North Shore at Canton

Baltimore, MD

Technical Report 2

Alternative Floor Systems

Beau Menard
Structural
Schneider
10/31/05

Executive Summary

In this report the current floor system of North Shore at Canton was compared to four alternative floor systems. A typical bay for North Shore, is approximately 25'x30', these spans line up directly over the concrete bents, spaced 25' apart, which make up the pier structure. The current floor system consists mainly of pre-engineered open web floor trusses, spaced at 16" on center, and span 25'. The floor trusses are topped with 3/4" OSB, and can be considered a rigid diaphragm. Four alternative floor systems were analyzed. The first, which was similar to the existing system, involved pre-engineered composite wood joist, which are spaced at 19.2" and span 25'. The second system analyzed was a 2-way concrete system composed of a flat plate with drop panels, since the bay size is considered large for concrete residential construction, the 30' spans have been reduced to 20'; this does not create any problems since the building is 60' wide and the columns being moved are directly supported by the concrete bents. The third system analyzed is a 30" concrete pan joist system, with 36" beams supporting the joist at the column line, the reduced bay size was also used for this system. The fourth system analyzed was an open web steel joist system supported by steel girders and columns, since steel allows for longer spans the original bay size of 30'x25' was used. The joists are topped with 1.5" metal decking and 2.5" of concrete.

The loading used was in accordance with the IBC 2003, and only gravity loading was considered at this time. Besides loading other factors were used in determining if each system was a viable option for further investigation. Those factors included, but were not limited to; fire rating, availability, economy of the system, and impact on the pier foundation.

Of the four alternative systems analyzed, only one will not need any further investigation. The only system that will not be looked at, is the composite wood joist system. Since the system offers no great advantage over the current system, it will not be regarded. All other systems shall be used for future consideration.

Introduction

North Shore at Canton is a three story town home structure built on top of a parking garage, all of which is built on top of a concrete pier, located in Baltimore harbor. This report will give a description of the current floor system used as well as an analysis of four alternative systems. The analysis will provide preliminary sizes for floor member, cost, availability, as well as various pros and cons of each system.

The loading used in this analysis will be in accordance with the IBC 2003, though is should be noted that BOCA '96 was used in the design of the structure, and some loads have increased through the years. As noted in Technical Report one a live load of 60 psf, which includes partition loading, will be used on all floor systems. Also as noted in Technical Report 1 a dead load of 50 psf, this is subject to change as it includes the weight of the original floor system.

Existing system:

Description

The existing floor system of North Shore at Canton is made up of 25' x 30' bays. A typical floor system is comprised of 16" open web wood floor trusses spaced at 16" on center, bearing on steel stud shear walls, spanning 25'. Approximately 10' from the exterior face there is a PSL beam which supports traverse spanning 2x10's at 16" on center. The PSL beam is supported on each end by a, 3" or 4" diameter, hollow steel tube. The floors are topped with 3/4" OSB. A visual representation is located in Appendix A

Pros and cons

This system is relatively cheap and light in weight. The open webs enable easy access to both the mechanical and electrical systems. The system is also relatively easy to install. Some downfalls include shallow depth of members which reduces spacing between members. Also a thicker floor diaphragm has to be used to help stay with in the fire rating. This system is quite labor intensive, some connections could be complex and any type of mis-installation could result in serviceability issues in the future.

Alternative Systems:

1st Alternative System

The first alternative floor system that will be investigated, will be similar to the existing system, in that the members will be bearing on shear walls. The floor will be topped with 3/4" OSB. Trus Joist pre-engineered TJI floor joist will be analyzed and sized accordingly. A design deflection of L/480 will be used, also a live load of 40 psf will be used as well as a dead load of 20 psf, not including selfweight.

Reference: Trus Joist #2027 Specifier's Guide TJI: 110, 230, 360, 560

Span tables located in Appendix A.

- **Joist**: TJI 560
- **Depth**: 16"
- **Spacing**: 19.2"
- **Max Span**: 26'-3"

The spacing between members increases only slightly, so it might prove more economical to step down the grade of the joist, to a TJI 360. This, however, would return the spacing of the joists back to 16". Increasing the depth of the member allowed for longer spans and greater spacing; but it would create a more expensive system.

Pros and Cons

The TJI floor joists are actually cheaper than the open web trusses. They are also light in weight, which would keep the dead load on the pier bents relatively low. The joist can also be cut to various lengths, considering that all bays of the building are almost identical this will not be a major issue. Some problems do arise when the mechanical, electrical, and plumbing systems need to be installed through the floor system. Since the joist have a solid web member, holes will need to be cut, though this type of operation is acceptable it requires skilled laborers and is time consuming. Since deflection is part of the criteria of design it is not an issue with this type of system. Vibration is not a factor either since the joists create a diaphragm member, when correctly connected to the sub-floor. Fire rating will not be an issue if gypsum board is used as a ceiling material.

This system will not be considered for further investigation.

Diagrams of this system are located in Appendix A.

2nd Alternative System

The second alternative system that will be investigated will consist of a flat slab concrete system with drop panels. Since the original bay size of 30'x25' is considered large for a concrete residential system, a bay size of 20'x25' will be used. The building is 60' wide so converting the 30' spans to 20' spans will not pose any problems; also, the concrete bents, which make ups the pier structure, are directly under these columns so it will not create major issues for the foundation.

Reference: Concrete Floor Systems: Guide to Estimating and Economizing, 2nd edition

The larger bay size controls the thickness of the slab. At 25' the approximate slab depth will be 9". References located in Appendix A.

f'c = 4000 psi
Dead Load = 20 psf
Live Load = 50 psf

- **Bay Size**: 20'x 25'
- **Slab Thickness**: 8.5"
- **Drop Panel Size**: 7'x 8'-6"
- **Drop Panel Depth**: 2.25" (below slab), 10.75" (total depth)
- **Square Column Sizes**: 22"
- **Concrete Volume**: 365 ft^3, (0.73 ft^3/ ft^2)
- **Reinforcement**: 2.27 psf (approximately 2 #6 bars / ft)

Pros and Cons

The maximum depth of concrete would be approximately 11", leaving enough space between the bottom of the slab and ceiling to install the MEP. The system is cost effective and since the building is in Baltimore, availability is not a concern. The flat slab is also relatively easy to form. This system has a disadvantage, in that it inherently adds extra weight to the structure. Punching shear is also an issue, though the drop panels are used to circumvent this failure. Since beams are not inherent in this system, the lateral load capacity decreases, so some additional analysis of the lateral resisting system will need to be made. Vibration will not be a big concern since the bay sizes are relatively small and this is a residential structure. As long as proper cover is used fire rating is not of concern. This system has not been checked against the ACI 318 code, therefore a further analysis will be required to verify minimum requirements.

This system will be considered for further investigation.

Diagrams of this system are located in Appendix A.

3rd Alternative System

The third alternative system looked at will be a one way pan joist system. The bay sizes will be the same as the previous floor system, 20'x25'. The pan width used will be 30", and the slab depth will be 4.5".

