TECHNICAL ASSIGNMENT 2

PRO-CON STRUCTURAL STUDY OF ALTERNATE FLOOR SYSTEMS

GATEWAY COMMONS
ITHACA, NEW YORK

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STRUCTURAL OPTION
OCTOBER 10, 2006
AE 481W
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Executive Summary

The Gateway Commons building in Ithaca, New York is a mixed-use development building being used for retail and residential apartments. It has a basement floor below grade and six floors above grade at a height of 62 feet. CMU walls supporting precast concrete hollow core planks make up the building structure. The building façade uses a combination of brick, an Exterior Insulation Finish System (EIFS), and metal panels.

The objective of this report is to explore alternative floor framing systems for the Gateway Commons building and analyze their feasibility. The feasibility of each system was based on cost, constructability, floor depth, fire resistance, and the impact on the lateral system and foundation. A framing plan for each alternative was developed and representative bays were designed and compared against the other alternatives. The four alternatives that were analyzed are:

- Hollow Core Planks on Steel Beams
- Two Way Slab with Edge Beams
- Composite Steel
- Non-Composite Steel

Based on the findings of this report the hollow core planks on steel beams system and the non-composite system were discarded as possibilities. The two way slab with edge beams and the composite design were both considered as possible alternatives to the existing hollow core planks on CMU walls system. Due a lower cost and a shallower floor depth than the composite steel design, the two way slab with edge beams was chosen as the best alternative to the existing system.

Introduction

Gateway Commons located in Ithaca, New York is a mixed use project containing retail and residential spaces. It has a basement floor below grade and six floors above grade at a height of 62 feet. The basement has a floor to floor height of 11'-4" and the floors above grade have height of 10' except for the first floor which has a height of 12'. The total building area is 43,000 square feet. The ground floor is retail spaces and the others contain residential apartments. Construction for this project was completed in April of 2007. A typical floor plan of the building is shown in Figure 1.

The building has a basement space between grid lines A and D. The floor for this space is a 5" thick slab on grade. Between grid lines D and E there is a compacted structural fill instead of basement space. The slab on grade that lies on that compacted structural fill is the first floor's floor system between grid lines D and E. Between grid lines A and D hollow core planks are supported by concrete foundation walls that transfer the loads from above onto strip footings.

Located above the concrete foundations walls are CMU walls. Some of the walls are part of the gravity framing system and only support the gravity loads bearing on them. Other walls are part of the lateral system and are designed to resist lateral forces from wind and seismic.

The walls that are part of the lateral system are considered intermediate reinforced masonry shear walls. These walls span in both the N-S and E-W directions. These shear walls are classified as wall types MW2 and MW3. These shear walls are highlighted in green on the plan in Figure 1.

The walls that are part of the gravity framing system are considered wall type MW1. These are all of the other walls on the plan that are not highlighted in green. These walls support the precast concrete hollow core floor planks that act as the flooring system. The roof is constructed out of the same hollow core planks and is also supported by CMU walls as well as two different steel shapes that support the roof planks at their 2'-8" overhang. The building sections in Figures 2 and 3 should also help describe the structure of the Gateway Commons building.

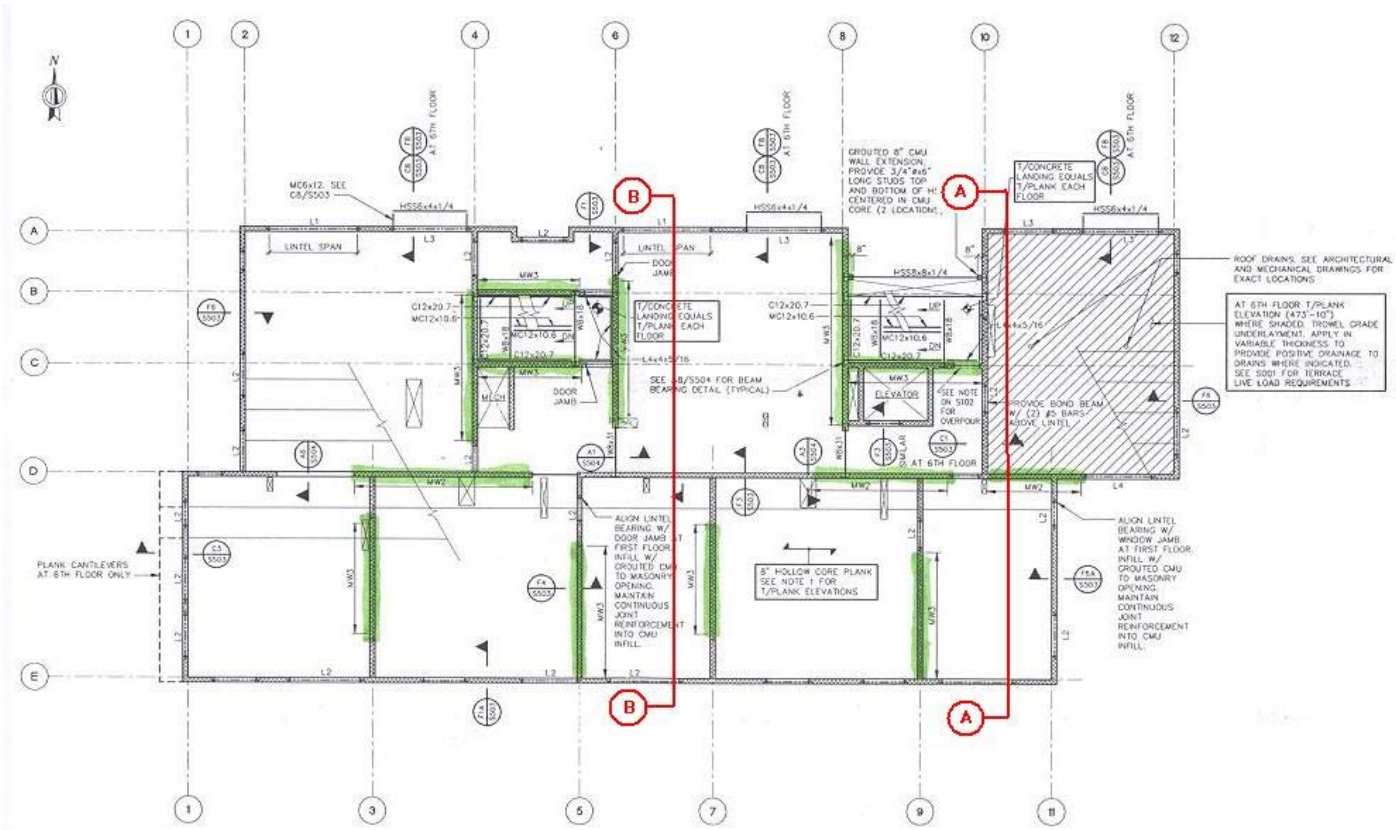


Figure 1 – Typical Framing Plan

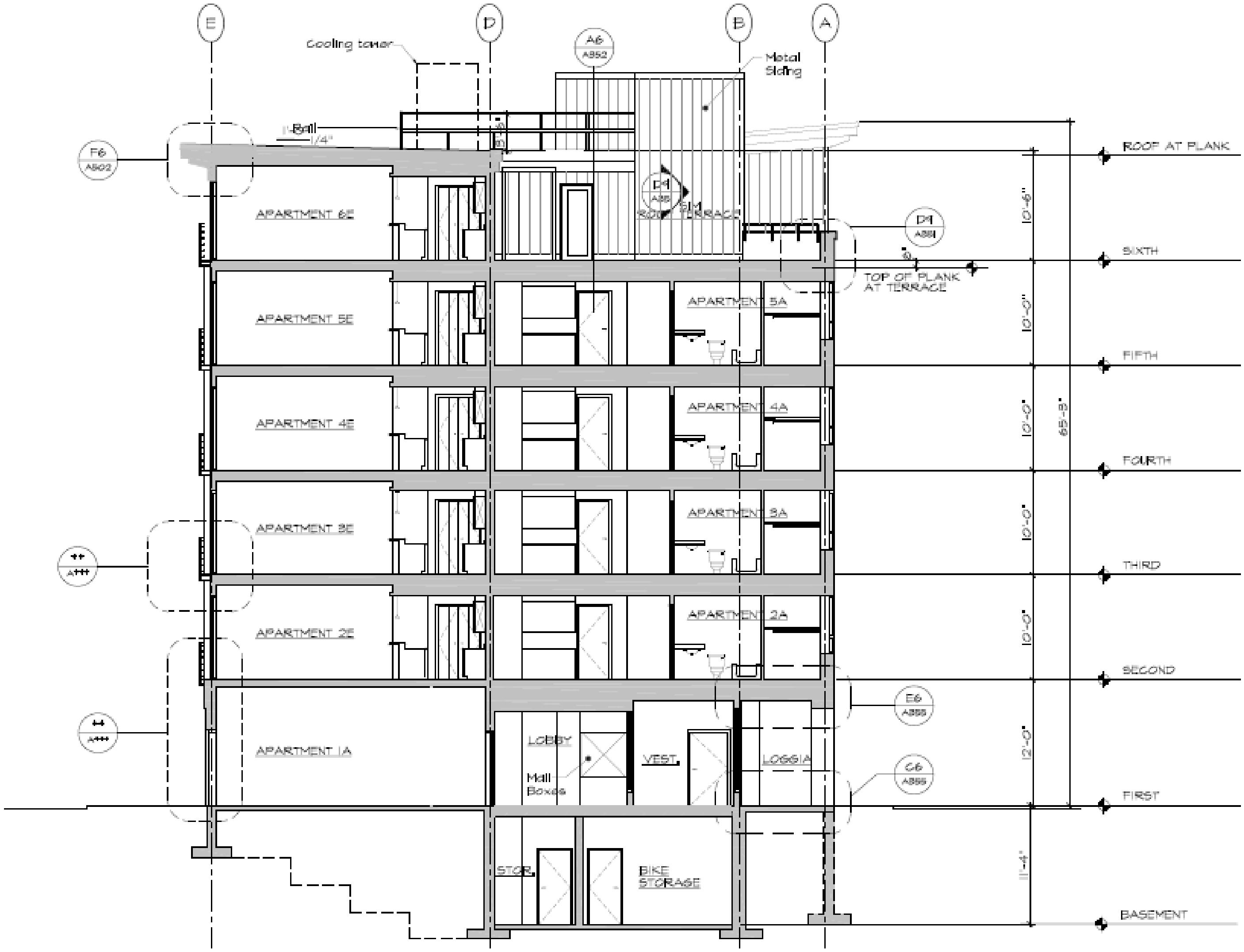


Figure 2 – Section A

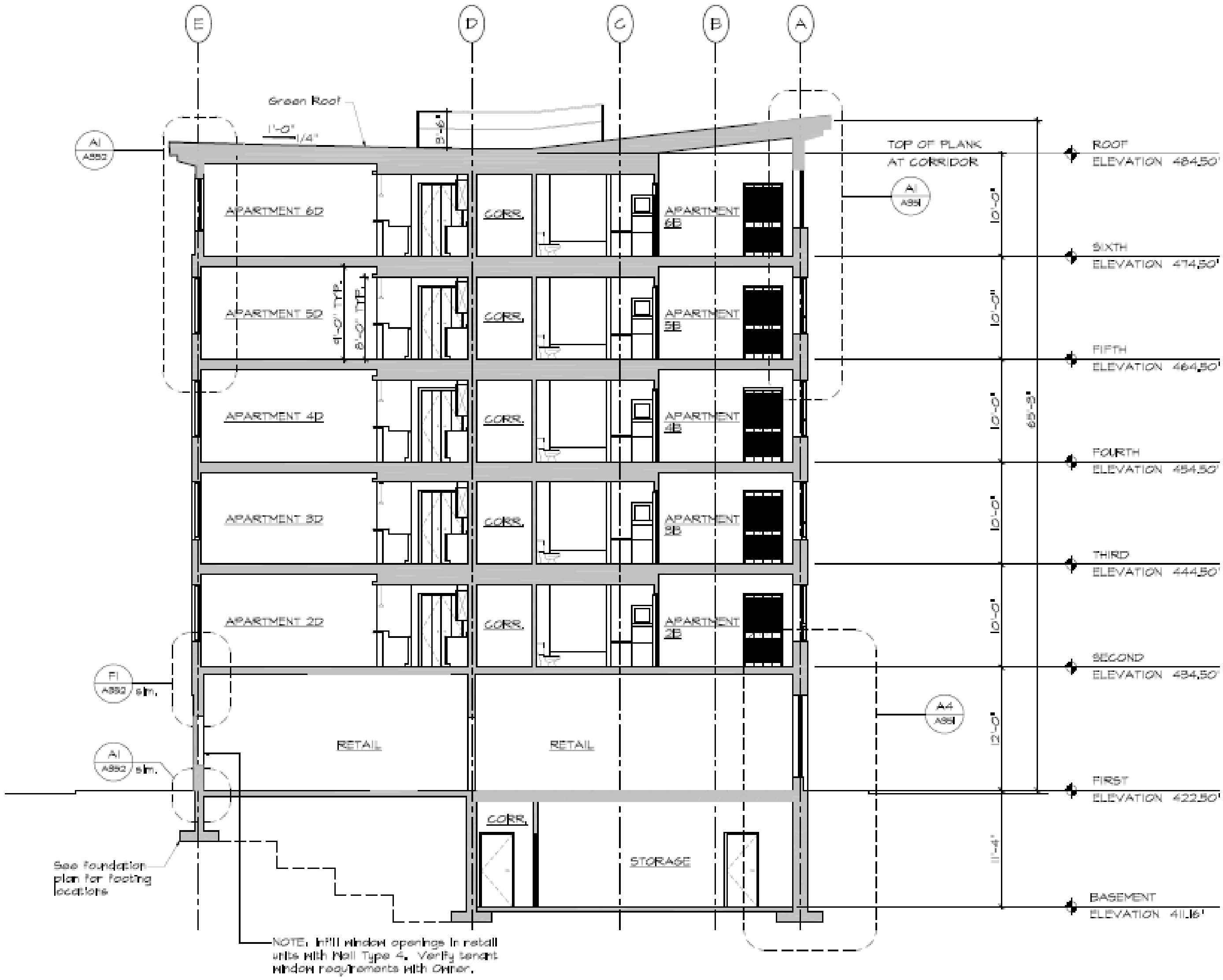


Figure 3 – Section B

Loads

This gravity load information was obtained from the general notes page of the building plans. These loads were used by the engineer to design the gravity load bearing walls. For this report these loads will be used to size members for the alternative systems.

Live Loads

First Floor………………………………....100 psf
Second – Sixth Floor……………………...40 psf
Sixth Floor Terrace………………………..100 psf

Dead Loads

First Floor………………………………....100 psf
Second – Sixth Floor……………………...70 psf
CMU Walls………………………………. 55 psf
Brick Façade………………………………40 psf
Green Roof or Roof Top Pavers…………..95 psf
Other Roof Areas…………………………75 psf
Mechanical Equipment……………………5 psf
Partition walls……………………………..10 psf

Snow Loads

Ground Snow load (Pg)……………….......45 psf
Flat Roof Snow Load (Pf)……….………....32 psf

Codes and References

This section lists the codes and reference material used to design the Gateway Commons building by the original engineer. The codes and reference material used to design the alternative systems in this report are also listed below. Tables listing the material properties of the existing system's structural components are also shown below.

