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Boyds Bear Country
Pigeon Forge, TN

Technical Report 2
Analysis and Comparison of Alternative Floor Systems

Executive Summary:

Boyds Bear Country, located in Pigeon Forge, Tennessee, is designed as a multi-functional space and tourist attraction for Boyds Collections Ltd. The 112,620 square foot building houses three floors of retail space with multiple cashier and information desks, warehouse storage, a loading dock, a full sized restaurant, food court, ice cream parlor, special events areas, and offices.

This report investigates alternative floor systems for the building. A brief summary of each system is as follows:

- **Existing composite slab** – 5½" composite slab on a typical steel frame. W16x31 joists at 10' OC frame to W24x62 girders which frame to HSS12x12x5/8" columns.
- **Open-web steel joists** – 5½" composite slab on a similar steel frame. 22K8 joists at 3' OC frame to same girders and columns.
- **Two-way concrete slab** – 11" thick slab with 7" deep, 10' wide drop panel around minimum 15"x15' cast-in-place column.
- **Pre-cast concrete plank** – 12"x4' SpanDeck J952 framing to either a steel frame of W30x99 girders and W14x120 columns, or a pre-cast system of 24IT36 268-S girders and a minimum 18"x18" column.
- **Pre-cast double-tees** – 15' wide, 15DT34, double-tees span 2 typical bays to frame into a 12LB44 168-S pre-cast girder and a minimum of a 18"x18" column per tee.
- **Wood framing** – 5-ply 48" span sheathing covers 7"x20" commercial Parallam joists spaced at 4' OC which frame to 7"x42" commercial Parallam girders. These are supported by HSS12x12x½" steel tubes.

All systems are based on a 30'x30' typical bay, with the exception of the pre-cast double-tees, which spans a 30'x60' bay. Floor to floor height of the building is 17'-4", of which 7' are used within to floor / ceiling assembly, as a result, the system depth was not a consideration in this report.

The original loadings were determined using ASCE 7-95 and ASCE 7-98 and original member selections were chosen using Allowable Stress Design. For the purposes of comparative design, all systems were analyzed with the same superimposed loading and in Allowable Stress Design where possible. In all cases, the requirements as specified by the manufacturer or specific material design guide were followed as applicable.

Comparisons are made at the end of this report, considering factors such as system weight, lateral system changes, and cost. Based on these factors, it can be determined that the pre-cast systems and the wooden framing should all be candidates for further study in application to Boyds Bear Country as a whole.

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Boyds Bear Country
Pigeon Forge, TN

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Background Description of Boyds Bear Country:

Boyds Bear Country, located in Pigeon Forge, Tennessee, is designed as a multi-functional space and tourist attraction for Boyds Collections Ltd. The 112,620 square foot building houses three floors of retail space with multiple cashier and information desks, warehouse storage, a loading dock, a full sized restaurant, food court, ice cream parlor, special events areas, and offices.

The main structural system of the building is composed of a steel grid supporting composite slabs. Wooden trusses support the roof, covered in plywood sheathing. Lateral resistance is provided by concentric braced frames and masonry shear walls. Foundations consist of shallow footings and piers, built as a mixture of cast-in-place concrete and masonry. No expansion joints are present in the structure.

The original design was performed using the 1999 Standard Building Code and its respective related codes. Loadings were determined using ASCE 7-95 and ASCE 7-98 and original member selections were chosen using AISC Manual of Steel Construction, Allowable Stress Design, 9th Edition (1989).

Loading Conditions

As the building is home to multiple use spaces, it is also home to multiple loading conditions. Below is a list of those used in the original design of the building as required by the Standard Design Code 1999.

Gravity loading conditions as listed in plans in the original design:

Design Floor Dead Loads:	**[psf]**
Composite Floor Slab 5½" with 3" Deck	50
Beams / Columns	8
Flooring Finish	1
Ceiling Finish	1
Mechanical / Electrical	5
Total	**65**

Design Floor Live Loads:	**[psf]**
Retail Areas	100
Office Areas	100
Stairs, including landings, platforms, and exits	100
Light Storage Area	125

Design Roof Dead Loads:	**[psf]**
Wooden trusses	15
Sheathing and finish	5
Total	**20**

Design Roof Live Loads:		**[psf]**
Minimum Roof Live Load		20
Ground Snow Load	Pg	15
Flat Roof Snow Load	Pf	15.0
Snow Exposure Factor	Ce	1.0
Snow Load Importance Factor	I	1.0
Thermal Factor	Ct	1.0

Additional Design Dead Loads:		Unit
Escalators (each)	30	kips
Stairs	100	psf
Elevator	100	psf
Decorative Timbers (each)	10	kips
Fireplace (ground to 2nd floor) (3rd and 4th floors)	150 75	pcf pcf
Exterior Light Gauge Walls	10	psf

Special Load Design Conditions

Special consideration was taken for additional systems in the original structural design.

This most notably includes the additional loading requirements of Christmas decorations to be hung within the building for several months of the year. Additional loading was also supplied by the decorative wooden timbers, the gas fireplace, and escalators. More specific information about the loads created by these features may be found in technical report 1. Stairwells and elevators are designed as would be in any typical building at 100 psf.

Building Weight by Floor with Live Load:	[kips]
1st floor	2869
2nd floor	2505
3rd floor	2336
4th floor	2085
Roof	524
Total	**10319**

Building Dead Loads for Framing Systems:

Original Composite Steel Framing

Design Floor Dead Loads:	[psf]
Composite Floor Slab 5½" with 3" Deck	50
Beams / Columns	8
Flooring Finish	1
Ceiling Finish	1
Mechanical / Electrical	5
Total	**65**
Compared to Original Steel System	**100%**

Open-Web Steel Joist Framing

Design Floor Dead Loads:	[psf]
Composite Floor Slab 5½" with 3" Deck	50
Open-Web Steel Joists	5
Steel Columns	3
Flooring Finish	1
Ceiling Finish	1
Mechanical / Electrical	5
Total	**65**
Compared to Original Steel System	**100%**

Two-way Concrete Slab System

Design Floor Dead Loads:	[psf]
Slab and Drop Panel	167
Concrete Column	4
Flooring Finish	1
Ceiling Finish	1
Mechanical / Electrical	5
Total	**178**
Compared to Original Steel System	**274%**

Pre-cast Plank System on Steel

Design Floor Dead Loads:	[psf]
Pre-cast Plank	103
Girders / Columns	6
Flooring Finish	1
Ceiling Finish	1
Mechanical / Electrical	5
Total	**116**
Compared to Original Steel System	**178%**

Pre-cast Plank System on Pre-Cast Concrete

Design Floor Dead Loads:	[psf]
Pre-cast Plank	103
Girders	36
Columns	7
Flooring Finish	1
Ceiling Finish	1
Mechanical / Electrical	5
Total	**153**
Compared to Original Steel System	**235%**

Pre-cast Double-Tee System

Design Floor Dead Loads:	[psf]
Double-Tee	82
Girders / Columns	25
Flooring Finish	1
Ceiling Finish	1
Mechanical / Electrical	5
Total	**114**
Compared to Original Steel System	**175%**

Wooden System

Design Floor Dead Loads:	**[psf]**
Joists / Sheathing	15
Girders / Columns	3
Flooring Finish	1
Ceiling Finish	1
Mechanical / Electrical	5
Total	**25**
Compared to Original Steel System	**38%**

Descriptions of the Structural Systems:

Existing Composite Slab System

The primary structural framing at Boyds Bear Country is currently a steel grid with wooden roof trusses. The main structural grid is made of standard steel shapes.

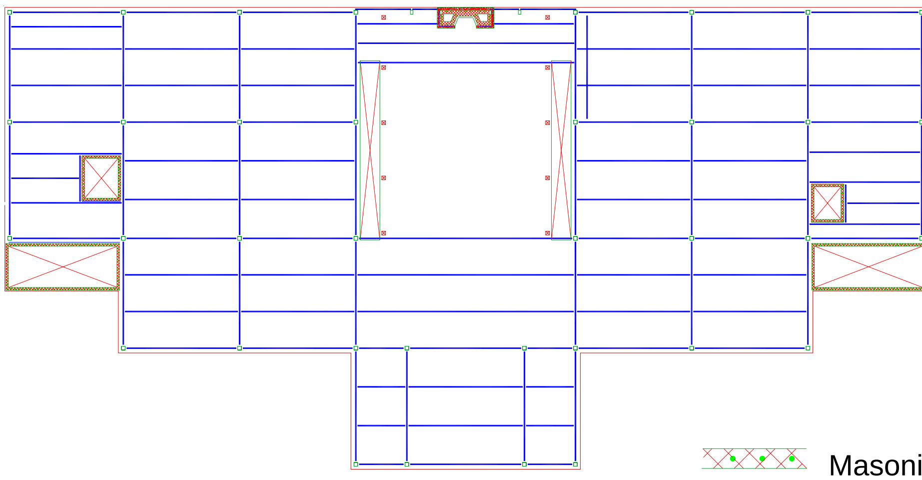
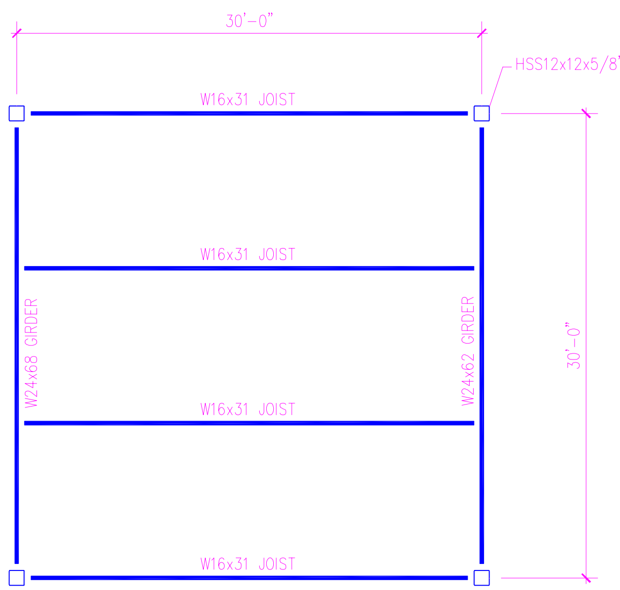


Figure 2.01: Typical Existing Framing Plan

Typical bays measure ~30'x30' square with W16 beams, framing to W24 girders, which connect to steel tube columns. This framing grid varies around stairwells, elevators, and the front façade projection of the building as can be seen in figure 2.01.



Deeper members are located within the center bay, which features spans of up to 60'. On the central floors, this center bay becomes and atrium flanked on either side by large escalators with primarily decorative wooden framing.

Figure 2.02: Typical Existing 30'x30' bay

Wooden framing is located in other areas of the building as structural support, primarily in exterior seating areas. Structural joists, girders, and posts are typically designed as No. 2 Southern Pine. All roof framing consists of wooden trusses spaced 2' on center and were manufactured off site of primarily 2x4 No. 2 Southern Pine. This can be seen during construction in figure 2.04.

Exterior walls on the ground floor are primarily concrete block, ranging from 8" to 16" thick; both common concrete blocks (1500 psi) and high strength Ivany blocks (2800 psi) are used. These blocks are also used in the construction of walls surrounding stairwells, mechanical rooms, and elevator shafts, some of which act as shear walls in the building. Interior walls throughout, and exterior walls on the upper floors, are cold-formed steel framing sheathed in plywood and gypsum board, as shown in figure 2.03.

Figure 2.03:
Light gauge steel framing with plywood sheathing[1]

Figure 2.04:
Roof trusses of 2x4 No.2 Southern Pine spaced at 2' OC.[1]

Elevated slabs in the building are composite construction. All elevated slabs are supported on 3" x 20 gauge Type VL galvanized steel decking, and the slabs of the main structure are composed of 6½" thick, monofilament synthetic polypropylene fiber reinforced, 3,000 psi lightweight concrete. The slab of the Northeast pavilion / mechanical area is composed of 5½" of normal weight concrete. Secondary reinforcing consists of 6x6-W2.0xW2.0 welded wire mesh in both types of concrete. The application of these slabs can be seen in figures 2.05 and 2.06.

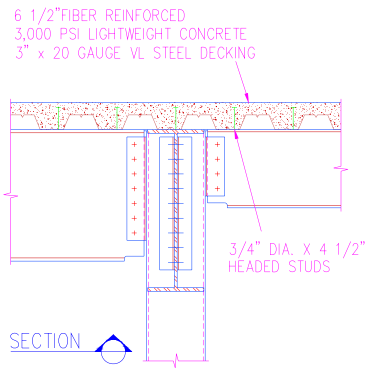


Figure 2.05:
Cross-section of typical slab

Figure 2.06: Composite slab as placed during construction[1]

The floor to floor height in Boyds Bear Country is 17'-4", however the floor to ceiling height is not nearly this great. As can be seen in the overall building section and photographs, figures 2.07, 2.08 and 2.09, the finished ceiling is a drop panel grip hung 7' below to top of the finished floor. As a result, the depth of structural systems is not a major concern in the design of the building.

