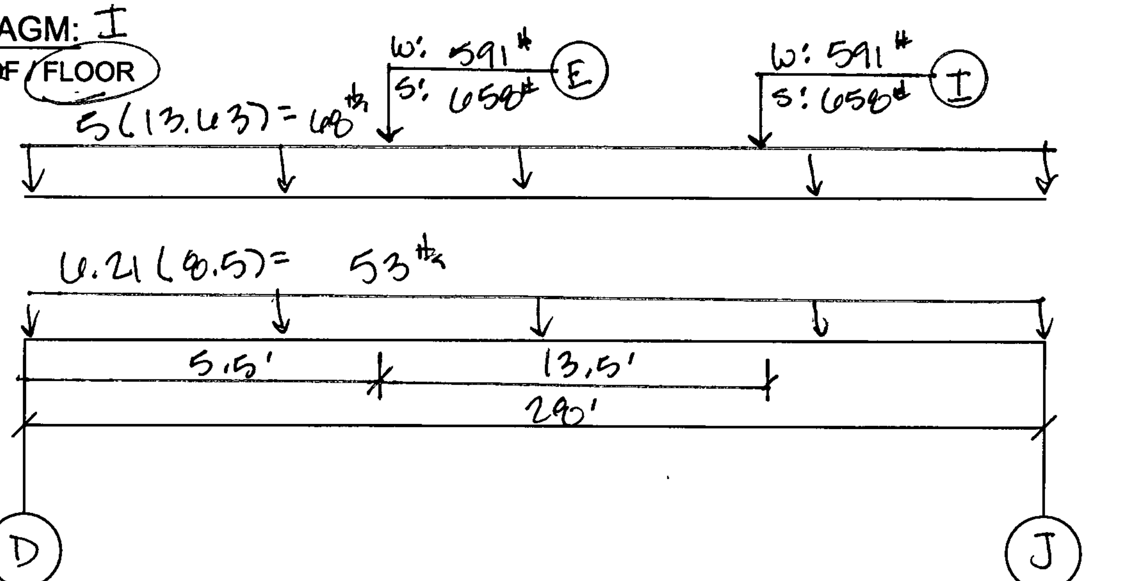
Date: 11/22 By: HW Project: 2022-024 Kruggel

DIAPHRAGM: I
N/S - ~~ROOF~~ / FLOOR



WIND
SEISMIC
WIND
SEISMIC
CHORD

DIAPHRAGM: I
E/W - ~~ROOF~~ / FLOOR



WIND
SEISMIC

952 + 475 + 190 = 1617#
742 + 529 + 211 = 1482#
(ret wall ok by insp)
12-16d ok by insp.

952 + 116 + 401 = 1469#
742 + 129 + 447 = 1318#

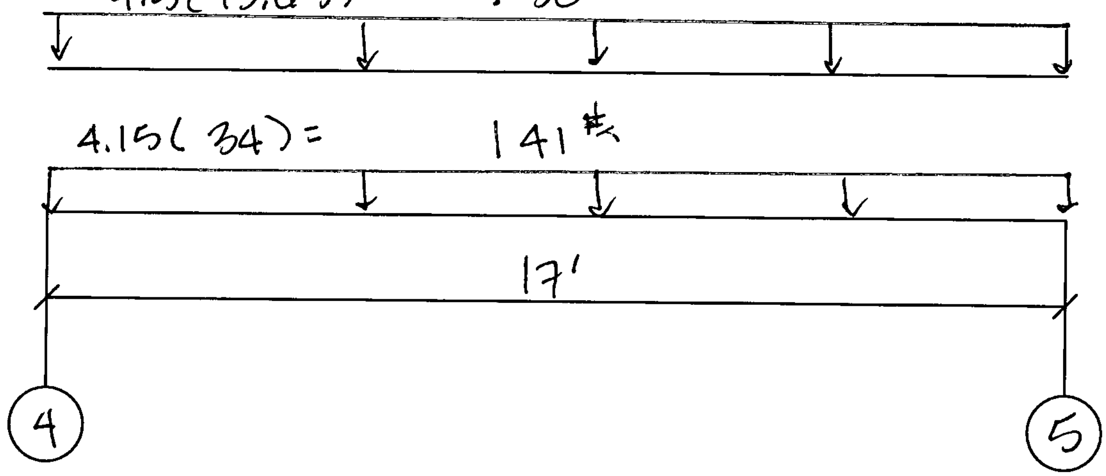
WIND
SEISMIC
CHORD

WETHINGTON ENGINEERING, INC.

Date: 11/22 By: HW Project: 2022-024 Kniggel

DIAPHRAGM: II
N/S - ~~ROOF~~ / FLOOR

9.5(13.63) = 130#/'



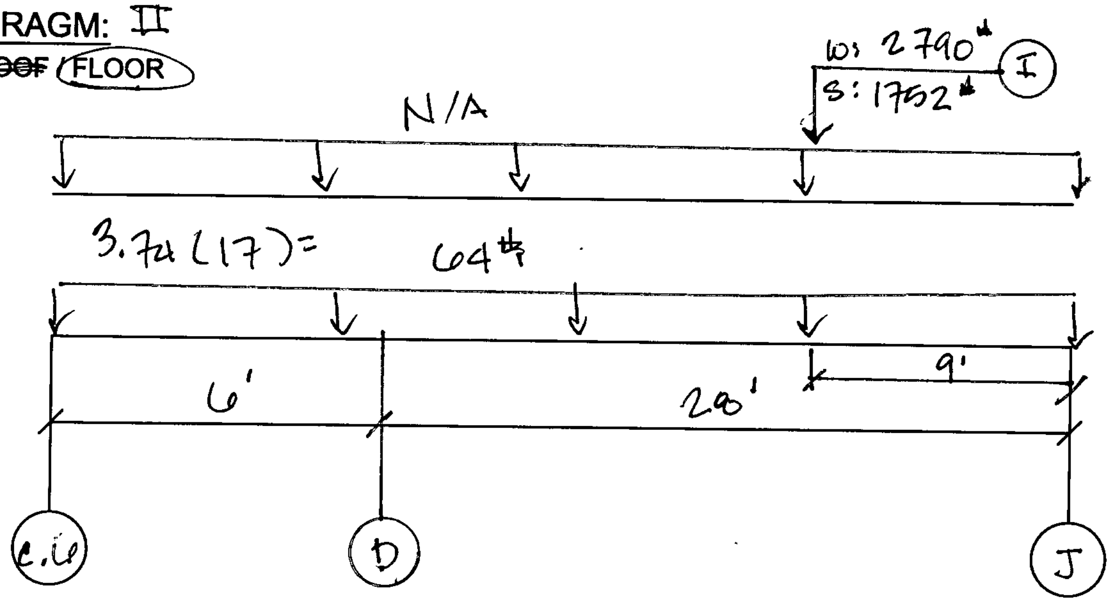
WIND

SEISMIC

	Line 4		Line 5
WIND	1105		1105
SEISMIC	1199		1199
CHORD		150	

DIAPHRAGM: II
E/W - ~~ROOF~~ / FLOOR

N/A



WIND

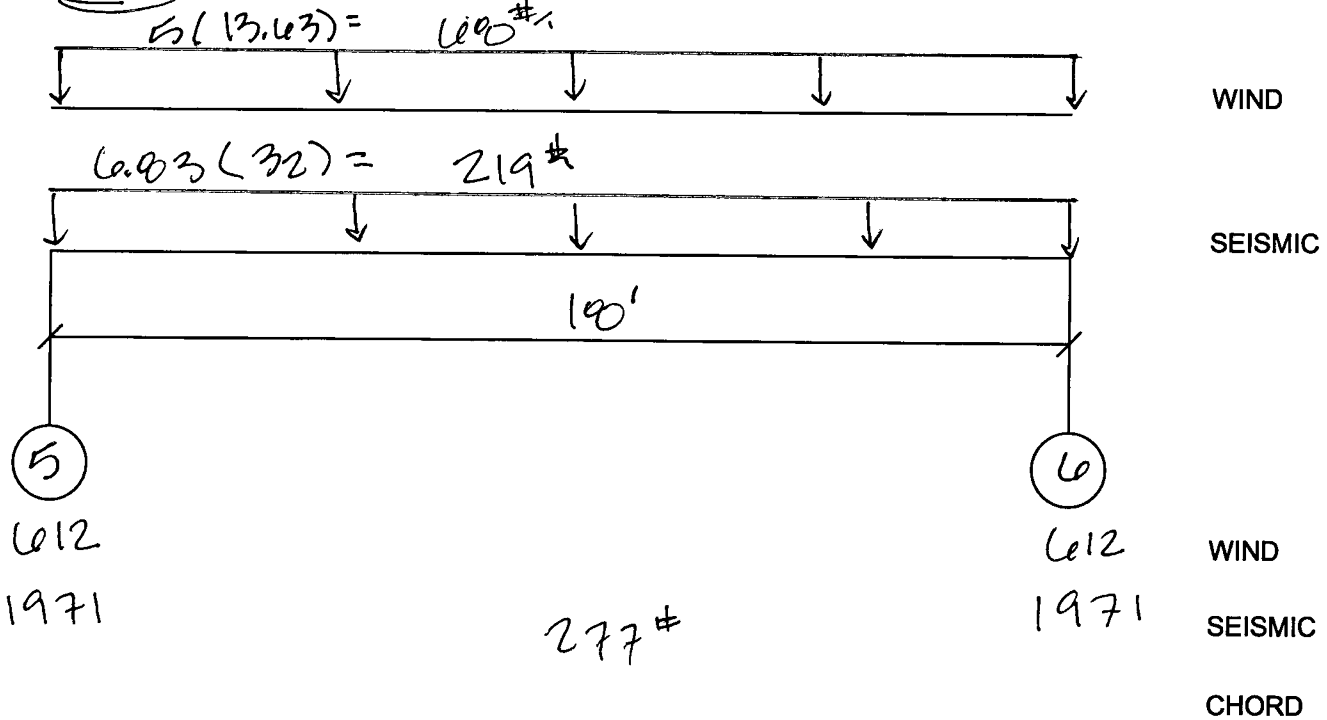
SEISMIC

	C.6	D	J
WIND	—	897	1893
SEISMIC	192 (ret wall ok by insp)	1088 + 563 = 1651 (ret wall ok by insp)	896 + 1189 = 2085
CHORD			

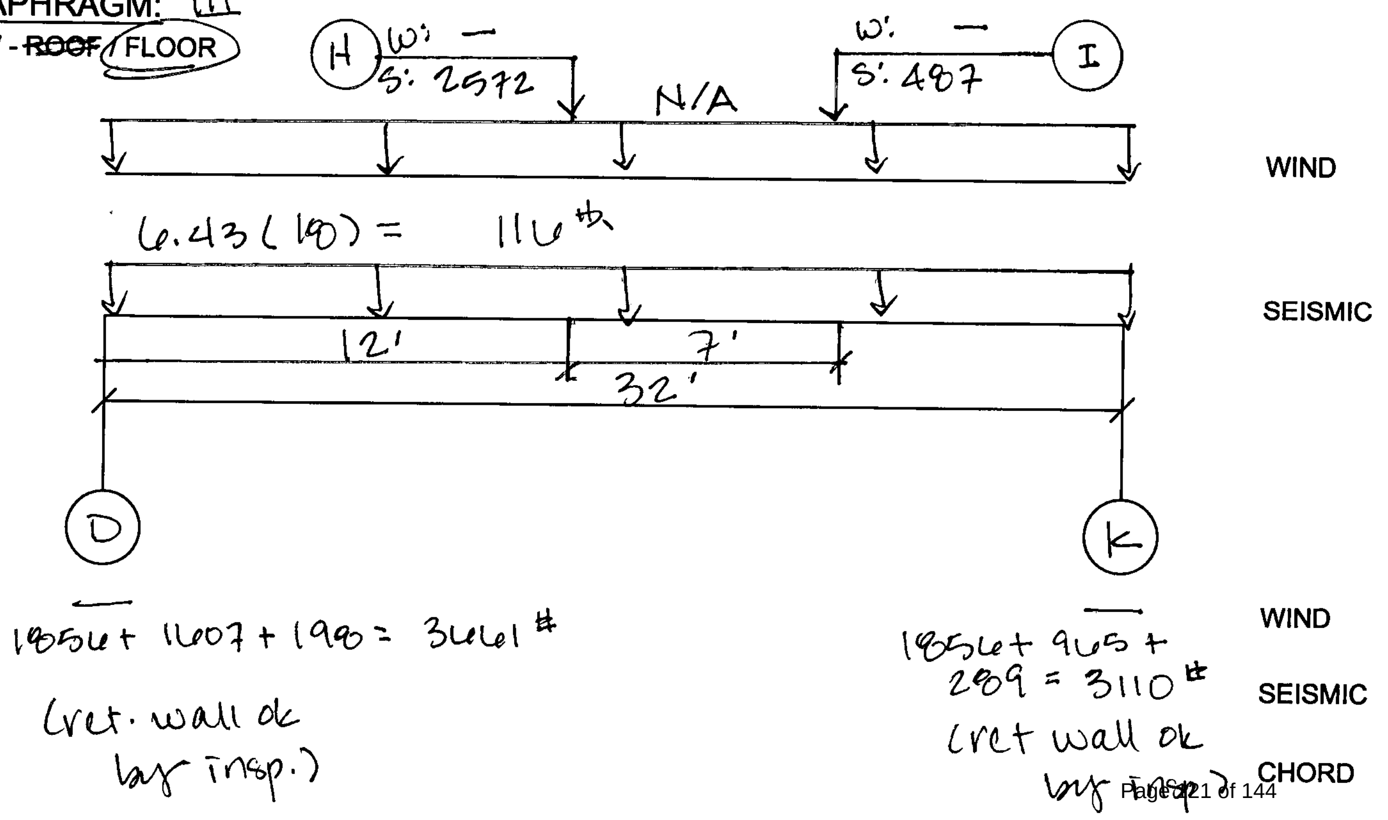
WETHINGTON ENGINEERING, INC.

Date: 11/22 By: thw Project: 2022-024 Kruggel

DIAPHRAGM: III
N/S - ~~ROOF~~ / FLOOR



DIAPHRAGM: III
E/W - ~~ROOF~~ / FLOOR



Lateral Member Design

Concrete Finish on Wood w/ Ply. Sheathing [Original Design]

&

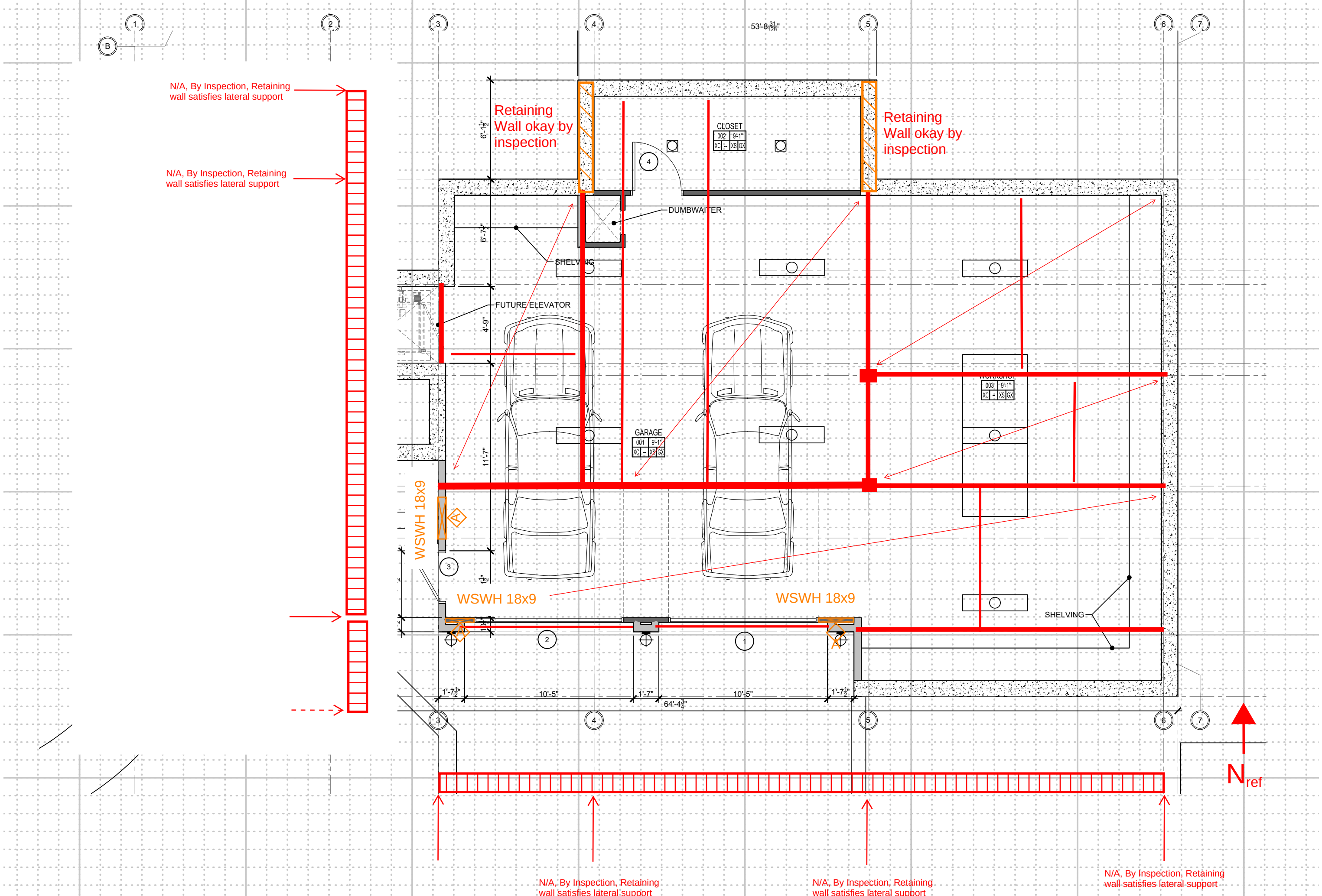
Non-Structural Concrete on Wood w/ Shallow Vercor

WETHINGTON
ENGINEERING, INC.

