Executive Summary

The Quantum II office building was built as a part of The Southside Works commercial development in Pittsburgh Pennsylvania. The 6 story 186,000 square foot office suite was later purchased, and is currently being fitted-out by the American Eagle Outfitters Corporation. Being that the structure was built without a contracted tenant the designers took steps to make it versatile and attractive to business. The building is conveniently located just outside the confusion of the city where there is more space and parking. Moreover, the engineers strived to keep as many options for fit-out as open as possible. To achieve this they utilized composite slab floor decks, large bays, and moment frame connections. The use of moment connections avoided blocking bays and obstructing the floor plan, as is par with alternate methods of lateral support, mainly cross bracing or shear walls.

The objective of this report is to design an alternative lateral system of cross bracing. Utilizing the new interior plans of the fit-out frames can be located in a manner that minimized conflict with the final architectural floor plan.

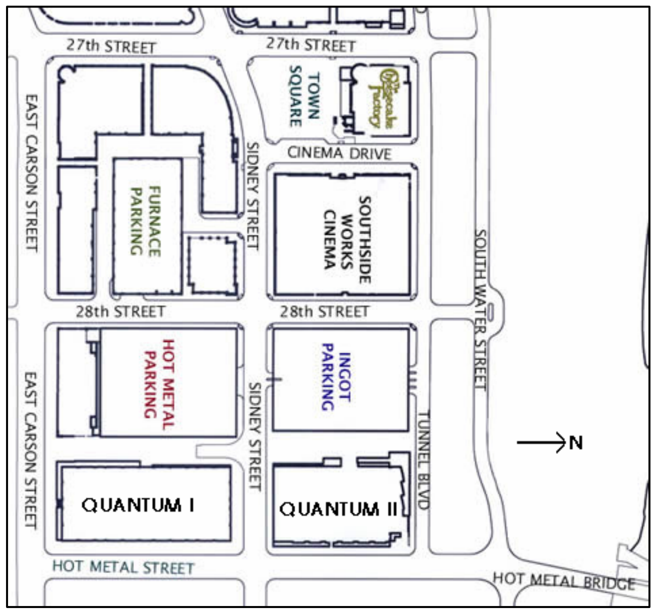
Any major structural change will have some impact on the building cost. For this reason a cost analysis and comparison of the existing and redesigned structures was performed as a breadth study. In the same spirit construction schedule of the redesigned system was also assembled.

Also, an extensive investigation into an alternative floor system, hollow core concrete planks, was performed.

Building Description & Project Background

Location & History

The Quantum II office building sits on the shore of the Monongahela River just outside the city of Pittsburgh at the site of the old Southside Works steel plant, one of many manufacturing facilities in south western Pennsylvania that made the religion and the nation an industrial power during the Second World War. The appearance of cheaper foreign steel in the 1970's and the economic decline of the 1980's closed the plants, and severely hurt the region. After over a decade of inactivity a city/county task force was assembled to utilize the prime riverfront real-estate and revitalize the area. Opening in 2002 the new Southside Works is a 34 acre milti-million dollar commercial develpoment that includes retal, dining, class A office space, parking and apartments. The first office developments were the Quantum I and Quantum II office buildings. These structures were both designed and constructed as shells that would be fitted out once a tenant was found. Quantum II caught the eye of the American Eagle Outfitters clothing company, and is now in the tenant fit-out phase of construction.



Architecture

Quantum II makes an impression the first building seen when traveling to Pittsburgh's Southside via the historic Hot Metal Bridge. Travelers are met by its jagged glass façade and smooth vertical lines created by decorative exterior columns. All together the facility provides 6 stories and 186,000 square feet of versatile space. Large

bays and an open floor plan were utilized to maximize this versatility. The majority of space will be used as offices and conference rooms with the exception of a cafeteria on the sixth floor and lobbies and human resources on the first. A series of balconies climb up the North West corner of the building. The structure has a contemporary shape and look utilizing a brick and glass curtain wall, and fits in well with its other modern neighbors in the new district.

Project Team

Developer: The Soffer Organization
Owner: American Eagle Outfitters
Base Building Architect: Davis Gardner Gannon Pope
Base Building Engineer: Watson Engineers
Fit-out Architect: The Design Alliance
Fit-out Engineer: Atlantic Engineering Services
Fit-out MEP: Tower Engineering

The South Side Works Town Square at night.

Building Systems

Mechanical

Hating and cooling of Quantum II is handled by a CAV system. The structure has two roof top units; an 18000 CMF and a 7200 CMF.

Lighting / Electrical

Quantum II's primary electrical system is a 480/277V – 3 phase – 4 wire configuration. It also has a 208/120V – 3 phase – 4 wire secondary system. Lighting in large open office spaces is provided by fluorescent luminaries. Conference rooms, corridors, lobbies and other public spaces are illuminated by incandescent bulbs. An arrangement of halogen lamps illuminates the front façade at night.

Fire Protection

The floors plans are blanketed in an extensive sprinkler system. Upright sprinkler heads cover open office spaces, where as enclosed spaces such as conference rooms have recessed pendant sprinklers.

Transportation

The structure has three main portals on the first floor; the main entrance in the front, a side entrance on the west length, and a service loading dock in the rear. There are two adjacent elevators that lay just off center on the plan and service all six floors, as well as two fire stair wells located toward the front and rear of the building.