Applicable Codes and References-Original Design

- 2002 Building Code of New York State (BCNYS)
- ASTM Standards
- NCMA Tek Notes
- ACI Standards
- ASCE 7-98

Applicable Codes and References-This Report

- AISC steel manual
- PCA slab
- The Nitterhouse Concrete Products website
- RAM Structural Systems
- The United Steel Deck design manual

Cast in Place Concrete	
Member	28 Day Compressive Strength (f'c)
Columns and Beams	4,000 psi
Interior Slabs on Grade	3,500 psi
Footings, Foundations Walls, Piers, Misc.	3,000 psi
Retaining Walls, Basement Walls, Exterior Slabs	4,000 psi

Structural and Miscellaneous Steel		
Material	ASTM Standard	Fy (ksi)
Rolled Steel W Shapes	A 992	50
Rolled Steel C and MC Shapes	A 36	36
Rolled Steel Plates, Bars, and Angles	A 36	36
Hollow Structural Sections (HSS)	A 500, Grade B or C	46 or 50
Pipe	A 53, Type E or S, Grade B	35
Reinforcing Bars	A 615, Grade 60	60

Alternative Systems

In this report I will evaluate four alternate floor systems and compare them against the existing masonry bearing walls and precast hollow core concrete plank system. The impact that each proposed system will have on the buildings foundation will be discussed. New lateral systems will also have to be proposed for the alternative systems. All of the new systems use columns instead of walls as their vertical supports. Columns should be placed in areas where walls were originally in order to maintain the same floor plan. Light gauge steel framing will be used to create interior partitions where the masonry walls use to be. The four systems evaluated in this report include:

- Hollow Core Planks on Steel Beams
- Two Way Slab with Edge Beams
- Composite Steel
- Non-Composite Steel

Existing Floor System

Between grid lines A and D, the basement floor slab-on-grade and loads from the concrete foundations walls are transferred onto strip footings with a 28-day strength of f'c = 3,000 psi. These strip footings sit on undisturbed indigenous soils composed of sand and gravel with an allowable bearing capacity of 5,000 psf . The footings will have a concrete strength of f'c = 3,000 psi. The foundations walls will have a concrete strength of f'c = 3,000 psi or 4,000 psi depending on the type of wall. Between grid lines D and E the footings sit on a compacted structural fill that has an allowable bearing capacity of 5,000 psf.

A plan of a typical floor for the existing system is shown in Figure 4. The walls that are part of the gravity framing system are considered wall type MW1. These are all of the other walls on the plan that are not highlighted in green. Unlike the concrete foundations walls these walls are constructed out of 8" thick concrete masonry units (CMU). These walls support the precast concrete hollow core floor planks that act as the flooring system. A wall schedule describing how these walls are reinforced can be found in Figure 5.

The primary flooring system for the elevated floors of the building is precast concrete hollow core planks. The planks span in the east/west direction. On the first floor the planks have a thickness of 10", but on floors two through six the plank thickness is 8". The planks on the first floor have a 2" thick concrete topping. All planks have a maximum width of 4' and are allowed to have a minimum width of 1'-6". Planks located at interior bearing partitions must be connected with a 6' long #3 bar or 5/16" diameter strand grouted into the keyway, as shown in Figure 6. Planks are often connected to exterior CMU walls with #4 dowels that are bent into the keyways, as shown in Figure 7.

The structure is laterally supported by intermediate reinforced masonry shear walls in the N-S and E-W directions. Like the load bearing walls for the gravity framing system the shear walls are also 8" thick CMU walls. However, the shear walls are designed to resist the lateral loads due to seismic and wind forces. There are two different shear wall types, MW2 and MW3. The shear walls are highlighted in green on the floor plan in Figure 4. The wall schedule in Figure 5 describes the reinforcing for both shear wall types.

Advantages

- Does not need to be fireproofed
- Less expensive
- Small floor depth
- Planks can be installed quickly and are quality insured due to being manufactured off site

Disadvantages

- CMU walls take longer to construct than steel framing
- Assembly of the planks requires a high level of skill
- CMU is a heavy building material
- The amount of load bearing walls in the building leaves less flexibility for future modification of the floor plan

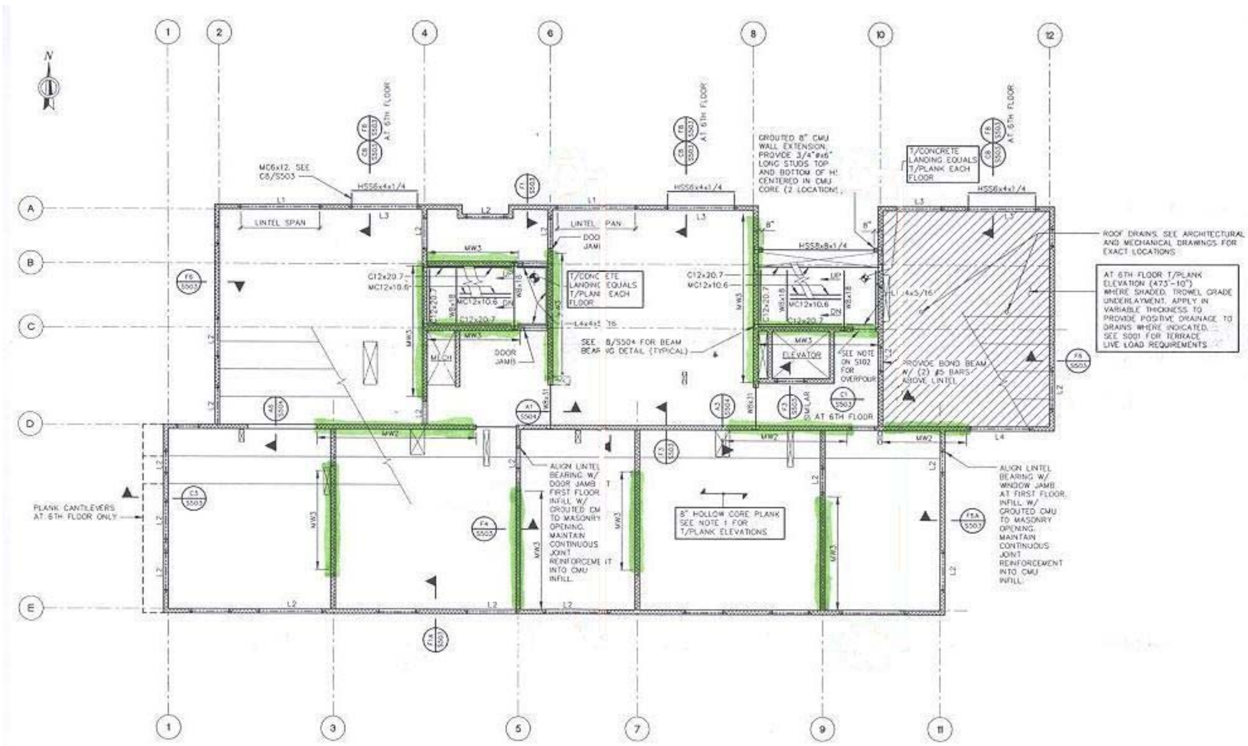


Figure 4 – Typical Framing Plan

WALL ~~LINTEL~~ SCHEDULE			
MARK	VERTICAL REINFORCING	HORIZONTAL REINFORCING	REMARKS
MW1	#5 AT 4'-0"OC	STANDARD JOINT REINFORCING AT 16"OC	GROUT WALL SOLID 1ST-2ND FLOORS GROUT WALL AT 2'-0"OC 2ND-3RD FLOORS
MW2	#5 AT 4'-0"OC (TYPICAL) (6)#6 EACH END (1ST-2ND) (4)#6 EACH END (2ND-4TH) (2)#5 EACH END (4TH-ROOF)	STANDARD JOINT REINFORCING 1ST-2ND AND 6TH-ROOF, HEAVY DUTY JOINT REINFORCING AT 8"OC 2ND-6TH	GROUT WALL SOLID 1ST-2ND FLOORS
MW3	#5 AT 4'-0"OC (TYPICAL) (2)#5 EACH END	STANDARD JOINT REINFORCING 1ST-2ND AND 6TH-ROOF, HEAVY DUTY JOINT REINFORCING AT 8"OC 2ND-6TH	GROUT WALL SOLID 1ST-2ND FLOOR

NOTES:
1. UNLESS NOTED OTHERWISE ON PLAN, ALL WALLS ARE TYPE MW1.
2. MINIMUM REINFORCING REQUIREMENTS SHOWN ON A3/S506 APPLY TO ALL WALLS.
3. SEE F6/S506 FOR PLACEMENT OF VERTICAL BARS AT ENDS OF WALLS.

Figure 5 – Wall Schedule

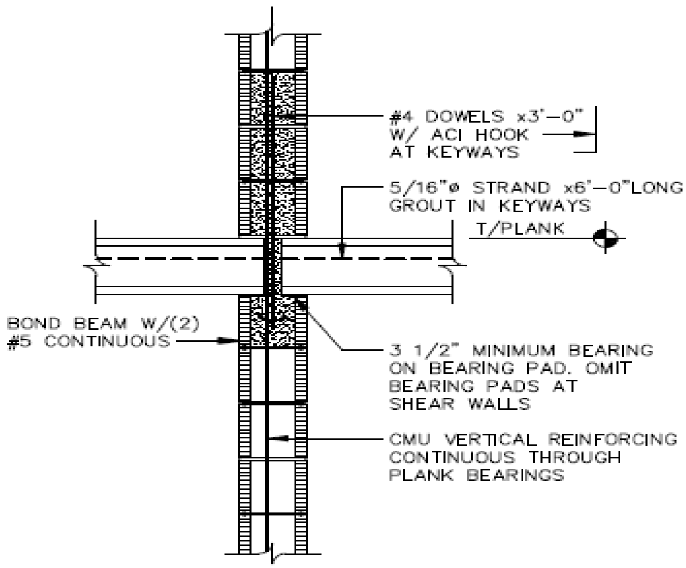


Figure 6 – Floor Planks at Interior Walls

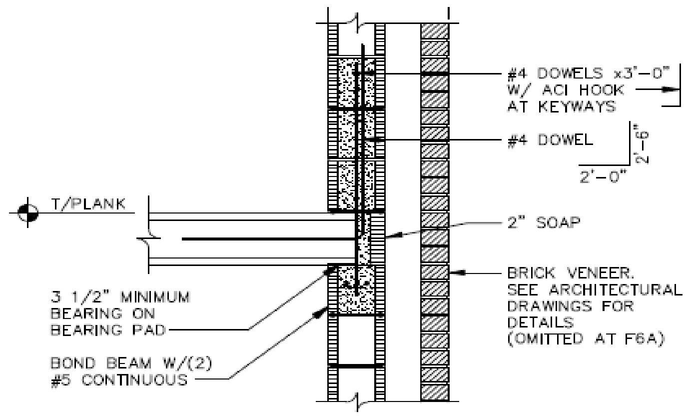


Figure 7 – Floor Planks at Exterior Walls

Hollow Core Planks on Steel Beams

The steel framing plan for a typical floor is shown in Figure 9 with the bay that was chosen to be designed for this system highlighted in red. Specifications and load tables provided by the Nitterhouse Concrete Products website were used to design the hollow core floor system that spans in the east-west direction across the steel framing. Load tables were used to select a plank size based on a live load a 100 psf, a superimposed dead load of 15 psf, and 68 psf due to the self weight of the planks. It was determined that untopped 10 inch thick planks reinforced with ½" diameter steel strands will support the given loads at a span of 28 feet. After the hollow core planks were designed the beams that supported them were designed. The representative bay that was chosen to be designed for this system is shown in Figure 8 with beams sizes labeled. In this bay W12x19 span 27'-6". The W12x19 beams support a brick façade on the exterior and at the interior they only act as lateral support for the columns. The hollow core planks are supported by W24x76 that span 31'-5". The beams were designed by simple hand calculations and the AISC Handbook was referenced to aid in the design. The designs were based on moment capacity and deflection. These calculations can be found in the Appendix A along with the load table for the hollow core planks.

Some additional concerns due to changing the building structure are the lateral system, foundation, and fireproofing. Concrete or masonry shear walls are an option for this structure's lateral force resisting system. This design will not call for as many shear walls as the original design due to the new layout and reduction in weight. Also, due to this reduction in weight the wind may become the controlling lateral force acting on this building. Steel moment frames are also another option for the structure's lateral system. The foundation should be able to support the loads generated by this framing system since this is a lighter system than masonry. The way this system is connected to the foundation will be different due to different materials. Fireproofing for the steel beams will be necessary but the hollow core planks are concrete and have a 2 hour fire resistance rating.

Advantages

- Longer spans with higher load capacities
- This system can be constructed quickly
- This system weights less than the existing masonry system

Disadvantages

- Long lead time
- Assembly of the planks requires a high level of skill
- Fireproofing for the steel

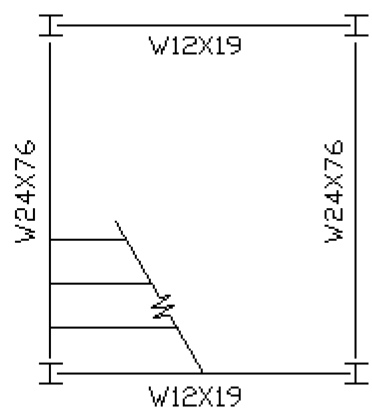


Figure 8 – Hollow Core Planks on Steel Beams

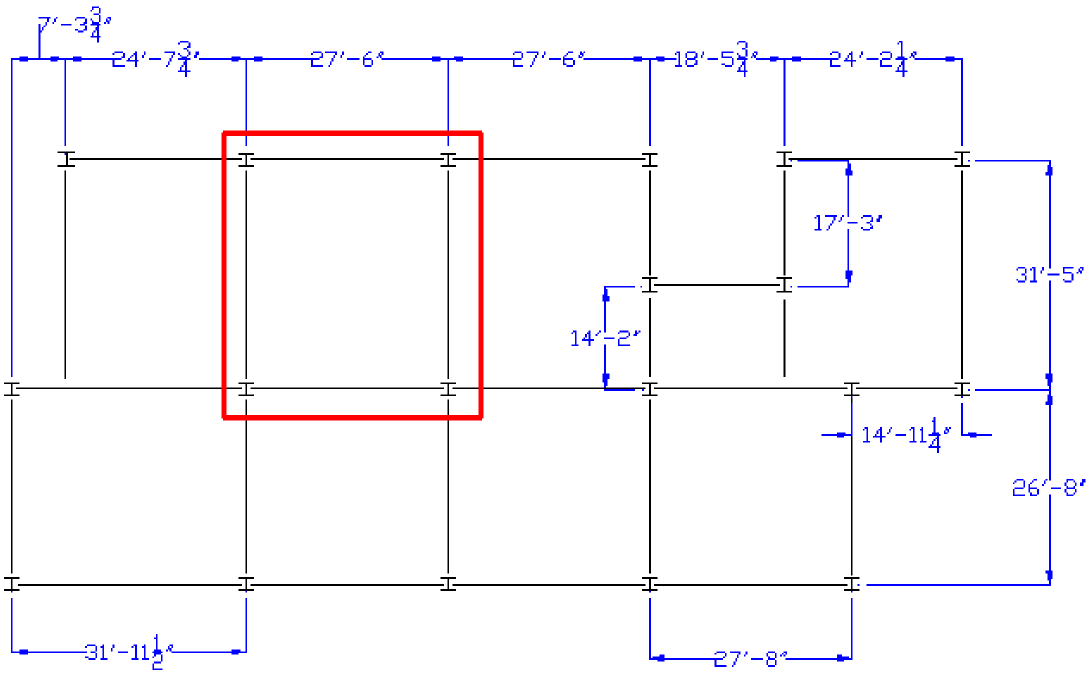


Figure 9 – Steel Framing Plan

Two Way Slab With Edge Beams

The framing plan for a typical floor redesigned as a two way slab with edge beams is shown below in Figure 10. Two design strips were analyzed. Design strip one runs in the north-south direction and design strip two runs east-west along the edge. A live load of 100 psf and a superimposed dead load of 15 psf were used to design this system. Both design strips are labeled on the plan in Figure 10. The PCA-Slab computer program was used to design both of these strips. Normal weight concrete with a compressive strength of 5,000 psi was used for the design. A 10” slab and 14”x20” edge beams around the whole perimeter were needed for the design. Both are reinforced with number 6 bars. All columns are 16”x16”. Instead of using costly shear reinforcement to resist punching shear around the columns, drop panels with a depth of 3” below the slab were designed for this function. The design results from the PCA program can be found in Appendix B along with a slab deflection diagram and a diagram showing the reinforcing in the column strip, middle strip, and the edge beam.