Date: ____________ By: ___________ Project: ____

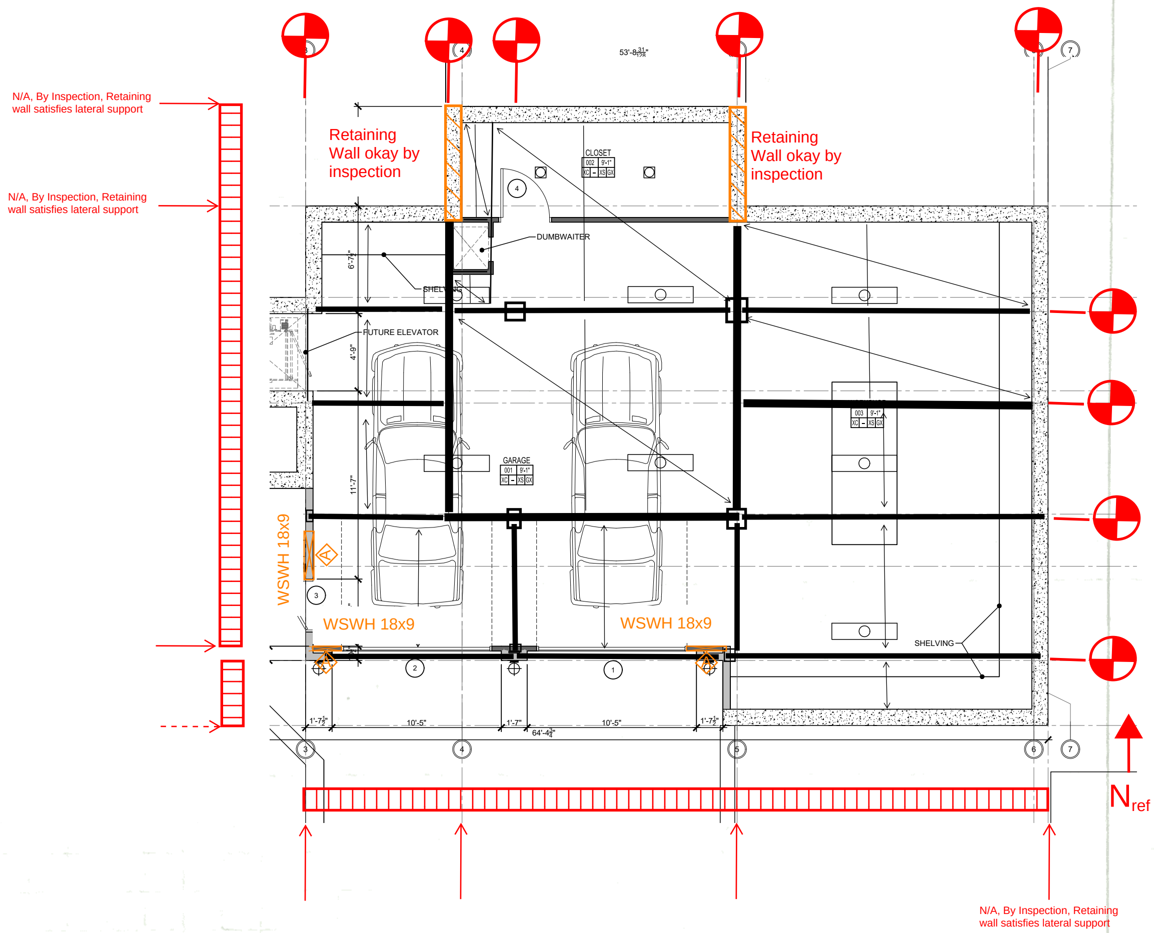
Current Design: Key Structural Plan

Lateral Key Plan
Floor



Prior Consideration:
Strucutral, Verco decking with Wood/GLB Framing

Design Key Plan



Standard and Balloon Framing on Concrete Foundations

SIMPSON Strong-Tie

Strong-Wall High-Strength Wood Shearwall Model No.	Panel Evaluation Height, He (lb.)[6]	Allow Vertical Load, P (lb.)[4]	2,500 psi Concrete						3,000 psi Concrete					
			Seismic[3]			Wind			Seismic[3]			Wind		
			Allowable ASD Shear Load, V (lb.)	Drift at Allowable Shear, Δ (in.)[7]	Anchor Tension at Allowable Shear, T (lb.)[11]	Allowable ASD Shear Load, V (lb.)	Drift at Allowable Shear, Δ (in.)[7]	Anchor Tension at Allowable Shear, T (lb.)[11]	Allowable ASD Shear Load, V (lb.)	Drift at Allowable Shear, Δ (in.)[7]	Anchor Tension at Allowable Shear, T (lb.)[11]	Allowable ASD Shear Load, V (lb.)	Drift at Allowable Shear, Δ (in.)[7]	Anchor Tension at Allowable Shear, T (lb.)[11]
WSWH12x7	78	1,000	1,300	0.32	13,295	1,670	0.43	17,075	1,300	0.32	13,295	1,670	0.43	17,075
		4,000	1,300	0.32	13,295	1,670	0.43	17,075	1,300	0.32	13,295	1,670	0.43	17,075
		7,500	1,300	0.32	13,295	1,670	0.43	17,075	1,300	0.32	13,295	1,670	0.43	17,075
WSWH18x7	78	1,000	3,795	0.32	23,680	4,470	0.39	27,890	3,795	0.32	23,680	4,470	0.39	27,890
		4,000	3,795	0.32	23,680	4,365	0.38	27,245	3,795	0.32	23,680	4,470	0.39	27,890
		7,500	3,795	0.32	23,680	4,050	0.36	25,285	3,795	0.32	23,680	4,470	0.39	27,890
WSWH24x7	78	1,000	7,450	0.30	33,210	7,795	0.34	34,755	7,450	0.30	33,210	7,795	0.34	34,755
		4,000	7,450	0.30	33,210	7,565	0.33	33,715	7,450	0.30	33,210	7,795	0.34	34,755
		7,500	7,115	0.28	31,715	7,115	0.31	31,715	7,450	0.30	33,210	7,795	0.34	34,755
WSWH12x8	93.25	1,000	1,030	0.40	12,580	1,325	0.53	16,195	1,030	0.40	12,580	1,325	0.53	16,195
		4,000	1,030	0.40	12,580	1,325	0.53	16,195	1,030	0.40	12,580	1,325	0.53	16,195
		7,500	1,030	0.40	12,580	1,325	0.53	16,195	1,030	0.40	12,580	1,325	0.53	16,195
WSWH18x8	93.25	1,000	3,060	0.39	22,835	3,880	0.52	28,925	3,060	0.39	22,835	3,955	0.53	29,490
		4,000	3,060	0.39	22,835	3,650	0.49	27,245	3,060	0.39	22,835	3,955	0.53	29,490
		7,500	3,060	0.39	22,835	3,390	0.46	25,285	3,060	0.39	22,835	3,955	0.53	29,490
WSWH24x8	93.25	1,000	6,240	0.37	33,240	6,650	0.43	35,430	6,240	0.37	33,240	6,910	0.45	36,815
		4,000	6,240	0.37	33,240	6,330	0.41	33,715	6,240	0.37	33,240	6,910	0.45	36,815
		7,500	5,950	0.35	31,715	5,950	0.38	31,715	6,240	0.37	33,240	6,910	0.45	36,815
WSWH12x9	105.25	1,000	850	0.45	11,750	1,095	0.60	15,145	850	0.45	11,750	1,095	0.60	15,145
		4,000	850	0.45	11,750	1,095	0.60	15,145	850	0.45	11,750	1,095	0.60	15,145
		7,500	850	0.45	11,750	1,095	0.60	15,145	850	0.45	11,750	1,095	0.60	15,145
WSWH18x9	105.25	1,000	2,575	0.45	21,680	3,325	0.60	27,975	2,575	0.45	21,680	3,325	0.60	27,975
		4,000	2,575	0.45	21,680	3,235	0.58	27,245	2,575	0.45	21,680	3,325	0.60	27,975
		7,500	2,575	0.45	21,680	3,005	0.54	25,285	2,575	0.45	21,680	3,325	0.60	27,975
WSWH24x9	105.25	1,000	5,150	0.43	30,975	5,890	0.52	35,430	5,150	0.43	30,975	6,120	0.54	36,815
		4,000	5,150	0.43	30,975	5,605	0.50	33,715	5,150	0.43	30,975	6,120	0.54	36,815
		7,500	5,150	0.43	30,975	5,275	0.47	31,715	5,150	0.43	30,975	6,120	0.54	36,815
WSWH12x10	117.25	1,000	700	0.50	10,750	900	0.67	13,855	700	0.50	10,750	900	0.67	13,855
		4,000	700	0.50	10,750	900	0.67	13,855	700	0.50	10,750	900	0.67	13,855
		7,500	700	0.50	10,750	900	0.67	13,855	700	0.50	10,750	900	0.67	13,855
WSWH18x10	117.25	1,000	2,140	0.50	20,055	2,755	0.67	25,840	2,140	0.50	20,055	2,755	0.67	25,840
		4,000	2,140	0.50	20,055	2,755	0.67	25,840	2,140	0.50	20,055	2,755	0.67	25,840
		7,500	2,140	0.50	20,055	2,695	0.65	25,285	2,140	0.50	20,055	2,755	0.67	25,840
WSWH24x10	117.25	1,000	4,010	0.48	26,860	5,215	0.67	34,935	4,010	0.48	26,860	5,215	0.67	34,935
		4,000	4,010	0.48	26,860	5,030	0.64	33,715	4,010	0.48	26,860	5,215	0.67	34,935
		7,500	4,010	0.48	26,860	4,735	0.61	31,715	4,010	0.48	26,860	5,215	0.67	34,935
WSWH12x11	129.25	1,000	595	0.56	10,055	765	0.73	12,930	595	0.56	10,055	765	0.73	12,930
		4,000	595	0.56	10,055	765	0.73	12,930	595	0.56	10,055	765	0.73	12,930
		7,500	595	0.56	10,055	765	0.73	12,930	595	0.56	10,055	765	0.73	12,930
WSWH18x11	129.25	1,000	1,960	0.55	20,240	2,520	0.73	26,060	1,960	0.55	20,240	2,520	0.73	26,060
		4,000	1,960	0.55	20,240	2,520	0.73	26,060	1,960	0.55	20,240	2,520	0.73	26,060
		7,500	1,960	0.55	20,240	2,445	0.71	25,285	1,960	0.55	20,240	2,520	0.73	26,060
WSWH24x11	129.25	1,000	4,000	0.54	29,550	4,795	0.68	35,430	4,000	0.54	29,550	4,985	0.70	36,815
		4,000	4,000	0.54	29,550	4,565	0.64	33,715	4,000	0.54	29,550	4,985	0.70	36,815
		7,500	4,000	0.54	29,550	4,295	0.60	31,715	4,000	0.54	29,550	4,985	0.70	36,815

See foonotes on p. 15.

High-Strength Wood Shearwall Anchorage Solutions

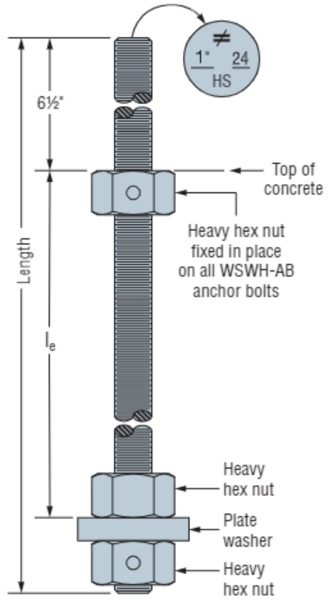
WSWH-AB Anchor Bolts

WSWH-AB anchor bolts in 1" diameters offer flexibility to meet specific project demands. Inspection is easy; the head is stamped with a No-Equal® symbol for identification, bolt length, bolt diameter, and optional "HS" for "High-Strength" if specified.

Material: ASTM F1554 Grade 36;
High-Strength (HS) ASTM A193 Grade B7

An additional nut for template installation is provided with each WSWH-AB.

Strong-Wall® High-Strength Wood Shearwall Model No.	Model No.	Dia. (in.)	Total Length (in.)	l_e (in.)
WSWH12 WSWH18 WSWH24	WSWH-AB1x24	1	24	15½
	WSWH-AB1x24HS	1	24	15½
	WSWH-AB1x30	1	30	21½
	WSWH-AB1x30HS	1	30	21½
	WSWH-AB1x36	1	36	27½
	WSWH-AB1x36HS	1	36	27½



WSWH-AB

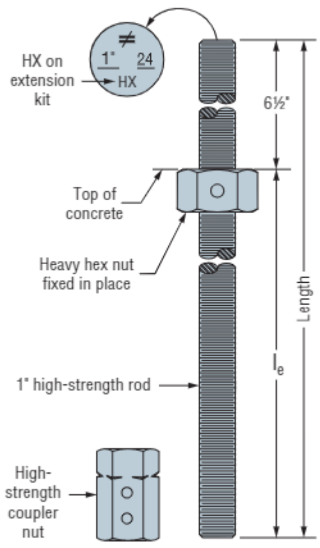
WSWH-HSR Extension Kit

WSWH-HSR allows for anchorage in tall stemwall applications where full embedment of a WSWH-AB into the footing is required. The head is stamped for identification like a WSWH-AB. Kit includes ASTM A193 Grade B7 high-strength rod with heavy hex nut fixed in place and high-strength coupler nut.

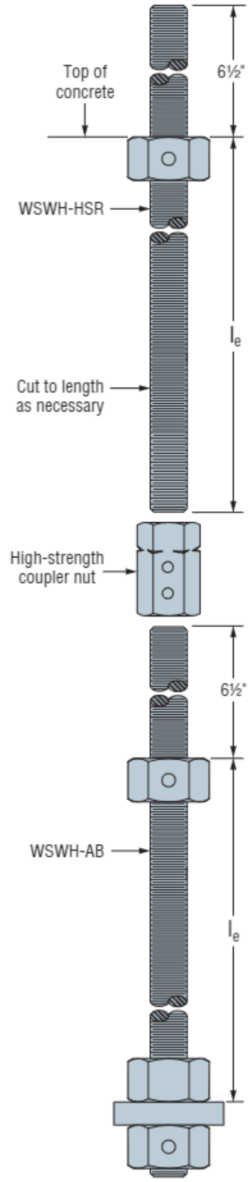
Strong-Wall High-Strength Wood Shearwall Model No.	Model No.	Dia. (in.)	Total Length (in.)	l_e (in.)
WSWH12 WSWH18 WSWH24	WSWH-HSR1x24KT	1	24	17½
	WSWH-HSR1x36KT	1	36	29½

Note: Do not use in place of WSWH-AB.

Total l_e = WSWH-HSR l_e + WSWH-AB l_e + 6½"



WSWH-HSRXXKT



WSWH-HSR and WSWH-AB Assembly

Strong-Wall® High-Strength Wood Shearwalls

High-Strength Wood Shearwall Anchorage Solutions

Tension Anchorage Solutions — 2,500 psi Concrete[1,5,6]

Design Criteria	Concrete Condition	Anchor Strength[2]	WSWH-AB1 Anchor Bolt		
			ASD Allowable Tension (lb.)	W (in.)	d_e (in.)
Seismic[3]	Cracked	Standard	16,000	33	11
			17,100	35	12
		High-Strength	34,100	52	18
			36,800	55	19
	Uncracked	Standard	15,700	28	10
			17,100	30	10
		High-Strength	33,500	45	15
			36,800	48	16
Wind[4]	Cracked	Standard	6,200	16	6
			11,400	24	8
			17,100	32	11
		High-Strength	21,100	36	12
			27,300	42	14
			34,100	48	16
			36,800	51	17
	Uncracked	Standard	6,400	14	6
			12,500	22	8
			17,100	28	10
		High-Strength	22,900	33	11
			26,400	36	12
			34,200	42	14
			36,800	44	15

See footnotes on p. 23.

Tension Anchorage Solutions — 3,000 psi Concrete[1,5,6]

Design Criteria	Concrete Condition	Anchor Strength[2]	WSWH-AB1 Anchor Bolt		
			ASD Allowable Tension (lb.)	W (in.)	d_e (in.)
Seismic[3]	Cracked	Standard	16,000	31	11
			17,100	33	11
		High-Strength	33,900	49	17
			36,800	52	18
	Uncracked	Standard	16,300	27	9
			17,100	28	10
		High-Strength	34,000	43	15
			36,800	46	16
Wind[4]	Cracked	Standard	5,600	14	6
			10,200	21	7
			17,100	30	10
		High-Strength	20,000	33	11
			26,500	39	13
			33,600	45	15
			36,800	48	16
	Uncracked	Standard	6,200	13	6
			12,800	21	7
			17,100	26	9
		High-Strength	21,800	30	10
			28,900	36	12
			33,100	39	13
			36,800	42	14

See footnotes on p. 23.

SIMPSON Strong-Tie

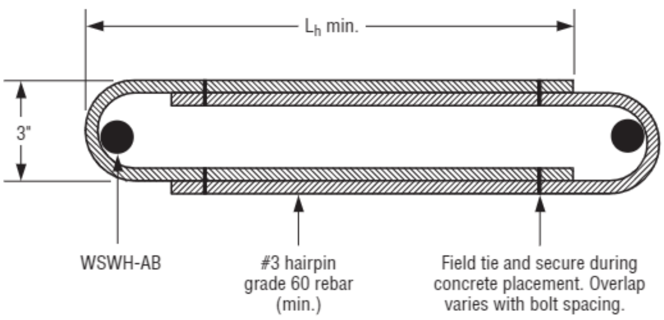
High-Strength Wood Shearwall Anchorage Solutions

Foundation shear reinforcement to resist shear forces from Strong-Wall® high-strength wood shearwalls located at the edge of concrete is shown in the table below. The WSWH12 used in wind applications does not require shear reinforcement when the panel design shear force is less than the anchorage allowable shear load shown in the table below.

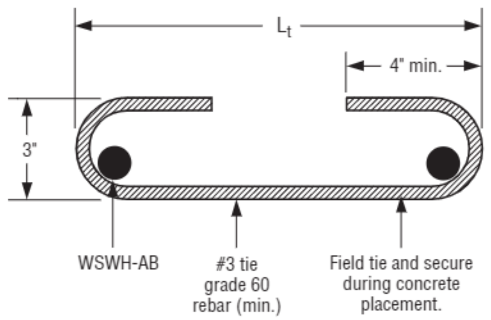
Shear Anchorage Solutions

Strong-Wall High-Strength Wood Shearwall Model No.	L_t or L_h (in.)	Seismic[3]		Wind[4]			
		Shear Reinforcement	Minimum Curb/ Stemwall Width (in.)	Shear Reinforcement	Minimum Curb/ Stemwall Width (in.)	ASD Allowable Shear Load, V (lb.)[7]	
						Uncracked	Cracked
WSWH12	10¼	(1) #3 Tie	6	See Note 7	6	1,080	770
WSWH18	15	(2) #3 hairpins[5, 6]	6	(1) #3 hairpin	6	Hairpin reinforcement achieves maximum allowable shear load of the Strong-Wall® WSWH	
WSWH24	19	(2) #3 hairpins[5]	6	(2) #3 hairpins[5]	6		

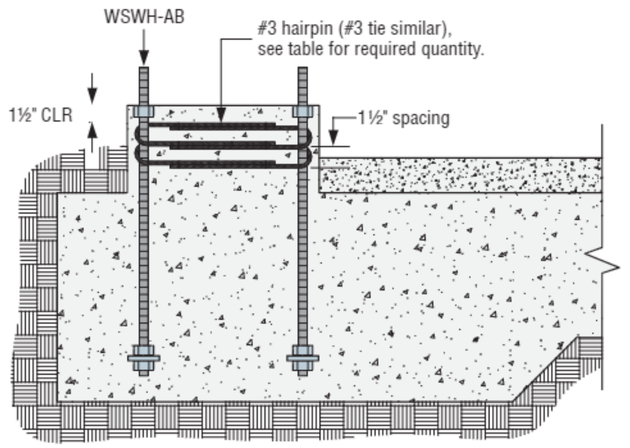
1. Shear anchorage designs conform to ACI 318-14 Chapter 17 and ACI 318-11 and assume minimum 2,500 psi concrete. See pp. 22–23 for tension anchorage.
2. Shear reinforcement is not required for interior foundation applications (panel installed away from edge of concrete), or braced wall panel applications.
3. Seismic indicates seismic design category C through F. Detached one- and two-family dwellings in SDC C may use wind anchorage solutions. Seismic shear reinforcement designs conform to ACI 318-14, section 17.2.3.5.3 and ACI 318-11 section D.3.3.5.
4. Wind includes seismic design category A and B and detached one- and two-family dwellings in SDC C.
5. Additional ties may be required at garage curb or stemwall installations below anchor reinforcement per designer.
6. Use (1) #3 hairpin for WSWH18 when standard strength anchor is used.
7. Use (1) #3 tie for WSWH12 when panel design shear force exceeds tabulated anchorage allowable shear load.
8. No. 4 grade 40 shear reinforcement may be substituted for WSWH shear anchorage solutions.
9. Concrete edge distance for anchors must comply with ACI 318-14 section 17.7.2 and ACI 318-11 section D.8.2.
10. The designer may specify alternate shear anchorage.