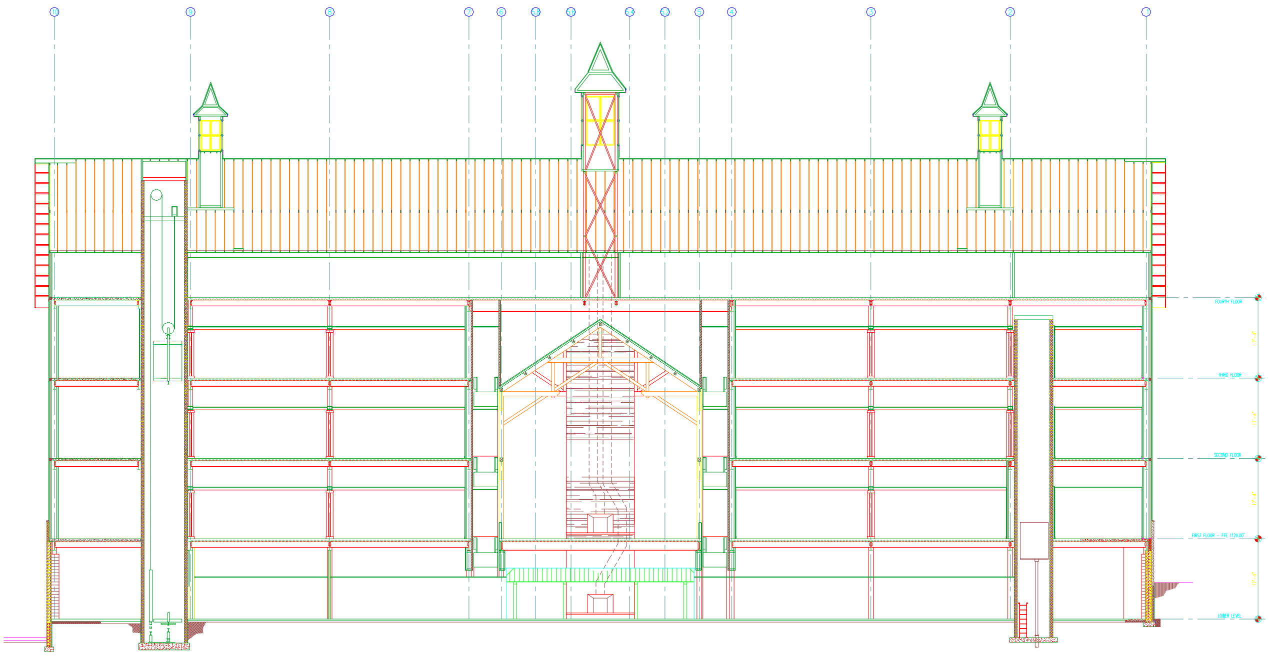


Figure 2.07: Building Section

Figure 2.08: Drop Ceiling[2]

Figure 2.09: Interior bay illustrating ceiling height[2]

The lateral resisting system of the building is again a combination of systems. Both concentric braced frames and concrete shear walls were utilized in the structure to absorb wind and seismic loading.

Braced frames are located in figure 2.10, highlighted in blue. These are designed such that each frame in the direction shares and equal amount of the lateral load. Each braced frame is steel with bolted connections, and is surrounded in masonry at the lower level, illustrated in figure 2.11. This wall, made of 2,800 psi reinforced Ivany block, incorporates masonry piers to transfer loads to the earth.

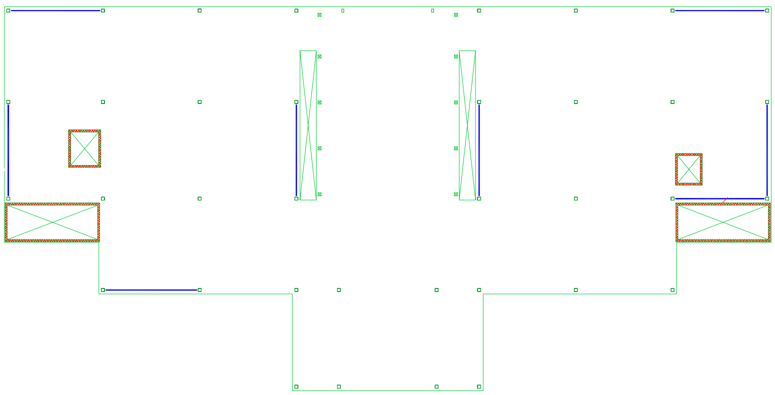


Figure 2.10: Lateral system plan

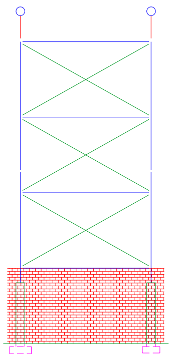


Figure 2.11: Typical braced frame elevation

Concrete shear walls can be found highlighted above in red. These shear walls are reinforced masonry and generally run the full height of the building, located around areas of vertical transportation. They are designed as a secondary lateral system, mainly supporting the loads created by the special areas of elevators and stairwells, but are not considered to absorb any of the overall lateral forces on the building.

Open-Web Steel Joist Framing

For ease of comparison, an open-web steel joist system was designed with the same bay framing as the original composite steel framing, a typical bay of 30'x30'. Based on the requirements and load tables of Vulcraft 2003, 22K9 joists were selected and spaced at 3' O.C. The same 3VLI composite deck with 5½" of concrete was used in this system as in the original. This allows for the deck to be continuous to the portions of the building which are used for light storage. This combination resulted in a system with the same W24x68 girder as designed for the original structural system, and thus the original 12x12x5/8" columns as well.

Fire rating requirements, as specified by IBC 2003, requires a 2 hour fire separation for all of the occupancy factors present in the building. This is provided by the selected system, as can be seen in the appendix.

Overall, the open-web system weighs 65 psf, the same as the existing structure. This will cause little or no changes in the design of the foundation and lateral systems.

The weights and stiffnesses change very little between the two framing systems; this will create little or no change in the application of lateral forces and lateral systems in the building.

In an overall comparison, this system is most similar to the composite steel section used in the original construction. The principles of design used here simply swap the members used as beams.

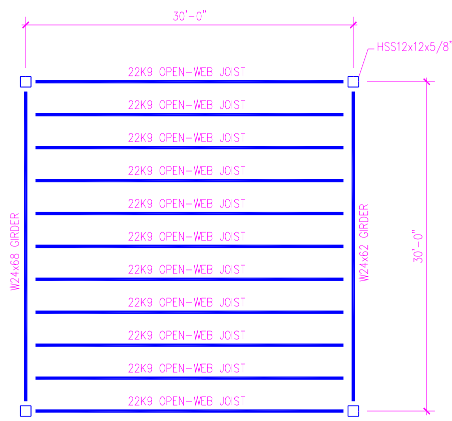


Figure 2.12: Typical open-web steel joist framing 30'x30' bay

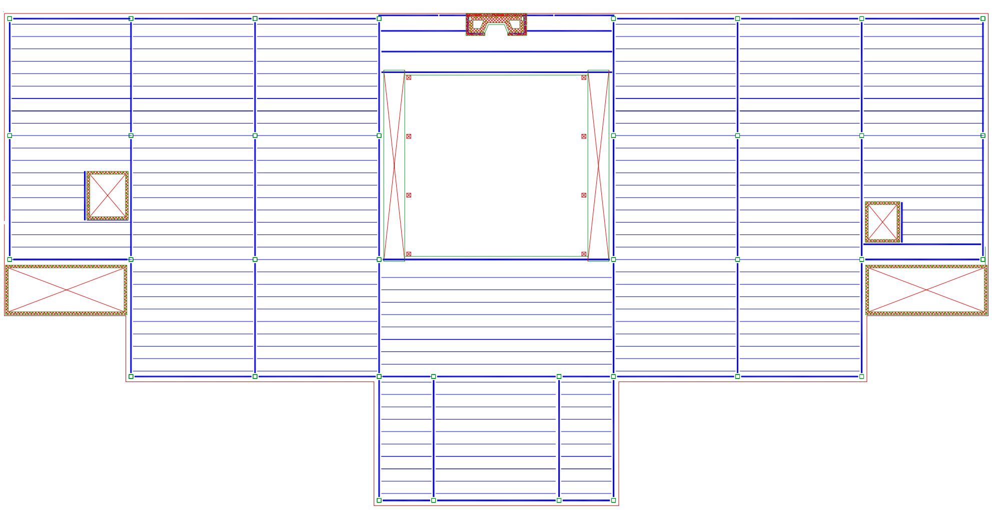


Figure 2.13: Open-Web Joist Layout

Two-way Concrete Slab System

For ease of comparison, the two-way concrete slab system was designed with the same bay framing as the original composite steel framing, a typical bay of 30'x30'. In the application of 200 psf superimposed load (used conservatively with applicable load factors) a selection of a flat two-way slab system was made based on the requirements of the Concrete Reinforcing Steel Institute. Using these requirements two standard options may be selected, a set based around an 11" concrete slab, and a set based around a 12" concrete slab.

The details of the system utilizing the 11" slab may be found in section 2 of the appendix. The major details included in this design feature a 7" deep by 10' wide square drop panel, with no beams, and a 15" square column. Total required steel is 4.19 psf in edge panels and 3.40 psf in interior panels.

The major details included in the design of the 12" slab feature the same 7"x10' drop panel and an adjustment in steel requirements. Total required steel is 3.99 psf in edge panels and 3.32 psf in interior panels, showing slight decrease in required steel area.

Because of the small changes in requirements between the two options, the 11" slab should be chosen, as it results in a lighter system. Overall, the system weighs 178 psf, nearly 275% of the dead load of the original system. This will create an increase in the required design of the foundation system, including increases in both reinforcement and concrete amounts.

A two-way concrete slab system will be more expensive than most compared in this report due to the increased costs of formwork and field labor. This system also has the potential for increased time loss in construction as nearly every part of the system must be created on site.

An alternative lateral system will be required with the use of this system. A set of concrete shear walls around the storage areas and vertical transportation along with a slab diaphragm is most typically applied to the two-way slab. These will experience greater forces due to the greater self weight of the structure.

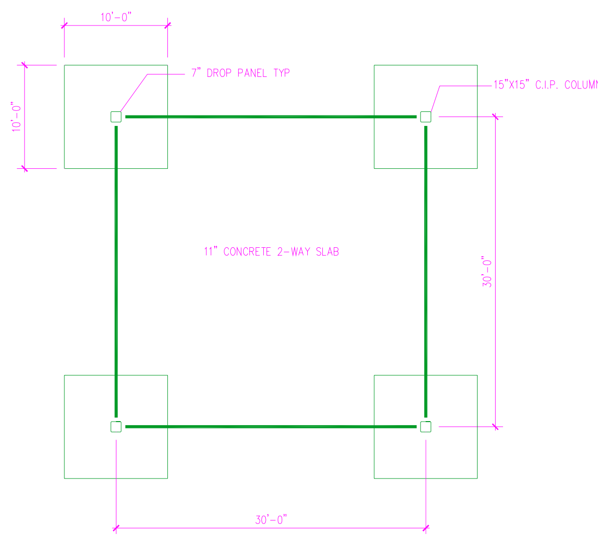


Figure 2.14: Typical two-way concrete slab with drop panels 30'x30' bay

Please note that this system does not require beams, the illustration of the typical bay merely represents the confines of the bay.

Pre-cast Plank System

For ease of comparison, the pre-cast plank was designed with the same bay framing as the original composite steel framing, a typical bay of 30'x30'. In the application of 150 psf superimposed load (used conservatively) a selection of a 12"x4' SpanDeck J952 was made based on load tables which can be found in the appendix. This member is 12" deep and 4' wide with 6 half-inch pre-stressing strands.

A steel frame used to support these planks consists of W30x99 girders and W14x120 columns as shown in figure 2.15. These members are considerably larger than those used in the existing steel frame due to the increased weight of the floor system. The combination of pre-cast plank and steel framing weighs 116 psf, over 175% of the dead load of the original system.

Pre-cast members may also be used in framing for the planks, allowing for a consistent application of material, as shown in figure 2.16. An inverted-tee beam, designed under the requirements of PCI, results in the selection of a 24IT36 268-S girder. A column, designed solely on the requirements of compression loading, results in the selection of an 18"x18" 4ksi member. The combination of pre-cast planks and pre-cast framing weighs 153 psf, at 235% of the dead load of the original system. The larger self weight of either system creates an increase in the required design of both the foundation and lateral systems.

Pre-cast system is comparable in price to the original steel system. Considerations such as the shipping costs of larger and heavier members increase the cost of the structure, while factors such as a greater amount of factory produced material decrease the cost of the structure.

An alternative lateral system is most likely required with the use of this system. Concrete shear walls can be incorporated into the pre-cast structure, while both can feature a diaphragm developed in the topping of the concrete planks.

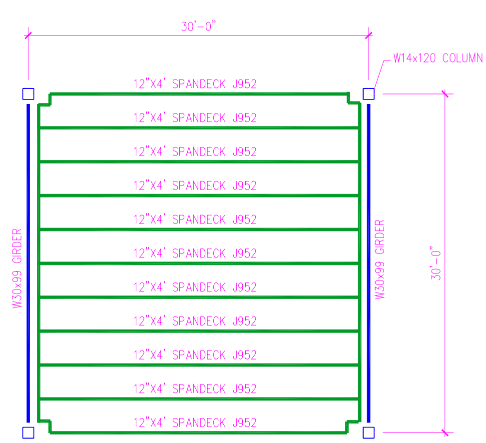


Figure 2.15: Typical pre-cast plank Supported by steel, 30'x30' bay

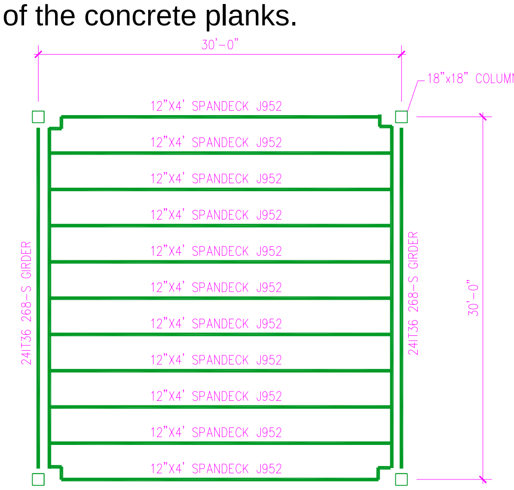


Figure 2.16: Typical pre-cast plank supported by pre-cast, 30'x30' bay

Pre-cast Double-Tee System

Due to the nature of long-span pre-cast double tees, it becomes very simple to reduce the number of bays located in the building as originally designed. The bay layout in applying 60' double-tees may be seen in figures 2.17 and 2.18.

