Evaluating Prescriptive Design Requirements through the Lens of Low-Income Housing in Huntington, West Virginia

BY

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Contents

Abstract

Journeyman International is a non-profit organization that pairs graduating seniors in the fields of architecture, architectural engineering, and construction management with professional mentors to provide practical services for humanitarian projects that seek their aid. The particular project of interest is economical housing for Habitat for Humanity in Huntington (West Virginia). The project aims to provide structural calculations and drawings for three different building layouts which the client would be able to submit as construction documents to the local authority having jurisdiction. This report includes the background of the project, the organizations involved, challenges faced by the sole architectural engineering student involved, structural design and calculations for the project.

Introduction

Habitat for Humanity (HFH) is a nonprofit organization that works all across the United States to build affordable housing in communities of need. They build houses with the sweat equity of volunteers, staff, and the recipients of these homes. The beneficiary of those efforts are allowed to purchase the home with a subsidized mortgage loan provided by HFH; eligibility criteria includes current housing insecurity or inadequacy, steady income, good credit, and sweat equity. For years, HFH of Huntington, West Virginia has been able to apply for building permits without traditional construction documents based on the good will of the local building department. Partnering with Journeyman International, this project aims to provide HFH a full set of construction documents that HFH could submit to their building department. Anything not covered by the scope of this project would fall in the hands of a design professional registered in that jurisdiction.

Journeyman International (JI) is another nonprofit design-build organization founded by fellow Cal Poly San Luis Obispo alum Daniel Wiens. Their mission statement is to foster the next generation of humanitarian designers. By partnering graduating seniors with licensed mentors, the students get training and exposure to humanitarian work in the field of their passion. Even if the thesis project doesn't get built or used in its entirety, the hope is that the student designer will continue to do humanitarian design work.

Project

The client furnished existing architectural and electrical plans (on 8.5x11) that they have been using to submit as construction documents to the local building department. The HFH chapter that reached out to JI is specifically for Huntington, West Virginia. For other jurisdictions, this would not be sufficient as construction documents. Luckily for HFH, the local (Huntington, WV) building department has an unspoken agreement to look the other way for the sake of fighting poverty. The past workmanship of the homes constructed by HFH have demonstrated proper construction methods and adequate designs.

Since the building that is to be designed has been constructed many times before with slight variations between them, there were very few design choices that need to be made. The primary intent was to create adequate structural drawings and calculations to go with them, so that they would be able to submit the more professional set of construction documents to the building department. In addition to that, the new set of construction documents will be used as fundraising material; a full construction set that is drafted using modern computer-aided design (CAD) looks much more convincing than a xerox of penciled plans drawn on standard printer paper.

Deliverables

Because the different floor plan layouts generally share the same structural design criteria, the calculations were based off of the largest of the floor plans (resulting in the greatest base shear to design for). The largest floor plan is a 24’x60’ detached single-family dwelling with 5 bedrooms and 2 bathrooms. The building also includes a front porch that extends roughly 5 feet beyond the front of the house. Both the main structure and the front porch will likely be raised due to local conditions/preferences in Huntington, WV.

For personal exploration and enrichment, additional design methodologies were investigated for the design of this project. Based on the official building code adopted by the city of Huntington, WV (International Building Code, 2015, IBC), typical residential construction falls within the scope of the International Residential Code (IRC). The IRC and the IBC both allow a design method that is not mentioned in our curriculum: prescriptive design. As long as the building falls within the design limitations outlined by each prescriptive design method (IBC/IRC/Wood Frame Construction Manual), the amount of analysis required to produce a code-compliant structure is reduced. Most of the design proposed by the existing architectural drawings fell within the scope of both prescriptive methods. The parts of the current design that fell outside the scope are the porch at the front of the house and the raised floor (more precisely the girders); these must be designed by the accepted engineered method.

The analyses are separated into two modules: traditional engineered design and prescriptive design based on the Wood Frame Construction Manual (WFCM) published by the American Wood Council. The prescriptions given by the WFCM are explicitly permitted in the 2015 IBC in §2301.2 and in the 2015 IRC in §R301.1. While collating the results of the different analyses, it became evident that the limitations that permit for prescriptive design were very carefully shaped. The buildings that are permitted to be designed prescriptively must be similar enough that the prescriptions are sufficient for all the variations that may still occur within those bounds. The results for a typical roof rafter (gravity calculation) and for the length of braced wall required (lateral calculation) were essentially at parity. The tangible differences between the design methods are the detailing requirements and the code classifications of braced wall methods.

Challenges

Because the focus of the project was to compare prescriptive design methods versus engineered design, difficulties arise when parts of the project fall outside the permitted scope of prescriptive design. The juxtapositions stopped there so that no apples were compared to oranges. There were two discrete parts of the house that had to be engineered: the front porch (posts supporting the beams and the floor framing) and the desired floor framing layout (have to do stem walls instead of piers). The beams at the porch supporting the roof framing didn't explicitly fall within a prescription but it was possible to finagle a table for load bearing headers to achieve the same loading and design criteria. Ideally, the prescriptive design methods would have permitted a floor framing system with intermediate beam (instead of load-bearing walls);

instead, to create a foundation and floor framing layout that is prescriptive compliant, a separate layout had to be calculated and drawn with stem walls instead of a joist and beam configuration.

Impact

The global impact of this senior thesis project is limited. As of 2019, there are still efforts to push prescriptive light frame construction into other regions and nations. Unifying building codes in developing nations with tried and true construction methods would ideally ensure more safe buildings for everyone governed by those codes. Even though compliance is relatively costly compared to ignoring building codes, including a prescriptive design method in said building code would be a good compromise that promotes safer building standards.

The social impacts of this project are will be felt by the residents of the communities that Habitat for Humanity in Huntington West Virginia serves. By helping fight housing insecurity by being a non-predatory lender and builder, the effect of HFH's work should alleviate the largest worry of families living paycheck to paycheck. Based on Maslow's Hierarchy of Needs, by helping fulfill basic physiological and security needs (shelter in this case) one is free to pursue personal development and growth. A byproduct of the "modernized" plans is any resistance that the building department may put up in the future regarding these homes should be mitigated.

The economic impact will be felt by the recipients of these low-income housing ventures. Ideally, this design package consisting of revamped construction documents will serve as a fundraising tool that allows them to bring in more donation revenue. Any additional donations that may occur from this project would help finance the construction of more homes for the underserved.

The cultural impact of the project will hopefully be the continued flourishing of Habitat for Humanity. Not only would the design package help them be more successful in their particular venture in Huntington, WV, the lessons learned from the prescriptive design exploration should help them produce more code compliant plans for other jurisdictions and localities. Since the need of a “stamp” is evaluated on a state-by-state basis, the designs can be easily extrapolated within the state to all municipalities that adopt the IBC.

The environment influenced the project in a design sense. Because of the location of the project, it affects the types of wood that could be reasonably specified. Different species have different capacities (and even the loss of adjustment factors). Projects in West Virginia would have difficulty sourcing the Douglas Fir that we are familiar with in our curriculum; the design package is prepared with Southern Pine. If the client ever communicates that Spruce Pine Fir or another species of wood is more desirable or practical, the prescriptive methods will allow for quick adjustments to be made within minutes.

Lifelong Learning

Because codes are very specific to the region in which the design is being done, familiarity with a particular code is secondary to being able to parse and navigate whatever is relevant. This project has taught me how to dive into codes that have grey areas and navigate dependencies. Sometimes two applicable codes (the IBC and the IRC) will have different requirements while stating that both must be fulfilled; a reasonable interpretation would be to abide by the result that is more stringent and promoted the public health best. Essentially, this project introduced a new code and I needed to digest and extract all the relevant provisions. This is important training for being an adaptable engineer; it is paramount that they can constantly learn and improve themselves.

Personal Reflection

The work Journeyman International does seems very effective to me. Outside of the humanitarian aspect, the project was good practice on designing and drafting a small residential project. Furthermore, this project allowed me to practice self-reliance and taught me how to explore reference material on my own. I was able to dip my toes into humanitarian design through this project. I am now able to make an informed conclusion that I would love to continue down this path of humanitarian work. It has been gratifying taking the education that I have a passion for and putting it to work in a tangible way for those less fortunate than I. Aside from doing more humanitarian designing/engineering, I am confident I want to get involved with disaster relief volunteer work when my career progression permits it.

Structural Calculations for Low-Income Housing

In Huntington, West Virginia

With Habitat for Humanity and Journeyman International

BY

DAVID HSU

Contents

Engineered analysis:

Typical header	4x4 Southern Pine #1 or btr
Typical floor joist	2x6 southern Pine #2 or btr @ 24” cc
Typical floor girder (if occurs)	(2)-2x8 Southern Pine #1 or btr
Typical ceiling joist	2x10 Southern Pine SS or btr @ 24” cc
Typical roof rafter	2x8 Southern Pine #1 or btr @ 24” cc
Shear wall	3/8” SP w/ 8d @ 6”, 6”, 12”
	4’ in each braced wall line in both directions
	w/ HD5B ea chord
	use 3x chord in EW direction
Shear transfer	H1 ea joist to top plate connection
	1/2"ø A.B. w/ 6” min embed spaced at 48” cc

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Typical porch joist	2x6 Southern Pine #2 or btr @ 24” cc
Typical porch beam	(2)-2x6 Southern Pine #1 or btr

Lateral analysis:

ASCE 7-16 Governing Load Combinations

(2.4.1) 2. D +L

3. D + L_r

4. D + 0.75L + 0.75L_r

5. D + 0.6W

6. D + 0.75L + 0.75*0.6W + 0.75L_r

7. 0.6D + 0.6W

Seismic Equivalent Lateral Force procedure from Chapter 12

$S_{DS} = 0.163$

$S_{D1} = 0.109$

(T1.5-2) $I_e = 1.00$

(T12.2-1) $R = 6.5$ (A15)

see pg.   for unit loads

2

	psf	Effective Area	Net Weight
Roof	16	1560	24960
Floor	14	1560	21840
Interior Partitions	8	1680	13440
Exterior Partitions	12	1344	16128
		$W =$	**76368 #**

(12.8-1) $V = C_s W$

(12.8-2) $C_s = S_{DS}/(R/I_e) = 0.163/(6.5/1.0) = 0.0251$

(T12.8-2) $C_t = 0.02$

$x = 0.75$

(12.8.2) $T = C_t h_n^x = 0.02 * 10^{0.75} = 0.112\ s$

(12.8-3) $C_{s,max} = S_{D1}/(T * R/I_e) = 0.109/0.112/6.5/1.00 = 0.150 > \mathbf{0.0251}$

(12.8-5) $C_{s,min} = 0.044\ S_{DS}\ I_e = 0.044 * 0.163 * 1.0 = 0.007 < \mathbf{0.0251}$

$V = 0.0251 * 76368\ \# =$ **1917 #**

Seismic will not govern in either direction

Wind analysis per projected area approach from Chapter 28, Part 2, ASCE 7-16

V = 106 mph → take as 110 mph to use tables in ASCE 7-16

(26.7.3) Exposure C (see 26.7.4.2?)

(28.5-1) $p_s = \lambda K_{zt} p_{s30}$

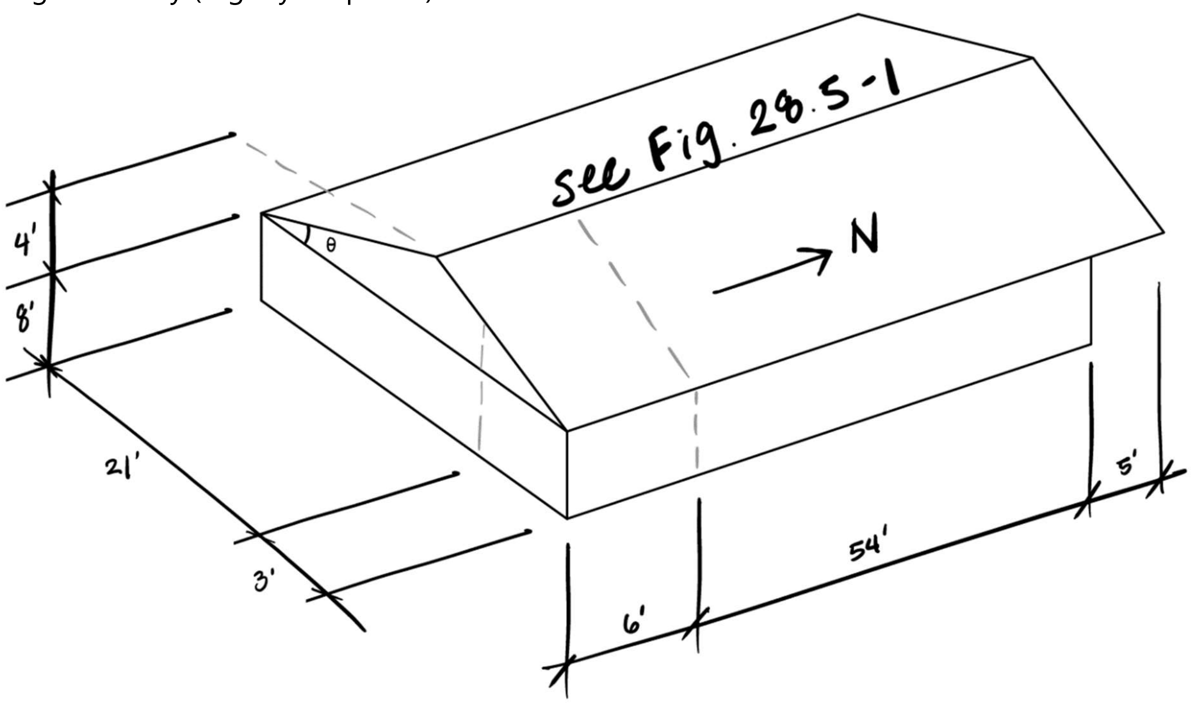
(F28.5-1) λ = 1.21 (Mean roof height = 15′, exposure C)

(26.8.2) k_{zt} = 1.0

$\theta = \tan^{-1}(4/12) = 18.4°$ → take as 20° to use tables

Note: in hind sight. Exposure should be B. Shears are roughly 20% larger than they should be. Resulting design is conservative.