Hairpin Shear Reinforcement



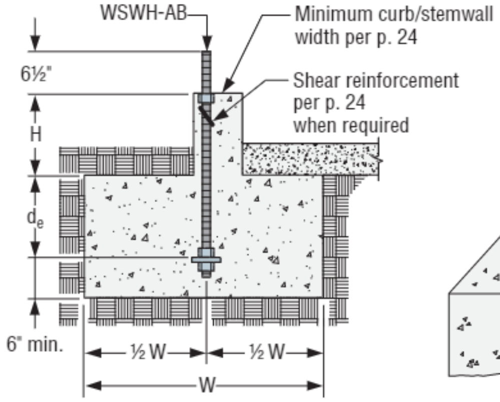
Tie Shear Reinforcement



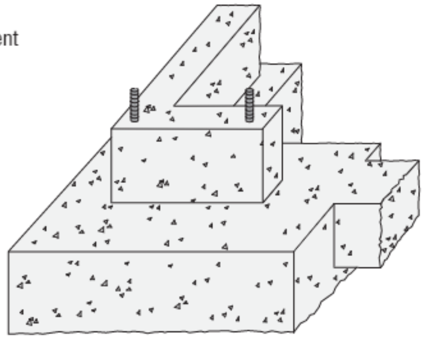
Hairpin Installation
(Garage curb shown, other footing types similar)

High-Strength Wood Shearwall Anchorage Solutions

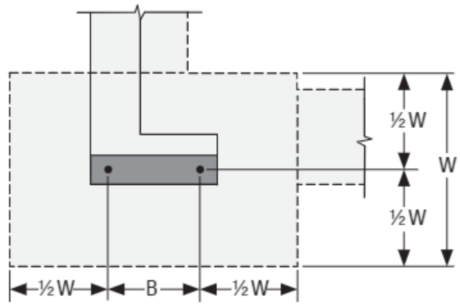
Curb or Stemwall Installation



Curb or Stemwall Section View

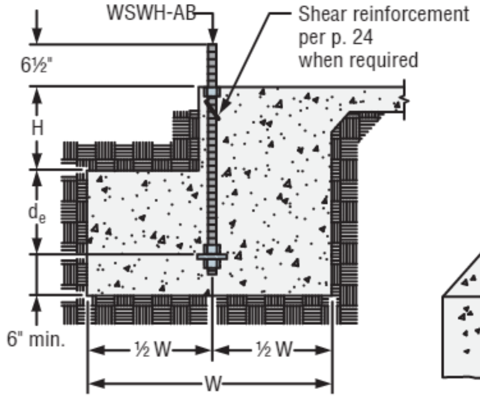


Perspective View
(Slab not shown for clarity)

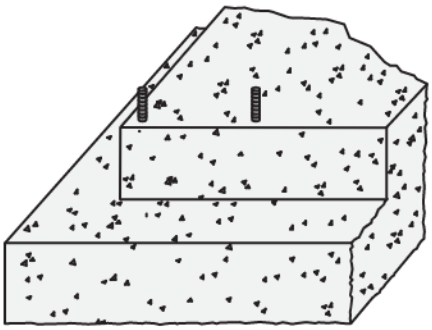


Footing Plan

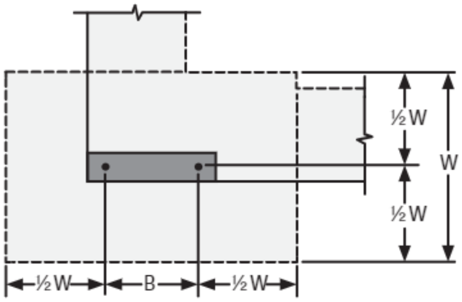
Slab-on-Grade Installation



Slab-on-Grade Section View

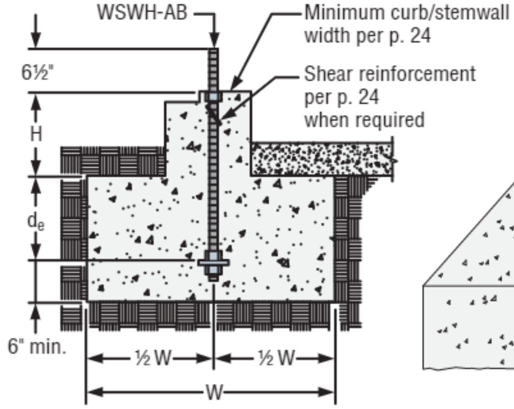


Perspective View

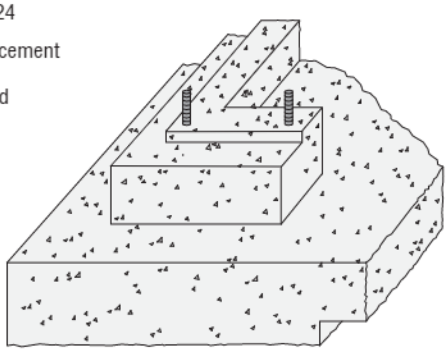


Footing Plan

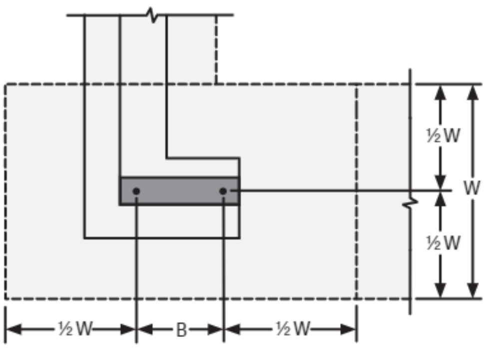
Brick Ledge Installation



Brick Ledge Section View



Perspective View



Footing Plan

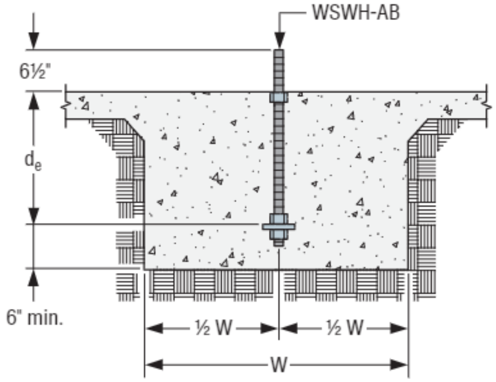
Anchorage Solutions General Notes

1. The designer may specify alternate embedment, footing size or bolt grade.
2. Footing dimensions and rebar requirements are for anchorage only.
3. See pp. 22–23 for W and d_e and p. 26 for B definitions.

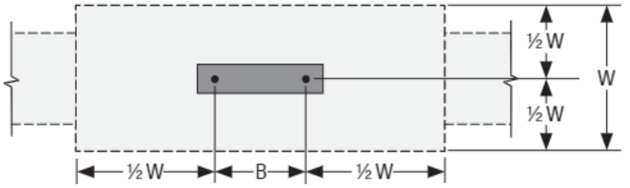
Foundation design
(size and reinforcement) by designer.

High-Strength Wood Shearwall Anchorage Solutions

Interior Installation

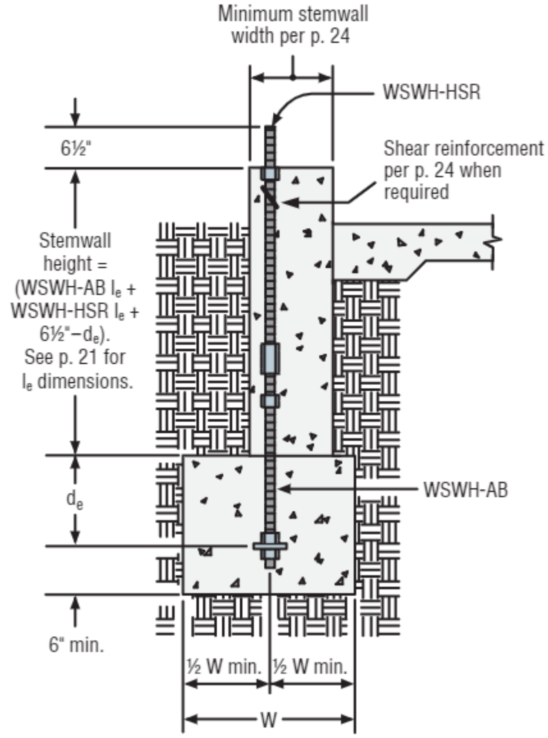


Interior Section View



Footing Plan

Stemwall Extension Installation



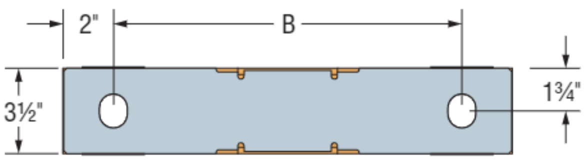
Section at Stemwall
WSWH-AB and WSWH-HSR
Extension Application

Anchorage Solutions General Notes

1. The designer may specify alternate embedment, footing size or bolt grade.
2. Footing dimensions and rebar requirements are for anchorage only.
3. See pp. 22–23 for W and d_e definitions.

Anchor Bolt Layout

Strong-Wall High-Strength Wood Shearwall Model No.	Distance from Center-to-Center of WSWH-AB, B (in.)
WSWH12	8⅛
WSWH18	14
WSWH24	20



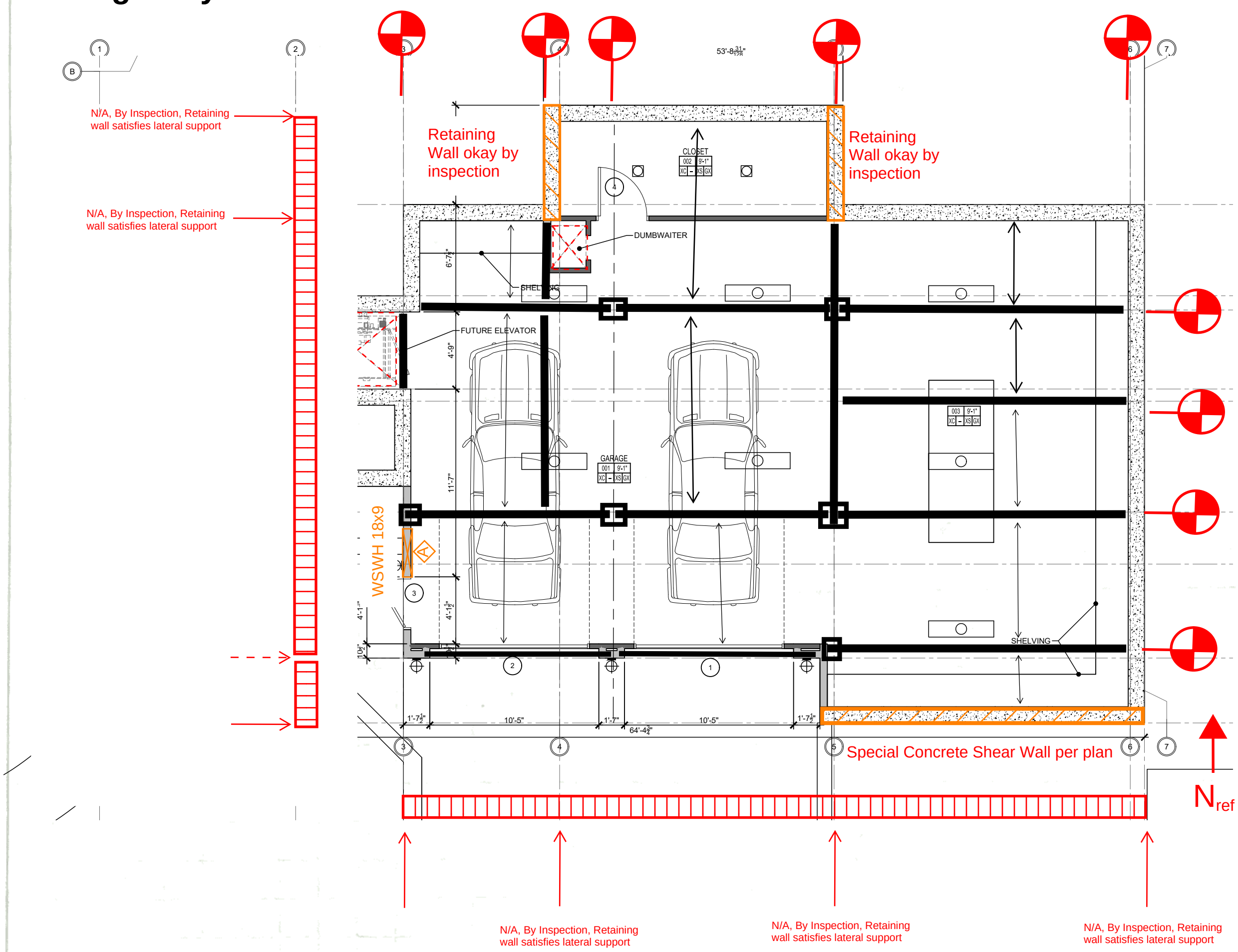
WSWH Plan View
Anchorage Layout

Lateral Member Design

Structural Concrete on Steel w/ Verco

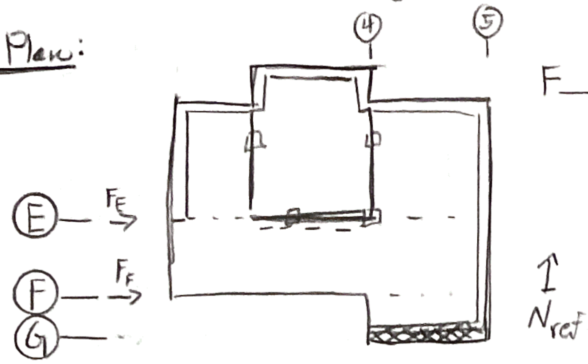
Alternative Steel Design:
Structural, Verco Decking with all Steel Framing

Design Key Plan

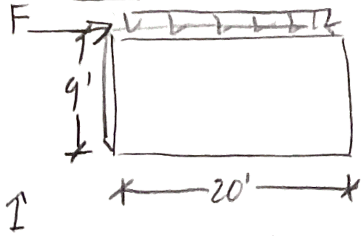


→ Special-Case Conc. S.W. Design

~ Key Plan:



FBD:



→ Loading:
- via irregular diaphragm load transfer, will consider shear wall on Gridline-G loaded from gridlines E & F through structural conc. on Verco decks
- For vertical design, by inspection retaining wall satisfies gravity design

~ For Lateral Forces

Project 2022-024 Structural Calculations Package →

	0.6 (Wind)	0.7 (Seismic)
$F_E = F_{SW(above)}$ =	3,495#	3,022#
$F_F = F_{St.W.}$ =	3,362#	3,403#
Total	6,857#	6,425#

← wind controls

→ For Shear Friction check (T.11.7.4.1)

ICC Code Master, & ACI 318-19 BLDG Code Req. for Struc. Conc. →

$V_e = 6{,}857^{\#}$

$V_n = (6{,}857^{\#}/1000^{\#/k})/20' = 0.343^{k/ft}$

(Table 22.9.4.2) $V_n = A_v * f_y * \mu$

└ for μ, will consider $\mu = 1.4\lambda$ where $\lambda = 1.0$ for normal weight concrete

$A_{v(req.)} = V_n / (f_y \times \mu)$
$= (0.343^{k/ft})/(60^{ksi} \times 1.4(1))$

$A_{v(req.)} = 0.004\ in^2/ft$

└ try #4∅ @ 48" o.c. ; $A_v = 0.050\ in^2/ft$

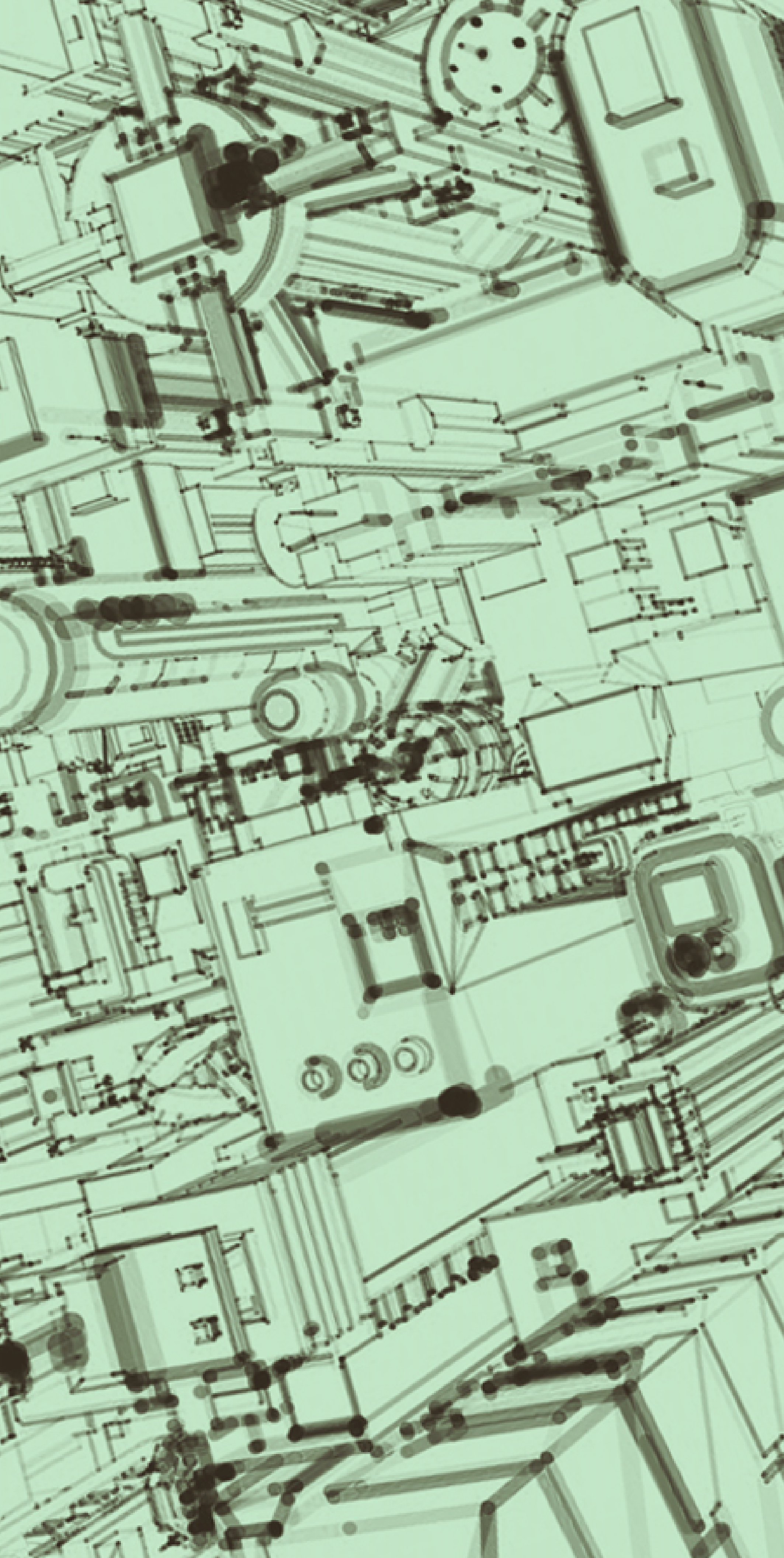
$V_n > V_e$

$0.050^{in^2/ft}(60^{ksi})(1.4(1.0)) > V_e$

$4.2^{k/ft} > 0.343^{k/ft}$ ✓

For pelimary conc. designs:
use Horiz: #4∅ @ 48" o.c.
Vert: #4 @ 48" o.c.

