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Structural Option
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Wellington at Hershey's Mill
West Chester, Pennsylvania
10/31/2005

Structural Technical Report 2

Executive Summary

Wellington at Hershey's Mill is a retirement community located in West Chester, Pennsylvania. Consisting of 370,000 square feet and a total of 5 stories, Wellington offers 197 independent living apartments on the top three levels, a garage level directly below them, and a section with a lobby and offices for businesses within the building.

Technical report two is a comparison of the current floor system with the alternate systems that will be introduced and examined. At the conclusion of this report, it will be clear what options are viable as an alternate floor system for Wellington and which are not.

The existing floor system consists of a non-composite steel beam and concrete slab system for the lobby level and first level and a wood joist floor system bearing on wood framed walls for the second and third levels. The alternate systems being considered are:

- Pre-cast hollowcore plank system
- Wood Joist system
- One-way concrete joist construction (CRSI)
- Light-gauge steel system

The layouts of the systems were similar to the existing one due to the intended use of each level. Since the layouts are different between the first level and second and third levels, the same section on both the first and second levels will be evaluated for the alternate systems.

The systems were evaluated for cost, depth of the system, susceptibility to vibrations, fireproofing, and weight. The light-gauge steel system was determined to be the most efficient in cost, weight, and depth. The wood joist and hollowcore plank systems were not ruled out as possibilities but are not superior to the light-gauge system. The one-way concrete joist system was determined to not be an advantageous solution due to cost and construction time issues.

Existing Floor System

Wellington at Hershey's Mill is a 370,000 square foot retirement community in West Chester, Pennsylvania. Wellington includes 3 levels of independent living apartments, a garage level below the residential levels with a lobby alongside it, and a lower level containing the offices of doctors and other businesses for Wellington directly below the lobby.

Wellington has an existing system that combines a non-composite steel beam and concrete slab system on the lobby and first levels with a wood joist floor system bearing on wood framed walls on the second and third levels. There is a garage under the residential levels, which makes the first level framing different from the second and third levels. Because of this difference, a full section of the building will be evaluated instead of one typical bay. This evaluation will be of the first floor layout and the second and third floors' layout.

The following figures show the chosen section with the current floor system.

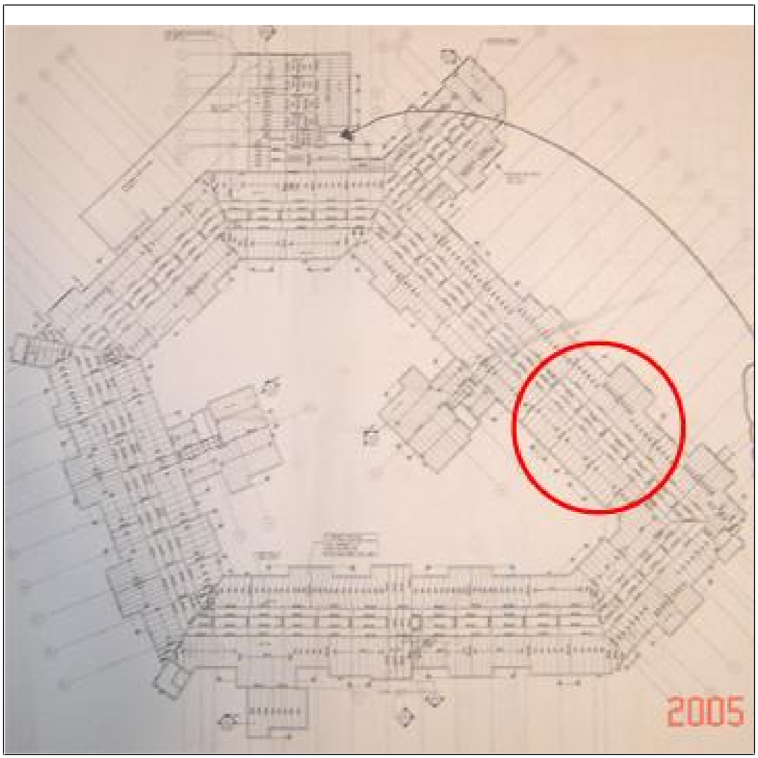


Figure 1

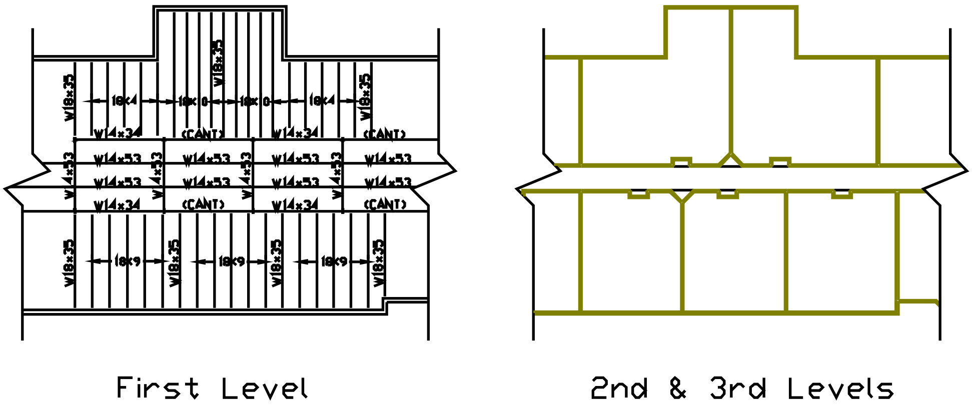


Figure 2

For the alternate systems, the layout will be the same as the existing system. It is important to remember the intended use of the floors when designing the structure. The first level framing has to be designed around the space needed for the maneuvering of cars in the garage. The center bay is 18’ wide in the existing system and will remain at this dimension for the alternate systems. For the second and third levels, the existing system has bearing walls separating the apartments and the corridor. In order to keep structural elements from disturbing the apartment layout, the same spacing will be used in the alternate systems again keeping the supporting members on either side of the corridor.

Many systems were considered but eliminated due to the restrictions mentioned above. The range of alternate system is limited due to this, but still shows a variety of options for Wellington.

Floor Loads

Assumed Dead Loads:

MEP = 10 psf
Carpet = 1 psf
Ceiling = 1 psf
Total = 12 psf

Live Loads: Private rooms & the corridors serving them: **40 psf**

Alternate System #1 – Pre-cast hollowcore plank system

This system was designed using the Nitterhouse Concrete Products Manual. The 8”-4’ Spandeck – U.L. – J952 with 2” topping was chosen for this system. Using a span of 12’ in the load table and a 4-1/2”ø strand pattern, it was determined that this plank was more than sufficient to carry the superimposed loads. This system will be bearing on masonry walls which were designed using an empirical design procedure.

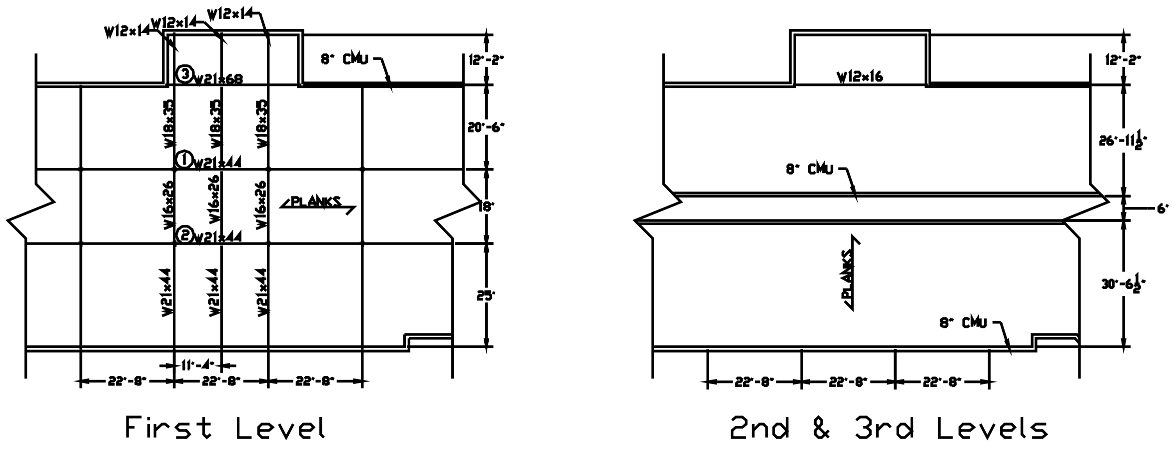


Figure A (1)

Pre-cast hollowcore planks are an excellent alternative for many reasons. Construction time is lessened because the planks are pre-cast and ready for quick installation in any type of weather. Cost is less of an issue when compared to a full concrete slab of the same depth because less concrete is used, which in turn provides a lighter weight floor system. On the second and third levels, the depth is only 10" total, which provides a higher ceiling. Other benefits are that no extra fireproofing is required, vibrations are reduced, and the planks are durable.

Alternate System #2 – Wood Joist Floor System

The wood joist floor system was designed using the TrusJoist TJI® 110, 210, 230, 360 & 560 Joists Beam, Header, and Column Specifier's Guides. The first floor will have wood columns as interior supports instead of interior masonry bearing walls. The second and third floors have the wood joists spanning from bearing wall to bearing wall. The wood columns were designed to be 7"x7" 1.8E Parallam PSL and the floor girder beams 5 ¼"x20" Microllam LVL. The joists were calculated to be 11 7/8" TJI 560 joists at 16" o.c. bearing on 10" ungrouted, unreinforced CMU. The joists for the second and third floors were designed to be 14" TJI 560 joists at 12" o.c. bearing on 10" ungrouted, unreinforced CMU.

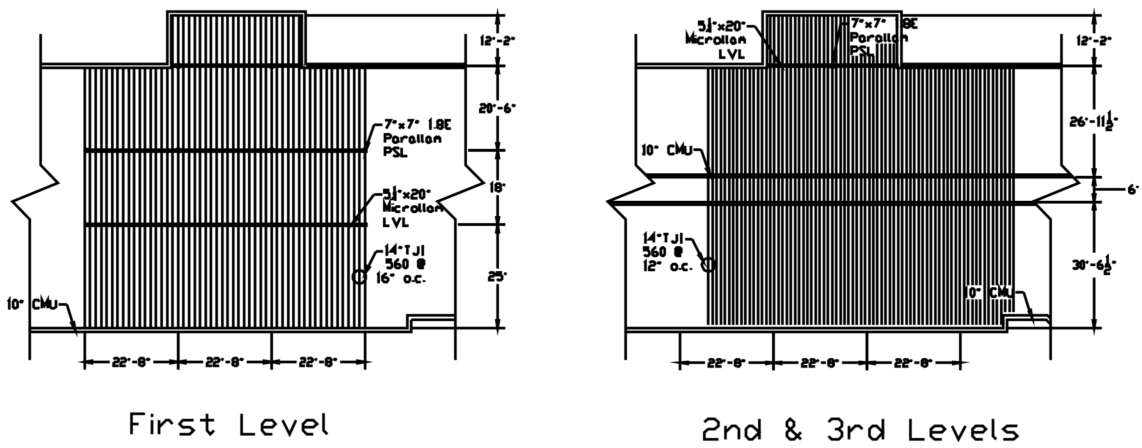


Figure A (2)

This system is an appropriate arrangement for the intended use of the building. The floors are lightweight and allow for faster installation because their components are premanufactured. Since wood is a combustible material and the joists are not manufactured to withstand fire, fireproofing is required by code. A negative aspect of this system is the limited sound proofing the wood provides in the floor. Vibrations can also be a disadvantage because of the flexible quality of wood. The system is also deeper than the other systems.

Alternate System #3 – One-way concrete Joist construction

A one-way concrete joist system consists of a monolithically cast-in-place slab, joist, and girder combination. The joists are evenly spaced spanning in one direction with a thin concrete slab over top. This system is also known as a concrete pan floor system and involves pan forms that are removed after the concrete is cured and finished.

The CRSI Design Handbook 2002 was used for the design of this system. 30" pans with a 12" rib depth and 3" top slab were selected. For a clear span of 22', a 5" rib at 35" c.c. was found to be sufficient. The system self weight is 63 psf. Deflection calculations were not necessary because the system thickness was greater than $l_n/18.5$ for the end span and greater than $l_n/21$ for the interior span. The girders were designed using the width calculated for the girder with the longest span and then used for the other girders to maintain a recurring system. The width of the girders was found to be 22" with a depth of 15" to equal the joist depth.