Reference: Concrete Floor Systems: Guide to Estimating and Economizing, 2nd edition

f'c = 4000 psi
Dead Load = 20 psf
Live Load = 50 psf

- **Bay Size**: 20'x 25'
- **Pan Depth:** 8"
- **Rib Width:** 5"
- **Beam Width:** 36"
- **Square Column Size:** 22"
- **Volume:** 280 ft^3, (0.56 ft^3/ ft^2)
- **Reinforcement:** 2.20 psf (approximately 2 #6 bars / rib)

This system, like the previous one, uses 22" square columns, which line up directly over the concrete bents in the pier structure. This system will weight less than the previous system, since there is about 90 ft^3 less concrete. This system has not been checked against the ACI 318 code, therefore a further analysis will be required to verify minimum requirements.

Pros and Cons

The maximum depth of concrete would be approximately 12.5", leaving enough space between the ribs and ceiling to install the MEP. The system is cost effective, though it is a little more expensive than the flat slab, and since the building is in Baltimore, availability is not a concern. The pans are also relatively easy to form. This system also weighs about 25% less than a flat slab system. Since beams are inherent in this system, the lateral load capacity increases, so some additional analysis of the lateral resisting system will need to be looked into. Vibration will not be a concern since the bay sizes are relatively small and the addition of ribs as well as the beams increases the stiffness of the structure. As long as proper cover is used fire rating is not of concern.

This system will be considered for further investigation.

Diagrams of this system are located in Appendix A.

4th Alternative System

The fourth alternative system uses a bay size of 30'x25' and the floor system is comprised of open web steel joist bearing on steel I beams. The joists are topped with a non-composite steel decking and light weight concrete. The joists are spaced at 36" on center, and span 25'.

Reference: Steel Joist and Joist Girders, K Series United Steel Deck: Design Manuel

Service Loads
Live Load = 60 psf
Dead Load = 20 psf (not including weight of material)

Live load per foot = 1.6 * 60 psf * 3 ft = 288 plf

From K-series open web joist table:

- **Preliminary size**: 16K9
- **Span**: 25'
- **Depth**: 16"
- **Weight**: 10 plf
- **Live Load Capacity**: 311 plf
- **Total Load Capacity**: 514 plf

From Steel Deck manuel:

Deck: 1.5"x6"
Fy = 33 ksi
f'c = 3 ksi
Weight Concrete = 115 pcf

- **19 Gauge Steel Decking**
- **Max unshored span**: 9.05' (3 span)
- **Uniform Live Load Capacity**: 155 psf (no studs, service load)
- **Slab Depth**: 4"
- **Weight**: 29 psf
- **Connection**: 1/8" thick 1" long fillet weld on each side

The steel joist bear on steel I beam, though a more complex analysis is needed due to the fact that the beam will be part of the lateral force resisting system; a preliminary beam size was selected from the AISC moment tables located in chapter 5. The design moment used was 360 ft k, from the tables it was determined to use a W 16x57, which has a moment capacity of approximately 394 ft k. A preliminary column size was selected from the AISC chapter 6, assumed effective length of 0.5L = 6'. The preliminary size chosen was W 14x90, note a further analysis is needed in determining the actual size of the column when it is exposed to lateral loading as well.

4^{th} Alternative System

Pros and Cons

This system utilizes the original bay size of the structure. The spacing between members can also be increased. Since there is a concrete topping, fire rating is not an issue. The open web members also provide adequate space for the MEP. Since the spans are of medium length the depth of members stayed at 16”. Cost issues raise some concerns, though money can be saved in other parts of the system, since the lateral system would consist of a moment frame, the cost of a sheer wall system could be subtracted. The weight of the system has increased from the existing system since wood is a much lighter material, though removing the shear wall reduces weight as well, so a further analysis will need to be done to see the complete effects of the weight on the foundation.

This system will be considered for further investigation.

Diagrams of this system are located in Appendix A.

System Comparison

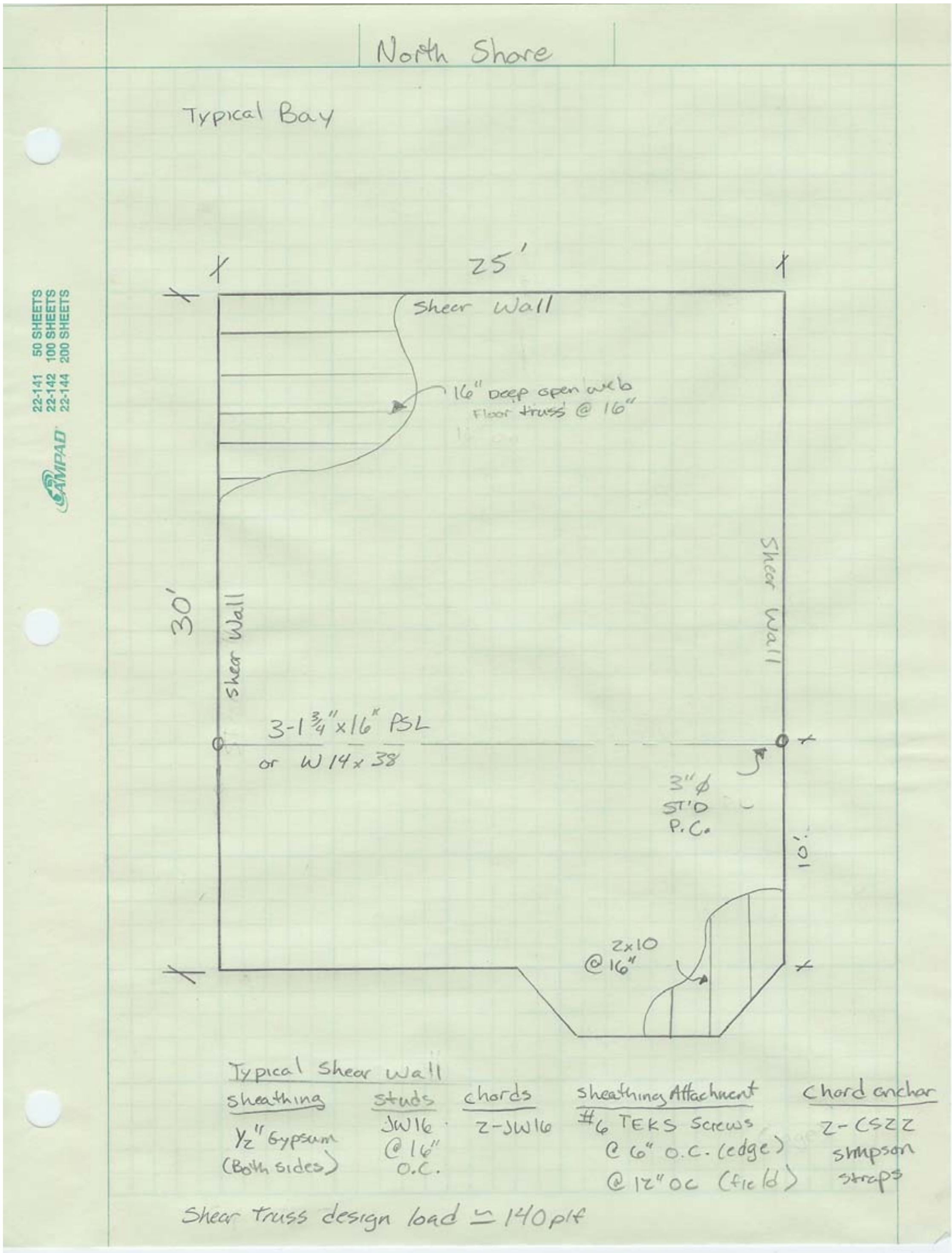
	Existing	Trus Joist	Flat Slab	Pan Joist	Steel Joist
Availability	Yes	Yes	Yes	Yes	Yes
Cost	Inexpensive	Inexpensive	Relatively Inexpensive	Relatively Inexpensive	More Expensive
Weight	Light	Light	Heavy	Heavy	Moderate
Deflection	Not of Concern	Accounted For in Design	Not of Concern	Not of Concern	Not of Concern
Vibration	Not of Concern	Not of Concern	Not of Concern	Not of Concern	Not of Concern
Foundation Issues	No	No	Yes, Further Investigation Required	Yes, Further Investigation Required	Yes, Further Investigation Required
Notes			A Further investigation is needed to check code requirements.	A Further investigation is needed to check code requirements.	A Further investigation is needed to check code requirements.
Further Analysis		No	Yes	Yes	Yes