Building Geometry (slightly simplified)



(F28.5-1) EW

	p_{s30} @ exposure B	p_s @ exposure C	Projected Area	Net Force
A	26.6	32.2	48	1546
B	-7.0	-8.5	24	-204
C	17.7	21.4	432	9245
D	-3.9	-4.7	236	-1109
			$V_{wind,EW}$ =	9478 #

NS

	p_{s30} @ exposure B	p_s @ exposure C	Projected Area	Net Force
A	19.2	23.2	68	1578
C	12.7	15.4	172	2649
			$V_{wind,NS}$ =	**4227 #**

EW (vs minimum design load per 28.5.4)

		Prescribed minimum p_s	Projected Area	Net Force
A	–	16	48	768
B	–	8	24	192
C	–	16	432	6912
D	–	8	236	1888
			$V_{wind,EW}$ =	**9760 #**

NS (vs minimum design load per 28.5.4)

4 ______

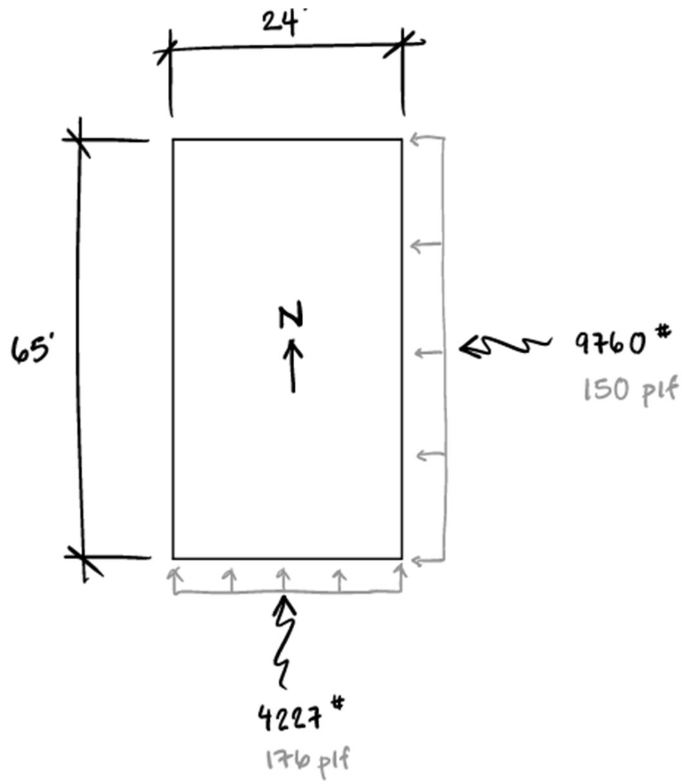
	p_{s30} @ exposure B	p_s @ exposure C	Projected Area	Net Force
A	19.2	16	68	1088
C	12.7	16	172	2752
			$V_{wind,NS}$ =	3840 #

Wind governs in both directions (vs 1,917 # seismic base shear)

Uplift

	p_{s30} @ exposure B	p_s @ exposure C	Projected Area	Net Force
E	-23.1	-28.0	84	-2352
F	-16.0	-19.4	84	-1630
G	-16.0	-19.4	756	-14666
H	-12.2	-14.8	756	-11189
E_{OH}	-32.3	-39.1	70	-2737
G_{OH}	-25.3	-30.6	70	-2142
			F_{uplift} =	-**34716 #**

Diaphragm analysis:



NDS SDPWS

2015 (T4.2C) $v_n = 475\, plf \rightarrow v_{ASD} = 475/2 = 237\, plf > v_u = 0.6 * 176\, plf = 106\, plf$ 5

5/16″ sheathing w/ 6d @ 6″, 6″, 12″ permitted ($v_{ASD} = 237\, plf$)

Aspect ratio check:

(4.2.4) $L/W = 65/24 = 2.71$; **unblocked** wood structural panels OK

$T = C = M_u / diaphragm\ depth$

$M_u = w_u L^2/8 = 0.6\, w_n L^2/8$

$M_{u,EW} = 0.6 * 150 * 65^2/8 = 47531\ \# - ft$

$C_{EW} = 47531\ \# - ft/24' = 1980\ \#$

$M_{u,NS} = 0.6 * 176 * 24^2/8 = 7603\ \# - ft$

$C_{NS} = 7603\ \# - ft/65' = 117\ \#$

Design chords running EW for 1980# axial force;

negligible chord force running NS

Uplift anchorage:

0.6D + 06W

$F_u = 0.6 * F_{uplift} = 0.6 * 34716\ \# = 20830\ \#$

see catalog use Simpson H1, uplift capacity: 480#/tie, shear capacity: 510#/tie

one tie at each end of rafters → 60 ties

$R_n = 480\ \# * 60 = 28800\ \# > F_u = 20830\ \#\ OK$

NDS 2018 $Z_{\perp} = 410\ \#$

(T12E) $Z'_{\perp} = Z_{\perp} * C_D = 410 * 1.6 = \mathbf{656}$ # for ea 1/2″ø A.B. w/ 6″ min. embed

Bearing perimeter: 168′

$s = Z'_{\perp}/(F_u/wall\ length) = 656/(20830/168) = 5.3'$ → s = 4′

use Simpson H1 at each end of typical rafters

use 1/2″ø A.B. w/ 6″ min. embed @ 48″ cc

Shear Wall analysis

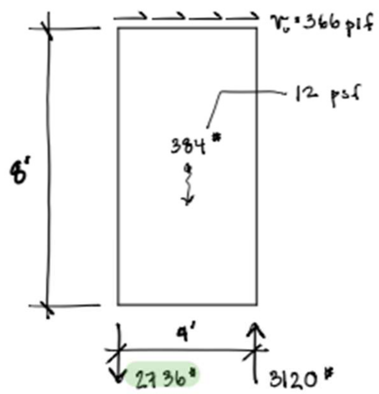
V = 106 mph → take as 110 mph to use tables in ASCE 7-16

3/8″ sheathing w/ 8d @ 6″, 6″, 12″ ($v_{ASD} = 730/2 = 365\ plf$)

Wall length required NS = $4227 * 0.6/365 = 6.9' \rightarrow$ **(2) 4′ panels NS**

Wall length required EW = $9760 * 0.6/365 = 16.0' \rightarrow$ **(4) 4′ panels EW**

EW



$\Sigma M_A = 0;\ 384^{\#}(2') + 366\,plf(4')(8') = C(4')$

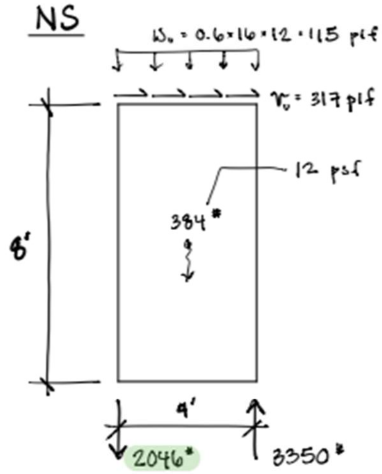
$C = 3120^{\#}$

$\Sigma F_y = 0;\ T = 2736^{\#}$

HD5B w/ 3x chord

$T_{allow} = 3750^{\#} > 2736^{\#}$ ok

NS



$\Sigma M_A = 0;\ 384^{\#}(2') + 366\,plf(4')(8') + 115(4)(2) = C(4')$

$C = 3350^{\#}$

$\Sigma F_y = 0;\ T = 2046^{\#}$

HD5B w/ 2x chord

$T_{allow} = 2405^{\#} > 2046^{\#}$ ok

USE HD5B both directions

in NS, use 2x chord min.

in EW, use 3x chord min.

Typical header

Checking worst case of 4′ span

DL = 16 psf

ASCE 7-16 4 LL = 10 psf uninhabited attic, irreducible

LL_r = 20 psf typical sloped roof, irreducible

Governing load combination: D + 0.75L + 0.75Lr

$w_u = (16 + 0.75(10 + 20)) * 14' = 539\ plf$

$w_L = (20) * 14' = 280\ plf$

$w_{0.5D+L} = (0.5 * 16 + 20) * 14' = 392\ plf$

$M_u = w_u\ L^2/8 = 539 * 4^2/8 = 1078\ \# - ft = 12936\ \# - in$

presume Southern Pine #2 $E = 1400000\ psi$

$\Delta_{L,max} = L/240 = 48/240 = 0.2''$

$\rightarrow I_{req} = 5\ w_L\ L^4/(384\ E\ \Delta_{max}) = 5.76\ in^4$

$\Delta_{0.5D+L,max} = L/180 = 48/180 = 0.267''$

$\rightarrow I_{req} = 5\ w_{0.5D+L}\ L^4/(384\ E\ \Delta_{max}) = 6.04\ in^4$ 8

presume 4x6 $I_x = 48.53\ in^4$

(Table 4B) $F_b' = F_b * C_D = 1100\ psi * 1.25 = 1375\ psi$

$f_b = M_u/S_x = 12936/17.65 = 733\ psi < F_b' = 1375\ psi\ OK$

check Southern Pine #3 $E = 1300000\ psi$

$\Delta_{0.5D+L} = 5\ w_{0.5D+L}\ L^4/(384\ E\ I) = 0.035\ in < \Delta_{max} = 0.267"\ OK$

$F_b' = 650\ psi * 1.25 = 813\ psi > f_b = 733\ psi\ OK$

$V_u = w_u L/2 = 539 * 4/2 = 1078\#$ → bearing will be non-issue

check (2)-2x4 Southern Pine #2

$S_x \approx 6\ in^3 \rightarrow f_b = 12936/6 = 2156\ psi > 1375\ psi\ NG$

check 4x4 Southern Pine #1

$S_x = 7.15\ in^3 \rightarrow f_b = 12936/7.15 = 1809\ psi > 1875\ psi\ OK$

use 4x4 Southern Pine #1 or btr

Typical floor joist

$L = 8', s = 24"$

DL = 14 psf

ASCE 7-16 4 LL = 40 psf living areas or sleeping areas and partitions, irreducible

Governing load combination: D + L

$w_u = (14 + 40) * 2' = 108\ plf$

$w_L = (40) * 2' = 80\ plf$

$w_{0.5D+L} = (0.5 * 14 + 40) * 2' = 94\ plf$

$M_u = w_u\ L^2/8 = 108 * 8^2/8 = 864\ \# - ft = 10368\ \# - in$

presume Southern Pine #2 $E = 1400000\ psi$

$\Delta_{L,max} = L/360 = 96/360 = 0.267"$

$\rightarrow I_{req} = 5\ w_L\ L^4/(384\ E\ \Delta_{max}) = 19.72\ in^4$

$\Delta_{0.5D+L,max} = L/240 = 96/240 = 0.4"$

$\rightarrow I_{req} = 5\ w_{0.5D+L}\ L^4/(384\ E\ \Delta_{max}) = 15.47\ in^4$

presume 2x6 $I_x = 20.80\ in^4, S_x = 7.56\ in^3$ 9

(Table 4B) $F_b' = F_b * C_D * C_r = 1100\ psi * 1.0 * 1.15 = 1265\ psi$

$f_b = M_u/S_x = 10368/7.56 = 1371\ psi < F_b' = 1265\ psi\ NG$

Try Southern Pine #1 $E = 1600000\ psi$

$F_b' = 1500\ psi * 1.0 * 1.15 = 1725\ psi > f_b = 1371\ psi\ OK$

use 2x6 Southern Pine #1 or btr

Typical floor girder

$L = 8', s = 96"$

DL = 14 psf

ASCE 7-16 4 LL = 40 psf living areas or sleeping areas and partitions, irreducible

Governing load combination: D + L

$w_u = (14 + 40) * 8' = 432\ plf$

$w_L = (40) * 8' = 320\ plf$

$w_{0.5D+L} = (0.5 * 14 + 40) * 8' = 376\ plf$

$M_u = w_u\ L^2/8 = 376 * 8^2/8 = 3008\ \# - ft = 36096\ \# - in$

presume Southern Pine #2 $E = 1400000\ psi$

$\Delta_{L,max} = L/360 = 96/360 = 0.267"$

$\rightarrow I_{req} = 5\ w_L\ L^4/(384\ E\ \Delta_{max}) = 78.99\ in^4$

$\Delta_{0.5D+L,max} = L/240 = 96/240 = 0.4"$

$\rightarrow I_{req} = 5\ w_{0.5D+L}\ L^4/(384\ E\ \Delta_{max}) = 61.88\ in^4$

presume (2)-2x8 $I_x = 2 * 47.63 = 95.26\ in^4$ 10

(Table 4B) $F_b' = F_b * C_D = 1100\ psi * 1.0 = 1100\ psi$

$f_b = M_u/S_x = 36096/(2 * 13.14) = 1374\ psi < F_b' = 1100\ psi\ NG$

Try Southern Pine #1 $E = 1600000\ psi$

$F_b' = 1500\ psi * 1.0 = 1500\ psi > f_b = 1374\ psi\ OK$

use (2)-2x8 Southern Pine #1 or btr

$V_u = w_u L/2 = 376 * 8/2 = 1504\ \#$ → bearing will be non-issue

Typical ceiling joist

$L = 24', s = 24"$

DL = 16 psf

ASCE 7-16 4 LL = 10 psf uninhabited attic, irreducible

Governing load combination: D + L

$w_u = (16 + 10) * 2' = 52\, plf$

$w_L = (10) * 2' = 20\, plf$

$w_{0.5D+L} = (0.5 * 16 + 10) * 2' = 36\, plf$

$M_u = w_u\, L^2/8 = 52 * 24^2/8 = 3744\, \# - ft = 44928\, \# - in$

presume Southern Pine SS $E = 1800000\, psi$

$\Delta_{L,max} = L/240 = 24 * 12/240 = 1.2”$

$\rightarrow I_{req} = 5\, w_L\, L^4/(384\, E\, \Delta_{max}) = 69.1\, in^4$

$\Delta_{0.5D+L,max} = L/180 = 24 * 12/180 = 1.6”$

$\rightarrow I_{req} = 5\, w_{0.5D+L}\, L^4/(384\, E\, \Delta_{max}) = 93\, in^4$

presume 2x10 $I_x = 98.93\, in^4, S_x = 21.39\, in^3$

(Table 4B) $F_b' = F_b * C_D * C_r = 2350\, psi * 1.15 = 2703\, psi$

$f_b = M_u/S_x = 44928/21.39 = 2100\, psi < F_b' = 2703\, psi\ OK$

use 2x10 Southern Pine SS or btr

$V_u = w_u L/2 = 52 * 24/2 = 624\, \#$

$\rightarrow f_{c\perp} = V_u/A_{brg} = 624/(1.5 * 3.5) = 119\, psi$

$F_{c\perp}' = F_{c\perp} * C_b = 565 * C_b = 565 * 1.25 = 706\, psi > f_{c\perp} = 119\, psi$