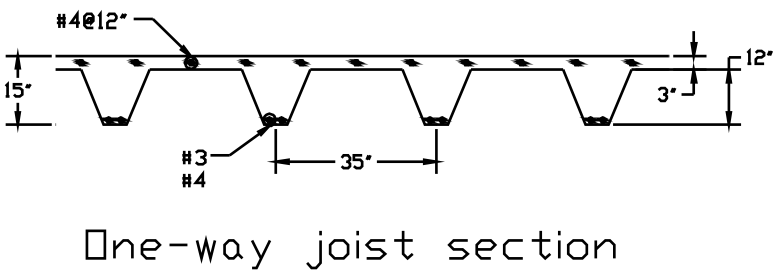


Figure A (3)

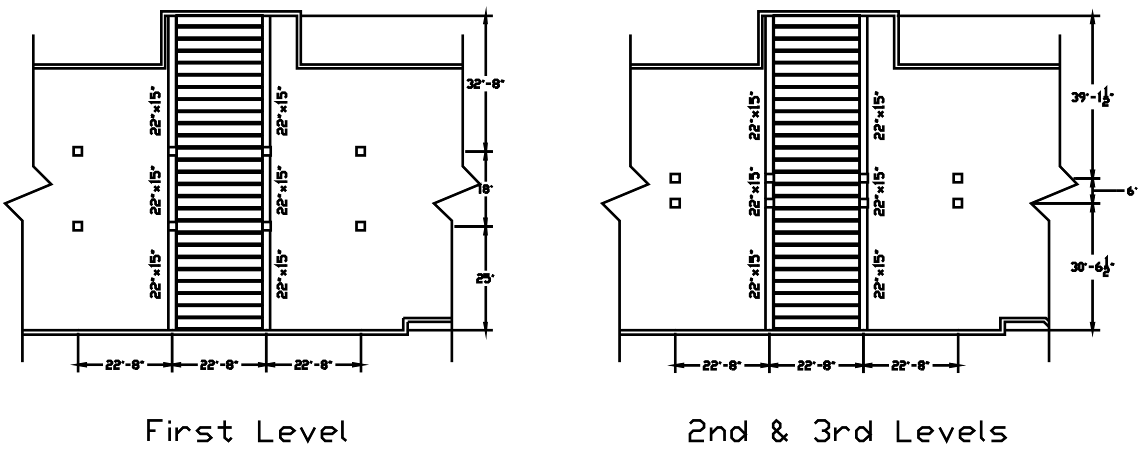


Figure B (4)

A repetitive structure and no requirement of additional fireproofing are advantages for the one-way joist system. However, cast-in-place construction often costs more in time and money and is a heavier structure altogether. This system will also require the re-design of the foundations because of the overall weight.

Alternate System #4 – Light-Gauge Steel system

The light-gauge steel system was designed using the Marino Lightweight Steel Framing Catalogue. The first level has exterior 10" CMU bearing walls; ungrouted and unreinforced. The joists chosen are Marino's 12J14 joists at 16" o.c. The columns were spaced at 11'-4", half the original spacing, because the headers could just support the load at the original spacing. The headers were designed to be the 16SW12. The second and third floors have 14JE10 joists @ 24" o.c. over the apartments and 6SW18 joists @ 24" o.c. in the corridor. The joists rest on metal stud bearing walls designed to have 3-5/8" studs @ 16" o.c.

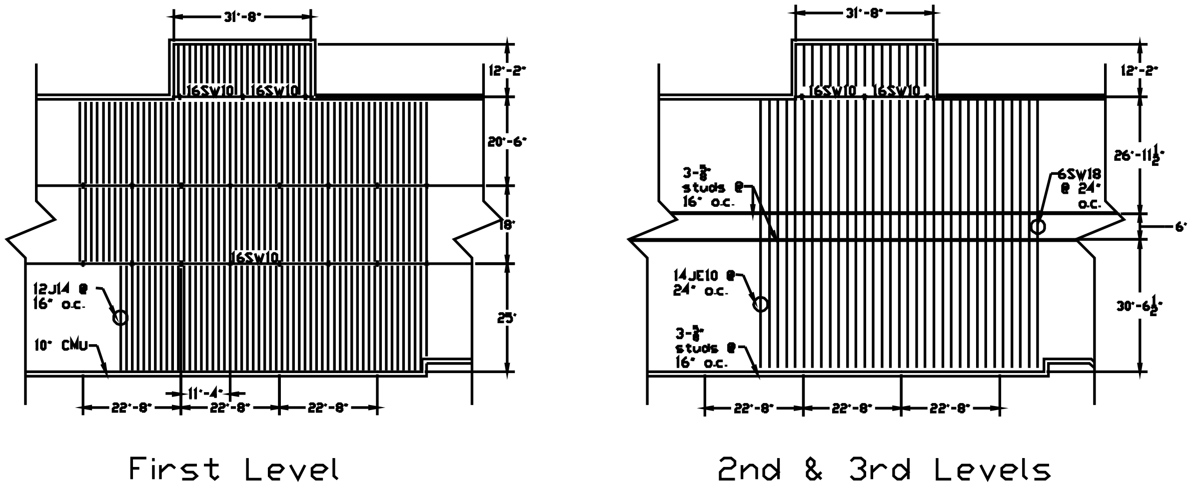


Figure A (4)

For the parts of the building that include a jutted-out section (see Figure B (4) below), a header was placed to break up the span of the joists. Because the headers do not take the applied loads at the full span, a column was placed at the midspan as well as one foot away from the exterior wall. The placement of the columns one foot distance from the wall was necessary to decrease the header span to 14' so it was able to take the applied load. The header was designed as a 16SW10.

The member positions are awkward and will be altered if this system is chosen as the alternative to the present system.

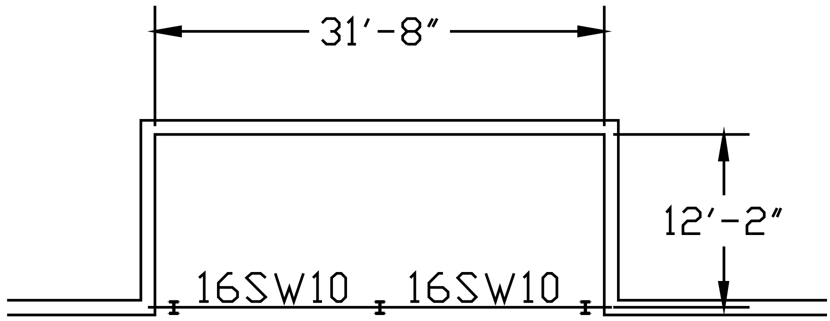


Figure B (4)

A light-gauge steel system is a good alternative for this building because of the low cost and non-combustible construction. The system is lightweight and not very deep. Prefabrication of the members allows for faster, easier installation. A shallow foundation, like the existing one, will work with this system because of the light weight.

Conclusion

After the examination of the four alternate systems, it was determined that the light-gauge steel system would be the best alternative to the existing one. Although the layout of the example system is awkward, this can be remedied with further investigations. The wood joist and the hollowcore plank systems cannot be ruled out as alternatives, but they are not considered superior to the light-gauge system because of a few disadvantages such as sound proofing. The one way joist system is not a good alternative due to cost, construction time, and weight issues.

Floor System	**Weight**	**Depth (Approx.)**	**Cost**	**Fireproofing**	**Vibration**	**Conclusion**
Wood Joist System	Light	34” + plywood	Efficient	Necessary	Increased vibration	Not ruled out
Pre-cast Hollowcore Planks	Moderate	29” + 2” topping = 31”	Efficient	Not necessary for planks	Reduced vibration	Not ruled out
One-way Joist System	Heavy	15”	Not Efficient	Not necessary	Reduced vibration	Too costly
Light-gauge Steel System	Light	16” + slab	Efficient	Necessary	Increased vibration	Most efficient

Appendix 1 – Alternate System #1

Hollowcore Plank floor system – Reference: Nitterhouse Guide

Liveload: private rooms & the corridors serving them
40psf

Superimposed dead loads: MEP – 10psf
ceiling – 1psf
carpet – 1psf
12psf

$W_u = 1.2(12psf) + 1.6(40psf) = 78.4psf$

Use 8"x4' Spandeck w/ 2" topping (U.L.-J952)
Span – 11'-4" → use 12' span
Allowable Superimposed Load (psf):
flexure 4-½" ϕ = 611psf > 78.4psf
shear 4-½" ϕ = 421psf > 78.4psf

Design beams w/ LRFD:

$W_u = 1.2(12psf + 82.5psf) + 1.6(40psf) = 177.4psf$ (82.5 psf = plank self wt)

1st floor

25' Span Beam
$W_u = 177.4psf(11.33') = 2009.94\ lb/ft = 2.01\ k/ft$

$$M_u = \frac{wL^2}{8} = \frac{(2.01k/ft)(25')^2}{8} = 157.03'k$$

$$V_u = \frac{wL}{2} = \frac{(2.01k/ft)(25')}{2} = 25.13k$$

$$\text{For } \Delta_{max} = \frac{l}{360},\ I_{req'd} = \frac{5(2.01k/ft)(25')^4 \times (12in/ft)^3}{384(29{,}000ksi)(0.833")} = 731.3in^4$$

Try W21x44
$I = 847in^4 > 731.3in^4$
$\phi M_p = 359'k > 157.03'k$
$\phi V_n = 196k > 25.13k$

18' Span beam

$w_u = 2.01 k/ft$

$M_u = \frac{wL^2}{8} = \frac{(2.01 k/ft)(18')^2}{8} = 81.41'k$

$V_u = \frac{wL}{2} = \frac{(2.01 k/ft)(18')}{2} = 18.09k$

For $\Delta_{max} = \frac{l}{360}$, $I_{req'd} = \frac{5(2.01k/ft)(18')^4 \times (12in/ft)^3}{384(29,000ksi)(0.6")} = 272.85in^4$

Try W16x26

$I = 301in^4 > 272.85in^4$

$\phi M_p = 166'k > 81.41'k$

$\phi V_n = 100k > 18.09k$

20'-6" Span Beam

$w_u = 2.01 k/ft$

$M_u = \frac{wL^2}{8} = \frac{(2.01 k/ft)(20.5')^2}{8} = 105.59'k$

$V_u = \frac{wL}{2} = \frac{(2.01 k/ft)(20.5')}{2} = 20.6k$

For $\Delta_{max} = \frac{l}{360}$, $I_{req'd} = \frac{5(2.01k/ft)(20.5')^4 \times (12in/ft)^3}{384(29,000ksi)(0.683")}$

$= 403.25in^4$

Try W18x35

$I = 510in^4 > 403.25in^4$

$\phi M_p = 249'k > 105.59'k$

$\phi V_n = 143k > 20.6k$

12'-2" Span Beam

$w_u = 2.01\,k/ft$

$M_u = \frac{wL^2}{8} = \frac{(2.01\,k/ft)(12.17')^2}{8} = 37.21'k$

$V_u = \frac{wL}{2} = \frac{(2.01\,k/ft)(12.17')}{2} = 12.23k$

For $\Delta_{max} = \frac{l}{360}$, $I_{req'd} = \frac{5(2.01\,k/ft)(12.17')^4 \times (12in/ft)^3}{384(29{,}000\,ksi)(0.41")}$

$= 83.44\,in^4$

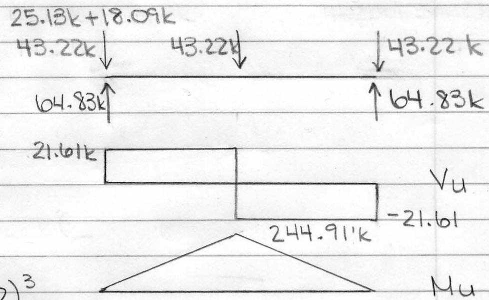
Try W12x14

$I = 88.5\,in^4 > 83.44\,in^4$

$\phi M_p = 65.2'k > 37.21'k$

$\phi V_n = 64.3k > 12.23k$

Design Girders:



1st floor

① $V_u = 21.61k$

$M_u = 21.61k(11.33')$

$= 244.91'k$

For $\Delta_{max} = \frac{l}{360}$,

$I_{req'd} = \frac{43.22k\,(22.67' \times 12)^3}{48(29{,}000\,ksi)(22.67' \times 12/360)}$

$= 827.21\,in^4$

Try W21x44

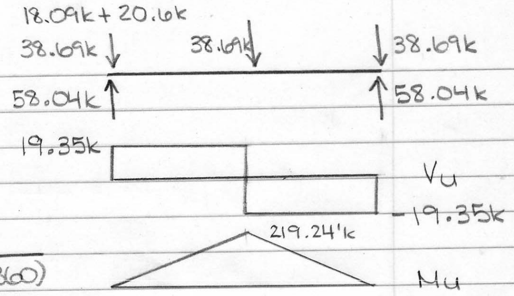
$I = 847\,in^4 > 827.21\,in^4$

$\phi M_p = 359 > 244.91'k$

$\phi V_n = 196k > 21.61k$

② $V_u = 19.35k$

$M_u = 219.24'k$



For $\Delta_{max} = \frac{l}{360}$,

$$I_{req'd} = \frac{38.69k\,(22.67' \times 12)^3}{48(29{,}000\,ksi)(22.67' \times 12/360)}$$

$$= 740.5\,in^4$$

Try W21x44

$I = 847\,in^4 > 740.5\,in^4$

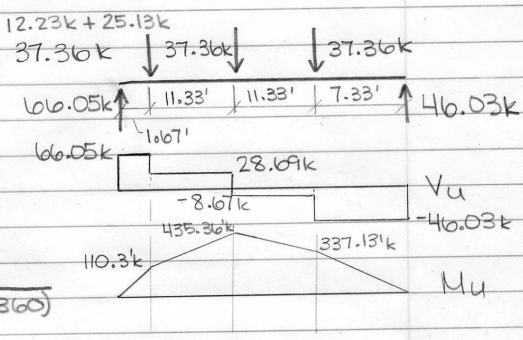
$\phi M_p = 359'k > 219.24'k$

$\phi V_n = 196k > 19.35k$

③ 31'-8" Span

$V_u = 66.05k$

$M_u = 435.36'k$



For $\Delta_{max} = \frac{l}{360}$,

$$I_{req'd} = \frac{37.36k\,(31.67' \times 12)^3}{48(29{,}000\,ksi)(31.67' \times 12/360)}$$

$$= 1395.5\,in^4$$

Try W21x68

$I = 1480\,in^4 > 1395.5\,in^4$

$\phi M_p = 600'k > 435.36'k$

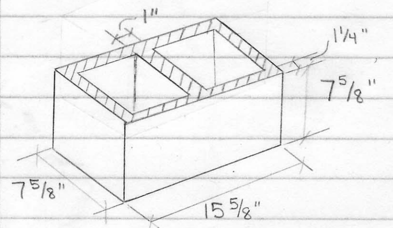
$\phi V_n = 245k > 66.05k$

<u>2nd & 3rd floors</u> – Plank span direction changed

Longest span = 30'-6½" → use 31'
w_u = 78.4 psf

<u>Use 8"x4' Spandeck w/2" topping (U.L.-J917)</u>
Allowable Superimposed Load (psf):
flexure 6- ½"ϕ = 90psf > 78.4psf
shear 6- ½"ϕ = 110psf > 78.4psf