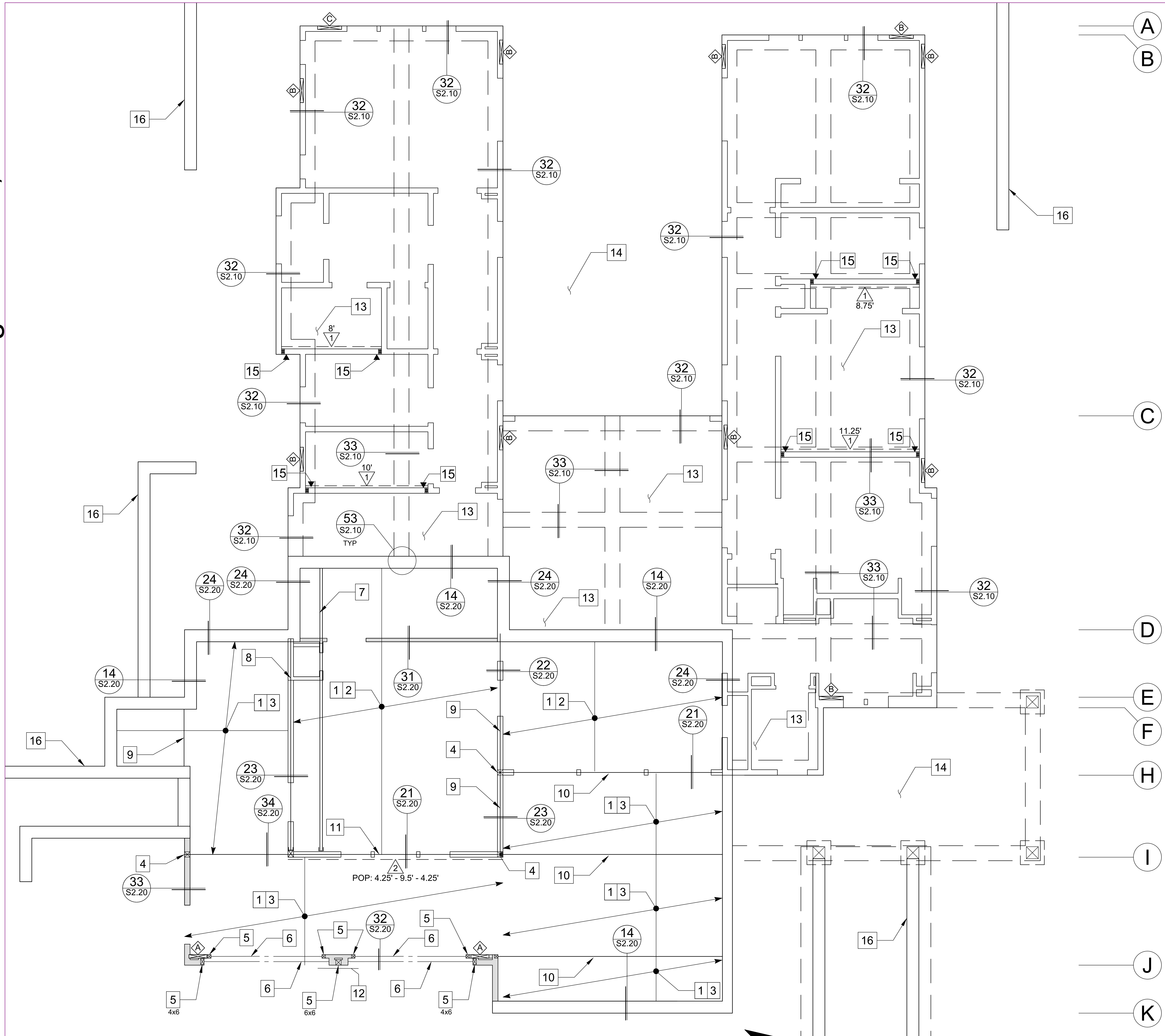
Framing Plan & Section Detail Sheets



Framing Plan & Section Detail Sheets

Concrete Finish on Wood w/ Ply. Sheathing [Original Design]

Structural Plans when Submitted in Calc. Package Dec. 26, 2022



FLOOR FRAMING AND UPPER FOUNDATION PLAN

Scale: 1/4"=1'-0"

Floor Framing Reference Notes:

1. Typical Floor/Deck Sheathing: ¾" APA-Rated CDX T&G Plywood
   - A. Panel Index 48/24
   - B. Glue and Fasten with 10d @ 6:6:10" o.c.
2. Typical Floor Joist: 16" TJI 230 @ 16" o.c.
   - A. Provide IUS2.37/16 hanger at suspended conditions
3. Typical Deck Joist: 1¾" x 9 ¼" LVL @ 16" o.c.
   - A. Provide MIU1.81/9 hanger at suspended conditions.
   - B. Joist to remain level - slope to drain provided at concrete topping
4. HSS5x5x⅜" steel column
5. Trimmer post - Double 2x wall width (Typical, U.N.O.)
   - A. Provide LCE4 post cap.
6. Header: 3-1 ¾" x 9 ¼" LVL
7. Floor beam: 2-1 ¾" x 16" LVL
   - A. Provide IUS3.56/16 hanger at suspended conditions
8. Floor Beam: 7" x 16" PSL
   - A. Provide HGU7.25-SDS hanger at suspended conditions
9. Floor Beam: 5 ¼" x 16" PSL
   - A. Provide MGU5.50-SDS hanger at suspended conditions
10. Floor Beam: 7" x 18" PSL
11. Floor Beam: W16x67
12. ST6224 strap centered about break in beam
13. Concrete Slab on Grade: 5" slab w/ #4 bars @ 16" o.c. each way.
    - A. For slab section and underlayment, see detail 23/S2.10
14. Flatwork by others
15. HDU2 holdown to face of wood post with SSTB anchor at footing per details 41/S2.10 and 42/S2.10
16. Site retaining wall shown for reference only - see Grading Permit Plans (GRAD2022-00106)

WETHINGTON ENGINEERING, INC.

[REDACTED PRIVATE INFORMATION]

FOR REVIEW ONLY

CLIENT:
MW ARCHITECTS
[REDACTED PRIVATE INFORMATION]

PROJECT:
[REDACTED PRIVATE INFORMATION]

[REDACTED PRIVATE INFORMATION]
SAN LUIS OBISPO, CA
[REDACTED PRIVATE INFORMATION]

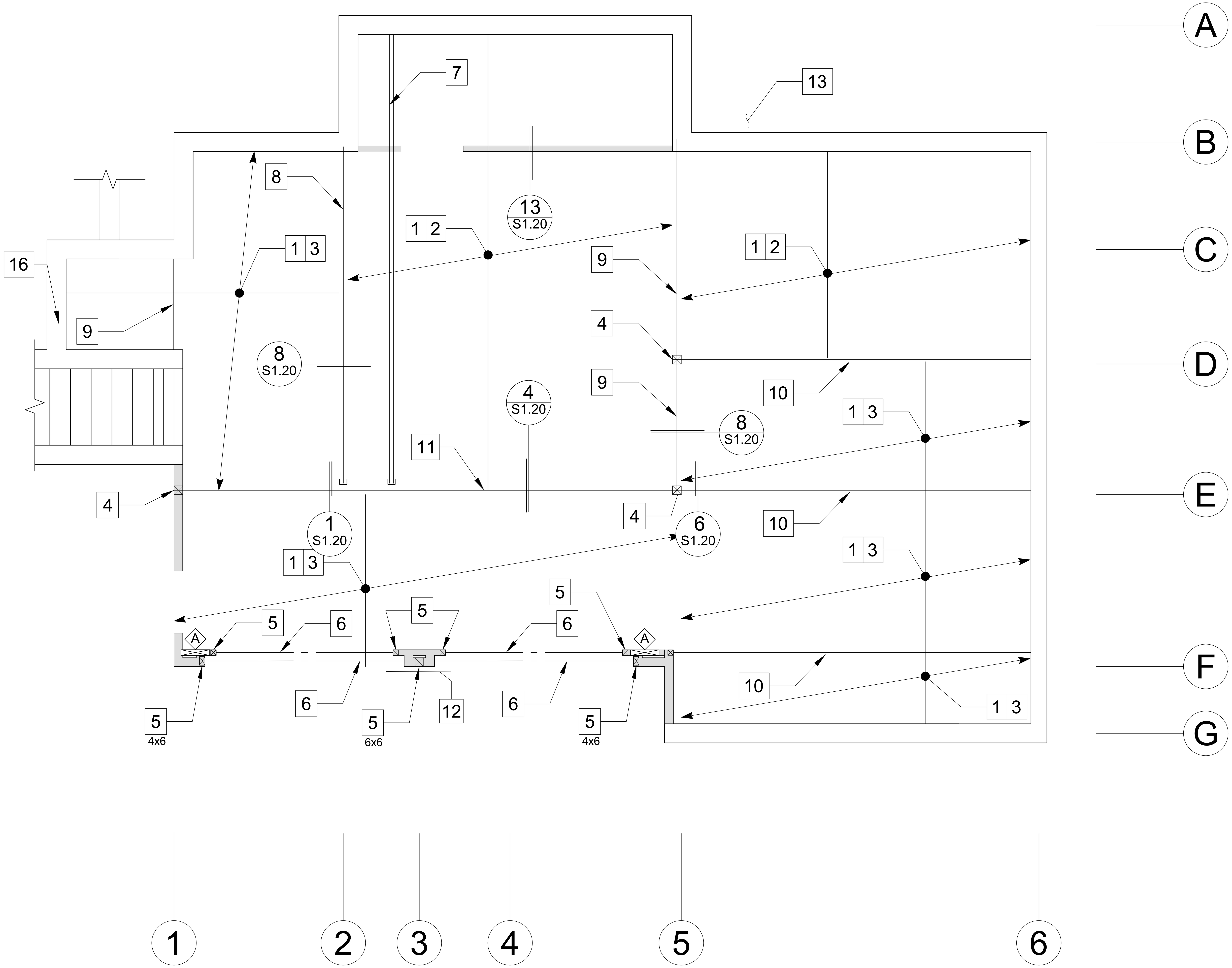
SHEET TITLE:
FLOOR FRAMING & UPPER FOUNDATION PLAN

REVISIONS

SHEET:
S1.20

DATE: December 20, 2022
JOB #: 2022-024
DRAWN: HW DESIGNED: HMW

Structural Plan Reflect Majority of Original Project Design



FLOOR FRAMING AND UPPER FOUNDATION PLAN

Scale: 1/4"=1'-0"

Floor Framing Reference Notes:

1. Typical Floor/Deck Sheathing: ¾" APA-Rated CDX T&G Plywood
   A. Panel Index 48/24
   B. Glue and Fasten with 10d @ 6:6:10" o.c.
2. Typical Floor Joist: 16" TJI 230 @ 16" o.c.
   A. Provide IUS2.37/16 hanger at suspended conditions
3. Typical Deck Joist: 1¾" x 9 ¼" LVL @ 16" o.c.
   A. Provide MIU1.81/9 hanger at suspended conditions.
   B. Joist to remain level - slope to drain provided at concrete topping
4. HSS5x5x⅜" steel column
5. Trimmer post - Double 2x wall width (Typical, U.N.O.)
   A. Provide LCE4 post cap.
6. Header: 3-1 ¾" x 9 ¼" LVL
7. Floor beam: 2-1 ¾" x 16" LVL
   A. Provide IUS3.56/16 hanger at suspended conditions
8. Floor Beam: 7" x 16" PSL
   A. Provide HGU7.25-SDS hanger at suspended conditions
9. Floor Beam: 5 ¼" x 16" PSL
   A. Provide MGU5.50-SDS hanger at suspended conditions
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13. Concrete Slab on Grade: 5" slab w/ #4 bars @ 16" o.c. each way.
   A. For slab section and underlayment, see detail 23/S2.10
14. Flatwork by others
15. HDU2 holdown to face of wood post with SSTB anchor at footing per details 41/S2.10 and 42/S2.10
16. Site retaining wall shown for reference only - see Grading Permit Plans (GRAD2022-00106)

WETHINGTON
ENGINEERING, INC.

[Redacted]

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CLIENT:
MW Architects
[Redacted]

PROJECT:
Structural Designs Evaluation
1 Grand Ave, San Luis Obispo, CA 93407, SAN LUIS OBISPO, CA

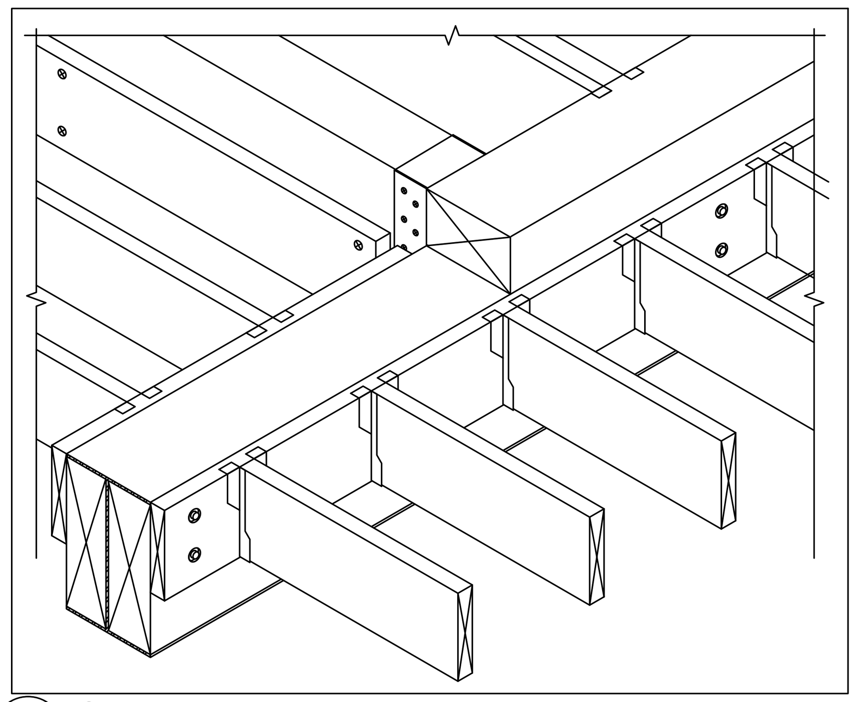
SHEET TITLE:
Conc. on Wood w/ Ply. Sheathing Floor Framing Plan

REVISIONS	

SHEET:
S1.10

DATE: Fall Q. 2023
JOB #: ARCE 453-01
DRAWN: CC DESIGNED: CC

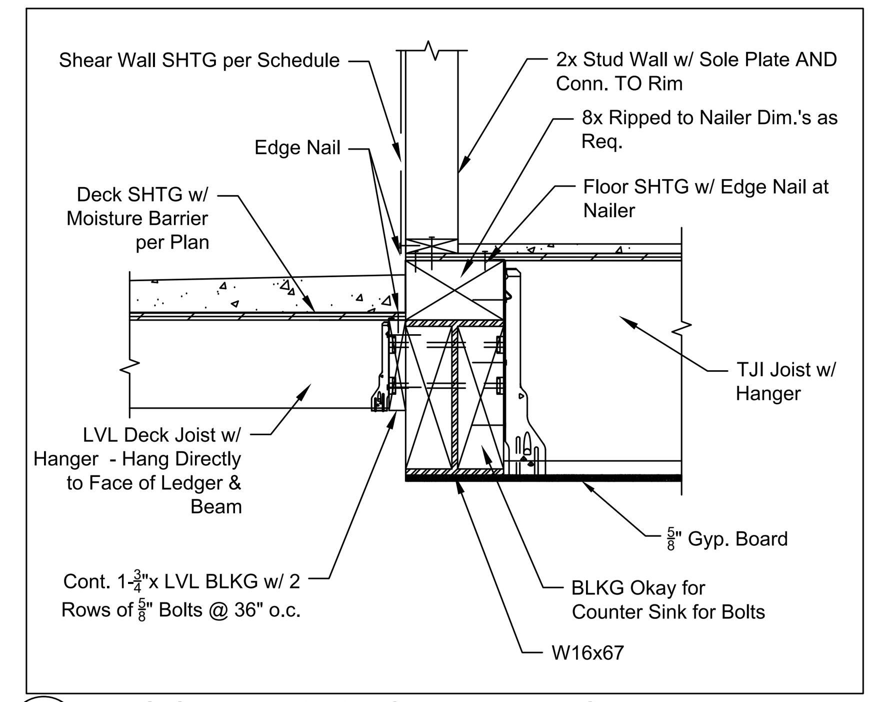
Structural Plans Reflect Original Project Design



1 Corner A - Isometric N.T.S.

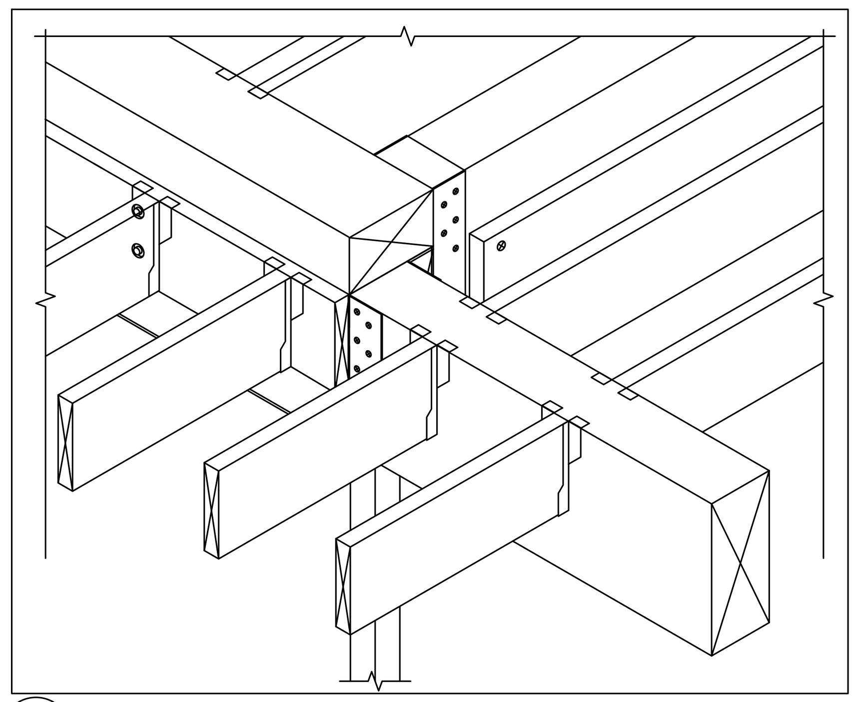
2 NOT USED N.T.S.

3 NOT USED N.T.S.



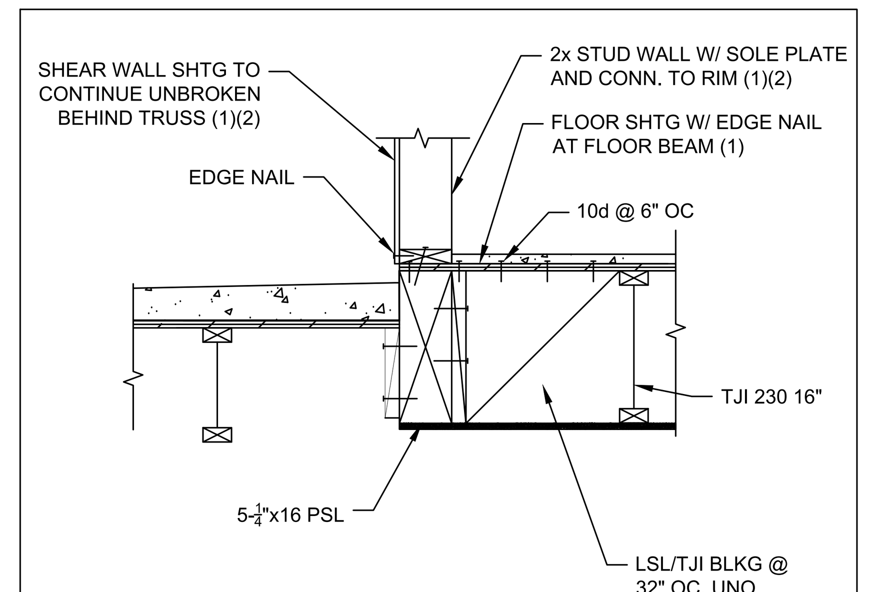
4 FLOOR AND DECK AT FLUSH BEAM N.T.S.

5 NOT USED N.T.S.



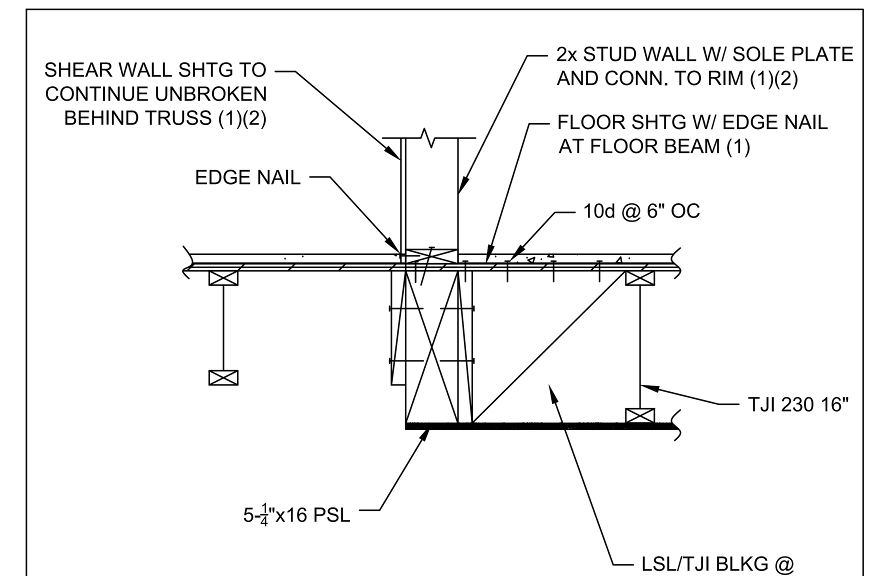
6 Corner B - Isometric N.T.S.