Final Summation

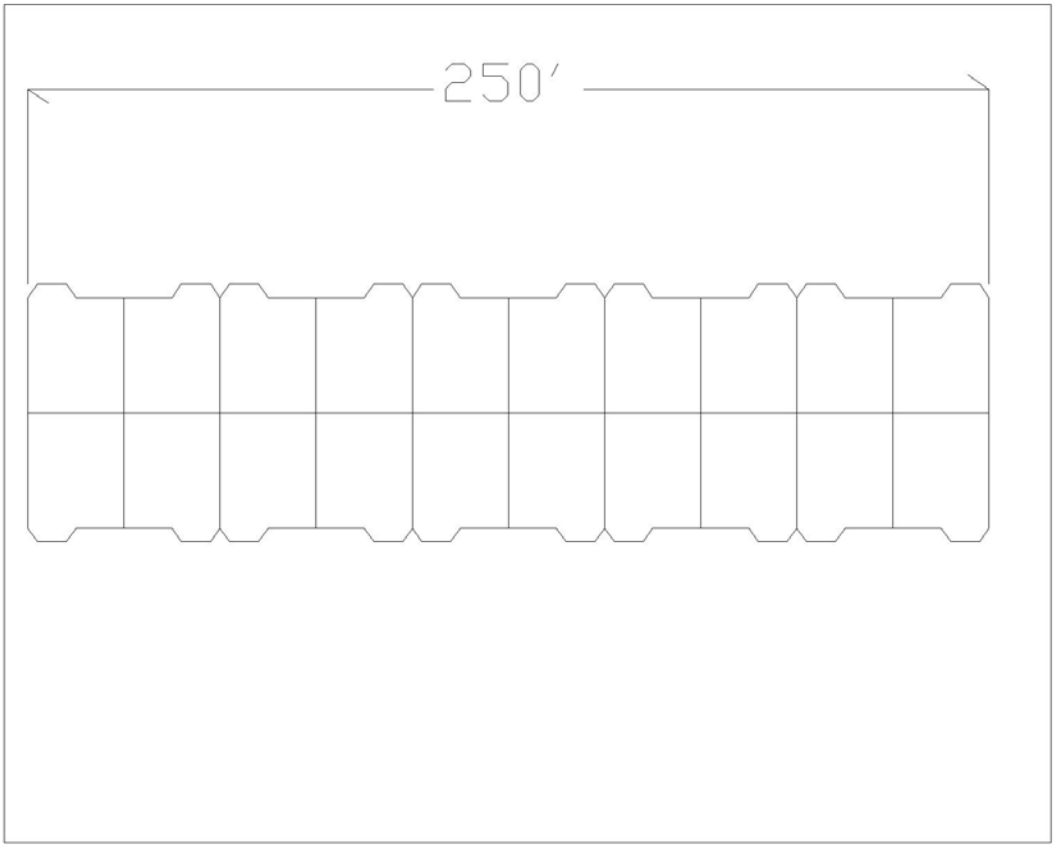
The only system that will not be considered for further investigation is 1st Alternative system. Since this system only slightly increases the member spacing, and only decreases the cost slightly; there is no clear advantage of this system over the existing open web floor trusses. All of the other systems will be considered for a further analysis, to determine actual sizing, the effects of lateral loads, and the effects of the system on the concrete pier structure. Vibration and deflection issues are not of great concern therefore an in-depth analysis will not be required. A more in-depth cost and schedule analysis will need to be done to compare theses systems to the existing system.