<u>Masonry Bearing Walls</u>
Floor Height = 10' · 12"/1' = 120"
Height to thickness ratio = 120"/8"(trial) = 15
<u>Use 8" CMU, ungrouted, unreinforced</u>



Gross cross-sectional area =
(15⅝" x 7⅝") – 2(5.125" x 6.0625")
= 119.14in² – 62.14in²
= <u>57in²</u>

Design Load = 78.4psf + 82.5psf (plank wt.) = 160.9psf · $\frac{144 in^2}{ft^2}$ = 23169.6psi

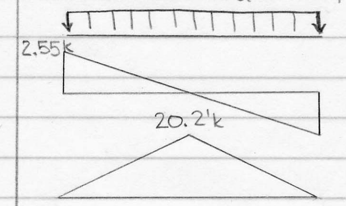
23169.6 psi / 57 = 406.5psi ∴ Use grouted

Gross cross-sectional area = 119.14in²
23169.6psi/119.4 = 194.05psi ∴

<u>Use 8" CMU, grouted, unreinforced</u> @ 4500psi or greater compressive strength, Type N mortar
200psi > 194.05psi

Design Steel Beam - LRFD   31'-8" span

$w_u = 78.4psf + 82.5psf = 160.9psf$



$V_u = 2.55k$

$M_u = 20.2'k$

For $\Delta_{max} = \frac{l}{360}$,

$I_{req'd} = \frac{2.55k(31.67' \times 12)^3}{48(29{,}000ksi)(31.67' \times 12/360)} = 95.25 in^4$

Try W12x16

$I = 103 in^4 > 95.25 in^4$

$\phi M_p = 75.4'k > 20.2'k$

$\phi V_n = 71.3k > 2.55k$

Prestressed Concrete

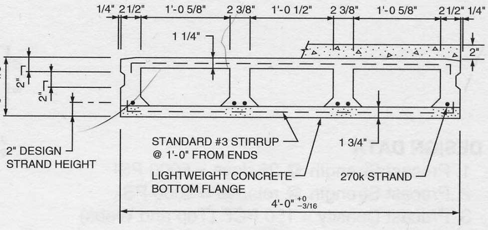
8" x 4' SpanDeck – U.L. – J952

(2" C.I.P. TOPPING)

PHYSICAL PROPERTIES

Composite

A' = 295 in.^{2}	S'_b = 468 in.^{3}
I' = 2624 in.^{4}	S'_t = 1096 in.^{3} (At Top of SpanDeck)
$Y_{b'}$ = 5.61 in.	S'_{tt} = 597 in.^{3} (At Top of Topping)
Y_t' = 2.39 in. (To Top of SpanDeck)	Wt.' = 330 PLF
Y_{tt}' = 4.39 in. (To Top of Topping)	Wt.' = 82.5 PSF



8" SPANDECK CROSS SECTION

UL FIRE RATED J952

DESIGN DATA

1. Precast Strength @ 28 days = 5000 PSI.
2. Precast Strength @ release = 3000 PSI.
3. Precast Density = 150 PCF (Top and Webs)
   = 115 PCF (Soffit)
4. Strand = 1/2"ø, 270K Lo-Relaxation.
5. Composite Strength = 3000 PSI.
6. Composite Density = 150 PCF.
7. Strand Height = 2.00 in.
8. Ultimate moment capacities (when fully developed) . . .
   4 – 1/2"ø, 270K = 88.3'K
   6 – 1/2"ø, 270K = 124.0'K
9. Maximum bottom tensile stress is $6\sqrt{f'c}$ = 424 PSI.
10. All superimposed load is treated as live load in the strength analysis of flexure and shear.
11. Flexural strength capacity is based on stress/strain strand relationships.
12. Shear values are the maximum allowable before shear reinforcement is required.
13. Deflection limits were not considered when determining allowable loads in this table.
14. Load values to the left of the solid line are controlled by ultimate strength. Load values to the right are controlled by service stress.
15. All loads shown refer to allowable loads applied after topping has hardened.

8" SPANDECK W/2" TOPPING			ALLOWABLE SUPERIMPOSED LOAD (PSF)																				
STRAND PATTERN			SPAN (FEET)																				
			10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Flexure	4 –	1/2"ø	750	675	611	546	462	394	338	291	252	218	191	167	146	128	112	98	85	74	63	51	41	31	
Shear	4 –	1/2"ø	527	469	421	382	348	317	294	272	252	235	219	197	176	157	140	129	122	110	98	88	78	70	
Flexure	6 –	1/2"ø	1098	900	898	794	676	580	502	437	382	336	296	262	233	207	185	165	147	132	116	101	87	74	63
Shear	6 –	1/2"ø	542	483	434	393	359	329	303	280	261	243	227	212	199	188	178	167	152	137	124	112	101	91	86

This table is for simple spans and uniform loads. Design data for any of these span-load conditions is available on request. Individual designs may be furnished to satisfy unusual conditions of heavy loads, concentrated loads, cantilevers, flange or stem openings and narrow widths.

NITTERHOUSE
CONCRETE PRODUCTS

2655 Molly Pitcher Hwy. South, Box N
Chambersburg, PA 17201-0813
717-267-4505 • FAX: 717-267-4518

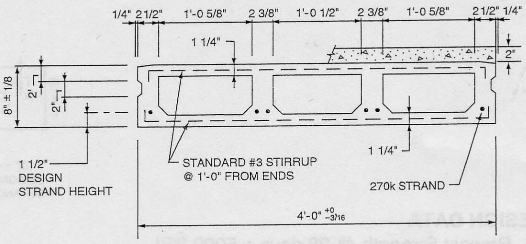
REVISED 12/93

Prestressed Concrete
8" x 4' SpanDeck – U.L. – J917
(2" C.I.P. TOPPING)

PHYSICAL PROPERTIES

Composite

A' = 254 in.^{2}	S'$_b$ = 547 in.^{3}
I' = 2944 in.^{4}	S'$_t$ = 1124 in.^{3} (At Top of SpanDeck)
Y$_{b'}$ = 5.38 in.	S'$_{tt}$ = 637 in.^{3} (At Top of Topping)
Y$_t$' = 2.62 in. (To Top of SpanDeck)	Wt.' = 330 PLF
Y'$_{tt}$ = 4.62 in. (To Top of Topping)	Wt.' = 82.5 PSF



8" SPANDECK CROSS SECTION

UL FIRE RATED J917

DESIGN DATA

1. Precast Strength @ 28 days = 5000 PSI.
2. Precast Density = 150 PCF
3. Strand = 1/2"ø, 270K Lo-Relaxation.
4. Composite Strength = 3000 PSI.
5. Composite Density = 150 PCF.
6. Strand Height = 1.5 in.
7. Ultimate moment capacities (when fully developed) . . .
   4 – 1/2"ø, 270K = 94.6'K
   6 – 1/2"ø, 270K = 133.3'K
8. Maximum bottom tensile stress is $6\sqrt{f'c}$ = 424 PSI.
9. All superimposed load is treated as live load in the strength analysis of flexure and shear.
10. Flexural strength capacity is based on stress/strain strand relationships.
11. Load values to the left of the solid line are controlled by ultimate strength. Load values to the right are controlled by service stress.
12. Shear values are the maximum allowable before shear reinforcement is required.
13. Deflection limits were not considered when determining allowable loads in this table.
14. All loads shown refer to allowable loads applied after topping has hardened.

8" SPANDECK W/2" TOPPING				ALLOWABLE SUPERIMPOSED LOAD (PSF)																						
STRAND PATTERN				SPAN (FEET)																						
				10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Flexure	4	–	1/2"ø	795	718	650	590	500	426	366	317	275	240	210	184	162	142	125	110	96	84	73	60	49	39	X
Shear	4	–	1/2"ø	571	509	458	415	378	347	320	296	275	257	240	222	199	178	160	145	133	126	115	103	93	84	X
Flexure	6	–	1/2"ø	1155	1040	945	859	732	629	544	474	416	366	324	287	256	228	204	183	164	147	132	118	103	90	77
Shear	6	–	1/2"ø	589	525	472	428	391	360	331	308	286	266	249	235	220	207	195	184	175	160	145	132	120	110	100

NITTERHOUSE
CONCRETE PRODUCTS

This table is for simple spans and uniform loads. Design data for any of these span-load conditions is available on request. Individual designs may be furnished to satisfy unusual conditions of heavy loads, concentrated loads, cantilevers, flange or stem openings and narrow widths.

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REVISED 12/93

Appendix 2 – Alternate System #2

Wood Joist System – Reference: TrusJoist TJI Joists & Beam, Header, & Column Specifier's Guides

1st Floor

Longest Span = 25'

Try 11 7/8" TJI 560 @16" o.c. (span = 26'-3" > 25') [Floor span tables]

Floor Load Table

LL = 40 psf → 54 plf (conversion table)

DL = 12 psf

Total Load = 52 psf → 69.8 plf (conversion table)

Interpolation in Floor load table ∴ try 14" TJI 560 @16"

LL ≅ 62 plf > 54 plf

TL ≅ 95 plf > 69.8 plf

Use 14" TJI 560 joists @16" o.c.

Floor Girder Beams (Sizing tables)

Floor Load (psf): 40 LL + 12 DL

Longest floor framing length = 40' x 0.8 = 32' ← table notes

Column spacing = 22'-8" use 24'

Use 5 1/4" x 20" Microllam LVL

Columns

Largest trib area = 22'-8" x 20' = 453.33 ft²

w_u = 12 psf + 40 psf = 52 psf

P = 52 psf (453.33 ft²) = 23,573.16 lbs

Effective column length = 15 ft

Try 7" x 7" 1.8E Parallam PSL

31,333 lbs > 23,573.16 lbs

Use 7" x 7" 1.8E Parallam PSL

(1)

Masonry Exterior Bearing Walls

Joist weight = 4.0 plf / (10" · 1'/12") = 4.8 psf

Floor Height = 15' · 12"/1' = 180"

Height to thickness ratio = 180"/8" (trial) = 22.5 NG

180"/10" = 18

Try 10" CMU, ungrouted, unreinforced

Gross cross-sectional area = (15 7/8" x 9 7/8") − 2(4.875" x 11.75")

= 150.4 in^2 − 57.3 in^2

= 93.1 in^2

Design Load = 52 psf + 4.8 psf = 56.8 psf · $\frac{144 in^2}{ft^2}$ = 8179.2 psi

8179.2 psi / 93.1 = 87.9 psi

Use 10" CMU, ungrouted, unreinforced @1500 psi compressive strength, type N mortar

100 psi > 87.9 psi

2nd & 3rd Floors

Longest span = 30'-6½"

Try 14" TJI 560 @ 12" o.c. (span = 32'-8" > 30'-6½")

Floor Load Table

LL = 40 psf → 40 plf (conversion table)

TL = 52 psf → 52 plf "   "

Interpolation: TL ≅ 80 plf > 52 plf

Use 14" TJI 560 @ 12" o.c.

Masonry Bearing walls

Joist weight = 4.2 plf / (8" · 1'/12") = 6.3 psf

Floor height = 10' · (12"/1') = 120"

Height to thickness ratio = 120"/8" = 15

Try 8" CMU, ungrouted, unreinforced

Gross cross-sectional area = 57 in^2 (calculated in Appendix 2)

Design Load = 52 psf + 6.3 psf = 58.3 psf · $\frac{144 in^2}{ft^2}$ = 8395.2 psi

8395.2 psi / 57 = 147.3 psi < 140 psi

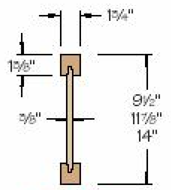
∴ Increase CMU size

(2)

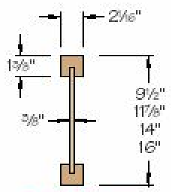
Try 10" CMU, ungrouted, unreinforced
Gross cross-sectional area = 93.1 in^2 (previously calculated)
8395.2 psi / 93.1 = 90.17 psi
Use 10" CMU, ungrouted, unreinforced @ 1500 psi
compressive strength, type N mortar
100 psi > 90.17 psi

(3)

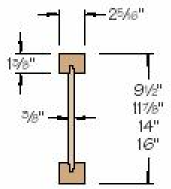
Not all products are available in all markets. Contact your Trus Joist representative for information.