7 NOT USED N.T.S.



NOTES: (#)
1. SEE FOUNDATION FRAMING PLAN AND NOTES
2. SEE SHEAR WALL SCHEDULE

8 JOIST AT FLOOR BEAM - PARALLEL N.T.S.



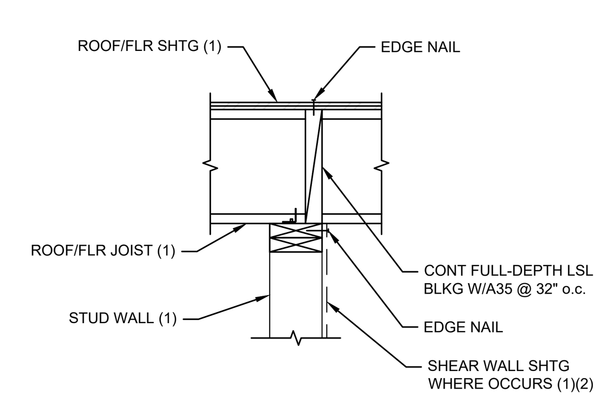
NOTES: (#)
1. SEE FOUNDATION FRAMING PLAN AND NOTES
2. SEE SHEAR WALL SCHEDULE

9 JOIST AT FLOOR BEAM - PARALLEL N.T.S.

10 NOT USED N.T.S.

11 NOT USED N.T.S.

12 NOT USED N.T.S.

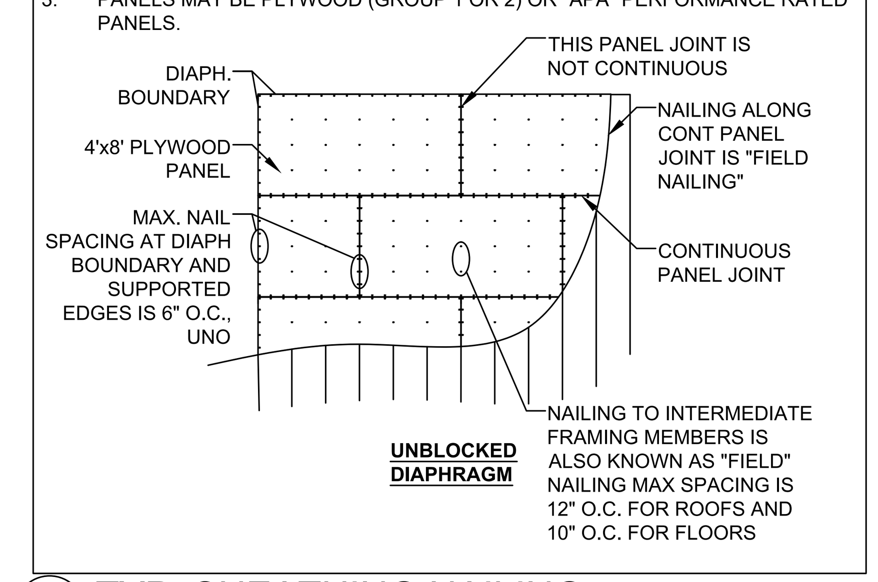


NOTES: (#)
1. SEE FRAMING PLAN AND NOTES
2. SEE SHEAR WALL SCHEDULE AND NOTES

13 JOIST BEARING ON INT WALL N.T.S.

14 NOT USED N.T.S.

NOTES
1. PANELS ARE TO BE APPLIED PERPENDICULAR TO SUPPORTS AND JOINTS ARE TO BE STAGGERED.
2. FIELD NAILING TO BE AT 12" O.C. FOR ROOFS AND 10" O.C. FOR FLOORS.
3. PANELS MAY BE PLYWOOD (GROUP 1 OR 2) OR "APA" PERFORMANCE RATED PANELS.

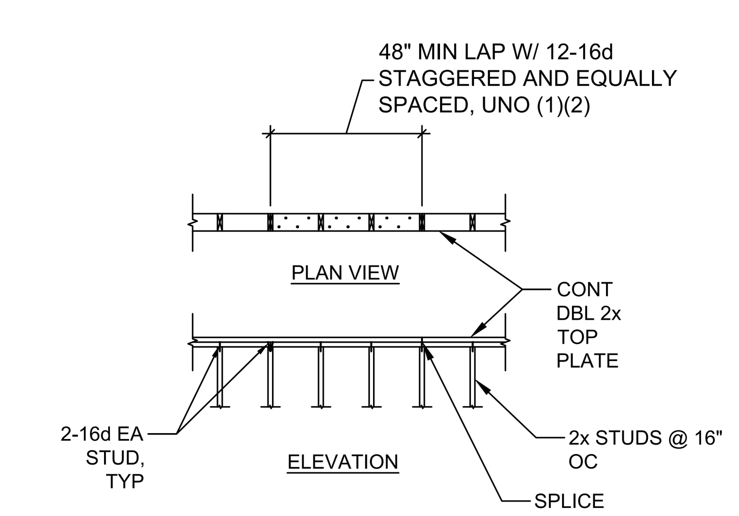


15 TYP. SHEATHING NAILING N.T.S.

16 NOT USED N.T.S.

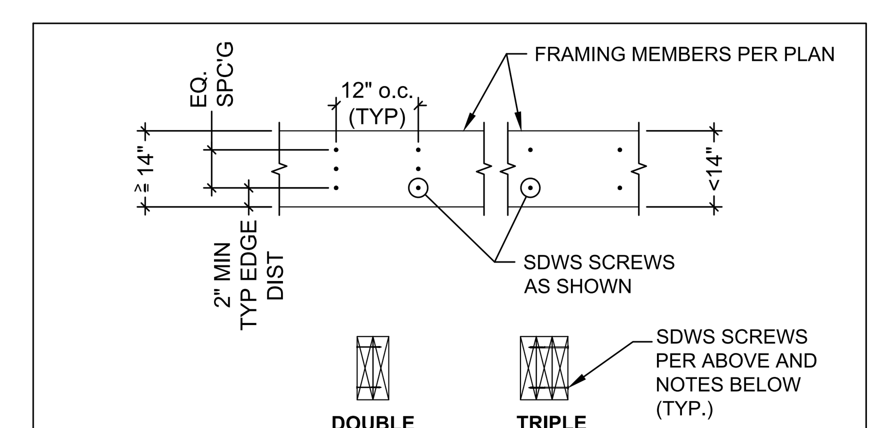
17 NOT USED N.T.S.

18 NOT USED N.T.S.



NOTES: (#)
1. SEE FRAMING PLAN AND NOTES
2. TYPICAL EACH SIDE OF SPLICE, AT UPPER AND LOWER PLATES

19 DBL TOP PLATE SPLICE N.T.S.



NOTES:
1. MIN. OF (2) ROWS OF SDWS SCREWS AT 12" o.c.
2. MIN. OF (3) ROWS OF SDWS SCREWS AT 12" o.c. FOR 14" OR DEEPER.
3. MIN. SCREW DIAMETER TO BE 0.22".
4. MIN. SCREW LENGTH TO BE: 3 ⅜" FOR 2-PLY MEMBERS; 4 ⅝" FOR 3-PLY MEMBERS
5. LOAD MUST BE APPLIED EVENLY ACROSS ENTIRE BEAM WIDTH. CONTACT ENGINEER OF RECORD IMMEDIATELY IF LOAD CAN NOT BE APPLIED EVENLY ACROSS BEAM.
6. INSTALL SDWS SCREWS PER IAPMO-UES ESR-192.

20 MULTI-LAM. BEAM - TOP LOADED N.T.S.

WETHINGTON ENGINEERING, INC.

[Redacted]

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CLIENT:
MW Architects
[Redacted]

PROJECT:
Structural Designs Evaluation
1 Grand Ave, San Luis Obispo, CA 93407, SAN LUIS OBISPO, CA

SHEET TITLE:
Conc. on Wood w/ Ply. Sheathing Floor Framing Section Details

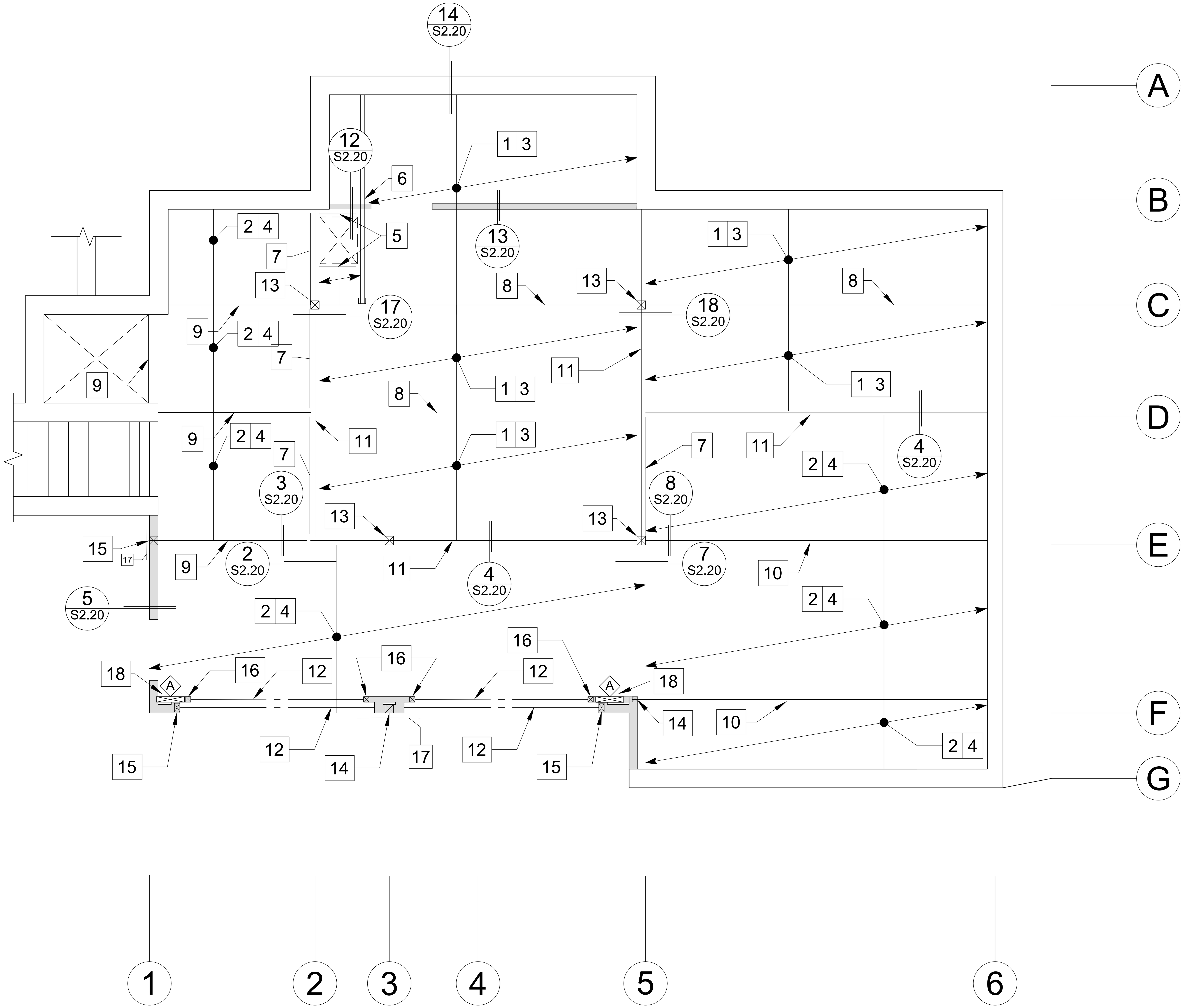
REVISIONS	
10/16	Post-Meeting Edits
11/14	Post-Meeting Edits
11/21	Post-Meeting Edits

SHEET:
S1.20

DATE: Fall Q. 2023			
JOB #:	ARCE 453-01		
DRAWN:	CC	DESIGNED:	CC

Framing Plan & Section Detail Sheets

Non-Structural Concrete on Wood w/ Shallow Vercor



Floor Framing Plan

Scale: 1/4"=1'-0"

Floor Framing Reference Notes:

1. Typical Floor/Deck Sheathing: 4.5" Normal Concrete Decking on Metal Decking
   A. Shallow Vercor - 22 Gage
   B. Fasteners with screws 12" o.c.
2. Typical Floor /Deck Sheathing: 3" Tapered Normal Concrete on Metal Decking
   A. Shallow Vercor - 26 Gage
   B. Fasteners with screws 12" o.c.
3. Typical Floor Joist: 14" TJI 230 @ 16" o.c.
   A. Provide IUS2.06/14 hanger at suspended conditions
   B. Equivalent ITS, BA, or HB hangers are acceptable
4. Typical Floor Joist: 9-1/2" TJI 230 @ 16" o.c.
   A. Provide IUS2.06/9.5 hanger at suspended conditions
   B. Equivalent ITS, BA, or HB hangers are acceptable
   C. For Face-Mount conditions, use HU2.1/9 hangers
5. 1-3/4"x14" Microllam LVL 2.0E-2600F_b
6. 2 - 1-3/4"x14" Microllam LVL 2.0E-2600F_b
7. 1-3/4"x5-1/2" Microllam LVL 2.0E-2600F_b
8. 5-1/2x14 24F-1.8E
9. 5-1/2x9-1/2 24F-1.8E
10. 5-1/2x16 24F-1.8E
11. 8-3/4x21 24F-1.8E
12. 3 - 1-3/4"x9-1/4" LVL
13. 8x8 DF-L No.1 Column
    A. Use ECCQ or CCQ94SDS2.5 Column Cap
14. 6x6 DF-L No.2 Column
    A. Use BC6 Post Cap
15. 4x6 DF-L No.2 Column
    A. Use LCE4 Post Cap
16. Trimmer Post - Double 2x wall width (Typical, U.N.O.)
    A. Provide LCE4 post cap.
17. ST6224 strap centered about break in beam
18. WSWH 18x9 Strong Wall

WETHINGTON ENGINEERING, INC.

[Redacted]

FOR REVIEW ONLY

CLIENT:

MW Architects
[Redacted]

PROJECT:

Structural Designs Evaluation
1 Grand Ave, San Luis Obispo, CA 93407, SAN LUIS OBISPO, CA

SHEET TITLE:

Conc. on Wood w/ Shallow Vercor Floor Framing Plan

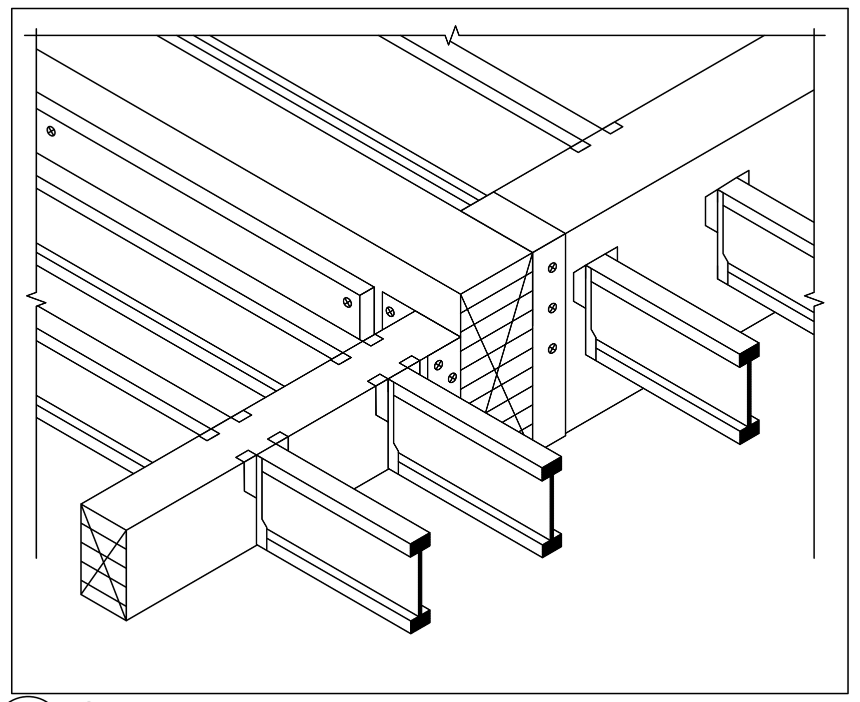
REVISIONS

10/16	Post-Meeting Edits
11/14	Post-Meeting Edits
11/21	Post-Meeting Edits

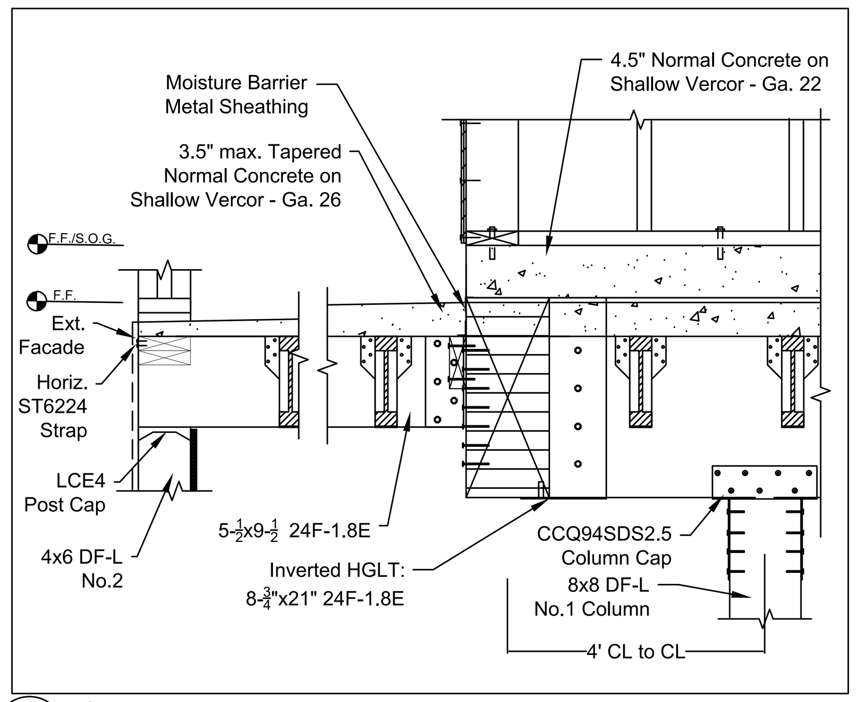
SHEET:

S2.10

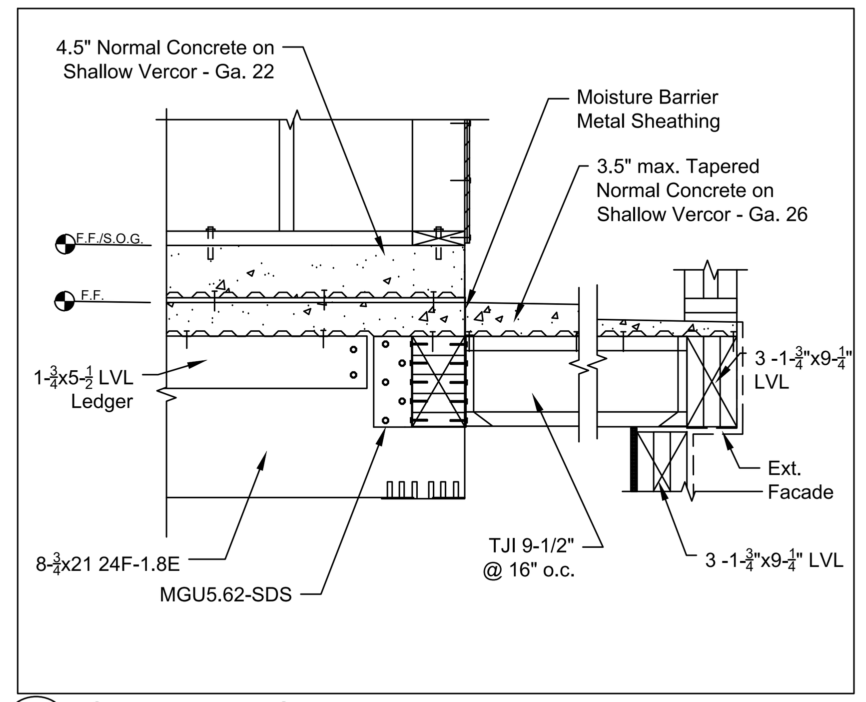
DATE: Fall Q. 2023			
JOB #:	ARCE 453-01		
DRAWN:	CC	DESIGNED:	CC



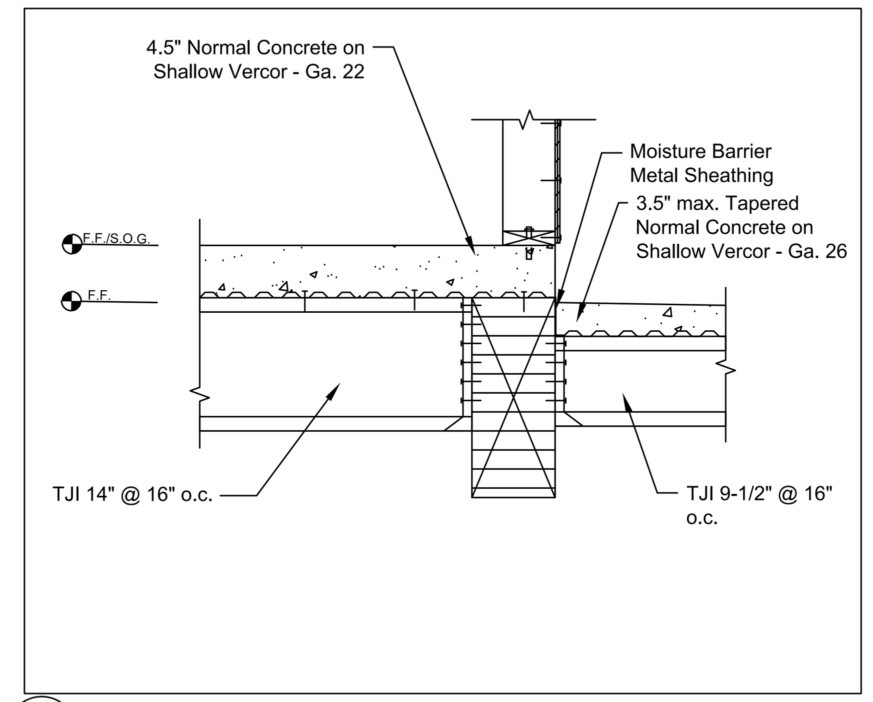
1 Corner A - Isometric N.T.S.