The slab in this design is thicker and heavier than the hollow core planks used in the existing system; however a significant amount of weight is lost by switching from CMU walls to concrete columns. Concrete or CMU shear walls are a good option for the lateral resisting system of this building. Less shear walls should be used in this design and they should be located in a way that the center of rigidity and the center of mass are close to each other so that the lateral forces create less of a torsion effect. The same strip footings and foundation walls should be able to support this new structure. Fireproofing will not be necessary because the entire structure is concrete.

Advantages

- Fireproofing is not required
- The use of columns instead of walls allows for more flexibility with the floor plan.
- Least expensive alternative

Disadvantages

- Precautions will need to be taken for holes made in the slab for running mechanical and electrical equipment.
- Concrete requires curing time before the additional stories can be constructed.

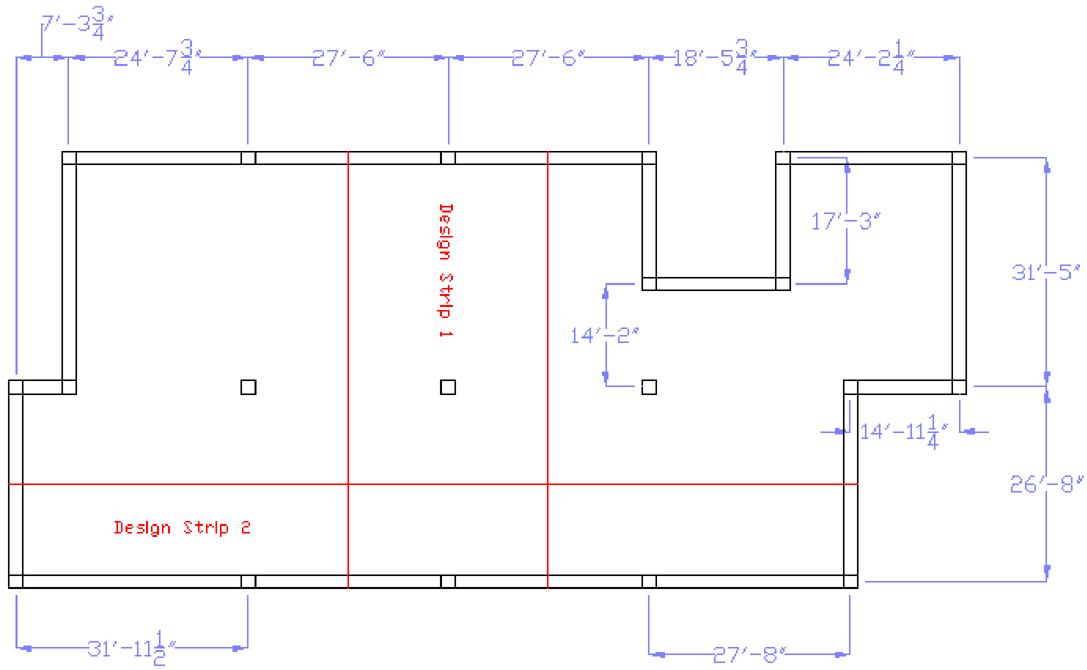


Figure 10 – Framing Plan for Two Way Slab with Edge Beams

Composite Steel

The steel framing plan for a typical floor is the same as the framing for the hollow core planks design and is shown in Figure 9. The bay that is being designed is highlighted in red. A live load of 100 psf and a superimposed dead load of 15 psf were used to design this system. The slab is made of 2" steel deck with 3-1/2" light weight concrete topping. To give the slab a composite action with the beam, ¾" diameter 4-1/2 in" long shear studs are used. Joists are framed in between the girders in order to meet span requirements for the 19 gauge steel deck. The unshored span length of 9.2' falls within the 10.01' maximum required span length for a 2" deep 19 gauge steel deck with a 5.5" deep light weight concrete slab. The section in the United Steel Deck design manual used to design the slab and determine the maximum span length can be found in Appendix C. After the slab was designed and the number of joists needed to support it was determined, the beams were designed using RAM Structural System. W16x26 joists with a camber of either 1" or 1-1/4" were chosen to support the deck. The joists are supported by W18x35 and W21x48 girders that span 27'-6". The W18x35 girder also supports a brick façade on the exterior of the building. Columns are oriented so that the girders are framed into the column flanges for a simpler connection. A design of the representative bay is shown in Figure 11. Beam sizes are labeled with camber if they have any, the numbers of shear studs on each span are in parenthesis, and reactions are given in kips. Appendix C also contains summaries of the beam designs and beam deflections.

Since this structure is much lighter than the existing one wind will more than likely be the controlling lateral load on the building. Moment frames and eccentrically braced frames are good option for the lateral resisting systems. The foundations should be able to support the loads generated by this framing system because it is much lighter than the existing masonry structure. The way this system is connected to the foundation will be different due to different materials. A 3-1/2" thick concrete slab will automatically provide the two hour fire protection required for the floor. The steel beams and columns will have to be fireproofed.

Advantages

- Fast construction time
- Lighter weight system
- High strength to weight ratio

Disadvantages

- Increases floor to floor height
- Cost of labor for installing shear studs
- Fireproofing needed for beams and columns

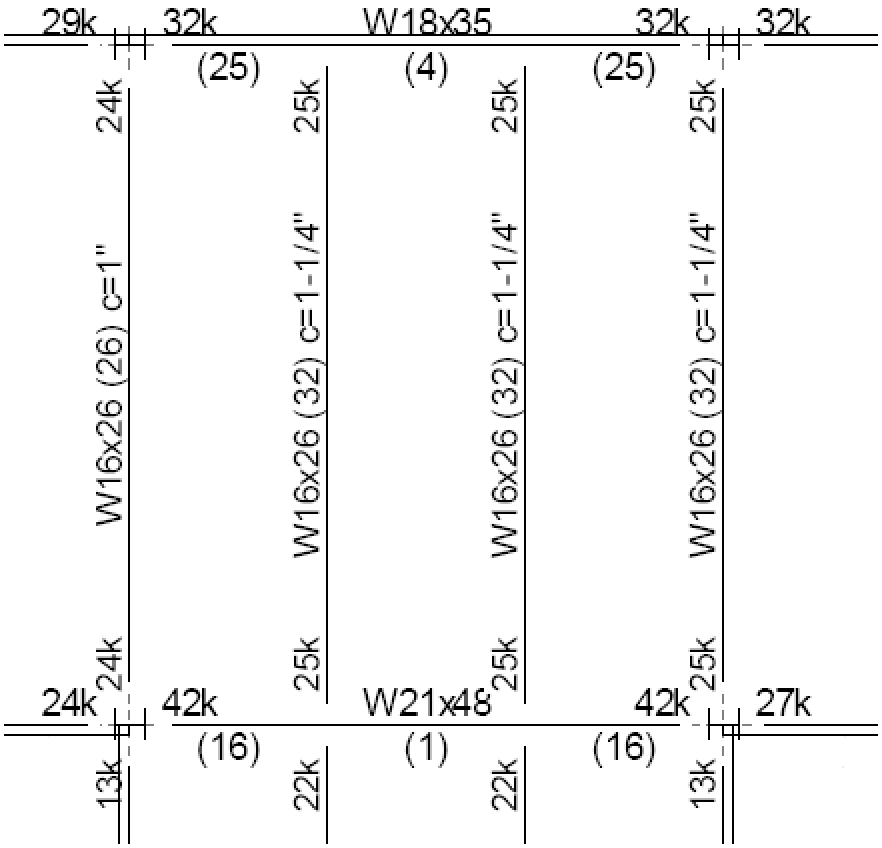


Figure 11 –Composite Steel

Non-Composite Steel

The steel framing plan for a typical floor is the same as the framing for the hollow core planks design and is shown in Figure 9. The bay that is being designed is highlighted in red. A live load of 100 psf and a superimposed dead load of 15 psf were used to design this system. The United Steel Deck design manual was used to design the non-composite slab. A 6.5" deep slab using light weight concrete with a 19 gauge 3" deck was chosen. The slab weights 42 psf. A 5.5" deep slab would have fulfilled the maximum span length requirements but it would not have been thick enough to provide adequate fire protection. With the slab designed RAM Structural Systems was then used to design the beams. W18x35 joists with a camber of ¾" span 31'-5". W24x55 and W24X68 girders span 27'-6". A design of the representative bay is shown in Figure 12. Beam sizes are labeled with camber if they have any and reactions are given in kips. Appendix D contains the United Steel Deck design manual section used to design the slab, summaries of the beam designs, and beam deflections.

This design uses the same framing plan as the composite design but the beams in this design are larger due to the non-composite nature. Moment frames and eccentrically braced frames are good option for the lateral resisting systems. The foundations should be able to support the loads generated by this framing system because it is much lighter than the existing masonry structure. The way this system is connected to the foundation will be different due to different materials. A 3-1/2" thick concrete slab will automatically provide the two hour fire protection required for the floor. The steel beams and columns will have to be fireproofed.

Advantages

- Faster erection time due to lack of shear studs

Disadvantages

- Not as efficient as a composite steel design
- Heavier and deeper beams compare to composite design
- Fireproofing needed for beams and columns
- Most expensive

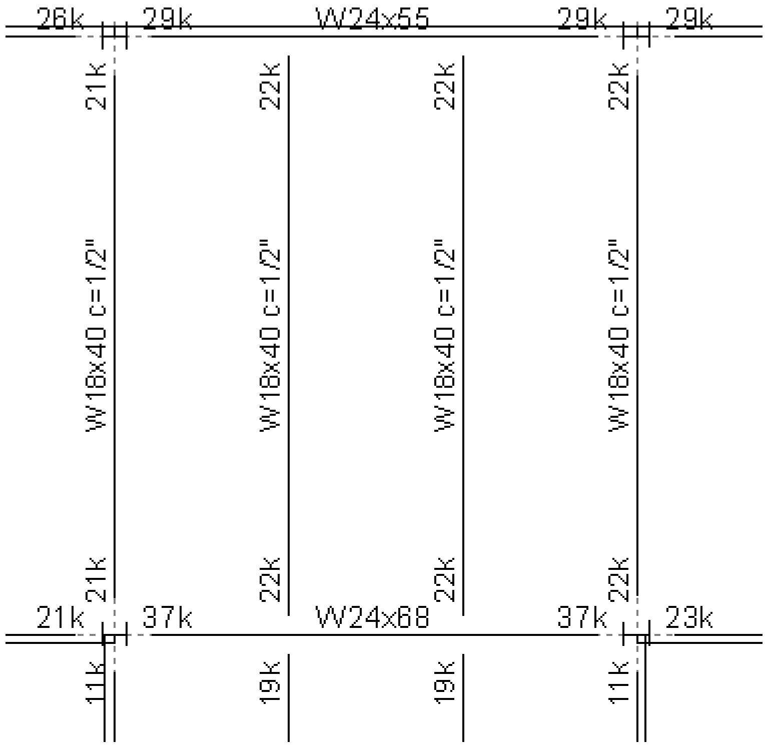


Figure 12 –Non-Composite Steel

Comparison

The results of the comparison study are shown in the table below. Cost was determined by using RSMeans Assemblies Cost Data 2007. All of the systems were analyzed for cost based on a 30x30 bay. The non-composite design is ruled out because the composite is more efficient and because it is the most expensive. The hollow core planks on steel beams system is ruled out because it is a bit more expensive than systems 2 and 3 and it is also the deepest floor system. Systems 2 and 3 are the cheapest of the alternatives and both seem to be possible solutions. The 2 way slab with edge beams appears to be the most feasible because it is cheaper, thinner, and does not require fireproofing.

Floor Framing System	Existing	System 1	System 2	System 3	System 4
	hollow core planks on CMU walls	hollow core planks on steel beams	2 way slab with edge beams	composite steel	non-composite steel
Total Depth	8"	34"	13"	26.5"	30.5"
Slab Depth	8"	10"	13"	5.5	6.5
Fireproofing	no	yes	no	yes	yes
Lead Time	long	longest	shortest	long	long
Weight	heaviest	lightest	heavy	light	light
Constructability	labor intensive	no formwork, fastest to construct	formwork, curing time required, longest to build	no formwork, shear studs	no formwork
Cost ($/SF)	17.65	23.65	21.89	22.55	28.36
Possible Solution	-	no	yes	yes	no

Conclusion

Four alternative floor systems were designed and compared to each other to determine which will be the best alternative to the existing hollow core planks on CMU walls structural system. The four alternatives are hollow core planks on steel beams, a two way slab with edge beams, composite steel, and non-composite steel.

The two way slab with edge beams and the composite steel design both appear to be viable solutions. The hollow core planks on steel beams and the non-composite steel systems were both discarded as possible options. The non-composite steel system is the most expensive and proves to be less efficient than the composite design. Although the hollow core planks on steel beams is the fastest to construct its materials have the longest lead time of all of the systems. It also has the deepest floor system and costs more than the two way slab with edge beams and the composite steel design.

The two way slab with edge beams proves to have advantages over the composite design. It is cheaper although not by much. The two way system has 20” deep beams but they are located on the building perimeter and do not affect the floor depth. The composite system has a floor depth of 26.5” due to the beams; this will cause an increase in the floor to floor height. The existing system proves to be the cheapest and have the shallowest floor system when compared to the alternatives. The two way system however proves to be the best choice out of the four alternatives.

Appendix A:

Hollow Core Planks on Steel Beams

Planks

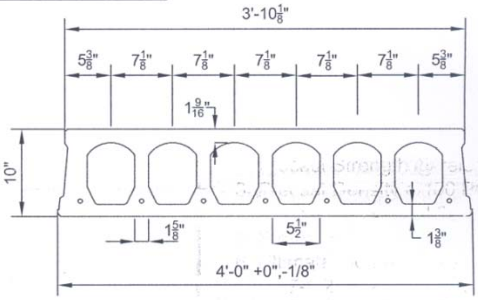
This load table from the Nitterhouse Concrete Products website shows that this plank is able to span 27'-6" while loaded with 164 psf. This is the factored loading due to the live load, superimposed dead load, and the self weight of the planks.

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

2 Hour Fire Resistance Rating (Untopped)

PHYSICAL PROPERTIES
Precast

A = 262 $in.^2$	S_b = 640 $in.^3$
I = 3196 $in.^4$	S_t = 638 $in.^3$
Y_b = 4.99 in.	Wt.= 272 PLF
Y_t = 5.01 in.	Wt.= 68.00 PSF
e = 3.24 in.	



DESIGN DATA

1. Precast Strength @ 28 days = 6000 PSI
2. Precast Strength @ release = 3500 PSI or 4000 PSI.
3. Precast Density = 150 PCF
4. Strand = 1/2"Ø and 0.6"Ø 270K Lo-Relaxation.
5. Strand Height = 1.75 in.
6. Ultimate moment capacity (when fully developed)...
   7-1/2"Ø, 270K = 163.8 k-ft
   7-0.6"Ø, 270K = 221.2 k-ft
7. Maximum bottom tensile stress is $7.5\sqrt{f'c}$ = 580 PSI
8. All superimposed load is treated as live load in the strength analysis of flexure and shear.
9. Flexural strength capacity is based on stress/strain strand relationships.
10. Deflection limits were not considered when determining allowable loads in this table.
11. Load values to the left of the solid line are controlled by ultimate shear strength.
12. Load values to the right are controlled by ultimate flexural strength or structural fire endurance.
13. Load values may be different for IBC 2000 & ACI 318-99. Load tables are available upon request.
14. Camber is inherent in all prestressed hollow core slabs and is a function of the amount of eccentric prestressing force needed to carry the superimposed design loads along with a number of other variables. Because prediction of camber is based on empirical formulas it is at best an estimate, with the actual camber usually higher than calculated values.