Structural System

Gravity

The structure is comprised of conventional steel framing. Most of the elements are made of A572-50 grade steel with a yield strength of 50 ksi. Other miscellaneous components are of A36 grade steel which has a lower yield of 36 ksi. The plan is dominated by three rows of bays measuring 30’ x 30’and one row of 30’ x 38’ bays. All bays contain two beams spaced 10’ apart spanning parallel to the 38’ long side of the larger bays. Each 31,000 square foot story of the structure consists of a composite floor deck of concrete poured over metal decking. 3” 20 gauge metal deck sits under 3” of 4ksi concrete. Steel studs ¾” in diameter and 4 ½” long are used to create composite action between the beams and the deck. Figure 1. shows beam layout for a typical floor.

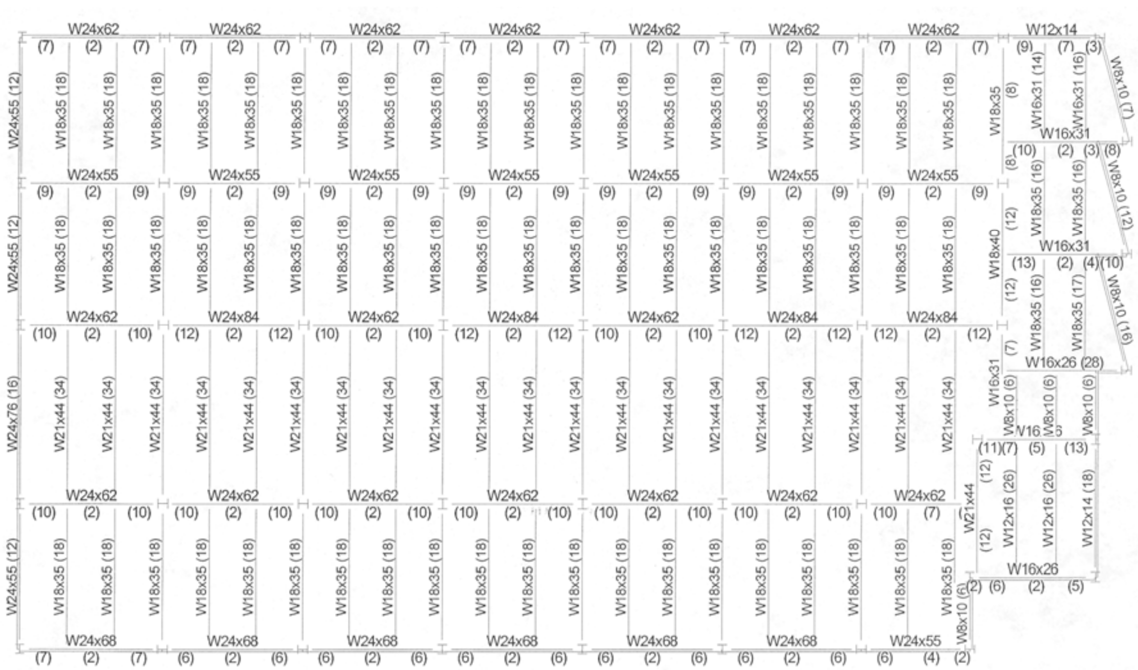


Figure 1. Existing Typical Floor

Lateral

Moment frames have been used to resist wind and seismic loads. This utilization avoided blocking bays with alternate methods of lateral support, mainly cross bracing or shear walls. This was to keep floor plan as open as possible for tenant fit-out. The system is extensive and nearly every connection in the steel frame is a moment connection and contributes in lateral force resistance.