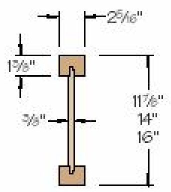
TJI® 110 joists



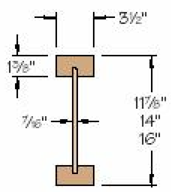
TJI® 210 joists



TJI® 230 joists



TJI® 360 joists



TJI® 560 joists

L/480 Live Load Deflection

Depth	TJI®	40 PSF Live Load / 10 PSF Dead Load				40 PSF Live Load / 20 PSF Dead Load			
		12" o.c.	16" o.c.	19.2" o.c.	24" o.c.	12" o.c.	16" o.c.	19.2" o.c.	24" o.c.
9½"	110	16'-5"	15'-0"	14'-2"	13'-2"	16'-5"	15'-0"	13'-11"	12'-5"
	210	17'-3"	15'-9"	14'-10"	13'-10"	17'-3"	15'-9"	14'-10"	13'-8"
	230	17'-8"	16'-2"	15'-3"	14'-2"	17'-8"	16'-2"	15'-3"	14'-2"
11⅞"	110	19'-6"	17'-10"	16'-10"	15'-5" (1)	19'-6"	17'-3"	15'-8"	14'-0" (1)
	210	20'-6"	18'-8"	17'-8"	16'-5"	20'-6"	18'-8"	17'-3"	15'-5" (1)
	230	21'-0"	19'-2"	18'-1"	16'-10"	21'-0"	19'-2"	18'-1"	16'-3" (1)
	360	22'-11"	20'-11"	19'-8"	18'-4"	22'-11"	20'-11"	19'-8"	17'-10" (1)
	560	26'-1"	23'-8"	22'-4"	20'-9"	26'-1"	23'-8"	22'-4"	20'-9" (1)
14"	110	22'-2"	20'-3"	18'-9"	16'-9" (1)	21'-8"	18'-9"	17'-1" (1)	14'-7" (1)
	210	23'-3"	21'-3"	20'-0"	18'-4" (1)	23'-3"	20'-7"	18'-9" (1)	16'-2" (1)
	230	23'-10"	21'-9"	20'-6"	19'-1"	23'-10"	21'-8"	19'-9"	17'-1" (1)
	360	26'-0"	23'-8"	22'-4"	20'-9" (1)	26'-0"	23'-8"	22'-4" (1)	17'-10" (1)
	560	29'-6"	26'-10"	25'-4"	23'-6"	***29'-6"***	***26'-10"***	25'-4" (1)	20'-11" (1)
16"	210	25'-9"	23'-6"	22'-0" (1)	19'-5" (1)	25'-5"	22'-0" (1)	20'-1" (1)	16'-2" (1)
	230	26'-5"	24'-1"	22'-9"	20'-7" (1)	***26'-5"***	23'-2"	21'-2" (1)	17'-1" (1)
	360	28'-9"	26'-3"	24'-8" (1)	21'-5" (1)	***28'-9"***	26'-3" (1)	22'-4" (1)	17'-10" (1)
	560	32'-8"	29'-8"	28'-0"	25'-2" (1)	***32'-8"***	***29'-8"***	26'-3" (1)	20'-11" (1)

L/360 Live Load Deflection (Minimum Criteria per Code)

Depth	TJI®	40 PSF Live Load / 10 PSF Dead Load				40 PSF Live Load / 20 PSF Dead Load			
		12" o.c.	16" o.c.	19.2" o.c.	24" o.c.	12" o.c.	16" o.c.	19.2" o.c.	24" o.c.
9½"	110	18'-2"	16'-7"	15'-3"	13'-8"	17'-8"	15'-3"	13'-11"	12'-5"
	210	19'-1"	17'-5"	16'-6"	15'-0"	19'-1"	16'-9"	15'-4"	13'-8"
	230	19'-7"	17'-11"	16'-11"	15'-9"	19'-7"	17'-8"	16'-1"	14'-5"
11⅞"	110	21'-7"	18'-11"	17'-3"	15'-5" (1)	19'-11"	17'-3"	15'-8"	14'-0" (1)
	210	22'-8"	20'-8"	18'-11"	16'-10"	21'-10"	18'-11"	17'-3"	15'-5" (1)
	230	23'-3"	21'-3"	19'-11"	17'-9"	***23'-0"***	19'-11"	18'-2"	16'-3" (1)
	360	25'-4"	23'-2"	21'-10"	20'-4" (1)	***25'-4"***	***23'-2"***	***21'-10" (1)***	17'-10" (1)
	560	28'-10"	26'-3"	24'-9"	23'-0"	***28'-10"***	***26'-3"***	***24'-9"***	20'-11" (1)
14"	110	23'-9"	20'-6"	18'-9"	16'-9" (1)	21'-8"	18'-9"	17'-1" (1)	14'-7" (1)
	210	25'-8"	22'-6"	20'-7"	18'-4" (1)	23'-9"	20'-7"	18'-9" (1)	16'-2" (1)
	230	26'-4"	23'-9"	21'-8"	19'-4" (1)	***25'-0"***	21'-8"	19'-9"	17'-1" (1)
	360	28'-9"	26'-3"	24'-9" (1)	21'-5" (1)	***28'-9"***	***26'-3" (1)***	22'-4" (1)	17'-10" (1)
	560	32'-8"	29'-9"	28'-0"	25'-2" (1)	***32'-8"***	***29'-9"***	***26'-3" (1)***	20'-11" (1)
16"	210	27'-10"	24'-1"	22'-0" (1)	19'-5" (1)	25'-5"	22'-0" (1)	20'-1" (1)	16'-2" (1)
	230	29'-2"	25'-5"	23'-2"	20'-7" (1)	***26'-9"***	23'-2"	21'-2" (1)	17'-1" (1)
	360	31'-10"	29'-0"	26'-10" (1)	21'-5" (1)	***31'-10"***	***26'-10" (1)***	22'-4" (1)	17'-10" (1)
	560	36'-1"	32'-11"	31'-0" (1)	25'-2" (1)	***36'-1"***	***31'-6" (1)***	26'-3" (1)	20'-11" (1)

*Long term deflection under dead load, which includes the effect of creep, has not been considered. **Bold italic** spans reflect initial dead load deflection exceeding 0.33".*

(1) Web stiffeners are required at intermediate supports of continuous-span joists when the intermediate bearing length is less than 5¼" and the span on either side of the intermediate bearing is greater than the following spans:

TJI®	40 PSF Live Load / 10 PSF Dead Load				40 PSF Live Load / 20 PSF Dead Load			
	12" o.c.	16" o.c.	19.2" o.c.	24" o.c.	12" o.c.	16" o.c.	19.2" o.c.	24" o.c.
110	N.A.	N.A.	N.A.	15'-4"	N.A.	N.A.	16'-0"	12'-9"
210	N.A.	N.A.	21'-4"	17'-0"	N.A.	21'-4"	17'-9"	14'-2"
230	N.A.	N.A.	N.A.	19'-2"	N.A.	N.A.	19'-11"	15'-11"
360	N.A.	N.A.	24'-5"	19'-6"	N.A.	24'-5"	20'-4"	16'-3"
560	N.A.	N.A.	29'-10"	23'-10"	N.A.	29'-10"	24'-10"	19'-10"

How to Use These Tables

1. Determine the appropriate live load deflection criteria.
2. Identify the live and dead load condition.
3. Select on-center spacing.
4. Scan down the column until you meet or exceed the span of your application.
5. Select TJI® joist and depth.

Live load deflection is not the only factor that affects how a floor will perform. To more accurately predict floor performance, use our TJ-Pro™ Rating system.

General Notes

- Tables are based on:
  - Uniform loads.
  - More restrictive of simple or continuous span.
  - Clear distance between supports (1¾" minimum end bearing).
- Assumed composite action with a single layer of 24" on-center span-rated, glue-nailed floor panels for deflection only. **Spans shall be reduced 6" when floor panels are nailed only.**
- Spans generated from Trus Joist software may exceed the spans shown in these tables because software reflects actual design conditions.
- For loading conditions not shown, refer to software or to load tables on page 5.

Floor—100% (PLF)

Depth	TJI®	Joist Clear Span 8'		10'		12'		14'		16'		18'		20'		22'		24'	
		Live Load L/480	Total Load	Live Load L/480	Total Load	Live Load L/480	Total Load	Live Load L/480	Total Load	Live Load L/480	Total Load	Live Load L/480	Total Load	Live Load L/480	Total Load	Live Load L/480	Total Load	Live Load L/480	Total Load
9½"	110	*	190	127	152	77	127	50	95										
	210	*	210	147	169	90	141	59	114	40	81								
	230	*	236	159	190	98	158	64	126	44	88								
11⅞"	110	*	190	*	152	*	127	83	109	57	92								
	210	*	210	*	169	*	141	97	121	67	106	48	87						
	230	*	236	*	190	*	158	105	136	73	119	52	97	39	78				
	360	*	241	*	193	*	162	136	139	95	121	69	108	51	97	39	78		
	560	*	294	*	236	*	197	*	169	138	148	101	132	76	119	58	108	45	91
14"	110	*	190	*	152	*	127	*	109	83	95	59	85						
	210	*	210	*	169	*	141	*	121	96	106	69	94	51	84				
	230	*	236	*	190	*	158	*	136	104	119	75	106	56	93	43	77		
	360	*	241	*	193	*	162	*	139	*	121	98	108	73	97	56	88	44	81
	560	*	294	*	236	*	197	*	169	*	148	*	132	107	119	83	108	65	99
16"	210	*	210	*	169	*	141	*	121	*	106	93	94	69	85	53	77		
	230	*	236	*	190	*	158	*	136	*	119	100	106	75	95	57	87		
	360	*	241	*	193	*	162	*	139	*	121	*	108	*	97	75	88	59	81
	560	*	294	*	236	*	197	*	169	*	148	*	132	*	119	*	108	86	99

*Indicates TOTAL LOAD value controls.

How to Use This Table

1. Calculate actual total and live load in pounds per linear foot (plf).
2. Select appropriate Joist Clear Span.
3. Scan down the column to find a TJI® joist that meets or exceeds actual total and live loads

General Notes

- Table is based on:
  - Uniform loads.
  - No composite action provided by sheathing.
  - More restrictive of simple or continuous span.
- Total Load limits joist deflection to L/240.
- Live Load is based on joist deflection of L/480.
- If a live load deflection limit of L/360 is desired, multiply value in Live Load column by 1.33. The resulting live load shall not exceed the Total Load shown.

PSF to PLF Conversions

O.C. Spacing	Load in Pounds Per Square Foot (PSF) 20	25	30	35	40	45	50	55	60
	Load in Pounds Per Linear Foot (PLF)								
12"	20	25	30	35	40	45	50	55	60
16"	27	34	40	47	54	60	67	74	80
19.2"	32	40	48	56	64	72	80	88	96
24"	40	50	60	70	80	90	100	110	120

Design Properties (100% Load Duration)

Depth	TJI®	Basic Properties: Joist Weight (lbs/ft)	Maximum Resistive Moment(1) (ft-lbs)	Joist Only EI x 10^6 (in.²-lbs)	Maximum Vertical Shear (lbs)	Reaction Properties: 1¾" End Reaction (lbs)	3½" Intermediate Reaction (lbs): No Web Stiffeners	3½" Intermediate Reaction (lbs): With Web Stiffeners
9½"	110	2.3	2,380	140	1,220	885	1,935	N.A.
	210	2.6	2,860	167	1,330	980	2,145	N.A.
	230	2.7	3,175	183	1,330	1,035	2,410	N.A.
11⅞"	110	2.5	3,015	238	1,560	885	1,935	2,295
	210	2.8	3,620	283	1,655	980	2,145	2,505
	230	3.0	4,015	310	1,655	1,035	2,410	2,765
	360	3.0	6,180	419	1,705	1,080	2,460	2,815
	560	4.0	9,500	636	2,050	1,265	3,000	3,475
14"	110	2.8	3,565	351	1,860	885	1,935	2,295
	210	3.1	4,280	415	1,945	980	2,145	2,505
	230	3.3	4,755	454	1,945	1,035	2,410	2,765
	360	3.3	7,335	612	1,955	1,080	2,460	2,815
	560	4.2	11,275	926	2,390	1,265	3,000	3,475
16"	210	3.3	4,895	566	2,190	980	2,145	2,505
	230	3.5	5,440	618	2,190	1,035	2,410	2,765
	360	3.5	8,405	830	2,190	1,080	2,460	2,815
	560	4.5	12,925	1,252	2,710	1,265	3,000	3,475

(1) Caution: Do not increase joist moment design properties by a repetitive member use factor.