Appendix A

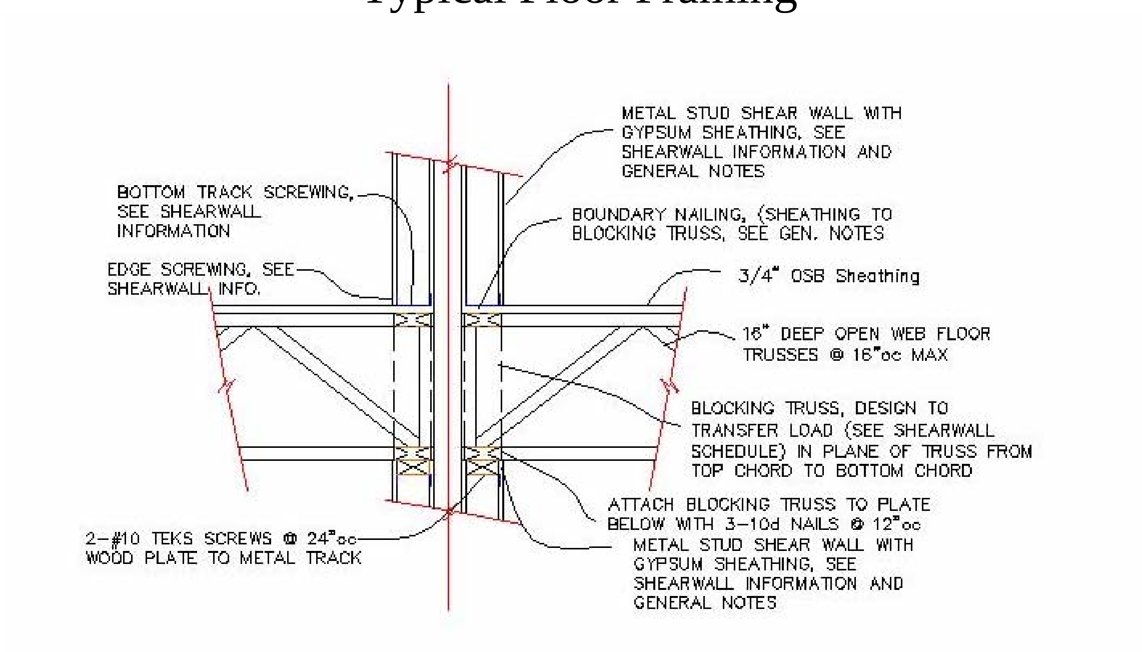
System Framing Diagrams



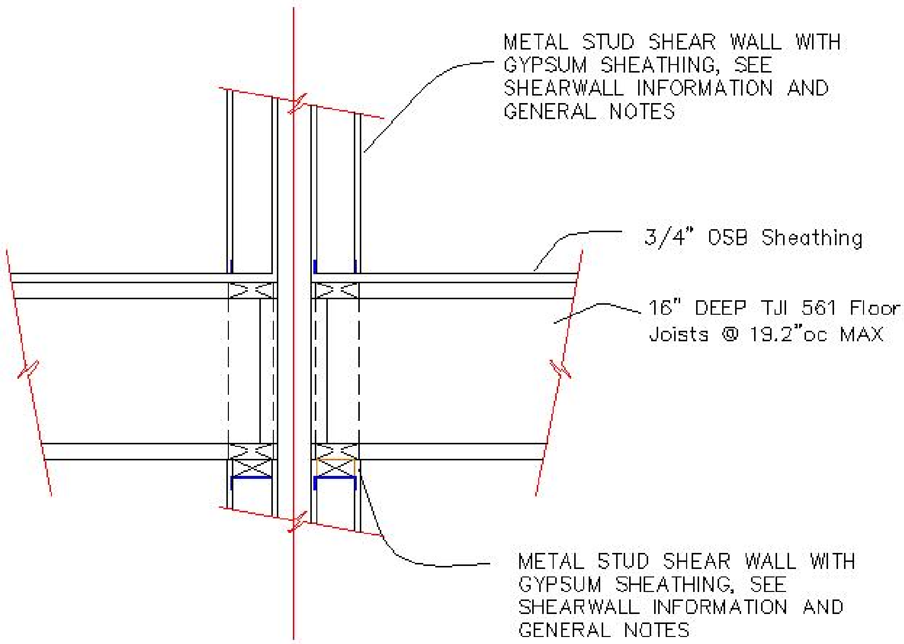
Floor Layout



Typical Floor Framing

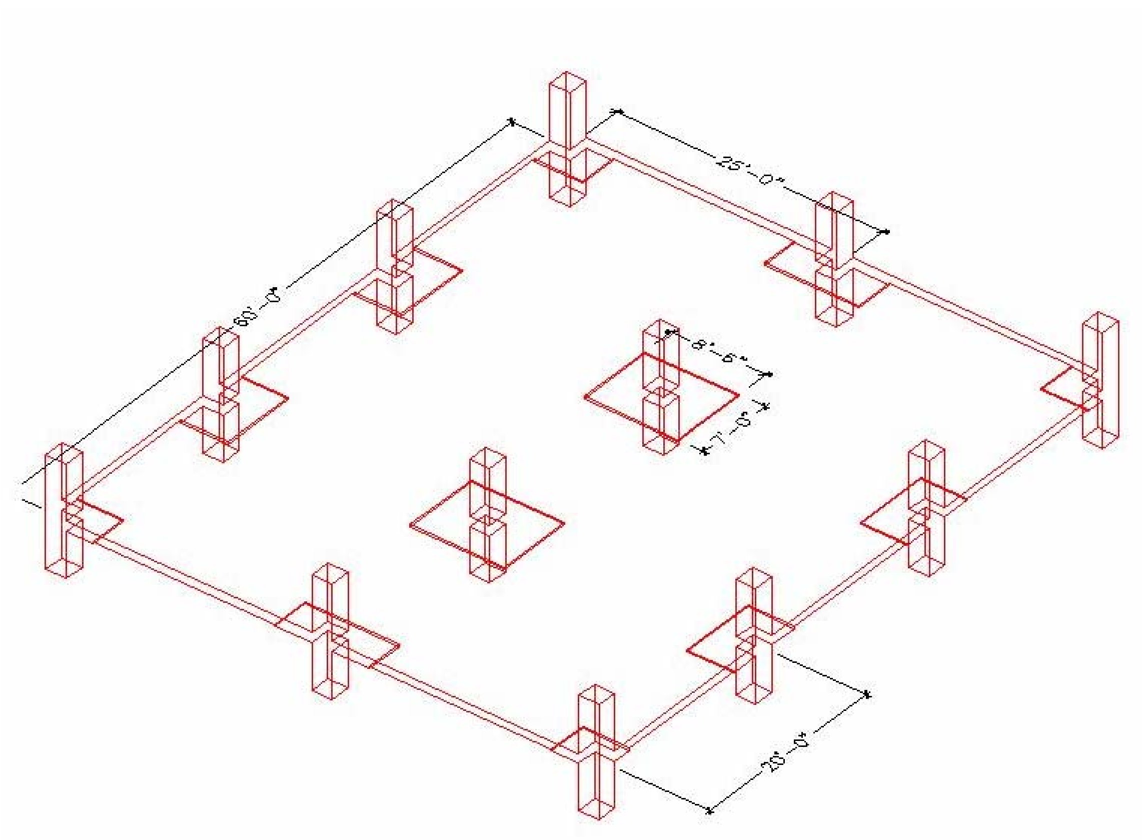


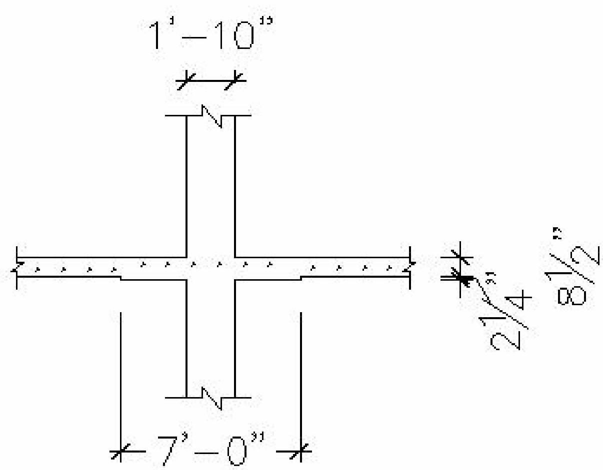
1st Alternative system Framing



1st Alternative System
TJI 560 Floor Joist

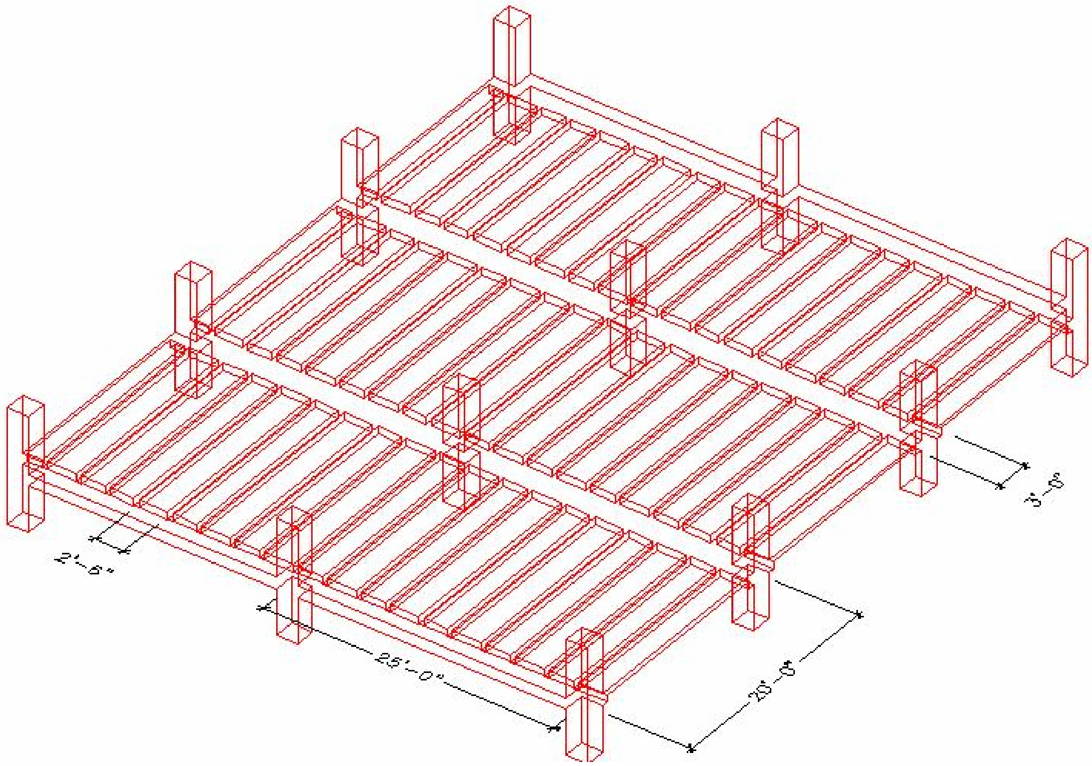
2nd Alternative System Framing

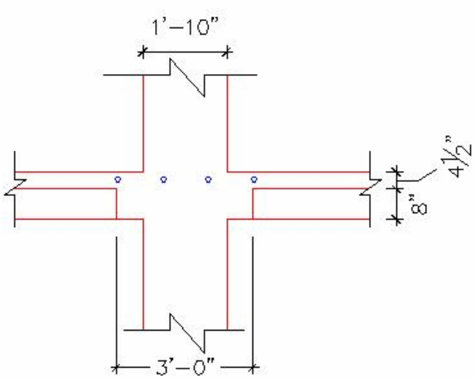


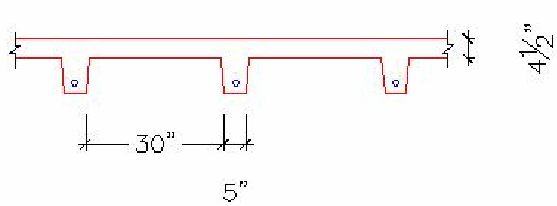


2nd Alternaive system
Flat Slab with Drop
Panels

3rd Alternative System Framing



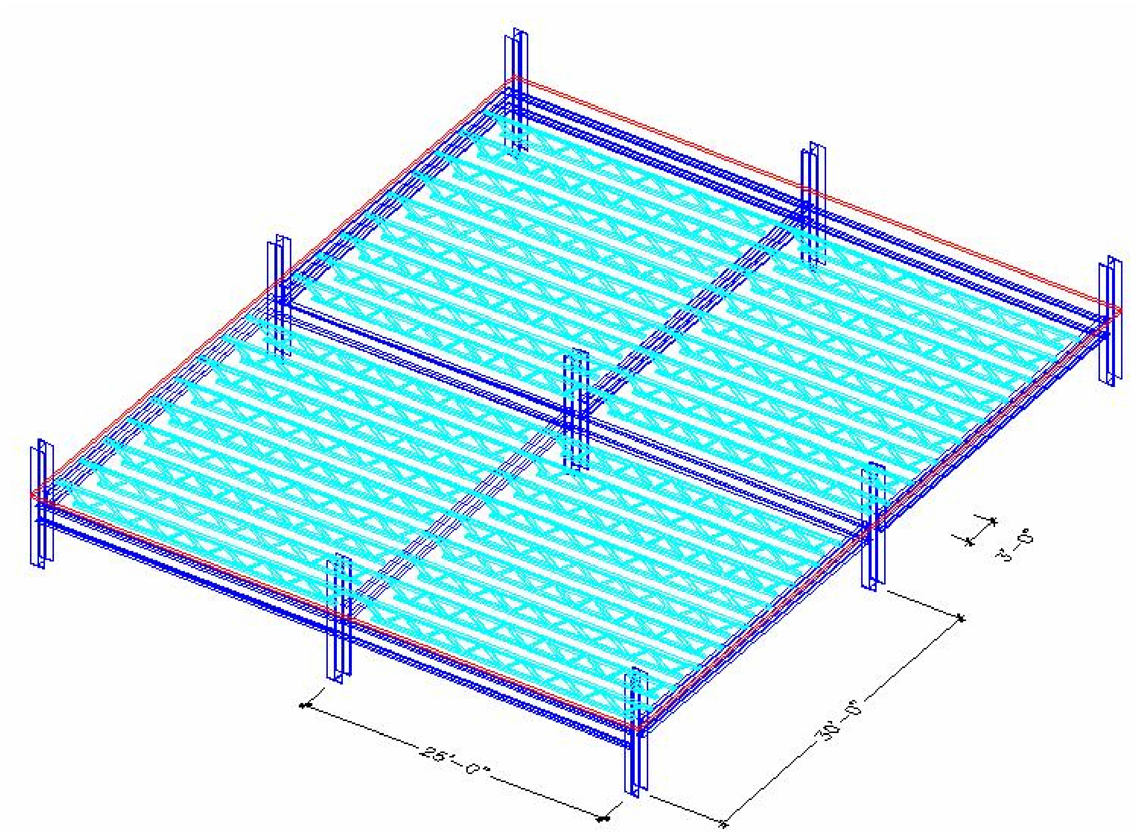


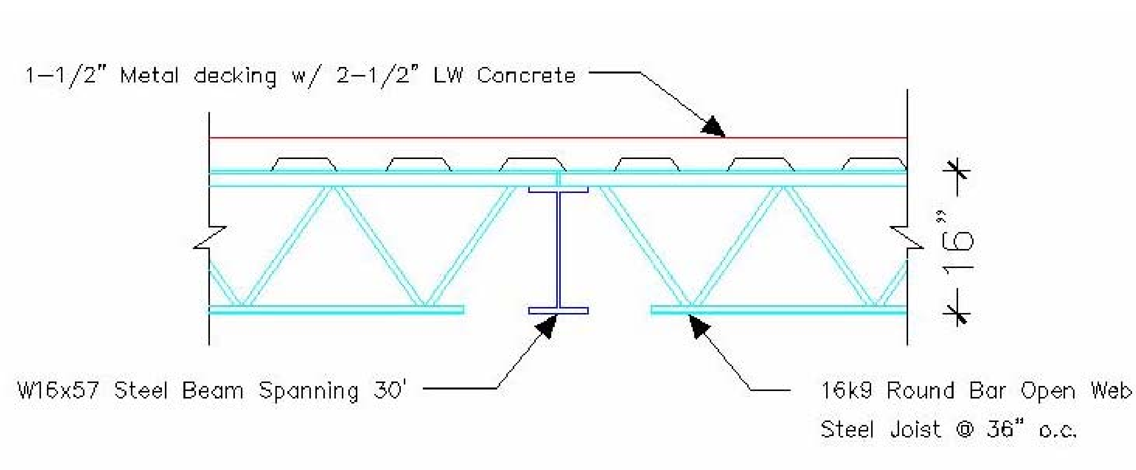


Column Section

Pan Section

4th Alternative System Framing





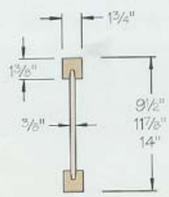
Design Tables

Trus Joist

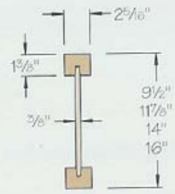
Floor Span Tables

Trus Joist • TJI® Joist Specifier's Guide 2027 • November 2004

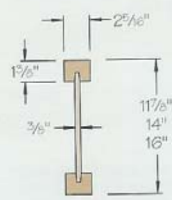
Not all products are available in all markets. Contact your Trus Joist representative for information.



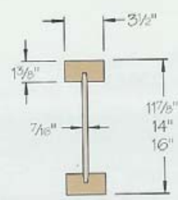
TJI® 110 joists



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.

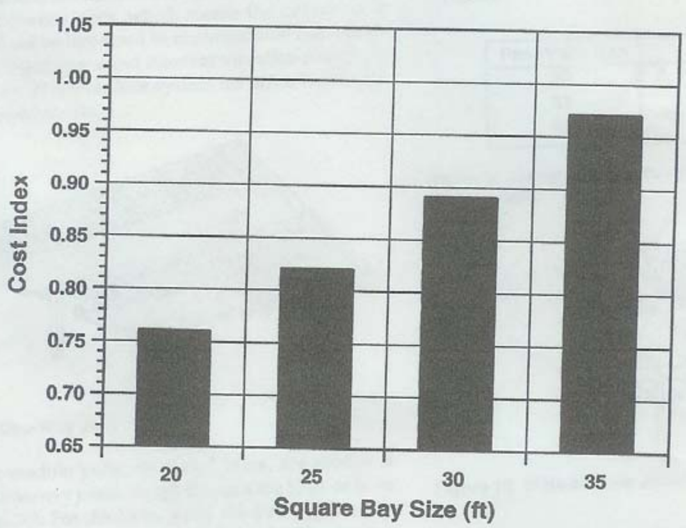
General Notes