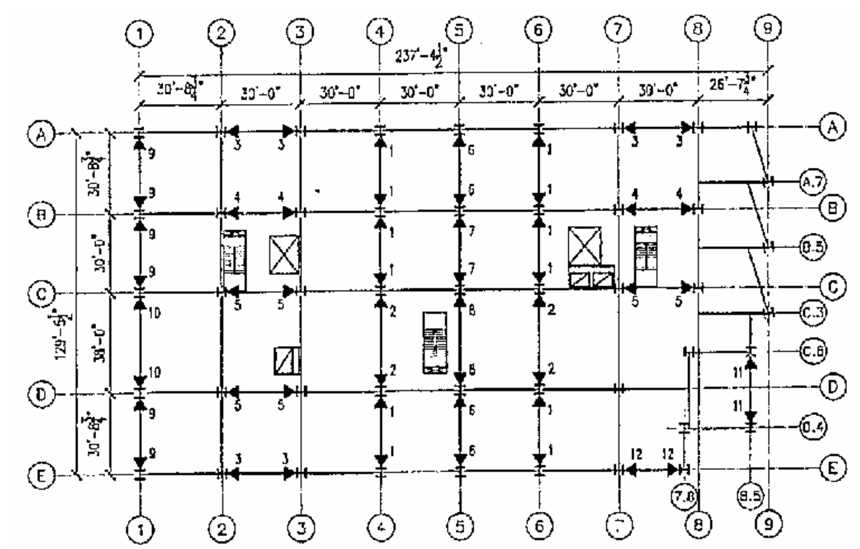


Figure 2.A. Moment Framing Plan

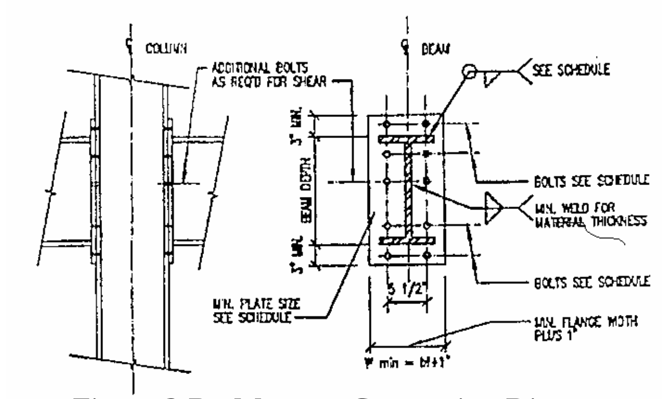


Figure 2.B. Moment Connection Diagram

Foundation

The main foundation element is a system of 45' concrete/auger piles. Columns sit on pile caps covering varying numbers of piles. Concrete grade beams run along the perimeter. All foundational elements are made of 3ksi concrete and reinforced with 60 ksi steel.

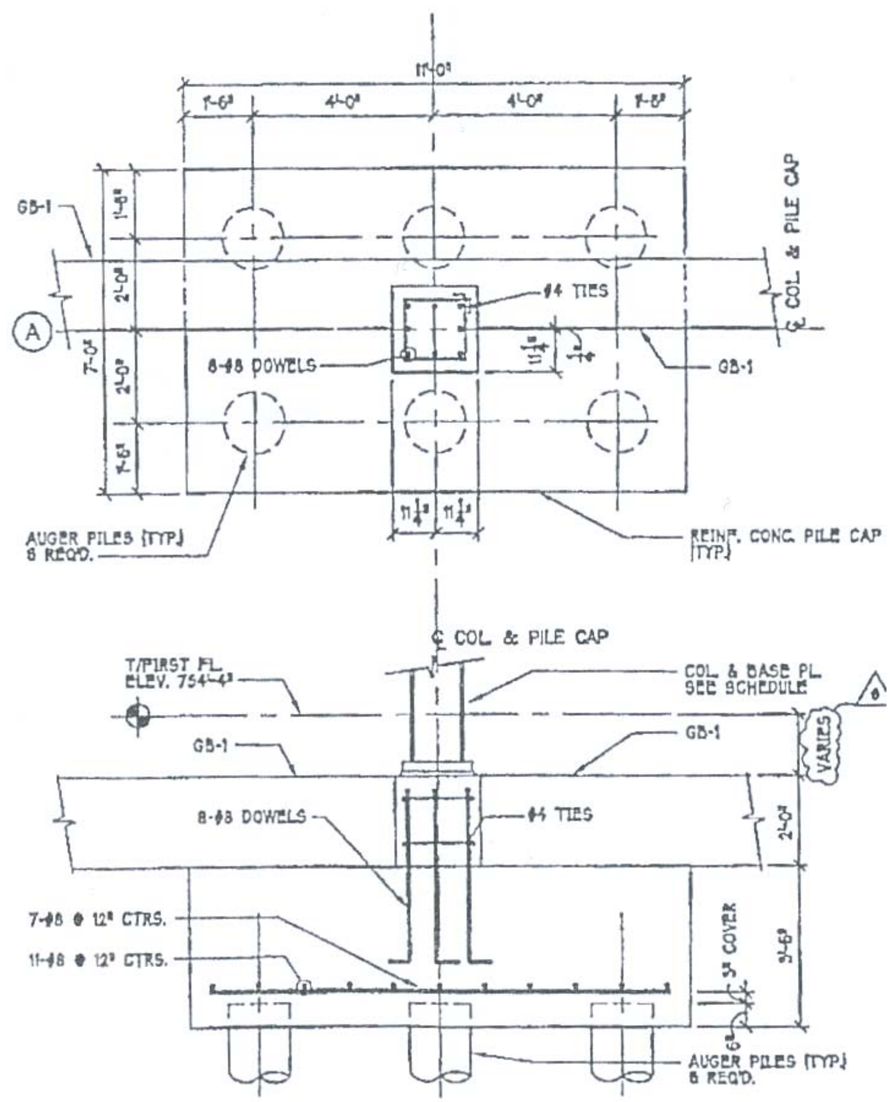


Figure 3. Pile Cap & Grade Beams

Problem Statement

As stated above Quantum II was designed for maximum adaptability during fit-out. The engineers needed a lateral system that would not obstruct the floor plan the way cross bracing and shear walls do. To achieve this fixed moment connections were utilized. Being that moment connections are less effective than their competition at resisting lateral forces, an extensive amount of the buildings connections had to be fixed. Indeed, nearly every beam column and connection is involved in the lateral system. The result of the moment frame's inefficiency is that beam and column sizes are forced to be so large that overall system cost is often greater than with other methods.

Solution Overview

An alternative to the moment connection frame would be one of lateral cross bracing, where vertical bays are filled with diagonal members to help absorb lateral load. The original designers of Quantum II avoided this method to create a completely open floor plan. However, with the advantage of the building's final architectural plans, the ability to design an alternative lateral system that does not obstruct the floor plan exists. The main objective of this thesis is to design a system of lateral cross bracing to replace the existing moment frame system.