General Notes

- Table is based on:
  - Uniform loads.
  - More restrictive of simple or continuous beam span. Ratio of short span to long span should be greater than 0.4 to prevent uplift.
  - Deflection criteria of L/360 live load and L/240 total load.

Also see General Assumptions on page 5.

Bearing Requirements

Minimum beam supports to be 2 trimmers (3") at each end and 7½" at continuous-span supports.

(3) Requires 3 trimmers (4½") at each end and 11¼" at continuous-span supports.

Floor Girder Beams *continued*

Floor Load (PSF)	Floor Framing Length	Column Spacing															
		18'				20'				22'				24'			
40LL + 12DL	24'	3½" x 18"		M	P	3½" x 18"			P	3½" x 20"(3)		M		5¼" x 20"		M	
		5¼" x 14"			P	3½" x 20"		M		5¼" x 18"		M	P	7" x 18"			P
		5¼" x 16"	T	M		5¼" x 16"		M	P	7" x 16"			P				
	28'	3½" x 18"		M	P	3½" x 20"(3)		M		5¼" x 18"		M	P	5¼" x 20"		M	
		5¼" x 16"	T	M	P	5¼" x 16"			P	7" x 16"			P	7" x 18"			P
		7" x 14"			P	5¼" x 18"		M									
	30'	3½" x 18"(3)		M	P	3½" x 20"(3)		M		5¼" x 18"		M	P	5¼" x 20"		M	
		5¼" x 16"	T	M	P	5¼" x 18"		M	P	7" x 16"			P	7" x 18"			P
		7" x 14"			P	7" x 16"			P								
	32'	3½" x 18"(3)			P	3½" x 20"(3)		M		5¼" x 18"			P	5¼" x 20"		M	
		3½" x 20"(3)		M		5¼" x 18"		M	P	5¼" x 20"		M		7" x 18"			P
		5¼" x 16"	T	M	P	7" x 16"			P								
	34'	3½" x 18"(3)			P	5¼" x 18"		M	P	5¼" x 20"		M		5¼" x 20"		M	
		3½" x 20"(3)		M		7" x 16"			P	7" x 18"			P	7" x 18"			P
		5¼" x 16"		M	P												
	36'	3½" x 18"(3)			P	5¼" x 18"		M	P	5¼" x 20"		M		7" x 18"			P
		3½" x 20"(3)		M		7" x 16"			P	7" x 18"			P				
		5¼" x 16"		M	P												
	40'	3½" x 20"(3)		M		5¼" x 18"		M	P	5¼" x 20"(3)		M					
		5¼" x 16"			P	7" x 16"			P	7" x 18"			P				
		5¼" x 18"		M													
40LL + 20DL	24'	3½" x 18"(3)		M	P	3½" x 20"(3)		M		5¼" x 18"		M	P	5¼" x 20"		M	
		5¼" x 16"	T	M	P	5¼" x 16"		M	P	7" x 16"			P	7" x 18"			P
		7" x 14"			P												
	28'	3½" x 18"(3)			P	5¼" x 18"		M	P	5¼" x 18"			P	5¼" x 20"		M	
		3½" x 20"(3)		M		7" x 16"			P	5¼" x 20"		M		7" x 18"			P
		5¼" x 16"	T	M	P					7" x 18"			P				
	30'	3½" x 18"(3)			P	5¼" x 18"		M	P	5¼" x 20"		M		7" x 18"			P
		3½" x 20"(3)		M		7" x 16"			P	7" x 18"			P				
		5¼" x 16"		M	P												
	32'	3½" x 20"(3)		M		5¼" x 18"		M	P	5¼" x 20"(3)		M					
		5¼" x 16"		M	P	7" x 16"			P	7" x 18"			P				
		7" x 14"			P												
	34'	5¼" x 16"			P	5¼" x 18"		M	P	5¼" x 20"(3)		M					
		5¼" x 18"		M		7" x 16"			P	7" x 18"			P				
	36'	5¼" x 16"			P	5¼" x 18"(3)			P	7" x 18"			P				
		5¼" x 18"		M		5¼" x 20"(3)		M									
						7" x 16"			P								
	40'	5¼" x 18"(3)		M	P	5¼" x 20"(3)		M		7" x 18"			P				
		7" x 16"			P	7" x 18"			P								

T 1.7E TimberStrand® LSL   **M** 1.9E Microllam® LVL   **P** 2.0E Parallam® PSL

Columns

Allowable Axial Loads (lbs) for 1.3E TimberStrand® LSL

Connection Type	Effective Column Length	3½" x 3½" 100%	3½" x 3½" 115%	3½" x 3½" 125%	3½" x 4⅜" 100%	3½" x 4⅜" 115%	3½" x 4⅜" 125%	3½" x 5½" 100%	3½" x 5½" 115%	3½" x 5½" 125%	3½" x 7¼" 100%	3½" x 7¼" 115%	3½" x 7¼" 125%	3½" x 8⅝" 100%	3½" x 8⅝" 115%	3½" x 8⅝" 125%
Steel and Column Bearing	3'	10,740	12,140	13,040	13,425	15,175	16,300	16,875	19,075	20,490	22,245	25,145	27,010	26,465	29,910	32,135
	4'	9,785	10,880	11,565	12,230	13,605	14,455	15,375	17,100	18,170	20,270	22,540	23,950	24,115	26,815	28,495
	5'	8,605	9,365	9,810	10,755	11,705	12,260	13,520	14,715	15,415	17,825	19,395	20,320	21,205	23,075	24,175
	6'	7,320	7,800	8,075	9,155	9,755	10,095	11,505	12,260	12,690	15,170	16,160	16,730	18,045	19,230	19,905
	7'	6,130	6,445	6,620	7,665	8,055	8,275	9,635	10,125	10,405	12,700	13,350	13,715	15,110	15,880	16,315
	8'	5,140	5,355	5,475	6,425	6,695	6,845	8,075	8,415	8,610	10,645	11,090	11,345	12,665	13,195	13,500
	9'	4,340	4,500	4,585	5,430	5,620	5,735	6,825	7,070	7,210	8,995	9,315	9,500	10,700	11,085	11,305
	10'	3,705	3,820	3,890	4,630	4,775	4,860	5,820	6,005	6,110	7,675	7,915	8,055	9,130	9,415	9,580
	12'	2,775	2,845	2,885	3,470	3,555	3,610	4,360	4,470	4,535	5,750	5,895	5,980	6,840	7,015	7,115
	14'	2,150	2,195	2,220	2,685	2,745	2,775	3,380	3,450	3,490	4,455	4,550	4,600	5,295	5,410	5,475
Plate Bearing(1)	3'–7'	5,425	5,425	5,425	6,650	6,650	6,650	8,225	8,225	8,225	10,675	10,675	10,675	12,600	12,600	12,600
	8'	5,140	5,355	5,425	6,425	6,650	6,650	8,075	8,225	8,225	10,645	10,675	10,675	12,600	12,600	12,600
	9'	4,340	4,500	4,585	5,430	5,620	5,735	6,825	7,070	7,210	8,995	9,315	9,500	10,700	11,085	11,305
	10'	3,705	3,820	3,890	4,630	4,755	4,860	5,820	6,005	6,110	7,675	7,915	8,055	9,130	9,415	9,580
	12'	2,775	2,845	2,885	3,470	3,555	3,610	4,360	4,470	4,535	5,750	5,895	5,980	6,840	7,015	7,115
	14'	2,150	2,195	2,220	2,685	2,745	2,775	3,380	3,450	3,490	4,455	4,550	4,600	5,295	5,410	5,475

(1) See connection details below.

Allowable Axial Loads (lbs) for 1.8E Parallam® PSL

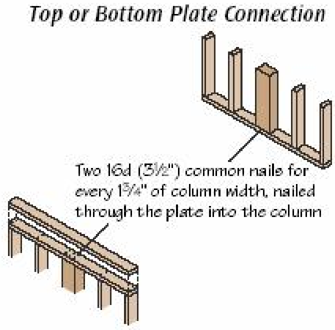
Connection Type	Effective Column Length	3½" x 3½" 100%	3½" x 3½" 115%	3½" x 3½" 125%	3½" x 5¼" 100%	3½" x 5¼" 115%	3½" x 5¼" 125%	3½" x 7" 100%	3½" x 7" 115%	3½" x 7" 125%	5¼" x 5¼" 100%	5¼" x 5¼" 115%	5¼" x 5¼" 125%	5¼" x 7" 100%	5¼" x 7" 115%	5¼" x 7" 125%	7" x 7" 100%	7" x 7" 115%	7" x 7" 125%
Steel and Column Bearing	6'	10,598	11,202	11,551	15,897	16,804	17,326	21,196	22,405	23,101	33,300	36,685	38,743						
	7'	8,740	9,143	9,375	13,111	13,715	14,063	17,481	18,287	18,751	30,016	32,551	34,041						
	8'	7,270	7,553	7,716	10,905	11,330	11,574	14,539	15,106	15,432	26,655	28,499	29,565	35,540	37,998	39,420			
	9'	6,115	6,323	6,441	9,173	9,484	9,662	12,231	12,645	12,883	23,484	24,845	25,631	31,312	33,127	34,175			
	10'	5,203	5,359	5,449	7,805	8,039	8,173	10,407	10,718	10,897	20,667	21,703	22,300	27,556	28,937	29,733			
	12'	3,885	3,979	4,033	5,827	5,969	6,050	7,770	7,959	8,067	16,166	16,810	17,180	21,555	22,413	22,907			
	14'	3,003	3,064	3,099	4,504	4,596	4,649	6,005	6,129	6,199	12,893	13,320	13,566	17,190	17,760	18,088	34,168	35,796	36,736
	16'										10,483	10,781	10,952	13,977	14,375	14,603	28,498	29,648	30,312
	18'										8,673	8,890	9,013	11,565	11,853	12,018	24,027	24,871	25,356
	20'										7,286	7,447	7,540	9,715	9,930	10,053	20,481	21,118	21,484
	22'																17,638	18,131	18,413
	24'																15,333	15,722	15,944

General Notes

- Tables are based on:
  - Solid, one-piece column members used in dry-service conditions.
  - Bracing in both directions at column ends.
  - 425 psi for plate bearing.
  - NDS® 2001.
- Allowable loads accommodate axial loads only with ⅙ column width/thickness eccentricity.

For Column Allowable Design Stresses see page 5.

Top or Bottom Plate Connection



The column and connector values listed are for dry-service conditions only. When wet-service conditions exist, contact your Trus Joist representative for other product solutions.

Appendix 3 – Alternate System #3

One way concrete joist construction – Reference: CRSI Design Handbook 2002

- 30" Forms Used Span = 22'-8"
  LL = 40psf ℓ_n = 21'-8" → use 22' span
  DL = 12psf

Superimposed Factored Loads: For table use 1.4DL + 1.7LL

1.4(12psf) + 1.7(40psf) = 84.8psf

From Table on p. 8-22:

12" Deep Rib + 3" topslab = 15" Total depth

Endspan, ℓ_n = 22', 5" Rib @ 35" c.c.

Tabulated capacity = 103psf

Top bars #4 @ 12"

Bottom bars 2-#4

Wt of steel = 0.60psf

From Table 8-1: Slab wt = 63psf

ℓ_n/18.5 = 14.3" < 15" No deflection calculation req'd

From Table on p. 8-22:

12" Deep Rib + 3" topslab = 15" total depth

Interior span, ℓ_n = 22', 5" Rib @ 35" c.c

Tabulated capacity = 127psf

Top bars #4 @ 12"

Bottom bars #3 & #4

Wt. of steel = 0.63psf

From Table 8-1: Slab wt = 63psf

ℓ_n/21 = 12.57" < 15" ∴ No defl. calc. req'd.

Girder Design: To keep the repetitive design, the girders will be sized by calculating the width of the girder with the longest span and using the dimensions for all girders.