- Tables are based on:
  - Uniform loads.
  - More restrictive of simple or continuous span.
  - Clear distance between supports (1¾" minimum end bearing).
- Assumed composite action with a single layer of 2 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 softwa or to load tables on page 15.

Design Tables

Reinforced Concrete Floor Systems

Flat Slab					f'_c = 4,000 psi	SIDL = 20 psf LL = 50 psf	
Bay Size (ft)	Slab Thickness (in.)	Drop Size		Square Column Size (in.)	Concrete (ft^3/ft^2)	Reinforcement (psf)	Formwork (ft^2/ft^2)
		L × W (ft)	h_1 (in.)				
20 × 20	7.0	7 × 7	2.25	20	0.61	2.02	1.01
20 × 25	8.5	7 × 8½	2.25	22	0.73	2.27	1.01
20 × 30	10.5	7 × 10	4.25	24	0.92	2.79	1.02
20 × 35	12.0	7 × 12	4.25	30	1.04	3.27	1.02
25 × 25	8.5	8½ × 8½	2.25	26	0.73	2.50	1.01
25 × 30	10.0	8½ × 10	4.25	30	0.87	2.75	1.02
25 × 35	12.0	8½ × 12	4.25	32	1.04	3.35	1.02
30 × 30	10.0	10 × 10	4.25	32	0.87	2.96	1.02
30 × 35	12.0	10 × 12	4.25	36	1.04	3.44	1.02
35 × 35	12.0	12 × 12	4.25	38	1.04	3.80	1.02

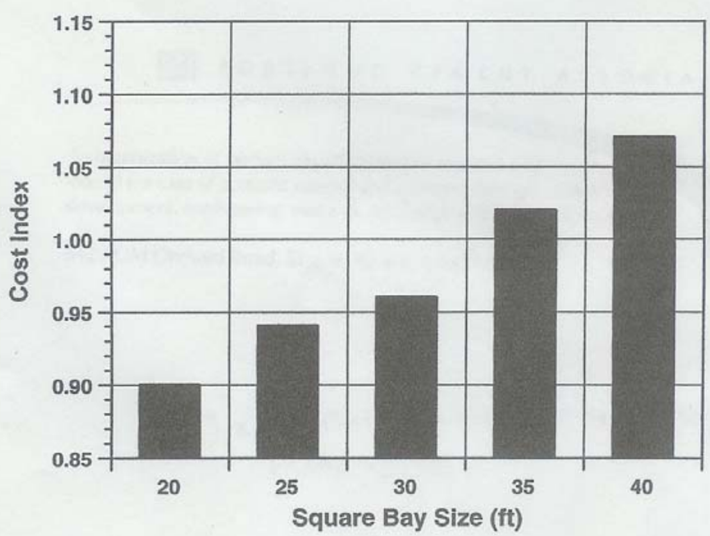


14

Design Tables

Reinforced Concrete Floor Systems

One-Way Joist – 30″ pan					f'_c = 4,000 psi SIDL = 20 psf Slab h = 4½″ LL = 50 psf		
