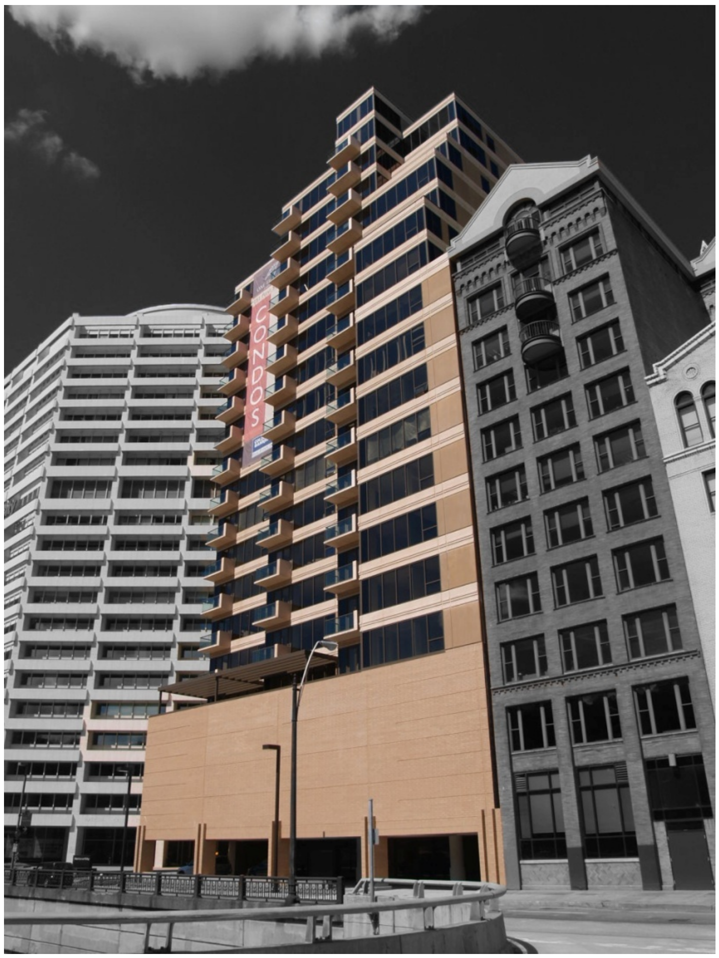
151 First Side

Technical Assignment 2

November 16th, 2007



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AE 481w – Senior Thesis

The Pennsylvania State University

Thesis Advisor: Kevin Parfitt

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Executive Summary

Report Summary:

The purpose of the second technical report is to determine the feasibility of four alternative systems and compare and contrast them with the current system. Of these four systems at least one must be comprised primarily of a different material than the current system. Also, no more than two variations of the same system can be analyzed. The four systems I chose to analyze are a steel composite system, a two-way flat plate system, a waffle slab system, and a hollow core precast concrete system in addition to the current Hambro floor system.

Conclusions:

My research shows that the alternative with the greatest chances of success would be conventional composite steel framing. Some of the main advantages of such a system are the relatively cheap cost, the easy and quick construction, the common availability of supplies and skilled labor, and the light weight. There will be slightly more steel that will need to be placed than the current system, but this should be no problem for any contractor.

Two of the other systems, the two-way flat plate and the hollow core precast planks, were also found to be possibilities, though their inherent disadvantages led me to not give them high recommendations.

The only remaining system, the waffle slab, was found to not be a suitable alternative. Though it was possible to use this system, it provided no benefits over the current system.

Structural System

Foundation:

The foundation was designed based on soil reports prepared by Engineering Mechanics, Inc. and Ackenheil Engineering, Inc., dated April, 2002 and July 1, 2005 respectively. Due to the close proximity of the Monongahela River pressure injected auger cast piles, 18" in diameter were used. Pile tips were placed at an elevation of 674'-0", which gives an average length of 52'. Each pile has a capacity of 120 tons. Pile caps are made of concrete with a 28 day strength of f'_c = 3000psi.

Slab on Grade:

The sub-basement and basement floors consist of slab on grade at elevations 725'-0" and 728'-0" respectively. The slabs are 5" of concrete with a 28 day strength of f'_c = 4000psi and are reinforced with 6x6 w2.1 x w2.1 welded wire fabric. Concrete was placed above 4" of AASHTO 57 well graded compacted granular stone.

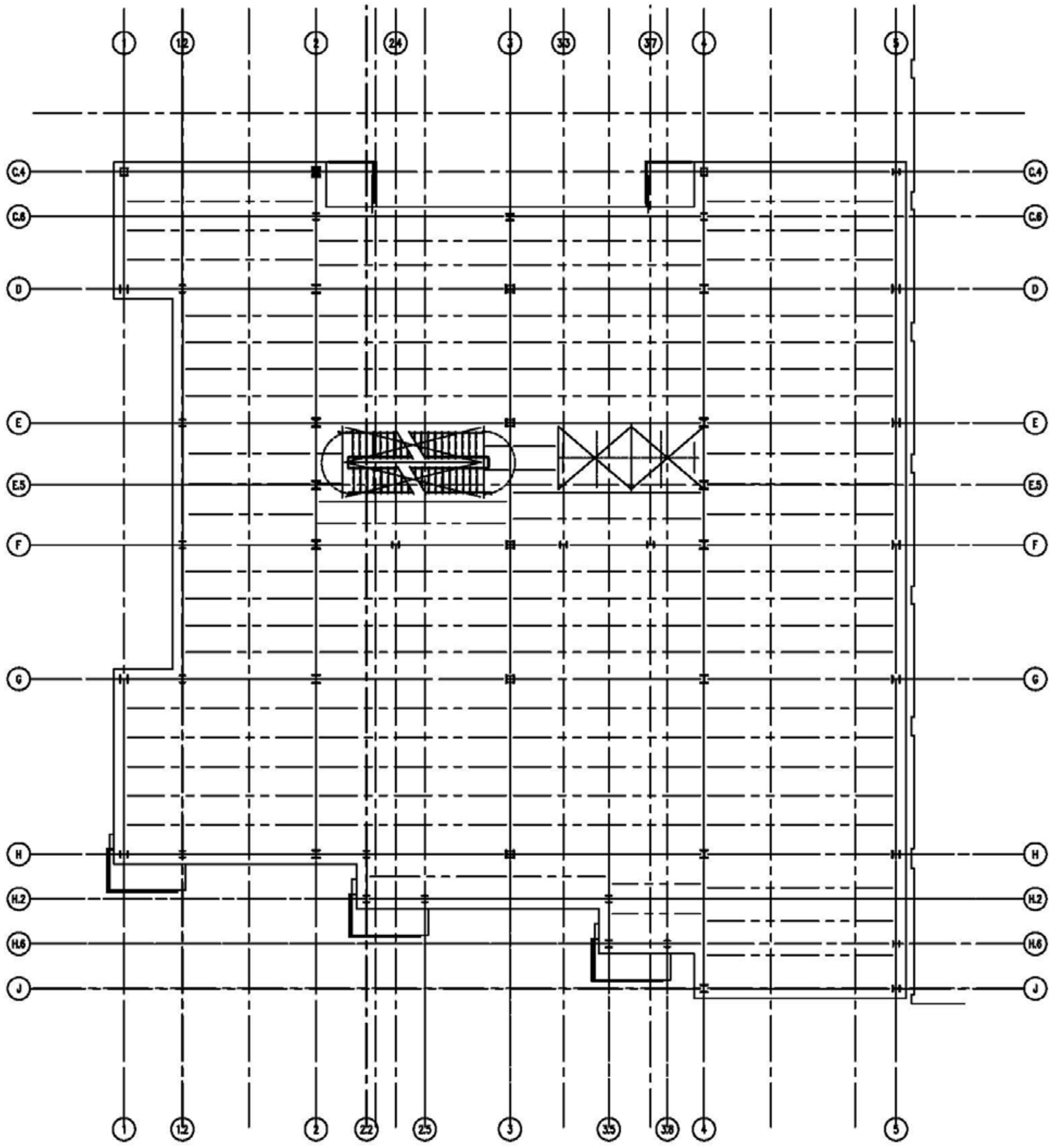
Structural Frame:

The structural framing is made of steel I shapes. The beams range from W10 to W16 with the most common size being a W14x61. The columns are W12 shapes with weights ranging from 40 to 336 pounds per linear foot. Common column splices occur at every second floor.

Floor and Roof System:

The parking levels on the first three stories as well as the terrace level have poured concrete floors. All parking floors are 4" of light weight concrete on a 2" 20ga. galvanized composite metal deck with the exception of some highly loaded areas of the ground floor in which there is a 6" slab. The 4" sections on the parking levels are reinforced with #4 rebar spaced at 12" in both the bottom and the top of the slab with the top bars continuing for ¼ of the span length past the supports. The 6" sections contain 6x6-W2.9xW2.9 welded wire fabric. The terrace level has 6x6-W1.4xW1.4 welded wire fabric for its reinforcement.