$C_b = (l_b + 0.375)/l_b = (1.5 + 0.375)/1.5 = 1.25$

Typical roof rafter

$L = 14', s = 24"$

DL = 16 psf

ASCE 7-16 4 LL_r = 20 psf typical sloped roof, irreducible

Governing load combination: D + Lr

$w_u = (16 + 20) * 2' = 72\, plf$

$w_L = (20) * 2' = 40\, plf$

$w_{0.5D+L} = (0.5 * 16 + 20) * 2' = 56\, plf$

$M_u = w_u\, L^2/8 = 72 * 14^2/8 = 1764\, \# - ft = 21168\, \# - in$

presume Southern Pine #2 $E = 1400000\, psi$

$\Delta_{L,max} = L/240 = 14 * 12/240 = 0.7"$

$\rightarrow I_{req} = 5\, w_L\, L^4/(384\, E\, \Delta_{max}) = 35.3\, in^4$

$\Delta_{0.5D+L,max} = L/180 = 14 * 12/180 = 0.9"$

$\rightarrow I_{req} = 5\, w_{0.5D+L}\, L^4/(384\, E\, \Delta_{max}) = 38.4\, in^4$

presume 2x8 $I_x = 47.63\, in^4, S_x = 13.14\, in^3$ 12

(Table 4B) $F_b' = F_b * C_D * C_r = 1100\, psi * 1.25 * 1.15 = 1581\, psi$

$f_b = M_u/S_x = 21168/13.14 = 1611\, psi > F_b' = 1581\, psi\ NG$

try #1 $E = 1600000\, psi$

$F_b' = 1500 * C_D * C_r = 1500\, psi * 1.25 * 1.15 = 2156\, psi > f_b = 1611\, psi\ OK$

use 2x8 Southern Pine #1 or btr

$V_u = w_u L/2 = 72 * 14/2 = 504\, \#$

Typical porch joist

$L = 4.75', s = 24"$

DL = 10 psf

ASCE 7-16 4 LL = 60 psf 1.5 x occupancy served

Governing load combination: D + L

$w_u = (10 + 60) * 2' = 140\ plf$

$w_L = (60) * 2' = 120\ plf$

$w_{0.5D+L} = (0.5 * 10 + 60) * 2' = 130\ plf$

$M_u = w_u\ L^2/8 = 140 * 4.75^2/8 = 395.8\ \# - ft = 4738\ \# - in$

presume Southern Pine #2 $E = 1400000\ psi$

$\Delta_{L,max} = L/360 = 4.75 * 12/360 = 0.158"$

$\rightarrow I_{req} = 5\ w_L\ L^4/(384\ E\ \Delta_{max}) = 6.21\ in^4$

$\Delta_{0.5D+L,max} = L/240 = 4.75 * 12/240 = 0.238"$

$\rightarrow I_{req} = 5\ w_{0.5D+L}\ L^4/(384\ E\ \Delta_{max}) = 4.67\ in^4$

presume 2x6 $I_x = 20.80\ in^4, S_x = 7.56\ in^3$

(Table 4B) $F_b' = F_b * C_D * C_r = 1100\ psi * 1.0 * 1.15 = 1265\ psi$

$f_b = M_u/S_x = 13440/13.14 = 627\ psi < F_b' = 1265\ psi\ OK$

use 2x6 Southern Pine #2 or btr @ 24" cc

$V_u = w_u L/2 = 140 * 8/2 = 560\ \#$ → bearing will be non-issue

Typical porch beam

$L = 8', s = 2.375'$

DL = 10 psf

ASCE 7-16 4 LL = 60 psf 1.5 x occupancy served

Governing load combination: D + L

$w_u = (10 + 60) * 2.375' = 166\, plf$

$w_L = (60) * 2.375' = 143\, plf$

$w_{0.5D+L} = (0.5 * 10 + 60) * 2.375' = 154\, plf$

$M_u = w_u\, L^2/8 = 166 * 8^2/8 = 1328\,\# - ft = 15936\,\# - in$

presume Southern Pine #2 $E = 1400000\, psi$

$\Delta_{L,max} = L/360 = 96/360 = 0.267"$

$\rightarrow I_{req} = 5\, w_L\, L^4/(384\, E\, \Delta_{max}) = 35.3\, in^4$

$\Delta_{0.5D+L,max} = L/240 = 96/240 = 0.4"$

$\rightarrow I_{req} = 5\, w_{0.5D+L}\, L^4/(384\, E\, \Delta_{max}) = 25.3\, in^4$

presume 2x8 $I_x = 47.63\, in^4, S_x = 13.14\, in^3$ 14

(Table 4B) $F_b' = F_b * C_D = 1100\, psi * 1.0 = 1100\, psi$

$f_b = M_u/S_x = 15936/13.14 = 1213\, psi > F_b' = 1100\, psi\ NG$

try #1 $E = 1600000\, psi$

$F_b' = 1500 * C_D = 1500\, psi * 1.25 = 1875\, psi > f_b = 1213\, psi\ OK$

$V_u = w_u L/2 = 140 * 8/2 = 560\,\#$ → bearing will be non-issue

check (2)-2x6 Southern Pine #1

$S_x \approx 15\, in^3 \rightarrow f_b = 15936/15 = 1062\, psi < F_b' = 1875\, psi\ OK$

use (2)-2x6 Southern Pine #1 or btr

Double top plate check

$P = 1980\ \#$

check 2x4 Southern Pine #3 $A = 5.25\ in^2, F_{c\parallel} = 850\ psi$

$F'_{c\parallel} = F_{c\parallel} * C_D = 850 * 1.6 = 1360\ psi$

$f_{c\parallel} = P/A = 1980\ \#/5.25\ in^2 = 377\ psi < F'_{c\parallel} = 1360\ psi\ OK$

use 2x4 Southern Pine #3 or btr

Light-framed wood construction prescriptions:

Typical header	2x8 Southern Pine #2 or btr
Typical floor joist	2x6 Southern Pine #1 or btr @ 24″ cc
Typical ceiling joist	2x10 Southern Pine SS @ 24″ cc
Typical roof rafter	2x8 Southern Pine #1 or btr @ 24″ cc
	w/ (8)-16d ea heel joint
	w/ (2)-8d ea end of ridge strap
Braced wall requirements	3/8″ SP w/ 8d @ 6″, 6″, 12″
	8′ in each braced wall line in EW direction
	4′ in each braced wall line in NS direction
	w/ HD5B at ea chord
Shear transfer	(3)-8d ea joist to top plate connection
	5/8″ ø A.B. w/ 6″ min embed spaced at 48″ cc

WFCM/IBC/IRC prescriptive approach does not cover design of porch

Floor system:

Floor joists

DL = 20 psf

LL = 40 psf living areas or sleeping areas + partitions

Deflection limited to L/360

T3.18B **use 2x6 Southern Pine #1 @ 24" cc**

or 2x8 Southern Pine #2 @ 24" cc

or 2x10 Southern Pine #3 @ 24" cc

3.3.1.4 no additional lateral bracing required

Roof System:

Rafter (with ceiling not attached to rafter)

DL = 20 psf

LL = 20 psf

Deflection limited to L/180

T3.26A **use 2x8 Southern Pine #1 or btr @ 24" cc**

or 2x10 Southern Pine #2 or btr @ 24" cc

3.3.1.4 no additional lateral bracing required

TA-3.6 **w/ (2)-8d common nails in each end of 1-1/4" strap as ridge strap**

Ceiling joist

Deflection limited to L/240 for flexible finishes

LL = 10 psf uninhabitable attics without storage

T3.25A1 **use 2x10 Southern Pine SS @ 24" cc**

T3.25A2 brittle finishes (L/360) all noncompliant for Southern Pine @ 24" cc

3.3.1.4 both edges of member shall be sheathed ("held in line for their entire length")

Rafter/ceiling joist heel joint connection

T3.9A **use (8)-16d common nails per connection**

Joist to top plate connection

T3.4A **use (3)-8d common nails per connection**

Roof sheathing

110 mph wind speed

Exposure B

Rafters spaced at 24" cc

T3.12CA **use 3/8" minimum Sheathing grade WSP**

T3.10 **w/ 8d common nails @ 6", 6", 12"**

or 10d box nails @ 6", 6", 12"

19

Lateral System:

Shear Walls

Exposure B, 110 mph

T3.4B **use 7/16" OSB or 15/32" plywood w/ 8d common nails @ 3", 6", 12"**

$NS \rightarrow 3.6' * 0.50\ (roof\ pitch\ reduc) = 1.8"\ ea\ wall\ line$

$EW \rightarrow 9.1' * 0.50\ (roof\ pitch\ reduc) = 4.6"\ ea\ wall\ line$

braced wall segment lengths based on minimums in IBC/IRC

Hold-downs

T3.17D $3488\#\ per\ holdown\ /\ 1.61 = 2167\#\ req\ per\ hold - down$

T3.17F **use HD5B at each shear wall chord** (2405# capacity)

Anchorage to foundation

T3.2A **use 5/8” ø A.B. w/ 6” min embed spaced at 48” cc max in both NS and EW**

T3.2B can use 1/2"ø A.B. as alternative but maximum spacing permitted is 31” cc

T3.2C

Wall System:

Typical Header (dropped exterior)

T3.22A **use 2x8 Southern Pine #2 or btr**

no flat configurations permitted

T3.22F **supported by (1)-2x jack stud**

General

1. Interpretation of drawings & specifications
   - A) For convenience, specifications have been prepared for this project and are arranged in several sections, but such separation shall not be considered as the limits of the work required by any separate trade. The terms and conditions of such limitations are wholly between the contractor and his subcontractors.
   - B) In general, the working details will indicate dimensions, positions and kind of construction, and the specifications will indicate qualities and methods. Any work indicated on the working details mentioned but not in the specifications, or vice versa, shall be furnished as though fully set forth in both. Work not particularly detailed, marked, or specified, shall be the same as similar parts that are detailed, marked, or specified. If conflicts occur between drawings and specifications, the most expensive materials or methods will prevail.
   - C) Should an error appear in the working details or specifications or in work done by others affecting this work, the contractor shall notify the architect at once and in writing. If the Contractor proceeds with the work so affected without having given such written notice and without receiving the necessary approval, decision or instruction in writing from the owner, then he shall have no valid claim against the owner, for the cost of so proceeding and shall make good any resulting damage or defect. No verbal approval, decision, or instruction shall be valid or be the basis for any claim against the owner, its officers, employees or agents. The foregoing includes typical errors in the specifications or notational errors in the working details where the interpretation is doubtful or where the error is sufficiently apparent as to place a reasonably prudent contractor on notice that, should he elect to proceed, he is doing so at his own risk.
2. Construction shall conform to all applicable codes and regulations.
3. Safety Note:
   - A) It is the Contractors responsibility to comply with the pertinent sections, as they apply to this project, of the "Construction Safety Orders" issued by the State of California latest edition, and all OSHA requirements.
   - B) The owner and the Structural Engineer do not accept any responsibility for the Contractor's failure to comply with these requirements.
   - C) The Contractor shall be responsible for adequate design and construction of all forms and shoring required.
4. The Contractor shall notify the Architect and Structural Engineer where a conflict or a discrepancy occurs between the structural drawings and any other portion of the contract documents or existing field conditions. Such notification shall be given in due time so as not to affect the construction schedule. In case of a conflict between structural drawings and specifications, the more restrictive condition shall take precedence unless written approval has been given for the least restrictive. Contractor shall verify all dimensions with architectural and structural drawings prior to commencing any work.
5. Where no specific detail is shown, the construction shall be identical or similar to that indicated for like cases of construction on this project. Should there be any question, contact the Architect prior to proceeding.
6. Any substitutions for structural members, hardware, or details shall be reviewed by the Architect. Such review will be billed on a time and materials basis to the General Contractor with no guarantee that the substitution will be allowed.
7. Do not scale drawings. Contact the Architect or Structural Engineer for any dimensions not shown.
8. These drawings are not complete until reviewed and accepted by the local building official and signed by the owner and the Structural Engineer.
9. The structure shown on these drawings is structurally sound only in its completed form. The stability of this structure depends on the diaphragms and the bracing members shown. The Contractor is to provide for the design and construction of shoring for all earth, forms, concrete, steel, wood, and masonry to resist gravity, earth, wind, seismic, and construction loads. Shoring shall remain in place until all diaphragms and lateral resisting elements are in place in their entirety. Construction materials shall be spread out if placed on framed floors or roofs. Load shall not exceed the design live load per square foot.

Wood

1. All sawn lumber shall be Southern Pine as graded by the Southern Pine Inspection Bureau (SPIB). All members shall have a minimum grade of No. 1 except 2x4 and 2x6 wall studs, plates, and blocking may be No. 2, u.n.o.
2. All structural sheathing used for shearwalls and roof sheathing shall conform to the requirements for their type in DOC PS1, DOC PS2 or ANSI/APA PRP 210. Each panel or member shall be identified for grade, bond classification, and performance category by the trademarks of an approved testing and grading agency.
3. All foundation plates or sills on concrete slabs which are in direct contact with earth, and plates or sills on concrete or masonry foundations, shall be pressure treated.
4. All wood shall have a moisture content of not more than 19% when sheathing is applied.
5. 8" minimum clearance shall be maintained at all exterior walls between finish grade and bottom of wood walls.
6. Sill plate anchor bolts shall be installed with plate washers 3x3x0.229 between nut and plate.
7. Provide solid blocking between joists and rafters at all supports.
8. Provide blocking at all ceiling levels.
9. Joists under and parallel to partitions shall be doubled and nailed together.
10. Holes for bolts in wood shall be bored with a bit of the same nominal diameter as the bolt plus 1/16".
11. Connector hardware model number are those for Simpson Strong-Tie Company. All joist hangers shall be Simpson U series unless noted otherwise. Equivalent connectors with ICC acceptance may be submitted for review as an alternate.
12. Notify Structural Engineer after wall, floor, and roof sheathing nailing has been completed and a minimum of 48 hours prior to concealing sheathing.

Design Criteria

1. Code: 2015 International Building Code (IBC)
2. Design Live Loads:

Area	Live Load	Remarks
Roof		
A) 4:12 to ≤ 12:12	L_r = 12-20 psf	Reducible per code
Floor	L = 40 psf	Reducible per code

3. Snow Design Parameters:
   - Ground Snow Load: P_g = N/A
   - Flat-Roof Snow Load: P_f = N/A
   - Snow Exposure Factor: C_e = N/A
   - Snow Load Importance Factor: I_s = N/A
   - Thermal Factor: C_t = N/A
4. Wind Design Parameters:
   - Ultimate Design Wind Speed (3-sec gust): V_{ult} = 110 mph
   - Nominal Design Wind speed (3-sec gust): V_{asd} = 85 mph
   - Risk Category: II
   - Exposure Category: B
   - Analysis Method: Enclosed Simple Diaphragm of Low-Rise Buildings Procedure
5. Earthquake Design Parameters:
   - 5.1. Seismic Importance Factor: I_E = 1.0
   - 5.2. Risk Category: II
   - 5.3. Soil Site Classification: 'D'
   - 5.4. Seismic Design Category: 'A'
   - 5.5. Mapped Spectral Response Accel
     - A) Short period: S_s = 0.152g
     - B) 1-sec period: S_1 = 0.068g
   - 5.6 Design Spectral Response Accel
     - A) Short Period: S_{DS} = 0.163g
     - B) 1-sec period: S_{D1} = 0.109g
   - 5.7 Seismic Force Resisting System
     - A) Wood Bearing / Shear Walls & Flexible Diaphragm
   - 5.8 Seismic Base Shear: V = 1900 #
   - 5.9 Seismic Response Coefficient: C_s = 0.03g
   - 5.10 Component Response Modification Factor: R = 6.5
   - 5.11 Analysis Procedure: Equivalent Lateral Force

Foundations

1. Foundation construction shall be done in accordance with the 2015 IBC & all local ordinances.
2. All building pad preparation and foundation work shall be done in accordance with the requirements of the 2015 IBC.
3. The Inspection Agency shall observe all footing excavations prior to placement of reinforcing steel and concrete.
4. Foundation depths indicated on plans are below undisturbed/compacted, non-expasive soil. Unexpected soil conditions shall be brought to the Architect's attention immediately.
5. When structural observation is required, structural engineer shall observe footing reinforcing steel prior to concrete placement. Provide 48 hours notice to structural engineer prior to concrete placement.
6. The contractor shall be solely responsible for all excavation procedures including, but no limited to, lagging, shoring and protection of adjacent property, structures, streets, and utilities in accordance with the local building department.
7. Foundation type: conventional spread footings
8. Spread footing design values:

   Allowable Bearing Pressure
   - Basic Load Combinations: 1500 psf
   - Alt ASD w/ wind or seismic: 2000 psf

   Lateral Resistance
   - Passive Pressure: 100 psf/ft below natural grade (up to 15')
   - Coefficient of Friction: N/A

   Minimum Footing Dimensions
   - Depth = 12"
   - Width = 12"

Nailing Schedule

1. All nails for structural work shall be common wire nails conforming to the following minimum sizes:
   - 8d: 0.131"Φx2½"
   - 10d: 0.148"Φx3"
   - 10d shorts: 0.148"Φx1⅝" plus thickness of shtg
   - 16d: 0.162"Φx3½"
   - 20d: 0.192"Φx4"
2. Provide nails at connections as indicated on the structural drawings. Where nails at connections are not indicated nail per nailing schedule in note 5.
3. Nailing not noted in schedule or on plans shall be a minimum of two nails at each contact. 8d nails for 1" material and 16d nails for 2" material.
4. Holes shall be pre-drilled where necessary to prevent splitting.
5. Nailing schedule:

Connection	Fastening	Location
1. Joist to sill or girder.	3-8d common (2½"x0.131")	toenail
2. Blocking to joist.	2-8d common (2½"x0.131")	toenail ea end
3. Sole plate to joist or blocking	16d (3½"x0.135") @ 16"cc	typical face nail
Sole plate to joist or blocking at braced wall panel	2-16d (3½"x0.135") @ 16"cc	typical face nail
4. Top plate to stud.	2-16d common (3½"x0.162")	end nail
5. Stud to sole plate	4-8d common (2½"x0.131") 2-16d common (3½"x0.162")	toenail end nail
6. Double studs.	16d (3½"x0.135") @ 24"cc 3"x0.131" nail @ 8"cc	face nail
7. Double top plates.	16d (3½"x0.135") @ 16"cc 8-16d common (3½"x0.162")	typical face nail lap splice
8. Blocking between joists or rafters to top plate.	3-8d common (2½"x0.131")	toenail
9. Top plates, laps and intersections.	2-16d common (3½"x0.162")	face nail
10. Cont. header, two pieces.	16d common (3½"x0.162")	16"cc along edge
11. Ceiling joists to plate.	3-8d common (2½"x0.131")	toenail
12. Continuous header to stud.	4-8d common (2½"x0.131")	toenail
13. Ceiling joists to parallel rafters.	8-16d common (3½"x0.162") min. WFCM Table 3.9A	face nail
14. Rafter to plate.	3-16d box (3½"x0.135")	toenail

Abbreviations

APA .... American Plywood Association
AB .... Anchor bolt
& .... And
@ .... At
b.o............ Bottom of
bm .... Beam
brg ....Bearing
btr ....Better
btwn ....Between
blkg ....Blocking
bott ....Bottom
BN .... Boundary nail
clg ....Ceiling
cc .... Center to center
℄.............. Center line
col .... Column
conn ....Connection
cont ....Continuous
DL .... Dead Load
det .... Detail
do ....Ditto
dbl .... Double
ea .... Each
EN ....Edge Nail
flr ....Floor
ftg .... Footing
fnd .... Foundation
f.o. .... Face of
frmg ....Framing
hdr ....Header
ht .... Height
jst .... Joist
jh ....Joist hanger
LL ....Live Load
max ....Maximum
min ....Minimum
nts ....Not to scale
...................Number or pounds
oc ....On center
opp ....Opposite
O.H. ....Opposite Hand
PL ....Plate
ply, plywd...Plywood
pcf................Pounds per cubic foot
psf................Pounds per square foot
psi ....Pounds per square inch
PT ....Pressure Treated
req'd ....Required
rf...................Roof
Φ ....Round or diameter
sched ....Schedule
shtg.............Sheathing
sht ....Sheet
sim ....Similar
s.o.g............Slab on grade
#...................square
stagg ....Staggered
struct ....Structural
t.o.f. ....Top of framing
t&g ....Tongue & Groove
typ ....Typical
WSP.............Wood structural panel
u.n.o.............Unless noted otherwise

JOURNEYMAN INTERNATIONAL

3BR/2BA
Habitat for Humanity Huntington, WV

DRAWING ISSUE / REVISIONS

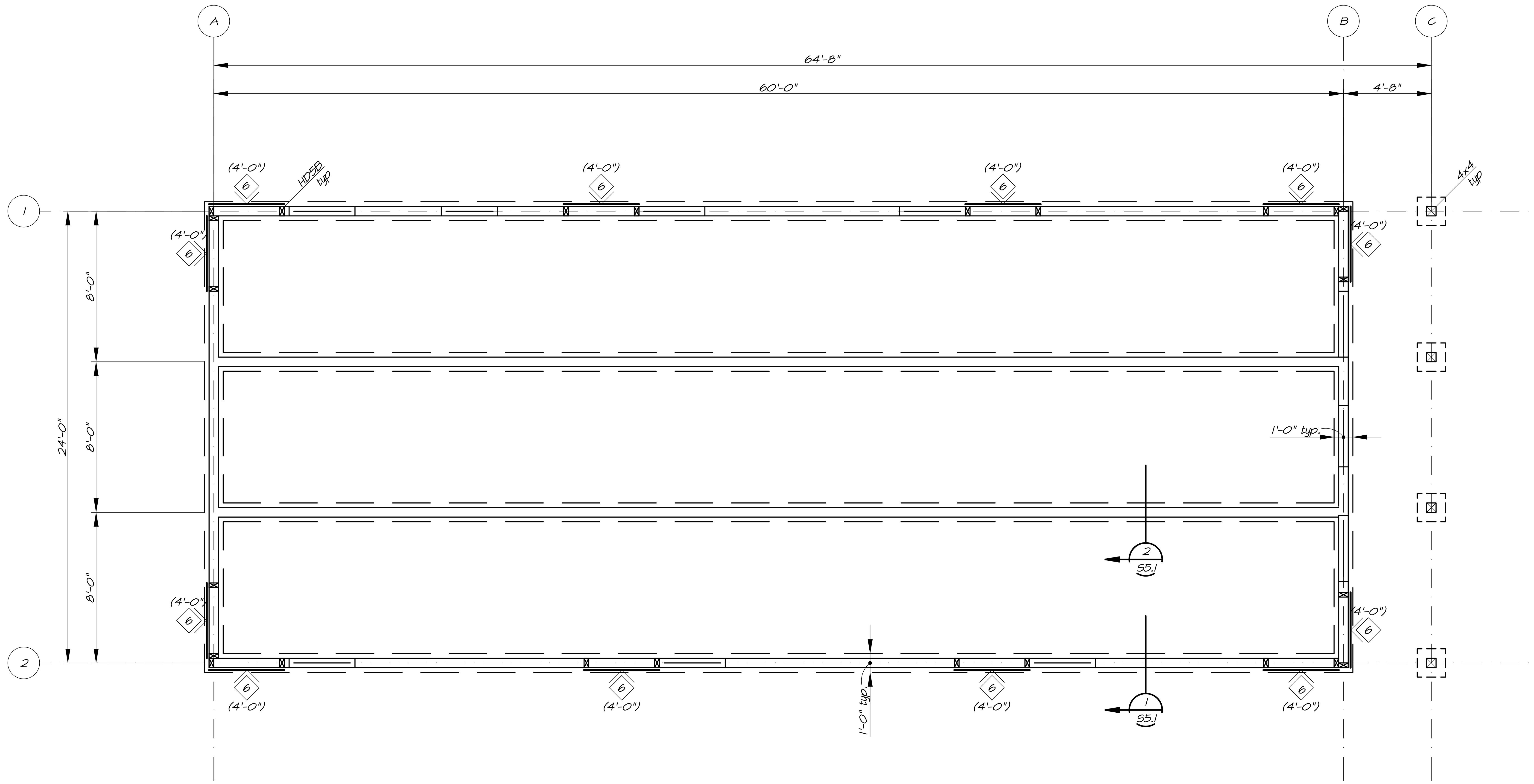
NO	DESCRIPTION	DATE
0	ORIGINAL	12.31.2019

SHEET INFORMATION

DATE	12.31.2019
JOB NUMBER	
DRAWN	DHH
CHECKED	
APPROVED	

GENERAL NOTES

SHEET
S1.1



1 / S2.1A **Foundation Plan**
1/4"=1'-0" Prescriptive compliant

North

2 / S2.1A **Shearwall Schedule**

Mark	Sheathing	Edge Nailing
6	3/8" APA rated shtg	8d @ 6"cc

Notes

1. Symbol Nomenclature:
   6 — number indicates shearwall type per schedule above
   (x'-x") — minimum required length of panel (actual length may be longer)
2. Field nailing to be 8d @ 12"cc typical.
3. Holdown bolts shall not be considered to replace (or act as) anchor bolts.
4. For typical plywood shearwall nailing see 8 / S5.1
5. All exterior walls not designated as shear walls shall be constructed per 6
6. The minimum edge distance for nails in the framing members and the plywood shall be 3/8" for 2" nominal framing members and 1/2" for 3" nominal framing members.
7. All nails to be common wire nails, typical u.n.o.
8. Shear material may be applied to either side of wall framing, typ u.n.o.

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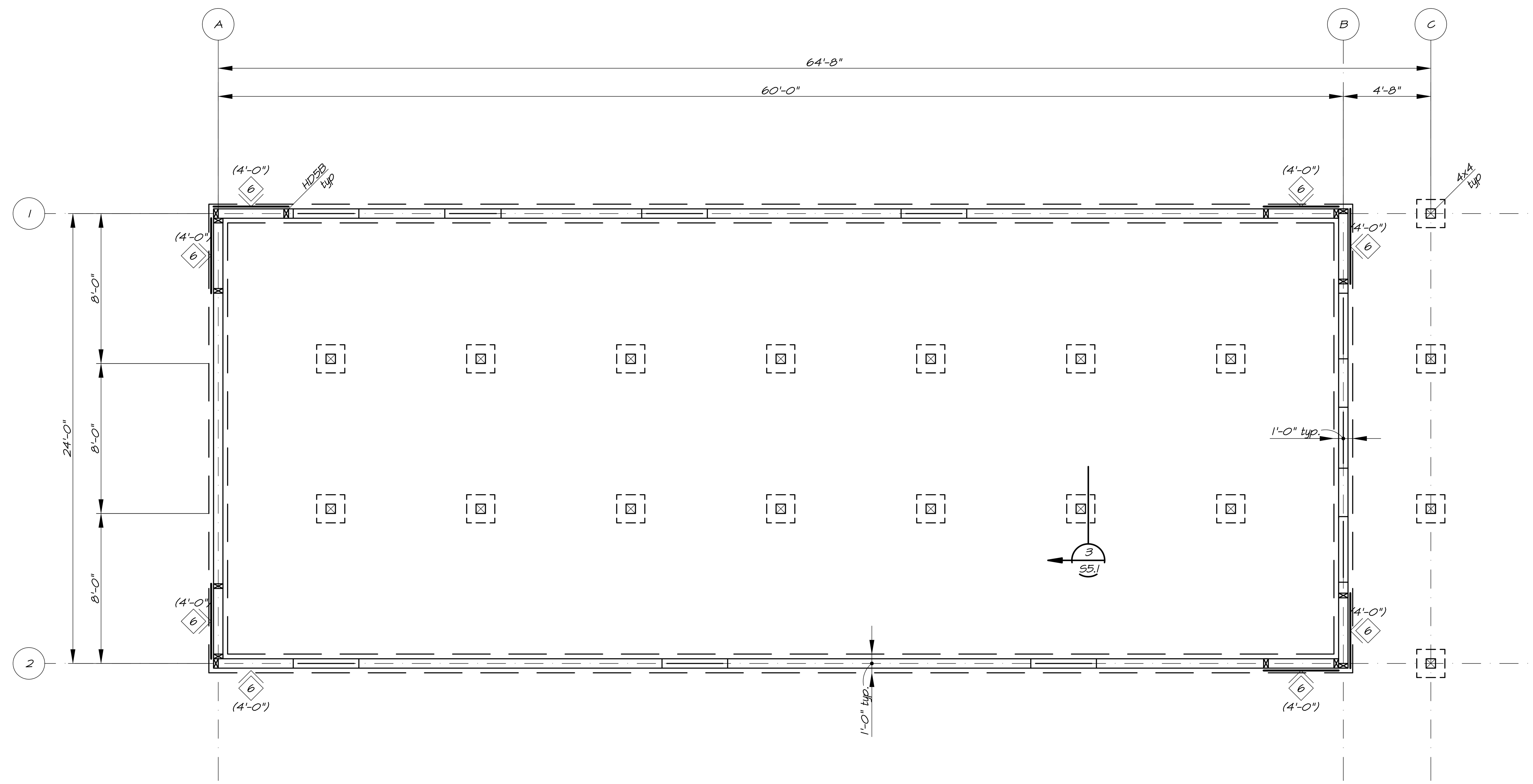
FOUNDATION PLAN

1/4" = 1'-0" SCALE

SHEET

S2.1A



Foundation Plan

1/4"=1'-0"

2 S2.1B	Shearwall Schedule	
Mark	Sheathing	Edge Nailing
6	3/8" APA rated shtg	8d @ 6"cc

Notes

1. Symbol Nomenclature:
   - 6 — number indicates shearwall type per schedule above
   - (x'-x") — minimum required length of panel (actual length may be longer)
2. Field nailing to be 8d @ 12"cc typical.
3. Holdown bolts shall not be considered to replace (or act as) anchor bolts.
4. For typical plywood shearwall nailing see 8/S5.1
5. All exterior walls not designated as shear walls shall be constructed per 6
6. The minimum edge distance for nails in the framing members and the plywood shall be 3/8" for 2" nominal framing members and 1/2" for 3" nominal framing members.
7. All nails to be common wire nails, typical u.n.o.
8. Shear material may be applied to either side of wall framing, typ u.n.o.