Bay Size (ft)	Pan Depth (in.)	Rib Width (in.)	Beam Width (in.)	Square Column Size (in.)	Concrete (ft^3/ft^2)	Reinforcement (psf)	Pan Area (%)
20 × 20	8	5	24	20	0.55	1.85	89
20 × 25	8	5	36	22	0.56	2.20	83
20 × 30	8	5	36	24	0.58	2.78	83
20 × 35	10	5	36	30	0.62	2.87	83
20 × 40	12	5	36	32	0.68	3.18	83
25 × 25	10	5	36	26	0.60	2.39	87
25 × 30	10	5	36	30	0.61	2.85	86
25 × 35	12	5	48	32	0.69	2.91	82
25 × 40	14	5	48	34	0.75	3.22	82
30 × 30	14	5	36	32	0.68	2.38	88
30 × 35	14	5	48	36	0.71	2.77	85
30 × 40	14	5	48	38	0.71	3.30	85
35 × 35	16	6	48	38	0.77	3.04	87
35 × 40	20	6	48	40	0.88	3.69	87
40 × 40	20	6	48	42	0.86	3.35	88



20

Design Tables

Open Web Steel Joist

STANDARD LOAD TABLE
FOR OPEN WEB STEEL JOISTS, K-SERIES

Based on a Maximum Allowable Tensile Stress of 30 ksi
Adopted by the Steel Joist Institute November 4, 1985;
Revised to May 1, 2000 – Effective August 1, 2002

The black figures in the following table give the TOTAL safe uniformly distributed load-carrying capacities, in pounds per linear foot, of K-Series Steel Joists. The weight of DEAD loads, including the joists, must be deducted to determine the LIVE load-carrying capacities of the joists. Sloped parallel-chord joists shall use span as defined by the length along the slope.