Standard 15' wide double-tees can be used with a 100 psf live load, as applied to all other systems. PCI requirements and design tables result in the selection of a 15DT34 248-S member, a 34" deep section with 24 half-inch pre-stressing strands.

Inverted-tee beams and L-beams are typically used to support the double-tee system. A standard L-beam can be used to support one typical bay. At 30' long, this beam is a 12LB44 168-S, a 44" deep beam with 16 half-inch pre-stressing strands. To support two adjacent bays, an inverted-tee beam would be specifically designed; however its requirements would not be outside the bounds of reasonable member construction. Columns designed solely on the requirements of compression loading, results in the conservative selection of an 18"x18" 4ksi member.

The double-tees and their supporting pre-cast system weighs 114 psf, approximately 175% of the dead load of the original system. The increased weight creates an larger requirements in the design of the foundation system, including increases in the amount of reinforcement and concrete. Larger forces will also be seen in the seismic resisting elements of the structure due to the increase in weight.

This pre-cast system is comparable in price to the original steel system. Considerations such as the shipping costs of larger and heavier members across potentially longer distances increase the cost of the structure, while the factory produced nature all members decreases its cost.

The lateral system of the building would be altered in a similar fashion to the changes made for the pre-cast plank system. A typical pre-cast lateral system involves the placement of shear walls around areas of storage and vertical transportation, while a diaphragm is incorporated into the pour-strip along the top edges of the tees.

The application of 15' wide double-tees, as opposed to typical 12' tees, creates the additional consideration of limited availability. The creation, shipping, and engineering of the system may all be dependant on the requirements of the manufacturer.

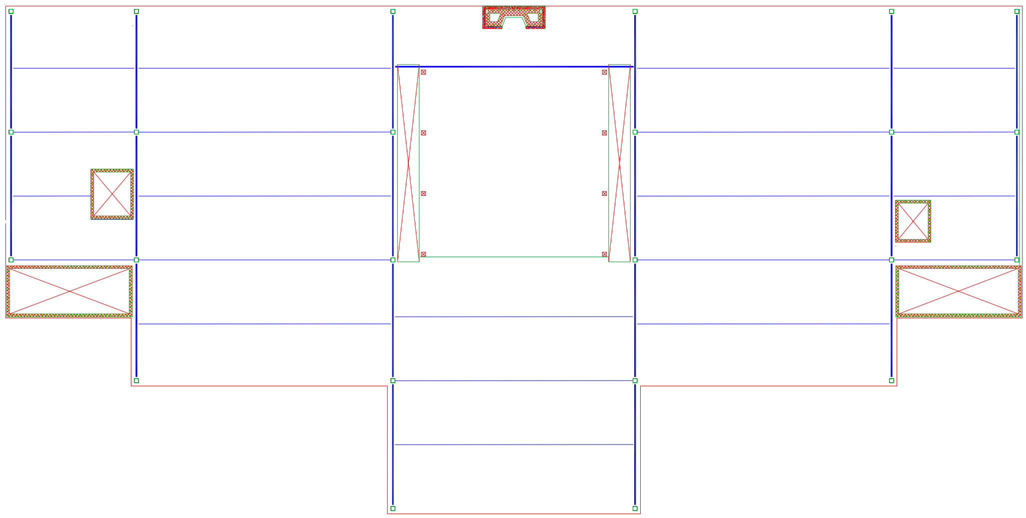


Figure 2.17: Double-tee framing plan with 60' spans

Figure 2.18: Typical pre-cast double-tee 30'x60' bay

Wooden System

As Boyds Bear Country is designed in the style of a Pennsylvania Dutch Barn, a wooden framing system is one which would be most authentic to the inspirations of the building. For the applications of this analysis, TrusJoist Parallam framing members were selected using the requirements of the manufacturer.

Beams were selected of 2.2E 7"x20" commercial Parallam spaced at 4' O.C. Girders were selected in a similar manner, resulting in 2.2E 7"x42" commercial Parallam. These selections can be found in section 5 of the appendix.

Steel columns were chosen to support the system due to the large 17'-4" floor to floor height. A HSS12x12x½" member was selected, which is slightly smaller than the existing column due to a reduction in system weight. This steel column could be clad in wood sheathing to create the appearance of a wooden column, as is done in the structure currently.

Floor sheathing was chosen as 5-ply 48" span rated plywood, based on NDS requirements. This allows for a consistent application of materials in the floor system and more authentic construction. The sheathing is attached using 8d nails at 6" spacing on all members. The design of this sheathing is at a close minimum in service and strength, and alternate sheathing systems can be investigated further.

The system as a whole weighs approximately 25 psf, only 40% of the dead load of the original system. This is the only system to be lighter than the original, and creates decreased strength requirements in the foundation design.

Alterations are required to the lateral system in changing to a wood framed system. A possible option for this is the use of masonry shearwalls around areas of storage and vertical transportation. The forces exerted on the system would be lower than those of the existing system, due to the decreased self-weight of the structure. If selected, lateral resistance options would require further study.

The wooden system has a similar cost to that of the original design. All members are standard sizes and can be readily ordered, produced, and shipped. Costs related to shipping are most likely reduced due to the size and weight of the system components. Construction of the wooden frame is completed in the field; however contractors are often familiar with the requirements and processes of installation, balancing charts.

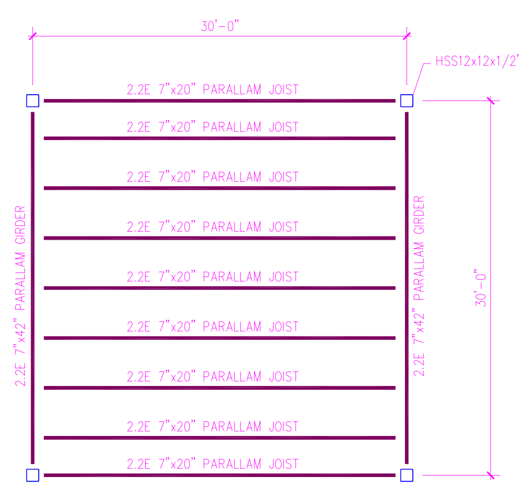


Figure 2.19: Typical wood system 30'x30' bay

Comparison of Systems:

System	Dead Load	Foundation Impact	Lateral System Impact	Lateral System Alteration
Existing Composite Steel	65 psf	No change	No change	No change
Open-Web Steel Joists	65 psf	No change	No change	No change
Two-Way Concrete Slab	178 psf	Larger foundation	Larger members	CIP shear walls
Pre-Cast Plank on Steel	116 psf	Larger foundation	Larger members	Pre-cast shear walls
Pre-Cast Plank on Concrete	153 psf	Larger foundation	Larger members	Pre-cast shear walls
Pre-Cast Double-Tees	114 psf	Larger foundation	Larger members	Pre-cast shear walls
Wood Framing	25 psf	Smaller foundation	Smaller members	Masonry shear walls

System	Shipping Cost	Erection Cost	Standard Bay Spacing	Members per Bay
Existing – Composite Steel	No change	No change	30’x30’	(3) @ 10’ OC
Open-Web Steel Joists	Slight increase for multiple materaials	Comparable, has more connections	30’x30’	(10) @ 3’ OC
Two-Way Concrete Slab	Potential decrease for only concrete mixers	Significant Increase for formwork and field labor	30’x30’	11” slab
Pre-Cast Plank on Steel	Moderate increase for multiple materials and weight	Comparable, has several materials	30’x30’	4’ span each
Pre-Cast Plank on Concrete	Moderate increase for material weight	Comparable, fast erection	30’x30’	4’ span each
Pre-Cast Double-Tees	Potentially high rise for distance and availability	Comparable, fast erection and few pieces	30’x30’	(2) @ 15’ span
Wood Framing	Potential decrease for material and weight	Potential decrease, common material	30’x30’	(8) @ 4’ OC

System	Largest Positive Change	Largest Negative Change
Existing – Composite Steel	No change	No change
Open-Web Steel Joists	Decreased deck span	Increased number of connections
Two-Way Concrete Slab	Decrease in vibration	Increased cost and weight
Pre-Cast Plank on Steel	Decrease in field work	Increased weight Multiple materials
Pre-Cast Plank on Concrete	Decrease in field work Quicker installation	Increased weight
Pre-Cast Double-Tees	Larger spans / fewer columns Quicker installation	Increased weight
Wood Framing	Architecturally pleasing Decreased weight	Increased deflection and vibration

System	Recommendation	Further Study
Existing – Composite Steel	No change	No change
Open-Web Steel Joists	Too similar	Potential for support by joist-girder Influence of increased number of connections
Two-Way Concrete Slab	Too large Too heavy	Impact on lateral system Potential for various bay sizes
Pre-Cast Plank on Steel	Potential option	Influence of the increased weight of the system
Pre-Cast Plank on Concrete	Potential option	Influence of the increased weight of the system Impact on lateral system
Pre-Cast Double-Tees	Potential option	Interaction of members at column lines Influence of increased weight of the system
Wood Framing	Potential option	Floor sheathing alternatives Vibration and deflection influences Fire-rating permissability

Conclusions:

In analyzing various floor systems for use in Boyds Bear Country, it is apparent that each presents improvements in some areas and are lacking in the requirements of others.

The existing system is composed of nearly every building material possible, however is designed with an efficient layout within the building. The open-web steel joist system is nearly identical to the existing composite system. Further investigation in this area could include the use of joist-girders to replace the traditional girders, and the impact of decreasing the span of the floor system from 10' to 3'.

Every other system analyzed requires changes to the lateral resisting system by the nature of the materials used. The effects of this can be studied further to create a picture of the changes induced by these systems on the building as a whole. These other systems also require changes in the design of the foundation system, as they each have a substantially different self-weight from the original design.

Additional considerations were not made for special loading cases as described earlier. Further investigation of these systems should include the methods and efficiencies of these systems in adapting to these loads.

Citation Note: [1] Photographs c/o Kinsley Construction.
[2] Photographs by Lauren Wilke.

Appendix Section 1:
Open Web Steel Joist System

CLASS: AE 481W
DATE: 10-27-06
ASSIGNMENT: TECH REPORT #2.
— OPEN WEB STEEL JOIST SYSTEM.
PAGE: ____ of ____

PENN STATE UNIVERSITY

OPEN WEB STEEL JOIST SYSTEM TO REPLACE TYPICAL 30'x30' BAY.

@ 8' O.C. SPACING. – JOISTS
100 psf LL = 800 plf LL
65 psf DL = 195 plf DL

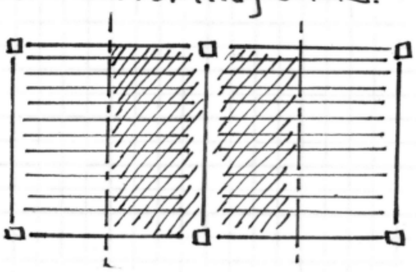
495 plf TL.

MINIMUM JOIST: 22K9 — LL = 349 plf > 300 plf OK ← CONTROLS.
wt = 11.3 plf — TL = 497 plf > 495 plf OK

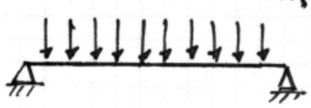
24K8 — LL = 387 plf > 300 plf OK
wt = 11.5 plf — TL = 500 plf > 495 plf OK

USE 22K9 JOISTS @ 8' O.C.

GIRDER SUPPORTING JOISTS.



(10) @ 7.43k EACH, EACH SIDE



P = (495 plf)(30')/2 = 7.43k.
AS DISTRIBUTED LOAD:
(10)(7.43k)/30' = (2.5 klf)(2) = 5 klf.

V = (10)(7.43k) = 74.3k
$M = \frac{(5.0\ klf)(30')^2}{8} = 563'k$

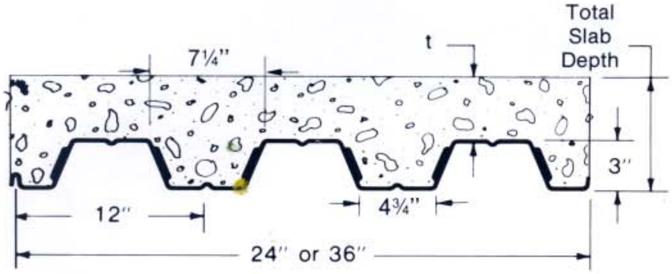
[TABLE 3-19] AISC 13th
@ Y2 = 4.5" M = 608'k ≥ 563'k OK.
PNA = 7
ΣQn = 251 k
a = 1.09" < 2" OK

[TABLE 3-21]
Qn = 17.1k $\frac{251k}{17.1k}$ = 14.67 → 15 STUDS.

USE W24x68 W/ (30) 3/4" ϕ STUDS. NOTE: SAME AS EXISTING.