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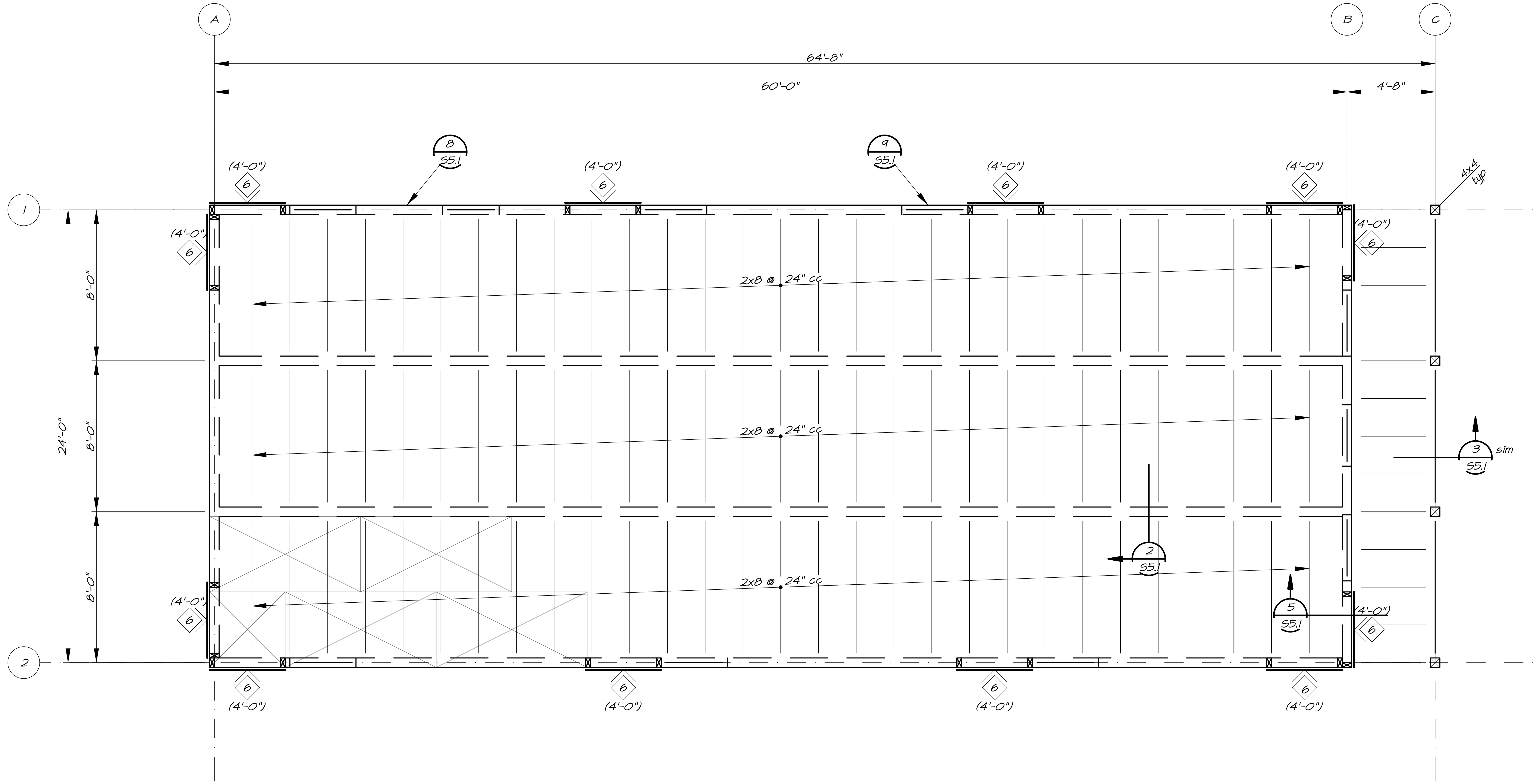
FOUNDATION PLAN

1/4" = 1'-0" SCALE

SHEET

S2.1B



Floor Framing Plan
1/4"=1'-0" Prescriptive compliant
1 S2.2A
North

Floor Framing Notes

Filename: Floor-Frmg-Notes-(wood)

1. ☒ Indicates wood post, see plan for size. 4x4 typical u.n.o.
2. For porch framing, see S2.2B

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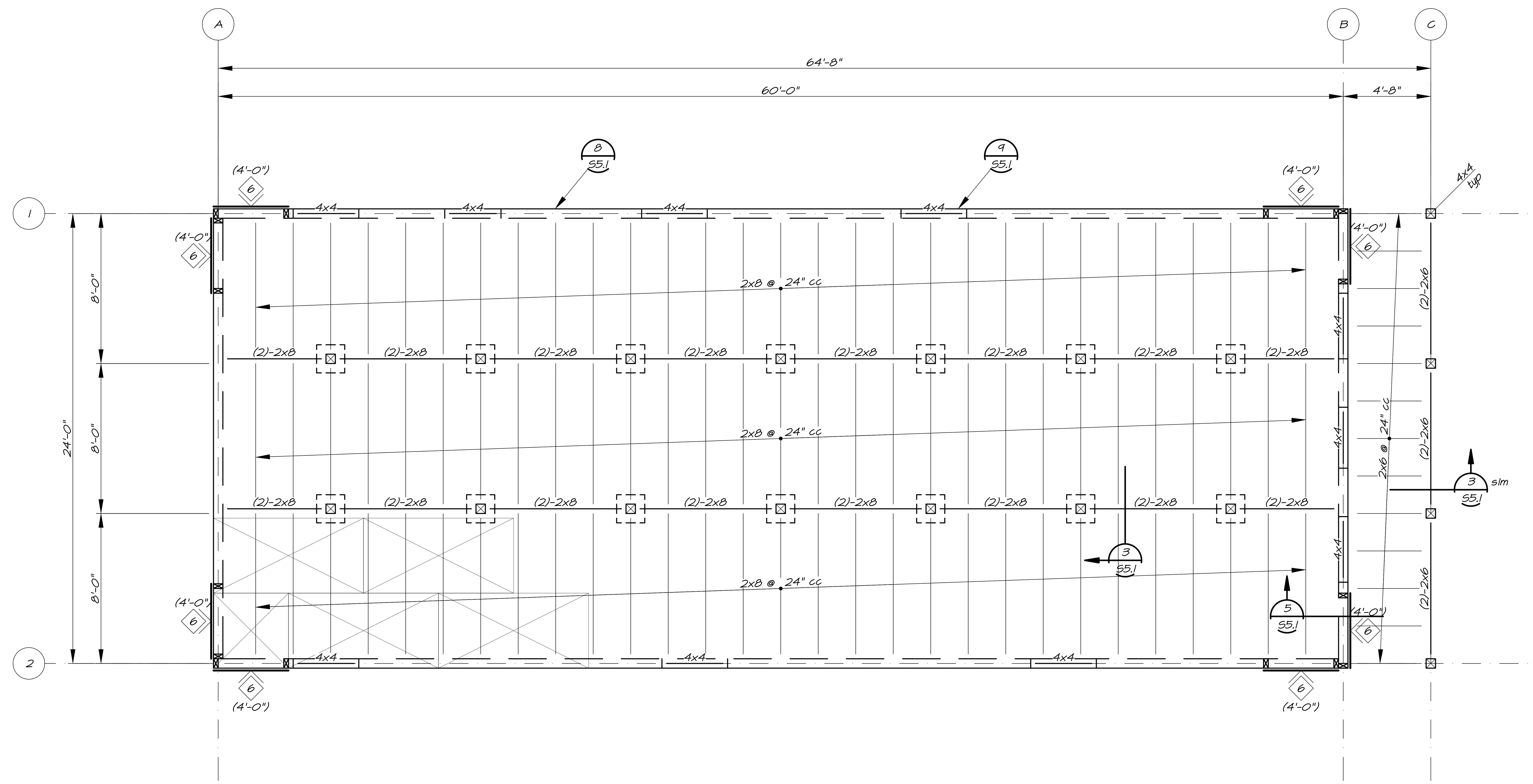
FLOOR FRAMING PLAN

1/4" = 1'-0" SCALE

SHEET

S2.2A



Floor Framing Plan

1 / S2.2B

1/4"=1'-0"

North

Floor Framing Notes

Filename: Floor-Frmg-Notes-(wood)

1. ☒ Indicates wood post, see plan for size. 4x4 typical u.n.o.
2. For porch framing, see S2.2B

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SHEET INFORMATION

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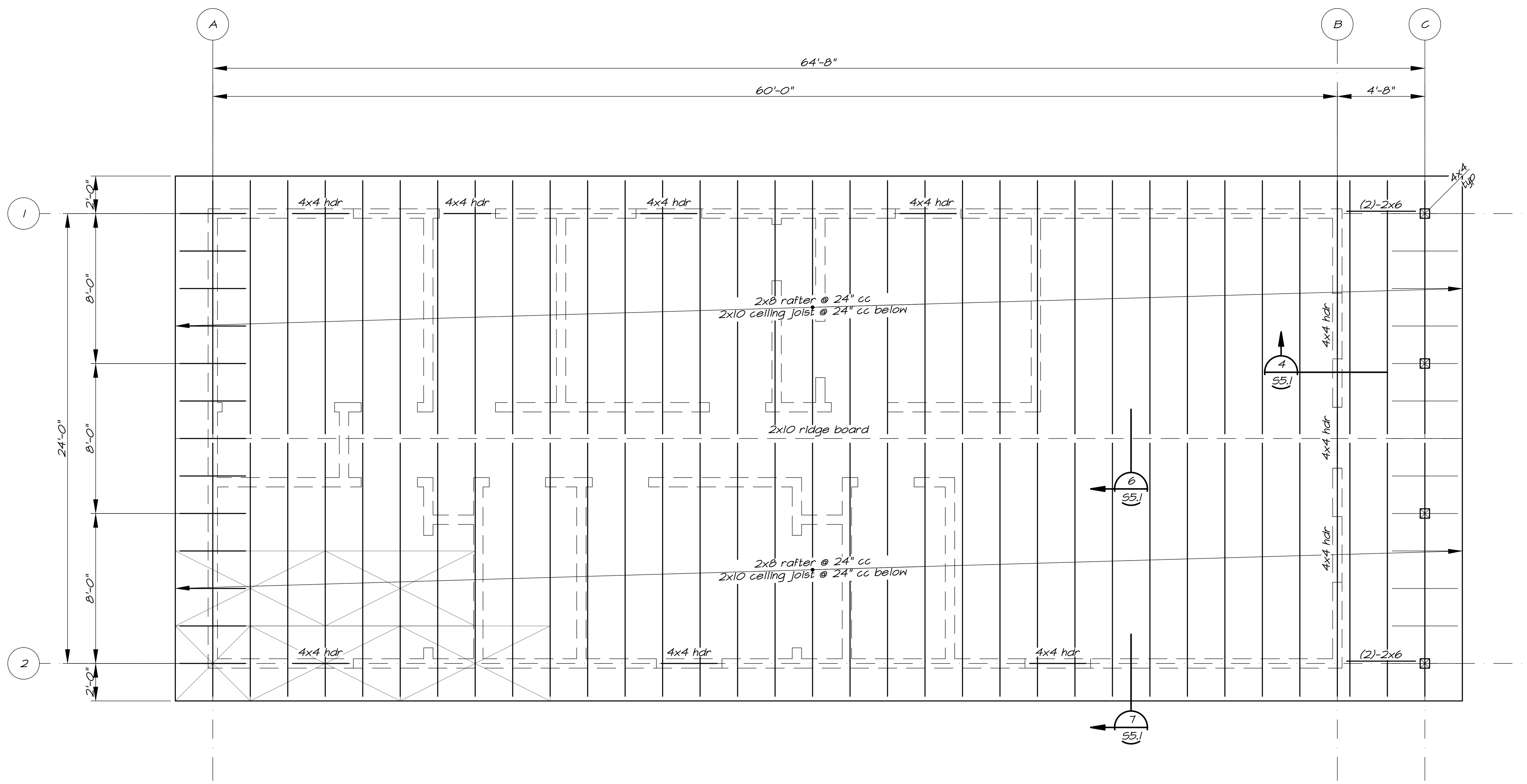
CHECKED	
APPROVED	

FLOOR FRAMING PLAN

1/4" = 1'-0" SCALE

SHEET

S2.2B



1 S2.3 **Roof Framing Plan**

1/4"=1'-0" Prescriptive compliant

North

Roof Framing Notes

1. ☒ Indicates wood post. See Foundation Plan for size.
2. Ceiling joists must be 2x10 Southern Pine Structural Select or better.

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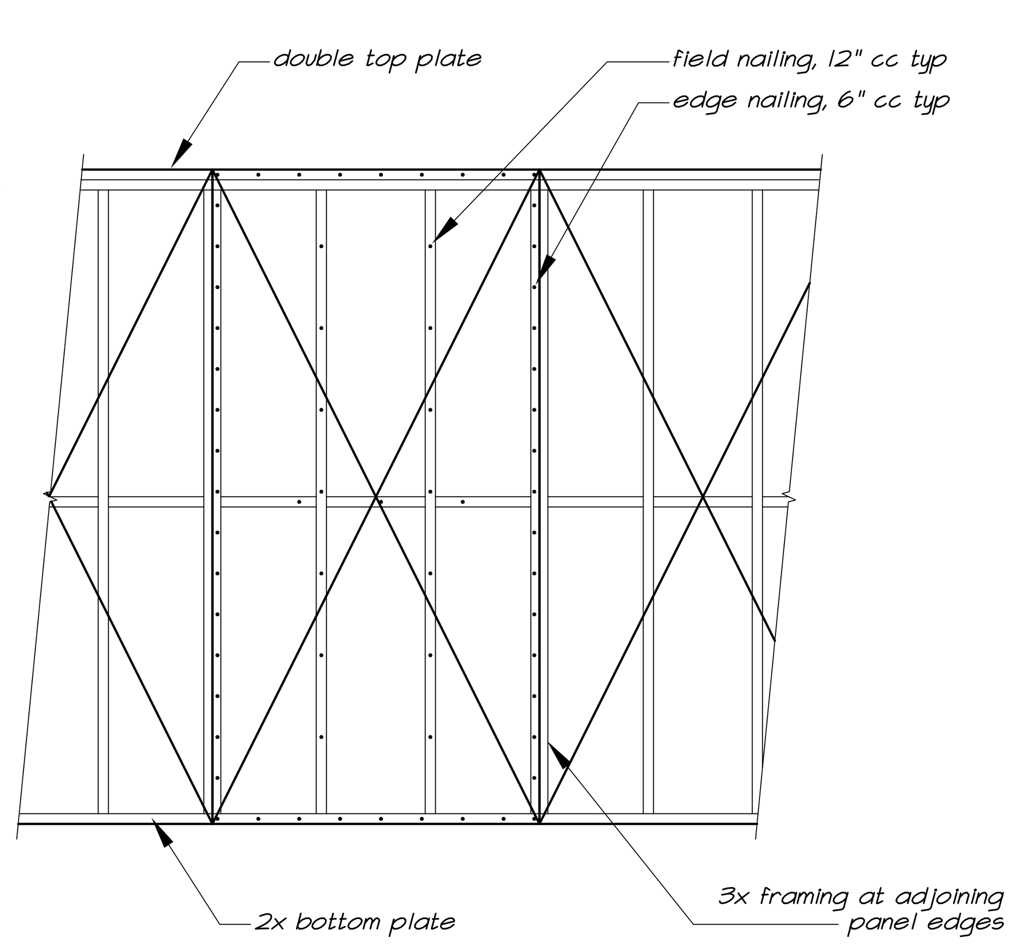
SHEET INFORMATION	
DATE	12.31.2019
JOB NUMBER	
DRAWN	DHH
CHECKED	
APPROVED	