Depth: Lateral System Redesign

Frame Layout

The challenge of retro-fitting the structure with a new lateral system lays in locating ample placement of bracing without disrupting the spaces and flow of the floor plans. Quantum II has three basic floor plans; the first floor which contains lobbies human resources and utility space, floors two through five are a typical plan of open office space surrounding a central core, and the sixth floor offering more office space and an extensive kitchen and dinning facilities. The jagged shape of the front façade made placement at the north end of the structure problematic. However, comparing the three different floor plans yielded seven suitable locations for five different frames placed throughout the floor plan in a manner that provides even support. Unfortunately, circumstances were not ideal and in two instances bracing could not be placed in one of the frame's bays. Ultimately this was overcome as the systems design proved adequate. Figure 4. outlines the frame locations in plan and 3D.

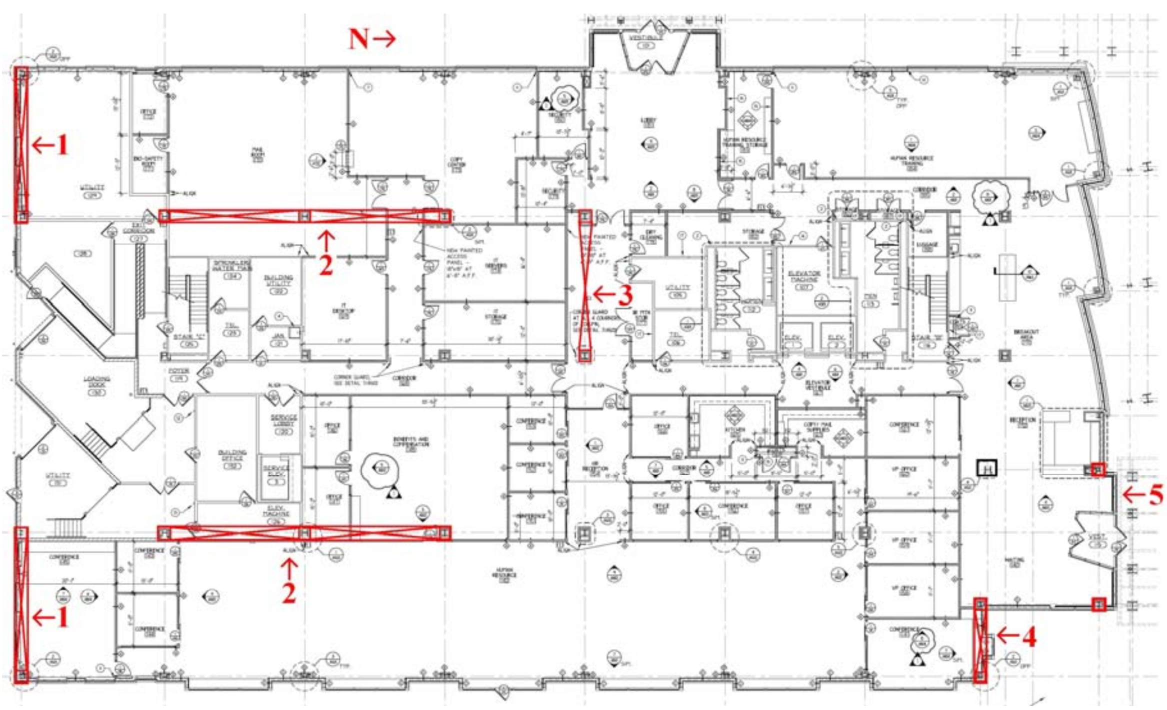


Figure 4.A. 1st Floor Frame Layout

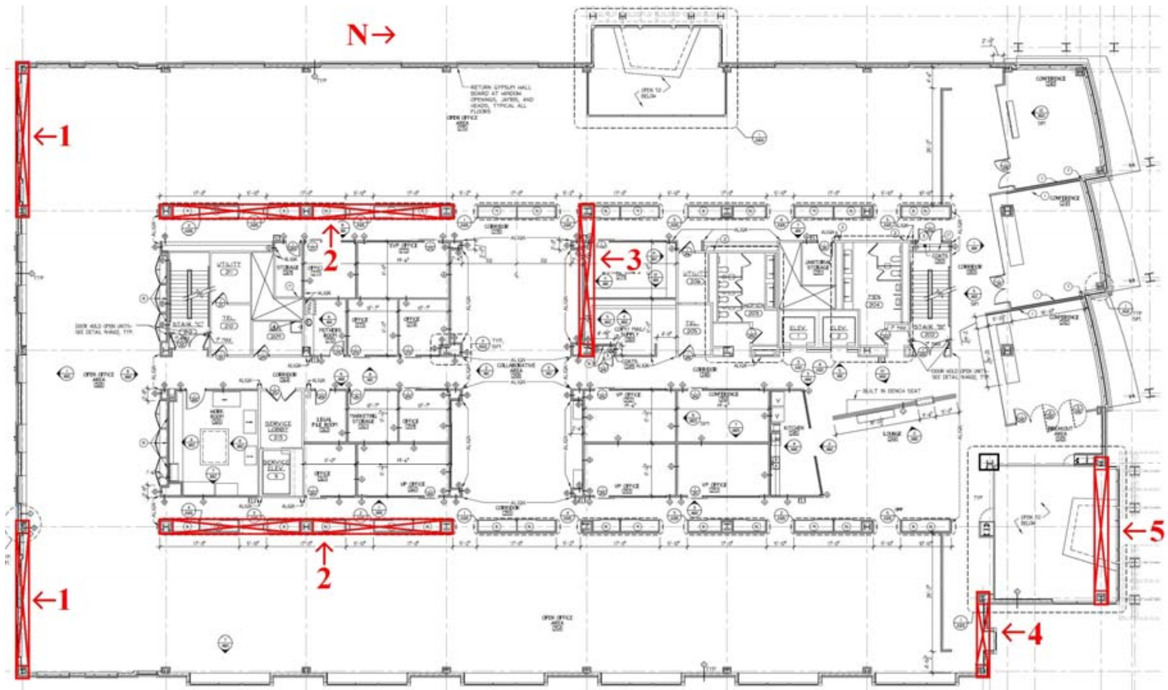


Figure 4.B. Typical Floor Frame Layout

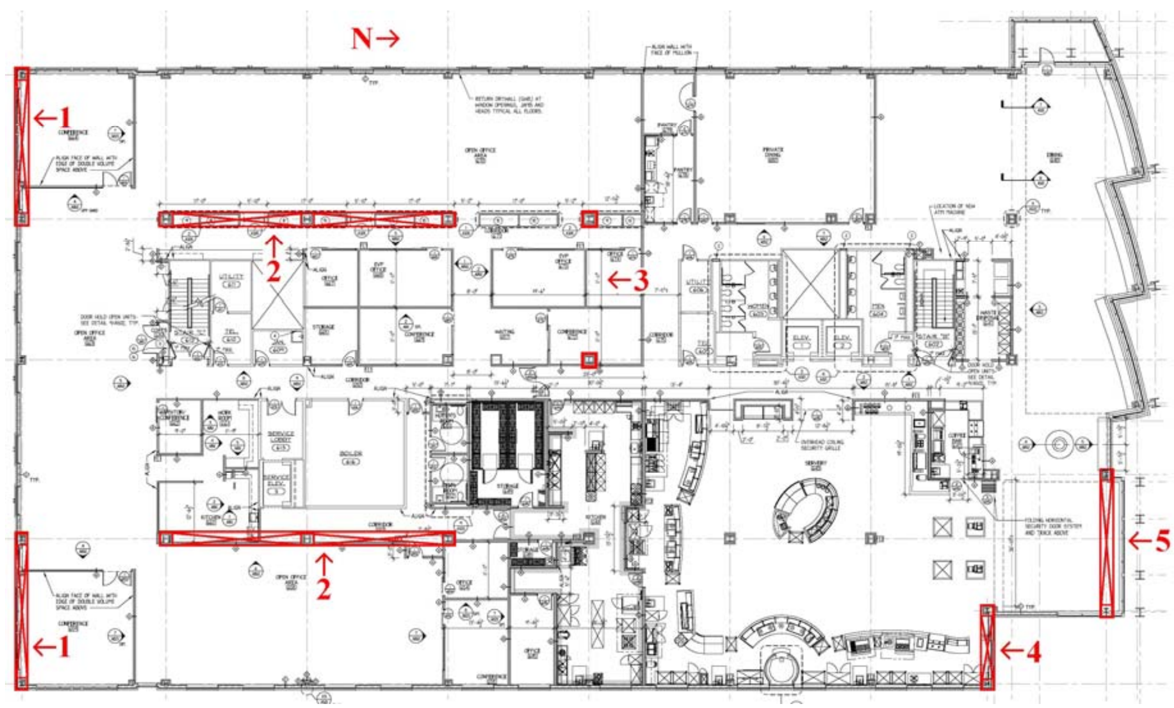


Figure 4.C. 6th Floor Frame Layout

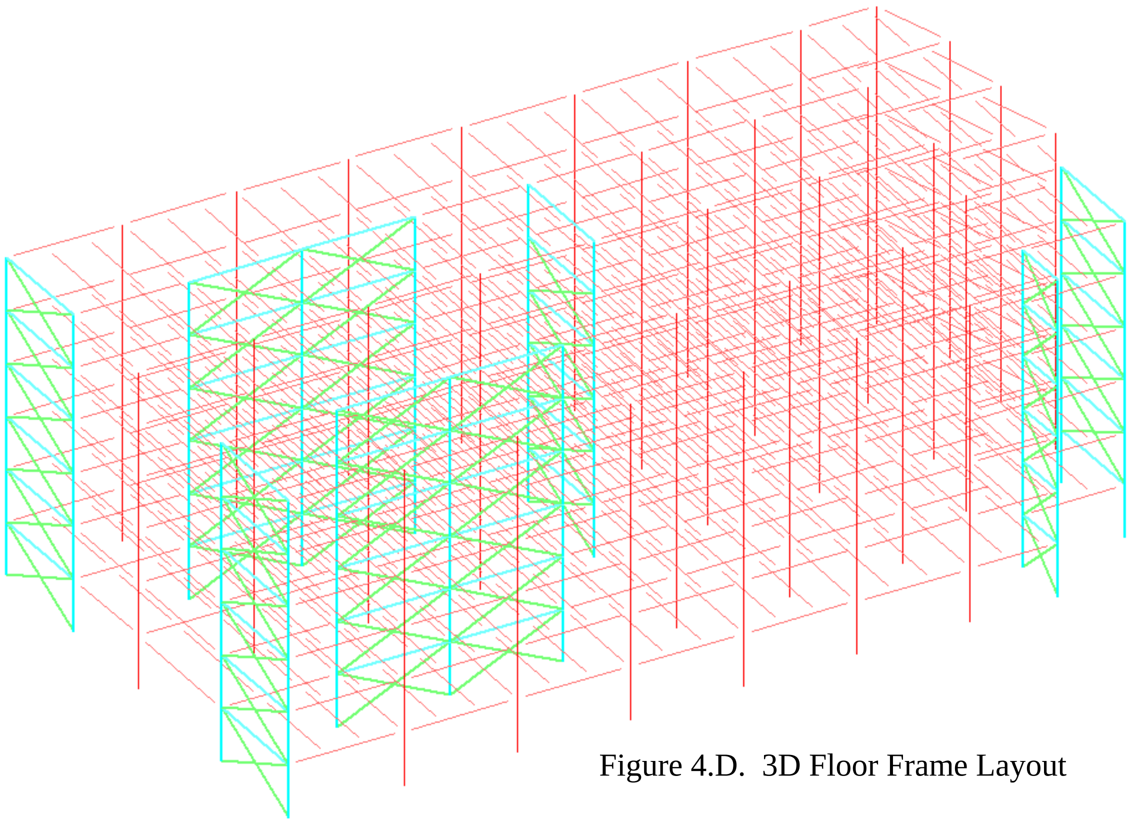


Figure 4.D. 3D Floor Frame Layout

Loads

The gravity system was designed with the following load specifications. Dead load values were derived from information in the building's structural mechanical and fit-out plans. Live loads were taken from ASCE7-02 with the exception of the floor load which has been enlarged to account for the variability of fit-out.

Dead Loads		**Live Loads**	
Typical Floor Slab	57 psf	Roof	30 psf
Roof Slab	57 psf	All Floors	100 psf
Exterior Curtin Wall	20 psf	Stairs	100 psf
MEP	10 psf	Balconies	100 psf
Miscellaneous	5 psf	Flat Roof Snow	21 psf