The residential and mechanical levels, as well as the roof, contain an MD200 composite floor joist system provided by Hambro. The concrete slab is 3¼" thick and is made with concrete with a 28 day strength of f'_c=4000psi. Reinforcing within the concrete is a 6x6-W2.9xW2.9 welded wire mesh. The concrete is supported by 22ga. 1½" galvanized steel deck. The joist depth is 16" unless otherwise noted. The top chord is an "S' shape piece of cold-rolled, ASTM A 1008, Grade 50, 13ga. steel which works as both a compressive member as well as a shear connector. The bottom chord is made of two steel angles. Both chords have a minimum F_y=50,000psi. The web is formed from 7/16" hot-rolled steel bars with an F_y=44,000psi. The roof is also topped with a waterproof membrane.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G
H
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H.6
J
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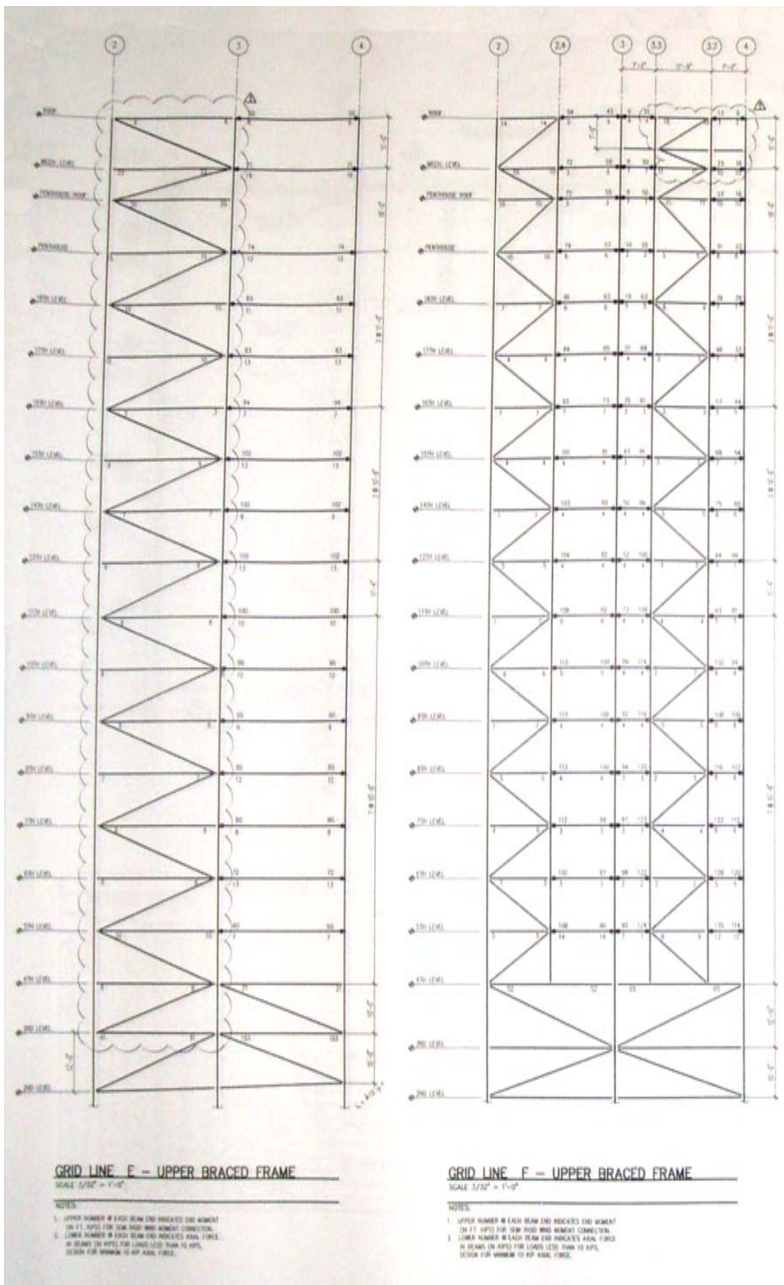
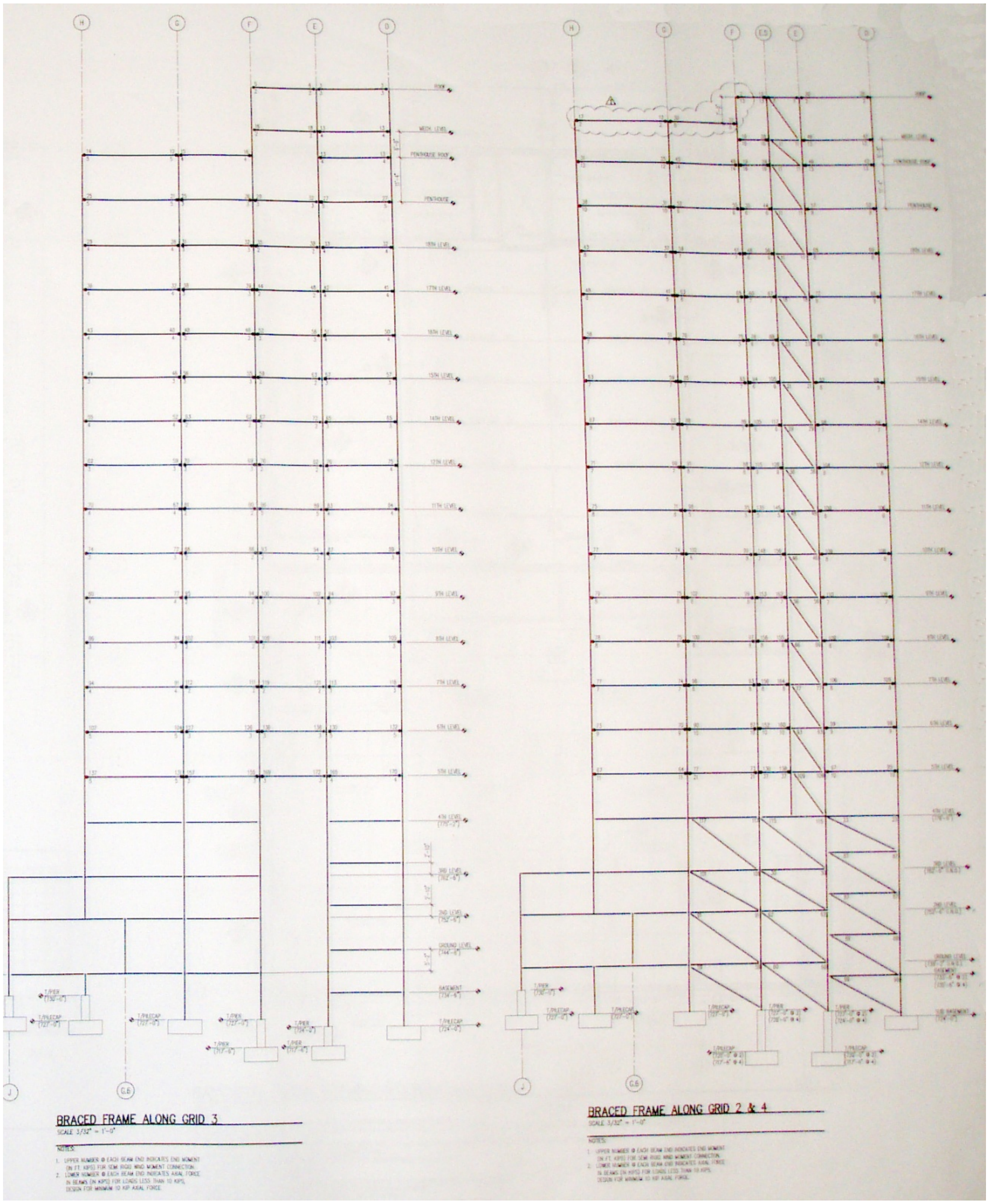
2.5
3.5
3.8

Lateral System:

The lateral system is composed of both braced frames as well as special moment frames. On column grid lines 2, 3, 4, E, and F there is some braced frames in the parking levels. Above level 5 every frame is braced, or if bracing is not architecturally feasible a special moment frame is used. Diagonal braces are made from W12 shapes.




BRACED FRAME ALONG GRID 3
BRACED FRAME ALONG GRID 2 & 4

Design Loads

General Loads:

Floor Live Loads

Load Area	**Design Load**	**Minimum Load (ASCE 7-05)**
Common Areas	100 psf	100 psf
Corridors	100 psf	100 psf
Parking	40 psf	40 psf
Residential	40 psf	40 psf
Mechanical	150 psf	n/a

Dead Loads

Item	**Design Value**
Superimposed Dead Loads	
Mechanical , Electrical, Sprinkler	20 psf
Ceiling Finishes	5 psf
Floor Finishes	5 psf
Structure	Varies
Other Dead Loads	Where Applicable

Analysis Overview

Systems Analyzed:

Hambro Composite Joist System (Current)
Steel Composite System
Two Way Flat Plate System
Waffle Slab System
Steel Supported Hollow Core Plank System

Design Criteria:

Live Load: 40psf + 20psf partition allowance (except common areas)
Superimposed Dead Load: 30psf
Self Weight: Varies
Deflection:
- Steel:
  - Total = L / 240
  - Live = L / 360
- Concrete:
  - Total = L / 420

Fire Rating: 2 Hours

Area of Design:

The area being analyzed is the residential levels as these contain the typical framing system of the building and provide the most opportunity for change. Depending on the system being analyzed, either a single worst case bay or a worst case frame will be used. I will then use these values to determine general properties for the entire system. These values will be conservative due to the methods used to obtain them, but this will allow for special details and situations which will not be discussed in this report. Note that only gravity loads will be considered.

Hambro Composite Joist System (Current)

Overview:

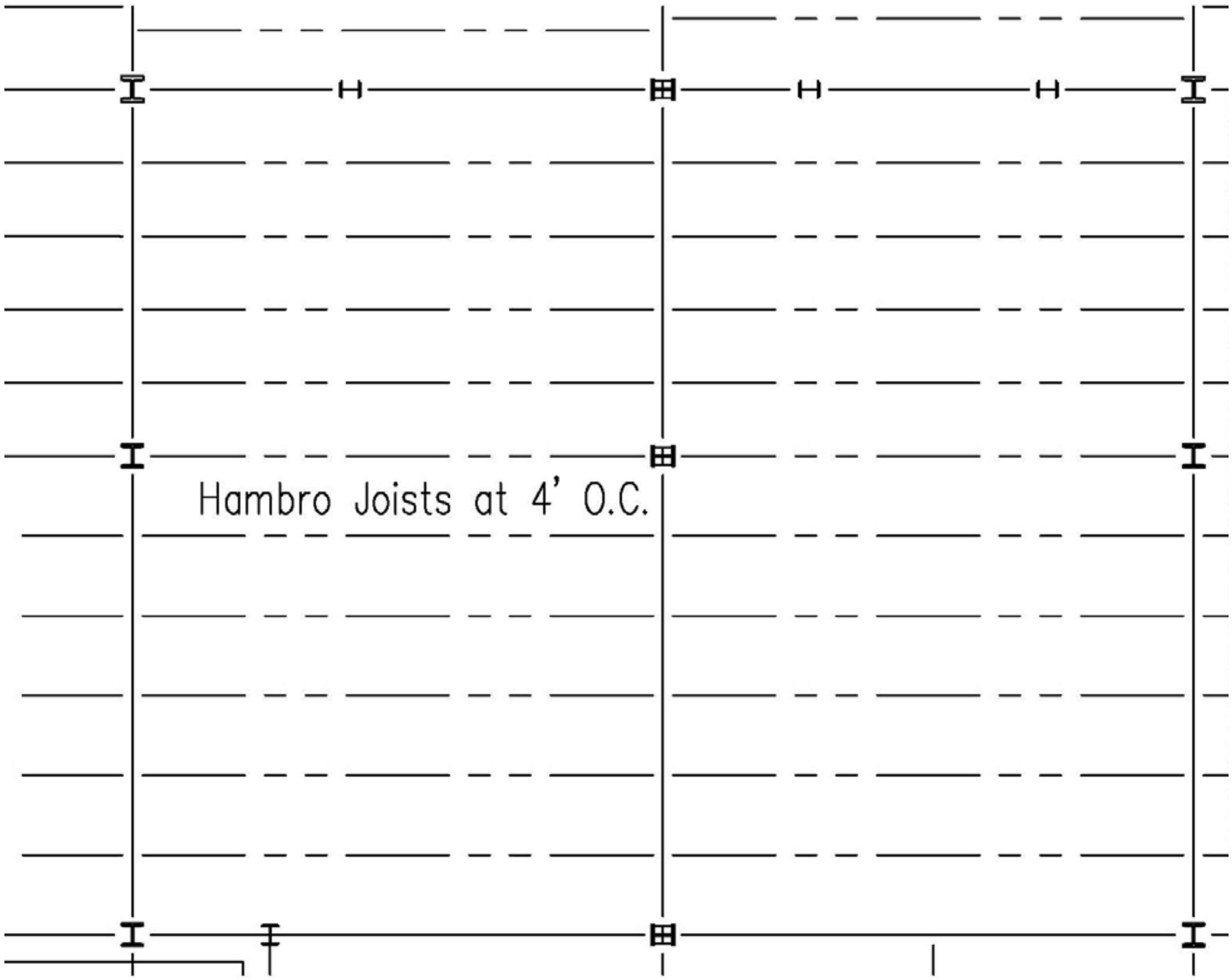
The current floor system is a MD2000 Hambro system which contains proprietary composite joists. It is comprised of a 3¼" slab with 16" composite joists resting on W14x61. These values are higher than what the Hambro design guide recommends. After discussion with a Hambro representative, I have found that the concrete slab was increased in depth by ½" for both vibration and acoustical reasons. The deeper joists were used due to slightly higher loads than what the design guide is written for, the need for larger mechanical openings, as well as the ability to hang the ceiling from the joists without interference from the beams. More information can be found in the Appendix on page 23.