W_u = 1.2 (12psf + 63psf) + 1.6 (40psf) = 154 psf

154psf (22') = 3388 lb/ft = 3.4 k/ft

$M_u = \frac{wL^2}{8} = \frac{3.4 k/ft (22')^2}{8} = 205.7'k$

(1)

Assume $\rho = 0.6\rho_{max} = 0.6(0.0206) = 0.01236$

$\rho = \frac{A_s}{bd} \therefore A_s = \rho bd \qquad a = \frac{\rho \not{b} d f_y}{0.85 f'_c \not{b}}$

$M_u = \phi M_n = 0.9 A_s f_y (d - \frac{a}{2}) = 0.9 \rho b d f_y (d - \frac{\rho d f_y}{0.85 f'_c})$

joist depth

$205.7'k = 0.9 \rho b d^2 f_y (1 - \frac{\rho f_y}{0.85 f'_c}) = 0.9(0.01236) b (15")^2 (60ksi)(1 - \frac{0.01236(60ksi)}{0.85(4ksi)})$

$2468.4"k = 150.174(1 - 0.218) b$

$\therefore b = 21.02" \rightarrow$ use $b = 22"$

22x15 Girders

(2)

STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS	30" Forms + 5" Rib @ 35" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

12" Deep Rib + 3.0" Top Slab = 15.0" Total Depth

TOP BARS Size @	# 4 12	# 4 11	# 4 9	# 5 11	# 5 9.5	End Span Defl. Coeff. (3)	# 4 12	# 4 11	# 4 8.5	# 5 10.5	# 5 8.5	Int. Span Defl. Coeff. (3)
BOTTOM BARS # #	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6		# 3 # 4	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6	
Steel (psf)	.60	.72	.89	1.09	1.29		.63	.77	.97	1.22	1.48	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
19'-0"	168	236	291*	301*	311*	1.525	201	285	334*	340*	350*	.939
	0	0	306	385	422*		0	0	384	485	532*	
20'-0"	143	205	267*	275*	283*	1.873	173	248	309*	314*	322*	1.153
	0	0	0	339	387*		0	0	338	429	481*	
21'-0"	121	177	234	253*	260*	2.276	149	217	286*	290*	298*	1.401
	0	0	0	299	365		0	0	298	381	432*	
22'-0"	103	154	205	233*	239*	2.742	127	190	264	269*	276*	1.687
	0	0	0	265	325		0	0	0	339	391*	
23'-0"	86	133	180	215*	221*	3.276	109	166	234	250*	257*	2.016
	0	0	0	235	290		0	0	0	303	357*	
24'-0"	72	115	158	199*	204*	3.884	93	145	208	233*	239*	2.390
	0	0	0	208	259		0	0	0	271	327*	
25'-0"	60	99	139	185*	189*	4.572	79	127	184	218*	223*	2.814
	0	0	0	0	232		0	0	0	243	301*	
26'-0"	48	85	122	164	176*	5.349	66	111	164	204*	209*	3.292
	0	0	0	0	207		0	0	0	218	278*	
27'-0"		72	107	146	164*	6.221	55	96	145	192*	196*	3.828
		0	0	0	186		0	0	0	195	253	
28'-0"		61	93	129	153*	7.195	45	83	129	175	184*	4.428
		0	0	0	167		0	0	0	0	229	
29'-0"		51	81	115	143*	8.279		72	114	158	173*	5.095
		0	0	0	149			0	0	0	207	
30'-0"		42	69	101	134	9.481		61	101	141	163*	5.835
		0	0	0	0			0	0	0	188	
31'-0"			59	89	120	10.810		52	89	127	153*	6.652
			0	0	0			0	0	0	170	
32'-0"			50	78	107	12.274		43	78	114	145*	7.553
			0	0	0			0	0	0	154	

(1) For gross section properties, see Table 8-1.
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE .42 CF/SF) (4)

NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	.58	.64	.78	.99	1.14		.58	.64	.82	1.03	1.28	
STEEL % (UNIFORM)	.69	.75	.92	1.17	1.36		.69	.75	.97	1.23	1.52	
(TAPERED)	.38	.42	.51	.65	.75		.38	.42	.54	.68	.84	
EFF. DEPTH, IN.	13.8	13.8	13.8	13.7	13.7		13.8	13.8	13.8	13.7	13.7	
– ICR/IGR	.176	.188	.220	.259	.287		.176	.188	.229	.268	.310	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	.40	.51	.62	.75	.88		.31	.40	.51	.62	.75	
STEEL %	.08	.11	.13	.16	.18		.06	.08	.11	.13	.16	
EFF. DEPTH, IN.	13.8	13.7	13.7	13.6	13.6		13.8	13.8	13.7	13.7	13.6	
+ICR/IGR	.165	.205	.245	.288	.332		.130	.165	.205	.245	.288	

Appendix 4 – Alternate System #4

Light-Gauge Steel system – Reference: Marino Lightweight Steel Framing Catalog

First floor

Joists

Longest span = 25'

LL = 40psf, TL = 52psf

Try 12J14 joists @ 16" o.c.

LL = 46psf > 40psf

TL = 69psf > 52psf

Use 12J14 joists @ 16" o.c.

Header - Girder

Span 11'-4" → use 12'

LL = 40psf · 21.5' (largest trib width) = 860plf

TL = [52psf + [(9 joists · 4.057plf)/16" · 1'/12"]] · 21.5'

= 1706.77plf

Try 16SW12 : TL = 1856plf > 1706.77plf

Use 16SW12

Masonry exterior bearing walls

Joist weight = 4.057plf / (10" · 1'/12") = 3.38 psf

Floor Height = 15' · 12"/1' = 180"

Height to thickness ratio = 180"/10" = 18

Try 10" CMU, ungrouted, unreinforced

Gross cross-sectional area = 93.1in² (previously calculated in Appendix 2)

Design Load = 52psf + 3.38psf = 55.38psf · 144in²/ft² = 7974.84psi

7974.84psi / 93.1 = 85.66 psi

Use 10" CMU, ungrouted, unreinforced @ 1500psi compressive strength, type N mortar

100psi > 87.9 psi

(1)

2nd & 3rd Floors

Joists

Longest Span = 30'-6½" → use 31'

LL = 40psf, TL = 52psf

Try 14JE10 @24" o.c.

LL = 45psf > 40psf

TL = 67psf > 52psf

Use 14JE10 joists @24" O.C.

IN CORRIDOR

Use 6SW18 @24" O.C.

Studs of bearing walls

Use Wind Load = 20psf

Assume: 16" spacing & 18'-4" trib area (largest used)

Joist weight = 8.344 plf / (24" · 1'/12") = 4.172 psf

TL = 52psf + 4.172 psf = 56.172 psf · [(16" · 1'/12")(18.33')]

= 1373.1 lb. = 1.4k

Floor Ht = 15'

From Stud table (Axial Loads)

Try 3-5/8" @16" o.c (10 gauge)

interpolation: 3.4k > 1.4k

Use 3-5/8" studs @16" o.c.

Header on all floors

Span: 31'-8" Place column @ midspan where partition wall is & one 1' outside of wall to shorten span to 14'

1st floor: TL = [52psf + (11 joists · 4.057 plf) / 16" · 1'/12"] · 16.33'

= 1395.7 plf

Use 16SW10: 1766 plf > 1395.7 plf

2nd & 3rd floors: TL = [52psf + (7 joists · 8.344 plf) / 24" · 1'/12"] · 19.6'

= 1591.6 plf

Use 16SW10: 1766 plf > 1591.6 plf

(2)

Floor and Roof Applications

Member MW Type (SSMA)	o.c.	23'-0" T	23'-0" L	24'-0" T	24'-0" L	25'-0" T	25'-0" L	26'-0" T	26'-0" L	27'-0" T	27'-0" L	28'-0" T	28'-0" L	29'-0" T	29'-0" L
12" Members															
12J14 (1200S200-68)	12"	118	79	104	69	92	61	82	55	73	49	66	44	59	39
	16"	89	59	78	52	69	46	61	41	55	37	49	33	44	29
	24"	59	39	52	35	46	31	41	27	37	24	33	22	29	20
12J12 (1200S200-97)	12"	164	109	144	96	128	85	113	76	101	68	91	61	82	55
	16"	123	82	108	72	96	64	85	57	76	51	68	45	61	41
	24"	82	55	72	48	64	43	57	38	51	34	45	30	41	27
12J10 (1200S200-118)	12"	200	133	176	117	156	104	138	92	123	82	111	74	100	66
	16"	150	100	132	88	117	78	104	69	93	62	83	55	75	50
	24"	100	67	88	59	78	52	69	46	62	41	55	37	50	33
12JE16* (1200S250-54)	12"	84	71	78	62	71	55	66	49	61	44	57	39	53	35
	16"	63	53	58	47	54	41	50	37	46	33	43	29	40	26
	24"	42	35	39	31	36	28	33	24	31	22	28	20	26	18
12JE14 (1200S250-68)	12"	123	88	113	77	103	68	91	61	82	54	73	49	66	44
	16"	92	66	85	58	77	51	68	46	61	41	55	37	49	33
	24"	62	44	57	39	51	34	46	30	41	27	37	24	33	22
12JE12 (1200S250-97)	12"	183	122	161	108	143	95	127	85	113	76	102	68	91	61
	16"	137	92	121	81	107	71	95	63	85	57	76	51	69	46
	24"	92	61	81	54	71	48	63	42	57	38	51	34	46	30
12JE10 (1200S250-118)	12"	224	149	197	131	174	116	155	103	138	92	124	83	112	74
	16"	168	112	148	98	131	87	116	77	104	69	93	62	84	56
	24"	112	75	98	66	87	58	77	52	69	46	62	41	56	37
14" Members															
14J14 (1400S200-68)	12"	142	116	130	102	120	90	111	80	103	72	96	64	87	58
	16"	106	87	98	77	90	68	83	60	77	54	72	48	65	43
	24"	71	58	65	51	60	45	55	40	51	36	48	32	43	29
14J12 (1400S200-97)	12"	242	161	213	142	188	125	167	112	149	100	134	89	121	80
	16"	181	121	160	106	141	94	125	84	112	75	100	67	90	60
	24"	121	81	106	71	94	63	84	56	75	50	67	45	60	40
14J10 (1400S200-118)	12"	295	197	260	173	230	153	204	136	182	122	164	109	147	98
	16"	221	148	195	130	172	115	153	102	137	91	123	82	110	74
	24"	148	98	130	87	115	77	102	68	91	61	82	55	74	49
14JE12 (1400S250-97)	12"	260	179	236	157	209	139	186	124	166	110	149	99	134	89
	16"	195	134	177	118	157	104	139	93	124	83	111	74	100	67
	24"	130	89	118	79	104	70	93	62	83	55	74	50	67	45
14JE10 (1400S250-118)	12"	328	219	289	192	255	170	227	151	203	135	182	121	164	109
	16"	246	164	217	144	192	128	170	114	152	101	136	91	123	82
	24"	164	109	144	96	128	85	114	76	101	68	91	61	82	55
14JX12 (1400S300-97)	12"	307	207	273	182	242	161	215	143	192	128	172	115	155	103
	16"	230	155	205	137	181	121	161	107	144	96	129	86	116	77
	24"	153	103	137	91	121	81	107	72	96	64	86	57	77	52
14JX10 (1400S300-118)	12"	381	254	335	223	296	198	263	176	235	157	211	141	190	127
	16"	285	190	251	167	222	148	198	132	176	118	158	105	142	95
	24"	190	127	167	112	148	99	132	88	118	78	105	70	95	63
14JXW12 (1400S350-97)	12"	309	225	284	198	262	175	233	155	208	139	187	124	168	112
	16"	232	168	213	148	196	131	175	117	156	104	140	93	126	84
	24"	155	112	142	99	131	87	117	78	104	69	93	62	84	56
14JXW10 (1400S350-118)	12"	414	276	364	243	322	215	286	191	256	170	229	153	206	138
	16"	310	207	273	182	242	161	215	143	192	128	172	115	155	103
	24"	207	138	182	121	161	107	143	95	128	85	115	76	103	69

Member MW Type (SSMA)	o.c.	30'-0" T	30'-0" L	31'-0" T	31'-0" L	32'-0" T	32'-0" L	33'-0" T	33'-0" L	34'-0" T	34'-0" L	35'-0" T	35'-0" L	36'-0" T	36'-0" L
12" Members															
12J14 (1200S200-68)	12"	148	99	134	89	122	81	111	74	102	68	93	62	86	57
	16"	111	74	100	67	91	61	83	56	76	51	70	47	64	43
	24"	74	49	67	45	61	41	56	37	51	34	47	31	43	29
12J12 (1200S200-97)	12"	100	67	91	61	83	55	75	50	69	46	63	42	58	39
	16"	75	50	68	45	62	41	56	38	52	34	47	32	43	29
	24"	50	33	45	30	41	28	38	25	34	23	32	21	29	19
12J10 (1200S200-118)	12"	140	93	127	84	115	77	105	70	96	64	88	59	81	54
	16"	105	70	95	63	86	58	79	53	72	48	66	44	61	40
	24"	70	47	63	42	58	38	53	35	48	32	44	29	40	27
12JE16* (1200S250-54)	12"	172	114	155	104	141	94	129	86	118	79	108	72	99	66
	16"	129	86	117	78	106	71	97	64	88	59	81	54	74	50
	24"	86	57	78	52	71	47	64	43	59	39	54	36	50	33
12JE14 (1200S250-68)	12"	104	72	98	66	89	60	82	54	75	50	68	46	63	42
	16"	78	54	73	49	67	45	61	41	56	37	51	34	47	31
	24"	52	36	49	33	45	30	41	27	37	25	34	23	31	21
12JE12 (1200S250-97)	12"	152	101	138	92	125	83	114	76	104	70	96	64	88	59
	16"	114	76	103	69	94	63	86	57	78	52	72	48	66	44
	24"	76	51	69	46	63	42	57	38	52	35	48	32	44	29
12JE10 (1200S250-118)	12"	186	124	169	113	154	102	140	93	128	85	117	78	108	72
	16"	140	93	127	84	115	77	105	70	96	64	88	59	81	54
	24"	93	62	84	56	77	51	70	47	64	43	59	39	54	36
14" Members															
14J14 (1400S200-68)	12"	94	71	88	65	83	59	78	54	73	49	67	45	62	41
	16"	71	53	66	48	62	44	58	40	55	37	50	34	46	31
	24"	47	36	44	32	41	29	39	27	37	24	34	22	31	21
14J12 (1400S200-97)	12"	153	102	139	92	126	84	115	77	105	70	96	64	89	59
	16"	115	77	104	69	95	63	86	58	79	53	72	48	66	44
	24"	77	51	69	46	63	42	58	38	53	35	48	32	44	30
14J10 (1400S200-118)	12"	187	125	170	113	154	103	141	94	129	86	118	79	108	72
	16"	140	94	127	85	116	77	106	70	96	64	88	59	81	54
	24"	94	62	85	57	77	51	70	47	64	43	59	39	54	36
14JE12 (1400S250-97)	12"	169	112	153	102	139	93	127	84	116	77	106	71	98	65
	16"	127	84	115	76	104	69	95	63	87	58	80	53	73	49
	24"	84	56	76	51	69	46	63	42	58	39	53	35	49	33
14JE10 (1400S250-118)	12"	207	138	187	125	170	114	155	104	142	95	130	87	120	80
	16"	155	103	140	94	128	85	116	78	106	71	98	65	90	60
	24"	103	69	94	62	85	57	78	52	71	47	65	43	60	40
14JX12 (1400S300-97)	12"	194	129	176	117	160	106	146	97	133	89	122	81	112	75
	16"	145	97	132	88	120	80	109	73	100	67	92	61	84	56
	24"	97	65	88	59	80	53	73	49	67	44	61	41	56	37
14JX10 (1400S300-118)	12"	238	159	216	144	196	131	179	119	164	109	150	100	138	92
	16"	179	119	162	108	147	98	134	89	123	82	112	75	103	69
	24"	119	79	108	72	98	65	89	60	82	55	75	50	69	46
14JXW12 (1400S350-97)	12"	204	140	190	127	173	115	157	105	144	96	132	88	121	81
	16"	153	105	142	95	129	86	118	79	108	72	99	66	91	61
	24"	102	70	95	63	86	58	79	52	72	48	66	44	61	40
14JXW10 (1400S350-118)	12"	257	172	233	156	212	141	193	129	177	118	162	108	149	99
	16"	193	129	175	117	159	106	145	97	133	88	122	81	112	74
	24"	129	86	117	78	106	71	97	64	88	59	81	54	74	50