Figure 5.
Gravity Load Summary

Lateral loads applied to the system will be based on ASCE7-02 chapters 6 for wind and 9 for seismic. Full calculations of these loads can be found in Appendix B, load diagrams are shown in Figure 6.

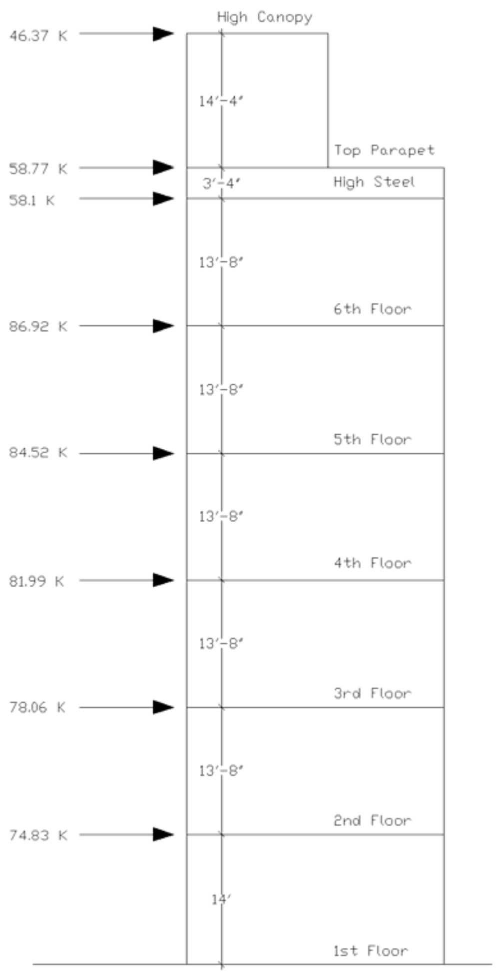


Figure 6.A. Wind Force Diagram

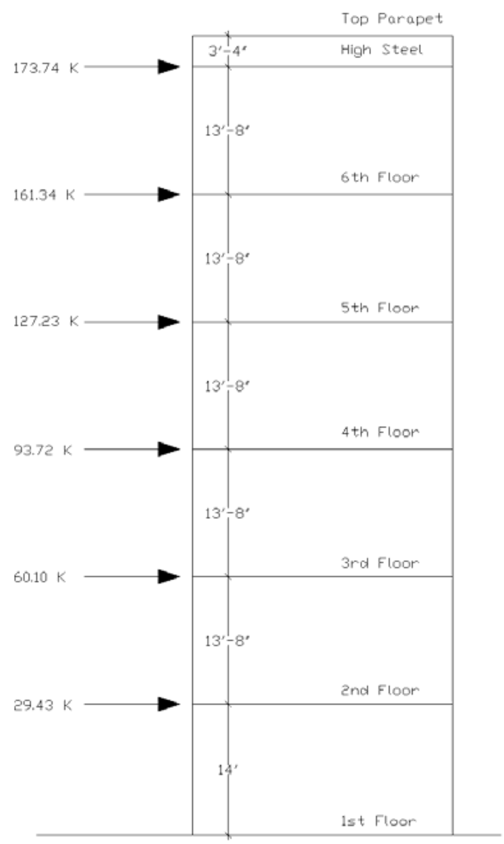


Figure 6.B. Seismic Force Diagram

Gravity System

The RAM Steel computer analysis program was an instrumental tool in the design and analysis of the new system. An assessment of the gravity system yielded the designs shown in Figure 7. The beam values here are smaller than in the existing plan. This is due to the fact that in the existing design a majority of members are active in the lateral system, and therefore must be larger to handle the additional loading. The same applies to the columns which are also smaller from only carrying gravity load. A full column schedule is located in Appendix C.