3 VLI

Maximum Sheet Length 42'-0
Extra Charge for Lengths Under 6'-0
ICBO Approved (No. 3415)



STEEL SECTION PROPERTIES Fy= 40 KSI

Deck Type	Design Thick.	Weight PSF	Ip in^4/Ft	In in^4/Ft	Sp in^3/Ft	Sn in^3/Ft
3VLI22	0.0295	1.77	0.746	0.745	0.429	0.442
3VLI21	0.0329	1.97	0.850	0.848	0.495	0.511
3VLI20	0.0358	2.14	0.938	0.937	0.553	0.572
3VLI19	0.0418	2.50	1.105	1.103	0.677	0.700
3VLI18	0.0474	2.84	1.251	1.251	0.795	0.803
3VLI17	0.0538	3.22	1.421	1.421	0.913	0.913
3VLI16	0.0598	3.58	1.580	1.580	1.013	1.013

(N=9) NORMAL WEIGHT CONCRETE (145 PCF)

Total Slab Depth	Deck Type	SDI Max. Unshored Clear Span			Superimposed Live Load, PSF Clear Span (ft.-in.)														
		1 Span	2 Span	3 Span	7'-0	7'-6	8'-0	8'-6	9'-0	9'-6	10'-0	10'-6	11'-0	11'-6	12'-0	12'-6	13'-0	13'-6	14'-0
	3VLI22	7'-8	9'-7	9'-7	216	195	149	133	120	109	99	90	83	76	70	64	59	54	50
5"	3VLI21	8'-11	11'-3	11'-4	230	206	187	170	128	116	106	96	88	81	74	68	63	58	54
	3VLI20	9'-6	11'-11	12'-4	241	216	196	178	163	150	111	101	93	85	78	72	66	61	57
(t=2")	3VLI19	10'-8	13'-2	13'-7	265	237	214	194	178	163	151	140	102	94	86	79	73	67	62
	3VLI18	11'-8	14'-1	14'-6	289	261	238	218	201	186	173	161	151	142	106	98	92	86	80
44 PSF	3VLI17	12'-7	14'-11	15'-5	309	278	253	231	212	196	182	170	159	150	141	133	97	91	85
	3VLI16	13'-4	15'-8	15'-11	327	294	267	243	223	206	191	178	167	156	147	139	132	96	89
	3VLI22	7'-0	8'-9	8'-9	247	190	170	152	137	124	113	103	94	87	80	73	67	62	57
5 1/2"	3VLI21	8'-4	10'-4	10'-4	262	235	213	162	146	133	120	110	101	92	85	78	72	66	61
	3VLI20	9'-0	11'-5	11'-9	275	247	223	203	186	140	127	116	106	97	89	82	76	70	65
(t=2 1/2")	3VLI19	10'-1	12'-7	13'-0	302	270	244	222	203	186	172	128	117	107	98	90	83	77	71
	3VLI18	11'-1	13'-5	13'-11	330	298	271	248	229	212	197	184	173	130	121	112	105	98	92
50 PSF	3VLI17	11'-11	14'-3	14'-9	352	317	288	263	242	224	208	194	182	171	128	119	111	104	97
	3VLI16	12'-8	15'-0	15'-5	373	335	304	277	255	235	218	203	190	178	168	159	117	109	102
	3VLI22	6'-5	8'-1	8'-1	242	214	191	171	154	140	127	116	106	97	89	82	76	70	65
6"	3VLI21	7'-8	9'-7	9'-7	294	264	204	183	165	149	135	124	113	104	95	88	81	75	69
	3VLI20	8'-7	10'-11	10'-11	309	277	250	228	173	157	143	130	119	109	100	92	85	79	73
(t=3")	3VLI19	9'-8	12'-1	12'-6	339	304	274	249	227	209	157	143	131	120	110	102	94	87	80
	3VLI18	10'-7	12'-11	13'-4	370	334	304	279	257	238	221	207	158	146	136	126	118	110	103
57 PSF	3VLI17	11'-5	13'-9	14'-2	395	356	323	296	272	251	233	218	204	155	144	134	125	117	109
	3VLI16	12'-0	14'-5	14'-11	400	376	341	311	286	264	245	228	213	200	189	141	132	123	115
	3VLI22	6'-0	7'-5	7'-5	268	237	212	190	171	155	141	129	118	108	99	91	84	78	72
6 1/2"	3VLI21	7'-1	8'-10	8'-10	326	254	226	203	183	165	150	137	126	115	106	97	90	83	77
	3VLI20	8'-1	10'-1	10'-1	343	307	278	214	192	174	158	144	132	121	111	103	95	87	81
(t=3 1/2")	3VLI19	9'-3	11'-7	12'-0	377	337	304	276	252	192	175	159	146	134	123	113	104	96	89
	3VLI18	10'-1	12'-5	12'-10	400	371	338	309	285	264	246	189	175	162	151	140	131	122	115
63 PSF	3VLI17	10'-11	13'-3	13'-8	400	395	359	328	302	279	259	242	186	172	160	149	139	130	121
	3VLI16	11'-6	13'-11	14'-4	400	400	378	345	317	293	272	253	237	222	169	157	146	136	128
	3VLI22	5'-7	6'-11	6'-11	295	261	233	209	188	171	155	142	130	119	109	101	93	86	79
7"	3VLI21	6'-7	8'-3	8'-3	316	279	249	223	201	182	165	151	138	127	116	107	99	91	84
	3VLI20	7'-6	9'-5	9'-5	377	338	262	235	212	192	174	159	145	133	122	113	104	96	89
(t=4")	3VLI19	8'-11	11'-3	11'-7	400	370	334	303	234	211	192	175	160	147	135	124	115	106	98
	3VLI18	9'-9	12'-0	12'-5	400	400	371	340	313	290	226	208	192	178	166	154	144	135	126
69 PSF	3VLI17	10'-6	12'-9	13'-2	400	400	394	360	331	306	285	265	204	189	176	164	153	143	134
	3VLI16	11'-1	13'-5	13'-10	400	400	400	379	348	322	298	278	260	200	185	172	161	150	140
	3VLI22	5'-2	6'-6	6'-6	321	285	254	228	205	186	169	154	141	130	119	110	101	93	86
7 1/2"	3VLI21	6'-2	7'-9	7'-9	344	304	271	243	219	198	180	164	150	138	127	117	108	100	92
	3VLI20	7'-1	8'-10	8'-10	400	321	286	256	231	209	190	173	158	145	134	123	114	105	97
(t=4 1/2")	3VLI19	8'-7	10'-10	11'-2	400	400	364	331	255	231	209	191	175	160	147	136	125	116	107
	3VLI18	9'-4	11'-7	12'-0	400	400	400	370	341	269	246	227	210	195	181	168	157	147	138
75 PSF	3VLI17	10'-1	12'-4	12'-9	400	400	400	393	361	334	310	241	223	206	192	179	167	156	146
	3VLI16	10'-8	13'-0	13'-5	400	400	400	400	380	351	325	303	235	218	202	188	175	164	153

NOTES:
1. Minimum exterior bearing length required is 2.5 inches. Minimum interior bearing length required is 5.0 inches. If these minimum lengths are not provided, web crippling must be checked.
2. Always contact Vulcraft when using loads in excess of 200 psf. Such loads often result from concentrated, dynamic, or long term load cases for which reductions due to bond breakage, concrete creep, etc. should be evaluated.
3. All fire rated assemblies are subject to an upper live load limit of 250 psf.
4. Inquire about material availability of 17, 19 & 21 gage.

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

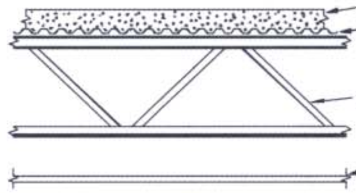
Joist Designation	28K6	28K7	28K8	28K9	28K10	28K12	30K7	30K8	30K9	30K10	30K11	30K12
Depth (In.)	28	28	28	28	28	28	30	30	30	30	30	30
Approx. Wt. (lbs./ft.)	11.4	11.8	12.7	13.0	14.3	17.1	12.3	13.2	13.4	15.0	16.4	17.6
Span (ft.) ↓												
28	548 541	550 543	550 543	550 543	550 543	550 543						
29	511 486	550 522	550 522	550 522	550 522	550 522						
30	477 439	531 486	550 500	550 500	550 500	550 500	550 543	550 543	550 543	550 543	550 543	550 543
31	446 397	497 440	550 480	550 480	550 480	550 480	534 508	550 520	550 520	550 520	550 520	550 520
32	418 361	466 400	515 438	549 463	549 463	549 463	501 461	549 500	549 500	549 500	549 500	549 500
33	393 329	438 364	484 399	527 432	532 435	532 435	471 420	520 460	532 468	532 468	532 468	532 468
34	370 300	412 333	456 364	496 395	516 410	516 410	443 384	490 420	516 441	516 441	516 441	516 441
35	349 275	389 305	430 333	468 361	501 389	501 389	418 351	462 384	501 415	501 415	501 415	501 415
36	330 252	367 280	406 306	442 332	487 366	487 366	395 323	436 353	475 383	487 392	487 392	487 392
37	312 232	348 257	384 282	418 305	474 344	474 344	373 297	413 325	449 352	474 374	474 374	474 374
38	296 214	329 237	364 260	396 282	461 325	461 325	354 274	391 300	426 325	461 353	461 353	461 353
39	280 198	313 219	346 240	376 260	447 306	449 308	336 253	371 277	404 300	449 333	449 333	449 333
40	266 183	297 203	328 222	357 241	424 284	438 291	319 234	353 256	384 278	438 315	438 315	438 315
41	253 170	283 189	312 206	340 224	404 263	427 277	303 217	335 238	365 258	427 300	427 300	427 300
42	241 158	269 175	297 192	324 208	384 245	417 264	289 202	320 221	348 240	413 282	417 284	417 284
43	230 147	257 163	284 179	309 194	367 228	407 252	276 188	305 206	332 223	394 263	407 270	407 270
44	220 137	245 152	271 167	295 181	350 212	398 240	263 176	291 192	317 208	376 245	398 258	398 258
45	210 128	234 142	259 156	282 169	334 198	389 229	251 164	278 179	303 195	359 229	389 246	389 246
46	201 120	224 133	248 146	270 158	320 186	380 219	241 153	266 168	290 182	344 214	380 236	380 236
47	192 112	214 125	237 136	258 148	306 174	372 210	230 144	255 157	277 171	329 201	372 226	372 226
48	184 105	206 117	227 128	247 139	294 163	365 201	221 135	244 148	266 160	315 188	362 215	365 216
49	177 99	197 110	218 120	237 130	282 153	357 193	212 127	234 139	255 150	303 177	347 202	357 207
50	170 93	189 103	209 113	228 123	270 144	350 185	203 119	225 130	245 141	291 166	333 190	350 199
51	163 88	182 97	201 106	219 115	260 136	338 175	195 112	216 123	235 133	279 157	320 179	343 192
52	157 83	175 92	193 100	210 109	250 128	325 165	188 106	208 116	226 126	268 148	308 169	336 184
53	151 78	168 87	186 95	203 103	240 121	313 156	181 100	200 109	218 119	258 140	296 159	330 177
54	145 74	162 82	179 89	195 97	232 114	301 147	174 94	192 103	209 112	249 132	285 150	324 170
55	140 70	156 77	173 85	188 92	223 108	290 139	168 89	185 98	202 106	240 125	275 142	312 161
56	135 66	151 73	166 80	181 87	215 102	280 132	162 84	179 92	195 100	231 118	265 135	301 153
57							156 80	173 88	188 95	223 112	256 128	290 145
58							151 76	167 83	181 90	215 106	247 121	280 137
59							146 72	161 79	175 86	208 101	239 115	271 130
60							141 69	156 75	169 81	201 96	231 109	262 124

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

Joist Designation	24K4	24K5	24K6	24K7	24K8	24K9	24K10	24K12	26K5	26K6	26K7	26K8	26K9	26K10	26K12
Depth (In.)	24	24	24	24	24	24	24	24	26	26	26	26	26	26	26
Approx. Wt. (lbs./ft.)	8.4	9.3	9.7	10.1	11.5	12.0	13.1	16.0	9.8	10.6	10.9	12.1	12.2	13.8	16.6
Span (ft.) ↓															
24	520 516	550 544	550 544	550 544	550 544	550 544	550 544	550 544							
25	479 456	540 511	550 520	550 520	550 520	550 520	550 520	550 520							
26	442 405	499 453	543 493	550 499	550 499	550 499	550 499	550 499	542 535	550 541	550 541	550 541	550 541	550 541	550 541
27	410 361	462 404	503 439	550 479	550 479	550 479	550 479	550 479	502 477	547 519	550 522	550 522	550 522	550 522	550 522
28	381 323	429 362	467 393	521 436	550 456	550 456	550 456	550 456	466 427	508 464	550 501	550 501	550 501	550 501	550 501
29	354 290	400 325	435 354	485 392	536 429	550 436	550 436	550 436	434 384	473 417	527 463	550 479	550 479	550 479	550 479
30	331 262	373 293	406 319	453 353	500 387	544 419	550 422	550 422	405 346	441 377	492 417	544 457	550 459	550 459	550 459
31	310 237	349 266	380 289	424 320	468 350	510 379	550 410	550 410	379 314	413 341	460 378	509 413	550 444	550 444	550 444
32	290 215	327 241	357 262	397 290	439 318	478 344	549 393	549 393	356 285	387 309	432 343	477 375	519 407	549 431	549 431
33	273 196	308 220	335 239	373 265	413 289	449 313	532 368	532 368	334 259	364 282	406 312	448 342	488 370	532 404	532 404
34	257 179	290 201	315 218	351 242	388 264	423 286	502 337	516 344	315 237	343 257	382 285	422 312	459 338	516 378	516 378
35	242 164	273 184	297 200	331 221	366 242	399 262	473 308	501 324	297 217	323 236	360 261	398 286	433 310	501 356	501 356
36	229 150	258 169	281 183	313 203	346 222	377 241	447 283	487 306	280 199	305 216	340 240	376 263	409 284	486 334	487 334
37	216 138	244 155	266 169	296 187	327 205	356 222	423 260	474 290	265 183	289 199	322 221	356 242	387 262	460 308	474 315
38	205 128	231 143	252 156	281 172	310 189	338 204	401 240	461 275	251 169	274 184	305 204	337 223	367 241	436 284	461 299
39	195 118	219 132	239 144	266 159	294 174	320 189	380 222	449 261	238 156	260 170	289 188	320 206	348 223	413 262	449 283
40	185 109	208 122	227 133	253 148	280 161	304 175	361 206	438 247	227 145	247 157	275 174	304 191	331 207	393 243	438 269
41	176 101	198 114	216 124	241 137	266 150	290 162	344 191	427 235	215 134	235 146	262 162	289 177	315 192	374 225	427 256
42	168 94	189 106	206 115	229 127	253 139	276 151	327 177	417 224	205 125	224 136	249 150	275 164	300 178	356 210	417 244
43	160 88	180 98	196 107	219 118	242 130	263 140	312 165	406 213	196 116	213 126	238 140	263 153	286 166	339 195	407 232
44	153 82	172 92	187 100	209 110	231 121	251 131	298 154	387 199	187 108	204 118	227 131	251 143	273 155	324 182	398 222
45	146 76	164 86	179 93	199 103	220 113	240 122	285 144	370 185	179 101	194 110	217 122	240 133	261 145	310 170	389 212
46	139 71	157 80	171 87	191 97	211 106	230 114	272 135	354 174	171 95	186 103	207 114	229 125	250 135	296 159	380 203
47	133 67	150 75	164 82	183 90	202 99	220 107	261 126	339 163	164 89	178 96	199 107	219 117	239 127	284 149	369 192
48	128 63	144 70	157 77	175 85	194 93	211 101	250 118	325 153	157 83	171 90	190 100	210 110	229 119	272 140	353 180
49									150 78	164 85	183 94	202 103	220 112	261 131	339 169
50									144 73	157 80	175 89	194 97	211 105	250 124	325 159
51									139 69	151 75	168 83	186 91	203 99	241 116	313 150
52									133 65	145 71	162 79	179 86	195 93	231 110	301 142

