Point Pleasant Apartments
Point Pleasant, NJ

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Structural Option
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Technical Report #2:
Alternate Floor Systems

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Executive Summary

The purpose of this report is to explore four different floor alternatives for floors two through four of building one at Point Pleasant Apartments. The current floor system is a 3.5" concrete slab on metal deck supported by 16" deep steel joists spaced at 48" o.c. The alternatives are compared to this system based on multiple criteria including cost, fireproofing, vibration resistance, depth, constructability, lead time, durability and span changes.

The four systems that were compared to the existing steel joist system are iLevel joists, a flat-plate two-way slab, precast hollow core planks, and open web wood floor trusses. Designs of each of these types of floor systems were completed using a typical span from the existing floor plan to determine if they are viable solutions. The iLevel joists were selected using the TrussJoist span tables, the two-way slab was designed using PCA-Slab, and the hollow core planks and wood trusses were chosen based on manufacturer's span tables available online.

Because these analyses are based on a typical span and not the overall building floor plan, these calculations are simply an estimated measure of how well the system would work. These results and the comparison of the different systems are summarized in the chart at the end of this report.

After analyzing each system it has been determined that the two wood options, the iLevel joists and the open web trusses are the best possible alternatives to the existing steel joist and concrete slab floor, while the two-way slab and the hollow core planks did not work out. The two-way slab was more expensive and significantly added to the weight of the building, while the hollow core planks yielded similar results to the existing system but added cost. Both wood options would greatly reduce the cost and weight of the building and the existing spans would work well with a wood system. The disadvantages of these two systems will need to be addressed, but iLevel joists and open web wood trusses are worthy of further exploration.

Introduction

Point Pleasant is a 5-building apartment complex located at the New Jersey Shore. This report will focus on building 1, which is 64,000 square feet and has four stories over a partially exposed parking garage. There are sixteen luxury apartments in the building, four on each floor. The apartments are approximately 2,500 square feet and each has a front balcony facing the central courtyard and a rear balcony overlooking the Manasquan River. The exterior of the building is a combination of stone, stucco, and hardshingle siding. This change in material along with the bump out balconies creates an interesting façade and effectively masks its basic box shape. The roof is a simple hip accented with multiple dormers, a dome feature on one side, and steeple at the center.

Codes

Because the Point Pleasant apartment complex was designed a few years ago, the most recent code books had not yet been published. In order to make my project a more practical and beneficial learning experience, I will be using the most up to date design codes available.

Design Codes used in original design:

- International Building Code (IBC), 2000 Edition
- American Society of Civil Engineers (ASCE-7), 2002 Edition
- American Concrete Institute (ACI 318), 2000 Edition
- American Institute of Steel Construction ASD (AISC), 9th Edition

Design Codes used in my analysis:

- International Building Code (IBC), 2006 Edition
- American Society of Civil Engineers (ASCE-7), 2005 Edition
- American Concrete Institute (ACI 318), 2005 Edition
- American Institute of Steel Construction (AISC), 13th Edition

Design Loads

Dead Loads

Composite Floor System…………………….. 65 psf
5" Concrete Slab……………………………... 63 psf
4" Concrete Slab……………………………... 50 psf
Roof Trusses…………………………………. 10 psf (top and bottom chord)

Superimposed Dead Loads

Mechanical, Electrical, Plumbing…………….5 psf
Ceiling Finishes……………………………… 3 psf
Floor Finishes………………………………... 5 psf

Live Loads

Residential (private rooms and corridors)…... 40 psf
Residential Balconies…………………………60 psf
First Floor Corridors and Lobbies.………….. 100 psf
Roof (Ground Snow)………………………... 30 psf
Partition Wall Allowance................................ 20 psf

Structural System

Foundation

For Point Pleasant Apartments, a traditional shallow foundation with spread footings was used. The building was designed based on a 3,000 PSF soil bearing capacity. The exterior foundation walls are 12” thick concrete over either a 2’-6”x12” thick footing with #5 @ 24” o.c. S.W.B. and (3) #4 L.W.B. or a 3’-0”x12” thick footing with #5 @ 16” o.c. S.W.B. and (3) # 5 L.W.B. There is a 5” concrete slab on grade with 6.0x6.0 – W2.0x2.0 welded wire fabric over 4” of crushed stone and a 6 Mil vapor barrier. The main columns at this level are 16”x24”, 18”x26”, or 24”x24” reinforced concrete columns. Beneath these columns are 11’-0”x11’-0”x26” deep concrete spread footings which are reinforced with (12) #7 bars each way.

Floor System

The framing for floors 2, 3, and 4 is all basically the same. These stories are supported by 16” deep Vescom composite joists with a 3 1/2”reinforced concrete slab. The slab is supported by a 1 5/16”, 22 gage UFX 36 metal form deck. The joists are spaced at 48” o.c. and are designed to carry a total load of about 380 plf. The typical span for these joists is approximately 20’, with a maximum span of about 24’. Spans run front to back. This composite system is supported by a series of steel girder trusses, wide flange beams, and HSS columns.

Each of the apartments throughout the building features front and rear balconies. The balconies are supported by a shallower composite joist of 12”. HSS shapes are used as both edge beams and columns for the balconies.

The first floor is framed very differently from the floors above. Instead of a composite joist system, the first floor is a 12” thick, reinforced two-way slab. In addition to the 12” thick slab, there are slab beams in the outer apartments for additional support. Above the concrete columns below, are 12’-0”x12’-0”x20” deep (20”-12”=8” below slab depth) drop panels.

Roof Sytem

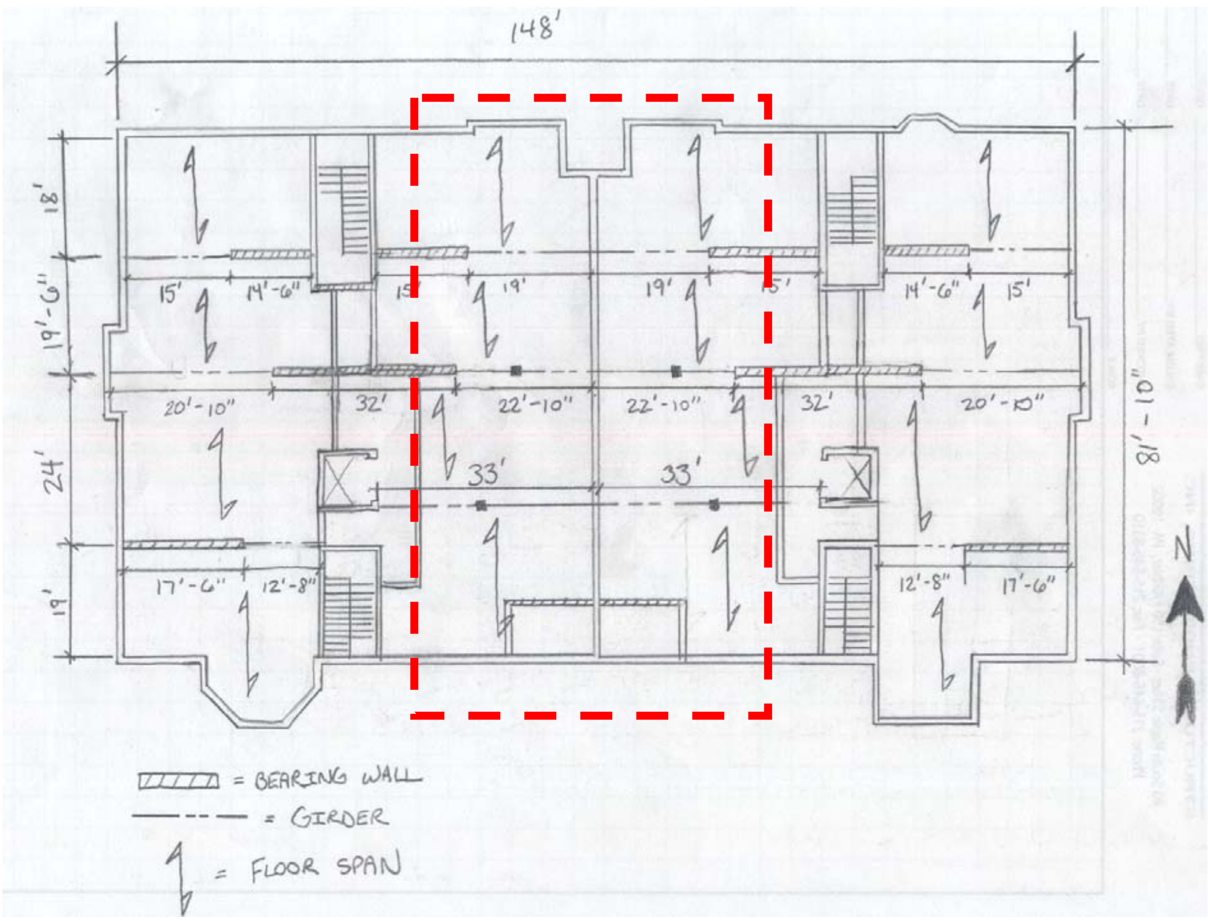
The roof system is a simple hip with two large dormers in the rear and two smaller dormers, a tower, and a dome feature in the front. The roof is made up of light gage metal roof trusses spaced at 48” o.c.