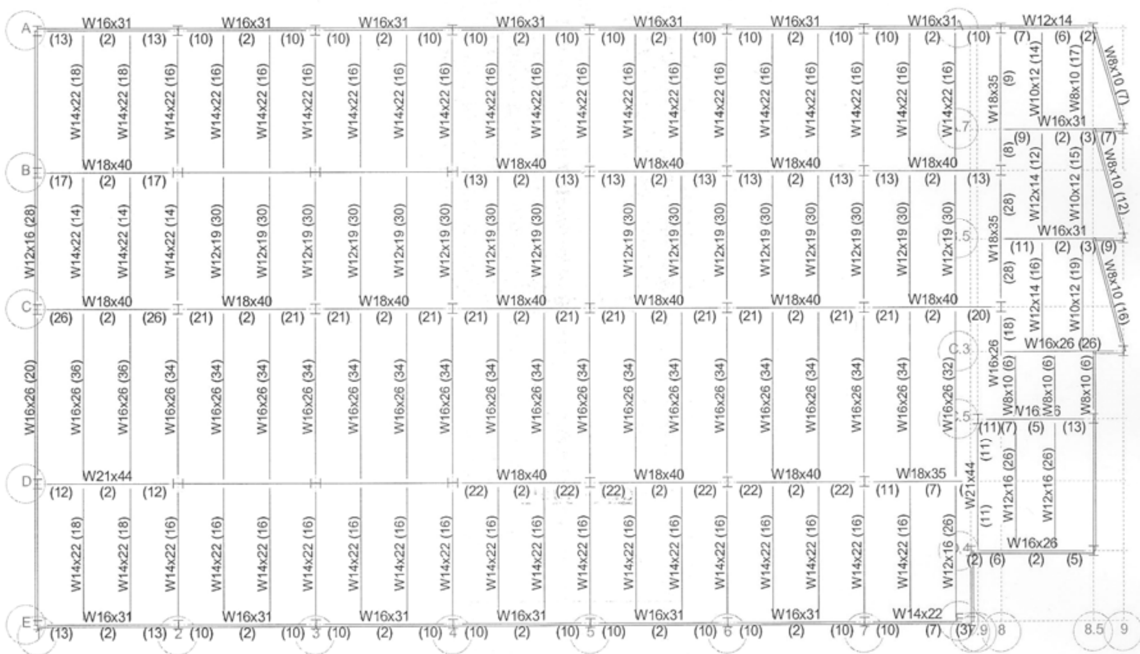


Figure 7.A. Typical Floor

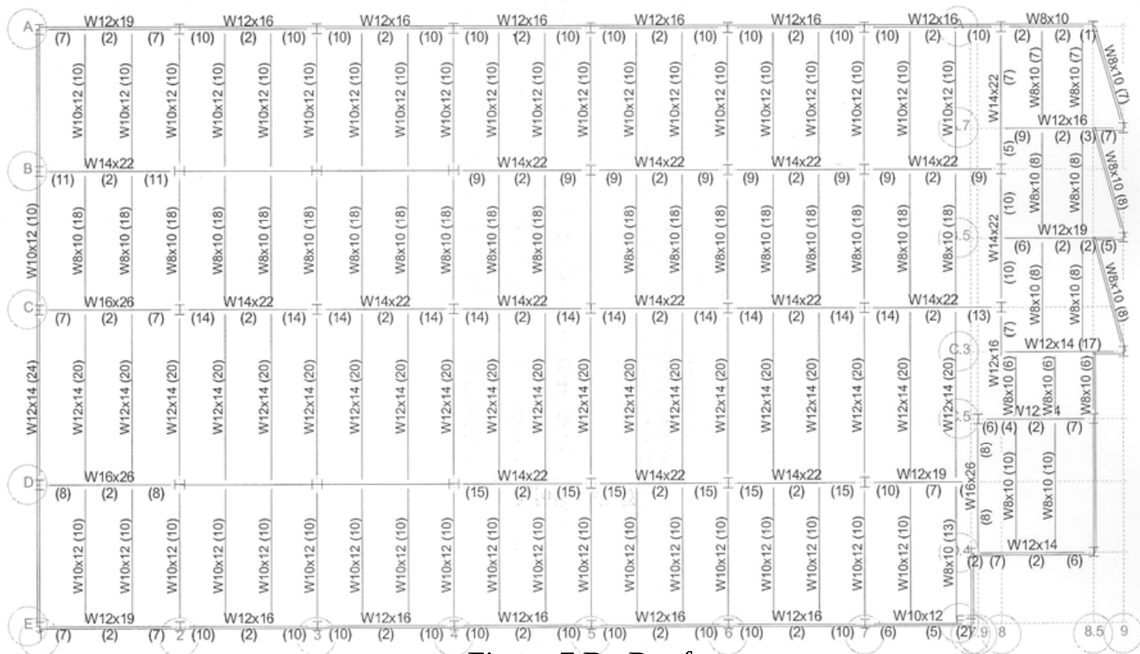


Figure 7.B. Roof

Lateral System

RAM Steel was further used in the design of the lateral system. Rectangular HSS steel members were used for diagonal bracing. Members were sized to support the load stresses and control drift to within acceptable limits. Drift limitations were taken as L/400. Results of the drift analysis are in appendix C. Results of the frame design process are shown in Figure 8. Frame numbers correspond to those on the floor plan frame layouts in Figure 4.