FIRE-RESISTANCE RATINGS WITH STEEL JOISTS

FLOOR-CEILING ASSEMBLIES WITH MEMBRANE PROTECTION



Restrained Assembly Rating	Type of Protection System	Concrete: Thickness Above Deck	Concrete: Type	Minimum Joist Size See Note #3 & #4	Maximum Joist Spacing See Note #2	Primary Support Member Min. Depth & Wt. See Note #3	U. L. Design Number
1 Hr.	Exposed Grid	2 1/2"	NW	10K1	72"	20G @14.0 plf. Min. Area Top & Bottom Chord 1.12 Sq. Inch	G256
			LW, NW	12K1, 18LH02	Unrestricted	---	D216
1 1/2 Hr.	Exposed Grid	2 1/2"	NW	10K1	48"	20G @13.0 plf.	G228
		2"	NW	10K1	48"	20G @13.0 plf.	G229
		2 1/2"	NW	10K1	48"	20G @13.0 plf.	G243
	Gypsum Brd.	2"	LW, NW	12K1	48"	----	G502
	Cementitious	2 1/2"	LW, NW	16K6 Min. 3/4" dia. web	Unrestricted	20G @20.0 plf.	G701
	Sprayed Fiber	2 1/2"	LW, NW	16K6 Min. 3/4" dia. web	Unrestricted	20G @20.0 plf.	G801
2 Hr.	Concealed Grid	2 1/4"	NW	10K1	48"	20G @13.0 plf.	G023
		2 1/2"	NW	8K1, 10K1	48"	20G @13.0 plf.	G031
		2 1/2"	NW	10K1	48"	20G @13.0 plf.	G036
	Exposed Grid	2 1/2"	NW	10K1	48"	W6x12	G213
			NW	10K1	48"	W8x31	G227
			NW	10K1	48"	20G @13.0 plf.	G228
			NW	10K1	48"	20G @13.0 plf.	G243
			NW	10K1	72"	20G @14.0 plf. Min. Area Top & Bottom Chord 1.12 Sq. inch	G256
			LW, NW	12K1, 18LH02	Unrestricted	----	D216
	Gypsum Board	2"	NW	10K1	48"	----	G505
		2 1/2"	NW	10K1	48"	20G @14.0 plf. Min. Area Top & Bottom Chord 1.12 Sq. inch	G514
			NW	10K1	48"	20G @ 13.0 plf.	G253
			LW,NW	10K1	48"	20G @ 13.0 plf.	G529
			NW	12K1	Unrestricted	20G @ 20.0 plf.	D502
	Cementitious	2 1/2"	LW, NW	16K6 Min. 3/4" dia. web	Unrestricted	20G @ 20.0 plf.	D701
	Sprayed Fiber	2 1/2"	LW, NW	16K6 Min.3/4" dia. web	Unrestricted	20G @ 20.0 plf.	D801
3 Hr.	Concealed Grid	3 1/2"	NW	10K1	48"	20G @ 13.0 plf.	G033
		3 1/2"	NW	10K1	48"	20G @ 13.0 plf.	G036
	Exposed Grid	3 1/2"	NW	10K1	48"	W6x12	G213
		3 1/2"	NW	10K1	48"	20G @ 13.0 plf.	G229
		3 1/2"	NW	10K1	48"	20G @14.0 plf. Min. Area Top & Bottom Chord 1.12 Sq. inch	G256
			NW	12K1, 18LH02	Unrestricted	----	D216
	Gypsum Board	3"	NW	10K1	48"	20 G @ 13.0 plf.	G523
		2 3/4"	LW, NW	10K1	48"	20 G @ 13.0 plf	G529

Appendix Section 2:
Two-Way Concrete Slab System

f'_c = 3,000 psi Grade 60 Bars		FLAT SLAB SYSTEM				SQUARE EDGE PANEL With Drop Panels						No Beams			SQUARE INTERIOR PANEL With Drop Panels (2)						No Beams		
SPAN	Factored Superimposed	Square Drop Panel		Square Column ℓ_c = 12'-0" (3)		REINFORCING BARS (E. W.)						MOMENTS			Factored Superimposed	Square Column ℓ_c = 12'-0" (3)		REINFORCING BARS (E. W.)					Concrete
c.-c.						Column Strip (1)			Middle Strip		Total							Col. Strip		Mid. Strip		Total	
$\ell_1 = \ell_2$ (ft)	posed Load (psf)	Depth (in.)	Width (ft)	Size (in.)	α_{ec}	Top Ext.	Bot.	Top Int.	Bot.	Top Int.	Steel (psf)	Edge (−) (ft-k)	Bot. (+) (ft-k)	Int. (−) (ft-k)	Load (psf)	Size (in.)	α_{ec}	Top	Bot.	Top	Bot.	Steel (psf)	(cu. ft / sq. ft)
h = 11 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS (CONTINUED)															h = 11 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS (CONTINUED)								
30	100	7	10.00	12	0.145	14-#5	11-#8	17-#6	10-#7	10-#6	3.40	77.1	555.7	689.2	100	12	0.072	15-#6	11-#6	12-#5	12-#5	2.77	0.981
30	200	7	10.00	15	0.305	14-#5	14-#8	16-#7	12-#7	10-#7	4.19	185.1	687.2	884.5	200	18	0.262	14-#7	20-#5	11-#6	13-#5	3.40	0.981
30	300	11	10.00	18	0.514	14-#5	22-#7	16-#7	11-#8	15-#6	4.92	331.1	801.9	1073.5	300	22	0.453	14-#7	10-#8	10-#7	16-#5	4.09	1.018
30	400	11	12.00	27	1.529	18-#6	22-#7	14-#8	11-#8	10-#8	5.49	687.4	805.8	1206.1	400	25	0.615	22-#6	17-#7	12-#7	14-#6	4.92	1.063
31	100	9	10.33	12	0.137	14-#5	16-#7	23-#5	14-#6	15-#5	3.42	81.3	618.7	765.8	100	12	0.068	15-#6	17-#5	13-#5	12-#5	2.75	1.000
31	200	9	10.33	16	0.358	14-#5	20-#7	16-#7	13-#7	19-#5	4.34	230.9	749.3	974.9	200	18	0.255	14-#7	22-#5	12-#6	15-#5	3.55	1.000
31	300	11	10.33	18	0.505	14-#5	18-#8	14-#8	12-#8	13-#7	5.25	362.5	890.1	1189.8	300	22	0.443	16-#7	15-#7	15-#6	18-#5	4.44	1.018
32	100	9	10.66	12	0.135	15-#5	14-#8	18-#6	12-#7	12-#6	3.74	88.7	682.4	844.3	100	12	0.067	16-#6	19-#5	15-#5	13-#5	2.93	1.000
32	200	9	10.66	16	0.352	15-#5	17-#8	18-#7	11-#8	15-#6	4.70	251.7	828.0	1076.1	200	18	0.251	16-#7	13-#7	19-#5	16-#5	3.88	1.000
32	300	11	10.66	18	0.496	15-#5	20-#8	15-#8	13-#8	11-#8	5.61	395.5	984.6	1314.2	300	22	0.433	17-#7	22-#6	13-#7	20-#5	4.69	1.018
h = 11½ in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS															h = 11½ in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS								
24	100	3	8.00	12	0.160	11-#5	9-#6	11-#6	10-#5	10-#5	2.60	43.1	284.2	353.8	100	12	0.080	14-#5	10-#5	10-#5	10-#5	2.48	0.986
24	200	3	8.00	15	0.333	11-#5	11-#6	14-#6	8-#6	10-#5	2.93	100.8	347.6	450.0	200	17	0.252	18-#5	10-#5	10-#5	10-#5	2.70	0.986
24	300	5	8.00	18	0.581	11-#5	13-#6	11-#7	12-#5	10-#5	3.18	180.7	398.6	539.4	300	21	0.471	13-#6	12-#5	10-#5	10-#5	2.90	1.004
24	400	7	8.00	20	0.777	11-#5	11-#7	11-#7	10-#6	12-#5	3.55	254.3	453.8	631.6	400	23	0.597	14-#6	14-#5	8-#6	10-#5	3.16	1.023
24	500	7	8.00	21	0.906	14-#5	10-#8	13-#7	16-#5	10-#6	4.25	319.6	523.7	726.6	500	24	0.675	12-#7	9-#7	9-#6	8-#6	3.81	1.023
24	600	9	9.60	23	1.073	11-#6	16-#7	13-#7	8-#8	11-#6	4.84	396.6	644.8	823.1	600	24	0.613	12-#7	15-#6	10-#6	10-#6	4.25	1.078
24	700	11	9.60	24	1.179	12-#6	20-#7	13-#7	12-#7	8-#8	5.70	465.0	746.4	919.9	700	24	0.589	12-#7	14-#7	16-#5	9-#7	4.97	1.105
25	100	3	8.33	12	0.157	12-#5	15-#5	18-#5	11-#5	11-#5	2.78	48.2	322.6	401.4	100	12	0.078	16-#5	11-#5	11-#5	11-#5	2.66	0.986
25	200	3	8.33	15	0.326	12-#5	13-#6	12-#7	12-#5	11-#5	3.14	112.3	394.1	509.5	200	18	0.294	14-#6	11-#5	11-#5	11-#5	2.88	0.986
25	300	5	8.33	18	0.568	12-#5	11-#7	13-#7	10-#6	12-#5	3.53	202.5	454.5	613.8	300	21	0.458	15-#6	14-#5	11-#5	11-#5	3.16	1.004
25	400	7	8.33	20	0.759	13-#5	17-#6	13-#7	11-#6	10-#6	3.85	285.4	518.0	719.2	400	23	0.580	12-#7	16-#5	12-#5	11-#5	3.42	1.023
25	500	9	8.33	21	0.849	14-#5	11-#8	13-#7	10-#7	11-#6	4.36	350.5	588.8	826.8	500	25	0.716	12-#7	13-#6	10-#6	12-#5	3.79	1.041
25	600	9	10.00	23	1.045	18-#5	14-#8	12-#8	9-#8	10-#7	5.31	444.3	707.1	934.5	600	25	0.675	18-#6	10-#8	16-#5	15-#5	4.59	1.078
25	700	11	10.00	24	1.149	13-#6	22-#7	12-#8	15-#7	14-#6	6.18	521.3	824.5	1044.5	700	25	0.653	26-#5	15-#7	10-#7	10-#7	5.34	1.105
26	100	5	8.66	12	0.147	12-#5	9-#7	12-#6	11-#5	11-#5	2.75	51.6	366.7	455.1	100	12	0.073	15-#5	11-#5	11-#5	11-#5	2.52	1.004
26	200	5	8.66	15	0.311	12-#5	11-#7	12-#7	10-#6	11-#5	3.28	122.9	448.3	577.9	200	18	0.278	14-#6	9-#6	11-#5	11-#5	2.90	1.004
26	300	7	8.66	18	0.532	12-#5	17-#6	23-#5	11-#6	13-#5	3.56	220.2	519.0	696.9	300	21	0.431	15-#6	15-#5	12-#5	11-#5	3.13	1.023
26	400	9	8.66	20	0.716	12-#5	11-#8	13-#7	10-#7	15-#5	4.11	311.7	589.7	813.9	400	24	0.620	12-#7	18-#5	10-#6	12-#5	3.55	1.041
26	500	9	8.66	21	0.829	16-#5	17-#7	12-#8	11-#7	10-#7	4.83	391.7	668.9	936.9	500	25	0.697	18-#6	11-#7	16-#5	10-#6	4.18	1.041
26	600	11	10.39	23	0.979	12-#6	20-#7	12-#8	10-#8	11-#7	5.48	486.2	788.3	1059.3	600	26	0.716	26-#5	18-#6	10-#7	9-#7	4.75	1.105

(Continued)

NOTES (1) 50 per cent of these bars may be placed in the middle third of column strip. (2) Drop panels same size as for edge panels. (3) Same column size and height above and below slab.