Advantages:

The Hambro system has many advantages. Since the lateral conditions are controlled by wind loading, the lighter weight of the joist is desirable. The open webs of the joist also allow for easy penetrations of mechanical, fire protection, and electrical equipment. The composite action of the joist also allows for a smaller system depth. This system is also relatively quick and easy to install.

Disadvantages:

Joist systems do have some inherent disadvantages. Because of the relative flexibility of the joists, the system can have problems with deflection and sound transmission. This has been taken into consideration in 151 First Side and the slab was made thicker to compensate. Also, more work is needed to obtain the required fire rating of 2 hours. Typical methods include spray-on fire protection or a fire rated suspended or gypboard ceiling, both of which can be costly and/or time consuming.



Typical bays H2-F4 for the Hambro System

Steel Composite System

Overview:

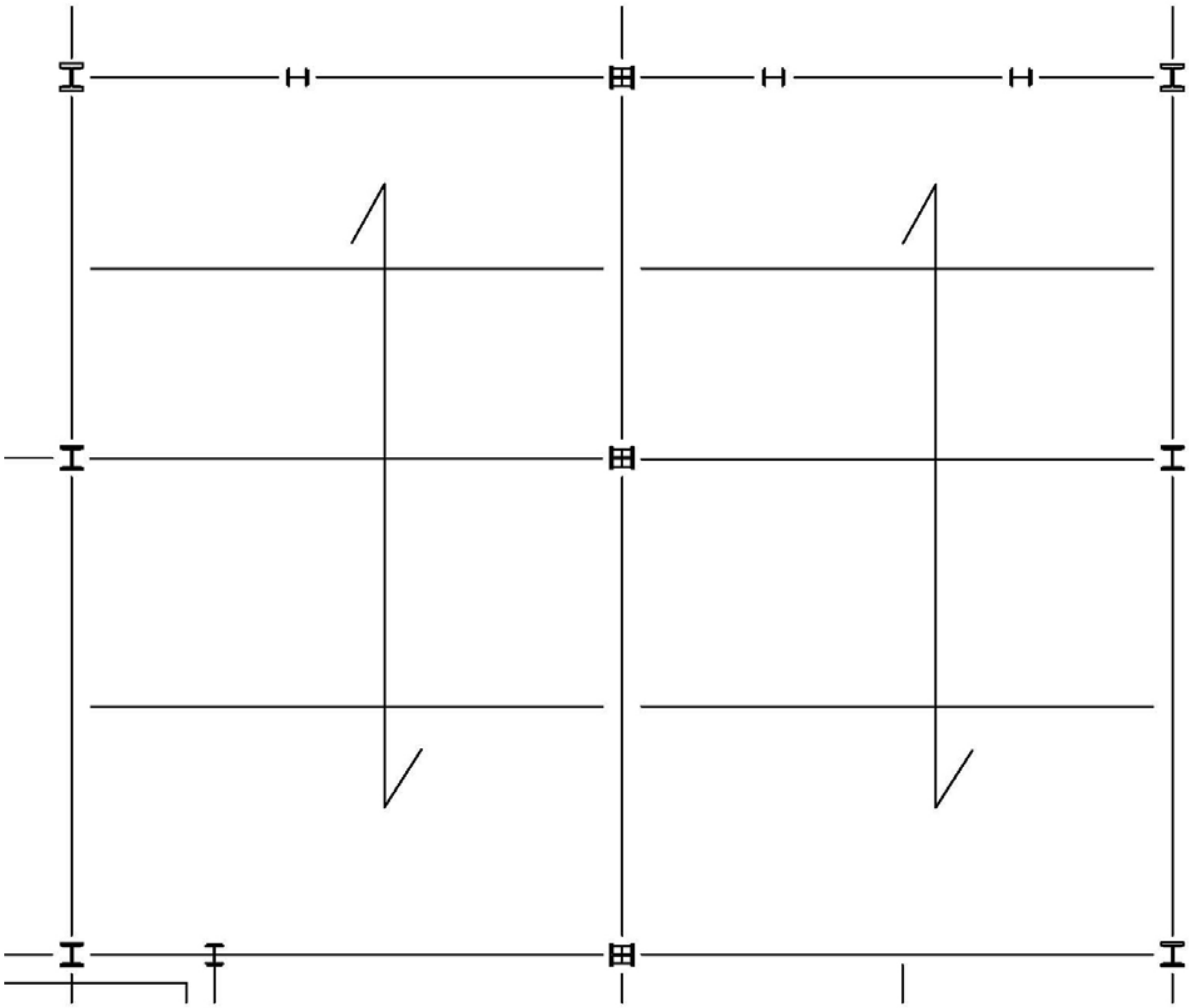
I chose to analyze a more conventional steel framing system consisting of composite beams and composite steel deck. Using the United Steel Deck design manual I have determined that a USD 2" Lok-Floor with 2½" of concrete would be the best choice in decking without requiring shoring. Using a RAM computer model, I have found that the majority of the beams would be W14x22 shapes with an average of 10 studs per beam. More information can be found in the Appendix on page 25.

Advantages:

Conventional steel systems are used often because of their many advantages. For 151 First Side the column grid would not need to be adjusted as the beams and decks could be adapted to fit the current layout. The floor would not need any extra fire protection and the beams could be quickly protected by a simple spraying process. Construction is also relatively quick with conventional steel framing, especially when the floor does not require any shoring. In addition, most of the materials that are needed will be readily available for quick delivery.

Disadvantages:

The obvious disadvantage of conventional steel framing is the extra labor involved in placing more beams as well as creating composite action. Another disadvantage is the closed webs. Penetrations may have to be made for mechanical equipment as well as sprinkler systems.



Typical bays H2-F4 for the Steel Composite System

Two Way Flat Plate System

Overview:

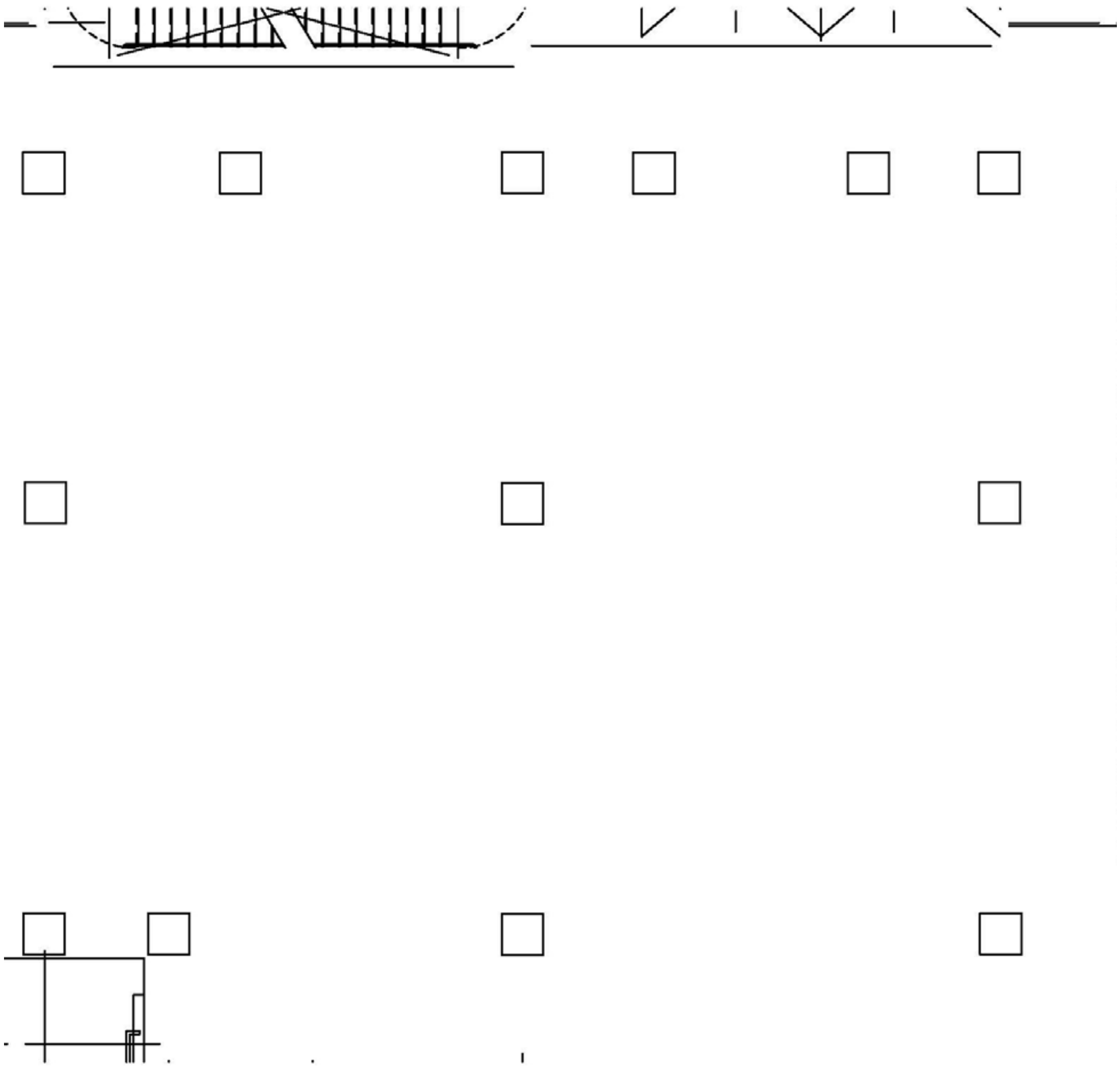
The first concrete system I chose to compare is a two way flat plate system. I have decided to use the values from the Concrete Reinforcing Steel Institute (CRSI) Handbook as a preliminary guideline to determine if such a system would be feasible and useful in 151 First Side. If this system is found to be acceptable, further calculations will be done. From the CRSI Handbook, I have determined that the floor will most likely be a 9" slab with 27" square columns needed. If this system is chosen, the parking levels will need to be changed as well. More information can be found in the Appendix on page 26.

Advantages:

With only a 9" depth, this system is quite shallow. Also, due to its nature it does not need any additional fire protection. There is also no need for intermediate beams with this system.

Disadvantages:

Concrete is a heavy material, and the added weight may have an effect on the foundation due to the proximity of the rivers. Also, since there is no webs or penetrations, all mechanical, electrical, and fire protection elements must be hung below the slab. This will cause the overall system to be somewhat deeper.