Lateral Framing

The walls of the building are comprised of metal studs, therefore, light gage shearpanels and special reinforced shearwalls are utilized to resist lateral load. The shearwalls typically consist of 4”x14 or 16 gage flat strap bracing with 3 1/2”x3 1/2”x1/2” or 6”x3 1/2”x1/2” HSS shapes. The flat straps can either be screwed or welded to the HSS’s.

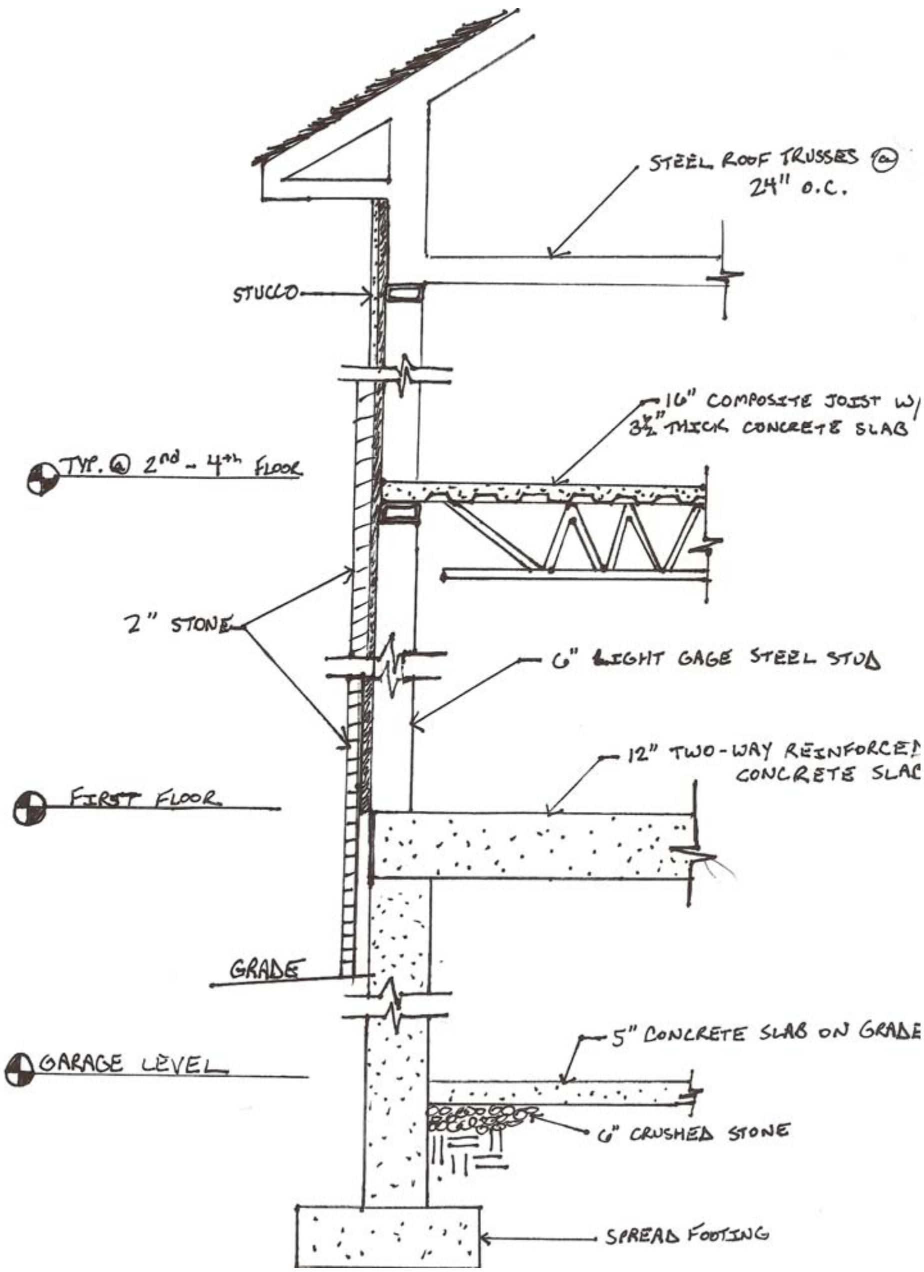
Typical Floor Plan (Structural Layout)

The floor plan below illustrates the typical framing for floors 2-4. The span arrows represent the composite joist system used for these floors. The highlighted area is the general frame or bay that was designed for each alternate floor system explored. More detailed drawings are provided at each design alternative.



Typical Exterior Wall Section

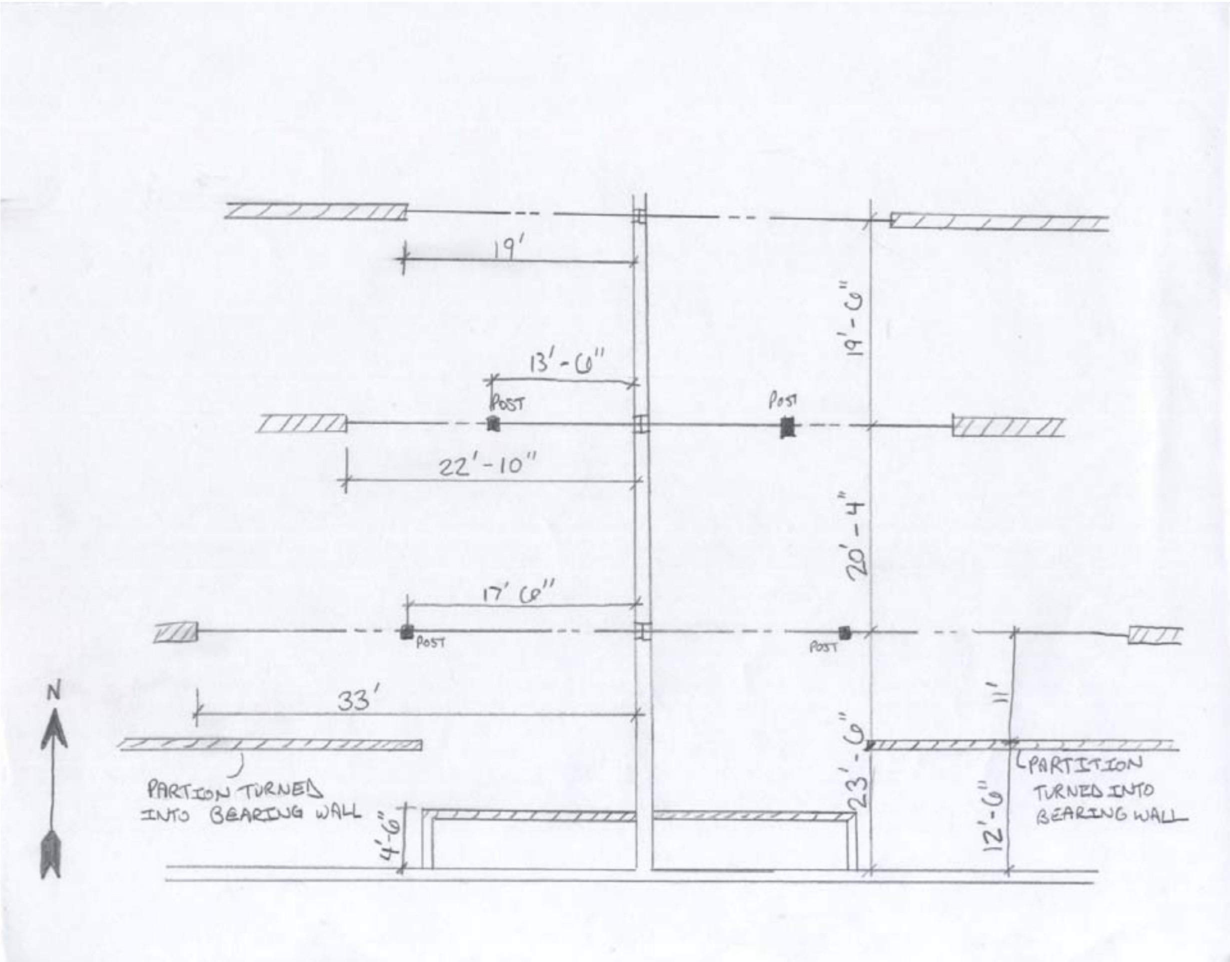
The section below shows the basic structural framing from the foundation up to the roof. Floors 2-4 were generalized with one section because they use the same composite joist system. At different areas of the building the façade material may change to include hardshingle siding but this image gives a typical snapshot of the framing. How much of the garage that is above grade also changes around the building. For example, at the rear of the building, the full height of the garage is exposed so that cars can enter and exit.



iLevel Floor Joists

iLevel floor joists by Weyerhaeuser are a common floor system used in residential and smaller commercial type projects. Code limits the use of wood for more than four stories, so for this project, wood is a viable solution to explore. The spans of building 1 are also short enough for the use of wood. Below is a sketch illustrating the bay layout used for the I-joist calculations. After moment, shear and deflection checks, 14" TJI 360 Series @ 16" o.c. are the best option, resulting in a deflection of 0.502" or L/486.