f'_c = 3,000 psi Grade 60 Bars — FLAT SLAB SYSTEM

SQUARE EDGE PANEL With Drop Panels — No Beams

h = 12 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS

SPAN c.-c. $\ell_1 = \ell_2$ (ft)	Factored Superimposed Load (psf)	Square Drop Panel Depth (in.)	Square Drop Panel Width (ft)	Square Column ℓ_c = 12'-0" (3) Size (in.)	α_{ec}	Column Strip (1) Top Ext.	Column Strip Bot.	Column Strip Top Int.	Middle Strip Bot.	Middle Strip Top Int.	Total Steel (psf)	Moments Edge (−) (ft-k)	Moments Bot. (+) (ft-k)	Moments Int. (−) (ft-k)
25	100	3	8.33	12	0.144	12-#5	10-#6	18-#5	11-#5	11-#5	2.76	45.8	333.6	413.6
25	200	3	8.33	15	0.298	12-#5	13-#6	12-#7	12-#5	11-#5	3.13	107.6	407.4	523.6
25	300	5	8.33	18	0.525	12-#5	11-#7	12-#7	13-#5	11-#5	3.41	195.8	466.8	626.0
25	400	7	8.33	20	0.705	12-#5	12-#7	13-#7	15-#5	13-#5	3.69	276.4	528.8	728.8
25	500	9	8.33	22	0.916	14-#5	11-#8	13-#7	9-#7	15-#5	4.29	368.2	591.0	831.8
25	600	9	10.00	23	0.976	12-#6	19-#7	12-#8	11-#7	9-#7	5.20	434.1	730.7	946.9
25	700	11	10.00	25	1.222	19-#5	20-#7	12-#8	10-#8	10-#7	5.84	539.3	829.6	1048.4
26	100	3	8.66	12	0.141	12-#5	16-#5	14-#6	11-#5	11-#5	2.75	51.1	376.7	466.9
26	200	5	8.66	15	0.288	12-#5	14-#6	12-#7	13-#5	11-#5	3.13	118.2	461.2	591.5
26	300	5	8.66	18	0.513	12-#5	12-#7	26-#5	15-#5	9-#6	3.63	218.2	529.3	708.5
26	400	7	8.66	20	0.689	13-#5	11-#8	14-#7	9-#7	15-#5	4.07	308.6	600.3	825.5
26	500	9	8.66	22	0.894	16-#5	12-#8	12-#8	10-#7	9-#7	4.53	410.1	665.4	939.4
26	600	11	10.39	24	1.047	18-#5	20-#7	12-#8	10-#8	10-#7	5.39	506.4	797.6	1064.4
26	700	11	10.39	25	1.191	15-#6	17-#8	22-#6	15-#7	15-#6	6.16	601.8	909.6	1184.6
27	100	5	9.00	12	0.133	12-#5	18-#5	14-#6	12-#5	12-#5	2.83	54.5	426.0	526.7
27	200	5	9.00	15	0.283	12-#5	9-#8	13-#7	15-#5	12-#5	3.41	131.2	519.5	665.5
27	300	7	9.00	18	0.487	12-#5	11-#8	26-#5	9-#7	10-#6	3.87	236.8	598.5	797.6
27	400	9	9.00	20	0.656	13-#5	12-#8	27-#5	14-#6	9-#7	4.29	338.2	681.4	932.7
27	500	11	9.00	22	0.858	16-#5	19-#7	12-#8	9-#8	10-#7	4.98	452.8	755.1	1061.5
27	600	11	10.80	24	1.022	14-#6	16-#8	22-#6	10-#8	9-#8	5.60	562.1	860.9	1196.8
28	100	5	9.33	12	0.131	13-#5	11-#7	16-#6	10-#6	12-#5	3.04	60.3	476.7	589.2
28	200	5	9.33	15	0.278	13-#5	18-#6	16-#7	12-#6	13-#5	3.57	144.9	582.4	745.4
28	300	7	9.33	18	0.477	13-#5	12-#8	16-#7	10-#7	16-#5	4.05	261.8	672.3	894.3
28	400	9	9.33	20	0.642	15-#5	14-#8	16-#7	12-#7	10-#7	4.81	374.4	766.1	1046.5
28	500	11	11.20	23	0.870	18-#5	16-#8	22-#6	10-#8	15-#6	5.24	511.8	845.1	1189.8
29	100	7	9.66	12	0.123	13-#5	17-#6	15-#6	15-#5	13-#5	3.10	63.5	534.6	659.3
29	200	7	9.66	15	0.264	13-#5	15-#7	19-#6	10-#7	15-#5	3.76	155.7	653.8	834.3
29	300	9	9.66	19	0.542	13-#5	13-#8	15-#7	15-#6	10-#7	4.26	317.5	738.3	992.9
29	400	11	9.66	20	0.624	14-#5	16-#8	16-#7	10-#8	11-#7	5.04	411.4	859.9	1171.3
29	500	11	11.60	23	0.851	14-#6	23-#7	14-#8	11-#8	10-#8	5.72	565.1	947.2	1330.5
30	100	7	10.00	12	0.121	14-#5	11-#8	17-#6	12-#6	13-#5	3.33	69.8	593.6	731.8
30	200	7	10.00	15	0.260	14-#5	13-#8	16-#7	11-#7	12-#6	3.99	170.9	727.2	927.0
30	300	9	10.00	19	0.532	14-#5	20-#7	17-#7	10-#8	14-#6	4.70	348.6	822.7	1104.6
30	400	11	10.00	20	0.612	1-6#5	23-#7	14-#8	12-#8	13-#7	5.34	452.1	958.6	1303.5

SQUARE INTERIOR PANEL With Drop Panels (2) — No Beams

h = 12 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS

SPAN c.-c. $\ell_1 = \ell_2$ (ft)	Factored Superimposed Load (psf)	Square Column ℓ_c = 12'-0" (3) Size (in.)	α_{ec}	Col. Strip Top	Col. Strip Bot.	Mid. Strip Top	Mid. Strip Bot.	Total Steel (psf)	Concrete (cu. ft / sq. ft)
25	100	12	0.072	16-#5	11-#5	11-#5	11-#5	2.66	1.027
25	200	17	0.227	14-#6	11-#5	11-#5	11-#5	2.87	1.027
25	300	21	0.427	15-#6	13-#5	11-#5	11-#5	3.10	1.046
25	400	24	0.616	15-#6	15-#5	12-#5	11-#5	3.28	1.064
25	500	25	0.674	12-#7	13-#6	10-#6	12-#5	3.79	1.083
25	600	25	0.634	18-#6	9-#8	11-#6	15-#5	4.42	1.120
25	700	25	0.611	18-#6	11-#8	10-#7	10-#7	5.22	1.146
26	100	12	0.070	17-#5	11-#5	11-#5	11-#5	2.60	1.027
26	200	18	0.257	14-#6	12-#5	11-#5	11-#5	2.82	1.046
26	300	21	0.417	13-#7	15-#5	12-#5	11-#5	3.31	1.046
26	400	24	0.600	13-#7	17-#5	13-#5	12-#5	3.54	1.064
26	500	26	0.733	13-#7	14-#6	15-#5	13-#5	3.94	1.083
26	600	26	0.672	18-#6	10-#8	10-#7	16-#5	4.60	1.146
26	700	26	0.672	12-#8	12-#8	14-#6	10-#7	5.40	1.146
27	100	12	0.066	12-#6	12-#5	12-#5	12-#5	2.65	1.046
27	200	18	0.251	12-#7	14-#5	12-#5	12-#5	3.06	1.046
27	300	22	0.453	12-#7	9-#7	9-#6	12-#5	3.38	1.064
27	400	24	0.568	13-#7	14-#6	15-#5	9-#6	3.77	1.083
27	500	26	0.698	18-#6	12-#7	9-#7	15-#5	4.25	1.101
27	600	27	0.733	12-#8	11-#8	14-#6	18-#5	4.94	1.146
28	100	12	0.065	14-#6	12-#5	12-#5	12-#5	2.67	1.046
28	200	18	0.246	13-#7	15-#5	12-#5	12-#5	3.10	1.046
28	300	22	0.442	26-#5	13-#6	10-#6	12-#5	3.44	1.064
28	400	24	0.554	15-#7	12-#7	12-#6	15-#5	4.22	1.083
28	500	27	0.714	15-#7	18-#6	14-#6	12-#6	4.54	1.146
29	100	12	0.061	13-#6	13-#5	13-#5	13-#5	2.69	1.064
29	200	18	0.234	13-#7	12-#6	13-#5	13-#5	3.24	1.064
29	300	22	0.417	26-#5	11-#7	16-#5	10-#6	3.70	1.083
29	400	24	0.526	15-#7	10-#8	10-#7	16-#5	4.35	1.101
29	500	27	0.696	13-#8	12-#8	12-#7	10-#7	5.07	1.146
30	100	12	0.060	15-#6	15-#5	13-#5	13-#5	2.81	1.064
30	200	18	0.230	14-#7	19-#5	15-#5	13-#5	3.32	1.064
30	300	22	0.408	15-#7	17-#6	10-#7	15-#5	4.01	1.083
30	400	24	0.514	16-#7	15-#7	11-#7	18-#5	4.61	1.101

(Continued)

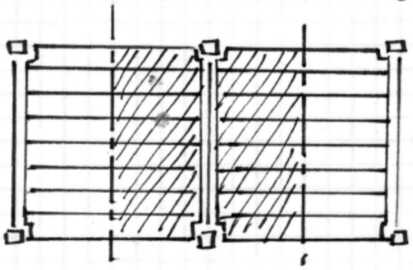
NOTES (1) 50 per cent of these bars may be placed in the middle third of column strip. (2) Drop panels same size as for edge panels. (3) Same column size and height above and below slab.

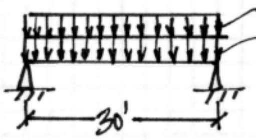
Appendix Section 3:
Pre-Cast Concrete Plank System Supported with Steel Framing and Supported with Pre-Cast Framing

CLASS: AE 481 W
DATE: 10-27-06
ASSIGNMENT: TECH REPORT # 2
PRECAST PLANK SYSTEM.
PAGE: ____ of ____

PENN STATE UNIVERSITY

PRECAST PLANK ON STEEL FRAMING TO REPLACE 30'x30' BAY - GIRDER.





$V = \frac{wl}{2} = \frac{(6.3\,klf)(30')}{2} = 94.5\ k$

$M = \frac{wl^2}{8} = \frac{(6.3\,klf)(30')^2}{8} = 708.8\ 'k$

Δ : Δ_T CONTROLS $\frac{5wL^4}{384EI} \le \frac{L}{240}$

$\frac{(5)(6.3\,klf)(30')^4(1728)}{(384)(29000\,ksi)\,I} \le \frac{(30')(12''/')}{240}$ $I \ge 2639\ in^4$

[TABLE 3-3] AISC 13th

TRY W27x84 $I_x = 2850\ in^4 \ge 2639\ in^4$ OK

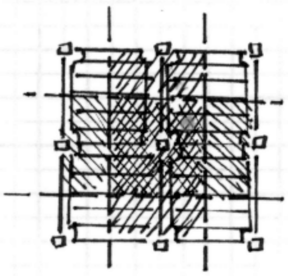
[TABLE 3-10] & [TABLE 3-6]

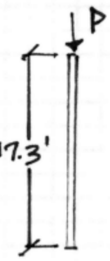
TRY W27x84 FAILS.

TRY W30x99 $M = 208'k \ge (30')(6.3\,klf) = 189k$ OK

USE W30x99 GIRDER.

PRECAST PLANK ON STEEL FRAMING TO REPLACE 30'x30' BAY - COLUMN.





$P = (30')(30')(100\ psf\ LL + 110\ psf\ DL)$
$= 189\ k\ /\ FLOOR.$
$= (30')(30')(20\ psf\ LL + 20\ psf\ DL)$
$= 36\ k\ /\ ROOF$
$\Sigma P = 36k + (4)(189k) = 792\ k$

ALLOWABLE COMPRESSION =
$(0.6)(46\ ksi) = 27.6\ ksi$ ← CONTROLS.
$(0.5)(58\ ksi) = 29\ ksi$

$A_{RQD} = \frac{P}{\sigma} = \frac{189k}{27.6k} = 6.85\ in^2$

$\frac{P}{\sigma} = \frac{792k}{27.6k} = 28.7\ in^2$

[TABLE 4-4], [TABLE 4-3] AISC 13th.

TRY HSS 14x14x5/8" $A = 30.3\ in^2 \geq 28.7\ in^2$ OK
$P = 756\ k \not\geq 792\ k$ FAILS.

TRY HSS. 20x12x5/8" $A = 35.0\ in^2 \geq 28.7\ in^2$ OK
$P = 854\ k \geq 792\ k$ OK

ALLOWABLE COMPRESSION =
$(0.6)(50\ ksi) = 30\ ksi$ ← CONTROLS.
$(0.5)(65\ ksi) = 32.5\ ksi$

$A_{RQD} = \frac{P}{\sigma} = \frac{792k}{30k} = 26.4\ in^2$

[TABLE 4-1]

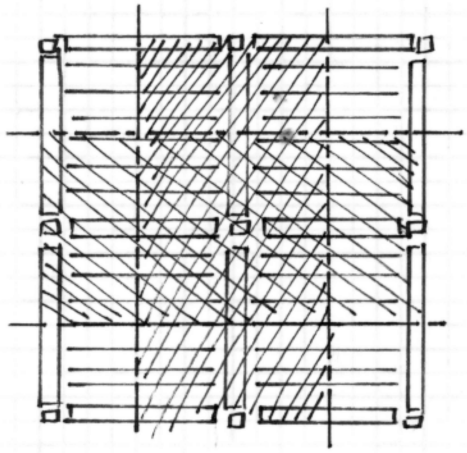
TRY W14x120 $A = 35.3\ in^2 \geq 26.4\ in^2$ OK $d = 14.5"$
$P = 820\ k \geq 792\ k$ OK $b = 14.7"$

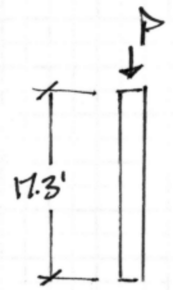
USE W14x120 COLUMN.

PENN STATE UNIVERSITY

CLASS: AE 481W
DATE: 10-27-06
ASSIGNMENT: TECH REPORT #2.
PRE-CAST PLANK SYSTEM
PAGE: ___ of ___

PRE-CAST PLANK SYSTEM SUPPORTED BY PRECAST GIRDER/ COLUMN.