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

Strand Pattern		SPAN (FEET)																		
		28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46
7 - 1/2"ø	LOAD (PSF)	166	150	136	123	111	100	91	82	73	66	59	52	46	41	36	31	27	X	X
7 - 0.6"ø	LOAD (PSF)	212	202	194	186	178	165	152	139	128	118	108	99	91	83	76	69	63	57	52

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

This table is for simple spans and uniform loads. Design data for any of these span-load conditions is available on request. Individual designs may be furnished to satisfy unusual conditions of heavy loads, concentrated loads, cantilevers, flange or stem openings and narrow widths. The allowable loads shown in this table reflect a 2 Hour & 0 Minute fire resistance rating.

05/14/07

10F2.0

Beam Design

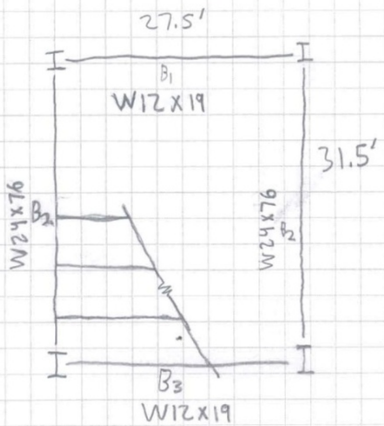
JOB

SHEET NO. OF JOB NO.

CALCULATED BY

SCALE DATE

structura
an engineering collaborative



LL = 40 psf (superimposed: mechanical equipment, partition walls)

DL = 68 + 15 = 83 psf

1.2(83) + 1.6(40) = 164 psf

Based on load tables use a 10" deep hollow core plank with a self weight of 68 psf

B2

Trib width = 27.5

$w = 0.164(27.5) = 4.51$ PLF

$M_u = \frac{wL^2}{8} = \frac{4.51(31.5)^2}{8} = 559$

W24X62 => $\phi M_n = 574 > 559$ ✓

$\Delta_T = \frac{L}{240} = \frac{31.5(12)}{240} = 1.58$

$\Delta_L = \frac{L}{360} = \frac{31.5(12)}{360} = 1.05$

$\Delta_T = \frac{5(4.51)(31.5)^4(1728)}{384(29000)(1550)} = 3.0 > 1.58$ not good

resize for deflection

$\Delta_L = \frac{5(1.76)(31.5)^4(1728)}{384(29000)(1550)} = 0.47$

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ROCKVILLE MD 20850

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SDG F301 987 9237
SRG F240 499 0155
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$$I = \frac{5(4.51)(31.5)^4(1728)}{1.58(384)(29000)} = 2180$$

2100 close to 2180 ok

750 > 559 ✓

use **W24X76** (from table 3-3)

$I = 2100$

$\phi M_n = 1060$ (from table 3-2)

B_1

Supports exterior brick facade 40 psf

$DL = 40(10') = 400\ PLF$ (story height)

$$M_u = \frac{(400)(27.5)^2}{8} = 38\ k\text{-}ft$$

W12X19 ⟹ $\phi M_n = 92.6\ k\text{-}ft > 38$ ✓ok

$$\Delta_T = \frac{27.5(12)}{240} = 1.38$$

$$\Delta_T = \frac{5(.4)(27.5)^4(1728)}{384(29000)(130)} = 1.37$$

1.38 > 1.37 ✓ok

B_3

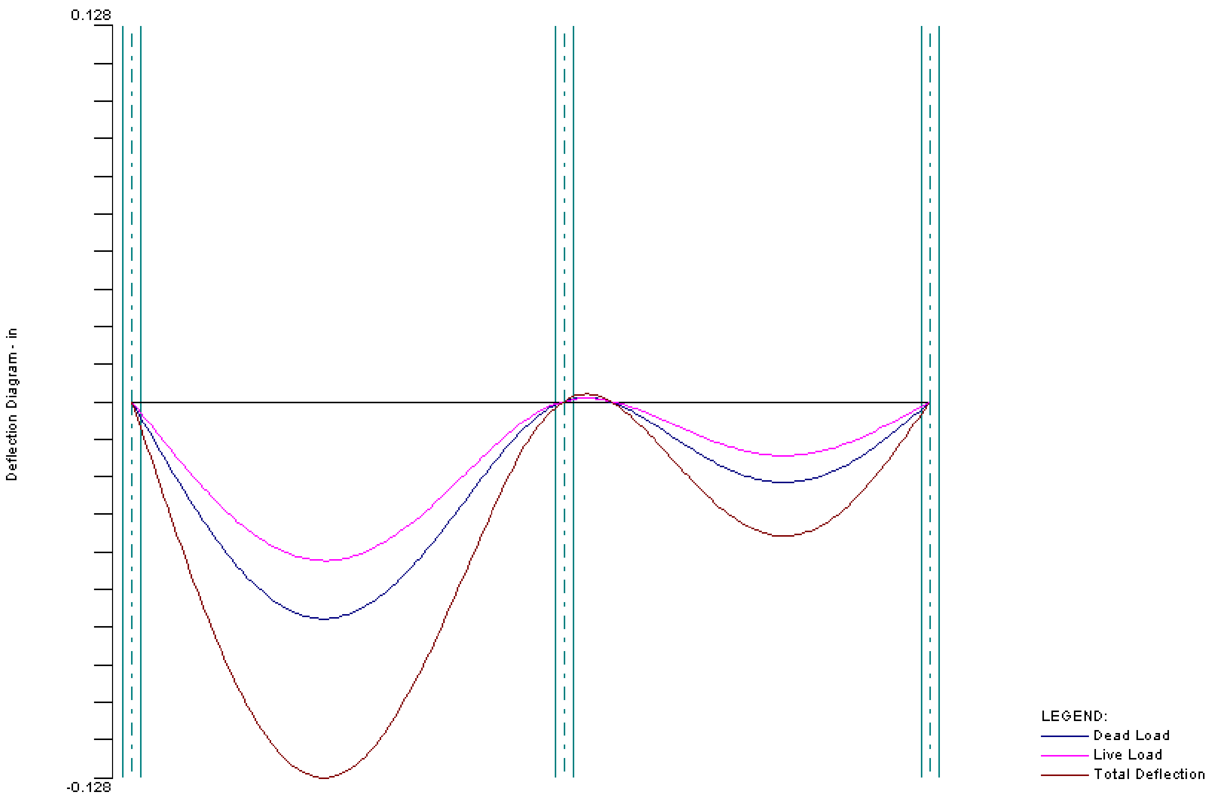
beam B_3 carries no load it only acts as lateral support for the columns. A beam size of **W12X19** will be used for B_3.

Appendix B:

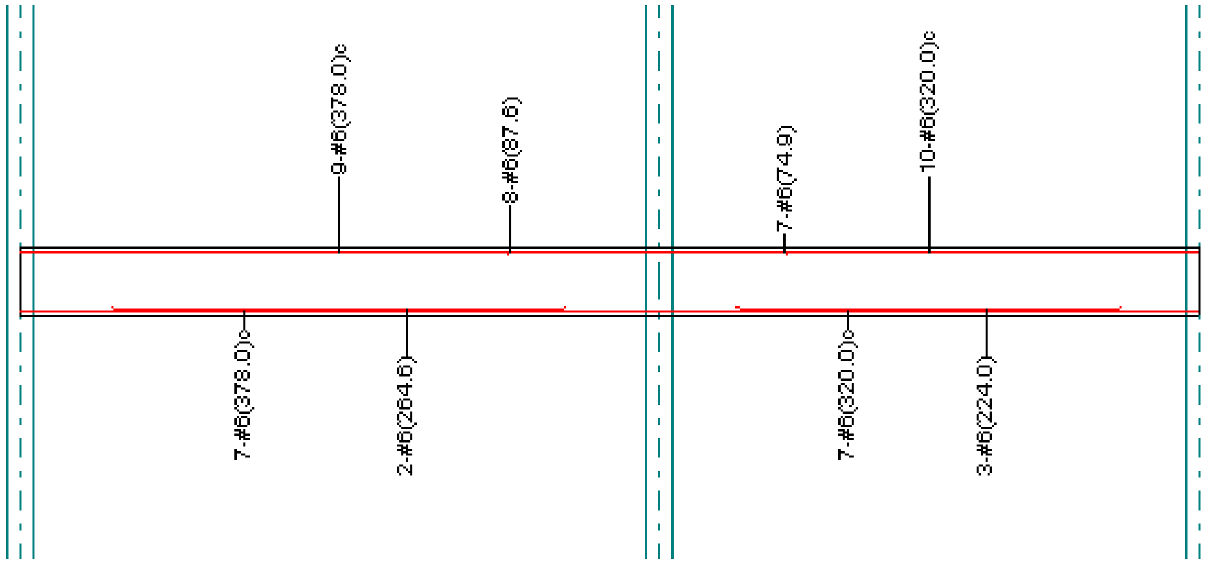
Two Way Slab with Edge Beams

Design Strip 1

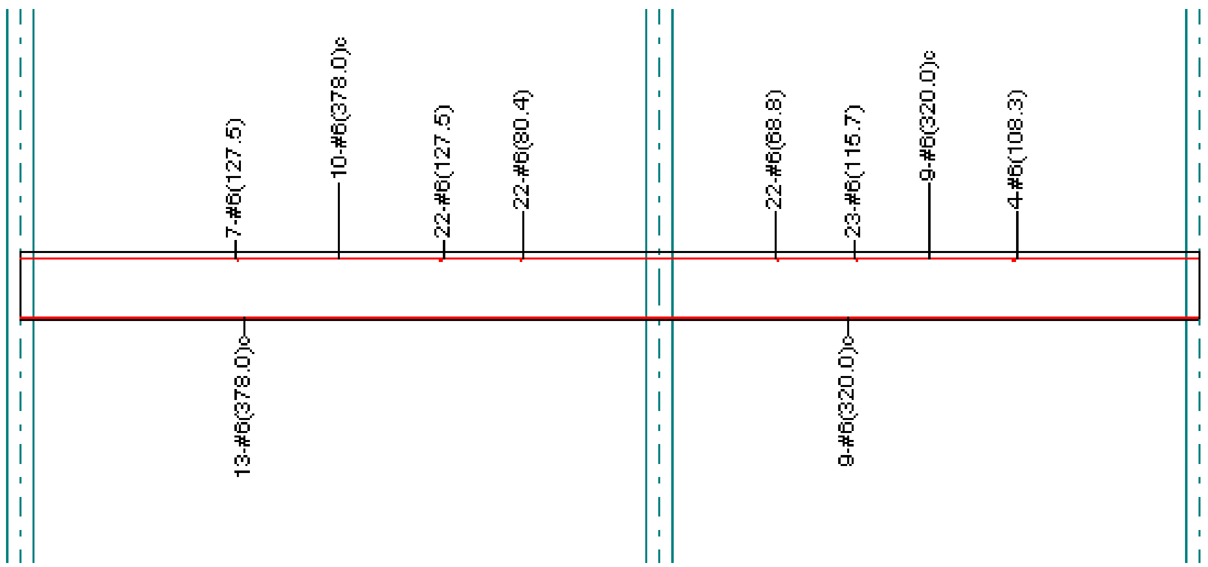
This is a deflection diagram for the slab. The largest deflection in the slab is 0.129".



This is a diagram of the top and bottom reinforcing that PCA Slab designed for the column strip and middle strip.



Middle Strip Flexural Reinforcement



Column Strip Flexural Reinforcement

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[2] DESIGN RESULTS

Top Reinforcement:

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

Span	Strip	Zone	Width	Mmax	Xmax	AsMin	AsMax	SpReq	AsReq	Bars	
1	Column	Left	14.75	274.26	0.667	3.186	33.381	10.412	7.093	17-#6	
		Middle	14.75	0.38	20.275	3.186	33.381	17.700	0.009	10-#6	*5
		Right	13.34	826.82	30.833	2.880	30.179	2.963	23.432	54-#6	
	Middle	Left	12.75	44.55	0.667	2.754	28.855	17.000	1.122	9-#6	*5
		Middle	12.75	0.10	20.275	2.754	28.855	17.000	0.003	9-#6	*5
		Right	14.16	275.61	30.833	3.060	32.057	9.999	7.140	17-#6	
2	Column	Left	13.34	770.80	0.667	2.880	30.179	2.963	21.624	54-#6	
		Middle	13.34	86.71	9.534	2.880	30.179	17.780	2.195	9-#6	*5
		Right	13.34	121.32	26.003	5.688	55.781	12.309	1.237	13-#6	
	Middle	Left	14.16	256.93	0.667	3.060	32.057	9.999	6.640	17-#6	
		Middle	14.16	28.90	9.534	3.060	32.057	16.998	0.726	10-#6	*5
		Right	14.16	40.44	26.003	3.060	32.057	16.998	1.017	10-#6	*5

NOTES:
*5 - Number of bars governed by maximum allowable spacing.

Top Bar Details:

Units: Length (ft)

		Left				Continuous		Right			
Span	Strip	Bars	Length	Bars	Length	Bars	Length	Bars	Length	Bars	Length
1	Column	7-#6	10.62	---		10-#6	31.50	22-#6	10.62	22-#6	6.70
	Middle	---		---		9-#6	31.50	8-#6	7.30	---	
2	Column	23-#6	9.65	22-#6	5.73	9-#6	26.67	4-#6	9.03	---	
	Middle	7-#6	6.24	---		10-#6	26.67	---		---	

Bottom Reinforcement:

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

Span	Strip	Width	Mmax	Xmax	AsMin	AsMax	SpReq	AsReq	Bars	
1	Column	14.75	222.18	12.750	3.186	33.381	13.615	5.710	13-#6	
	Middle	12.75	148.12	12.750	2.754	28.855	17.000	3.783	9-#6	
2	Column	13.34	144.67	16.196	2.880	30.179	17.780	3.690	9-#6	
	Middle	14.16	96.44	16.196	3.060	32.057	16.998	2.443	10-#6	*5

NOTES:
*5 - Number of bars governed by maximum allowable spacing.