ROOF FRAMING PLAN

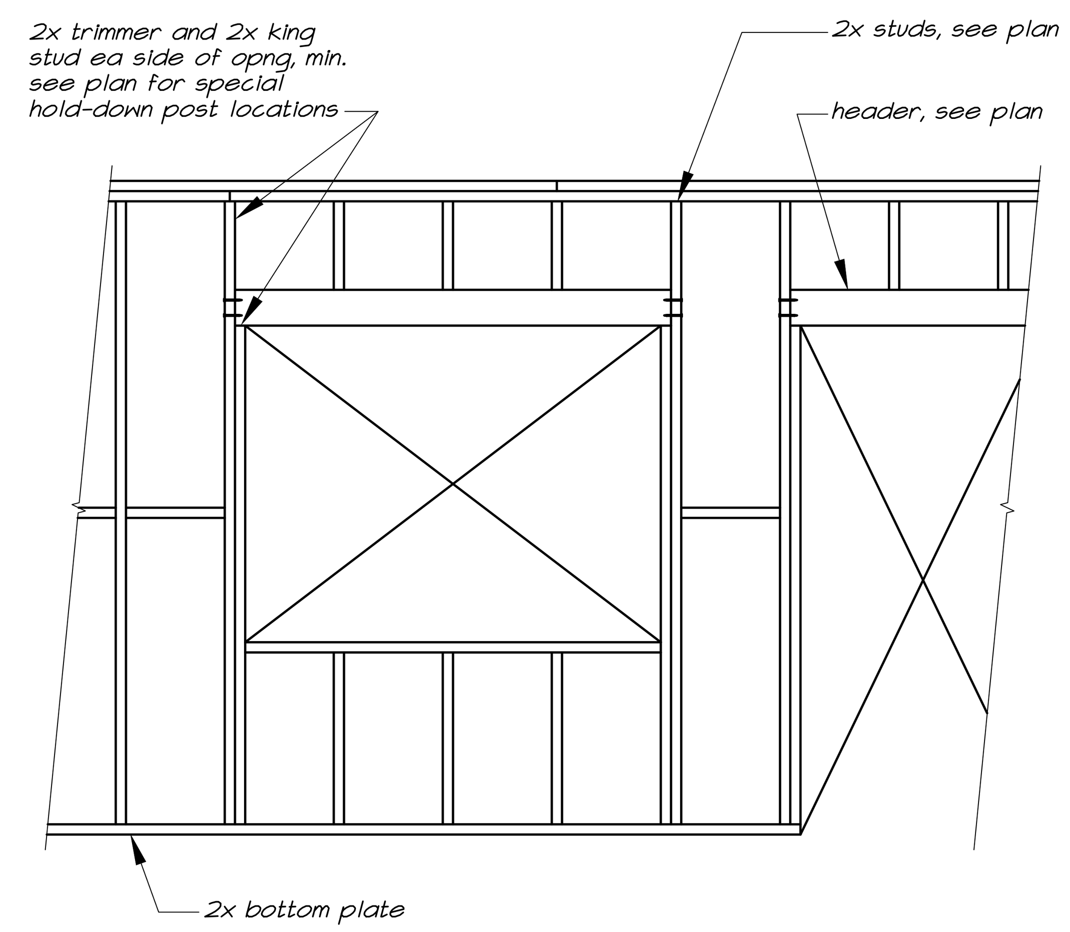
1/4" = 1'-0" SCALE

SHEET

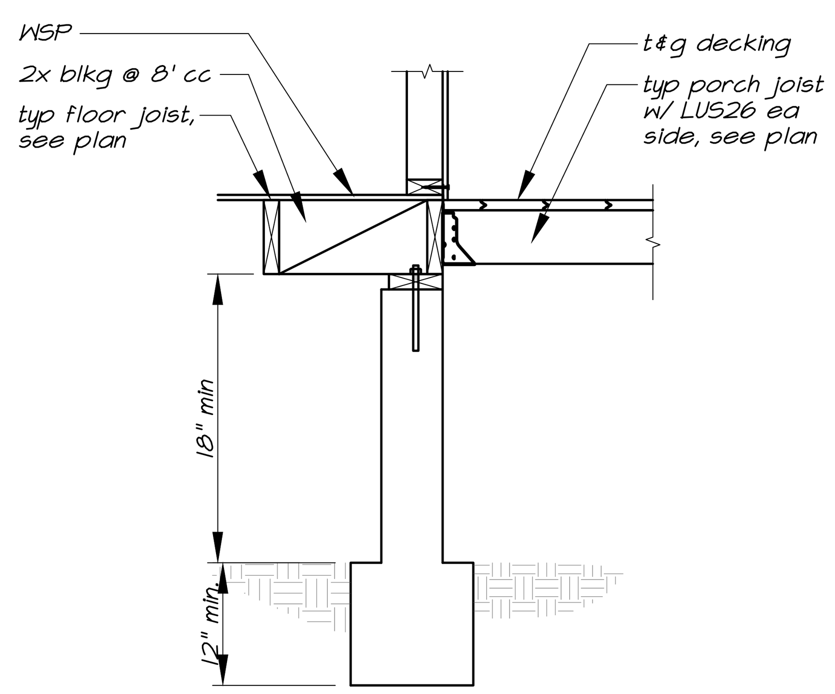
S2.3



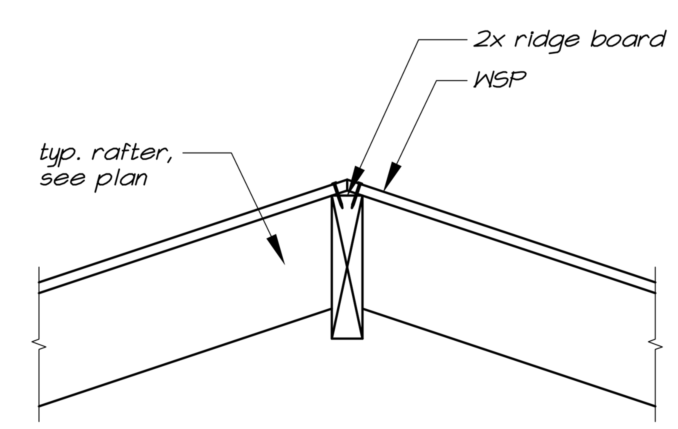
8 S5.1 Detail
½"=1'-0"



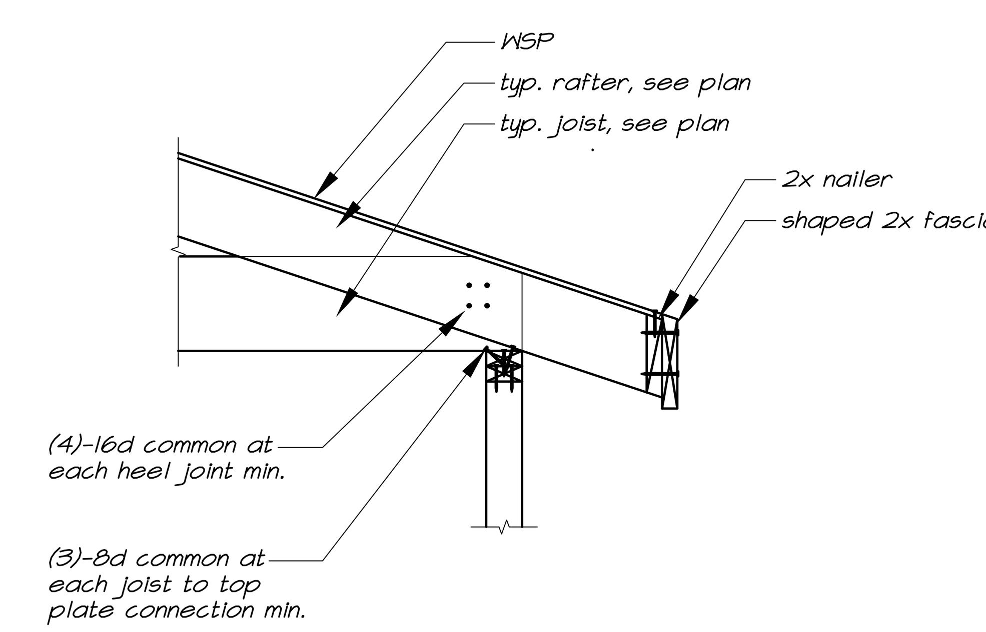
9 S5.1 Detail
½"=1'-0"



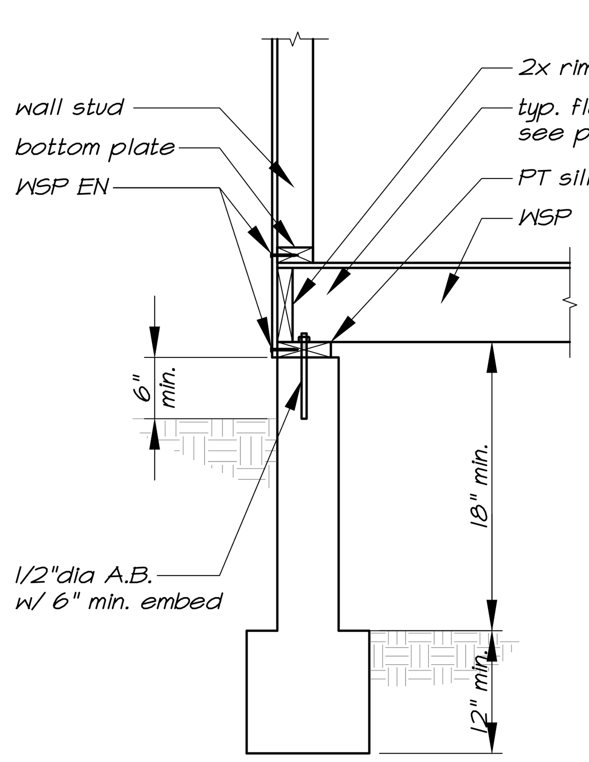
5 S5.1 Detail
¾"=1'-0"



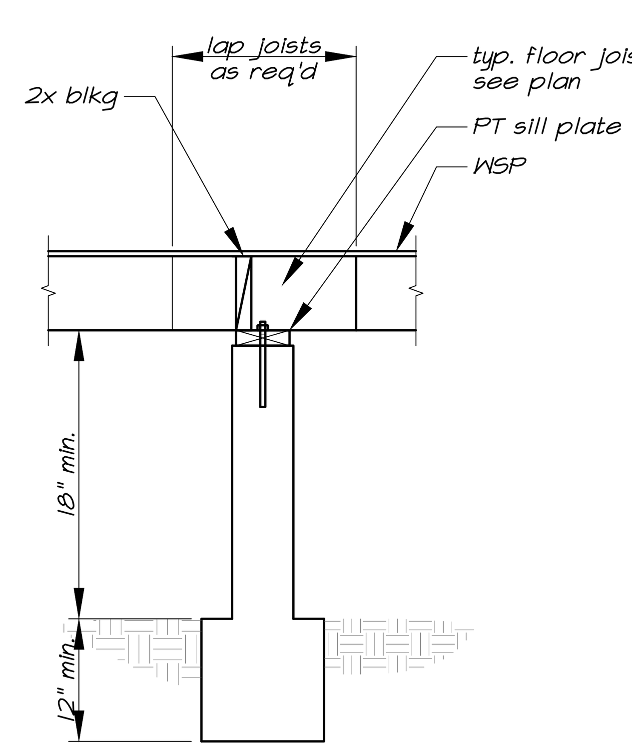
6 S5.1 Detail
1½"=1'-0"



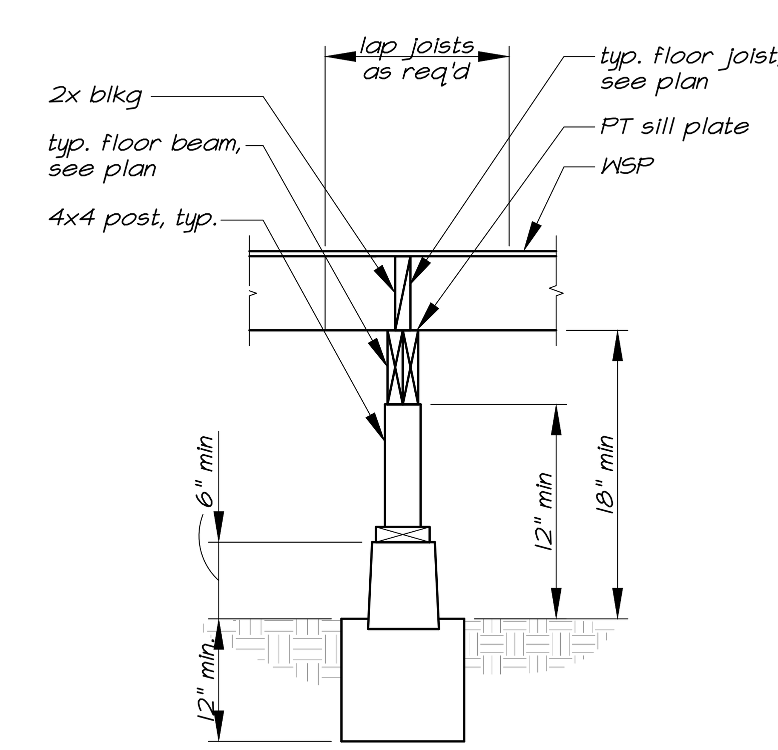
7 S5.1 Detail
¾"=1'-0"



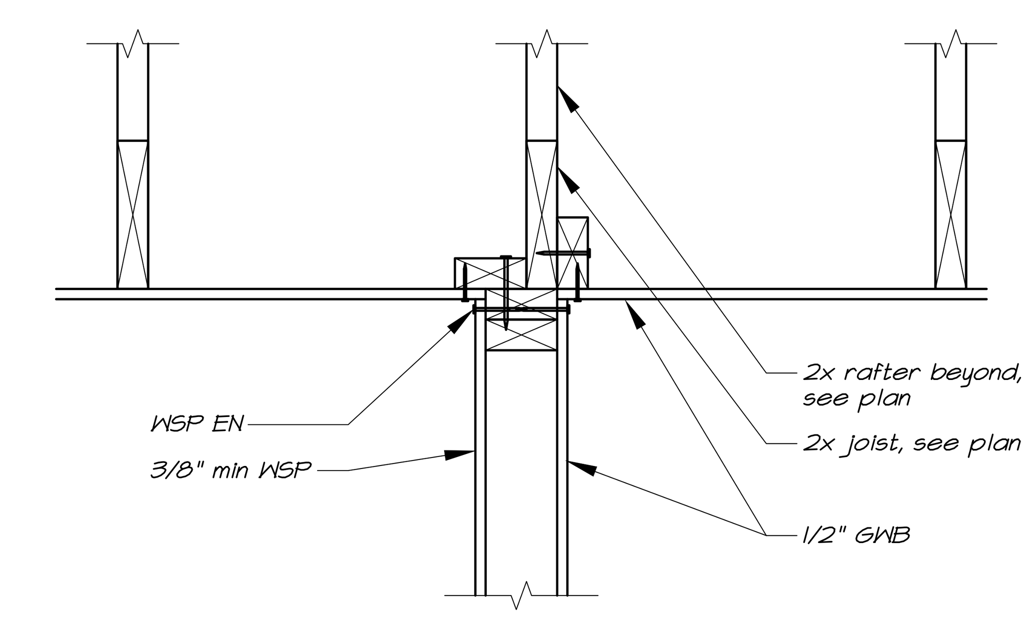
1 S5.1 Detail
¾"=1'-0"