Typical bays H2-F4 for the Two-Way Flat Plate System

Waffle Slab System

Overview:

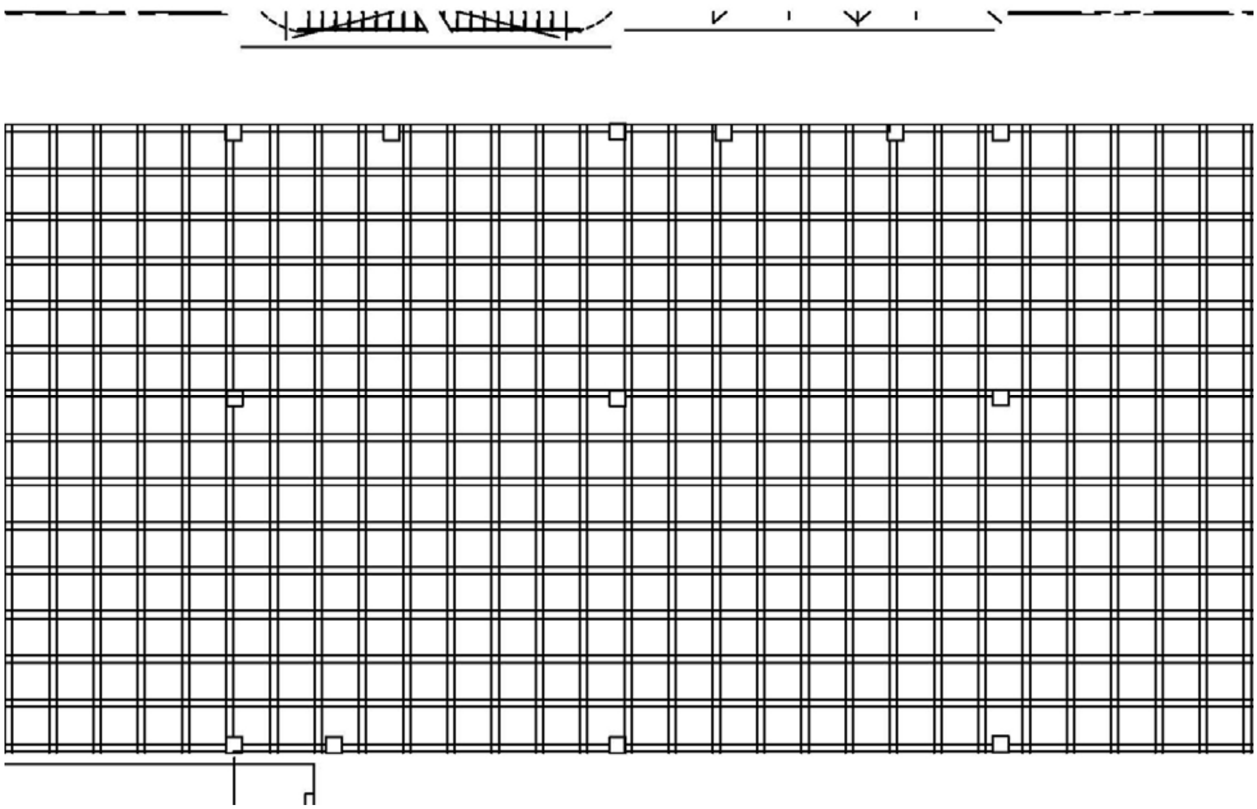
The next system I decided to look at was a waffle slab system made of 30" square voids and 6" ribs. I have once again used the CRSI Handbook, and have found that a conservative solution would be 8" deep ribs with 4½" of concrete slab for a total slab depth of 12½". The columns would need to be 13" square minimum. If this system is chosen, the parking levels will need to be changed as well. More information can be found in the Appendix on page 28.

Advantages:

Using a waffle slab system can have its advantages. It is a relatively shallow system with narrow columns. It can be quite stiff, and as a result it handles deflections, vibrations, and sound transmission relatively well. Once again, when constructed properly, this system may not need any extra fire protection.

Disadvantages:

Some of the disadvantages include the more complicated formwork required to create the voids and the extra labor and time needed because of this. Also, like the two way flat plate, the mechanical and fire protection must be placed below the bottom of the system, causing the overall depth to increase. Although the voids help reduce the amount of material, this is still a heavy system.



Typical bays H2-F4 for the Waffle Slab System

Steel Supported Hollow Core Concrete Plank System

Overview:

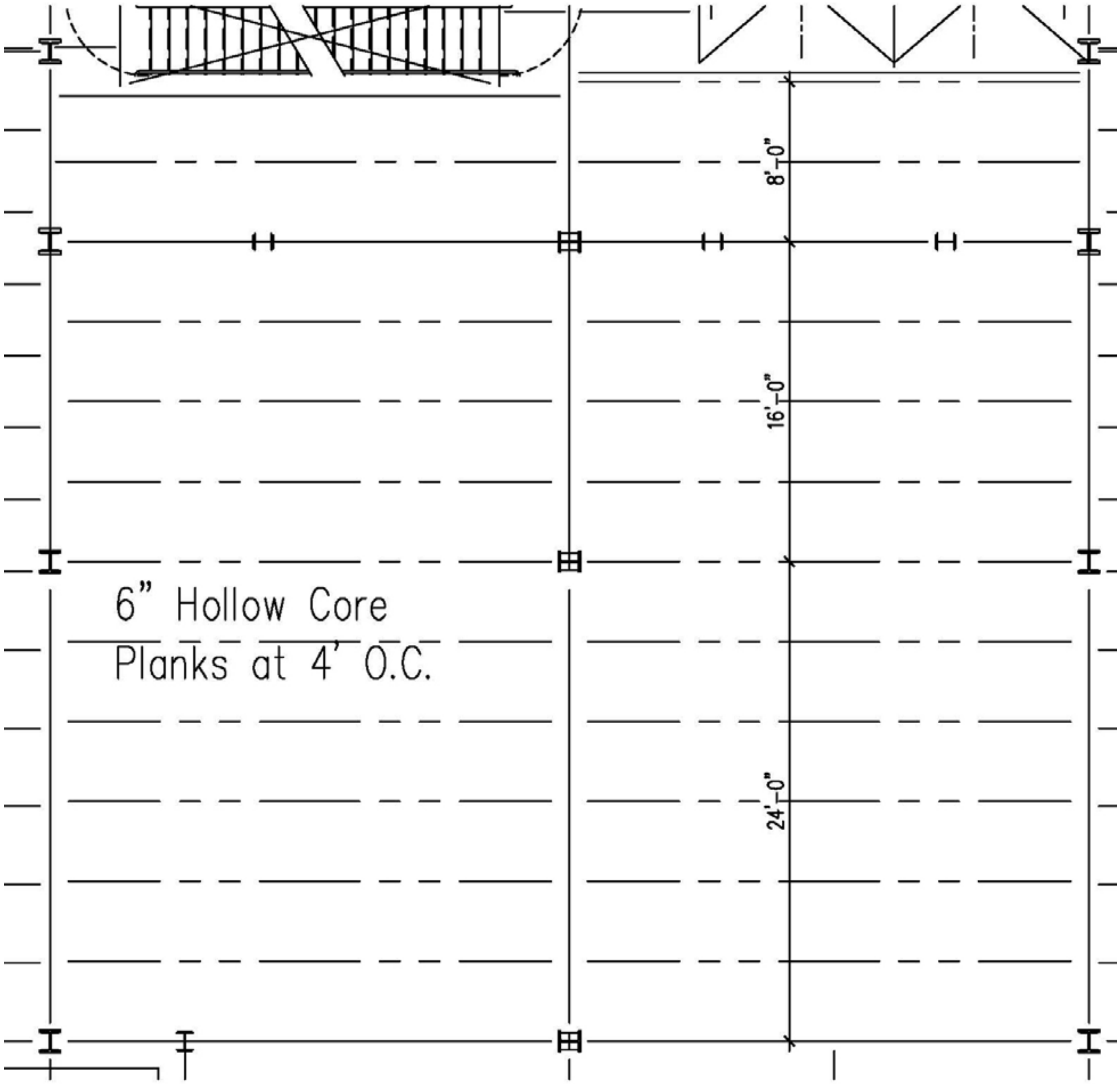
To try and combine the best of both steel and concrete systems, I have decided to look into a hollow core concrete plank system supported by steel beams. The column grid would have to go through a few simple changes to accommodate the 4’ wide planks. Most changes are just a matter of inches and do not affect the overall design, though a few areas will need to have cut planks in accordance with the manufacturer. A 6” hollow core concrete plank containing (7) ½” strands and a 2” topping would be sufficient to hold the required loads. According to a simple RAM model the main load carrying beams would need to be W14x22 shapes supporting the necessary 6” steel angles. More information can be found in the Appendix on page 29.

Advantages:

The depth of this system is 14” as required by the W-Shapes which includes 4” of space for mechanical and fire protection systems between the beams. Hollow core planks are also quick to install and relatively light. Due to the nature of the hollow core planks, they perform very well with sound transmission.

Disadvantages:

Even with a modified column layout there will still be sections that need customized planks. This can be costly and problematic.



Typical bays H2-F4 for the Hollow Core Precast Concrete System

Comparison Chart

	Hambro System (current)	Steel Composite	Two-Way Flat Plate	Waffle Slab	Hollow Core Plank
Weight (psf)	62	71	112.5	108.33	83
Cost ($/sf)	$18.95	$16.79	$14.20	$19.10	$17.20
Depth (in.)	19.25	18.25	9	12.5	14
Grid	-	Same	Same	Same	Adjusted to fit.
Extra Fire Protection	Spray On or Approved Ceiling	Spray On or Approved Ceiling	None	None	Spray On for beams
Foundation	-	Possibly larger	Larger	Larger	Possibly Larger
Construction	Easy & Quick	Easy & Quick	Easy but Slow	Difficult & Slow	Easy & Quick
Lateral System	-	Same	Shear Wall	Shear Wall	Same
Main Advantage	Weight	Constructability	Depth	Depth	Constructability
Main Disadvantage	Depth	Depth	Column Size	Cost	Non-Multiples of 4'
Possible Alternative	-	YES	MAYBE	NO	MAYBE
Key:	Good	Acceptable	Bad		

Final Overview

From the four alternatives that I have checked, the most feasible seems to be the conventional steel composite floor system. Although this system is relatively deep, it does leave room for mechanical and fire protection between the beams. Also, its relatively light weight is an asset due to the proximity of the river and subsequent foundation issues. This system is also fairly cheap and easy to construct. Since it is so commonly used the materials and skilled labor will be readily available.

Using a two-way flat plate system is also a possibility. It has the main advantage of being the cheapest and thinnest of the systems I have checked. It also does not require extra fire protection which can save both costs and labor. There are a couple of reasons, though, why this system does not receive a “YES.” Due to the solid concrete it is the heaviest of the systems. This weight will require a redesign of the foundation which will be costly due to sub-grade conditions. Also, due to the weight of the floor the columns will have to increase. This adds inconvenience to the open floor plan within the condos. Also, since braced frames and moment connections are not a possibility, shear walls would need to be designed. If there is not enough shear capacity in the elevator and stair core, additional shear walls will need to be placed within the condos themselves, which interferes with the open floor plan and also causes more costly structural detailing at the parking levels, where the shear walls would not be able to continue.