Bottom Bar Details:

Units: Start (ft), Length (ft)

		Long Bars			Short Bars		
Span	Strip	Bars	Start	Length	Bars	Start	Length
1	Column	13-#6	0.00	31.50	---		
	Middle	7-#6	0.00	31.50	2-#6	4.72	22.05
2	Column	9-#6	0.00	26.67	---		
	Middle	7-#6	0.00	26.67	3-#6	4.00	18.67

Flexural Capacity:

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

Span	Strip	From	To	AsTop	AsBot	PhiMn-	PhiMn+
1	Column	0.000	0.667	7.48	5.72	-288.69	222.57
		0.667	8.610	7.48	5.72	-288.69	222.57
		8.610	10.622	4.40	5.72	-172.25	222.57
		10.622	11.225	4.40	5.72	-172.25	222.57
		11.225	15.750	4.40	5.72	-172.25	222.57
		15.750	20.275	4.40	5.72	-172.25	222.57
		20.275	20.878	4.40	5.72	-171.88	222.57
		20.878	22.970	4.40	5.72	-171.88	222.57
		22.970	24.799	14.08	5.72	-522.97	222.57
		24.799	26.891	14.08	5.72	-522.97	222.57
		26.891	30.833	23.76	5.72	-836.85	222.57
		30.833	31.500	23.76	5.72	-836.85	222.57
	Middle	0.000	0.667	3.96	3.08	-154.90	121.04
		0.667	4.725	3.96	3.08	-154.90	121.04
		4.725	6.752	3.96	3.08	-154.90	121.04
		6.752	11.225	3.96	3.96	-154.90	154.90
		11.225	15.750	3.96	3.96	-154.90	154.90
		15.750	20.275	3.96	3.96	-154.90	154.90
		20.275	24.196	3.96	3.96	-155.22	154.90
		24.196	24.748	3.96	3.96	-155.22	154.90
		24.748	26.221	3.96	3.08	-155.22	121.04
		26.221	26.775	7.48	3.08	-288.28	121.04
		26.775	30.833	7.48	3.08	-288.28	121.04
		30.833	31.500	7.48	3.08	-288.28	121.04
2	Column	0.000	0.667	23.76	3.96	-836.85	155.04
		0.667	3.804	23.76	3.96	-836.85	155.04
		3.804	5.735	14.08	3.96	-522.97	155.04
		5.735	7.715	14.08	3.96	-522.97	155.04
		7.715	9.534	3.96	3.96	-155.04	155.04
		9.534	9.645	3.96	3.96	-155.04	155.04
		9.645	13.335	3.96	3.96	-155.04	155.04
		13.335	17.136	3.96	3.96	-155.04	155.04
		17.136	17.642	3.96	3.96	-155.04	155.04
		17.642	18.642	3.96	3.96	-155.04	155.04
		18.642	21.670	5.72	3.96	-221.95	155.04
		21.670	26.003	5.72	3.96	-554.40	155.04
		26.003	26.670	5.72	3.96	-554.40	155.04
	Middle	0.000	0.667	7.48	3.08	-288.28	121.23
		0.667	4.000	7.48	3.08	-288.28	121.23
		4.000	4.358	7.48	3.08	-288.28	121.23
		4.358	5.178	4.40	3.08	-172.11	121.23
		5.178	6.241	4.40	4.40	-172.11	172.11
		6.241	9.534	4.40	4.40	-172.11	172.11
		9.534	13.335	4.40	4.40	-172.11	172.11
		13.335	17.136	4.40	4.40	-172.11	172.11
		17.136	21.492	4.40	4.40	-172.11	172.11
		21.492	22.670	4.40	3.08	-172.11	121.23
		22.670	26.003	4.40	3.08	-172.11	121.23
		26.003	26.670	4.40	3.08	-172.11	121.23

Slab Shear Capacity:

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

Span	b	d	Vratio	PhiVc	Vu	Xu

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1	330.00	8.88	1.000	310.64	162.32	30.09
2	330.00	8.88	1.000	310.64	150.43	1.41

Flexural Transfer of Negative Unbalanced Moment at Supports:

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

Supp	Width	GammaF*Munb	Comb	Pat	AsReq	AsProv	Additional Bars
1	85.00	271.48	U2	All	7.296	3.592	9-#6
2	85.00	103.29	U2	Odd	2.652	12.621	---
3	85.00	150.73	U2	Even	1.540	3.038	---

Punching Shear Around Columns:

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

Supp	Vu	vu	Munb	Comb	Pat	GammaV	vu	Phi*vc
1	125.43	77.4	250.04	U2	All	0.320	127.0	212.1
2	340.23	103.6	-82.62	U2	All	0.400	112.5	212.1
3	93.64	57.8	-110.25	U2	S3	0.320	79.7	212.1

Punching Shear Around Drops:

Units: Vu (kip), vu (psi), Phi*vc (psi)

Supp	Vu	Comb	Pat	vu	Phi*vc
1	108.12	U2	All	46.5	142.1
2	305.72	U2	All	67.8	142.1
3	84.74	U2	S3	36.5	142.1

Maximum Deflections:

Units: Dz (in)

	Frame			Column Strip			Middle Strip		
Span	Dz(DEAD)	Dz(LIVE)	Dz(TOTAL)	Dz(DEAD)	Dz(LIVE)	Dz(TOTAL)	Dz(DEAD)	Dz(LIVE)	Dz(TOTAL)
1	-0.074	-0.054	-0.128	-0.097	-0.071	-0.167	-0.047	-0.035	-0.082
2	-0.027	-0.018	-0.046	-0.038	-0.026	-0.064	-0.017	-0.012	-0.029

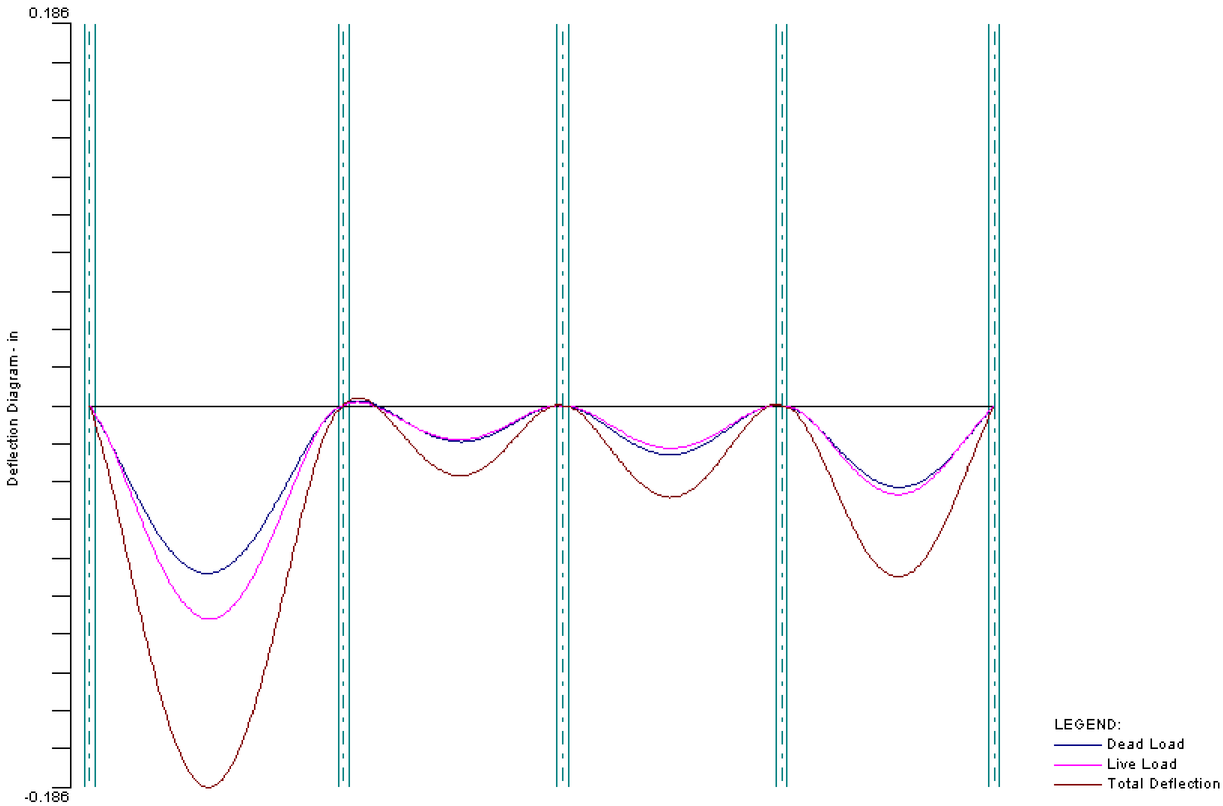
Material Takeoff:

Reinforcement in the Direction of Analysis

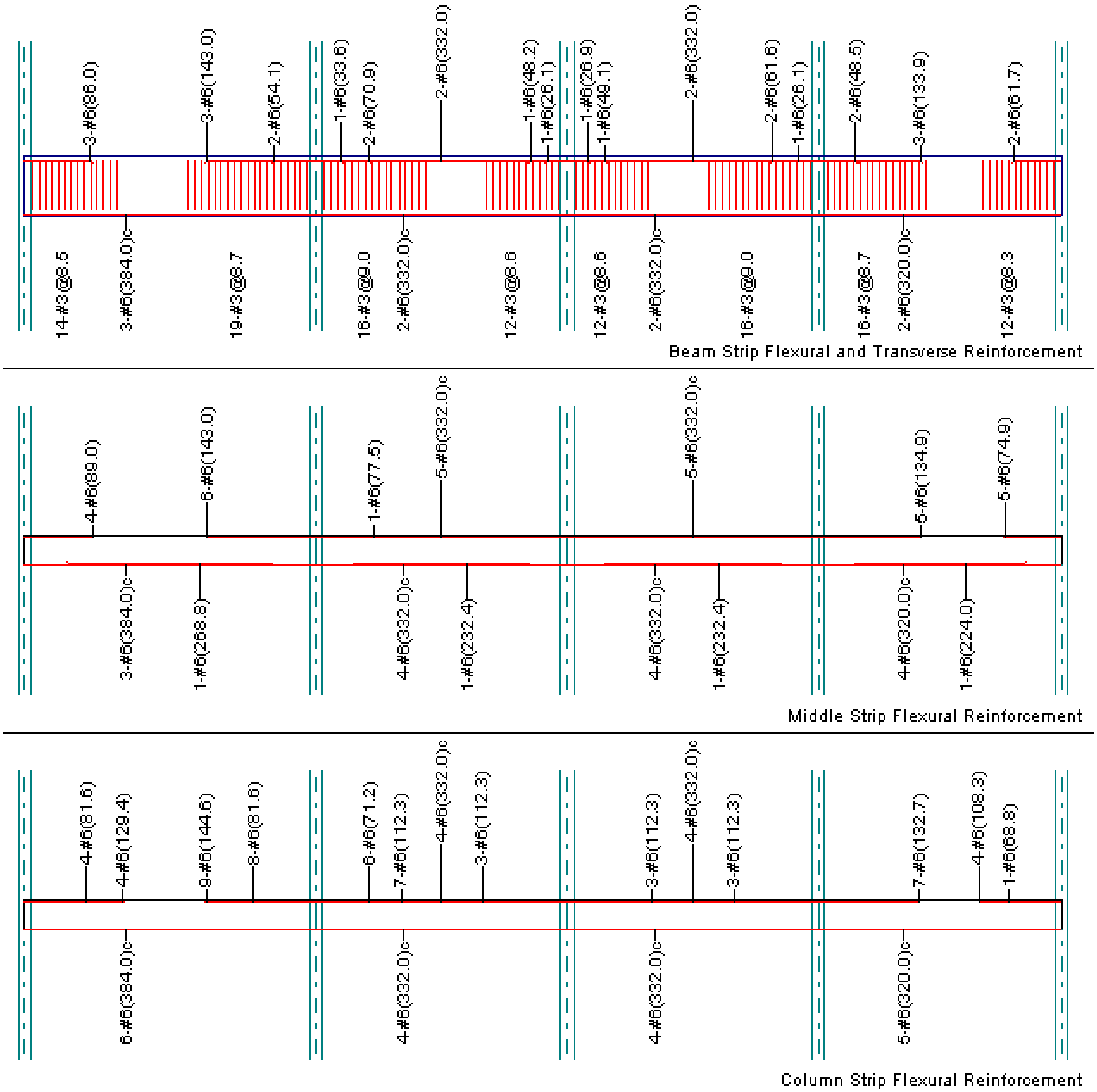
Top Bars:	3074.5 lb	<=>	52.85 lb/ft	<=>	1.922 lb/ft^2
Bottom Bars:	1737.6 lb	<=>	29.87 lb/ft	<=>	1.086 lb/ft^2
Stirrups:	0.0 lb	<=>	0.00 lb/ft	<=>	0.000 lb/ft^2
Total Steel:	4812.0 lb	<=>	82.72 lb/ft	<=>	3.008 lb/ft^2
Concrete:	1590.6 ft^3	<=>	27.34 ft^3/ft	<=>	0.994 ft^3/ft^2

Design Strip 1

This is a deflection diagram for the slab. The largest deflection in the slab is 0.186”.



This is a diagram of the top and bottom reinforcing that PCA Slab designed for the column strip and middle strip. This diagram also shows the reinforcing for the edge beam.



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[2] DESIGN RESULTS

Top Reinforcement:

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

Span	Strip	Zone	Width	Mmax	Xmax	AsMin	AsMax	SpReq	AsReq	Bars	
1	Column	Left	7.23	125.94	0.667	1.562	16.370	10.850	3.250	8-#6	
		Middle	7.23	0.00	16.000	0.000	16.370	0.000	0.000	---	
		Right	5.88	264.88	31.333	1.271	13.315	4.153	7.220	17-#6	
	Middle	Left	5.70	42.96	0.667	1.231	12.900	17.100	1.089	4-#6	*5
		Middle	5.70	0.00	16.000	0.000	12.900	0.000	0.000	---	
		Right	7.05	90.35	31.333	1.523	15.955	14.100	2.313	6-#6	
	Beam	Left	1.17	73.29	0.667	0.897	5.392	4.942	0.922	3-#6	
		Middle	1.17	0.00	16.000	0.000	5.392	0.000	0.000	---	
		Right	1.17	154.14	31.333	0.897	5.392	2.471	2.001	5-#6	
2	Column	Left	5.88	199.67	0.667	1.271	13.315	4.153	5.318	17-#6	
		Middle	5.88	14.53	9.884	1.271	13.315	17.650	0.365	4-#6	*5
		Right	5.88	138.96	27.003	2.815	30.680	10.086	1.422	7-#6	
	Middle	Left	7.05	74.41	0.667	1.523	15.955	14.100	1.897	6-#6	
		Middle	7.05	5.41	9.884	1.523	15.955	16.920	0.136	5-#6	*5
		Right	7.05	51.79	27.003	1.523	15.955	16.920	1.313	5-#6	*5
	Beam	Left	1.17	147.84	0.667	0.897	5.392	2.471	1.915	5-#6	
		Middle	1.17	10.76	9.884	0.176	5.392	9.884	0.132	2-#6	
		Right	1.17	102.89	27.003	0.897	5.392	3.295	1.309	4-#6	
3	Column	Left	5.88	141.80	0.667	2.815	30.680	10.086	1.451	7-#6	
		Middle	5.88	3.03	17.786	1.271	13.315	17.650	0.076	4-#6	*5
		Right	5.88	177.57	27.003	2.815	30.680	10.086	1.820	7-#6	
	Middle	Left	7.05	52.85	0.667	1.523	15.955	16.920	1.340	5-#6	*5
		Middle	7.05	1.13	17.786	1.523	15.955	16.920	0.028	5-#6	*5
		Right	7.05	66.17	27.003	1.523	15.955	16.920	1.684	5-#6	*5

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	Beam	Left	1.17	105.00	0.667	0.897	5.392	3.295	1.337	4-#6	
		Middle	1.17	2.25	17.786	0.037	5.392	9.884	0.028	2-#6	
		Right	1.17	131.48	27.003	0.897	5.392	2.471	1.692	5-#6	
4	Column	Left	5.88	186.86	0.667	2.815	30.680	10.086	1.916	7-#6	
		Middle	6.28	0.00	13.335	0.000	14.220	0.000	0.000	---	
		Right	6.28	52.78	26.003	1.357	14.220	15.080	1.341	5-#6	*5
	Middle	Left	7.05	71.73	0.667	1.523	15.955	16.920	1.828	5-#6	
		Middle	6.65	0.00	13.335	0.000	15.050	0.000	0.000	---	
		Right	6.65	20.26	26.003	1.436	15.050	15.960	0.510	5-#6	*5
	Beam	Left	1.17	147.64	0.667	0.897	5.392	2.471	1.912	5-#6	
		Middle	1.17	0.00	13.335	0.000	5.392	0.000	0.000	---	
		Right	1.17	41.70	26.003	0.690	5.392	9.884	0.519	2-#6	

NOTES:
*5 - Number of bars governed by maximum allowable spacing.