For beams, the largest span of the selected area is 13'-6". The best choice for a beam under these conditions is a 5 ¼"x14" PSL which can be dropped or flush to reduce the overall floor depth. The deflection of the PSL is 0.271" or L/598 under live load.



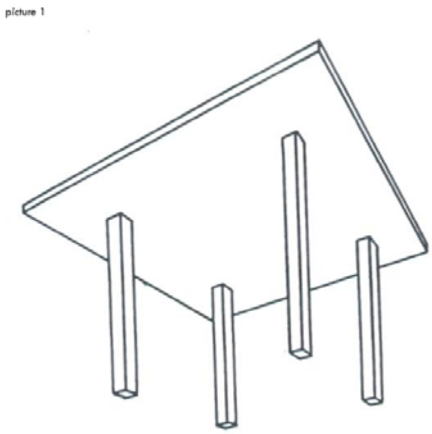
Advantages:

There are many advantages to using wood as a flooring option for floors 2-4 in building. For starters wood is relatively inexpensive as compared to concrete and steel. Using RS-Means, the cost for both material and labor for the I-joists and subflooring is only $4.37 per square foot. There would also be additional cost for the Gyp-crete required for sound and fireproofing as well as the cost of the PSL beams used for support, but this would still be significantly lower than the steel joist and slab system. If the PSL beams are flush, hangers would also have to be provided. I-joists do not require much lead time and can easily be stored on-site. Installation of the joists is simple and the construction time would be less than the current steel joist and concrete slab system. As far as depth is concerned, I-joists would reduce the floor depth from approximately 20" to 14" if flush beams are used. If dropped beams are used, there would be an additional 14" of depth added at beam locations. Using wood I-joists as an alternative would also greatly reduce the overall weight of the structure.

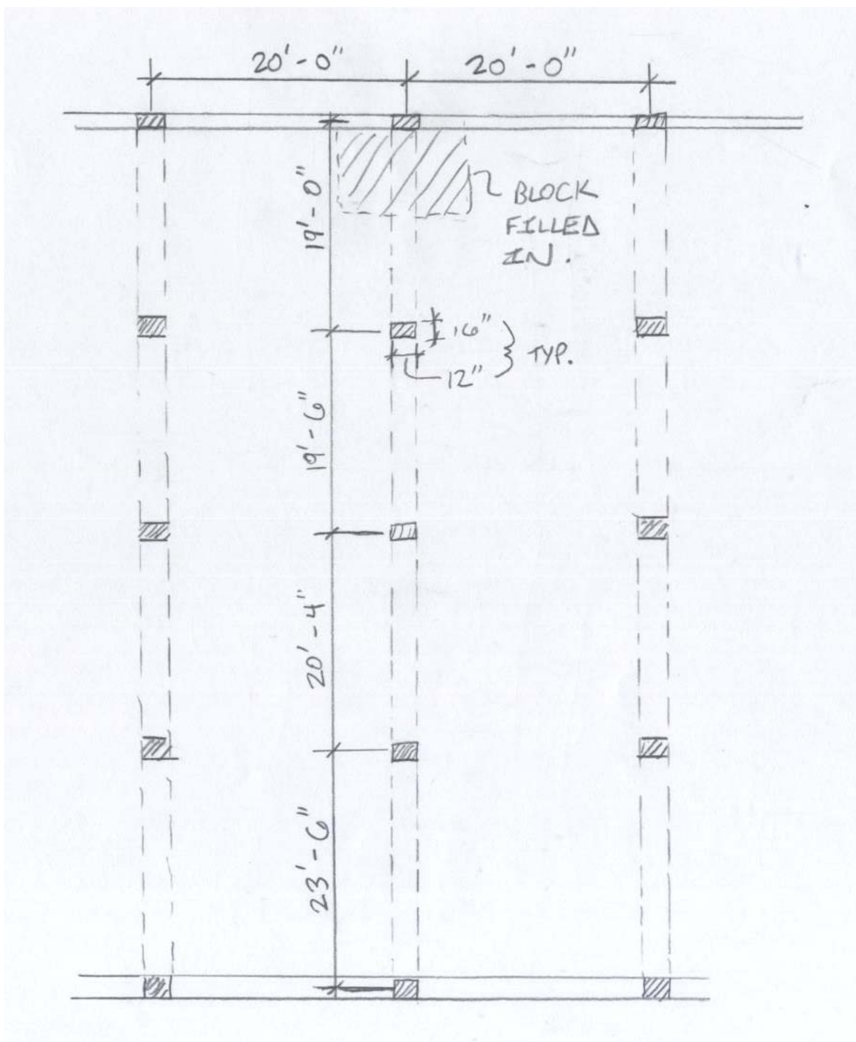
Disadvantages:

One of the biggest disadvantages of using I-joists is the sound that would be transmitted from floor to floor. Wood products will tend to creak when walked on which could be heard at the floor below. Drywall or an equivalent fireproofing material would also need to be installed on the sealing as well as a ¾" Gyp-crete topping on top of the subfloor to reduce soundproofing and increase the fire-rating. Gyp-crete has become a standard application in multi-family housing. Because I-joists are not an open web system like the steel joists, cuts in the joists or a drop ceiling would have to be utilized to run mechanical equipment, increasing the overall depth of the floor. Finally, wood products are not as durable as their steel and concrete counterparts and are more susceptible to water damage and possible even termite damage.

Flat-Plate 2-Way Slab



The second flooring option explored is a flat-plate, two-way concrete slab. For this option, an alternate bay spacing was utilized to create an effective column grid. This bay spacing is illustrated in the figure below. PCA Slab was used to design the reinforcement for the slab after a minimum slab thickness of 9" was calculated using the largest clear span of 22'-2". The output of PCA Slab indicated the need for #4 bars in both directions. The program output can be found in the appendix.



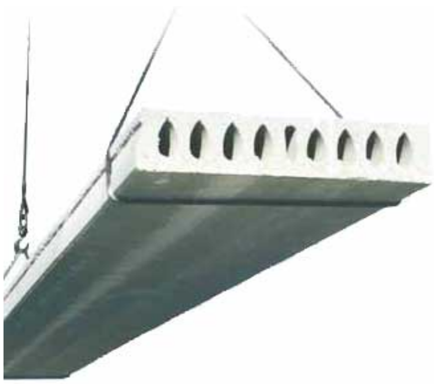
Advantages:

There are limited advantages to using a two-way slab as a possible floor system. Sound transmission and fireproofing are the two most obvious advantages for this type of flooring. The 9” slab results in very little vibration creating a more quiet transition from floor to floor. There is also no additional fireproofing required to achieve a two-hour fire-rating for a 9” thick concrete slab. Another advantage to a concrete slab versus the joist system is a slight decrease in lead time. The depth of the floor itself would be decreased, but a drop ceiling would have to be added to allow space for the mechanical equipment.

Disadvantages:

A two-way slab would increase the self-weight of the floor system from 65 PSF to nearly 115 PSF which would result in a larger base shear for the seismic design. The cost of construction would increase from $11.00 per square foot to $12.75 per square foot resulting in an overall increase of approximately $64,000. Constructability also becomes an issue with a concrete slab because of the need for form work as well as the time required for the concrete to set. In order to create a floor plan conducive to a flat-plate two-way slab, columns would need to be added, some of which would be visible in the apartments.

Hollow Core Precast Concrete Planks



The next flooring option chosen is the use of precast hollow core planks supported by steel girders. The Nitterhouse span tables used for this design are located in the appendix. The results indicated the need for a 6" thick plank with a 2" topping to achieve the required fire-rating. The 4 strand planks at a span of 21' were not sufficient so 7 strand planks with a capacity of 215 PSF were chosen. The longest span for a steel girder in the bay examined is 22'-10". In order to limit the deflection under live load to L/480, a W16x57 or W21x48 would have to be used. Another option would be to reduce the span by adding a column. This would reduce the weight and depth required to support the planks. The bay sizes are the same as with the wood I-joists pictured above.

Advantages:

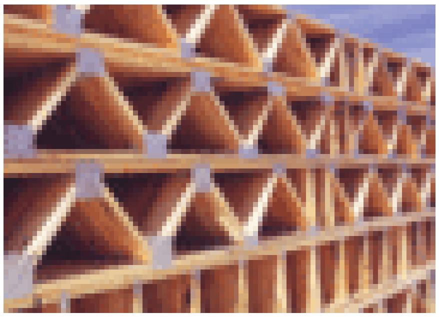
The biggest advantage to using hollow core planks would be the constructability. Because the planks are precast, the speed of construction would be greatly increased over the existing steel joist system. Hollow core planks are also excellent in resisting vibration and sound transmission through the floor. The precast planks would reduce the depth of the floor system, but again a drop ceiling would have to be utilized to run mechanical equipment.

Disadvantages:

One major disadvantage to using hollow core planks would be the lead in time required. Planks would also increase the weight of the structure by a slight amount from 65 PSF to approximately 75 PSF. The cost of construction for the planks and steel girders is more than both the existing system and the two-way slab at $13.72 per square foot. This would increase the overall cost by nearly $100,000.