The hollow core plank system supported by steel beams is another possibility. While it is generally easy to construct this type of system, there are more complicated details when there are spaces that are not at 4’ widths. This becomes more of a problem on upper levels where there are multiple setbacks which change the bay widths by various amounts. Because of this issue, and the lack of any added benefit, this system is feasible, but not highly recommended.

The final alternative I have checked is the waffle slab system. This system suffers many of the same disadvantages as the two-way flat plate system with the added disadvantages of a high cost, extra labor, and longer construction time. Since the disadvantages greatly outweigh the few advantages, I have decided that this system is not a feasible alternative to the current floor system.

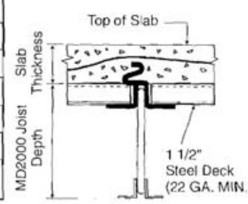
Appendix

HAMBRO SPAN TABLES

TABLE 8: MD2000® Clear Span Table

	Residential				Commercial	
Slab Thickness	2 3/4"	3"	3 1/4"	3 1/2"	2 3/4"	3 1/4"
Joist Depth*	LL = 40 psf DL = 68 psf	LL = 40 psf DL = 71 psf	LL = 40 psf DL = 74 psf	LL = 40 psf DL = 77 psf	LL = 50 psf DL = 68 psf	LL = 50 psf DL = 74 psf
8"	18' - 0"	18' - 0"	18' - 0"	18' - 0"	18' - 0"	18' - 0"
10"	22' - 6"	22' - 6"	22' - 6"	22' - 6"	22' - 6"	22' - 6"
12"	27' - 0"	27' - 0"	27' - 0"	27' - 0"	27' - 0"	27' - 0"
14"	31' - 6"	31' - 6"	31' - 6"	30' - 10"	31' - 6"	31' - 6"
16"	35' - 11"	35' - 0"	34' - 1"	33' - 2"	35' - 11"	34' - 1"
18"	38' - 7"	37' - 5"	36' - 5"	35' - 7"	38' - 7"	36' - 5"
20"	41' - 0"	39' - 11"	38' - 10"	37' - 9"	41' - 0"	38' - 9"
22"	43' - 0"	42' - 3"	41' - 0"	39' - 11"	43' - 0"	41' - 0"
24"	43' - 0"	43' - 0"	43' - 0"	42' - 1"	43' - 0"	43' - 0"

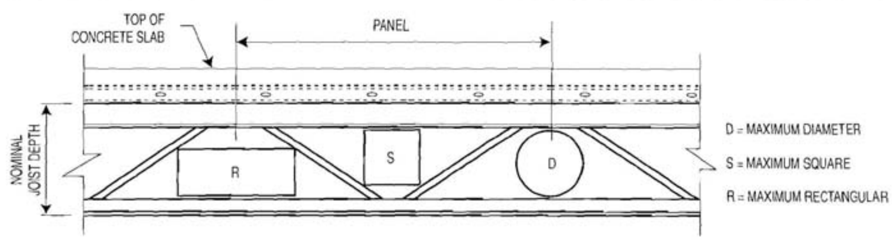
*Total floor depth = MD2000® Joist depth plus slab thickness



NOTES:

- Minimum slab thickness = *2 3/4"*
- Minimum top chord cover = *1 1/4"*
- $f'_c = 3{,}000$ psi, $F_y = 50$ ksi
- Joist spacing: *4'-1 1/4"*
- Table reflects uniform loads only.
- Metal deck standard: *1 1/2", 22 ga* (Galvanized)
- Nominal slab thickness = *slab thickness + 1/2" (Concrete in Deck)*
- Live load deflection design standard: *L / 360*
- Design clear spans, other than those shown in the above table, require additional structural review.

Maximum Duct Openings



DEPTH (in.)	PANEL (in.)	D (in.)	S (in.)	R (in. x in.)
8	20	4	4	6 x 3
10	20	6	5	7 x 4
12	24	8	6	9 x 5
14	24	9	7	9 1/2 x 6 11 x 5
16	24	10	8	10 1/2 x 6 1/2 13 x 5
18	24	11	8 1/2	11 x 7 12 1/2 x 6
20	24	11 1/2	9	12 x 7 13 x 6
22	24	12	9 1/2	12 x 8 14 x 6
24	24	12 1/2	10	13 x 8 14 x 7

NOTE: For other configurations, the maximum limits will be defined by the joist geometry.

HAMBRO

3

FIRE PROTECTION - CLEAR SPAN TABLE

HAMBRO®
Proven Concrete Floor System

MD2000® Fire Protection

Floor/ceiling assemblies using Hambro® have been tested under restrained and unrestrained conditions by independent laboratories. Fire resistance ratings have been issued by Underwriters Laboratories Inc. (UL) and by Underwriters Laboratories of Canada Inc. (ULC) covering gypsum board, acoustical tile and spray on protection systems. Reference to these published listings should be made in detailing ceiling construction. Check your UL and ULC directory for the latest update of these listings.

ULC/CUL Design No.	Rating (hr)	Slab Thickness* (in.)	Slab Thickness* (mm)	Ceiling	Beam Rating (hr)
I522	2	3	75	Gypboard 1/2" (12.7 mm)	1 1/2
I800	1 1/2 - 2	2 1/2 - 2 3/4 - 3 - 3 1/2	65 - 70 - 76 - 89	suspended or panel	1
G003	2	2 3/4	70	suspended or panel	-
G213	2 - 3	3 - 4	75 - 100	suspended or panel	3
G227	2	2 3/4	70	suspended or panel	3
G228	2	3 1/4	83	suspended or panel	2
G229	2 - 3	3 - 4	75 - 100	suspended or panel	2 - 3
G401	4	2 1/2	65	Plaster	-
G524	2 - 3	2 3/4 - 3 1/2**	70 - 90	Gypboard 1/2" (12.7 mm)	2 - 3
G525	3	3 1/4	83	Gypboard 5/8" (15.9 mm)	3
G702	1 - 2 - 3	Varies**	Varies**	Direct spray on	-
G802	1 - 2 - 3	Varies**	Varies**	Direct spray on	-

* Slab Thickness = concrete above decking
** Normal and lightweight concrete

MD2000® Clear Span Table

Slab Thickness	Residential 2 3/4" (70 mm)	Residential 3" (75 mm)	Residential 3 1/4" (83 mm)	Residential 3 1/2" (90 mm)	Commercial 2 3/4" (70 mm)	Commercial 3 1/4" (83 mm)
Joist Depth	LL = 40 psf (1.9 kPa) DL = 68 psf (3.2 kPa)	LL = 40 psf (1.9 kPa) DL = 71 psf (3.4 kPa)	LL = 40 psf (1.9 kPa) DL = 74 psf (3.5 kPa)	LL = 40 psf (1.9 kPa) DL = 77 psf (3.7 kPa)	LL = 50 psf (2.4 kPa) DL = 68 psf (3.2 kPa)	LL = 50 psf (2.4 kPa) DL = 74 psf (3.5 kPa)
8" (200 mm)	18' - 0" (5 485 mm)	18' - 0" (5 485 mm)	18' - 0" (5 485 mm)	18' - 0" (5 485 mm)	18' - 0" (5 485 mm)	18' - 0" (5 485 mm)
10" (250 mm)	22' - 6" (6 860 mm)	22' - 6" (6 860 mm)	22' - 6" (6 860 mm)	22' - 6" (6 860 mm)	22' - 6" (6 860 mm)	22' - 6" (6 860 mm)
12" (300 mm)	27' - 0" (8 230 mm)	27' - 0" (8 230 mm)	27' - 0" (8 230 mm)	27' - 0" (8 230 mm)	27' - 0" (8 230 mm)	27' - 0" (8 230 mm)
14" (350 mm)	31' - 6" (9 600 mm)	31' - 6" (9 600 mm)	31' - 6" (9 600 mm)	30' - 10" (9 400 mm)	31' - 6" (9 600 mm)	31' - 6" (9 600 mm)
16" (400 mm)	35' - 11" (10 945 mm)	35' - 0" (10 670 mm)	34' - 1" (10 390 mm)	33' - 2" (10 110 mm)	35' - 11" (10 945 mm)	34' - 1" (10 390 mm)
18" (450 mm)	38' - 7" (11 760 mm)	37' - 5" (11 405 mm)	36' - 5" (11 100 mm)	35' - 7" (10 845 mm)	38' - 7" (11 760 mm)	36' - 5" (11 100 mm)
20" (500 mm)	41' - 0" (12 495 mm)	39' - 11" (12 165 mm)	38' - 10" (11 835 mm)	37' - 9" (10 505 mm)	41' - 0" (12 495 mm)	38' - 9" (11 810 mm)
22" (550 mm)	43' - 0" (13 105 mm)	42' - 3" (12 880 mm)	41' - 0" (12 495 mm)	39' - 11" (12 165 mm)	43' - 0" (13 105 mm)	41' - 0" (12 495 mm)
24" (600 mm)	43' - 0" (13 105 mm)	43' - 0" (13 105 mm)	43' - 0" (13 105 mm)	42' - 1" (12 825 mm)	43' - 0" (13 105 mm)	43' - 0" (13 105 mm)

Notes: • Table reflects uniform loads only.
• Design clear spans, other than those shown in the above table, require additional structural review.