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

Units: Length (ft)

Span	Strip	Left				Continuous		Right			
		Bars	Length	Bars	Length	Bars	Length	Bars	Length	Bars	Length
1	Column	4-#6	10.79	4-#6	6.80	---		9-#6	12.05	8-#6	6.80
	Middle	4-#6	7.41	---		---		6-#6	11.92	---	
	Beam	3-#6	7.17	---		---		3-#6	11.92	2-#6	4.51
2	Column	7-#6	9.36	6-#6	5.93	4-#6	27.67	3-#6	9.36	---	
	Middle	1-#6	6.46	---		5-#6	27.67	---		---	
	Beam	2-#6	5.91	1-#6	2.80	2-#6	27.67	1-#6	4.01	1-#6	2.18
3	Column	3-#6	9.36	---		4-#6	27.67	3-#6	9.36	---	
	Middle	---		---		5-#6	27.67	---		---	
	Beam	1-#6	4.09	1-#6	2.24	2-#6	27.67	2-#6	5.13	1-#6	2.18
4	Column	7-#6	11.06	---		---		4-#6	9.03	1-#6	5.73
	Middle	5-#6	11.24	---		---		5-#6	6.24	---	
	Beam	3-#6	11.16	2-#6	4.04	---		2-#6	5.14	---	

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

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

Span	Strip	Width	Mmax	Xmax	AsMin	AsMax	SpReq	AsReq	Bars	
1	Column	7.23	94.79	14.250	1.562	16.370	14.467	2.428	6-#6	
	Middle	5.70	53.36	14.250	1.231	12.900	17.100	1.358	4-#6	
	Beam	1.17	55.16	14.250	0.897	5.392	4.942	0.690	3-#6	
2	Column	5.88	43.24	14.706	1.271	13.315	17.650	1.096	4-#6	*5
	Middle	7.05	25.26	14.706	1.523	15.955	16.920	0.636	5-#6	*5
	Beam	1.17	32.02	14.706	0.528	5.392	9.884	0.397	2-#6	
3	Column	5.88	47.15	13.213	1.271	13.315	17.650	1.197	4-#6	*5
	Middle	7.05	27.54	13.213	1.523	15.955	16.920	0.694	5-#6	*5
	Beam	1.17	34.91	13.213	0.576	5.392	9.884	0.433	2-#6	
4	Column	6.28	62.03	15.699	1.357	14.220	15.080	1.579	5-#6	*5
	Middle	6.65	36.75	15.699	1.436	15.050	15.960	0.929	5-#6	*5
	Beam	1.17	49.01	15.699	0.813	5.392	9.884	0.611	2-#6	

NOTES:
*5 - Number of bars governed by maximum allowable spacing.

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

Units: Start (ft), Length (ft)

Span	Strip	Long Bars			Short Bars		
		Bars	Start	Length	Bars	Start	Length
1	Column	6-#6	0.00	32.00	---		
	Middle	3-#6	0.00	32.00	1-#6	4.80	22.40
	Beam	3-#6	0.00	32.00	---		
2	Column	4-#6	0.00	27.67	---		
	Middle	4-#6	0.00	27.67	1-#6	4.15	19.37
	Beam	2-#6	0.00	27.67	---		
3	Column	4-#6	0.00	27.67	---		
	Middle	4-#6	0.00	27.67	1-#6	4.15	19.37
	Beam	2-#6	0.00	27.67	---		
4	Column	5-#6	0.00	26.67	---		
	Middle	4-#6	0.00	26.67	1-#6	4.00	18.67
	Beam	2-#6	0.00	26.67	---		

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

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

Span	Strip	From	To	AsTop	AsBot	PhiMn-	PhiMn+
1	Column	0.000	0.667	3.52	2.64	-136.05	102.88
		0.667	4.842	3.52	2.64	-136.05	102.88
		4.842	6.801	1.76	2.64	-69.16	102.88
		6.801	8.828	1.76	2.64	-69.16	102.88
		8.828	10.787	0.00	2.64	0.00	102.88
		10.787	11.400	0.00	2.64	0.00	102.88
		11.400	16.000	0.00	2.64	0.00	102.88
		16.000	19.953	0.00	2.64	0.00	102.88
		19.953	20.600	0.00	2.64	0.00	102.88
		20.600	22.000	0.00	2.64	0.00	102.88
		22.000	25.199	3.96	2.64	-151.10	102.88
		25.199	27.247	3.96	2.64	-151.10	102.88
		27.247	31.333	7.48	2.64	-273.56	102.88
		31.333	32.000	7.48	2.64	-273.56	102.88
	Middle	0.000	0.667	1.76	1.32	-68.85	51.91
		0.667	4.800	1.76	1.32	-68.85	51.91
		4.800	6.101	1.76	1.32	-68.85	51.91
		6.101	6.436	0.00	1.32	0.00	51.91
		6.436	7.414	0.00	1.76	0.00	68.85
		7.414	11.400	0.00	1.76	0.00	68.85
		11.400	16.000	0.00	1.76	0.00	68.85
		16.000	20.083	0.00	1.76	0.00	68.85
		20.083	20.600	0.00	1.76	0.00	68.85
		20.600	21.942	0.00	1.76	0.00	68.85
		21.942	25.564	2.64	1.76	-102.82	68.85
		25.564	27.200	2.64	1.32	-102.82	51.91
		27.200	31.333	2.64	1.32	-102.82	51.91
		31.333	32.000	2.64	1.32	-102.82	51.91
	Beam	0.000	0.667	1.32	1.32	-103.71	103.71
		0.667	6.167	1.32	1.32	-103.71	103.71
		6.167	7.167	0.00	1.32	0.00	103.71
		7.167	11.400	0.00	1.32	0.00	103.71
		11.400	16.000	0.00	1.32	0.00	103.71
		16.000	20.083	0.00	1.32	0.00	103.71
		20.083	20.600	0.00	1.32	0.00	103.71
		20.600	21.841	0.00	1.32	0.00	103.71
		21.841	27.493	1.32	1.32	-103.71	103.71
		27.493	29.250	1.32	1.32	-103.71	103.71
		29.250	31.333	2.20	1.32	-168.46	103.71
		31.333	32.000	2.20	1.32	-168.46	103.71
2	Column	0.000	0.667	7.48	1.76	-273.56	68.90
		0.667	4.426	7.48	1.76	-273.56	68.90
		4.426	5.935	4.84	1.76	-182.76	68.90
		5.935	7.850	4.84	1.76	-182.76	68.90
		7.850	9.358	1.76	1.76	-68.90	68.90
		9.358	9.884	1.76	1.76	-68.90	68.90
		9.884	13.835	1.76	1.76	-68.90	68.90
		13.835	17.786	1.76	1.76	-68.90	68.90
		17.786	18.312	1.76	1.76	-68.90	68.90
		18.312	19.312	1.76	1.76	-68.90	68.90
		19.312	22.670	3.08	1.76	-118.74	68.90
		22.670	27.003	3.08	1.76	-298.62	68.90
		27.003	27.670	3.08	1.76	-298.62	68.90
	Middle	0.000	0.667	2.64	1.76	-102.82	69.13
		0.667	4.150	2.64	1.76	-102.82	69.13
		4.150	4.937	2.64	1.76	-102.82	69.13
		4.937	5.150	2.20	1.76	-86.05	69.13
		5.150	6.461	2.20	2.20	-86.05	86.05
		6.461	9.884	2.20	2.20	-86.05	86.05
		9.884	13.835	2.20	2.20	-86.05	86.05
		13.835	17.786	2.20	2.20	-86.05	86.05
		17.786	22.520	2.20	2.20	-86.05	86.05
		22.520	23.520	2.20	1.76	-86.05	69.13
		23.520	27.003	2.20	1.76	-86.05	69.13
		27.003	27.670	2.20	1.76	-86.05	69.13
	Beam	0.000	0.667	2.20	0.88	-168.46	70.02
		0.667	1.121	2.20	0.88	-168.46	70.02
		1.121	2.802	1.76	0.88	-136.52	70.02
		2.802	4.231	1.76	0.88	-136.52	70.02
		4.231	5.912	0.88	0.88	-70.02	70.02
		5.912	9.884	0.88	0.88	-70.02	70.02
		9.884	13.835	0.88	0.88	-70.02	70.02
		13.835	17.786	0.88	0.88	-70.02	70.02
		17.786	23.657	0.88	0.88	-70.02	70.02
		23.657	24.735	0.88	0.88	-70.02	70.02
		24.735	25.493	1.32	0.88	-103.71	70.02
		25.493	26.571	1.32	0.88	-103.71	70.02
		26.571	27.003	1.76	0.88	-136.52	70.02

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	27.003	27.670	1.76	0.88	-136.52	70.02
3 Column	0.000	0.667	3.08	1.76	-298.62	68.90
	0.667	5.000	3.08	1.76	-298.62	68.90
	5.000	8.358	3.08	1.76	-118.74	68.90
	8.358	9.358	1.76	1.76	-68.90	68.90
	9.358	9.884	1.76	1.76	-68.90	68.90
	9.884	13.835	1.76	1.76	-68.90	68.90
	13.835	17.786	1.76	1.76	-68.90	68.90
	17.786	18.312	1.76	1.76	-68.90	68.90
	18.312	19.565	1.76	1.76	-68.90	68.90
	19.565	22.670	3.08	1.76	-118.74	68.90
	22.670	27.003	3.08	1.76	-298.62	68.90
	27.003	27.670	3.08	1.76	-298.62	68.90
Middle	0.000	0.667	2.20	1.76	-86.05	69.13
	0.667	4.150	2.20	1.76	-86.05	69.13
	4.150	5.150	2.20	1.76	-86.05	69.13
	5.150	9.884	2.20	2.20	-86.05	86.05
	9.884	13.835	2.20	2.20	-86.05	86.05
	13.835	17.786	2.20	2.20	-86.05	86.05
	17.786	22.520	2.20	2.20	-86.05	86.05
	22.520	23.520	2.20	1.76	-86.05	69.13
	23.520	27.003	2.20	1.76	-86.05	69.13
	27.003	27.670	2.20	1.76	-86.05	69.13
Beam	0.000	0.667	1.76	0.88	-136.52	70.02
	0.667	1.138	1.76	0.88	-136.52	70.02
	1.138	2.238	1.32	0.88	-103.71	70.02
	2.238	2.994	1.32	0.88	-103.71	70.02
	2.994	4.094	0.88	0.88	-70.02	70.02
	4.094	9.884	0.88	0.88	-70.02	70.02
	9.884	13.835	0.88	0.88	-70.02	70.02
	13.835	17.786	0.88	0.88	-70.02	70.02
	17.786	22.535	0.88	0.88	-70.02	70.02
	22.535	24.021	0.88	0.88	-70.02	70.02
	24.021	25.493	1.76	0.88	-136.52	70.02
	25.493	26.978	1.76	0.88	-136.52	70.02
	26.978	27.003	2.20	0.88	-168.46	70.02
	27.003	27.670	2.20	0.88	-168.46	70.02
4 Column	0.000	0.667	3.08	2.20	-298.62	85.82
	0.667	5.000	3.08	2.20	-298.62	85.82
	5.000	9.534	3.08	2.20	-118.74	85.82
	9.534	9.742	3.08	2.20	-119.01	85.82
	9.742	11.062	0.00	2.20	0.00	85.82
	11.062	13.335	0.00	2.20	0.00	85.82
	13.335	17.136	0.00	2.20	0.00	85.82
	17.136	17.642	0.00	2.20	0.00	85.82
	17.642	18.934	0.00	2.20	0.00	85.82
	18.934	20.935	1.76	2.20	-68.99	85.82
	20.935	22.228	1.76	2.20	-68.99	85.82
	22.228	26.003	2.20	2.20	-85.82	85.82
	26.003	26.670	2.20	2.20	-85.82	85.82
Middle	0.000	0.667	2.20	1.76	-86.05	69.06
	0.667	4.000	2.20	1.76	-86.05	69.06
	4.000	5.000	2.20	1.76	-86.05	69.06
	5.000	9.479	2.20	2.20	-86.05	85.94
	9.479	9.534	0.00	2.20	0.00	85.94
	9.534	11.241	0.00	2.20	0.00	85.94
	11.241	13.335	0.00	2.20	0.00	85.94
	13.335	17.136	0.00	2.20	0.00	85.94
	17.136	20.429	0.00	2.20	0.00	85.94
	20.429	21.429	0.00	2.20	0.00	85.94
	21.429	21.670	2.20	2.20	-85.94	85.94
	21.670	22.670	2.20	1.76	-85.94	69.06
	22.670	26.003	2.20	1.76	-85.94	69.06
	26.003	26.670	2.20	1.76	-85.94	69.06
Beam	0.000	0.667	2.20	0.88	-168.46	70.02
	0.667	2.363	2.20	0.88	-168.46	70.02
	2.363	4.041	1.32	0.88	-103.71	70.02
	4.041	9.479	1.32	0.88	-103.71	70.02
	9.479	9.534	0.00	0.88	0.00	70.02
	9.534	11.157	0.00	0.88	0.00	70.02
	11.157	13.335	0.00	0.88	0.00	70.02
	13.335	17.136	0.00	0.88	0.00	70.02
	17.136	21.531	0.00	0.88	0.00	70.02
	21.531	22.531	0.00	0.88	0.00	70.02
	22.531	26.003	0.88	0.88	-70.02	70.02
	26.003	26.670	0.88	0.88	-70.02	70.02

Longitudinal Beam Shear Reinforcement Required:

Units: d (in), Start, End, Xu (ft), PhiVc, Vu (kip), Av/s (in^2/in)

Span	d	PhiVc	Start	End	Vu	Xu	Av/s
1	18.13	26.91	2.177	6.126	25.77	2.177	0.0124

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			6.126	10.076	16.76	6.126	0.0124
			10.076	14.025	8.56	10.076	0.0000
			14.025	17.975	7.85	17.975	0.0000
			17.975	21.924	16.05	21.924	0.0124
			21.924	25.874	24.26	25.874	0.0124
			25.874	29.823	33.49	29.823	0.0124
2	18.13	26.91	2.177	5.508	31.96	2.177	0.0124
			5.508	8.839	22.76	5.508	0.0124
			8.839	12.170	14.76	8.839	0.0124
			12.170	15.500	6.99	12.170	0.0000
			15.500	18.831	10.62	18.831	0.0000
			18.831	22.162	17.68	22.162	0.0124
			22.162	25.493	26.44	25.493	0.0124
3	18.13	26.91	2.177	5.508	27.57	2.177	0.0124
			5.508	8.839	18.37	5.508	0.0124
			8.839	12.170	11.16	8.839	0.0000
			12.170	15.500	5.90	15.500	0.0000
			15.500	18.831	13.64	18.831	0.0124
			18.831	22.162	21.64	22.162	0.0124
			22.162	25.493	30.83	25.493	0.0124
4	18.13	26.91	2.177	5.365	35.07	2.177	0.0124
			5.365	8.553	25.89	5.365	0.0124
			8.553	11.741	17.94	8.553	0.0124
			11.741	14.929	10.00	11.741	0.0000
			14.929	18.117	6.60	18.117	0.0000
			18.117	21.305	13.84	21.305	0.0124
			21.305	24.493	22.75	24.493	0.0124

Longitudinal Beam Shear Reinforcement Details:

Units: spacing & distance (in).