2 S5.1 Detail
¾"=1'-0" Prescriptive



3 S5.1 Detail
¾"=1'-0" Engineered



4 S5.1 Detail
1½"=1'-0"

3BR/2BA

Habitat for Humanity Huntington, WV

DRAWING ISSUE / REVISIONS

NO	DESCRIPTION	DATE
0	ORIGINAL	12.31.2019

SHEET INFORMATION

DATE	12.31.2019
JOB NUMBER	
DRAWN	DHH
CHECKED	
APPROVED	

DETAILS

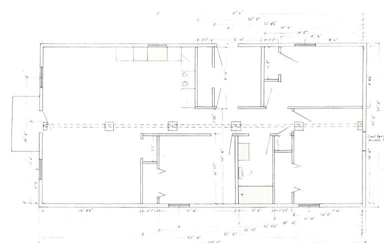
varies SCALE

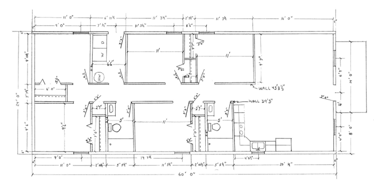
SHEET

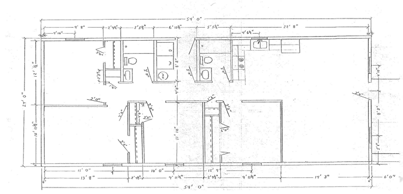
S5.1

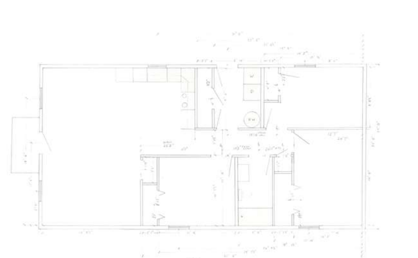
A Look At Prescriptive "Design"

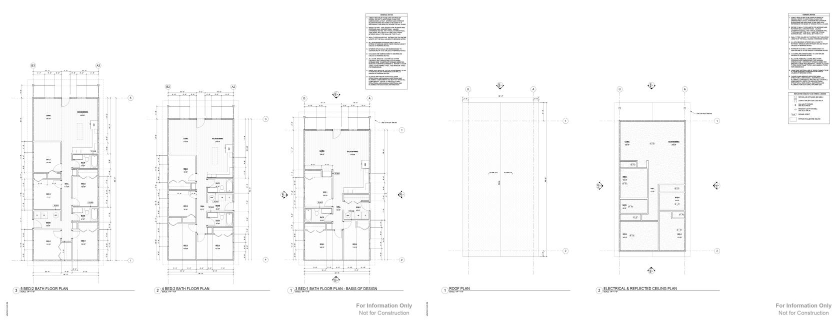
Presented by
David Hsu










For Information Only
Not for Construction
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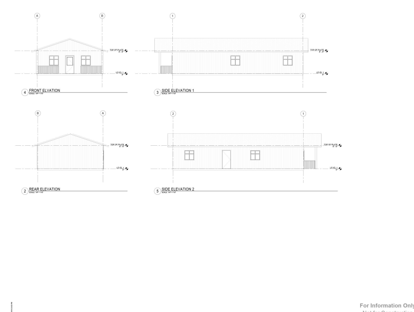
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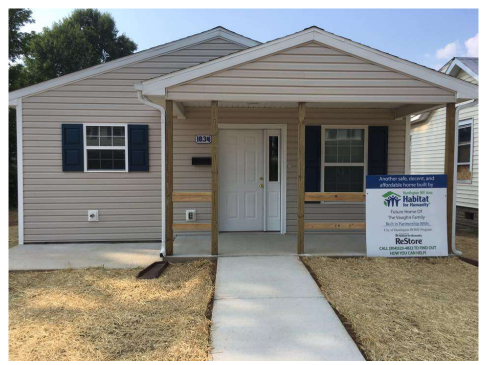

Do you need a stamp?

- Huntington West Virginia Municipal Code 1711.01.a
  - Adopts the IBC as the official building code of the city
- IBC 2015 101.2
  - Explicitly points towards IRC for construction of detached one- and two-family dwellings and townhouses less than three stories tall.
- IRC 2015 105.1, 106.1
  - Construction documents must be prepared by a “registered design professional”
- West Virginia Legislature §30-12-12
  - A detached single family dwelling is an exception to needing a professional license

1711.01 - ADOPTION.

(a) The International Building Code 2015 adopted as the Official Building Code of the State of West Virginia, as promulgated by the State Fire Commission pursuant to W. Va. Code §§ 29-3-5b, 8-12-13, and 7-1-3n, as amended, together with any amendments and modifications thereto as may hereafter be adopted and promulgated from time to time by the Commission, is hereby adopted as the Official Building Code of the City.

(b) The City of Huntington does not adopt any of the additional appendices authorized pursuant to the W. Va. Legislative Rule identified as § 87-4-1, et seq. and specifically authorized in § 87-4-7(7.3).

(c) The City of Huntington does adopt the provisions of the national codes with respect to the penalty for imprisonment, but the penalty for any violation shall be limited to a maximum of $500 and/or 30 days imprisonment for any single violation.

(d) The City of Huntington does not reject the International Property Maintenance Code and hereby incorporates said Code in its adoption of the Official Building Code.

(Ord. of 11-27-06; Ord. of 6-28-10(1); Ord. of 10-15-13(1); Ord. of 9-12-16(2))

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  - Explicitly points towards IRC for construction of detached one- and two-family dwellings and townhouses less than three stories tall.
- IRC 2015 105.1, 106.1
  - Construction documents must be prepared by a "registered design professional"
- West Virginia Legislature §30-12-12
  - A detached single family dwelling is an exception to needing a professional license

101.2 Scope

The provisions of this code shall apply to the construction, *alteration*, relocation, enlargement, replacement, *repair*, equipment, use and occupancy, location, maintenance, removal and demolition of every building or structure or any appurtenances connected or attached to such buildings or structures.

Exception: Detached one- and two-family *dwellings* and multiple single-family *dwellings (townhouses)* not more than three *stories above grade plane* in height with a separate *means of egress*, and their accessory structures not more than three *stories above grade plane* in height, shall comply with the *International Residential Code*.

Do you need a stamp?

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  - Adopts the IBC as the official building code of the city
- IBC 2015 101.2
  - Explicitly points towards IRC for construction of detached one- and two-family dwellings and townhouses less than three stories tall.
- IRC 2015 105.1, 106.1
  - Construction documents must be prepared by a "registered design professional"
- West Virginia Legislature §30-12-12
  - A detached single family dwelling is an exception to needing a professional license

R105.1 Required

Any owner or owner's authorized agent who intends to construct, enlarge, alter, repair, move, demolish or change the occupancy of a building or structure, or to erect, install, enlarge, alter, repair, remove, convert or replace any electrical, gas, mechanical or plumbing system, the installation of which is regulated by this code, or to cause any such work to be performed, shall first make application to the building official and obtain the required permit.

R106.1 Submittal Documents

Submittal documents consisting of *construction documents*, and other data shall be submitted in two or more sets with each application for a *permit*. The *construction documents* shall be prepared by a registered *design professional* where required by the statutes of the *jurisdiction* in which the project is to be constructed. Where special conditions exist, the *building official* is authorized to require additional *construction documents* to be prepared by a registered *design professional*.

Habitat for Humanity®

Do you need a stamp?

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- IBC 2015 101.2
  - Explicitly points towards IRC for construction of detached one- and two-family dwellings and townhouses less than three stories tall.
- IRC 2015 105.1, 106.1
  - Construction documents must be prepared by a “registered design professional”
- West Virginia Legislature §30-12-12
  - A detached single family dwelling is an exception to needing a professional license

§30-12-12. Exceptions.

Nothing in this article may be construed to prevent:

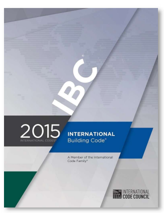
(a) Any of the activities that, apart from this exemption, would constitute the practice of architecture, if performed in connection with any of the following:

(1) A detached single family dwelling and any sheds, storage buildings and garages incidental thereto;

(2) A multifamily residential structure not in excess of three stories excluding any basement area;

(3) Farm buildings, including barns, silos, sheds, or housing for farm equipment and machinery, ...

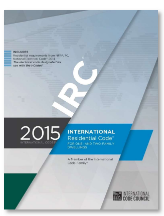
Prescriptive Design



2301.2 General design requirements.

The design of structural elements or systems, constructed partially or wholly of wood or wood-based products, shall be in accordance with one of the following methods:

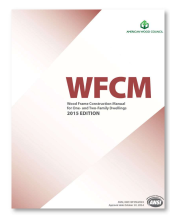
1. *Allowable stress design* in accordance with Sections 2304, 2305 and 2306.
2. *Load and resistance factor design* in accordance with Sections 2304, 2305, 2307.
3. *Conventional light-frame construction* in accordance with Sections 2304 and 2308.
4. AWC WFCM in accordance with Section 2309.
5. The design and construction of log structures in accordance with the provisions of ICC 400.



R301.1 Alternative provisions.

As an alternative to the requirements in Section R301.1, the following standards are permitted subject to the limitations of this code and the limitations therein. Where engineered design is used in conjunction with these standards, the design shall comply with the *International Building Code*.

1. AF&PA *Wood Frame Construction Manual* (WFCM).
2. AISI Standard for Cold-Formed Steel Framing – Prescriptive Method for One- and Two-Family Dwellings (AISI S230).
3. ICC *Standard on the Design and Construction of Log Structures* (ICC 400)



Prescriptive Criteria Check

Table 3 Prescriptive Design Limitations

	Attribute	Limitation	Reference Section	Figures
BUILDING DIMENSIONS				
Building	Mean Roof Height (MRH)	33'	2.1.3.1	1.2
	Number of Stories	3	1.1.3.1a	-
	Building Length and Width	80'	1.1.3.1b	-
FLOOR SYSTEMS				
Lumber Joists	Joist Span	26'	3.1.3.2a	-
	Joist Spacing	24" o.c.	3.1.3.2b	-
	Cantilevers - Supporting loadbearing walls[1]	d	3.1.3.2c	2.1a
	Setbacks - Loadbearing walls[1]	d	3.1.3.2d	2.1d
Floor Diaphragm	Vertical Floor Offset	d_f	3.1.3.2e	2.1i
	Floor Diaphragm Aspect Ratio	Tables 3.16B and 3.16C	3.1.3.2f	-
	Floor Diaphragm Openings	Lesser of 12' or 50% of Building Dimension	3.1.3.2g	2.1k
WALL SYSTEMS				
Wall Studs	Loadbearing Wall Height	10'	3.1.3.3a	-
	Non-Loadbearing Wall Height	20'	3.1.3.3a	-
	Wall Stud Spacing	24" o.c.	3.1.3.3b	-
Shear Walls	Shear Wall Line Offset[1]	4'	3.1.3.3c	2.1ℓ, 3.1b
	Shear Wall Story Offset[1]	No offset unless per Exception	3.1.3.3d	
	Shear Wall Segment Aspect Ratio	Table 3.17D	3.1.3.3e	
ROOF SYSTEMS				
Lumber Rafters	Rafter Span (Horizontal Projection)[2]	26'	3.1.3.4a	-
	Rafter Spacing	24" o.c.	3.1.3.4b	-
	Eave Overhang Length[1]	Lesser of 2' or rafter span/3	3.1.3.4c	2.1f
	Rake Overhang Length[1]	Lesser of 2' or purlin span/2	3.1.3.4c	2.1g
	Roof Slope	Flat - 12:12	3.1.3.4d	-
Roof Diaphragms	Roof Diaphragm Aspect Ratio[1]	Tables 3.16A and 3.16C	3.1.3.4e	-

2308.2 Limitations.

Buildings are permitted to be constructed in accordance with the provisions of *conventional light-frame construction*, subject to the limitations in Sections 2308.2.1 through 2308.2.6.

2308.2.1 Stories.

Structures of *conventional light-frame construction* shall be limited in *story* height in accordance with Table 2308.2.1.

TABLE 2308.2.1
ALLOWABLE STORY HEIGHT

SEISMIC DESIGN CATEGORY	ALLOWABLE STORY ABOVE GRADE PLANE
A and B	Three stories
C	Two stories
D and E[a]	One story

For SI: 1 inch = 25.4 mm.

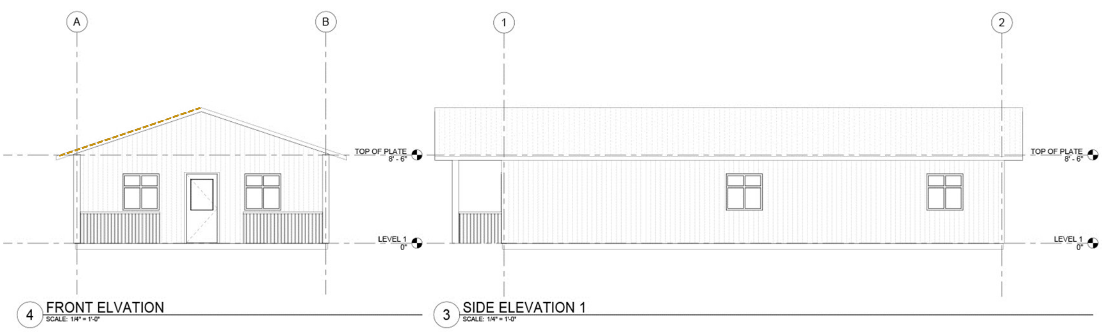
a. For the purposes of this section, for buildings assigned to *Seismic Design Category* D or E, cripple walls shall be considered to be a *story* unless cripple walls are solid blocked and do not exceed 14 inches in height.

2308.2.2 Allowable floor-to-floor height.

Maximum floor-to-floor height shall not exceed 11 feet, 7 inches (3531 mm). Exterior bearing wall and interior braced wall heights shall not exceed a stud height of 10 feet (3048 mm).