The figures shown in RED in this load table are the LIVE loads per linear foot of joist which will produce an approximate deflection of 1/360 of the span. LIVE loads which will produce a deflection of 1/240 of the span may be obtained by multiplying the figures in RED by 1.5. In no case shall the TOTAL load capacity of the joists be exceeded.

The approximate joist weights per linear foot shown in these tables do not include accessories.

The approximate moment of inertia of the joist, in inches^4 is;

$I_j = 26.767(W_{LL})(L^3)(10^{-6})$, where W_{LL} = RED figure in the Load Table and L = (Span - .33) in feet.

For the proper handling of concentrated and/or varying loads, see Section 5.5 in the Recommended Code of Standard Practice for Steel Joists and Joist Girders.

<u>Where the joist span exceeds the unshaded area</u> of the load table, the row of bridging nearest the mid-span shall be diagonal bridging with bolted connections at the chords and intersections.

STANDARD LOAD TABLE/OPEN WEB STEEL JOISTS, K-SERIES
Based on a Maximum Allowable Tensile Stress of 30 ksi

Joist Designation	8K1	10K1	12K1	12K3	12K5	14K1	14K3	14K4	14K6	16K2	16K3	16K4	16K5	16K6	16K7	16K9
Depth (in.)	8	10	12	12	12	14	14	14	14	16	16	16	16	16	16	16
Approx. Wt (lbs./ft.)	5.1	5.0	5.0	5.7	7.1	5.2	6.0	6.7	7.7	5.5	6.3	7.0	7.5	8.1	8.6	10.0
Span (ft.) ↓ 8	550 550															
9	550 550															
10	550 480	550 550														
11	532 377	550 542														
12	444 288	550 455	550 550	550 550	550 550											
13	377 225	479 363	550 510	550 510	550 510											
14	324 179	412 289	500 425	550 463	550 463	550 550	550 550	550 550	550 550							
15	281 145	358 234	434 344	543 428	550 434	511 475	550 507	550 507	550 507							
16	246 119	313 192	380 282	476 351	550 396	448 390	550 467	550 467	550 467	550 550	550 550	550 550	550 550	550 550	550 550	550 550
17		277 159	336 234	420 291	550 366	395 324	495 404	550 443	550 443	512 488	550 526	550 526	550 526	550 526	550 526	550 526
18		246 134	299 197	374 245	507 317	352 272	441 339	530 397	550 408	456 409	508 456	550 490	550 490	550 490	550 490	550 490
19		221 113	268 167	335 207	454 269	315 230	395 287	475 336	550 383	408 347	455 386	547 452	550 455	550 455	550 455	550 455
20		199 97	241 142	302 177	409 230	284 197	356 246	428 287	525 347	368 297	410 330	493 386	550 426	550 426	550 426	550 426
21			218 123	273 153	370 198	257 170	322 212	388 248	475 299	333 255	371 285	447 333	503 373	548 405	550 406	550 406
22			199 106	249 132	337 172	234 147	293 184	353 215	432 259	303 222	337 247	406 289	458 323	498 351	550 385	550 385
23			181 93	227 116	308 150	214 128	268 160	322 188	395 226	277 194	308 216	371 252	418 282	455 307	507 339	550 363
24			166 81	208 101	282 132	196 113	245 141	295 165	362 199	254 170	283 189	340 221	384 248	418 269	465 298	550 346
25						180 100	226 124	272 145	334 175	234 150	260 167	313 195	353 219	384 238	428 263	514 311
26						166 88	209 110	251 129	308 156	216 133	240 148	289 173	326 194	355 211	395 233	474 276
27						154 79	193 98	233 115	285 139	200 119	223 132	268 155	302 173	329 188	366 208	439 246
28						143 70	180 88	216 103	265 124	186 106	207 118	249 138	281 155	306 168	340 186	408 220
29										173 95	193 106	232 124	261 139	285 151	317 167	380 198
30										161 86	180 96	216 112	244 126	266 137	296 151	355 178
31										151 78	168 87	203 101	228 114	249 124	277 137	332 161
32										142 71	158 79	190 92	214 103	233 112	259 124	311 147

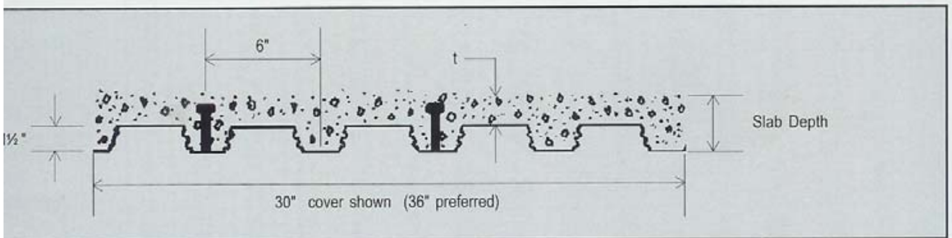
23

United Steel Deck

y = 33ksi f 'c = 3 ksi 115 pcf concrete

Deck, Inc.

LRFD



are per foot of width. The **I** value
the gage thickness in inches; **w**
ıre foot; S_p and S_n are the
ıegative bending (in.³); R_b and
d the shear in pounds (per foot
studs required per foot in order
ent, ϕM_{nf}.

DECK PROPERTIES									
Gage	t	w	As	I	S_p	S_n	R_b	ϕV_n	studs
22	0.0295	1.6	0.470	0.165	0.195	0.206	1320	2620	0.52
20	0.0358	1.9	0.570	0.212	0.247	0.260	1880	3170	0.63
19	0.0418	2.3	0.670	0.260	0.292	0.304	2500	3680	0.73
18	0.0474	2.6	0.760	0.308	0.337	0.349	3200	4160	0.83
16	0.0598	3.3	0.960	0.400	0.434	0.439	4750	5210	1.05

e a list of values for the
h is the distance from the
op of the slab in inches as
gs generally refer to the cover
mportant to be aware of the
factored resisting moment
when the "full" number of
ole are in place; inch kips (per
concrete available to resist
. is the volume of concrete in
e slab; no allowance for frame
V is the concrete weight in
n modulus of the "cracked"
er foot of width. I_{av} is the
uncracked" moments of inertia
lab; in.⁴ per foot of width. The I_{av}
based on steel; therefore, to
riate modulus of elasticity to use
ctored resisting moment of the
studs on the beams (the deck
ills on which it is resting) inch
the factored vertical shear
stem; it is the sum of the shear
d the concrete but is not
pounds (per foot of width). The
kimum unshored spans in
by using the construction
l; combined bending and
eactions are considered in
s the minimum area of welded
mperature reinforcing in the
per foot.