Open Web Wood Floor Trusses (By ALPINE)

The final alternative examined in this report is open web wood floor trusses manufactured by ALPINE. The analysis of this system is similar to that of the I-joists and uses the same spans. The ALPINE website contains the span table, which is included in the appendix, that was used to find the depth of floor truss that would be required. In order to meet the L/480 deflection criteria, 18" trusses at 24" o.c. are required. A 3 1/2" x 18 PSL is required for the same 13'-6" span as in the I-joist calculation. An 18" deep beam is a good choice here because it will be flush with the trusses.



Advantages:

Many of the advantages of wood trusses are similar to those of the I-joist system. Trusses will be nearly as inexpensive and also are easy to install. The one main advantage that wood trusses have over the I-joists is that the mechanical equipment can be run through the web without having to drop the ceiling. Also, there is the option to have the trusses be top chord bearing. That way the bottom of the supporting beam would be flush with the floor trusses creating an overall depth of 18" without having any exposed boxed out beams in the apartment units. This could create a more aesthetically pleasing interior. Like the I-joists, wood trusses would also greatly reduce the weight of the structure.

Disadvantages:

Again, as with the I-joists the sound transmission and vibration will be an issue. Gyp-crete will need to be installed and additional soundproofing may need to be included since these are supposed to be luxury apartments. The Gyp-crete is also required for fireproofing. Trusses will also not be as durable as the existing system or the concrete slab and hollow core alternatives. The major disadvantage of trusses over I-joists is lead time. The wood trusses will need to be fabricated and therefore will take a longer time to be shipped.

Conclusions

The following chart summarizes the advantages and disadvantages of the existing floor system as well as the four alternatives that were explored. Based on all of the criteria below, the two best alternatives to the existing structure are I-joists or wood trusses. The disadvantages of these two systems will need to be addressed, particularly vibration control and sound transmission, but the possible cost savings and other advantages make both options worth further developing. The two-way slab is the first one eliminated. The additional columns, cost, constructability, and weight are not sufficiently offset by the increased vibration resistance and short lead time. Hollow core planks actually could be a viable solution if the owner does not mind the additional cost. They are excellent in vibration resistance, would be more than adequate in soundproofing, and would be a more durable alternative than wood. The current spans also lend themselves to a hollow core floor system; however, the minimal benefits over the existing system may not be enough to justify the additional cost.

	Existing Steel Joists	**Two-Way Slab**	**Hollow Core Planks**	**iLevel Joists**	**Wood Trusses**
Cost	Average	Higher	Higher	Low	Low
Fireproofing	Gypsum Ceiling	None Extra	Gypsum for Steel	3/4" Gyp-crete	3/4" Gyp-crete
Lead Time	Average-Long	Short	Long	Short	Short-Average
Constructability	Average-Difficult	Difficult	Average	Easy	Easy
Vibration Resistance	Above Average	Above Average	Above Average	Average	Average
Depth	20"	9"	8"	14"	18"
Aesthetics	N/A	Add'l Int. Cols.	No Effect	No Effect	No Effect
Weight	65 PSF	112.5 PSF	75 PSF	25 PSF	25 PSF
Span Alterations	N/A	Significant	Minimal	Minimal	Minimal
Possible Solution	Yes	No	No	Yes	Yes

APPENDIX

iLevel Joist Calculations

RYAN FLYNN | FLOOR DESIGN | I-LEVEL JOISTS

LOADS

ASSUMED JOIST WT = 4.0 lb/ft

3/4" PLYWOOD = 2.7 psf

FLOOR FINISH = 5.0 psf

MEP = 5 psf

CEILING = 3 psf (GYPSUM)

GYPRETE UNDERLAYMENT = $\frac{0.75}{12}(100) = 6.25$ psf

21.95 psf

Assume 16" spacing

$21.95\left(\frac{16}{12}\right) + 4 = 33.3$ lb/ft

Live Load = 40 psf + 20 psf (partition allowance) = 60 psf $\left(\frac{16}{12}\right) =$ 80 lb/ft

Total Load = 113.3 lb/ft

LONGEST CLEARSPAN = 20'-4"

$$M = \frac{w l^2}{8} = \frac{113.3(20.333)^2}{8} = 5854 \text{ ft-lb}$$

$$\Delta_{TOT} \le \frac{L}{240} = \frac{20.333(12)}{240} = 1.02''$$

$$1.02 \ge \frac{5 w l^4}{384 EI}$$

$$1.02 \ge \frac{5(113.3)(20.333)^4 (1728)}{384 EI}$$

$$EI \ge 427 \times 10^6 \text{ psi}$$

RYAN FLYNN | FLOOR DESIGN | I-LEVEL JOISTS

$$\Delta_{LL} \le \frac{L}{480} = \frac{20.333(12)}{480} = 0.508''$$

$$0.508 \ge \frac{5(80)(20.333)^4(1728)}{384\,EI}$$

$EI \ge 606 \times 10^6$ psi CONTROLS

USING I-LEVEL DESIGN TABLES

14" TJI 360 SERIES
IS BEST OPTION

$M_{max} = 7{,}335$ ft·lb > 5854 ft·lb ✓

$EI = 612 \times 10^6$ psi $> 606 \times 10^6$ psi ✓

JOIST WEIGHT $= 3.3$ lb/ft < 4 lb/ft ✓

$$R = \frac{113.3(20.333)}{2} = 1152 \text{ lb} < 2190 \text{ lb}$$ ✓

ACTUAL DEFLECTION

$$\Delta = \frac{5(80)(20.333)^4(1728)}{384(612 \times 10^6)} = 0.502''$$

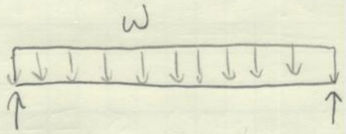
$$0.502'' = \frac{20.33(12)}{x} \Rightarrow x = 486$$

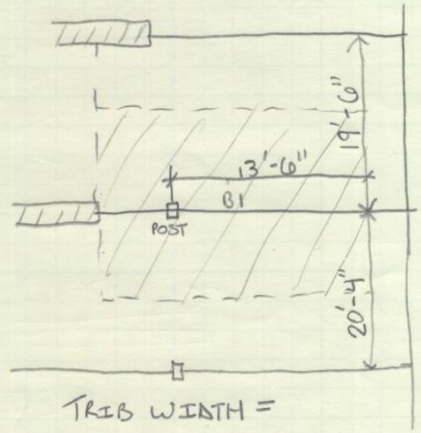
$\hookrightarrow \frac{L}{486}$

RYAN FLYNN | FLOOR DESIGN | I-LEVEL JOISTS

BEAM DESIGN

(B1)





REACTIONS

$\frac{19.5'(113.3)}{2} = 1105$ lb per 16"

$\frac{20.33(113.3)}{2} = 1152$ lb per 16"

$(1105 + 1152)\left(\frac{12}{16}\right) = 1693$ lb/ft $= w$

TRIB WIDTH =

$\frac{19.5}{2} + \frac{20.33}{2} = 19.9'$

$M = \frac{w l^2}{8} = \frac{1693(13.5')^2}{8} = 38.6$ k-ft

$\Delta_{TL} \le \frac{L}{240} = \frac{13.5(12)}{240} = 0.675$ in

ASSUMING PSL

$0.675 \ge \frac{5(1693)(13.5')^4(1728)}{384(2\times10^6)I}$

$I \ge 937$ in^4

LL = $1169\left(\frac{12}{16}\right) = 877$

$\Delta_{LL} \le \frac{13.5(12)}{480} = 0.34$ in

$0.34 \ge \frac{5(877)(13.5)^4(1728)}{384(2\times10^6)I}$

$I \ge 964$ in^4 CONTROLS ✓

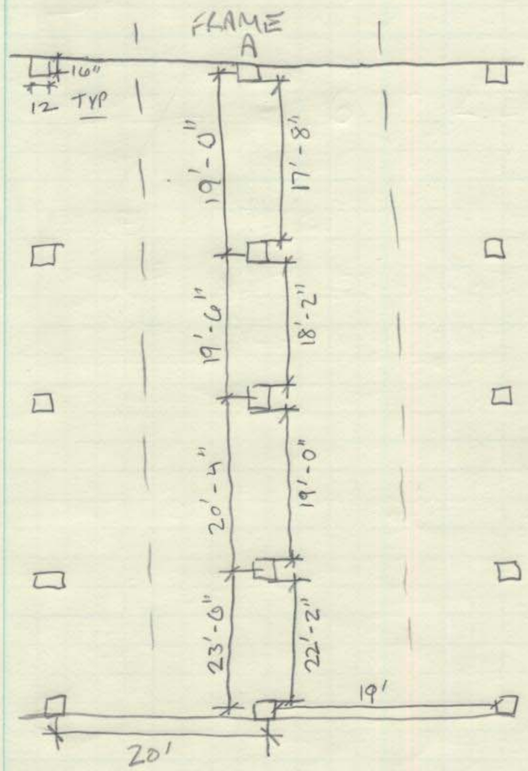
$R = \frac{1569(13.5)}{2} = 10.6^k < 14.2^k$ ✓

USE $5\frac{1}{4}" \times 14"$ PSL FLUSH
$M_{max} = 40{,}740 > 38.6$ ✓
$I = 1{,}201$ in^4 > 964 in^4 ✓

2-Way Slab Calcualtions

RYAN FLYNN | FLOOR DESIGN | TWO WAY SLAB

SLIGHT CHANGES MADE TO BEARING POINTS.
USED FRAME @ CENTERLINE OF BUILDING RUNNING NORTH – SOUTH AND OFFSET COLUMNS 20' CENTER TO CENTER SO THEY LINE UP



USED PCA SLAB FOR SLAB REINFORCING.
ASSUMED COLUMN SIZES OF 12" x 16".