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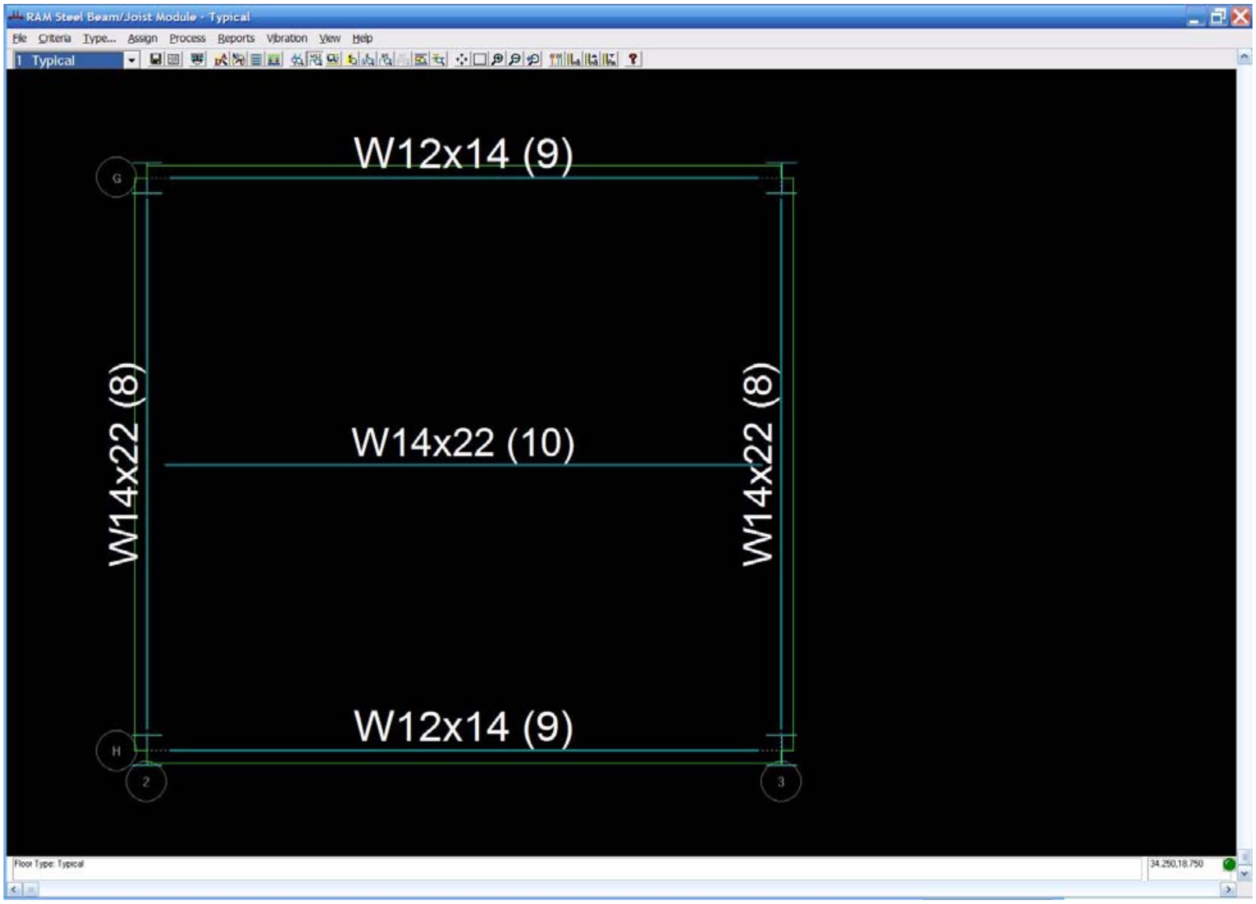

RAM Steel Beam/Joist Module - Typical
File Criteria Type... Assign Process Reports Vibration View Help
1 Typical
W12x14 (9)
W14x22 (8)
W14x22 (10)
W14x22 (8)
W12x14 (9)
G
H
2
3
Floor Type: Typical

9-26

FLAT PLATE SYSTEM
(WITHOUT SHEARHEADS)

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANEL

9 in. = TOTAL THICKNESS OF SLAB — 0.750 c.f./s.f.

SPAN c.-c. Cols. $\ell_1 = \ell_2$ (ft)	Factored Superimposed Load (psf)	(1) Min. Square Column (in.)	(1) Min. Square Column γ_f	Total Panel Moments −M Ext. (ft-kip)	Total Panel Moments +M Int. (ft-kip)	Total Panel Moments −M 1st. int. (ft-kip)	Reinforcing Bars, Each Column Strip: Top Ext.	+	Each Column Strip: Bottom	Each Column Strip: Top Int.	Each Middle Strip: Bottom	Each Middle Strip: Top Int.	End Panel Steel (psf), Location of Panel: E	EC	C
23	50	16	0.767	74	148	200	12-# 4	5	9-# 5	11-# 6	8-# 5	8-# 5	2.31	2.34	2.23
23	100	20	0.748	89	179	240	14-# 4	7	16-# 4	13-# 6	8-# 5	8-# 5	2.52	2.54	2.50
23	150	24	0.677	103	207	278	16-# 4	5	9-# 6	15-# 6	8-# 5	8-# 5	2.78	2.81	2.84
23	200	27	0.709	117	234	315	12-# 5	5	10-# 6	13-# 7	14-# 4	8-# 5	3.12	3.16	3.25
23	250	31	0.641	129	257	346	13-# 5	4	11-# 6	11-# 8	10-# 5	13-# 4	3.47	3.49	3.58
23	300	34	0.626	140	279	376	14-# 5	3	9-# 7	12-# 8	8-# 6	14-# 4	3.79	3.82	3.89
23	350	40	0.610	147	293	395	22-# 4	4	8-# 8	13-# 8	12-# 5	10-# 5	4.04	4.13	4.26
24	50	18	0.736	84	168	226	13-# 4	5	10-# 5	12-# 6	8-# 5	8-# 5	2.33	2.35	2.27
24	100	22	0.724	101	201	271	15-# 4	7	12-# 5	11-# 7	8-# 5	8-# 5	2.62	2.64	2.64
24	150	26	0.713	116	232	313	12-# 5	5	10-# 6	13-# 7	9-# 5	8-# 5	2.97	3.01	3.12
24	200	30	0.652	131	262	352	13-# 5	4	16-# 5	12-# 8	16-# 4	13-# 4	3.37	3.41	3.49
24	250	34	0.611	144	288	388	22-# 4	4	17-# 5	13-# 8	8-# 6	10-# 5	3.69	3.74	3.86
24	300	39	0.610	154	307	414	23-# 4	4	8-# 8	17-# 7	12-# 5	10-# 5	4.02	4.06	4.19
24	350	45	0.609	161	322	433	16-# 5	2	8-# 8	14-# 8	9-# 6	16-# 4	4.29	4.31	4.45
25	50	20	0.733	94	188	252	14-# 4	7	11-# 5	14-# 6	13-# 4	13-# 4	2.45	2.47	2.44
25	100	24	0.724	113	225	303	17-# 4	8	10-# 6	13-# 7	9-# 5	13-# 4	2.86	2.88	2.88
25	150	29	0.651	130	260	349	13-# 5	4	11-# 6	19-# 6	16-# 4	13-# 4	3.19	3.21	3.32
25	200	33	0.633	146	292	393	22-# 4	7	10-# 7	13-# 8	12-# 5	10-# 5	3.66	3.71	3.84
25	250	39	0.610	158	316	425	16-# 5	2	10-# 7	14-# 8	19-# 4	16-# 4	3.91	3.96	4.08
25	300	45	0.609	167	334	450	25-# 4	3	20-# 5	15-# 8	13-# 5	11-# 5	4.17	4.19	4.35
25	350	51	0.608	175	351	472	13-# 6	1	9-# 8	16-# 8	10-# 6	12-# 5	4.53	4.62	4.85
26	50	22	0.705	105	209	281	16-# 4	6	9-# 6	15-# 6	13-# 4	13-# 4	2.53	2.56	2.53
26	100	27	0.658	125	251	337	19-# 4	6	11-# 6	14-# 7	10-# 5	13-# 4	2.98	3.00	3.02
26	150	31	0.655	145	290	390	22-# 4	7	10-# 7	13-# 8	12-# 5	10-# 5	3.51	3.54	3.57
26	200	37	0.636	161	322	433	16-# 5	5	14-# 6	14-# 8	9-# 6	16-# 4	3.82	3.87	3.98
26	250	44	0.609	172	345	464	17-# 5	4	11-# 7	15-# 8	10-# 6	12-# 5	4.17	4.23	4.39
26	300	51	0.608	182	364	490	13-# 6	1	9-# 8	16-# 8	22-# 4	12-# 5	4.46	4.49	4.67
26	350	58	0.607	189	378	509	19-# 5	1	10-# 8	17-# 8	11-# 6	9-# 6	4.75	4.82	5.05
27	50	24	0.717	116	232	313	12-# 5	5	10-# 6	13-# 7	9-# 5	9-# 5	2.72	2.75	2.71
27	100	29	0.693	139	279	375	14-# 5	6	9-# 7	12-# 8	11-# 5	14-# 4	3.18	3.21	3.26
27	150	34	0.654	160	321	432	16-# 5	5	14-# 6	14-# 8	19-# 4	16-# 4	3.60	3.66	3.79
27	200	41	0.630	176	351	473	13-# 6	3	9-# 8	16-# 8	10-# 6	12-# 5	4.12	4.19	4.35
27	250	49	0.608	188	376	506	19-# 5	3	12-# 7	17-# 8	11-# 6	9-# 6	4.43	4.48	4.64
27	300	56	0.607	198	396	533	14-# 6	1	10-# 8	18-# 8	16-# 5	13-# 5	4.71	4.78	4.95
27	350	64	0.606	205	410	552	15-# 6	0	11-# 8	18-# 8	9-# 7	10-# 6	5.02	5.08	5.27
28	50	26	0.709	129	258	347	19-# 4	10	23-# 4	14-# 7	10-# 5	14-# 4	2.78	2.79	2.77
28	100	31	0.679	154	308	414	15-# 5	6	10-# 7	13-# 8	12-# 5	10-# 5	3.33	3.36	3.47
28	150	38	0.662	175	351	472	13-# 6	4	15-# 6	15-# 8	10-# 6	12-# 5	3.92	3.92	4.06
28	200	46	0.609	191	381	513	19-# 5	3	10-# 8	17-# 8	11-# 6	13-# 5	4.35	4.38	4.56
28	250	54	0.608	203	407	547	20-# 5	3	13-# 7	18-# 8	16-# 5	10-# 6	4.62	4.68	4.93
28	300	62	0.607	213	426	574	16-# 6	2	11-# 8	19-# 8	12-# 6	10-# 6	5.00	5.07	5.33
28	350	70	0.606	221	442	595	16-# 6	0	11-# 8	20-# 8	10-# 7	11-# 6	5.22	5.30	5.60

SQUARE INTERIOR PANEL

9 in. = TOTAL THICKNESS OF SLAB — 0.750 c.f./s.f.