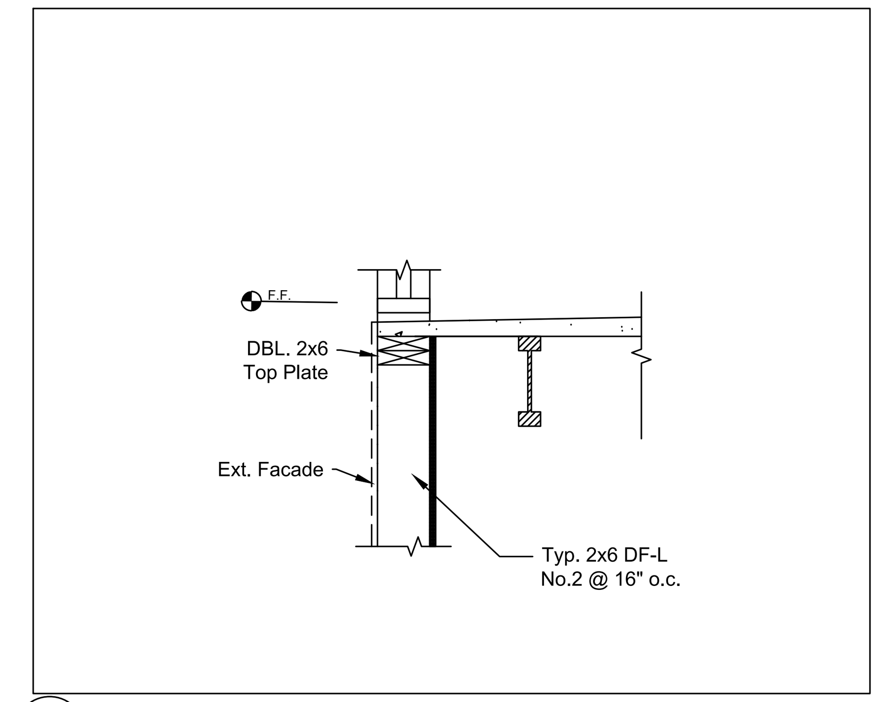
2 Corner A - Front View N.T.S.



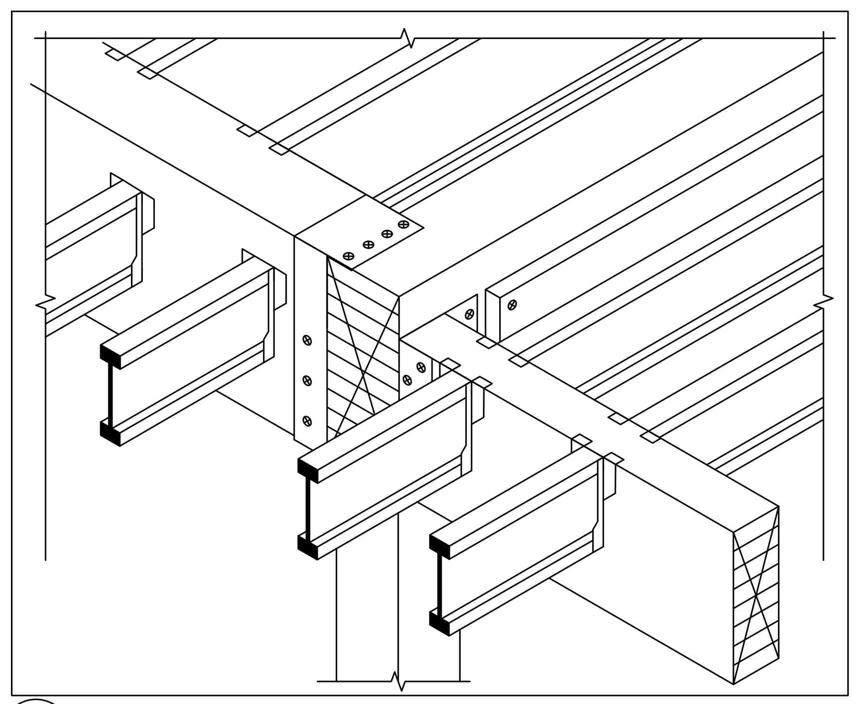
3 Corner A - Side View N.T.S.



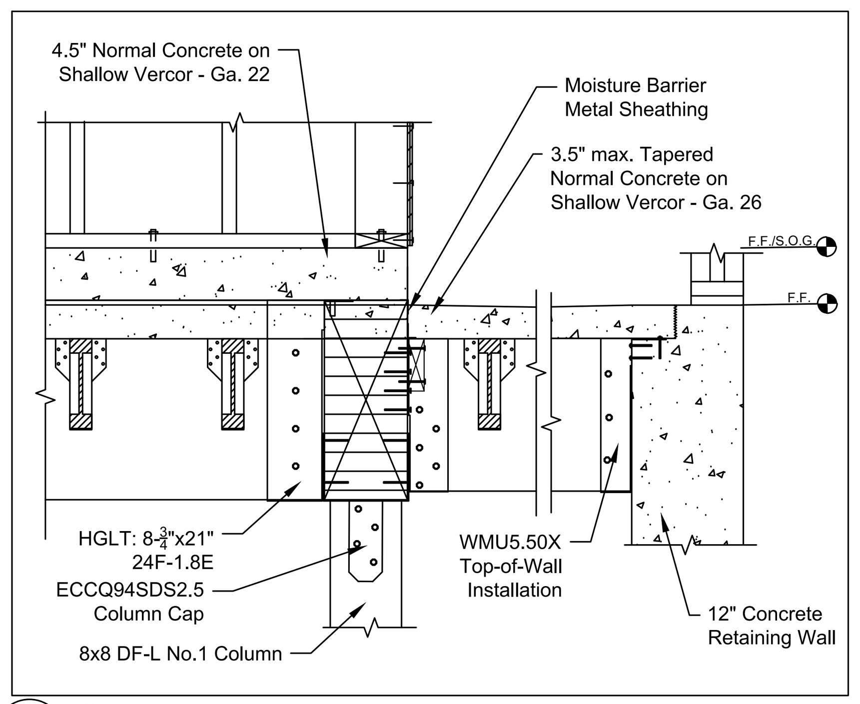
4 Typ. Ext. Wall on Beam N.T.S.



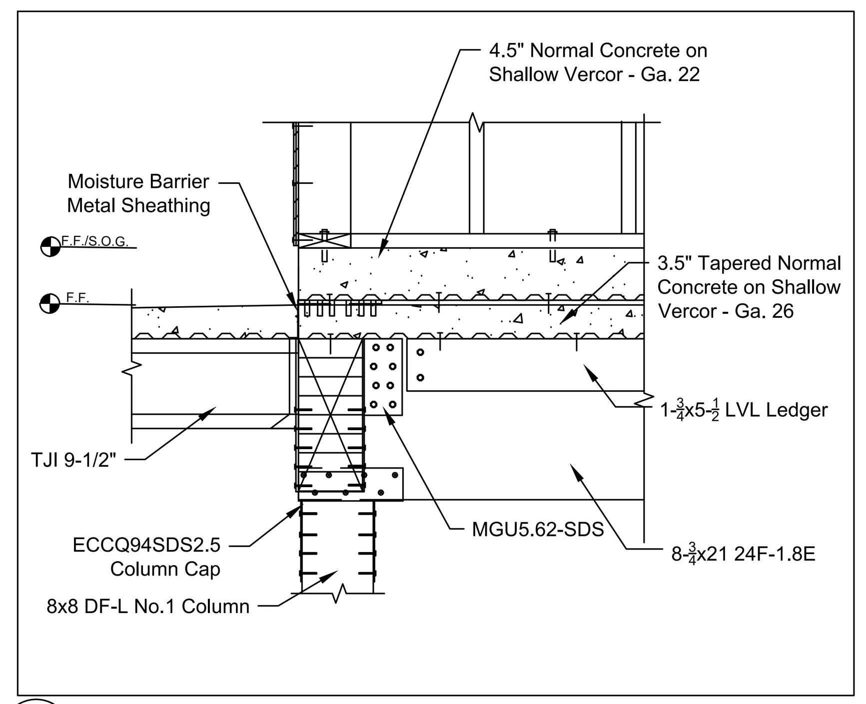
5 Ext. Patio Bearing on Ext. Wall N.T.S.



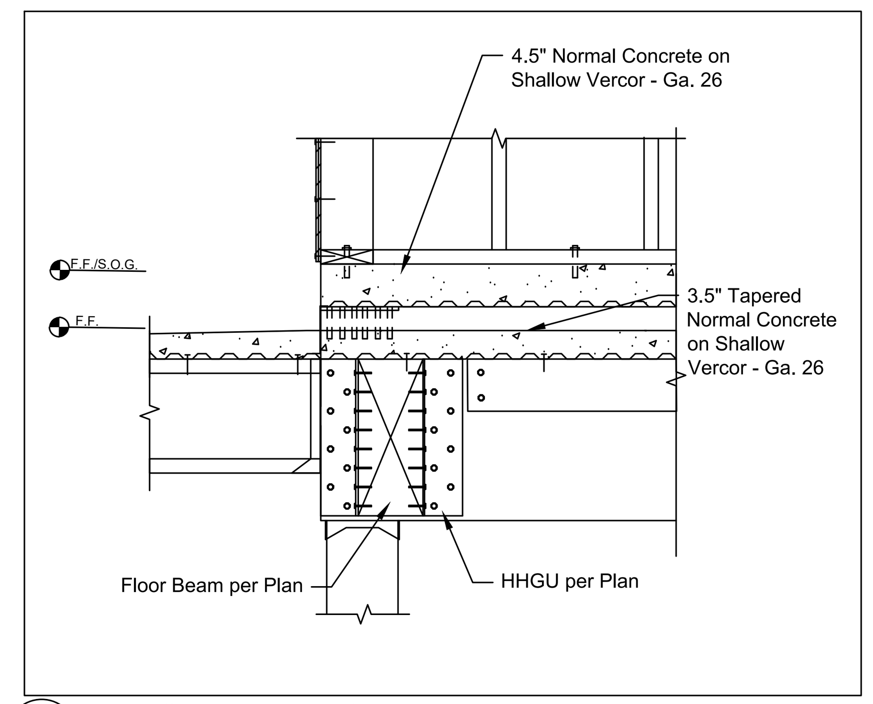
6 Corner B - Isometric N.T.S.



7 Corner B - Front View N.T.S.



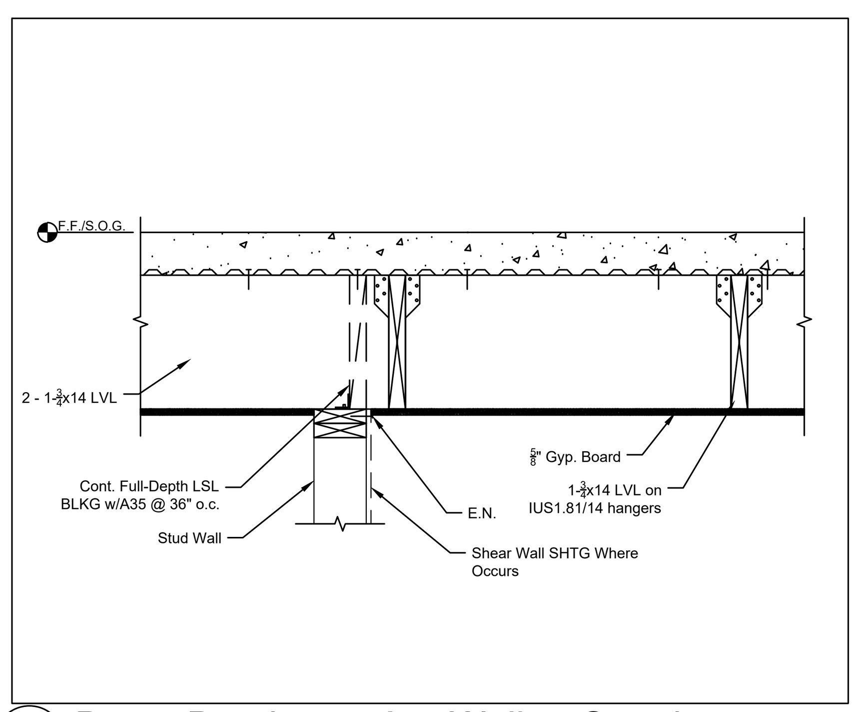
8 Corner B - Side View N.T.S.



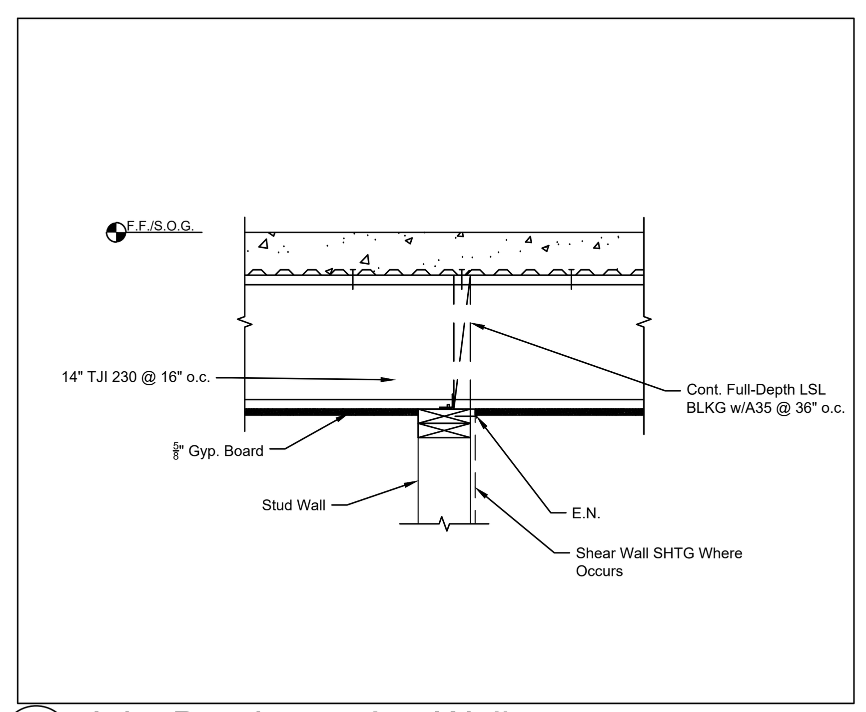
9 Alt. Corner B - Side View N.T.S.

10 NOT USED N.T.S.

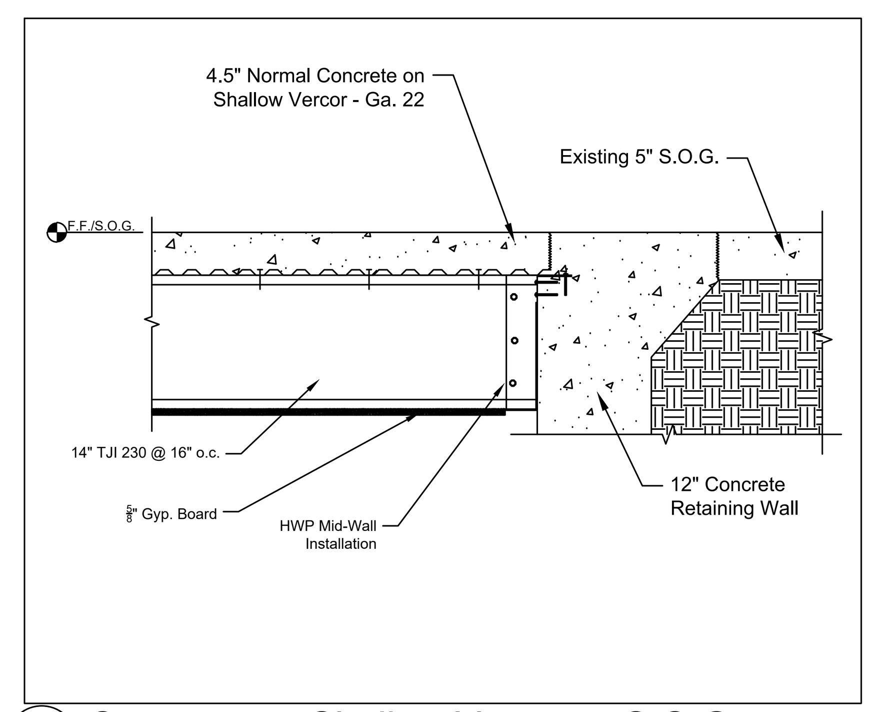
11 NOT USED N.T.S.



12 Beam Bearing on Int. Wall at Opening N.T.S.



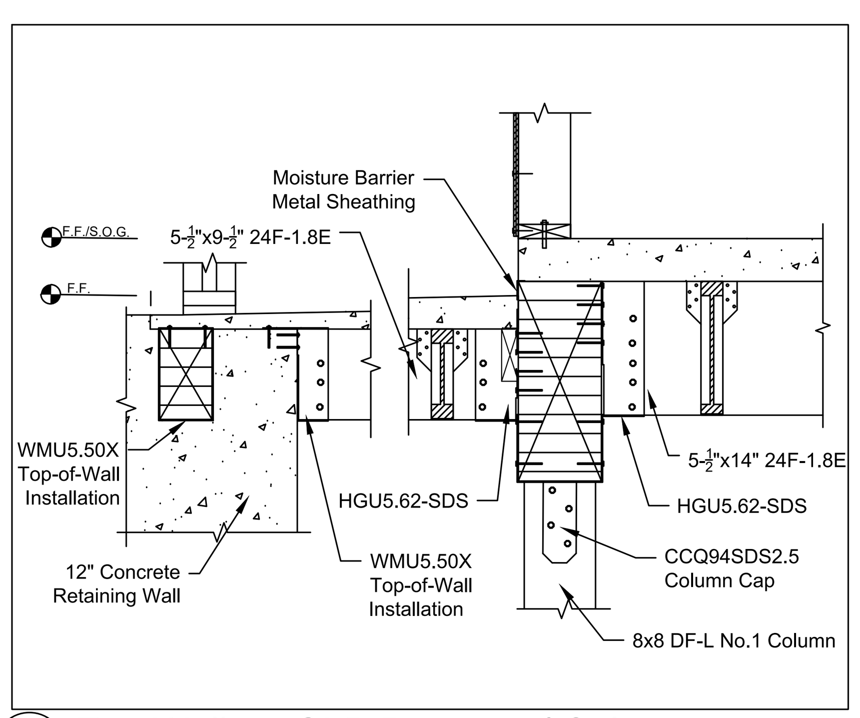
13 Joist Bearing on Int. Wall N.T.S.