$P = (30')(30')(100\,psf\,LL + 145\,psf\,DL)$
$= 221\,k/FLOOR$
$= (30')(30')(20\,psf\,LL + 20\,psf\,DL)$
$= 36\,k/ROOF$
$\Sigma P = 36k + (4)(221k) = 920\,k$

$P = \frac{\sigma}{A}$ $\quad A = \frac{P}{\sigma} = \frac{920k}{4\,ksi} = 230\,in^2 \rightarrow$ 16"x16" COLUMN.

M

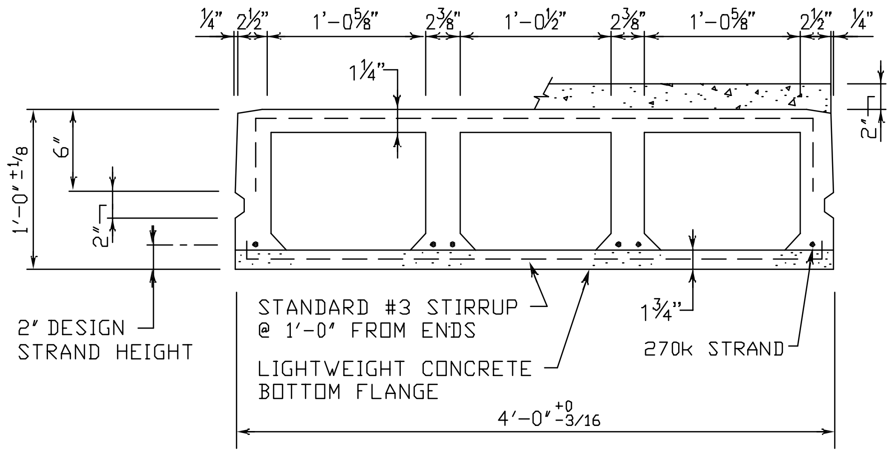
USE 18"x18" COLUMN FOR COMPRESSION.

Prestressed Concrete
12"x4' SpanDeck–U.L.–J952
(2" C.I.P. TOPPING)

PHYSICAL PROPERTIES

Composite

A' = 312 in.^{2}	S'_b = 826 in.^{3}
I' = 6542 in.^{4}	S'_t = 1602 in.^{3} (At Top of SpanDeck)
Y'_b = 7.92 in.	S'_{tt} = 1076 in.^{3} (At Top of Topping)
Y'_t = 4.08 in. (To Top of SpanDeck)	Wt. = 410 PLF
Y'_{tt} = 6.08 in. (To Top of Topping)	Wt. = 102.5 PSF



12" 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, 270 K 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 = 139.7'K
   6 – 1/2"ø, 270K = 198.7'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 determing allowable loads in this table.
14. All values in this table are based on ultimate strength and are not governed by service stress.
15. All loads shown refer to allowable loads applied after the topping has hardened.

12" SPANDECK W/2" TOPPING	ALLOWABLE SUPERIMPOSED LOAD (PSF)																						
STRAND PATTERN	SPAN (FEET)																						
	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Flexure 4 – 1/2"ø	422	370	326	288	255	226	200	179	159	140	125	111	98	86	76	66	60						
Shear 4 – 1/2"ø	409	381	357	335	315	294	266	242	221	201	184	171	162	152	139	127	115						
Flexure 6 – 1/2"ø	636	562	499	445	398	357	321	289	261	236	213	193	175	158	144	130	117	106	95	86	77	69	61
Shear 6 – 1/2"ø	423	395	370	348	327	308	292	276	261	248	236	221	202	186	172	158	146	134	124	115	110	105	98

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.

2655 MOLLY PITCHER HWY. SOUTH, BOX N
CHAMBERSBURG, PA 17201-0813
717-267-4505 • FAX: 717-267-4518

REVISED 12/93

HIGH CONCRETE STRUCTURES, INC.

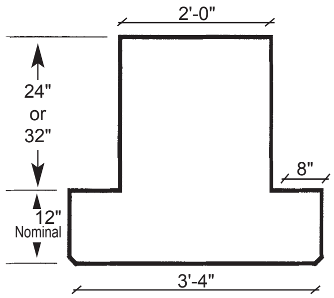
A Division of High Industries, Inc.

INVERTED TEE BEAMS

Strand Pattern Designation

108 - S

- No. of Stands (10)
- S = Straight
- Diameter of Strand in 16ths



Concrete:
f'_c = 7500 psi
Strand: 1/2" dia. low relaxation, 270ksi, special, A = 0.167 in^2

Loads shown are in addition to a dead load of 5000 plf for tee weight. (5000 plf is equivalent to 2-60'-0" bays of 34" deep tees)

24IT36

Normal Weight

Live load capacity in pounds per lineal foot (plf)

Strand Pattern	e	DESIGN SPAN (Ft.)														
		22	24	26	28	30	32	34	36	38	40	42	44	46	48	50
148–S	**11.75**	7799	5752	4160	2896	1876	1042									
188–S	**11.96**			6717	5101	3797	2730	1846	1105							
228–S	**11.86**				7152	5584	4301	3237	2346	1596	948					
268–S	**11.72**					7292	5802	4567	3533	2657	1909	1266	708			
308–S	**11.62**						7259	5858	4684	3690	2842	2112	1480	928		
348–S	**11.54**							7108	5799	4692	3746	2932	2227	1544	922	
388–S	**11.38**								6837	5554	4442	3466	2617	1876	1226	653
428–S	**11.18**								6986	5672	4550	3584	2747	1998	1339	756

Section Properties
A = 1041 in.^{2}
I = 114,588 in.^{4}
Y_b = 15.7 in.
Y_t = 19.93 in.
Z_b = 7299 in.^{3}
Z_t = 5750 in.^{3}
wt = 1084 plf
V/S = 6.91 in.

24IT44

Normal Weight

Live load capacity in pounds per lineal foot (plf)

Strand Pattern	e	DESIGN SPAN (Ft.)																	
		26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60
148–S	**15.45**	7558	5804	4389	3231	2271	1467	786	205										
188–S	**15.66**			7059	5577	4350	3321	2450	1707	1067	512								
228–S	**15.56**				7791	6310	5070	4020	3123	2352	1683	1100	588						
268–S	**15.42**						6756	5534	4490	3591	2813	2134	1537	1011	545				
308–S	**15.32**							7010	5822	4800	3914	3141	2463	1865	1334	861	438		
348–S	**15.24**								7120	5978	4987	4123	3365	2696	2103	1574	1081	582	
388–S	**15.08**									7092	6003	5053	4219	3483	2831	2230	1632	1096	612
428–S	**14.88**										6815	5726	4771	3927	3159	2473	1858	1307	809

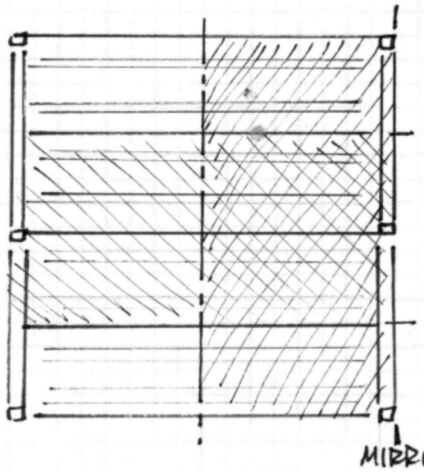
Section Properties
A = 1233 in.^{2}
I = 208,672 in.^{4}
Y_b = 19.4 in.
Y_t = 24.6 in.
Z_b = 10,756 in.^{3}
Z_t = 8483 in.^{3}
wt = 1284 plf
V/S = 7.39 in.

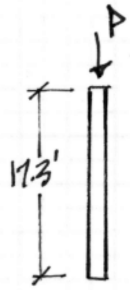
Appendix Section 4:
Pre-Cast Double-Tee System

PENN STATE UNIVERSITY

CLASS: AE 481 W
DATE: 10-27-06
ASSIGNMENT: TECH REPORT #2
PRECAST DOUBLE TEE SYSTEM.
PAGE: ____ of ____

PRECAST DOUBLE TEE SYSTEM.





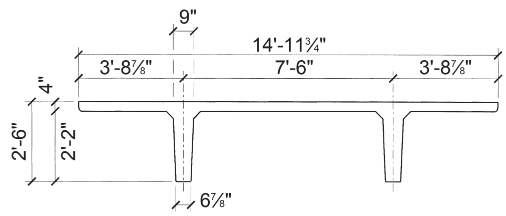
$P = (30')(30')(100\ psf\ LL + 100\ psf\ DL)$
$= 180\ k/FLOOR.$
$= (30')(30')(20\ psf + 20\ psf)$
$= 36\ k/FLOOR.$
$\Sigma P = 36k + (4)(180k) = 756\ k.$

$A = \frac{P}{\sigma} = \frac{756k}{4ksi} = 189\ in^2 \rightarrow 14" \times 14"$

* NOTE: THIS IS ONLY FOR ONE BAY OF DOUBLE-TEES AS THEY SPAN TWICE THE ORIGINAL & LOCATE AS SUCH IN THE BUILDING.

USE 16"x16" COLUMNS FOR COMPRESSION.

These are standard load tables for uniformly loaded simple spans. These tables are for guidance only. Individual designs may be furnished for unusual loading conditions, changes in cross-section, low camber requirements, etc.



Concrete:
f'_c = 6000 psi
w_c = 150 pcf
Strand: ½" dia. low relaxation, 270ksi special, A = 0.167 in^2

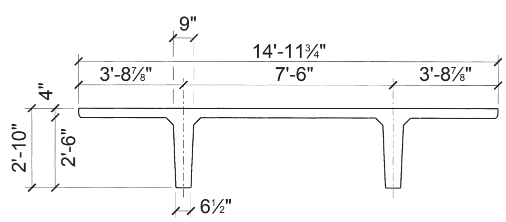
15DT30

Live load capacity in pounds per square foot (psf)

Strand Pattern	e_e	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
		DESIGN SPAN (FT)																				
88-S	16.64	158	144	131	119	109	99	90	82	74	67	61	54	49	44	39	34	30	26	22		
128-S	17.51			238	220	203	188	175	162	150	139	129	120	111	103	95	88	82	76	70	64	59
168-S	17.51							253	236	220	206	192	180	168	158	148	138	130	121	114	107	100
208-S	17.16																				145	137
248-S	16.64																					

Section Properties
A = 1132 $in.^2$
I = 78,349 $in.^4$
Y_b = 22.76 in.
Y_t = 7.24 in.
S_b = 3442 $in.^3$
S_t = 10,822 $in.^3$
wt = 1179 plf
79 psf
V/S = 2.42 in.

Strand Pattern	e_e	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70
		DESIGN SPAN (FT)																			
88-S	16.64																				
128-S	17.51	54	50	46	42	38	34	31	27	24	21										
168-S	17.51	93	87	82	76	71	66	62	57	53	49	46	42	39	36	33	30	27	24	22	
208-S	17.16	129	122	115	108	102	96	90	85	80	75	71	66	62	58	54	51	47	44	41	38
248-S	16.64										99	93	88	83	79	74	70	66	62	59	55



Concrete:
f'_c = 6000 psi
w_c = 150 pcf
Strand: ½" dia. low relaxation, 270ksi special, A = 0.167 in^2

15DT34

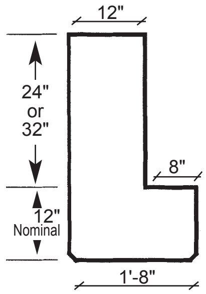
Live load capacity in pounds per square foot (psf)

Strand Pattern	e_e	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
		DESIGN SPAN (FT)																				
88-S	18.65	184	168	154	141	129	117	107	98	89	81	74	67	61	55	49	44	39	35	31	27	23
128-S	19.82				257	238	221	205	190	177	165	153	143	133	123	115	107	99	92	86	79	74
168-S	19.96										242	227	213	200	187	176	165	155	146	137	129	121
208-S	19.70																	207	195	184	174	165
248-S	19.23																					

Section Properties
A = 1185 $in.^2$
I = 109,621 $in.^4$
Y_b = 25.65 in.
Y_t = 8.35 in.
S_b = 4274 $in.^3$
S_t = 13,128 $in.^3$
wt = 1234 plf
82 psf
V/S = 2.45 in.

Strand Pattern	e_e	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70
		DESIGN SPAN (FT)																			
88-S	18.65																				
128-S	19.82	68	63	58	53	49	45	41	37	34	30	27	24	21							
168-S	19.96	114	107	100	94	88	83	77	72	68	63	59	55	51	47	44	41	37	34	31	28
208-S	19.70	156	147	139	132	124	118	111	105	99	94	88	83	79	74	70	66	62	58	54	51
248-S	19.23									128	122	116	110	104	99	94	89	84	80	76	71

These are standard load tables for uniformly loaded simple spans. These tables are for guidance only. Individual designs may be furnished for unusual loading conditions, changes in cross-section, low camber requirements, etc.



Concrete:
f'_c = 7500 psi
Strand: 1/2" dia. low relaxation, 270ksi, special, A = 0.167 in^2

L BEAMS

Normally Use 23.5" Wide Stem

Loads shown are in addition to a dead load of 2500 plf for tee weight. (2500 plf is equivalent to A-60'-0" bay of 34" deep tees)

12LB36

Normal Weight

Live load capacity in pounds per lineal foot (plf)

Strand Pattern	e	DESIGN SPAN (Ft.)									
		20	22	24	26	28	30	32	34	36	38
78–S	**12.76**	5989	4514	3392	2519	1826	1268	810	431		
98–S	**12.32**	7996	6173	4787	3708	2852	2161	1596	1127	734	402
118–S	**12.03**		7731	6096	4824	3814	3000	2333	1781	1318	926
138–S	**11.84**			7316	5864	4712	3782	3021	2391	1862	1415
168–S	**11.39**				6878	5585	4542	3688	2980	2387	1885
188–S	**11.09**				6706	5436	4412	3574	2879	2297	1804
218–S	**10.76**				6511	5268	4266	3445	2765	2195	1713

Section Properties

A	=	504 in.^{2}
I	=	56,406 in.^{4}
Y_b	=	16.28 in.
Y_t	=	19.71 in.
Z_b	=	3465 in.^{3}
Z_t	=	2862 in.^{3}
wt	=	525 plf
V/S	=	4.67 in.