$f'_c = 4$ ksi
$f_y = 60$ ksi
Live Load = 40 psf + 20 = 60 psf (partitions)
FLOOR FINISH = 5 psf
CEILING FINISH = 3 psf
MEP = 5 PSF

DEAD LOAD = 13 psf (excluding Slab)

CHECK TO FIND LARGEST REQ'D SLAB THICKNESS
FOR EXT w/OUT DROP PANELS OR BEAMS, $f_y = 60$ ksi

$$t_{min} = \frac{l_{n\,max}}{30} = \frac{22'\text{-}2''(12)}{30} = 8.9'' \rightarrow 9''$$

FOR INT w/OUT DP OR BEAMS, $f_y = 60$ ksi

$$t_{min} = \frac{l_{n\,max}}{33} = \frac{19'\text{-}0''(12)}{33} = 6.9 \rightarrow 7''$$

, USE 9" SLAB

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pcaSlab v1.51 © Portland Cement Association                                   10-25-2007, 09:53:13 PM
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==========================================================================
                      pcaSlab v1.51 (TM)
      A Computer Program Analysis, Design, and Investigation of
        Reinforced Concrete Slab and Continuous Beam Systems
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[2] DESIGN RESULTS

Top Reinforcement:

Units: Width (ft), Mmax (k-ft), Xmax (ft), As (in^2), Sp (in)

Span	Strip	Zone	Width	Mmax	Xmax	AsMin	AsMax	SpReq	AsReq	Bars
1	Column	Left	9.50	0.00	0.001	1.847	14.929	11.400	0.000	10-#4
		Middle	9.50	0.00	0.002	1.847	14.929	11.400	0.000	10-#4
		Right	9.50	0.00	0.003	1.847	14.929	11.400	0.000	10-#4
	Middle	Left	10.50	0.00	0.001	2.041	16.500	11.455	0.000	11-#4
		Middle	10.50	0.00	0.002	2.041	16.500	11.455	0.000	11-#4
		Right	10.50	0.00	0.003	2.041	16.500	11.455	0.000	11-#4
2	Column	Left	9.50	29.19	0.667	1.847	14.929	11.400	0.903	10-#4
		Middle	9.50	0.00	9.500	0.000	14.929	0.000	0.000	---
		Right	9.50	112.23	18.333	1.847	14.929	6.333	3.576	18-#4
	Middle	Left	10.50	-0.00	0.667	2.041	16.500	11.455	0.000	11-#4
		Middle	10.50	0.00	9.500	0.000	16.500	0.000	0.000	---
		Right	10.50	37.41	18.333	2.041	16.500	11.455	1.160	11-#4
3	Column	Left	9.50	107.63	0.667	1.847	14.929	6.333	3.424	18-#4
		Middle	9.75	0.00	9.750	0.000	15.322	0.000	0.000	---
		Right	9.75	88.91	18.833	1.895	15.322	7.800	2.807	15-#4
	Middle	Left	10.50	35.88	0.667	2.041	16.500	11.455	1.112	11-#4
		Middle	10.25	0.00	9.750	0.000	16.107	0.000	0.000	---
		Right	10.25	29.64	18.833	1.993	16.107	12.300	0.917	10-#4
4	Column	Left	9.75	89.12	0.667	1.895	15.322	7.800	2.814	15-#4
		Middle	10.00	0.20	13.014	1.944	15.714	12.000	0.006	10-#4
		Right	10.00	143.38	19.663	1.944	15.714	4.444	4.610	27-#4
	Middle	Left	10.25	29.71	0.667	1.993	16.107	12.300	0.919	10-#4
		Middle	10.00	0.07	13.014	1.944	15.714	12.000	0.002	10-#4
		Right	10.00	47.79	19.663	1.944	15.714	12.000	1.487	10-#4

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5	Column	Left	10.00	161.23	0.667	1.944	15.714	4.444	5.218	27-#4
		Middle	10.00	0.00	11.750	0.000	15.714	0.000	0.000	---
		Right	10.00	65.49	22.833	1.944	15.714	10.909	2.050	11-#4
	Middle	Left	10.00	53.74	0.667	1.944	15.714	12.000	1.676	10-#4
		Middle	10.00	0.00	11.750	0.000	15.714	0.000	0.000	---
		Right	10.00	-0.00	22.833	1.944	15.714	12.000	0.000	10-#4
6	Column	Left	10.00	0.00	0.667	1.944	15.714	10.909	0.000	11-#4
		Middle	10.00	0.00	0.668	1.944	15.714	12.000	0.000	10-#4
		Right	10.00	0.00	0.669	1.944	15.714	12.000	0.000	10-#4
	Middle	Left	10.00	0.00	0.667	1.944	15.714	12.000	0.000	10-#4
		Middle	10.00	0.00	0.668	1.944	15.714	12.000	0.000	10-#4
		Right	10.00	0.00	0.669	1.944	15.714	12.000	0.000	10-#4

Top Bar Details:
================

Units: Length (ft)

Span	Strip	Left Bars	Length	Bars	Length	Continuous Bars	Length	Right Bars	Length	Bars	Length
1	Column	---		---		10-#4	0.67	---		---	
	Middle	---		---		11-#4	0.67	---		---	
2	Column	10-#4	6.50	---		---		10-#4	6.50	8-#4	4.20
	Middle	11-#4	4.55	---		---		11-#4	6.25	---	
3	Column	10-#4	6.78	8-#4	4.30	---		10-#4	6.66	5-#4	4.30
	Middle	11-#4	6.78	---		---		10-#4	6.28	---	
4	Column	5-#4	6.94	---		10-#4	20.33	9-#4	6.94	8-#4	4.47
	Middle	---		---		10-#4	20.33	---		---	
5	Column	14-#4	7.98	13-#4	5.10	---		10-#4	7.98	1-#4	5.10
	Middle	10-#4	7.03	---		---		10-#4	5.54	---	
6	Column	1-#4	0.67	---		10-#4	0.67	---		---	
	Middle	---		---		10-#4	0.67	---		---	

Bottom Reinforcement:
=====================

Units: Width (ft), Mmax (k-ft), Xmax (ft), As (in^2), Sp (in)

Span	Strip	Width	Mmax	Xmax	AsMin	AsMax	SpReq	AsReq	Bars
1	Column	9.50	0.00	0.000	0.000	14.929	0.000	0.000	---
	Middle	10.50	0.00	0.000	0.000	16.500	0.000	0.000	---
2	Column	9.50	64.86	8.131	1.847	14.929	10.364	2.032	11-#4
	Middle	10.50	43.24	8.131	2.041	16.500	11.455	1.343	11-#4
3	Column	9.75	49.48	10.123	1.895	15.322	11.700	1.541	10-#4
	Middle	10.25	32.98	10.123	1.993	16.107	12.300	1.021	10-#4
4	Column	10.00	49.46	9.665	1.944	15.714	12.000	1.540	10-#4
	Middle	10.00	32.97	9.665	1.944	15.714	12.000	1.021	10-#4
5	Column	10.00	100.38	13.120	1.944	15.714	7.500	3.179	16-#4
	Middle	10.00	66.92	13.120	1.944	15.714	10.909	2.096	11-#4
6	Column	10.00	0.00	0.670	0.000	15.714	0.000	0.000	---
	Middle	10.00	0.00	0.670	0.000	15.714	0.000	0.000	---

Bottom Bar Details:
===================

Units: Start (ft), Length (ft)

Span	Strip	Long Bars	Start	Length	Short Bars	Start	Length
1	Column	---			---		
	Middle	---			---		
2	Column	11-#4	0.00	19.00	---		
	Middle	11-#4	0.00	19.00	---		
3	Column	10-#4	0.00	19.50	---		
	Middle	10-#4	0.00	19.50	---		
4	Column	10-#4	0.00	20.33	---		
	Middle	10-#4	0.00	20.33	---		
5	Column	16-#4	0.00	23.50	---		
	Middle	10-#4	0.00	23.50	1-#4	3.53	19.98

Span	Strip		
6	Column	---	---
	Middle	---	---

Flexural Capacity:
==================

Units: From, To (ft), As (in^2), PhiMn (k-ft)