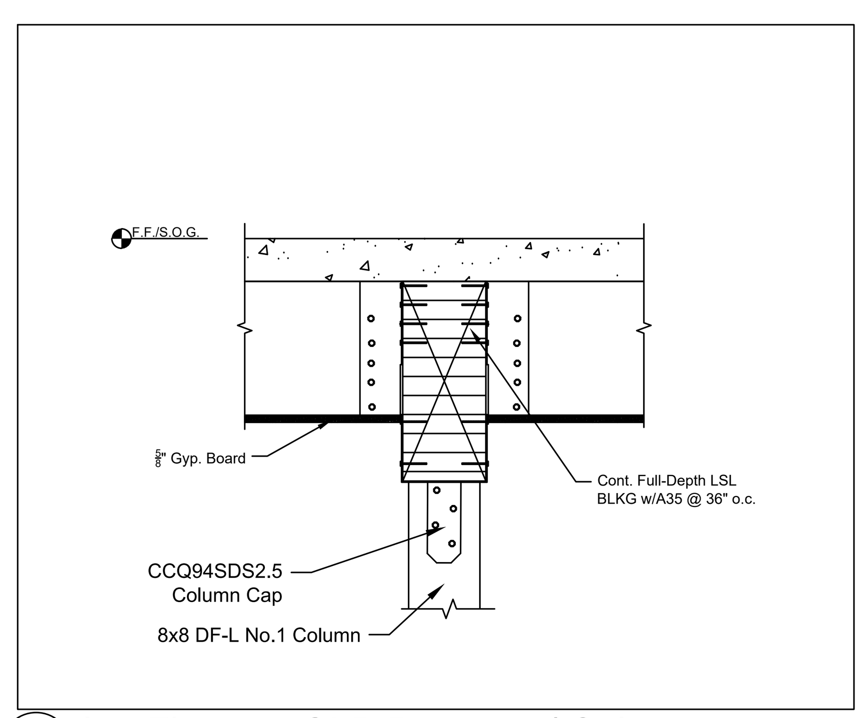
14 Concrete on Shallow Vercor to S.O.G. N.T.S.

15 NOT USED N.T.S.

16 NOT USED N.T.S.

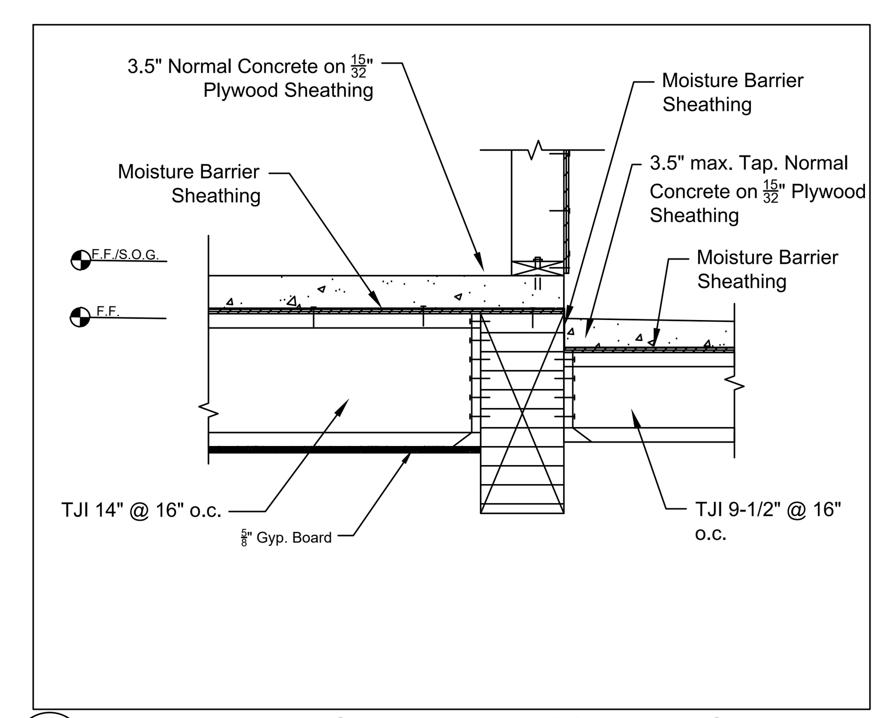


17 Ext. Wall on GLB Beams w/ Column N.T.S.



16 Int. Floor on GLB Beams w/ Column N.T.S.

19 NOT USED N.T.S.



20 ALternative - Concrete on Plywood Sheathing N.T.S.

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PROJECT:

Structural Designs Evaluation
1 Grand Ave, San Luis Obispo, CA 93407, SAN LUIS OBISPO, CA

SHEET TITLE:

Conc. on Wood w/ Shallow Vercor Floor Framing Details

REVISIONS

10/16	Post-Meeting Edits
11/14	Post-Meeting Edits
11/21	Post-Meeting Edits

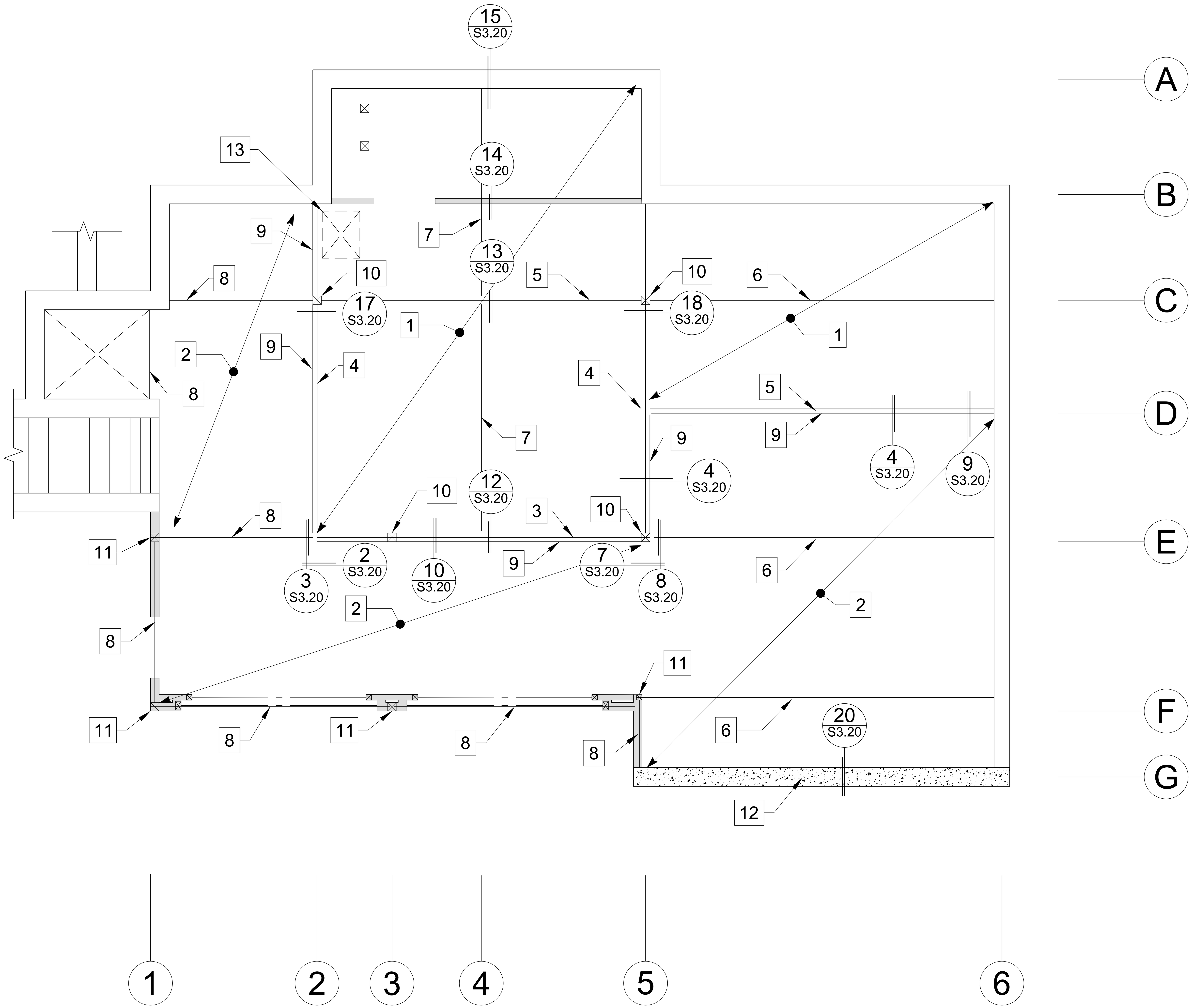
SHEET:

S2.20

DATE: Fall Q. 2023			
JOB #:	ARCE 453-01		
DRAWN:	CC	DESIGNED:	CC

Framing Plan & Section Detail Sheets

Structural Concrete on Steel w/ Verco



Floor Framing Plan

Scale: 1/4"=1'-0"

Floor Framing Reference Notes:

1. Typical Floor/Deck Sheathing:
   5" Normal Concrete on Metal Decking
   A. Verco PLW or B Formlok - Gage 16
2. Typical Floor/Deck Sheathing:
   5.5" max. to 3.5" min. Tapered Normal Concrete on Metal Decking
   A. Verco PLB or B Formlok - Gage 16
   B. Typ. 1.7-2.0% or $\frac{1}{4}$ "/ft min slope
3. W18x35
4. W16x26
5. W14x22
6. W10x19
7. W10x12
8. W8x10
9. L2x2x3/8
10. HSS 3x3x$\frac{1}{4}$ Column
11. HSS 2x2x$\frac{1}{4}$ Column
12. Special-Case Concrete Shear Wall
    A. Horiz.: #4 at 48" o.c.
    B. Vert.: #4 at 48" o.c.
13. Address opening in deck as per pg. 30-31 of VF5_Catalog_080818-1

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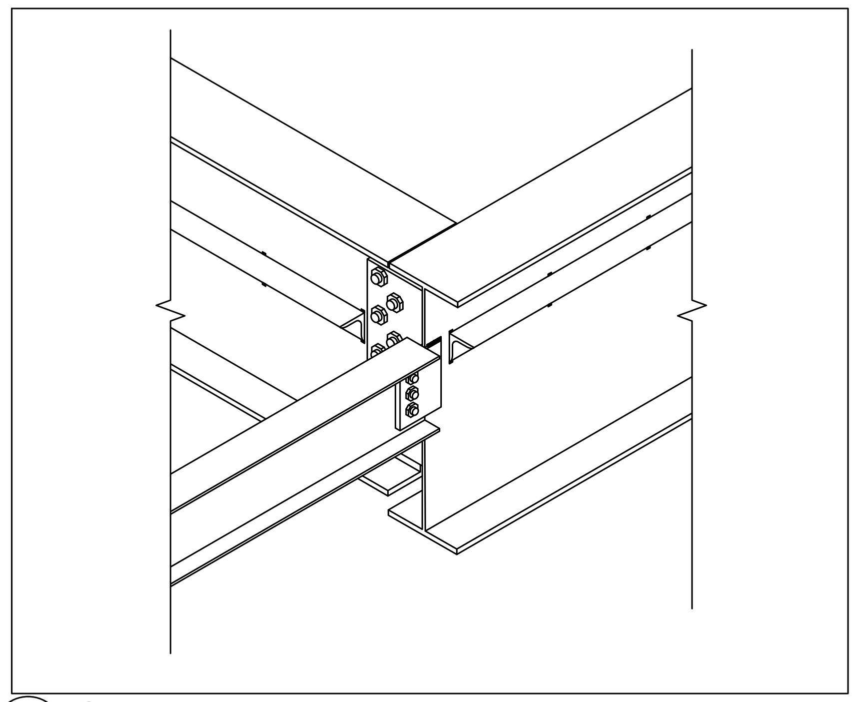
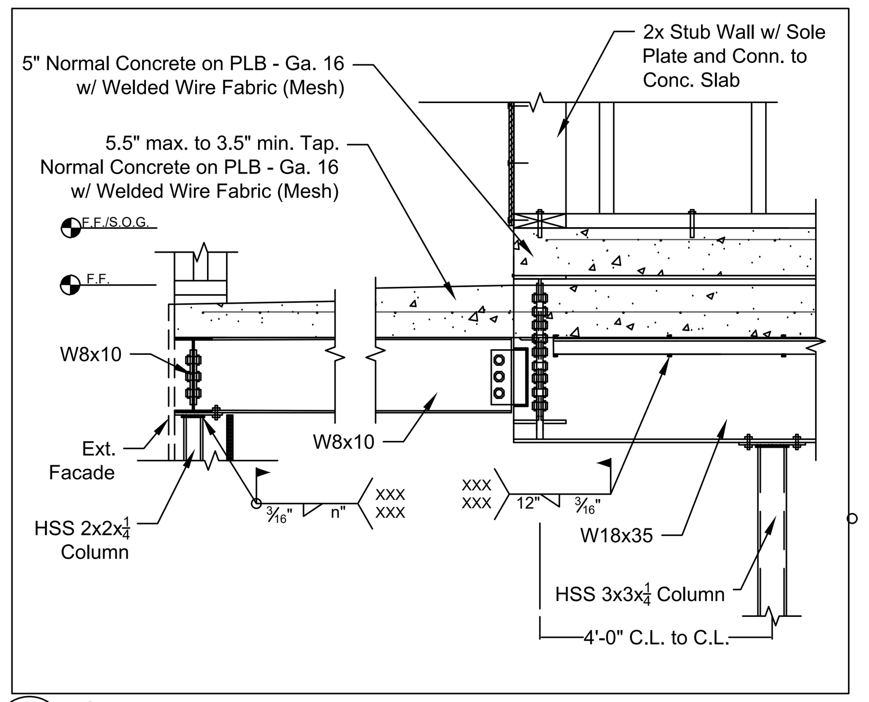
SHEET:
S3.10

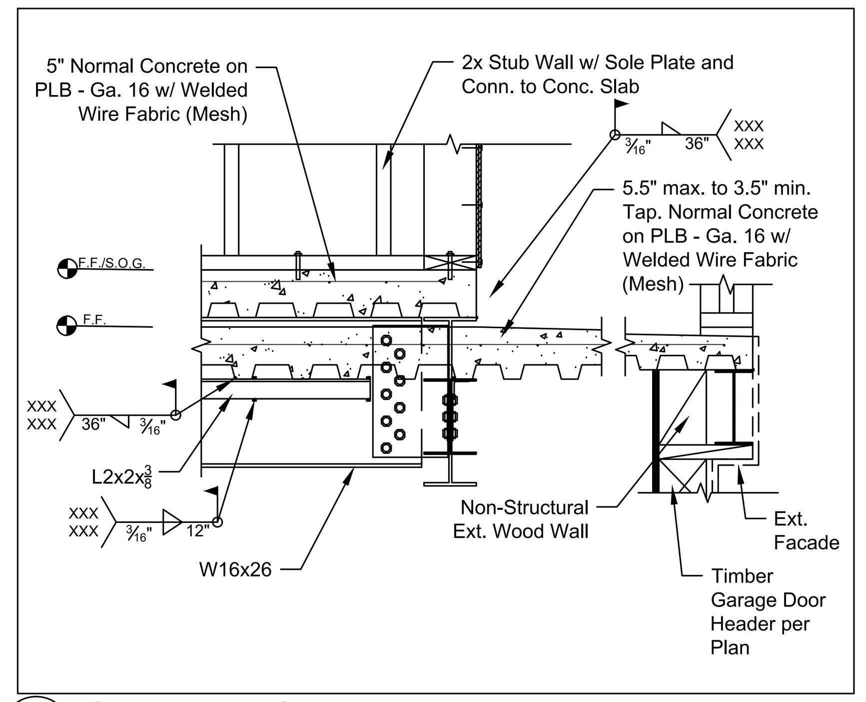
DATE: Fall Q. 2023
JOB #: ARCE 453-01
DRAWN: CC DESIGNED: CC



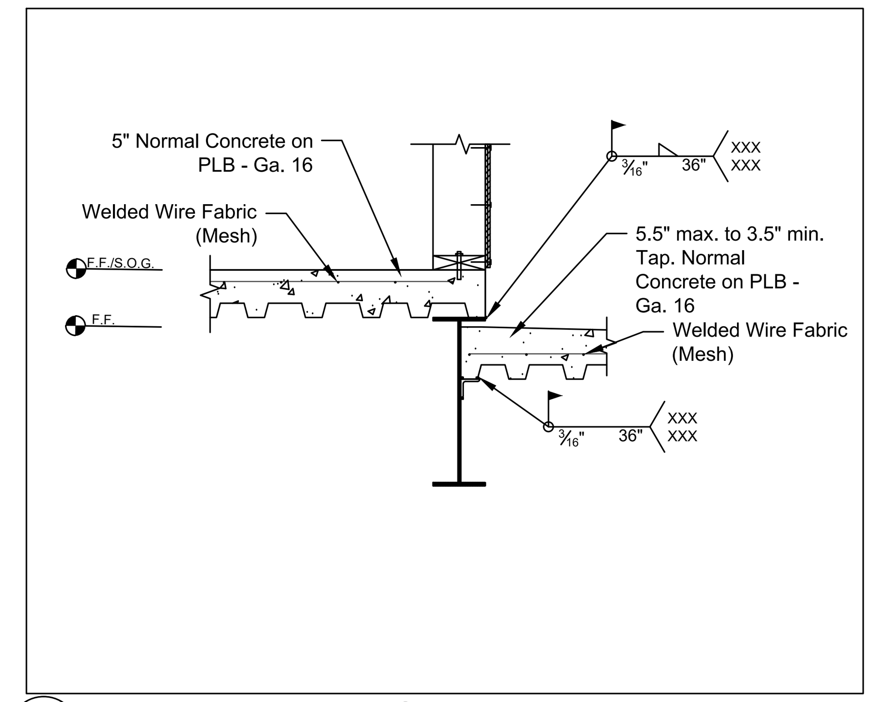
1 Corner A - Isometric — N.T.S.