* = Exceeds the H/T ratio of 200

L = Live Load

HEADERS, P.L.F.

Headers

MW Type	SSMA	4FT	5FT	6FT	7FT	8FT	9FT	10FT	11FT	12FT	13FT	14FT	15FT	16FT	17FT	18FT	19FT	20FT	21FT	22FT	23FT	24FT	25FT	26FT	27FT	28FT	29FT	30FT
3-5/8" Members																												
358SW20	362S162-33	42	283	196	137	9	55	47	35	27	2	17	14	11														
358SW18	362S162-43	14	393	273	178	119	54	61	46	35	2	22	18	15	12	1												
358SW16	362S162-54	1110	602	349	220	147	03	76	57	44	3	27	22	18	15	1	11											
358SW14	362S162-68	1438	741	429	270	181	27	93	70	54	4	34	27	23	19	1	4	12	10									
358SW12	362S162-97	1948	998	577	364	244	71	125	94	72	5	45	37	30	25	2	8	16	13	12	1							
358SW10	362S162-118	2309	1184	685	432	289	03	148	111	86	6	54	44	36	30	2	2	19	16	14	1	11						
6" Members																												
6 W20	600S162-33	36	608	422	310	238	88	152	118	91	7	57	46	38	32	2	23	20	17	15	1	11	10					
6 W18	600S162-43	36	669	557	415	318	51	202	152	117	9	74	60	49	41	3	30	25	22	19	1	15	13	12	10			
6 W16	600S162-54	313	1480	1028	729	488	43	250	188	145	114	91	74	61	51	4	38	31	27	23	2	18	16	14	13	1	0	
6 W14	600S162-68	931	1876	1303	898	602	23	308	231	178	140	12	91	75	63	5	45	39	33	29	2	22	20	18	16	1	3	11
6 W12	600S162-97	990	2553	1773	122	819	75	419	315	243	191	53	124	102	85	7	31	52	45	39	3	30	27	24	21	1	7	16
6 W10	600S162-118	786	3063	2127	146	982	90	503	378	291	229	83	149	123	102	8	73	63	54	47	4	36	32	29	26	2	21	19
8" Members																												
8 W20*	800S162-33	36	669	554	407	312	46	200	165	139	118	02	89	76	64	5	46	39	34	29	2	23	20	18	16	1	13	12
8 W18	800S162-43	36	669	557	478	418	72	305	252	212	181	48	120	99	82	6	59	51	44	38	3	29	26	23	21	1	17	15
8 W16	800S162-54	3486	2231	1550	113	872	88	501	377	290	228	83	149	122	102	8	73	63	54	47	4	36	32	29	25	2	21	19
8 W14	800S162-68	4422	2830	1965	144	1105	50	620	466	359	282	26	184	151	126	105	90	77	67	58	5	45	40	35	31	2	25	23
8 W12	800S162-97	6058	3877	2693	197	1515	1165	849	638	491	388	09	252	207	173	145	24	108	92	80	70	61	54	48	43	3	35	31
8 W10	800S162-118	7309	4678	3248	238	1827	1405	1024	770	593	468	73	303	250	208	178	49	128	111	96	8	74	66	58	52	4	42	38
10' Members																												
10 SW18*	1000S162-43	36	669	557	478	418	72	334	304	259	221	90	166	146	129	115	02	88	76	66	5	51	45	40	36	3	29	26
10 SW16	1000S162-54	4274	2735	1900	139	1099	44	684	565	475	398	17	258	212	177	149	27	109	94	82	7	63	56	49	44	4	36	32
10 SW14	1000S162-68	6150	3936	2733	200	1588	1215	984	809	623	400	93	319	263	219	185	57	135	116	101	8	78	69	61	55	4	44	40
10 SW12	1000S162-97	8466	5418	3763	276	2177	1672	1355	1114	858	675	40	439	382	302	254	16	185	160	139	122	07	95	84	75	6	61	55
10 SW10	1000S162-118	1256	6564	4558	334	2554	026	1641	1350	104	818	55	532	439	366	308	62	225	194	169	148	30	115	102	91	8	74	67
12' Members																												
12 SW16*	1200S162-54	053	3234	2246	165	1213	98	808	668	561	478	12	359	316	280	238	00	172	148	129	113	99	88	78	70	6	58	51
12 SW14	1200S162-68	7372	4718	3277	240	1813	1456	1180	975	819	698	02	505	416	347	293	49	213	184	160	140	23	109	97	87	7	70	63
12 SW12	1200S162-97	1213	7176	4983	366	2813	2215	1794	1483	124	1012	59	698	575	480	404	44	295	254	221	194	70	151	134	120	107	97	87
12 SW10	1200S162-118	1866	8721	6056	444	3496	2392	2180	1802	151	1200	1044	849	699	583	491	418	358	309	269	235	207	183	163	146	130	17	106
14' Members																												
14 SW14	1400S162-68	8443	5403	3752	275	2111	1568	1351	1116	938	799	89	800	528	467	417	89	318	273	238	203	83	162	144	129	115	04	94
14 SW12	1400S162-97	1866	9150	6354	466	3574	2324	2288	1891	158	1354	1167	1017	856	714	601	11	438	379	329	283	54	224	199	178	160	44	130
14 SW10	1400S162-118	1866	9492	7742	568	4355	3441	2787	2303	193	1699	1422	1239	1043	869	732	23	534	461	401	351	09	273	243	217	195	75	158
16' Members																												
16 SW14*	1600S162-68	9552	6113	4245	311	2308	1387	1528	1263	106	904	780	679	597	529	472	23	382	347	316	284	50	221	197	176	158	42	128
16 SW12	1600S162-97	1866	9492	7425	545	4176	3300	2673	2209	185	1512	1364	1188	1044	925	825	24	621	536	466	403	59	318	283	252	223	04	184
16 SW10	1600S162-118	1866	9492	7910	678	5498	4273	3461	2861	240	2068	1766	1538	1352	119	1040	84	758	655	569	493	39	388	345	308	273	49	225

The values represented in this chart are calculated for (2) of each member stated.

* = Exceeds the H/T ratio of 200

Allowable Axial Loads

3-5/8" Members — Wind Load = 5psf

Height	Spacing	SW 20-(33) 33ksi	SW 18-(43) 33ksi	SW 16-(54) 50ksi	SW 14-(68) 50ksi	SW 12-(97) 50ksi	SW 10-(118) 50ksi	J 20-(33) 33ksi	J 18-(43) 33ksi	J 16-(54) 50ksi	J 14-(68) 50ksi	J 12-(97) 50ksi	J 10-(118) 50ksi
		Marino\Ware - (SSMA)											
		3-5/8SW-gauge - (362S162-mils)						3-5/8J-gauge - (362S200-mils)					
8ft.	12"	2.09	2.85	4.28	5.45	7.82	9.86	2.49	3.51	5.34	6.76	9.49	11.75
	16"	2.09	2.85	4.28	5.45	7.82	9.86	2.49	3.51	5.34	6.76	9.49	11.75
	24"	2.09	2.85	4.28	5.45	7.82	9.86	2.49	3.51	5.34	6.76	9.49	11.75
9ft.	12"	2.02	2.75	4.05	5.12	7.32	9.18	2.41	3.37	5.03	6.33	8.85	10.92
	16"	2.02	2.75	4.05	5.12	7.32	9.18	2.41	3.37	5.03	6.33	8.85	10.92
	24"	1.88	2.75	4.05	5.12	7.32	9.18	2.32	3.37	5.03	6.33	8.85	10.92
10ft.	12"	1.93	2.64	3.79	4.76	6.76	8.44	2.32	3.22	4.68	5.85	8.15	10.03
	16"	1.87	2.64	3.79	4.76	6.76	8.44	2.30	3.22	4.68	5.85	8.15	10.03
	24"	1.66	2.48	3.79	4.76	6.76	8.44	2.06	3.14	4.68	5.85	8.15	10.03
11ft.	12"	1.79	2.51	3.48	4.35	6.15	7.65	2.21	3.05	4.31	5.35	7.43	9.11
	16"	1.66	2.44	3.48	4.35	6.15	7.65	2.06	3.05	4.31	5.35	7.43	9.11
	24"	1.43(6)	2.19	3.43	4.35	6.15	7.65	1.80	2.79	4.31	5.35	7.43	9.11
12ft.	12"	1.59	2.33	3.17	3.95	5.53	6.83	1.98	2.88	3.90	4.82	6.67	8.15
	16"	1.45	2.17	3.17	3.95	5.53	6.83	1.82	2.74	3.90	4.82	6.67	8.15
	24"	1.20(3)	1.89(6)	2.96	3.88	5.53	6.83	1.54(3)	2.43	3.75	4.82	6.67	8.15
14ft.	12"	1.21(6)	1.82	2.59	3.23	4.47	5.44	1.53	2.29	3.18	3.92	5.39	6.54
	16"	1.06(3)	1.65(6)	2.44	3.17	4.47	5.44	1.35(3)	2.10(6)	3.06	3.92	5.39	6.54
	24"	0.80(2)	1.35(3)	2.17(3)	2.89(6)	4.27	5.36	1.05(3)	1.78(3)	2.77(3)	3.69	5.39	6.54
16ft.	12"	0.88(3)	1.36(3)	1.99(6)	2.57	3.64	4.39	1.12(3)	1.74(6)	2.48	3.21	4.39	5.30
	16"	0.73(2)	1.20(3)	1.84(3)	2.41(6)	3.52	4.37	0.95(3)	1.56(3)	2.32(3)	3.06	4.39	5.30
	24"		0.91(2)	1.58(2)	2.14(3)	3.21(3)	4.03(6)	0.65(2)	1.24(2)	2.03(3)	2.77(3)	4.11(6)	5.13