Span	Strip	From	To	AsTop	AsBot	PhiMn-	PhiMn+
1	Column	0.000	0.001	2.00	0.00	-63.86	0.00
		0.001	0.002	2.00	0.00	-63.86	0.00
		0.002	0.003	2.00	0.00	-63.86	0.00
		0.003	0.335	2.00	0.00	-63.86	0.00
		0.335	0.670	2.00	0.00	-63.86	0.00
	Middle	0.000	0.001	2.20	0.00	-70.25	0.00
		0.001	0.002	2.20	0.00	-70.25	0.00
		0.002	0.003	2.20	0.00	-70.25	0.00
		0.003	0.335	2.20	0.00	-70.25	0.00
		0.335	0.670	2.20	0.00	-70.25	0.00
2	Column	0.000	0.667	2.00	2.20	-63.86	70.09
		0.667	5.497	2.00	2.20	-63.86	70.09
		5.497	6.497	0.00	2.20	0.00	70.09
		6.497	6.850	0.00	2.20	0.00	70.09
		6.850	9.500	0.00	2.20	0.00	70.09
		9.500	12.150	0.00	2.20	0.00	70.09
		12.150	12.503	0.00	2.20	0.00	70.09
		12.503	13.503	0.00	2.20	0.00	70.09
		13.503	14.799	2.00	2.20	-63.86	70.09
		14.799	15.799	2.00	2.20	-63.86	70.09
		15.799	18.333	3.60	2.20	-112.94	70.09
		18.333	19.000	3.60	2.20	-112.94	70.09
	Middle	0.000	0.667	2.20	2.20	-70.25	70.25
		0.667	3.554	2.20	2.20	-70.25	70.25
		3.554	4.554	0.00	2.20	0.00	70.25
		4.554	6.850	0.00	2.20	0.00	70.25
		6.850	9.500	0.00	2.20	0.00	70.25
		9.500	12.150	0.00	2.20	0.00	70.25
		12.150	12.750	0.00	2.20	0.00	70.25
		12.750	13.750	0.00	2.20	0.00	70.25
		13.750	18.333	2.20	2.20	-70.25	70.25
		18.333	19.000	2.20	2.20	-70.25	70.25
3	Column	0.000	0.667	3.60	2.00	-112.94	63.89
		0.667	3.301	3.60	2.00	-112.94	63.89
		3.301	4.301	2.00	2.00	-63.86	63.89
		4.301	5.779	2.00	2.00	-63.86	63.89
		5.779	6.779	0.00	2.00	0.00	63.89
		6.779	7.025	0.00	2.00	0.00	63.89
		7.025	9.750	0.00	2.00	0.00	63.89
		9.750	12.475	0.00	2.00	0.00	63.89
		12.475	12.838	0.00	2.00	0.00	63.89
		12.838	13.838	0.00	2.00	0.00	63.89
		13.838	15.199	2.00	2.00	-63.89	63.89
		15.199	16.199	2.00	2.00	-63.89	63.89
		16.199	18.833	3.00	2.00	-94.82	63.89
		18.833	19.500	3.00	2.00	-94.82	63.89
	Middle	0.000	0.667	2.20	2.00	-70.25	63.96
		0.667	5.779	2.20	2.00	-70.25	63.96
		5.779	6.779	0.00	2.00	0.00	63.96
		6.779	7.025	0.00	2.00	0.00	63.96
		7.025	9.750	0.00	2.00	0.00	63.96
		9.750	12.475	0.00	2.00	0.00	63.96
		12.475	13.219	0.00	2.00	0.00	63.96
		13.219	14.219	0.00	2.00	0.00	63.96
		14.219	18.833	2.00	2.00	-63.96	63.96
		18.833	19.500	2.00	2.00	-63.96	63.96
4	Column	0.000	0.667	3.00	2.00	-94.82	63.93
		0.667	5.936	3.00	2.00	-94.82	63.93
		5.936	6.936	2.00	2.00	-63.89	63.93
		6.936	7.315	2.00	2.00	-63.89	63.93
		7.315	10.165	2.00	2.00	-63.93	63.93
		10.165	13.014	2.00	2.00	-63.93	63.93
		13.014	13.394	2.00	2.00	-63.93	63.93
		13.394	14.394	2.00	2.00	-63.93	63.93
		14.394	15.863	3.80	2.00	-119.20	63.93
		15.863	16.863	3.80	2.00	-119.20	63.93
		16.863	19.663	5.40	2.00	-166.53	63.93
		19.663	20.330	5.40	2.00	-166.53	63.93
	Middle	0.000	0.667	2.00	2.00	-63.96	63.93
		0.667	7.315	2.00	2.00	-63.96	63.93
		7.315	10.165	2.00	2.00	-63.93	63.93
		10.165	13.014	2.00	2.00	-63.93	63.93
		13.014	19.663	2.00	2.00	-63.93	63.93
		19.663	20.330	2.00	2.00	-63.93	63.93

5 Column	0.000	0.667	5.40	3.20	-166.53	101.01
	0.667	4.101	5.40	3.20	-166.53	101.01
	4.101	5.101	2.80	3.20	-88.76	101.01
	5.101	6.982	2.80	3.20	-88.76	101.01
	6.982	7.982	0.00	3.20	0.00	101.01
	7.982	8.425	0.00	3.20	0.00	101.01
	8.425	11.750	0.00	3.20	0.00	101.01
	11.750	15.075	0.00	3.20	0.00	101.01
	15.075	15.518	0.00	3.20	0.00	101.01
	15.518	16.518	0.00	3.20	0.00	101.01
	16.518	18.399	2.00	3.20	-63.93	101.01
	18.399	19.399	2.00	3.20	-63.93	101.01
	19.399	22.833	2.20	3.20	-70.17	101.01
	22.833	23.500	2.20	3.20	-70.17	101.01
Middle	0.000	0.667	2.00	2.00	-63.93	63.93
	0.667	3.525	2.00	2.00	-63.93	63.93
	3.525	4.525	2.00	2.00	-63.93	63.93
	4.525	6.033	2.00	2.20	-63.93	70.17
	6.033	7.033	0.00	2.20	0.00	70.17
	7.033	8.425	0.00	2.20	0.00	70.17
	8.425	11.750	0.00	2.20	0.00	70.17
	11.750	15.075	0.00	2.20	0.00	70.17
	15.075	17.956	0.00	2.20	0.00	70.17
	17.956	18.956	0.00	2.20	0.00	70.17
	18.956	22.833	2.00	2.20	-63.93	70.17
	22.833	23.500	2.00	2.20	-63.93	70.17
6 Column	0.000	0.335	2.20	0.00	-70.17	0.00
	0.335	0.667	2.20	0.00	-70.17	0.00
	0.667	0.668	2.20	0.00	-70.17	0.00
	0.668	0.669	2.20	0.00	-70.17	0.00
	0.669	0.670	2.20	0.00	-70.17	0.00
Middle	0.000	0.335	2.00	0.00	-63.93	0.00
	0.335	0.667	2.00	0.00	-63.93	0.00
	0.667	0.668	2.00	0.00	-63.93	0.00
	0.668	0.669	2.00	0.00	-63.93	0.00
	0.669	0.670	2.00	0.00	-63.93	0.00

Slab Shear Capacity:

Units: b, d (in), Xu (ft), PhiVc, Vu(kip)

Span	b	d	Vratio	PhiVc	Vu	Xu
1	240.00	7.25	1.000	165.07	0.00	0.00
2	240.00	7.25	1.000	165.07	47.44	17.73
3	240.00	7.25	1.000	165.07	43.32	1.27
4	240.00	7.25	1.000	165.07	47.87	19.06
5	240.00	7.25	1.000	165.07	58.43	1.27
6	240.00	7.25	1.000	165.07	0.00	0.00

Flexural Transfer of Negative Unbalanced Moment at Supports:

Units: Width (in), Munb (k-ft), As (in^2)

Supp	Width	GammaF*Munb	Comb	Pat	AsReq	AsProv	Additional Bars
1	39.00	31.58	U2	All	0.999	0.684	2-#4
2	39.00	12.57	U2	Even	0.390	1.232	---
3	39.00	10.44	U2	Odd	0.323	1.000	---
4	39.00	25.13	U2	Odd	0.790	1.755	---
5	39.00	58.08	U2	All	1.892	0.715	6-#4

Punching Shear Around Columns:

Units: Vu (kip), Munb (k-ft), vu (psi), Phi*vc (psi)

Supp	Vu	vu	Munb	Comb	Pat	GammaV	vu	Phi*vc	
1	42.68	109.1	35.67	U2	All	0.404	174.1	189.7	
2	102.57	181.5	-8.87	U2	All	0.423	192.2	189.7	*EXCEEDED
3	91.98	162.7	-1.33	U2	All	0.423	164.3	189.7	
4	118.10	208.9	30.84	U2	All	0.423	246.3	189.7	*EXCEEDED
5	53.89	137.7	-75.58	U2	All	0.404	275.4	189.7	*EXCEEDED

Maximum Deflections:

Units: Dz (in)

	Frame			Column Strip			Middle Strip		
Span	Dz(DEAD)	Dz(LIVE)	Dz(TOTAL)	Dz(DEAD)	Dz(LIVE)	Dz(TOTAL)	Dz(DEAD)	Dz(LIVE)	Dz(TOTAL)
1	0.005	0.003	0.008	0.009	0.004	0.013	0.002	0.001	0.003
2	-0.048	-0.025	-0.073	-0.074	-0.039	-0.114	-0.024	-0.013	-0.037
3	-0.026	-0.013	-0.039	-0.036	-0.018	-0.053	-0.016	-0.008	-0.024
4	-0.022	-0.015	-0.037	-0.030	-0.020	-0.051	-0.015	-0.010	-0.024
5	-0.117	-0.075	-0.193	-0.173	-0.111	-0.284	-0.062	-0.040	-0.101
6	0.009	0.006	0.015	0.015	0.009	0.024	0.004	0.002	0.006