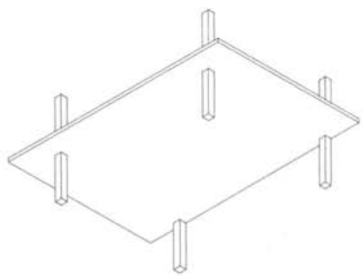
(2) Span c.-c. (ft)	(3) Load (psf	(1) Min. Sq. Col. (in.)	Reinforcing Bars, Column Strip: Top	Column Strip: Bottom	Middle Strip: Top	Middle Strip: Bottom	Steel (psf), Location of Panel: I	IE	IC
23	50	11	14-# 5	8-# 5	8-# 5	8-# 5	2.37	2.39	2.42
23	100	15	17-# 5	8-# 5	8-# 5	8-# 5	2.55	2.57	2.60
23	150	19	20-# 5	13-# 4	8-# 5	8-# 5	2.77	2.79	2.81
23	200	23	12-# 7	10-# 5	8-# 5	8-# 5	3.11	3.14	3.17
23	250	28	11-# 8	16-# 4	8-# 5	8-# 5	3.42	3.43	3.43
23	300	33	11-# 8	8-# 6	13-# 4	8-# 5	3.56	3.61	3.65
23	350	40	12-# 8	12-# 5	9-# 5	8-# 5	3.82	3.87	3.92
24	50	12	16-# 5	8-# 5	8-# 5	8-# 5	2.38	2.39	2.41
24	100	17	11-# 7	8-# 5	8-# 5	8-# 5	2.70	2.70	2.69
24	150	22	12-# 7	14-# 4	8-# 5	8-# 5	2.90	2.92	2.95
24	200	26	11-# 8	16-# 4	8-# 5	8-# 5	3.27	3.30	3.34
24	250	31	12-# 8	12-# 5	9-# 5	8-# 5	3.61	3.65	3.70
24	300	39	13-# 8	19-# 4	10-# 5	8-# 5	3.86	3.86	3.86
24	350	47	13-# 8	9-# 6	10-# 5	13-# 4	4.01	4.05	4.09
25	50	14	13-# 6	13-# 4	13-# 4	13-# 4	2.50	2.52	2.54
25	100	19	12-# 7	9-# 5	13-# 4	13-# 4	2.82	2.85	2.87
25	150	24	14-# 7	16-# 4	13-# 4	13-# 4	3.13	3.13	3.12
25	200	29	12-# 8	12-# 5	9-# 5	13-# 4	3.48	3.52	3.57
25	250	37	13-# 8	9-# 6	10-# 5	13-# 4	3.78	3.82	3.86
25	300	46	14-# 8	20-# 4	16-# 4	9-# 5	4.01	4.06	4.10
25	350	54	14-# 8	10-# 6	16-# 4	9-# 5	4.17	4.26	4.36
26	50	16	20-# 5	13-# 4	13-# 4	13-# 4	2.48	2.49	2.51
26	100	21	13-# 7	10-# 5	13-# 4	13-# 4	2.88	2.90	2.92
26	150	26	12-# 8	12-# 5	9-# 5	13-# 4	3.33	3.37	3.41
26	200	33	13-# 8	13-# 5	10-# 5	13-# 4	3.61	3.64	3.68
26	250	43	14-# 8	10-# 6	16-# 4	9-# 5	3.94	3.99	4.05
26	300	52	15-# 8	22-# 4	11-# 5	10-# 5	4.19	4.24	4.28
26	350	62	15-# 8	11-# 6	12-# 5	10-# 5	4.43	4.51	4.59
27	50	18	12-# 7	10-# 5	9-# 5	9-# 5	2.74	2.76	2.78
27	100	23	12-# 8	17-# 4	9-# 5	9-# 5	3.17	3.17	3.16
27	150	29	13-# 8	13-# 5	10-# 5	13-# 4	3.45	3.48	3.52
27	200	39	14-# 8	10-# 6	11-# 5	14-# 4	3.78	3.86	3.93
27	250	49	15-# 8	11-# 6	12-# 5	10-# 5	4.18	4.26	4.33
27	300	59	16-# 8	16-# 5	12-# 5	16-# 4	4.38	4.46	4.54
27	350	69	17-# 8	16-# 5	9-# 6	16-# 4	4.61	4.67	4.72
28	50	19	14-# 7	16-# 4	14-# 4	14-# 4	2.82	2.82	2.82
28	100	26	13-# 8	19-# 4	10-# 5	14-# 4	3.29	3.29	3.29
28	150	33	15-# 8	14-# 5	11-# 5	10-# 5	3.78	3.78	3.79
28	200	45	16-# 8	23-# 4	12-# 5	10-# 5	4.05	4.09	4.13
28	250	56	17-# 8	16-# 5	13-# 5	16-# 4	4.37	4.41	4.46
28	300	67	17-# 8	12-# 6	13-# 5	11-# 5	4.57	4.65	4.73
28	350	77	18-# 8	17-# 5	20-# 4	12-# 5	4.79	4.89	4.99

(1) Columns same above and below plate. (2) Center-to-center of columns; $\ell_1 = \ell_2$. (3) Superimposed factored load (factored dead load has been deducted).

CONCRETE REINFORCING STEEL INSTITUTE

B10 Superstructure

B1010 Floor Construction



General: Flat Plates: Solid uniform depth concrete two-way slab without drops or interior beams. Primary design limit is shear at columns.

Design and Pricing Assumptions:
Concrete f'c to 4 KSI, placed by concrete pump.
Reinforcement, fy = 60 KSI.
Forms, four use.
Finish, steel trowel.
Curing, spray on membrane.
Based on 4 bay x 4 bay structure.

System Components	QUANTITY	UNIT	COST PER S.F. MAT.	COST PER S.F. INST.	COST PER S.F. TOTAL
SYSTEM B1010 223 2000					
15'X15' BAY 40 PSF S. LOAD, 12" MIN. COL.					
Forms in place, flat plate to 15' high, 4 uses	.992	S.F.	1.56	4.73	6.29
Edge forms to 6" high on elevated slab, 4 uses	.065	L.F.	.01	.22	.23
Reinforcing in place, elevated slabs #4 to #7	1.706	Lb.	.87	.63	1.50
Concrete ready mix, regular weight, 3000 psi	.459	C.F.	1.95		1.95
Place and vibrate concrete, elevated slab less than 6", pump	.459	C.F.		.60	.60
Finish floor, monolithic steel trowel finish for finish floor	1.000	S.F.		.76	.76
Cure with sprayed membrane curing compound	.010	C.S.F.	.05	.08	.13
TOTAL			4.44	7.02	11.46

B1010 223 Cast in Place Flat Plate

	BAY SIZE (FT.)	SUPERIMPOSED LOAD (P.S.F.)	MINIMUM COL. SIZE (IN.)	SLAB THICKNESS (IN.)	TOTAL LOAD (P.S.F.)	COST PER S.F. MAT.	COST PER S.F. INST.	COST PER S.F. TOTAL
2000	15 x 15	40	12	5-1/2	109	4.44	7.05	11.49
2200		75	14	5-1/2	144	4.46	7.05	11.51
2400		125	20	5-1/2	194	4.63	7.10	11.73
2600		175	22	5-1/2	244	4.72	7.15	11.87
3000	15 x 20	40	14	7	127	5.10	7.10	12.20
3400		75	16	7-1/2	169	5.45	7.25	12.70
3600		125	22	8-1/2	231	5.95	7.45	13.40
3800		175	24	8-1/2	281	6	7.45	13.45
4200	20 x 20	40	16	7	127	5.10	7.10	12.20
4400		75	20	7-1/2	175	5.50	7.25	12.75
4600		125	24	8-1/2	231	6	7.40	13.40
5000		175	24	8-1/2	281	6.05	7.45	13.50
5600	20 x 25	40	18	8-1/2	146	5.95	7.45	13.40
6000		75	20	9	188	6.15	7.55	13.70
6400		125	26	9-1/2	244	6.65	7.75	14.40
6600		175	30	10	300	6.90	7.85	14.75
7000	25 x 25	40	20	9	152	6.15	7.55	13.70
7400		75	24	9-1/2	194	6.50	7.70	14.20
7600		125	30	10	250	6.90	7.90	14.80
8000								

301

WAFFLE FLAT SLAB SYSTEM 30″ X 30″ Voids: 6″ Ribs @ 36″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

Total Depth = 12½ in. Rib Depth = 8 in. Total Slab Depth = 4½ in.

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column: $c_1 = c_2$ (in.)	Square Edge Column: γ_f	Square Edge Column: (2) Stirrups	Column Strip: Top Edge No.-size +	Column Strip: Bottom No. Ribs	Column Strip: Bottom Bars per Rib	Column Strip: Top Interior No.-size	Middle Strip: Bottom No. Ribs	Middle Strip: Bottom Long Bars	Middle Strip: Bottom Short Bars	Middle Strip: Top Interior No.-size	Moments: −M Edge (ft-k)	Moments: +M Bot. (ft-k)	Moments: −M Int. (ft-k)
18'- 0" D= 6.500 RIB ON COLUMN LINE 0.648 CF/SF	50	1.86	12	0.688		13-#5+ 0	3	2-#4	13-#5	3	#4	#4	5-#5	30	60	81
	100	1.86	12	0.713		13-#5+ 0	3	2-#4	13-#5	3	#4	#4	5-#5	39	78	104
	150	1.92	12	0.737		13-#5+ 0	3	1-#4 and 1-#5	13-#5	3	#4	#4	5-#5	47	107	127
	200	1.98	12	0.761		13-#5+ 0	3	2-#5	13-#5	3	#4	#4	5-#5	56	134	150
	300	2.34	12	0.809		13-#5+ 0	3	2-#6	13-#5	3	#5	#5	5-#5	72	187	195
	400	2.61	12	0.858		13-#5+ 0	3	1-#6 and 1-#7	13-#5	3	#5	#6	5-#5	89	239	241
	500	3.02	12 *	0.633	3 S 4 1	13-#5+ 0	3	1-#7 and 1-#8	14-#5	3	#6	#6	5-#5	106	289	286
21'- 0" D= 9.500 RIB NOT ON COLUMN LINE 0.680 CF/SF	50	1.84	12	0.759		15-#5+ 0	4	2-#4	15-#5	3	#4	#4	6-#5	50	99	134
	100	1.84	12	0.787		15-#5+ 0	4	2-#4	15-#5	3	#4	#4	6-#5	63	129	171
	150	2.01	12	0.816		15-#5+ 0	4	2-#5	15-#5	3	#4	#5	6-#5	77	177	207
	200	2.23	12	0.844		15-#5+ 0	4	1-#5 and 1-#6	15-#5	3	#5	#5	6-#5	91	221	244
	300	2.70	12 *	0.906		15-#5+ 1	4	1-#6 and 1-#7	16-#5	3	#6	#6	6-#5	118	306	318
	400	3.30	12 *	0.633		15-#5+ 0	4	1-#7 and 1-#8	14-#6	3	#7	#7	7-#5	145	389	391
	500	3.81	15 *	0.629		15-#5+ 1	4	2-#8	23-#5	3	#7	#8	8-#5	170	460	457
24'- 0" D= 9.500 RIB NOT ON COLUMN LINE 0.661 CF/SF	50	1.92	12	0.823		18-#5+ 0	4	1-#4 and 1-#5	18-#5	4	#4	#4	7-#5	74	149	200
	100	1.98	12	0.854		18-#5+ 0	4	2-#5	18-#5	4	#4	#4	7-#5	95	193	256
	150	2.32	12 *	0.885		18-#5+ 0	4	2-#6	18-#5	4	#5	#5	7-#5	116	264	311
	200	2.64	12 *	0.921		18-#5+ 1	4	2-#7	18-#5	4	#5	#6	7-#5	136	330	367
	300	3.44	14 *	0.630		18-#5+ 0	4	2-#8	17-#6	4	#6	#7	8-#5	176	456	474
	400	4.19	18 *	0.626		18-#5+ 2	4	2-#9	16-#7	4	#7	#7	7-#6	212	546	569
27'- 0" D= 9.500 RIB NOT ON COLUMN LINE 0.648 CF/SF	50	2.06	13	0.847		20-#5+ 0	4	1-#5 and 1-#6	20-#5	5	#4	#4	8-#5	105	211	284
	100	2.22	13 *	0.889		20-#5+ 1	4	2-#6	20-#5	5	#4	#5	8-#5	135	270	363
	150	2.65	13 *	0.931		20-#5+ 3	4	2-#7	23-#5	5	#5	#5	8-#5	164	368	442
	200	3.26	15 *	0.629		20-#5+ 0	4	2-#8	19-#6	5	#6	#6	9-#5	192	458	518
	300	4.10	20 *	0.624		20-#5+ 1	4	2-#9	18-#7	5	#6	#7	8-#6	244	590	658
30'- 0" D=12.500 RIB ON COLUMN LINE 0.670 CF/SF	50	2.12	15 *	0.861		22-#5+ 1	5	1-#5 and 1-#6	22-#5	5	#4	#5	9-#5	146	292	393
	100	2.53	15 *	0.917		22-#5+ 5	5	1-#6 and 1-#7	25-#5	5	#5	#5	9-#5	186	372	501
	150	3.19	17 *	0.933		22-#5+ 8	5	1-#7 and 1-#8	22-#6	5	#6	#6	10-#5	225	484	606
	200	3.88	20 *	0.624		22-#5+ 4	5	1-#8 and 1-#9	20-#7	5	#6	#7	12-#5	263	604	708
33'- 0" D=12.500 RIB ON COLUMN LINE 0.658 CF/SF	50	2.45	16 *	0.900		25-#5+ 4	5	1-#6 and 1-#7	26-#5	6	#5	#5	10-#5	193	386	520
	100	2.99	17 *	0.937		25-#5+ 8	5	1-#7 and 1-#8	24-#6	6	#5	#6	11-#5	246	493	663
	150	3.71	23 *	0.622		25-#5+ 2	5	1-#8 and 1-#9	22-#7	6	#6	#6	10-#6	295	608	794

SQUARE INTERIOR PANELS

Total Depth = 12½ in. Rib Depth = 8 in. Total Slab Depth = 4½ in.