2 Corner A - Front View — N.T.S.

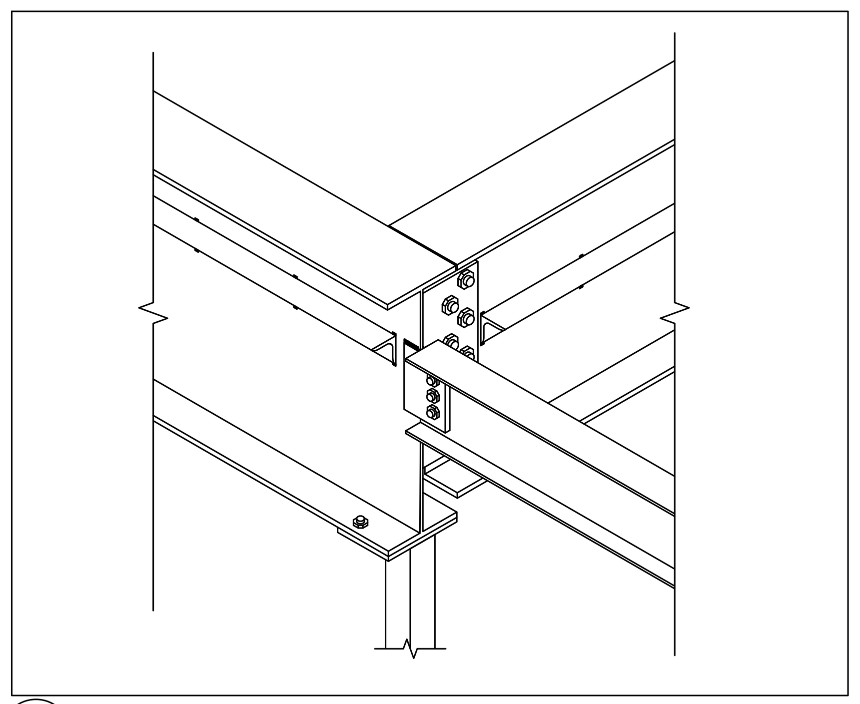


3 Corner A - Side View — N.T.S.

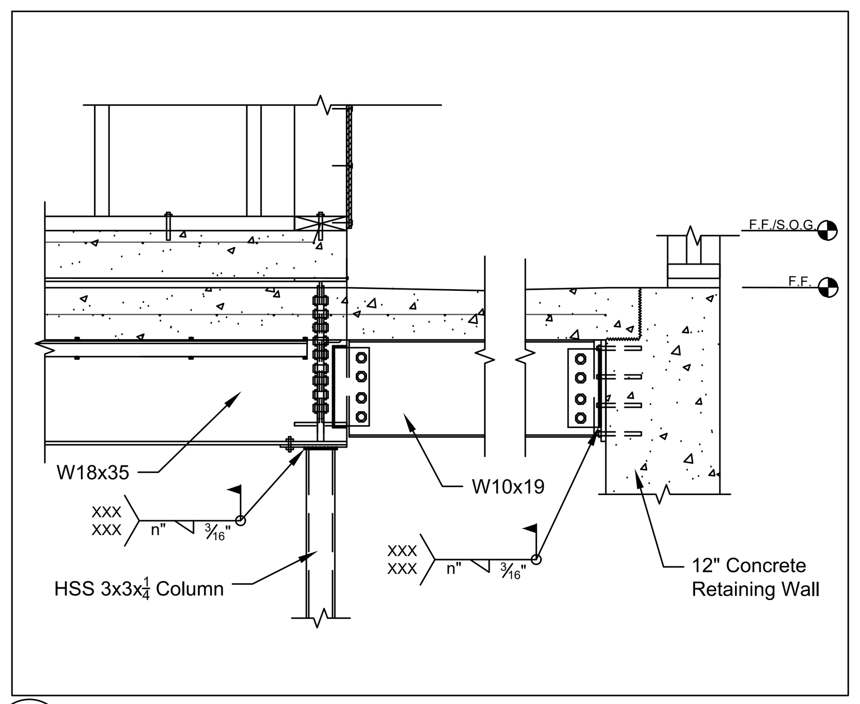


4 Typ. Ext. Wall on Steel Beam — N.T.S.

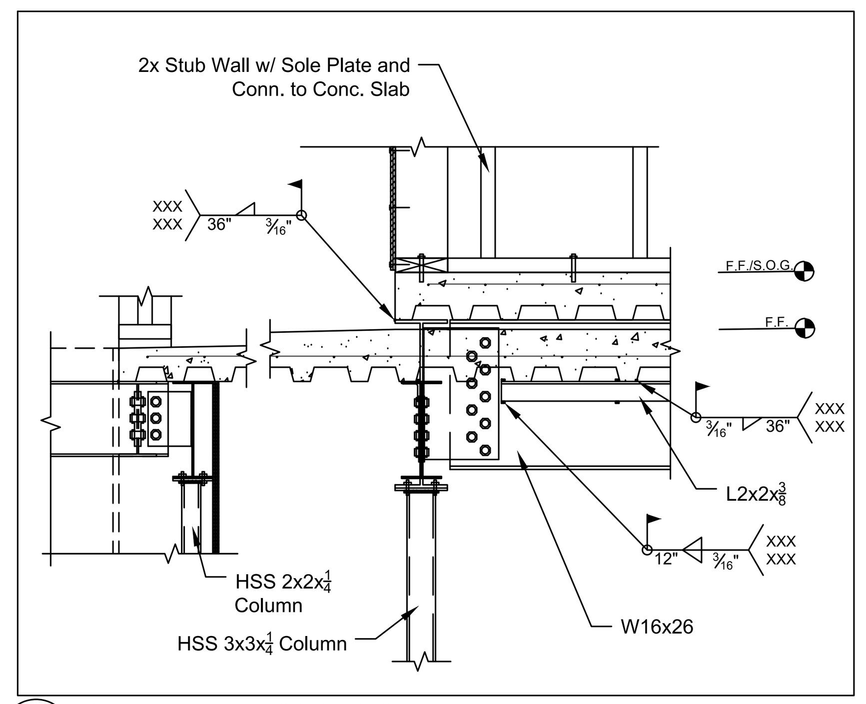
5 NOT USED — N.T.S.



6 Corner B - Isometric — N.T.S.

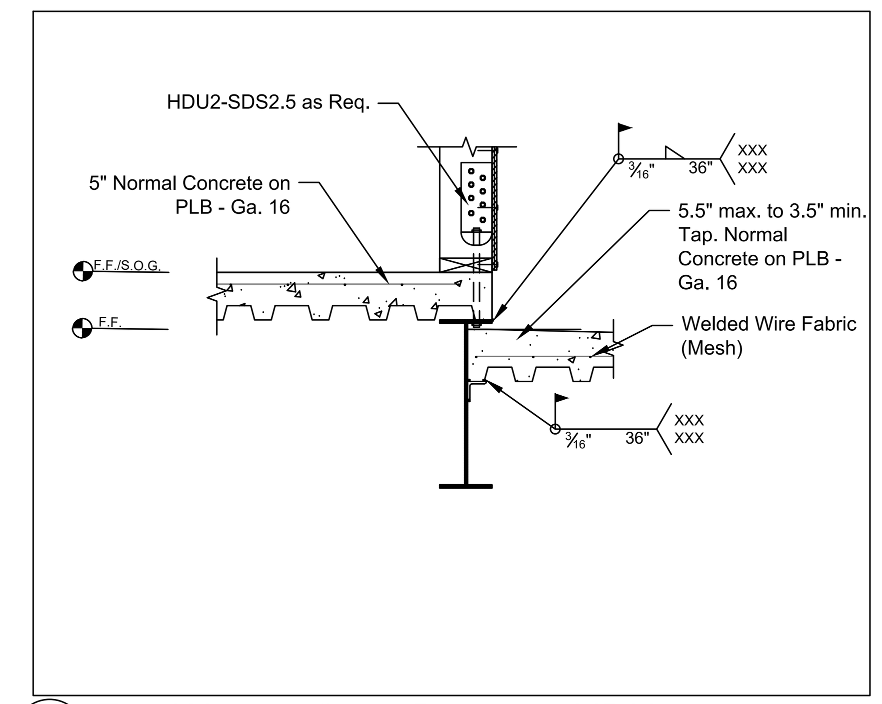


7 Corner B - Front View — N.T.S.



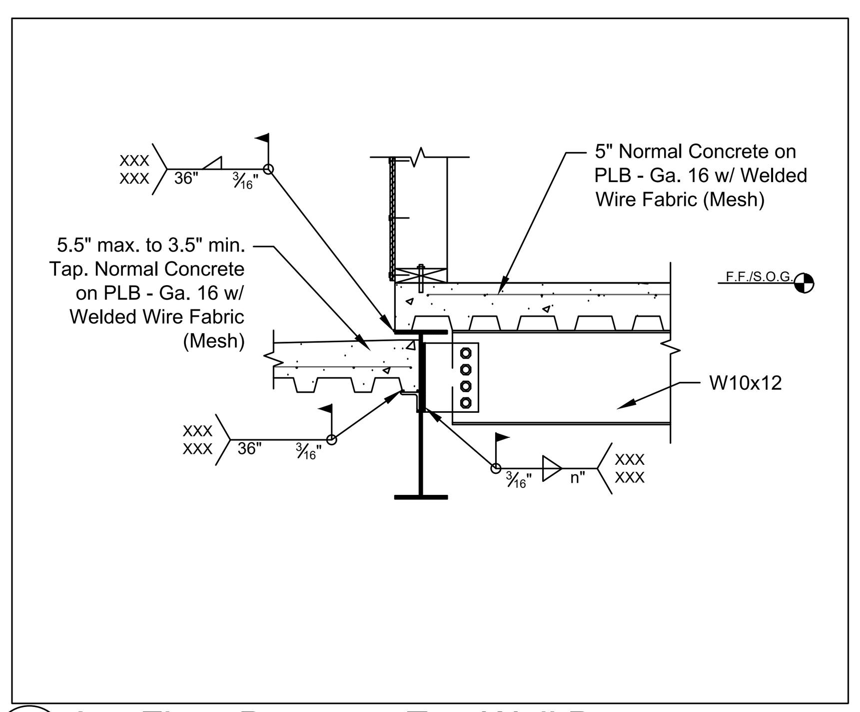
8 Corner B - Side View — N.T.S.

9 NOT USED — N.T.S.

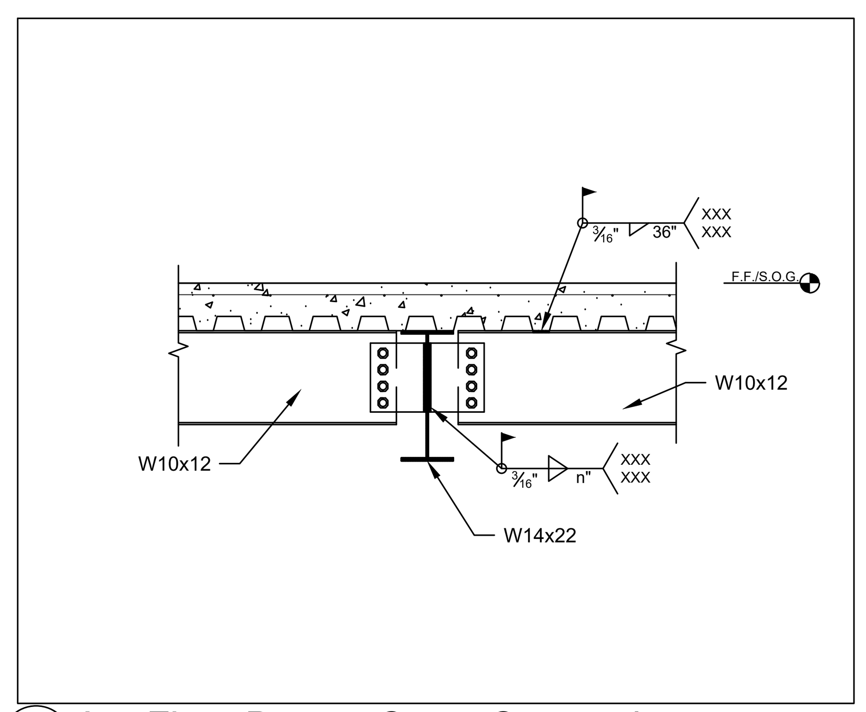


10 Ext. Wall on Steel Beam w/ HDU — N.T.S.

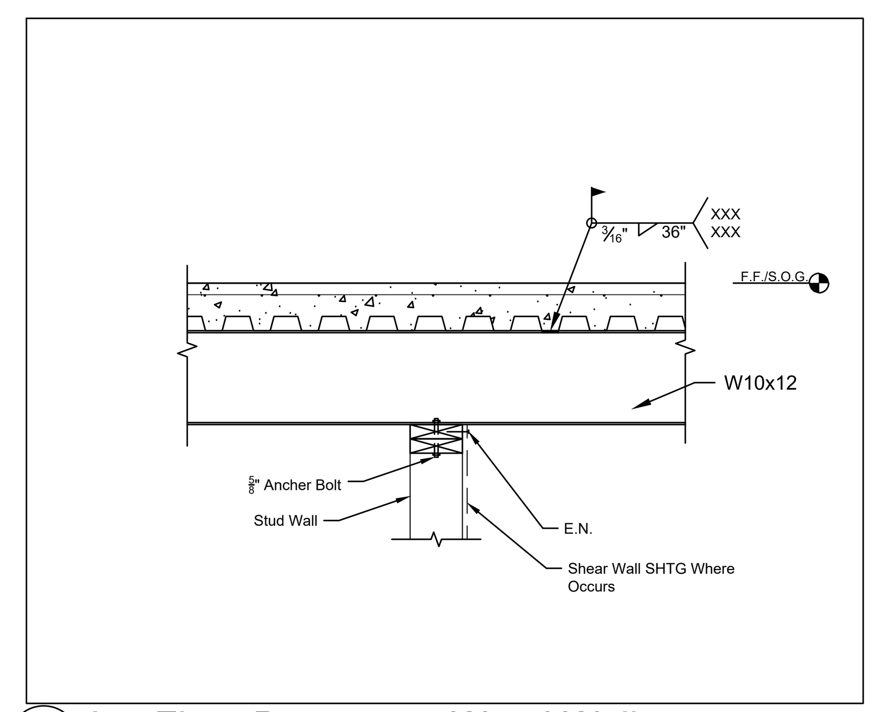
11 NOT USED — N.T.S.



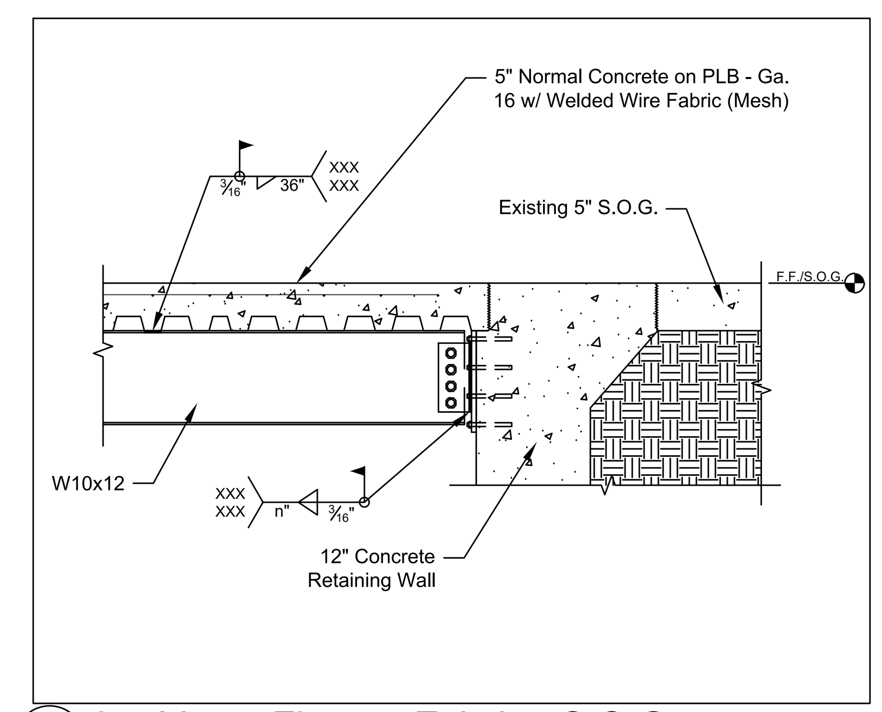
12 Int. Floor Beam on Ext. Wall Beam — N.T.S.



13 Int. Floor Beams Cross Connection — N.T.S.

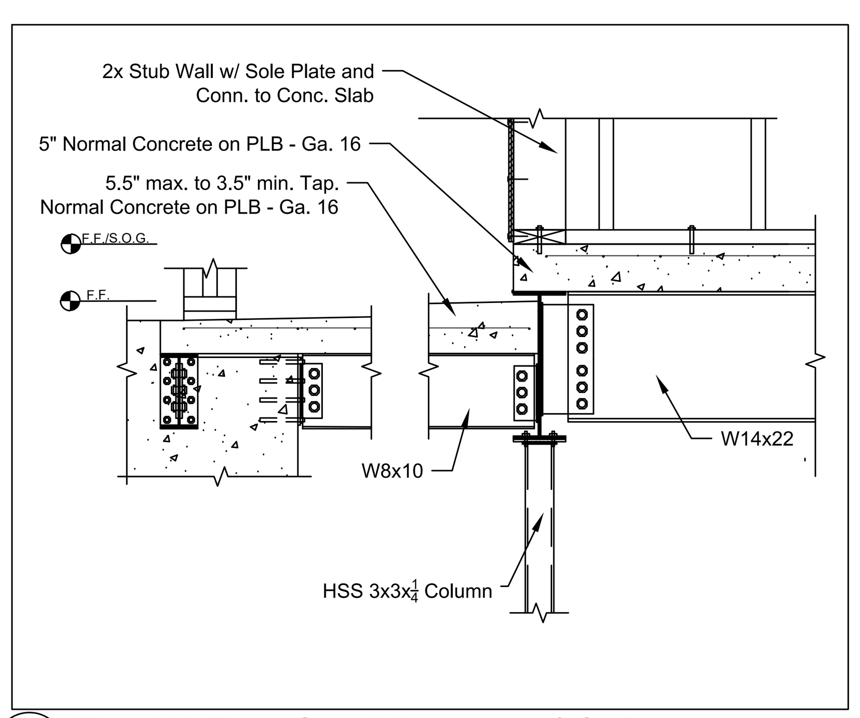


14 Int. Floor Beam over Wood Wall — N.T.S.

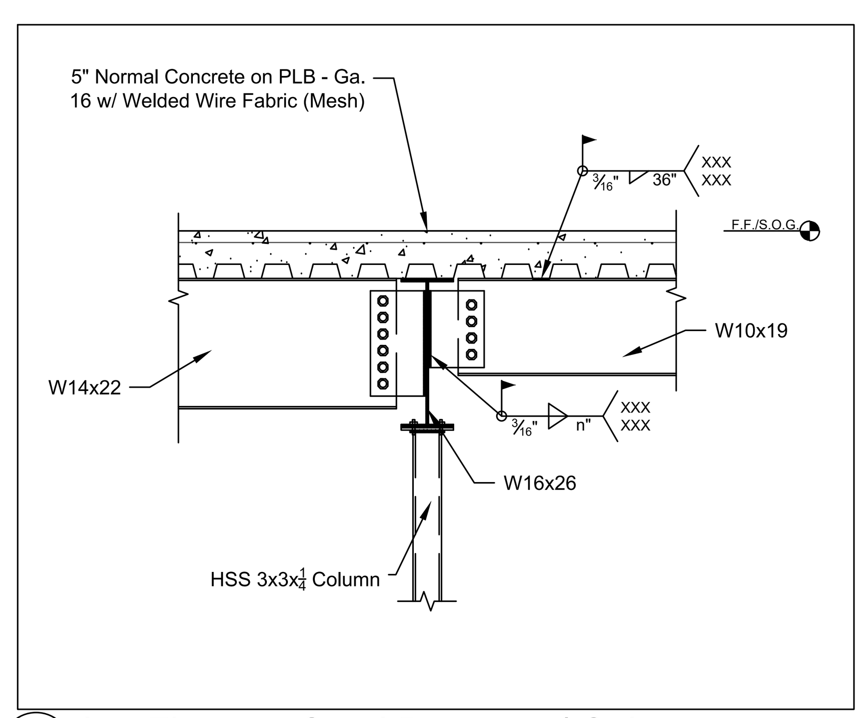


15 Int. Verco Floor to Existing S.O.G. — N.T.S.

16 NOT USED — N.T.S.

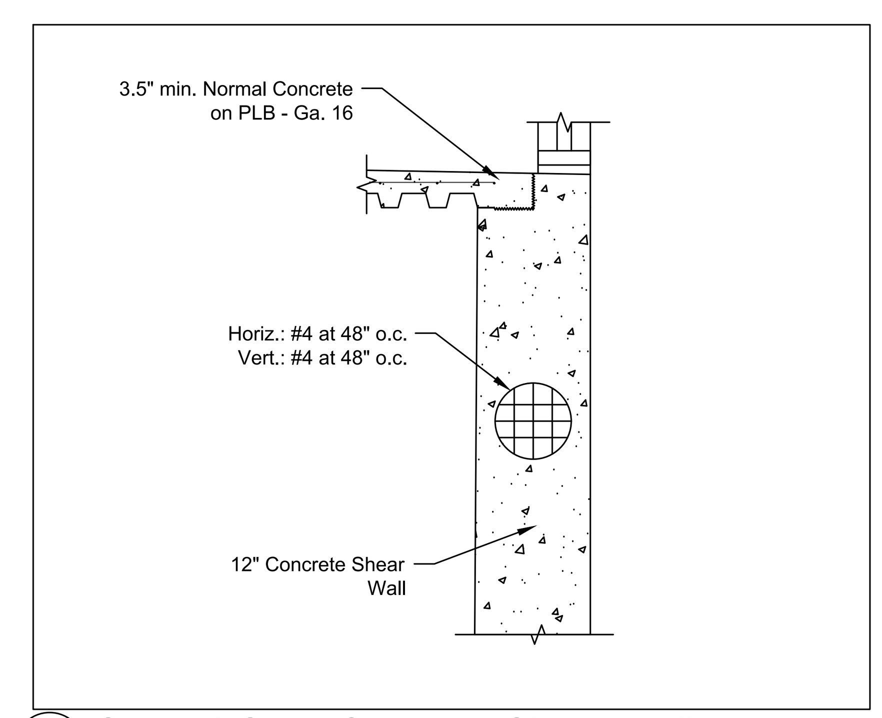


17 Ext. Wall on Steel Beams w/ Column — N.T.S.



18 Int. Floor on Steel Beams w/ Column — N.T.S.

19 NOT USED — N.T.S.



20 Special-Case Concrete Shear Wall — N.T.S.

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