Span	Size	Stirrups (2 legs each unless otherwise noted)
1	#3	14 @ 8.5 + <-- 94.8 --> + 19 @ 8.7
2	#3	16 @ 9.0 + <-- 79.9 --> + 12 @ 8.6
3	#3	12 @ 8.6 + <-- 79.9 --> + 16 @ 9.0
4	#3	16 @ 8.7 + <-- 76.5 --> + 12 @ 8.3

Beam Shear Capacity:

Units: d, Sp (in), Start, End, Xu (ft), PhiVc, PhiVn, Vu (kip), Av/s (in^2/in)

Span	d	PhiVc	Start	End	Av/s	Sp	PhiVn	Vu	Xu
1	18.13	26.91	0.000	0.917	-----	-----	48.14	31.41	0.000
			0.917	10.076	0.0260	8.5	48.14	25.77	2.177
			10.076	17.975	-----	-----	13.46	8.56	10.076
			17.975	31.083	0.0252	8.7	47.45	33.49	29.823
			31.083	32.000	-----	-----	47.45	38.81	32.000
2	18.13	26.91	0.000	0.917	-----	-----	46.85	38.11	0.000
			0.917	12.170	0.0244	9.0	46.85	31.96	2.177
			12.170	18.831	-----	-----	13.46	10.62	18.831
			18.831	26.753	0.0255	8.6	47.68	26.44	25.493
			26.753	27.670	-----	-----	47.68	32.59	27.670
3	18.13	26.91	0.000	0.917	-----	-----	47.68	33.72	0.000
			0.917	8.839	0.0255	8.6	47.68	27.57	2.177
			8.839	15.500	-----	-----	13.46	11.16	8.839
			15.500	26.753	0.0244	9.0	46.85	30.83	25.493
			26.753	27.670	-----	-----	46.85	36.98	27.670
4	18.13	26.91	0.000	0.917	-----	-----	47.64	41.45	0.000
			0.917	11.741	0.0254	8.7	47.64	35.07	2.177
			11.741	18.117	-----	-----	13.46	10.00	11.741
			18.117	25.753	0.0264	8.3	48.45	22.75	24.493
			25.753	26.670	-----	-----	48.45	29.52	26.670

Slab Shear Capacity:

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

Span	b	d	Vratio	PhiVc	Vu	Xu
1	155.20	8.88	0.567	146.10	46.36	30.59
2	155.20	8.88	0.499	146.10	34.07	1.41
3	155.20	8.88	0.499	146.10	32.94	26.26
4	155.20	8.88	0.481	146.10	34.56	1.41

Flexural Transfer of Negative Unbalanced Moment at Supports:

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

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Supp	Width	GammaF*Munb	Comb	Pat	AsReq	AsProv	Additional Bars
1	52.10	192.59	U2	All	5.242	2.113	8-#6
2	52.10	87.24	U2	Odd	2.263	5.520	---
3	52.10	48.65	U2	Odd	0.496	2.273	---
4	52.10	54.18	U2	Even	0.552	2.273	---
5	52.10	97.95	U2	Even	2.552	1.520	3-#6

Punching Shear Around Columns:

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

Supp	Vu	vu	Munb	Comb	Pat	GammaV	vu	Phi*vc
1	71.89	82.6	235.15	U2	All	0.333	201.1	212.1
2	164.49	100.6	-92.98	U2	All	0.414	129.2	212.1
3	131.16	80.2	16.72	U2	All	0.414	85.6	212.1
4	152.44	100.8	45.57	U2	All	0.414	116.8	212.1
5	52.80	78.8	-104.10	U2	Even	0.342	173.9	212.1

Punching Shear Around Drops:

Units: Vu (kip), vu (psi), Phi*vc (psi)

Supp	Vu	Comb	Pat	vu	Phi*vc
1	62.34	U2	All	32.4	175.8
2	143.91	U2	All	38.6	146.9
3	115.51	U2	S3	26.9	151.8
4	132.34	U2	All	35.3	147.3
5	47.44	U2	S5	37.1	175.8

Maximum Deflections:

Units: Dz (in)

	Frame			Column Strip			Middle Strip		
Span	Dz(DEAD)	Dz(LIVE)	Dz(TOTAL)	Dz(DEAD)	Dz(LIVE)	Dz(TOTAL)	Dz(DEAD)	Dz(LIVE)	Dz(TOTAL)
1	-0.082	-0.104	-0.186	-0.082	-0.105	-0.187	-0.089	-0.113	-0.202
2	-0.018	-0.017	-0.034	-0.019	-0.018	-0.037	-0.015	-0.014	-0.029
3	-0.024	-0.021	-0.045	-0.026	-0.023	-0.049	-0.020	-0.018	-0.038
4	-0.040	-0.043	-0.083	-0.043	-0.046	-0.089	-0.036	-0.039	-0.075

Material Takeoff:

Reinforcement in the Direction of Analysis

Top Bars:	2251.9 lb	<=>	19.75 lb/ft	<=>	1.401 lb/ft^2
Bottom Bars:	1968.5 lb	<=>	17.27 lb/ft	<=>	1.225 lb/ft^2
Stirrups:	681.9 lb	<=>	5.98 lb/ft	<=>	0.424 lb/ft^2
Total Steel:	4902.2 lb	<=>	43.00 lb/ft	<=>	3.050 lb/ft^2
Concrete:	1655.4 ft^3	<=>	14.52 ft^3/ft	<=>	1.030 ft^3/ft^2

Appendix C:

Composite Steel

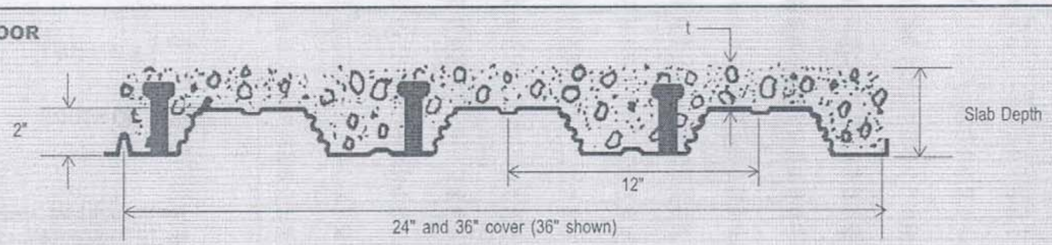
Composite Slab Design

The United Steel Deck design manual was used as a design aid as described in the report.

2 x 12" DECK F_y = 33ksi f'_c = 3 ksi 115 pcf concrete

USD United Steel Deck, Inc. LRFD

2" LOK-FLOOR



The **Deck Section Properties** are per foot of width. The **I** value is for positive bending (in.[4]); **t** is the gage thickness in inches; **w** is the weight in pounds per square foot; S_p and S_n are the section moduli for positive and negative bending (in.[3]); R_b and ϕV_n are the interior reaction and the shear in pounds (per foot of width); studs is the number of studs required per foot in order to obtain the full resisting moment, ϕM_{nf}.

DECK PROPERTIES									
Gage	t	w	As	I	S_p	S_n	R_b	ϕV_n	studs
22	0.0295	1.5	0.440	0.338	0.284	0.302	714	1990	0.43
20	0.0358	1.8	0.540	0.420	0.367	0.387	1010	2410	0.52
19	0.0418	2.1	0.630	0.490	0.445	0.458	1330	2810	0.61
18	0.0474	2.4	0.710	0.560	0.523	0.529	1680	3180	0.69
16	0.0598	3.1	0.900	0.700	0.654	0.654	2470	3990	0.87

The **Composite Properties** are a list of values for the composite slab. The **slab depth** is the distance from the bottom of the steel deck to the top of the slab in inches as shown on the sketch. U.L. ratings generally refer to the cover over the top of the deck so it is important to be aware of the difference in names. ϕM_{nf} is the factored resisting moment provided by the composite slab when the "full" number of studs as shown in the upper table are in place; inch kips (per foot of width). A_c is the area of concrete available to resist shear, in.[2] per foot of width. **Vol.** is the volume of concrete in ft.[3] per ft.[2] needed to make up the slab; no allowance for frame or deck deflection is included. **W** is the concrete weight in pounds per ft.[2]. S_c is the section modulus of the "cracked" concrete composite slab; in.[3] per foot of width. I_{av} is the average of the "cracked" and "uncracked" moments of inertia of the transformed composite slab; in.[4] per foot of width. The I_{av} transformed section analysis is based on steel; therefore, to calculate deflections the appropriate modulus of elasticity to use is 29.5 x 10[6] psi. ϕM_{no} is the factored resisting moment of the composite slab if there are no studs on the beams (the deck is attached to the beams or walls on which it is resting) inch kips (per foot of width). ϕV_{nt} is the factored vertical shear resistance of the composite system; it is the sum of the shear resistances of the steel deck and the concrete but is not allowed to exceed $\phi 4(f'_c)^{1/2}A_c$; pounds (per foot of width). The next three columns list the **maximum unshored spans** in feet; these values are obtained by using the construction loading requirements of the SDI; combined bending and shear, deflection, and interior reactions are considered in calculating these values. A_{wwf} is the minimum area of welded wire fabric recommended for temperature reinforcing in the composite slab; square inches per foot.

COMPOSITE PROPERTIES													
	Slab Depth	ϕM_{nf} in.k	A_c in²	Vol. ft³/ft²	W psf	S_c in³	I_{av} in³	ϕM_{no} in.k	ϕV_{nt} lbs.	Max. unshored spans, ft. 1span	2span	3span	A_{wwf}
22 gage	4.50	40.27	32.6	0.292	34	1.00	4.4	28.13	4270	6.32	8.46	8.56	0.023
	5.00	46.44	37.5	0.333	38	1.18	6.0	33.12	4610	6.03	8.09	8.19	0.027
	5.25	49.53	40.0	0.354	41	1.27	6.9	35.69	4790	5.90	7.93	8.02	0.029
	5.50	52.61	42.6	0.375	43	1.36	7.9	38.29	4970	5.77	7.77	7.86	0.032
	6.00	58.78	48.0	0.417	48	1.55	10.1	43.58	5340	5.55	7.49	7.58	0.036
	6.25	61.87	50.8	0.438	50	1.65	11.3	46.26	5540	5.45	7.36	7.45	0.038
	6.50	64.95	53.6	0.458	53	1.75	12.7	48.97	5730	5.36	7.24	7.32	0.041
	7.00	71.12	59.5	0.500	58	1.94	15.7	54.44	6150	5.18	7.01	7.10	0.045
	7.25	74.21	61.9	0.521	60	2.04	17.4	57.20	6310	5.10	6.91	6.99	0.047
	7.50	77.29	64.3	0.542	62	2.14	19.2	59.97	6480	5.05	6.81	6.89	0.050
20 gage	4.50	48.60	32.6	0.292	34	1.20	4.8	33.77	4560	7.42	9.71	10.03	0.023
	5.00	56.18	37.5	0.333	38	1.42	6.5	39.80	5030	7.07	9.28	9.59	0.027
	5.25	59.96	40.0	0.354	41	1.53	7.4	42.91	5210	6.91	9.09	9.39	0.029
	5.50	63.75	42.6	0.375	43	1.64	8.5	46.05	5390	6.76	8.91	9.20	0.032
	6.00	71.32	48.0	0.417	48	1.87	10.9	52.47	5760	6.49	8.57	8.86	0.036
	6.25	75.11	50.8	0.438	50	1.99	12.2	55.73	5960	6.37	8.42	8.70	0.038
	6.50	78.90	53.6	0.458	53	2.10	13.7	59.02	6150	6.26	8.27	8.55	0.041
	7.00	86.47	59.5	0.500	58	2.34	16.9	65.67	6570	6.05	8.00	8.27	0.045
	7.25	90.26	61.9	0.521	60	2.46	18.7	69.03	6730	5.95	7.87	8.14	0.047
	7.50	94.05	64.3	0.542	62	2.58	20.6	72.41	6900	5.89	7.75	8.01	0.050
19 gage	4.50	55.85	32.6	0.292	34	1.38	5.1	38.67	4560	8.35	10.55	10.91	0.023
	5.00	64.68	37.5	0.333	38	1.63	6.9	45.61	5240	7.94	10.10	10.43	0.027
	5.25	69.10	40.0	0.354	41	1.75	7.9	49.19	5590	7.76	9.89	10.22	0.029
	5.50	73.52	42.6	0.375	43	1.88	9.0	52.83	5790	7.59	9.69	10.01	0.032
	6.00	82.35	48.0	0.417	48	2.15	11.6	60.25	6160	7.29	9.33	9.64	0.036
	6.25	86.77	50.8	0.438	50	2.28	13.0	64.02	6360	7.15	9.16	9.47	0.038
	6.50	91.19	53.6	0.458	53	2.42	14.5	67.83	6550	7.02	9.00	9.30	0.041
	7.00	100.03	59.5	0.500	58	2.69	17.9	75.53	6970	6.78	8.71	9.00	0.045
	7.25	104.44	61.9	0.521	60	2.83	19.8	79.42	7130	6.67	8.57	8.86	0.047
	7.50	108.86	64.3	0.542	62	2.97	21.8	83.33	7300	6.59	8.44	8.72	0.050
18 gage	4.50	62.08	32.6	0.292	34	1.53	5.4	42.99	4560	9.20	11.33	11.71	0.023
	5.00	72.04	37.5	0.333	38	1.81	7.3	50.72	5240	8.75	10.84	11.20	0.027
	5.25	77.02	40.0	0.354	41	1.95	8.3	54.72	5590	8.54	10.62	10.97	0.029
	5.50	82.00	42.6	0.375	43	2.10	9.5	58.78	5950	8.35	10.41	10.76	0.032
	6.00	91.95	48.0	0.417	48	2.39	12.1	67.07	6530	8.01	10.02	10.36	0.036
	6.25	96.93	50.8	0.438	50	2.54	13.6	71.29	6730	7.86	9.84	10.17	0.038
	6.50	101.91	53.6	0.458	53	2.69	15.2	75.55	6920	7.71	9.68	10.00	0.041
	7.00	111.87	59.5	0.500	58	3.00	18.8	84.17	7340	7.44	9.36	9.67	0.045
	7.25	116.85	61.9	0.521	60	3.16	20.7	88.52	7500	7.32	9.21	9.52	0.047
	7.50	121.83	64.3	0.542	62	3.31	22.8	92.91	7670	7.24	9.07	9.38	0.050

Beam Design Results

The beams that were being designed for the representative bay are highlighted in the reports.

Beam Summary

RAM Steel v11.0
DataBase: Newman
Building Code: IBC

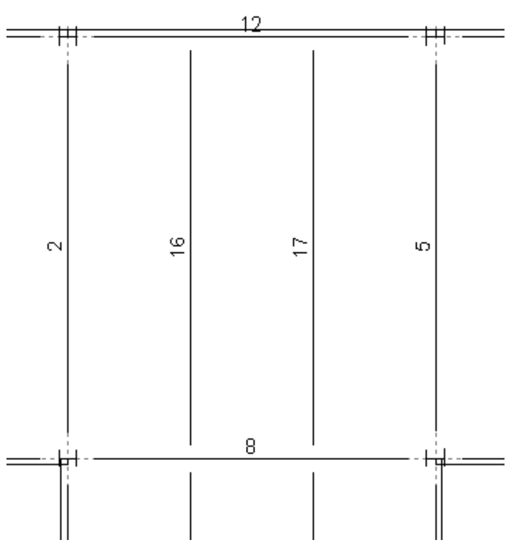
12/22/07 04:54:36
Steel Code: ASD 9th Ed.

STEEL BEAM DESIGN SUMMARY:

Floor Type: Typical

Bm #	Length ft	+M kip-ft	-M kip-ft	Seff in3	Fy ksi	Beam Size	Studs
3	31.53	156.0	0.0	63.8	50.0	W16X26	24
7	24.60	192.4	0.0	81.7	50.0	W18X35 u	7, 1, 7
11	24.60	222.6	0.0	81.7	50.0	W18X35 u	7, 1, 7
14	31.53	177.8	0.0	65.5	50.0	W16X26	22
15	31.53	177.8	0.0	65.5	50.0	W16X26	22
1	26.67	82.7	0.0	30.9	50.0	W12X14	14
10	27.50	243.9	0.0	89.8	50.0	W18X35 u	11, 2, 11
2	31.53	186.0	0.0	67.9	50.0	W16X26	26
8	27.50	380.7	0.0	139.5	50.0	W21X48 u	16, 1, 16
12	27.50	273.0	0.0	105.1	50.0	W18X35	25, 4, 25
20	26.67	143.1	0.0	52.5	50.0	W14X22	20
16	31.53	194.3	0.0	71.8	50.0	W16X26	32
21	26.67	143.1	0.0	52.5	50.0	W14X22	20
17	31.53	194.3	0.0	71.8	50.0	W16X26	32
4	26.67	82.7	0.0	30.9	50.0	W12X14	14
5	31.53	194.3	0.0	71.8	50.0	W16X26	32
9	27.50	235.2	0.0	91.2	50.0	W18X35	13, 1, 13
13	27.50	273.0	0.0	105.1	50.0	W18X35	25, 4, 25
18	31.53	194.3	0.0	71.8	50.0	W16X26	32
19	31.53	194.3	0.0	71.8	50.0	W16X26	32
6	31.53	166.8	0.0	71.2	50.0	W16X26	36

* after Size denotes beam failed stress/capacity criteria.
# after Size denotes beam failed deflection criteria.
u after Size denotes this size has been assigned by the User.