Typical Rafter

Design assumptions: use Southern Pine, simplified 14’ span



Typical roof rafter

$L = 14', s = 24"$

DL = 16 psf

LL_r = 20 psf typical sloped roof, irreducible

Governing load combination: D + Lr

$w_u = (16 + 20) * 2' = 72\,plf$

$w_L = (20) * 2' = 40\,plf$

$w_{0.5D+L} = (0.5 * 16 + 20) * 2' = 56\,plf$

$M_u = w_u\,L^2/8 = 72 * 14^2/8 = 1764\,\# - ft = 21168\,\# - in$

presume Southern Pine #2 $E = 1400000\,psi$

$\Delta_{L,max} = L/240 = 14 * 12/240 = 0.7"$

$\rightarrow I_{req} = 5\,w_L\,L^4/(384\,E\,\Delta_{max}) = 35.3\,in^4$

$\Delta_{0.5D+L,max} = L/180 = 14 * 12/180 = 0.9"$

$\rightarrow I_{req} = 5\,w_{0.5D+L}\,L^4/(384\,E\,\Delta_{max}) = 38.4\,in^4$

presume 2x8 $I_x = 47.63\,in^4, S_x = 13.14\,in^3$

(Table 4B) $F_b' = F_b * C_D * C_r = 1100\,psi * 1.25 * 1.15 = 1581\,psi$

$f_b = M_u/S_x = 21168/13.14 = 1611\,psi > F_b' = 1581\,psi\ NG$

try #1 $E = 1600000\,psi$

$F_b' = 1500 * C_D * C_r = 1500\,psi * 1.25 * 1.15 = 2156\,psi > f_b = 1611\,psi\ OK$

<u>**use 2x8 Southern Pine #1 or btr**</u>

Table 3.26A Rafter Spans for Common Lumber Species

(Ceiling Not Attached to Rafters) Live Load = 20 psf, $L/\Delta_{LL} = 180$

LL = 20 psf

L/Δ_{LL} = 180

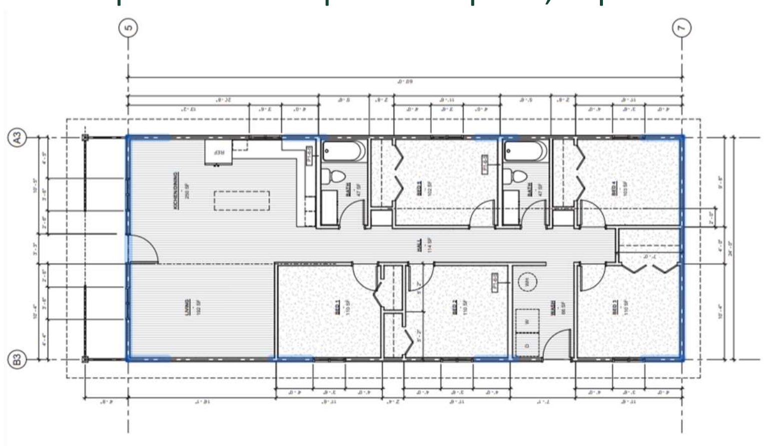
			Dead Load = 10 psf					Dead Load = 20 psf				
			2x4	2x6	2x8	2x10	2x12	2x4	2x6	2x8	2x10	2x12
			Maximum Rafter Spans[1,2,3,4]									
Joist Spacing (in.)	Species	Grade	(ft-in.)	(ft-in.)	(ft-in.)	(ft-in.)	(ft-in.)	(ft-in.)	(ft-in.)	(ft-in.)	(ft-in.)	(ft-in.)
12	Douglas Fir-Larch	SS	11 - 6	18 - 0	23 - 9	26-0†	26-0†	11 - 6	18 - 0	23 - 9	26-0†	26-0†
	Douglas Fir-Larch	No.1	11 - 1	17 - 4	22 - 5	26-0†	26-0†	10 - 6	15 - 4	19 - 5	23 - 9	26-0†
	Douglas Fir-Larch	No.2	10 - 10	16 - 10	21 - 4	26-0†	26-0†	10 - 0	14 - 7	18 - 5	22 - 6	26-0†
	Douglas Fir-Larch	No.3	8 - 9	12 - 10	16 - 3	19 - 10	23 - 0	7 - 7	11 - 1	14 - 1	17 - 2	19 - 11
	Hem-Fir	SS	10 - 10	17 - 0	22 - 5	26-0†	26-0†	10 - 10	17 - 0	22 - 5	26-0†	26-0†
	Hem-Fir	No.1	10 - 7	16 - 8	22 - 0	26-0†	26-0†	10 - 4	15 - 2	19 - 2	23 - 5	26-0†
	Hem-Fir	No.2	10 - 1	15 - 11	20 - 8	25 - 3	26-0†	9 - 8	14 - 2	17 - 11	21 - 11	25 - 5
	Hem-Fir	No.3	8 - 7	12 - 6	15 - 10	19 - 5	22 - 6	7 - 5	10 - 10	13 - 9	16 - 9	19 - 6
	Southern Pine	SS	11 - 3	17 - 8	23 - 4	26-0†	26-0†	11 - 3	17 - 8	23 - 4	26-0†	26-0†
24	Douglas Fir-Larch	No.2	8 - 2	11 - 11	15 - 1	18 - 5	21 - 4	7 - 0	10 - 4	13 - 0	15 - 11	18 - 6
	Douglas Fir-Larch	No.3	6 - 2	9 - 1	11 - 6	14 - 1	16 - 3	5 - 4	7 - 10	10 - 0	12 - 2	14 - 1
	Hem-Fir	SS	8 - 7	13 - 6	17 - 10	22 - 9	26-0†	8 - 7	12 - 10	16 - 3	19 - 10	23 - 0
	Hem-Fir	No.1	8 - 5	12 - 4	15 - 8	19 - 2	22 - 2	7 - 4	10 - 9	13 - 7	16 - 7	19 - 3
	Hem-Fir	No.2	7 - 11	11 - 7	14 - 8	17 - 10	20 - 9	6 - 10	10 - 0	12 - 8	15 - 6	17 - 11
	Hem-Fir	No.3	6 - 1	8 - 10	11 - 3	13 - 8	15 - 11	5 - 3	7 - 8	9 - 9	11 - 10	13 - 9
	Southern Pine	SS	8 - 11	14 - 1	18 - 6	23 - 8	26-0†	8 - 11	13 - 10	17 - 6	20 - 10	24 - 8
	Southern Pine	No.1	8 - 7	12 - 9	16 - 2	18 - 11	22 - 6	7 - 5	11 - 1	14 - 0	16 - 5	19 - 6
	Southern Pine	No.2	7 - 4	11 - 0	13 - 11	16 - 6	19 - 6	6 - 4	9 - 6	12 - 1	14 - 4	16 - 10
	Southern Pine	No.3	5 - 8	8 - 4	10 - 6	12 - 9	15 - 1	4 - 11	7 - 3	9 - 1	11 - 0	13 - 1
	Spruce-Pine Fir	SS	8 - 5	13 - 3	17 - 5	21 - 8	25 - 2	8 - 4	12 - 2	15 - 4	18 - 9	21 - 9
	Spruce-Pine Fir	No.1	8 - 0	11 - 9	14 - 10	18 - 2	21 - 0	6 - 11	10 - 2	12 - 10	15 - 8	18 - 3

Typical Rafter 4 ways

Engineered	2x8 Southern Pine #1	
IBC	2x8 Southern Pine #1 2x10 Southern Pine #2	2308.7.2(1)
IRC	2x8 Southern Pine #1 2x10 Southern Pine #2	R802.5.1(1)
WFCM	2x8 Southern Pine #1 2x10 Southern Pine #2	T3.26A

Shear Walls (WSP)

Design assumptions: 110 mph wind speed, Exposure B



R602.12 Simplified wall bracing.

Buildings meeting all of the conditions listed below shall be permitted to be braced in accordance with this section as an alternate to the requirements of Section R602.10. The entire building shall be braced in accordance with this section; the use of other bracing provisions of Section R602.10, except as specified herein, shall not be permitted.

1. There shall be not more than three stories above the top of a concrete or masonry foundation or basement wall. Permanent wood foundations shall not be permitted.
2. Floors shall not cantilever more than 24 inches (607 mm) beyond the foundation or bearing wall below.
3. Wall height shall not be greater than 10 feet (3048 mm).
4. The building shall have a roof eave-to-ridge height of 15 feet (4572 mm) or less.
5. Exterior walls shall have gypsum board with a minimum thickness of $^1/_2$ inch (12.7 mm) installed on the interior side fastened in accordance with Table R702.3.5.
6. The structure shall be located where the ultimate design wind speed is less than or equal to 130 mph (58 m/s), and the exposure category is B or C.
7. The structure shall be located in Seismic Design Category A, B or C for detached one- and two-family dwellings or Seismic Design Category A or B for townhouses.
8. Cripple walls shall not be permitted in three-story buildings.

R602.12.3 Bracing unit.

A bracing unit shall be a full-height sheathed segment of the exterior wall without openings or vertical or horizontal offsets and a minimum length as specified herein. Interior walls shall not contribute toward the amount of required bracing. Mixing of Items 1 and 2 is prohibited on the same story.

1. Where all framed portions of all exterior walls are sheathed in accordance with Section R602.12.2, including wall areas between bracing units, above and below openings and on gable end walls, the minimum length of a bracing unit shall be 3 feet (914 mm).
2. Where the exterior walls are braced with sheathing panels in accordance with Section R602.12.2 and areas between bracing units are covered with other materials, the minimum length of a bracing unit shall be 4 feet (1219 mm).

TABLE R602.12.4
MINIMUM NUMBER OF BRACING UNITS ON EACH SIDE OF THE CIRCUMSCRIBED RECTANGLE

ULTIMATE DESIGN WIND SPEED (mph)	STORY LEVEL	EAVE-TO-RIDGE HEIGHT (feet)	MINIMUM NUMBER OF BRACING UNITS ON EACH LONG SIDE[a, b, d]						MINIMUM NUMBER OF BRACING UNITS ON EACH SHORT SIDE[a, b, d]					
			Length of short side (feet)[c]						Length of long side (feet)[c]					
			10	20	30	40	50	60	10	20	30	40	50	60
115		10	1	2	2	2	3	3	1	2	2	2	3	3
			2	3	3	4	5	6	2	3	3	4	5	6
			2	3	4	6	7	8	2	3	4	6	7	8
		15	1	2	3	3	4	4	1	2	3	3	4	4
			2	3	4	5	6	7	2	3	4	5	6	7

Shear Walls 4 ways (EW direction)		
Engineered	3/8” WSP w/ 8d @ 6”, 6”, 12” 16’ required of shear wall required ≈ 8’ required *per braced wall line* *	
IBC	3/8” WSP w/ 8d @ 6”, 6”, 12” “Each end and ≤ 25’-0” o.c.” ≈ 8’ required *per braced wall line*	2308.6.1
IRC	3/8” WSP w/ 8d @ 6”, 6”, 12” 3 bracing units ≈ 9’ required per *braced wall line*	R602.12.4
WFCM	7/16” OSB or 15/32” plywood 9.1’ required *per shear wall line* *	T3.4B T3.17A

Cookbook OK?

- Prescriptive/tabulated approach meets rigor and intent of code
- Sometimes overstressed (e.g. holdowns)
- Sometimes limiting (e.g. headers, joists)

Table 3.22A1 Laterally Unsupported (Dropped) Header Spans for Exterior Loadbearing Walls **Dropped Exterior**

(Supporting a Roof and Ceiling)

Dead Load Assumptions: Roof/Ceiling Assembly = 20 psf, L/Δ_{LL}=240

Headers Supporting	Size	Roof Live Load 20 psf			Ground Snow Load 30 psf			50 psf			70 psf		
		Building Width (ft)											
		12	24	36	12	24	36	12	24	36	12	24	36
		Maximum Header/Girder Spans (ft-in.) for Common Lumber Species[1,3,4]											
Roof and Ceiling	1-2x6	4 - 4	3 - 4	2 - 9	3 - 11	3 - 0	2 - 7	3 - 4	2 - 7	2 - 2	3 - 0	2 - 4	2 - 0
	1-2x8	5 - 3	4 - 1	3 - 6	4 - 10	3 - 9	3 - 3	4 - 2	3 - 3	2 - 9	3 - 9	2 - 11	2 - 6
	1-2x10	6 - 0	4 - 9	4 - 0	5 - 7	4 - 5	3 - 9	4 - 10	3 - 10	3 - 3	4 - 4	3 - 5	2 - 11
	1-2x12	6 - 6	5 - 3	4 - 7	6 - 2	5 - 0	4 - 4	5 - 5	4 - 5	3 - 9	4 - 11	4 - 0	3 - 4
	2-2x4	4 - 4	3 - 3	2 - 9	3 - 11	3 - 0	2 - 7	3 - 4	2 - 7	2 - 2	3 - 0	2 - 4	1 - 11
	2-2x6	6 - 2	4 - 10	4 - 1	5 - 8	4 - 5	3 - 9	4 - 11	3 - 10	3 - 3	4 - 5	3 - 5	2 - 11
	2-2x8	7 - 2	5 - 9	4 - 11	6 - 9	5 - 5	4 - 8	5 - 11	4 - 8	4 - 0	5 - 4	4 - 3	3 - 7
	2-2x10	7 - 10	6 - 4	5 - 6	7 - 6	6 - 1	5 - 3	6 - 7	5 - 4	4 - 8	6 - 0	4 - 10	4 - 2
	2-2x12	8 - 5	6 - 10	6 - 0	8 - 1	6 - 7	5 - 10	7 - 2	5 - 11	5 - 2	6 - 6	5 - 5	4 - 9
	3-2x8	8 - 5	6 - 10	5 - 11	8 - 0	6 - 6	5 - 7	7 - 1	5 - 8	4 - 11	6 - 5	5 - 2	4 - 5
	3-2x10	9 - 2	7 - 5	6 - 6	8 - 9	7 - 2	6 - 3	7 - 9	6 - 4	5 - 6	7 - 1	5 - 9	5 - 0
	3-2x12	9 - 9	8 - 0	7 - 0	9 - 4	7 - 8	6 - 9	8 - 4	6 - 10	6 - 1	7 - 8	6 - 3	5 - 7
	4-2x8	9 - 4	7 - 7	6 - 8	8 - 11	7 - 3	6 - 4	7 - 11	6 - 5	5 - 7	7 - 2	5 - 10	5 - 0
	4-2x10	10 - 2	8 - 3	7 - 3	9 - 8	8 - 0	7 - 0	8 - 8	7 - 1	6 - 3	7 - 11	6 - 6	5 - 8
	4-2x12	10 - 10	8 - 10	7 - 9	10 - 4	8 - 7	7 - 6	9 - 3	7 - 8	6 - 9	8 - 6	7 - 0	6 - 2
	Size	Maximum Header/Girder Spans (ft-in.) for Glued Laminated Timber Beams[2,3,4]											
	3.125x5.500	8 - 5	6 - 10	5 - 8	8 - 1	6 - 3	5 - 3	7 - 0	5 - 4	4 - 6	6 - 2	4 - 9	4 - 0
	3.125x6.875	10 - 7	8 - 5	7 - 1	10 - 1	7 - 9	6 - 7	8 - 8	6 - 8	5 - 7	7 - 8	5 - 11	5 - 0
	3.125x8.250	12 - 8	10 - 1	8 - 5	12 - 0	9 - 3	7 - 10	10 - 3	8 - 0	6 - 9	9 - 2	7 - 1	6 - 0
	3.125x9.625	14 - 9	11 - 6	9 - 9	13 - 8	10 - 8	9 - 0	11 - 10	9 - 2	7 - 9	10 - 7	8 - 3	6 - 11
	3.125x11.000	16 - 1	12 - 10	10 - 11	15 - 1	12 - 0	10 - 2	13 - 2	10 - 4	8 - 10	11 - 10	9 - 3	7 - 10
	3.125x12.375	17 - 1	13 - 9	11 - 11	16 - 2	13 - 1	11 - 3	14 - 3	11 - 5	9 - 9	12 - 11	10 - 3	8 - 9
	3.125x13.750	17 - 10	14 - 7	12 - 8	17 - 0	13 - 11	12 - 1	15 - 1	12 - 3	10 - 7	13 - 9	11 - 1	9 - 6
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

What good is it?

- Allows an entrepreneurial homeowner/builder (or a dropout) to do much of the "structural" work on typical residential homes without an engineer
- Can produce a design without design analysis or load calculations