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Interior Column: $c_1 = c_2$ (in.)	Square Interior Column: (2) Stirrups	Column Strip: Bottom No. Ribs	Column Strip: Bottom Bars per Rib	Column Strip: Top Interior No.-size	Middle Strip: Bottom No. Ribs	Middle Strip: Bottom Long Bars	Middle Strip: Bottom Short Bars	Middle Strip: Top Interior No.-size
18'- 0" D= 6.500 RIB ON COLUMN LINE 0.648 CF/SF	50	1.84	12		3	2-#4	13-#5	3	#4	#4	5-#5
	100	1.84	12		3	2-#4	13-#5	3	#4	#4	5-#5
	150	1.84	12		3	2-#4	13-#5	3	#4	#4	5-#5
	200	1.84	12		3	2-#4	13-#5	3	#4	#4	5-#5
	300	2.05	12	3 S 4 1	3	2-#5	13-#5	3	#4	#4	5-#5
	400	2.28	12	3 S 4 1	3	1-#5 and 1-#6	13-#5	3	#4	#5	5-#5
	500	2.53	12 *	3 S 4 1	3	2-#6	13-#5	3	#5	#5	5-#5
21'- 0" D= 9.500 RIB NOT ON COLUMN LINE 0.680 CF/SF	50	1.82	12		4	2-#4	15-#5	3	#4	#4	6-#5
	100	1.82	12		4	2-#4	15-#5	3	#4	#4	6-#5
	150	1.82	12		4	2-#4	15-#5	3	#4	#4	6-#5
	200	2.01	12		4	1-#4 and 1-#5	15-#5	3	#4	#5	6-#5
	300	2.35	12 *	3 S 4 1	4	1-#5 and 1-#6	15-#5	3	#5	#5	6-#5
	400	2.73	12 *	3 S 4 1	4	2-#6	18-#5	3	#5	#6	6-#5
	500	3.29	13 *	3 S 4 1	4	1-#6 and 1-#7	15-#6	3	#6	#6	7-#5
24'- 0" D= 9.500 RIB NOT ON COLUMN LINE 0.661 CF/SF	50	1.86	12		4	2-#4	18-#5	4	#4	#4	7-#5
	100	1.86	12		4	2-#4	18-#5	4	#4	#4	7-#5
	150	2.05	12	3 S 4 1	4	2-#5	18-#5	4	#4	#4	7-#5
	200	2.25	12 *	3 S 4 1	4	1-#5 and 1-#6	18-#5	4	#4	#5	7-#5
	300	2.97	12 *	3 S 4 1	4	1-#6 and 1-#7	16-#6	4	#5	#6	7-#5
	400	3.64	15 *	3 S 4 1	4	2-#7	20-#6	4	#6	#6	9-#5
27'- 0" D= 9.500 RIB NOT ON COLUMN LINE 0.648 CF/SF	50	1.94	13		4	1-#4 and 1-#5	20-#5	5	#4	#4	8-#5
	100	2.02	13	3 S 4 1	4	2-#5	20-#5	5	#4	#4	8-#5
	150	2.38	13 *	3 S 4 1	4	2-#6	21-#5	5	#4	#5	8-#5
	200	2.84	13 *	3 S 4 1	4	1-#6 and 1-#7	25-#5	5	#5	#5	8-#5
	300	3.74	16 *	3 S 4 2	4	1-#7 and 1-#8	23-#6	5	#5	#6	8-#6
30'- 0" D=12.500 RIB ON COLUMN LINE 0.670 CF/SF	50	1.94	15		5	1-#4 and 1-#5	22-#5	5	#4	#4	9-#5
	100	2.28	15 *	3 S 4 1	5	1-#5 and 1-#6	23-#5	5	#4	#5	9-#5
	150	2.84	15 *	3 S 4 1	5	2-#6	21-#6	5	#5	#5	10-#5
	200	3.50	15 *	3 S 4 1	5	2-#7	25-#6	5	#5	#6	12-#5
33'- 0" D=12.500 RIB ON COLUMN LINE 0.658 CF/SF	50	2.16	16	3 S 4 1	5	1-#5 and 1-#6	25-#5	6	#4	#4	10-#5
	100	2.65	16 *	3 S 4 1	5	2-#6	23-#6	6	#4	#5	10-#5
	150	3.36	16 *	3 S 4 1	5	2-#7	28-#6	6	#5	#5	13-#5

See the notes on Page 11-19.

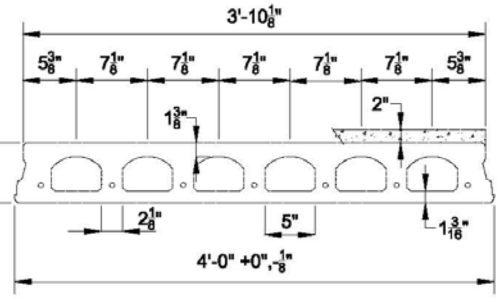
Prestressed Concrete
6"x4'-0" Hollow Core Plank

2 Hour Fire Resistance Rating With 2" Topping

PHYSICAL PROPERTIES
Composite Section

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

DESIGN DATA



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

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

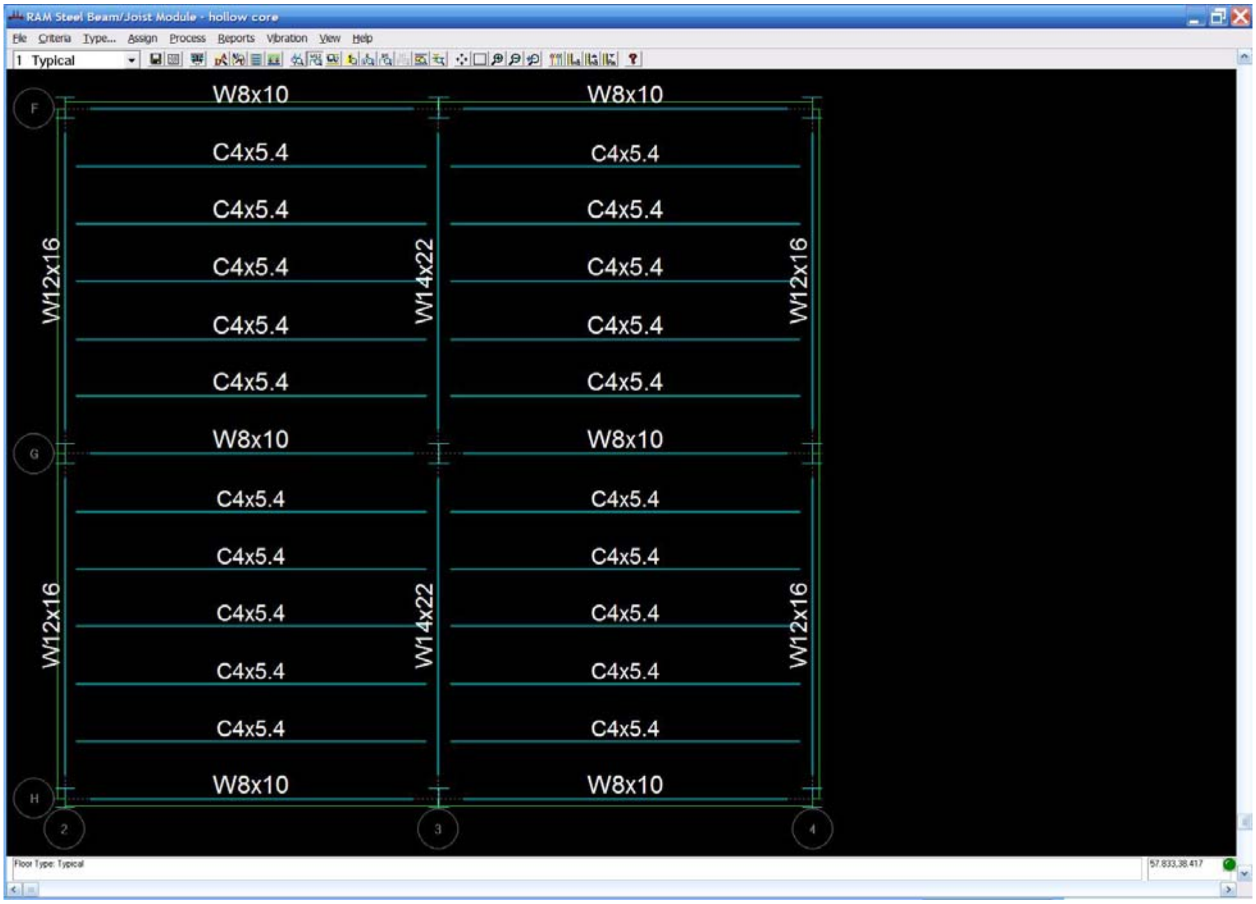
Strand Pattern		SPAN (FEET)																		
		11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
4 - 1/2"ø	LOAD (PSF)	227	187	360	306	268	229	194	165	141	120	102	86	73	61	50				
7 - 1/2"ø	LOAD (PSF)	367	305	495	455	418	387	340	312	275	243	215	189	167	147	130	114	97	83	70

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

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

05/14/07

6F2.0T


RAM Steel Beam/Joist Module - hollow core
File Criteria Type... Assign Process Reports Vibration View Help
1 Typical
W8x10
W8x10
C4x5.4
C4x5.4
C4x5.4
C4x5.4
W12x16
C4x5.4
W14x22
C4x5.4
W12x16
C4x5.4
C4x5.4
C4x5.4
C4x5.4
W8x10
W8x10
C4x5.4
C4x5.4
C4x5.4
C4x5.4
W12x16
C4x5.4
W14x22
C4x5.4
W12x16
C4x5.4
C4x5.4
C4x5.4
C4x5.4
W8x10
W8x10
Floor Type: Typical