Hollow Core Plank Calculations

RYAN FLYNN | FLOOR DESIGN | HOLLOW CORE PLANKS

I USED THE NITTERHOUSE WEBSITE DESIGN TABLES

ALLOWABLE LOAD IN TABLES INCLUDES THE SELF WEIGHT OF THE PLANKS BUT NOT 2" TOPPING

START W/ 6" PLANK W/ 2" TOPPING

LOADS

2" TOPPING - 25 PSF
FLOOR FINISH - 5 PSF
CEILING - 3 PSF
MEP - 5 PSF

38 PSF

LIVE LOAD = 40 + 20 (partitions) = 60 PSF

$W = 1.2D + 1.6L$
$W = 1.2(38) + 1.6(60)$
$W = 142$ PSF

USING SAME SPAN AS WOOD DESIGN, 20'-4"

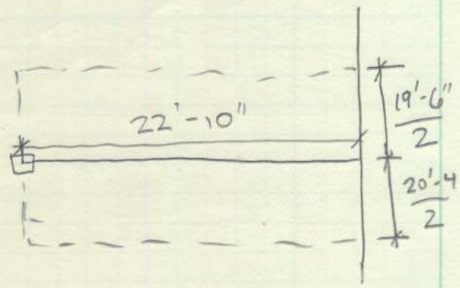
HAVE TO USE 7 - ½" ϕ STRAND ;
$W_{max} = 215$ PSF > 142 PSF

RYAN FLYNN | FLOOR DESIGN | HOLLOW CORE PLANKS

DESIGN OF SAME BEAM AS WOOD JOISTS BUT REMOVED POST TO SPAN FULL 22'-10"

$DL = 48.75 \text{ PSF} + 38 \text{ PSF} = 86.75 \text{ PSF}$ (wt of plank)

$LL = 60 \text{ PSF}$



$1.2(86.75) + 1.6(60) = 200 \text{ PSF}$

$\frac{19.5 + 20.83}{2}(22.833) = 454.75 \text{ ft}^2 \left(\frac{200 \text{ PSF}}{22.833 \text{ ft}}\right) = 4 \text{ klf}$

ADD IN 0.1 KLF SELF WEIGHT

$M = \frac{w l^2}{8} = \frac{4.1(22.833)^2}{8} = 267 \text{ k-ft}$

$\phi M_n = 0.9(267)$

$\phi M_n = 240.3 \text{ k-ft}$

$\Delta_{TL} = \frac{5 w l^4}{384 EI} \Rightarrow \frac{22.833(12)}{240} \geq \frac{5(4.1)(22.833)^4(1728)(1000)}{384(29\times10^6) I}$

$I \geq 757.3 \text{ in}^4$ CONTROLS

$\Delta_{LL} = \frac{5(w_L)(22.833^4)\,1728\,(1000)}{384} \leq \frac{22.833(12)}{480}$ (w_L = 1.9 KLF)

$I \geq 702 \text{ in}^4$

$\frac{19.5 + 20.33}{2}(22.833)\left(\frac{1.6(60)}{22.833}\right) = 1912$

RYAN FLYNN | FLOOR DESIGN | HOLLOW CORE PLANKS

USE W16×57

$\phi M_{n_{max}} = 394\text{ k-ft} > 240.3\text{ k-ft}$ ✓

$I = 758\text{ in}^4 > 757.3\text{ in}^4$ ✓

$\frac{4.1(22.833)}{2} = 46.8^k < 212^k$ ✓

MORE EFFICIENT WOULD BE W21×48.
BUT DEPTH IS LARGER. COULD ALSO PUT THE POST BACK AND SHORTEN THE SPAN TO 13'-6"

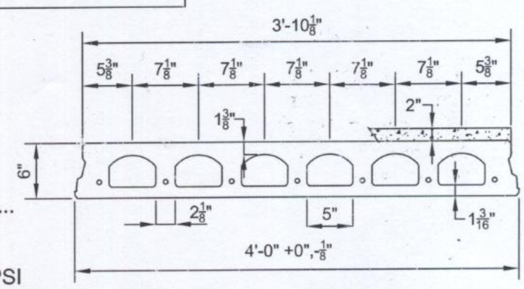
Nitterhouse Span Chart

Prestressed Concrete
6"x4'-0" Hollow Core Plank

2 Hour Fire Resistance Rating With 2" Topping

PHYSICAL PROPERTIES
Composite Section

A_c = 253 in.^{2}	Precast S_{bc} = 370 in.^{3}
I_c = 1519 in.^{4}	Topping S_{tc} = 551 in.^{3}
Y_{bc} = 4.10 in.	Precast S_{tc} = 799 in.^{3}
Y_{tc} = 1.90 in.	Wt.= 195 PLF
	Wt.= 48.75 PSF



DESIGN DATA

1. Precast Strength @ 28 days = 6000 PSI
2. Precast Strength @ release = 3500 PSI.
3. Precast Density = 150 PCF
4. Strand = 1/2"Ø 270K Lo-Relaxation.
5. Strand Height = 1.75 in.
6. Ultimate moment capacity (when fully developed)...
   4-1/2"Ø, 270K = 67.5 k-ft
   7-1/2"Ø, 270K = 104.2 k-ft
7. Maximum bottom tensile stress is $7.5\sqrt{f'c}$ = 580 PSI
8. All superimposed load is treated as live load in the strength analysis of flexure and shear.
9. Flexural strength capacity is based on stress/strain strand relationships.
10. Deflection limits were not considered when determining allowable loads in this table.
11. Topping Strength @ 28 days = 3000 PSI. Topping Weight = 25 PSF.
12. These tables are based upon the topping having a uniform 2" thickness over the entire span. A lesser thickness might occur if camber is not taken into account during design, thus reducing the load capacity.
13. Load values to the left of the solid line are controlled by ultimate shear strength.
14. Load values to the right are controlled by ultimate flexural strength or fire endurance limits.
15. Load values may be different for IBC 2000 & ACI 318-99. Load tables are available upon request.
16. Camber is inherent in all prestressed hollow core slabs and is a function of the amount of eccentric prestressing force needed to carry the superimposed design loads along with a number of other variables. Because prediction of camber is based on empirical formulas it is at best an estimate, with the actual camber usually higher than calculated values.

SAFE SUPERIMPOSED SERVICE LOADS — IBC 2003 & ACI 318-02 (1.2 D + 1.6 L)

Strand Pattern		SPAN (FEET)																		
		11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
4 - 1/2"ø	LOAD (PSF)	227	187	360	306	268	229	194	165	141	120	102	86	73	61	50				
7 - 1/2"ø	LOAD (PSF)	367	305	495	455	418	387	340	312	275	243	215	189	167	147	130	114	97	83	70

NITTERHOUSE
CONCRETE PRODUCTS
2655 Molly Pitcher Hwy. South, Box N
Chambersburg, PA 17201-0813
717-267-4505 Fax 717-267-4518

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. The allowable loads shown in this table reflect a 2 Hour & 0 Minute fire resistance rating.

05/14/07

6F2.0T

Wood Truss Calculations

RYAN FLYNN | FLOOR DESIGN | WOOD FLOOR TRUSSES

LOADS

3/4" PLYWOOD = 2.7 psf
FLOOR FINISH = 5.0 psf
MEP = 5 psf
CEILING = 3 psf
GYP. CRETE = 6.25 psf
21.95 psf

ASSUMING 16" SPACING

$DL = 21.95(\frac{16}{12}) = 29.3\ lb/ft$

$LL = 60(\frac{16}{12}) = 80\ lb/ft$

$TL = 109.3\ lb/ft$

USING SAME SPANS AS WOOD I-JOISTS

20'-4" LONGEST SPAN

$\frac{L}{480}$ LL Δ CRITERIA

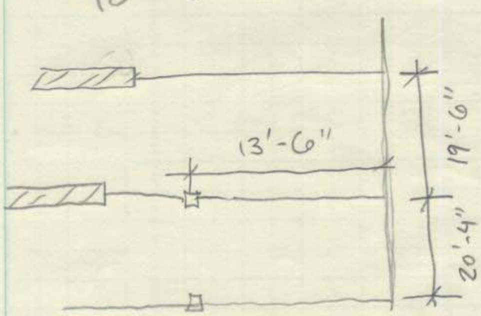
USING SPAN CHARTS FOR ALPINE FLOOR TRUSSES

@ 16" O.C. USE 18" DEEP TRUSS

w/ 4×2 TC & BC LUMBER

NEARLY IDENTICAL LOADING TO WOOD I-JOIST BUT DEEPER SYSTEM

SO USE 18" DEEP PSL



3½" × 18" PSL WORKS

$M_{max} = 43,665\ lb\text{-}ft$

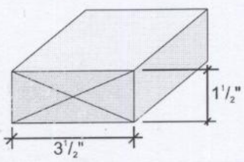
$I = 1701\ in^4$

$V_{max} = 12,180\ lb$

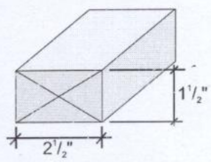
Floor Truss Span Tables

These allowable spans are based on NDS 91. Maximum deflection is limited by L/360 or L/480[1] under live load. Basic Lumber Design Values are $F_{(b)}=2000$ psi $F_{(t)}=1100$ psi $F_{(c)}=2000$ psi $E=1{,}800{,}000$ psi Duration Of Load = 1.00. Spacing of trusses are center to center (in inches). Top Chord Dead Load = 10 psf. Bottom Chord Dead Load = 5 psf. Center Line Chase = 24" max. Trusses must be designed for any special loading, such as concentrated loads. Other floor and roof loading conditions, a variety of species and other lumber grades are available.