Beam Deflection Summary

RAM Steel v11.0
DataBase: Newman
Building Code: IBC

12/22/07 04:54:36
Steel Code: ASD 9th Ed.

STEEL BEAM DEFLECTION SUMMARY:

Floor Type: Typical

Composite / Unshored

Bm #	Beam Size	Initial in	PostLive in	PostTotal in	NetTotal in	Camber in
3	W16X26	0.832	0.368	0.744	1.575	
7	W18X35	0.584	0.323	0.378	0.962	
11	W18X35	0.584	0.323	0.475	1.059	
14	W16X26	1.430	0.554	0.645	1.076	1
15	W16X26	1.430	0.554	0.645	1.076	1
1	W12X14	1.533	0.499	0.573	1.107	1
10	W18X35	0.773	0.364	0.551	1.324	
2	W16X26	1.511	0.541	0.632	1.143	1
8	W21X48	0.853	0.327	0.397	1.250	
12	W18X35	0.908	0.311	0.462	1.371	
20	W14X22	1.224	0.445	0.516	0.990	3/4
16	W16X26	1.591	0.511	0.599	0.940	1-1/4
21	W14X22	1.224	0.445	0.516	0.990	3/4
17	W16X26	1.591	0.511	0.599	0.940	1-1/4
4	W12X14	1.533	0.499	0.573	1.107	1
5	W16X26	1.591	0.511	0.599	0.940	1-1/4
9	W18X35	0.908	0.394	0.463	1.371	
13	W18X35	0.908	0.311	0.462	1.371	
18	W16X26	1.591	0.511	0.599	0.940	1-1/4
19	W16X26	1.591	0.511	0.599	0.940	1-1/4
6	W16X26	0.912	0.339	0.657	1.569	

Appendix D:

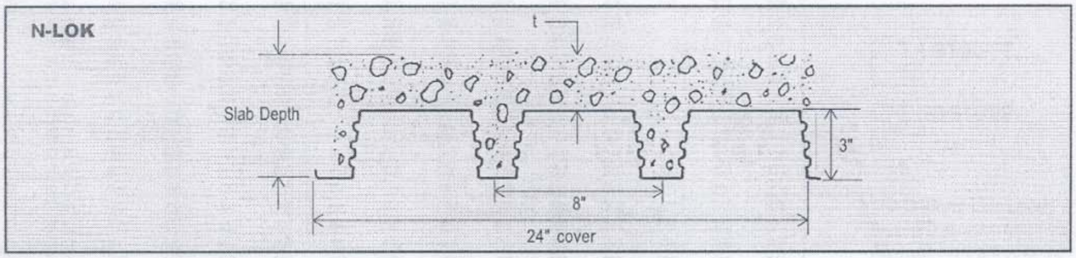
Non-Composite Steel

Non-Composite Slab Design

The United Steel Deck design manual was used as a design aid as described in the report.

NO STUDS F_y = 33ksi f'_c = 3 ksi 145 and 115 pcf concrete

LRFD



DECK PROPERTIES

Gage	t	w	As	I	S_p	S_n	R_b	ϕV_n
22	0.0295	2.0	0.586	0.636	0.374	0.424	1090	3410
20	0.0358	2.4	0.712	0.819	0.492	0.541	1580	5020
19	0.0418	2.8	0.831	1.001	0.584	0.647	2112	6000
18	0.0474	3.2	0.942	1.194	0.680	0.740	2700	6980
16	0.0598	4.0	1.189	1.624	0.882	0.933	4020	8770

The **Deck Section Properties** are per foot of width. The **I** value is for positive bending (in.[4]); **t** is the gage thickness in inches; **w** is the weight in pounds per square foot; S_p and S_n are the section moduli for positive and negative bending (in.[3]); R_b and ϕV_n are the interior reaction and the shear in pounds (per foot of width).

COMPOSITE PROPERTIES

			Normal Weight Concrete (145 pcf)								Light Weight Concrete (115 pcf)							
								Max. unshored spans, ft.								Max. unshored spans, ft.		
Gage	Slab Depth	A in²	W psf	S_c in³	I_{av} in⁴	ϕM_{no} in.k	ϕV_{nt} lbs.	1 span	2 span	3 span	W psf	S_c in³	I_{av} in⁴	ϕM_{no} in.k	ϕV_{nt} lbs.	1 span	2 span	3 span
22 gage	5.50	21.1	40	1.20	7.4	33.63	3930	7.01	9.45	9.56	32	1.13	5.7	31.67	2950	7.63	10.24	10.37
	6.00	23.6	46	1.42	9.7	39.78	4390	6.65	8.98	9.09	37	1.34	7.5	37.57	3290	7.25	9.76	9.88
	6.25	24.9	49	1.53	11.0	42.96	4630	6.49	8.78	8.88	39	1.45	8.5	40.64	3470	7.08	9.55	9.66
	6.50	26.2	52	1.65	12.5	46.20	4870	6.34	8.59	8.69	42	1.56	9.6	43.78	3650	6.93	9.35	9.46
	7.00	28.8	59	1.88	15.8	52.85	5370	6.07	8.24	8.34	46	1.79	12.1	50.22	4030	6.65	8.99	9.09
	7.25	30.2	62	2.00	17.6	56.24	5620	5.97	8.08	8.18	49	1.91	13.5	53.53	4220	6.52	8.82	8.92
	7.50	31.6	65	2.13	19.6	59.67	5880	5.90	7.94	8.03	51	2.03	15.0	56.87	4410	6.40	8.67	8.77
	8.00	34.4	71	2.38	24.1	66.64	6410	5.75	7.66	7.75	56	2.27	18.3	63.68	4810	6.18	8.38	8.48
	8.25	35.9	74	2.50	26.6	70.17	6690	5.68	7.54	7.63	58	2.39	20.1	67.13	5010	6.08	8.25	8.34
	8.50	37.4	77	2.63	29.2	73.73	6890	5.62	7.42	7.51	61	2.52	22.1	70.62	5220	5.99	8.12	8.22
20 gage	5.50	21.1	40	1.43	8.0	40.18	3930	8.26	10.83	11.20	32	1.34	6.3	37.68	2950	9.02	11.69	12.08
	6.00	23.6	46	1.69	10.5	47.49	4390	7.82	10.32	10.67	37	1.59	8.2	44.67	3290	8.56	11.18	11.55
	6.25	24.9	49	1.83	12.0	51.29	4630	7.63	10.09	10.43	39	1.72	9.3	48.31	3470	8.36	10.94	11.31
	6.50	26.2	52	1.97	13.5	55.16	4870	7.45	9.87	10.20	42	1.86	10.5	52.04	3650	8.17	10.72	11.08
	7.00	28.8	59	2.25	17.1	63.12	5370	7.13	9.48	9.80	46	2.13	13.2	59.74	4030	7.82	10.32	10.67
	7.25	30.2	62	2.40	19.0	67.19	5620	7.01	9.30	9.61	49	2.27	14.7	63.68	4220	7.67	10.14	10.48
	7.50	31.6	65	2.54	21.2	71.30	5880	6.92	9.13	9.43	51	2.41	16.3	67.68	4410	7.53	9.96	10.30
	8.00	34.4	71	2.84	25.9	79.67	6410	6.74	8.81	9.11	56	2.70	19.9	75.83	4810	7.26	9.64	9.96
	8.25	35.9	74	2.99	28.5	83.92	6690	6.66	8.66	8.95	58	2.85	21.9	79.97	5010	7.14	9.49	9.80
	8.50	37.4	77	3.14	31.3	88.20	6960	6.58	8.52	8.81	61	3.00	24.0	84.15	5220	7.03	9.34	9.65
19 gage	5.50	21.1	40	1.65	8.6	46.24	3930	9.13	11.83	12.22	32	1.54	6.8	43.24	2950	9.99	12.75	13.18
	6.00	23.6	46	1.95	11.3	54.62	4390	8.64	11.27	11.65	37	1.83	8.8	51.20	3290	9.47	12.20	12.61
	6.25	24.9	49	2.10	12.8	58.98	4630	8.43	11.02	11.39	39	1.97	10.0	55.37	3470	9.24	11.94	12.35
	6.50	26.2	52	2.26	14.4	63.44	4870	8.23	10.78	11.14	42	2.13	11.3	59.65	3650	9.03	11.71	12.10
	7.00	28.8	59	2.59	18.2	72.60	5370	7.87	10.35	10.70	46	2.44	14.1	68.47	4030	8.64	11.27	11.65
	7.25	30.2	62	2.76	20.3	77.29	5620	7.73	10.16	10.50	49	2.60	15.7	73.01	4220	8.47	11.07	11.44
	7.50	31.6	65	2.93	22.5	82.05	5880	7.63	9.97	10.31	51	2.77	17.5	77.61	4410	8.31	10.88	11.25
	8.00	34.4	71	3.27	27.5	91.72	6410	7.43	9.63	9.95	56	3.10	21.3	87.01	4810	8.01	10.53	10.88
	8.25	35.9	74	3.44	30.3	96.63	6690	7.34	9.47	9.79	58	3.27	23.4	91.78	5010	7.87	10.36	10.71
	8.50	37.4	77	3.62	33.3	101.58	6960	7.26	9.32	9.63	61	3.44	25.6	96.61	5220	7.76	10.20	10.55
18 gage	5.50	21.1	40	1.85	9.2	51.92	3930	9.97	12.63	13.05	32	1.73	7.3	48.45	2950	10.92	13.61	14.07
	6.00	23.6	46	2.18	12.0	61.26	4390	9.43	12.03	12.44	37	2.04	9.4	57.29	3290	10.34	13.02	13.46
	6.25	24.9	49	2.36	13.6	66.13	4630	9.19	11.77	12.16	39	2.21	10.7	61.93	3470	10.09	12.75	13.18
	6.50	26.2	52	2.54	15.3	71.12	4870	8.97	11.52	11.90	42	2.38	12.0	66.69	3650	9.86	12.50	12.92
	7.00	28.8	59	2.90	19.2	81.38	5370	8.58	11.06	11.43	46	2.73	15.0	76.54	4030	9.43	12.03	12.44
	7.25	30.2	62	3.09	21.4	86.64	5620	8.43	10.85	11.22	49	2.91	16.7	81.61	4220	9.24	11.82	12.22
	7.50	31.6	65	3.28	23.8	91.97	5880	8.31	10.65	11.01	51	3.09	18.5	86.76	4410	9.06	11.62	12.01
	8.00	34.4	71	3.67	29.0	102.83	6410	8.10	10.29	10.63	56	3.47	22.6	97.28	4810	8.73	11.24	11.62
	8.25	35.9	74	3.86	31.9	108.34	6690	8.00	10.12	10.46	58	3.66	24.8	102.64	5010	8.58	11.07	11.44
	8.50	37.4	77	4.06	35.0	113.91	6960	7.90	9.96	10.29	61	3.85	27.1	108.05	5220	8.46	10.90	11.27

Beam Design Results

The beams that were being designed for the representative bay are highlighted in the reports.

Beam Summary

RAM Steel v11.0
DataBase: Newman-NonComposite
Building Code: IBC

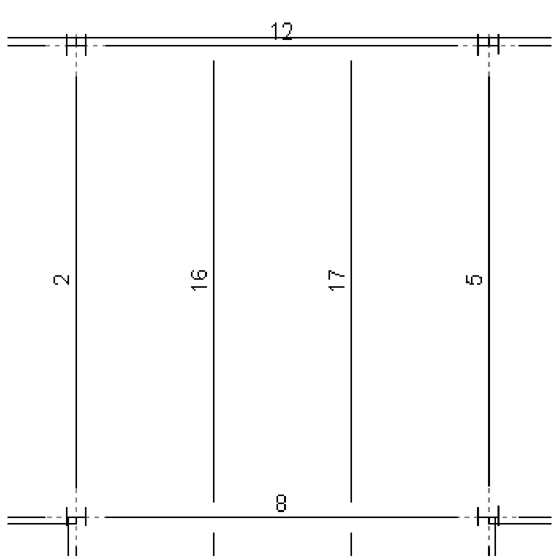
12/22/07 04:02:00
Steel Code: ASD 9th Ed.

STEEL BEAM DESIGN SUMMARY:

Floor Type: Typical

Bm #	Length ft	+M kip-ft	-M kip-ft	Seff in3	Fy ksi	Beam Size	Studs
3	31.53	143.8	0.0	57.6	50.0	W18X35	
7	24.60	169.3	0.0	81.6	50.0	W21X44	
11	24.60	199.9	0.0	93.0	50.0	W21X48	
14	31.53	155.8	0.0	68.4	50.0	W18X40	
15	31.53	155.8	0.0	68.4	50.0	W18X40	
1	26.67	73.3	0.0	38.4	50.0	W16X26	
10	27.50	219.5	0.0	93.0	50.0	W21X48	
2	31.53	162.6	0.0	68.4	50.0	W18X40	
8	27.50	329.3	0.0	154.0	50.0	W24X68	
12	27.50	245.0	0.0	115.0	50.0	W24X55	
20	26.67	125.2	0.0	57.6	50.0	W18X35	
16	31.53	169.5	0.0	68.4	50.0	W18X40	
21	26.67	125.2	0.0	57.6	50.0	W18X35	
17	31.53	169.5	0.0	68.4	50.0	W18X40	
4	26.67	73.3	0.0	38.4	50.0	W16X26	
5	31.53	169.5	0.0	68.4	50.0	W18X40	
9	27.50	206.5	0.0	93.0	50.0	W21X48	
13	27.50	245.0	0.0	115.0	50.0	W24X55	
18	31.53	169.5	0.0	68.4	50.0	W18X40	
19	31.53	169.5	0.0	68.4	50.0	W18X40	
6	31.53	153.2	0.0	57.6	50.0	W18X35	

* after Size denotes beam failed stress/capacity criteria.
# after Size denotes beam failed deflection criteria.
u after Size denotes this size has been assigned by the User.



Beam Deflection Summary

RAM Steel v11.0
DataBase: Newman-NonComposite
Building Code: IBC

12/22/07 04:02:00
Steel Code: ASD 9th Ed.

STEEL BEAM DEFLECTION SUMMARY:

Floor Type: Typical

Noncomposite

Bm #	Beam Size	Dead in	Live in	NetTotal in	Camber in
3	W18X35	1.048	0.692	0.990	3/4
7	W21X44	0.323	0.447	0.770	
11	W21X48	0.404	0.393	0.797	
14	W18X40	0.636	0.935	1.071	1/2
15	W18X40	0.636	0.935	1.071	1/2
1	W16X26	0.412	0.663	1.075	
10	W21X48	0.561	0.531	1.093	
2	W18X40	0.670	0.969	1.140	1/2
8	W24X68	0.408	0.455	0.863	
12	W24X55	0.445	0.416	0.861	
20	W18X35	0.429	0.655	1.084	
16	W18X40	0.705	1.004	1.209	1/2
21	W18X35	0.429	0.655	1.084	
17	W18X40	0.705	1.004	1.209	1/2
4	W16X26	0.412	0.663	1.075	
5	W18X40	0.705	1.004	1.209	1/2
9	W21X48	0.442	0.590	1.032	
13	W24X55	0.445	0.416	0.861	
18	W18X40	0.705	1.004	1.209	1/2
19	W18X40	0.705	1.004	1.209	1/2
6	W18X35	1.090	0.764	1.104	3/4