12LB44

Normal Weight

Live load capacity in pounds per lineal foot (plf)

Strand Pattern	e	DESIGN SPAN (Ft.)									
			22	24	26	28	30	32	34	36	38
78–S	**16.49**		6278	4861	3759	2885	2179	1602	1124	723	383
98–S	**16.05**			6701	5327	4236	3357	2637	2040	1540	1117
118–S	**15.76**				6823	5527	4481	3625	2916	2322	1819
138–S	**15.57**					6755	5551	4566	3750	3065	2486
168–S	**15.11**						6977	5820	4861	4058	3378
188–S	**14.82**						7826	6567	5524	4649	3909
218–S	**14.49**							6836	5760	4858	4095

Section Properties

A	=	600 in.^{2}
I	=	102,268 in.^{4}
Y_b	=	20.08 in.
Y_t	=	23.92 in.
Z_b	=	5093 in.^{3}
Z_t	=	4275 in.^{3}
wt	=	625 plf
V/S	=	4.84 in.

Lauren Wilke
Structural Option
Advisor: M.K. Parfitt

Boyds Bear Country
Pigeon Forge, TN

Appendix Section 5:
Wooden Framing System

TrussJoist Allowable Uniform Load Table
7" 2.2E Parallam ® PSL Commercial Beams – Typical 30' Beam Design at 4' O.C.

Depth	20"		22"		24"		26"		28"		30"		32"	
Span	100% TL	115% TL	100% TL	115% TL	100% TL	115% TL	100% TL	115% TL	100% TL	115% TL	100% TL	115% TL	100% TL	115% TL
	100% LL	125% TL	100% LL	125% TL	100% LL	125% TL	100% LL	125% TL	100% LL	125% TL	100% LL	125% TL	100% LL	125% TL
16'	3,286	3,785	3,938	4,536	4,646	5,351	5,409	6,229	6,226	7,169	7,097	8,171	8,021	9,235
	3,182	4,118	3,938	4,935	4,646	5,821	5,409	6,775	6,226	7,798	7,097	8,887	8,021	10,044
18'	2,587	2,982	3,102	3,574	3,660	4,217	4,262	4,909	4,906	5,651	5,593	6,442	6,323	7,282
	2,304	3,245	2,994	3,889	3,660	4,588	4,262	5,341	4,906	6,148	5,593	7,008	6,323	7,921
20'	2,087	2,407	2,503	2,886	2,954	3,406	3,441	3,966	3,962	4,566	4,518	5,206	5,108	5,885
	1,717	2,620	2,241	3,141	2,847	3,706	3,441	4,316	3,962	4,968	4,518	5,664	5,108	6,403
22'	1,717	1,981	2,060	2,376	2,433	2,805	2,834	3,268	3,264	3,763	3,722	4,291	4,209	4,851
	1,312	2,157	1,717	2,587	2,190	3,054	2,731	3,557	3,264	4,095	3,722	4,670	4,209	5,279
24'	1,436	1,658	1,723	1,989	2,036	2,349	2,372	2,736	2,733	3,152	3,117	3,595	3,526	4,065
	1,024	1,806	1,343	2,166	1,717	2,558	2,148	2,979	2,636	3,431	3,117	3,913	3,526	4,425
26'	1,177	1,406	1,461	1,688	1,727	1,994	2,013	2,323	2,319	2,677	2,646	3,053	2,994	3,453
	814	1,532	1,070	1,839	1,370	2,171	1,717	2,530	2,113	2,915	2,557	3,325	2,994	3,760
28'	941	1,206	1,249	1,449	1,481	1,712	1,728	1,995	1,991	2,299	2,273	2,624	2,572	2,968
	657	1,270	865	1,579	1,110	1,865	1,394	2,174	1,717	2,505	2,083	2,857	2,490	3,232
30'	762	1,031	1,015	1,256	1,284	1,484	1,497	1,731	1,727	1,995	1,971	2,277	2,231	2,576
	537	1,031	709	1,369	911	1,618	1,145	1,886	1,414	2,174	1,717	2,481	2,057	2,806
32'	624	847	834	1,098	1,082	1,298	1,309	1,514	1,510	1,746	1,725	1,993	1,952	2,256
	445	847	588	1,128	756	1,415	952	1,651	1,177	1,903	1,432	2,172	1,717	2,458
34'	516	702	691	937	899	1,144	1,143	1,335	1,331	1,540	1,520	1,758	1,721	1,990
	373	702	493	937	634	1,217	800	1,456	990	1,679	1,205	1,917	1,448	2,169
36'	429	587	577	786	754	1,014	960	1,184	1,180	1,367	1,349	1,561	1,528	1,768
	315	587	417	786	537	1,023	678	1,292	840	1,491	1,024	1,702	1,231	1,927
38'	360	494	486	664	636	866	813	1,057	1,017	1,220	1,204	1,394	1,364	1,579
	269	494	356	664	459	866	580	1,103	718	1,332	877	1,521	1,055	1,723

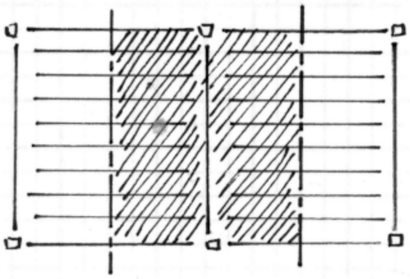
Lauren Wilke
Structural Option
Advisor: M.K. Parfitt

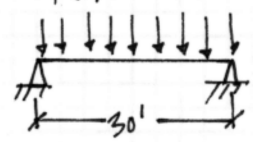
Boyds Bear Country
Pigeon Forge, TN

TrussJoist Allowable Uniform Load Table
7" 2.2E Parallam ® PSL Commercial Beams – Typical 30' Girder Design

Depth	38"		40"		42"		44"		46"		48"	
Span	100% TL	115% TL	100% TL	115% TL	100% TL	115% TL	100% TL	115% TL	100% TL	115% TL	100% TL	115% TL
	100% LL	125% TL	100% LL	125% TL	100% LL	125% TL	100% LL	125% TL	100% LL	125% TL	100% LL	125% TL
16'	10,556	12,152	11,512	13,252	12,539	14,433	13,645	15,706	14,840	17,081	16,135	18,571
	10,556	13,216	11,512	14,412	12,539	15,697	13,645	17,080	14,840	18,575	16,135	20,195
18'	8,732	10,055	9,465	10,898	10,242	11,792	11,068	12,743	11,948	13,755	12,887	14,835
	8,732	10,936	9,465	11,853	10,242	12,826	11,068	13,860	11,948	14,960	12,887	16,135
20'	7,081	8,156	7,806	8,990	8,563	9,862	9,305	10,716	9,994	11,508	10,721	12,345
	7,081	8,872	7,806	9,779	8,563	10,727	9,305	11,656	9,994	12,518	10,721	13,428
22'	5,838	6,726	6,436	7,414	7,061	8,134	7,714	8,885	8,394	9,668	9,100	10,481
	5,838	7,318	6,436	8,067	7,061	8,849	7,714	9,666	8,394	10,517	9,100	11,402
24'	4,892	5,638	5,394	6,216	5,919	6,820	6,466	7,451	7,037	8,107	7,630	8,790
	4,892	6,136	5,394	6,764	5,919	7,421	6,466	8,107	7,037	8,821	7,630	9,564
26'	4,156	4,792	4,583	5,283	5,029	5,798	5,495	6,334	5,981	6,893	6,486	7,474
	4,156	5,216	4,583	5,750	5,029	6,310	5,495	6,893	5,981	7,501	6,486	8,133
28'	3,572	4,120	3,939	4,543	4,324	4,986	4,725	5,448	5,143	5,930	5,578	6,430
	3,572	4,486	3,939	4,946	4,324	5,428	4,725	5,930	5,143	6,454	5,578	6,998
30'	3,101	3,578	3,420	3,946	3,755	4,332	4,104	4,734	4,467	5,152	4,845	5,588
	3,101	3,897	3,420	4,297	3,755	4,716	4,104	5,154	4,467	5,609	4,845	6,083
32'	2,715	3,135	2,995	3,458	3,289	3,796	3,595	4,149	3,914	4,516	4,246	4,898
	2,715	3,415	2,995	3,766	3,289	4,134	3,595	4,518	3,914	4,918	4,246	5,333
34'	2,395	2,767	2,643	3,053	2,903	3,352	3,173	3,664	3,455	3,989	3,749	4,327
	2,342	3,015	2,643	3,326	2,903	3,651	3,173	3,991	3,455	4,345	3,749	4,712
36'	2,128	2,459	2,348	2,714	2,579	2,980	2,820	3,258	3,071	3,547	3,332	3,848
	1,998	2,681	2,304	2,957	2,579	3,247	2,820	3,549	3,071	3,864	3,332	4,192
38'	1,901	2,199	2,099	2,427	2,305	2,665	2,521	2,914	2,746	3,173	2,980	3,443
	1,717	2,397	1,983	2,645	2,271	2,905	2,521	3,176	2,746	3,458	2,980	3,752

TRUSJOIST PARALLAM TO REPLACE 30' BAY - GIRDER & COLUMN.





$P = (100\,psf)(15')(4') + (145\,pcf)(7''/12)(20''/12)(15')$
$= 6656$ pounds
$= 6.7\,k$

AS DISTRIBUTED LOAD:
$(8)(6.7k)/30' = (1.8\,klf)(2)$
$= 3.6\,klf.$

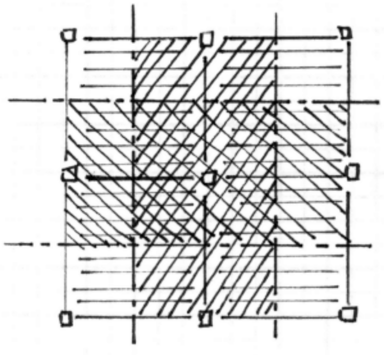
APPLIED LOAD = 3600 plf. @ 30' SPAN.

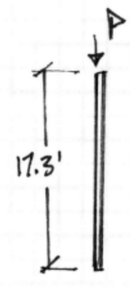
$V = \frac{wL}{2} = \frac{(3.6\,klf)(30')}{2} = 54k$

$M = \frac{wL^2}{8} = \frac{(3.6\,klf)(30')^2}{8} = 405'k.$

USE 2.2E 7"x 42" PARALLAM FROM TRUSJOIST TABLE

3755 plf ≥ 3600 plf OK





$P = (30')(30')(100\,psf\,LL + 25\,psf\,DL)$
$= 113k$ / FLOOR

$= (30')(30')(20\,psf\,LL + 20\,psf\,DL)$
$= 36k$ / ROOF

$\Sigma P = 36k + (4)(113k) = 488\,k.$

$A_{REQD} = \frac{P}{\sigma} = \frac{488k}{(0.6)(46\,ksi)} = 17.7\,in^2.$

[TABLE 4-4] AISC 13th.

TRY HSS 12x12x1/2". $A = 20.9\,in^2 \geq 17.7\,in^2$ OK
$P = 503\,k \geq 488k$ OK.

USE HSS 12x12x1/2 COLUMN.

WOODEN FRAMING SYSTEM - FLOOR SHEATHING.

[TABLE 3.1] NDS.

SUPPORTS 48" o.c. 5 PLY PLYWOOD. STRENGTH AXIS ⊥ TO SUPPORTS.

$EI = 1{,}150{,}000$ lb-in²/ft.

$F_bS = 1{,}600$ lb-in/ft.

[TABLE 3.1.1]

$C_g = 1.1$ for EI

$C_g = 1.2$ for F_bS

$C_s = 1.0$ SINCE REGULAR SIZING.

BENDING:

$$W_b = \frac{120 F_b' S}{l_1^2} = \frac{(1.2)(1600\ \text{"lb/ft})(1.2)(1.0)}{(48")^2} = 100\ \text{psf} \geq 100\ \text{psf} \quad \text{OK}$$

↑ CONTROLS.

DEFLECTION:

$$\Delta = \frac{W l_3^4}{1743 EI'} = \frac{l}{360} \qquad l_3 = 48" - 7" = 41.0"$$

$$\frac{l}{360} = \frac{48"}{360} = \frac{W(41.0")^4}{(1743)(1150000)(1.1)} \qquad W = 104\ \text{psf} \geq 100\ \text{psf} \quad \text{OK}$$

$$l_3 = 48" - 7" + 0.25" = 41.25"$$

$$\frac{l}{360} = \frac{48"}{360} = \frac{W(41.25")^4}{(1743)(1150000)(1.1)} \therefore W = 102\ \text{psf} \geq 100\ \text{psf} \quad \text{OK}$$

SHEAR:

[TABLE 3.3]

$$\frac{F_s I b}{Q} = 385\ \text{lb/ft}$$

[TABLE 3.3.1]

$C_g = 1.3$. $\quad l_2 = 48" - 7" = 41.0"$

$$W_s = \frac{20 F_s' (Ib/Q)}{l_2} = \frac{(20)(385\ \text{lb/ft})(1.3)}{41.0"} = 244\ \text{psf} \geq 100\ \text{psf} \quad \text{OK}$$

WOODEN FRAMING SYSTEM - FLOOR SHEATHING CONT.

USE, 5-PLY PLYWOOD NON-STRUCTURAL I GRADE 48" O.C. SPAN RATING.

[TABLE 6.1]

SINGLE FLOOR - 48" O.C. SPAN.

USE 8d NAILS @ 6" ON ALL SUPPORTS W/ GLUE.