nbers — Wind Load = 15psf

Height	Spacing	SW 20-(33) 33ksi	SW 18-(43) 33ksi	SW 16-(54) 50ksi	SW 14-(68) 50ksi	SW 12-(97) 50ksi	SW 10-(118) 50ksi	J 20-(33) 33ksi	J 18-(43) 33ksi	J 16-(54) 50ksi	J 14-(68) 50ksi	J 12-(97) 50ksi	J 10-(118) 50ksi
		Marino\Ware - (SSMA)											
		3-5/8SW-gauge - (362S162-mils)						3-5/8J-gauge - (362S200-mils)					
8ft.	12"	1.89	2.80	4.28	5.45	7.82	9.86	2.33	3.51	5.34	6.76	9.49	11.75
	16"	1.69	2.59	4.28	5.45	7.82	9.86	2.11	3.33	5.34	6.76	9.49	11.75
	24"	1.32(3)	2.20(6)	3.97	5.35	7.82	9.86	1.70(6)	2.91	5.16	6.76	9.49	11.75
9ft.	12"	1.63	2.50	4.05	5.12	7.32	9.18	2.04	3.19	5.03	6.33	8.85	10.92
	16"	1.40(3)	2.25	3.86	5.12	7.32	9.18	1.78(6)	2.93	4.95	6.33	8.85	10.92
	24"	0.97(3)	1.79(3)	3.40(6)	4.65	7.13	9.18	1.31(3)	2.43(3)	4.45	6.07	8.85	10.92
10ft.	12"	1.37(3)	2.17	3.61	4.76	6.76	8.44	1.74(6)	2.81	4.60	5.85	8.15	10.03
	16"	1.11(3)	1.89(3)	3.34(6)	4.46	6.74	8.44	1.45(3)	2.50(6)	4.30	5.76	8.15	10.03
	24"	0.41(2)	1.38(3)	2.83(3)	3.93(3)	6.12	7.94	0.84(2)	1.95(3)	3.74(3)	5.20(6)	7.86	10.00
11ft.	12"	1.11(3)	1.85(3)	3.10(6)	4.12	6.15	7.65	1.45(3)	2.42(6)	3.99	5.29	7.43	9.11
	16"	0.83(2)	1.54(3)	2.81(3)	3.80(6)	5.80	7.43	1.13(3)	2.08(3)	3.66(6)	4.95	7.37	9.11
	24"		0.99(2)	2.28(2)	3.24(3)	5.14(3)	6.71(6)	0.19(2)	1.49(2)	3.07(3)	4.38(3)	6.71(6)	8.57
12ft.	12"	0.87(2)	1.53(3)	2.62(3)	3.51(6)	5.28	6.71	1.17(3)	2.04(3)	3.38(6)	4.53	6.67	8.15
	16"	0.41(2)	1.21(2)	2.32(3)	3.19(3)	4.91(6)	6.30	0.76(2)	1.69(3)	3.04(3)	4.19(3)	6.31	7.97
	24"			1.79(2)	2.62(2)	4.25(3)	5.57(3)		0.92(2)	2.45(2)	3.59(3)	5.63(3)	7.23(6)
14ft.	12"		0.98(2)	1.83(2)	2.52(3)	3.85(3)	4.90(6)	0.56(2)	1.37(2)	2.39(3)	3.30(3)	4.96(6)	6.24
	16"			1.53(2)	2.20(2)	3.48(3)	4.49(3)			2.06(2)	2.96(3)	4.58(3)	5.83(3)
	24"					2.84(2)	3.80(2)				2.38(2)	3.92(2)	5.11(3)
16ft.	12"				1.78(2)	2.80(3)	3.59(3)			1.67(2)	2.40(2)	3.69(3)	4.68(3)
	16"					2.46(2)	3.21(2)				2.08(2)	3.33(2)	4.28(3)
	24"												3.60(2)

3-5/8" Members — Wind Load = 20psf

Height	Spacing	SW 20-(33) 33ksi	SW 18-(43) 33ksi	SW 16-(54) 50ksi	SW 14-(68) 50ksi	SW 12-(97) 50ksi	SW 10-(118) 50ksi	J 20-(33) 33ksi	J 18-(43) 33ksi	J 16-(54) 50ksi	J 14-(68) 50ksi	J 12-(97) 50ksi	J 10-(118) 50ksi
		Marino\Ware - (SSMA)											
		3-5/8SW-gauge - (362S162-mils)						3-5/8J-gauge - (362S200-mils)					
8ft.	12"	1.69	2.59	4.28	5.45	7.82	9.86	2.11	3.33	5.34	6.76	9.49	11.75
	16"	1.44(6)	2.33	4.10	5.45	7.82	9.86	1.83	3.05	5.29	6.76	9.49	11.75
	24"	0.97(3)	1.83(3)	3.61(6)	4.97	7.67	9.86	1.32(3)	2.52(6)	4.76	6.53	9.49	11.75
9ft.	12"	1.40(3)	2.25	3.86	5.12	7.32	9.18	1.78(6)	2.93	4.95	6.33	8.85	10.92
	16"	1.11(3)	1.93(3)	3.55(6)	4.80	7.30	9.18	1.46(3)	2.59(6)	4.61	6.23	8.85	10.92
	24"	0.22(2)	1.37(3)	2.99(3)	4.20(3)	6.62	8.65	0.67(2)	1.97(3)	3.99(3)	5.61(6)	8.54	10.90
10ft.	12"	1.11(3)	1.89(3)	3.34(6)	4.46	6.74	8.44	1.45(3)	2.50(6)	4.30	5.76	8.15	10.03
	16"	0.73(2)	1.54(3)	2.99(3)	4.10(6)	6.32	8.16	1.10(3)	2.12(3)	3.92(6)	5.38	8.06	10.03
	24"		0.67(2)	2.38(2)	3.44(3)	5.56(3)	7.32(6)	0.00	1.45(2)	3.24(3)	4.69(3)	7.30(6)	9.38
11ft.	12"	0.83(2)	1.54(3)	2.81(3)	3.80(6)	5.80	7.43	1.13(3)	2.08(3)	3.66(6)	4.95	7.37	9.11
	16"		1.17(2)	2.45(3)	3.42(3)	5.35(6)	6.94	0.54(2)	1.68(3)	3.26(3)	4.55(3)	6.92	8.80
	24"			1.82(2)	2.74(2)	4.56(3)	6.07(3)		0.62(2)	2.56(2)	3.83(3)	6.11(3)	7.92(6)
12ft.	12"	0.41(2)	1.21(2)	2.32(3)	3.19(3)	4.91(6)	6.30	0.76(2)	1.69(3)	3.04(3)	4.19(3)	6.31	7.97
	16"			1.95(2)	2.80(3)	4.46(3)	5.80(3)		1.27(2)	2.64(2)	3.78(3)	5.84(3)	7.46(6)
	24"				2.12(2)	3.67(2)	4.93(3)				3.06(2)	5.03(3)	6.58(3)
14ft.	12"			1.53(2)	2.20(2)	3.48(3)	4.49(3)			2.06(2)	2.96(3)	4.58(3)	5.83(3)
	16"					3.05(2)	4.02(3)				2.56(2)	4.13(3)	5.33(3)
	24"						3.19(2)					3.34(2)	4.48(2)
16ft.	12"					2.46(2)	3.21(2)				2.08(2)	3.33(2)	4.28(3)
	16"						2.77(2)					2.90(2)	3.81(2)
	24"												

nbers — Wind Load = 25psf

Height	Spacing	SW 20-(33) 33ksi	SW 18-(43) 33ksi	SW 16-(54) 50ksi	SW 14-(68) 50ksi	SW 12-(97) 50ksi	SW 10-(118) 50ksi	J 20-(33) 33ksi	J 18-(43) 33ksi	J 16-(54) 50ksi	J 14-(68) 50ksi	J 12-(97) 50ksi	J 10-(118) 50ksi
		Marino\Ware - (SSMA)											
		3-5/8SW-gauge - (362S162-mils)						3-5/8J-gauge - (362S200-mils)					
8ft.	12"	1.50(6)	2.39	4.16	5.45	7.82	9.86	1.90	3.12	5.34	6.76	9.49	11.75
	16"	1.20(3)	2.07(6)	3.85	5.22	7.82	9.86	1.57(3)	2.78	5.02	6.76	9.49	11.75
	24"	0.29(2)	1.49(3)	3.27(3)	4.60(6)	7.26	9.52	0.80(3)	2.14(3)	4.38(6)	6.15	9.35	11.75
9ft.	12"	1.18(3)	2.01(6)	3.63	4.88	7.32	9.18	1.54(3)	2.67(6)	4.69	6.32	8.85	10.92
	16"	0.79(2)	1.64(3)	3.26(3)	4.49(6)	6.95	9.02	1.16(3)	2.27(3)	4.29(6)	5.91	8.85	10.92
	24"		0.70(2)	2.60(3)	3.79(3)	6.14(6)	8.12	0.00	1.55(2)	3.56(3)	5.17(3)	8.06	10.39
10ft.	12"	0.87(2)	1.62(3)	3.08(3)	4.19(6)	6.42	8.27	1.18(3)	2.21(3)	4.01(6)	5.47	8.15	10.03
	16"	0.11(2)	1.22(2)	2.68(3)	3.76(3)	5.93(6)	7.73	0.50(2)	1.77(3)	3.57(3)	5.02(3)	7.67	9.79
	24"			1.97(2)	3.00(2)	5.05(3)	6.75(3)		0.55(2)	2.79(2)	4.22(3)	6.77(3)	8.81(6)
11ft.	12"	0.34(2)	1.26(2)	2.53(3)	3.51(3)	5.46(6)	7.06	0.72(2)	1.78(3)	3.35(3)	4.65(3)	7.03	8.92
	16"		0.56(2)	2.12(2)	3.06(3)	4.94(3)	6.49(6)		1.29(2)	2.89(3)	4.18(3)	6.50(6)	8.35
	24"				2.29(2)	4.04(2)	5.48(3)			2.09(2)	3.35(2)	5.57(3)	7.33(3)
12ft.	12"		0.81(2)	2.04(2)	2.89(3)	4.57(3)	5.92(6)		1.37(2)	2.74(3)	3.88(3)	5.95(6)	7.59
	16"				2.45(2)	4.05(3)	5.35(3)			2.28(2)	3.41(2)	5.42(3)	7.00(3)
	24"					3.15(2)	4.36(2)					4.49(2)	5.99(3)
14ft.	12"				1.91(2)	3.15(2)	4.13(3)				2.66(2)	4.23(3)	5.45(3)
	16"					2.65(2)	3.59(2)					3.72(2)	4.89(2)
	24"												
16ft.	12"						2.88(2)					3.00(2)	3.93(2)
	16"												
	24"												

(2) = L/240 (3) = ./600

Appendix 5 – Tables used in Masonry design

Table 1—Wall Lateral Support Requirements (ref. 1)

Construction	Maximum wall length-to thickness or height-to thickness ratio[a]
Bearing walls	
Solid or solid grouted	20
All other	18
Nonbearing walls	
Exterior	18
Interior	36
Cantilever Walls[b]	
Solid	6
Hollow	4
Parapets (8-in. (203-mm) thick min)[b]	3

[a] Ratios are determined using nominal dimensions. For multiwythe walls where wythes are bonded by masonry headers, the thickness is the nominal wall thickness. When multiwythe walls are bonded by metal wall ties, the thickness is taken as the sum of the wythe thicknesses.

[b] The ratios are maximum height-to-thickness ratios and do not limit wall length.

Table 2—Maximum Wall Spans, ft (m)

Wall thickness, in. (mm)	6 (152)	8 (203)	10 (254)	12 (305)
Bearing walls				
Solid or solid grouted	10 (3.0)[a]	13.3 (4.1)	16.6 (5.1)	20 (6.1)
All other	9 (2.7)[a]	12 (3.7)	15 (4.5)	18 (5.5)
Nonbearing walls				
Exterior	9 (2.7)	12 (3.7)	15 (4.5)	18 (5.5)
Interior	18 (5.5)	24 (7.3)	30 (9.1)	36 (11)
Cantilever Walls[b]				
Solid	3 (0.9)	4 (1.2)	5 (1.5)	6 (1.8)
Hollow	2 (0.6)	2.6 (0.8)	3.3 (1.0)	4 (1.2)
Parapets[b]	1.5 (0.5)	2 (0.6)	2.5 (0.8)	3 (0.9)

[a] 6-in. (152-mm) thick bearing walls are limited to one story in height.

[b] For these cases, spans are maximum wall heights.

Table 3—Allowable Compressive Stress for Empirical Design of Masonry (ref. 1)

Gross area compressive strength of unit, psi (MPa)	Allowable compressive stresses based on gross cross-sectional area, psi (MPa)[a] Type M or S mortar	Type N mortar
Solid concrete brick:		
8000 (55) or greater	350 (2.41)	300 (2.07)
4500 (31)	225 (1.55)	200 (1.38)
2500 (17)	160 (1.10)	140 (0.97)
1500 (10)	115 (0.79)	100 (0.69)
Grouted concrete masonry:		
4500 (31) or greater	225 (1.55)	200 (1.38)
2500 (17)	160 (1.10)	140 (0.97)
1500 (10)	115 (0.79)	100 (0.69)
Solid concrete masonry units:		
3000 (21) or greater	225 (1.55)	200 (1.38)
2000 (14)	160 (1.10)	140 (0.97)
1200 (8.3)	115 (0.79)	100 (0.69)
Hollow concrete masonry units:		
2000 (14) or greater	140 (0.97)	120 (0.83)
1500 (10)	115 (0.79)	100 (0.69)
1000 (6.9)	75 (0.52)	70 (0.48)
700 (4.8)	60 (0.41)	55 (0.38)
Hollow walls (noncomposite masonry bonded[b])		
solid units:		
2500 (17) or greater	160 (1.10)	140 (0.97)
1500 (10)	115 (0.79)	100 (0.69)
hollow units	75 (0.52)	70 (0.48)

[a] Linear interpolation for intermediate values of compressive strength is permitted.

[b] Where floor and roof loads are carried on one wythe, the gross cross-sectional area is that of the wythe under load; if both wythes are loaded, the gross cross-sectional area is that of the wall minus the area of the cavity between the wythes. Walls bonded with metal ties shall be considered as noncomposite walls unless collar joints are filled with mortar or grout.

Reference: Beavertown Block Company (www.ncma.org/etek/index.cfm)