4x2 Lumber



3x2 Lumber



40 PSF Live Load / 55 PSF Total Load

Center Spacing	Deflection Limit	4x2 12"	4x2 14"	4x2 16"	4x2 18"	4x2 20"	4x2 22"	3x2 12"	3x2 14"	3x2 16"	3x2 18"	3x2 20"	3x2 22"
16" o.c.	L/360	22'2"	24'11"	26'10"	28'8"	30'4"	31'11"	19'0"	20'9"	22'4"	23'10"	25'3"	26'7"
	L/480	20'2"	22'7"	24'11"	27'2"	29'4"	31'5"	18'0"	20'2"	22"4'	23'10"	25'3"	26'7"
19.2" o.c.	L/360	20'9"	22'8"	24'4"	26'0"	27'6"	29'0"	17'3"	18'9"	20'3"	21'7"	22'10"	24'1"
	L/480	18'11"	21'3"	23'6"	25'7"	27'6"	29'0"	16'11"	18'9"	20'3"	21'7"	22'10"	24'1"
24" o.c.	L/360	18'5"	20'1"	21'7"	23'1"	24'5"	25'9"	15'2"	16'7"	17'10"	19'1"	20'2"	21'3"
	L/480	17'7"	19'9"	21'7"	23'1"	24'5"	25'9"	15'2"	16'7"	17'10"	19'1"	20'2"	21'3"

60 PSF Live Load / 75 PSF Total Load

Center Spacing	Deflection Limit	4x2 12"	4x2 14"	4x2 16"	4x2 18"	4x2 20"	4x2 22"	3x2 12"	3x2 14"	3x2 16"	3x2 18"	3x2 20"	3x2 22"
16" o.c.	L/360	19'4"	21'4"	23'0"	24'6"	26'0"	27'4"	16'3"	17'9"	19'2"	20'5"	21'8"	22'9"
	L/480	17'7"	19'9"	21'10"	23'9"	25'8"	27'4"	15'9"	17'8"	19'2"	20'5"	21'8"	22'9"
19.2" o.c.	L/360	17'9"	19'4"	20'10"	22'3"	23'7"	24'10"	14'9"	16'1"	17'4"	18'6"	19'7"	20'7"
	L'480	16'7"	18'7"	20'6"	22'3"	23'7"	24'10"	14'9"	16'1"	17'4"	18'6"	19'7"	20'7"
24" o.c.	L/360	15'9"	17'2"	18'6"	19'9"	20'11"	22'0"	13'0"	14'2"	15'3"	16'4"	17'3"	18'2"
	L/480	15'4"	17'2"	18'6"	19'9"	20'11"	22'0"	13'0"	14'2"	15'3"	16'4"	17'3"	18'2"

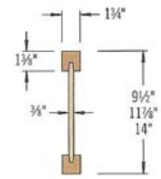
85 PSF Live Load / 100 PSF Total Load

Center Spacing	Deflection Limit	4x2 12"	4x2 14"	4x2 16"	4x2 18"	4x2 20"	4x2 22"	3x2 12"	3x2 14"	3x2 16"	3x2 18"	3x2 20"	3x2 22"
16" o.c.	L/360	16'11"	18'6"	19'11"	21'3"	22'6"	23'8"	14'1"	15'5"	16'7"	17'8"	18'9"	19'9"
	L/480	15'8"	17'7"	19'5"	21'2"	22'6"	23'8"	14'0"	15'5"	16'7"	17'8"	18'9"	19'9"
19.2" o.c.	L/360	15'4"	16'9"	18'1"	19'3"	20'5"	21'6"	12'9"	13'11"	15'0"	16'0"	16'11"	17'10"
	L/480	14'9"	16'6"	18'1"	19'3"	20'5"	21'6"	12'9"	13'11"	15'0"	16'0"	16'11"	17'10"
24" o.c.	L/360	13'8"	14'10"	16'0"	17'1"	18'1"	19'1"	11'3"	12'3"	13'3"	14'1"	14'11"	15'9"
	L/480	13'8"	14'10"	16'0"	17'1"	18'1"	19'1"	11'3"	12'3"	13'3"	14'1"	14'11"	15'9"

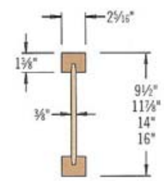
(1) Vibration Control -- Research by Virginia Tech indicates that L/480 live load deflection criteria provides a high degree of resistance to floor vibration (bounce). The building designer desiring this benefit may choose to specify an L/480 live load deflection criteria to be used for the floor trusses.

FLOOR SPAN TABLES

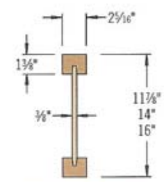
Not all products are available in all markets. Contact your iLevel representative for information.



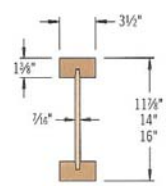
TJI® 110 Joists



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"
	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]
	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]
	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"	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"
	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]
	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]
	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"	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"
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 site 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 iLevel™ 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.

DESIGN PROPERTIES

Allowable Design Properties(1) (100% Load Duration)

Grade	Width	Design Property	Depth												
			4⅜"	5½"	5½" Plank Orientation	7¼"	8⅝"	9¼"	9½"	11¼"	11⅞"	14"	16"	18"	20"
TimberStrand® LSL															
1.3E	3½"	Moment (ft-lbs)	1,735	2,685	1,780	4,550	6,335	7,240		10,520					
		Shear (lbs)	4,085	5,135	1,925	6,765	8,050	8,635		10,500					
		Moment of Inertia (in.⁴)	24	49	20	111	187	231		415					
		Weight (plf)	4.5	5.6	5.6	7.4	8.8	9.4		11.5					
1.55E	1¾"	Moment (ft-lbs)							5,210		7,975	10,920			
		Shear (lbs)							3,435		4,295	5,065			
		Moment of Inertia (in.⁴)							125		244	400			
		Weight (plf)							5.2		6.5	7.7			
	3½"	Moment (ft-lbs)							10,420		15,955	21,840			
		Shear (lbs)							6,870		8,590	10,125			
		Moment of Inertia (in.⁴)							250		488	800			
		Weight (plf)							10.4		13	15.3			
Microllam® LVL															
1.9E	1¾"	Moment (ft-lbs)		2,125		3,555		5,600	5,885	8,070	8,925	12,130	15,555	19,375	23,580
		Shear (lbs)		1,830		2,410		3,075	3,160	3,740	3,950	4,655	5,320	5,985	6,650
		Moment of Inertia (in.⁴)		24		56		115	125	208	244	400	597	851	1,167
		Weight (plf)		2.8		3.7		4.7	4.8	5.7	6.1	7.1	8.2	9.2	10.2
Parallam® PSL															
2.0E	2¹¹⁄₁₆"	Moment (ft-lbs)						9,535	10,025	13,800	15,280	20,855	26,840	33,530	
		Shear (lbs)						4,805	4,935	5,845	6,170	7,275	8,315	9,350	
		Moment of Inertia (in.⁴)						175	192	319	375	615	917	1,305	
		Weight (plf)						7.8	8.0	9.5	10.0	11.8	13.4	15.1	
	3½"	Moment (ft-lbs)						12,415	13,055	17,970	19,900	27,160	34,955	43,665	
		Shear (lbs)						6,260	6,430	7,615	8,035	9,475	10,825	12,180	
		Moment of Inertia (in.⁴)						231	250	415	488	800	1,195	1,701	
		Weight (plf)						10.1	10.4	12.3	13.0	15.3	17.5	19.7	
	5¼"	Moment (ft-lbs)						18,625	19,585	26,955	29,855	40,740	52,430	65,495	
		Shear (lbs)						9,390	9,645	11,420	12,055	14,210	16,240	18,270	
		Moment of Inertia (in.⁴)						346	375	623	733	1,201	1,792	2,552	
		Weight (plf)						15.2	15.6	18.5	19.5	23.0	26.3	29.5	
	7"	Moment (ft-lbs)						24,830	26,115	35,940	39,805	54,325	69,905	87,325	
		Shear (lbs)						12,520	12,855	15,225	16,070	18,945	21,655	24,360	
		Moment of Inertia (in.⁴)						462	500	831	977	1,601	2,389	3,402	
		Weight (plf)						20.2	20.8	24.6	26.0	30.6	35.0	39.4	

(1) For product in beam orientation, unless otherwise noted.

TimberStrand® LSL Grade Verification

TimberStrand® LSL is available in more than one grade. The product will be stamped with its grade information, as shown in the examples below. With the 1.55E TimberStrand® LSL Beam, larger holes can be drilled through the beam. See **Allowable Holes** on page 36.