COMPOSITE PROPERTIES													
	Slab Depth	ϕM_{nf} in.k	A_c in²	Vol. ft³/ft²	W psf	S_c in³	I_{av} in⁴	ϕM_{no} in.k	ϕV_{nt} lbs.	Max. unshored spans, ft. 1span	2span	3span	A_{wwf}
22 gage	4.00	38.19	21.3	0.255	29	0.91	3.1	25.66	2980	5.14	6.82	6.91	0.023
	4.50	44.78	24.8	0.297	34	1.11	4.3	31.13	3460	4.90	6.53	6.61	0.027
	4.75	48.07	26.5	0.318	37	1.21	5.1	33.93	3700	4.80	6.39	6.47	0.029
	5.00	51.37	28.3	0.339	39	1.31	5.9	36.77	3960	4.70	6.27	6.34	0.032
	5.50	57.96	32.1	0.380	44	1.52	7.9	42.53	4480	4.52	6.04	6.11	0.036
	5.75	61.26	34.0	0.401	46	1.62	8.9	45.45	4750	4.43	5.94	6.01	0.038
	6.00	64.55	36.0	0.422	49	1.73	10.1	48.39	5030	4.36	5.84	5.91	0.041
	6.50	71.15	40.1	0.464	53	1.94	12.8	54.31	5420	4.21	5.66	5.73	0.045
	6.75	74.44	42.2	0.484	56	2.04	14.3	57.30	5570	4.15	5.58	5.64	0.047
	7.00	77.74	44.3	0.505	58	2.15	15.9	60.30	5720	4.09	5.50	5.56	0.050
20 gage	4.00	45.45	21.3	0.255	29	1.09	3.3	30.45	2980	6.02	8.01	8.11	0.023
	4.50	53.44	24.8	0.297	34	1.32	4.7	36.98	3460	5.72	7.64	7.74	0.027
	4.75	57.44	26.5	0.318	37	1.44	5.5	40.33	3700	5.59	7.48	7.57	0.029
	5.00	61.44	28.3	0.339	39	1.56	6.4	43.73	3960	5.47	7.33	7.41	0.032
	5.50	69.43	32.1	0.380	44	1.81	8.5	50.64	4480	5.25	7.05	7.13	0.036
	5.75	73.43	34.0	0.401	46	1.93	9.7	54.14	4750	5.15	6.92	7.00	0.038
	6.00	77.43	36.0	0.422	49	2.06	11.0	57.67	5030	5.06	6.80	6.88	0.041
	6.50	85.42	40.1	0.464	53	2.31	13.8	64.79	5600	4.89	6.58	6.66	0.045
	6.75	89.42	42.2	0.484	56	2.44	15.4	68.38	5890	4.81	6.48	6.56	0.047
	7.00	93.42	44.3	0.505	58	2.57	17.1	71.98	6190	4.73	6.39	6.46	0.050
19 gage	4.00	52.41	21.3	0.255	29	1.25	3.6	35.09	2980	6.70	8.94	9.05	0.023
	4.50	61.81	24.8	0.297	34	1.52	5.1	42.65	3460	6.36	8.52	8.62	0.027
	4.75	66.51	26.5	0.318	37	1.66	6.0	46.54	3700	6.21	8.33	8.43	0.029
	5.00	71.20	28.3	0.339	39	1.80	6.9	50.49	3960	6.08	8.16	8.25	0.032
	5.50	80.60	32.1	0.380	44	2.09	9.1	58.52	4480	5.83	7.84	7.93	0.036
	5.75	85.30	34.0	0.401	46	2.23	10.4	62.60	4750	5.71	7.69	7.78	0.038
	6.00	90.00	36.0	0.422	49	2.38	11.7	66.71	5030	5.61	7.56	7.65	0.041
	6.50	99.39	40.1	0.464	53	2.67	14.8	75.02	5600	5.41	7.31	7.39	0.045
	6.75	104.09	42.2	0.484	56	2.82	16.5	79.20	5890	5.32	7.19	7.28	0.047
	7.00	108.79	44.3	0.505	58	2.97	18.3	83.41	6190	5.24	7.08	7.17	0.050
18 gage	4.00	58.42	21.3	0.255	29	1.40	3.8	39.20	2980	7.34	9.64	9.93	0.023
	4.50	69.07	24.8	0.297	34	1.70	5.4	47.67	3460	6.96	9.19	9.44	0.027
	4.75	74.40	26.5	0.318	37	1.85	6.3	52.03	3700	6.79	8.99	9.23	0.029
	5.00	79.73	28.3	0.339	39	2.01	7.3	56.46	3960	6.64	8.80	9.03	0.032
	5.50	90.39	32.1	0.380	44	2.33	9.6	65.49	4480	6.36	8.46	8.67	0.036
	5.75	95.72	34.0	0.401	46	2.50	11.0	70.08	4750	6.24	8.30	8.51	0.038
	6.00	101.05	36.0	0.422	49	2.66	12.4	74.71	5030	6.12	8.15	8.35	0.041
	6.50	111.71	40.1	0.464	53	3.00	15.6	84.06	5600	5.90	7.88	8.07	0.045
	6.75	117.04	42.2	0.484	56	3.16	17.4	88.78	5890	5.80	7.75	7.94	0.047
	7.00	122.37	44.3	0.505	58	3.33	19.3	93.52	6190	5.71	7.63	7.82	0.050
16 gage	4.00	58.42	21.3	0.255	29	1.70	4.3	39.20	2980	8.58	10.76	11.12	0.023
	4.50	69.07	24.8	0.297	34	2.08	6.0	47.67	3460	8.12	10.27	10.61	0.027
	4.75	74.40	26.5	0.318	37	2.27	7.0	52.03	3700	7.92	10.05	10.38	0.029
	5.00	79.73	28.3	0.339	39	2.46	8.1	56.46	3960	7.73	9.84	10.17	0.032
	5.50	90.39	32.1	0.380	44	2.86	10.7	65.49	4480	7.40	9.46	9.78	0.036
	5.75	95.72	34.0	0.401	46	3.07	12.1	70.08	4750	7.25	9.28	9.60	0.038
	6.00	101.05	36.0	0.422	49	3.27	13.7	74.71	5030	7.11	9.12	9.43	0.041
	6.50	111.71	40.1	0.464	53	3.69	17.2	84.06	5600	6.85	8.81	9.11	0.045
	6.75	117.04	42.2	0.484	56	3.90	19.2	88.78	5890	6.74	8.67	8.96	0.047
	7.00	122.37	44.3	0.505	58	4.11	21.3	93.52	6190	6.62	8.54	8.82	0.050