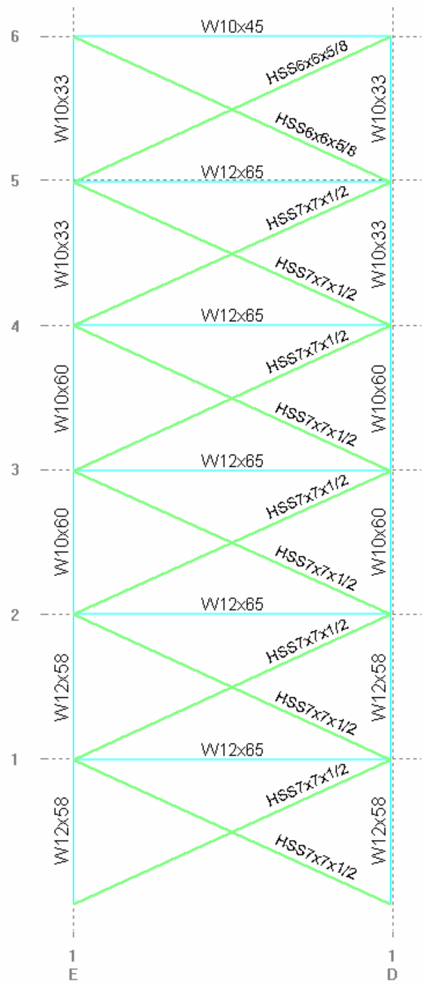


Figure 8.A. Frame 1

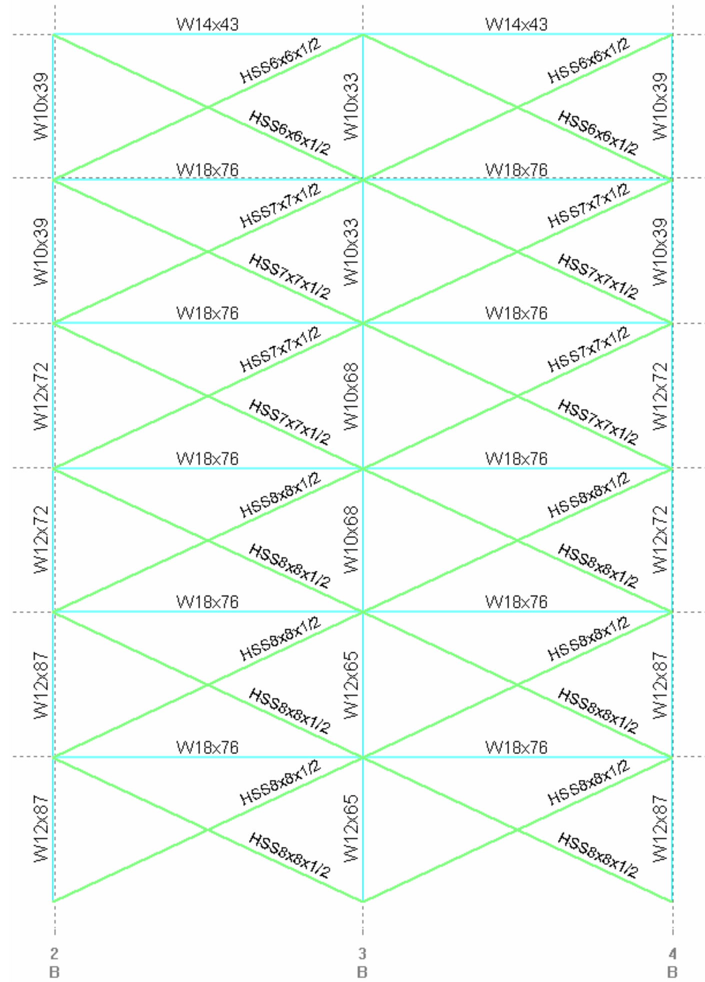


Figure 8.B. Frame 2

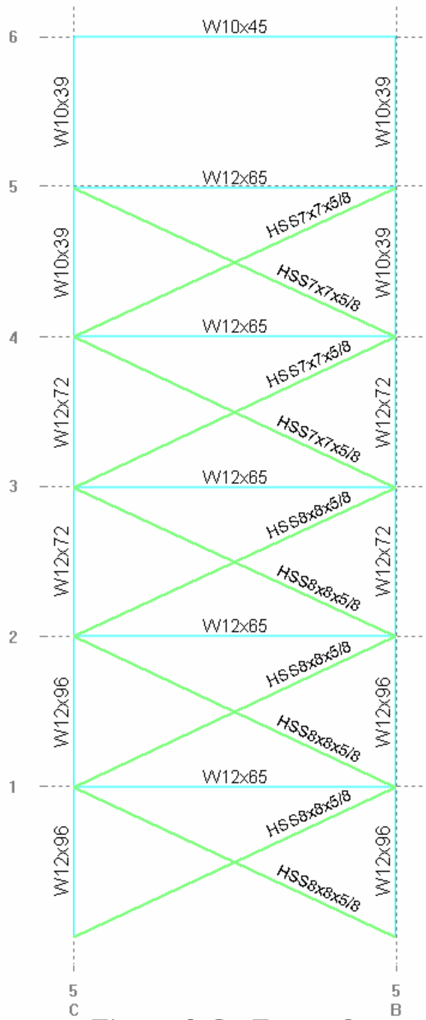


Figure 8.C. Frame 3

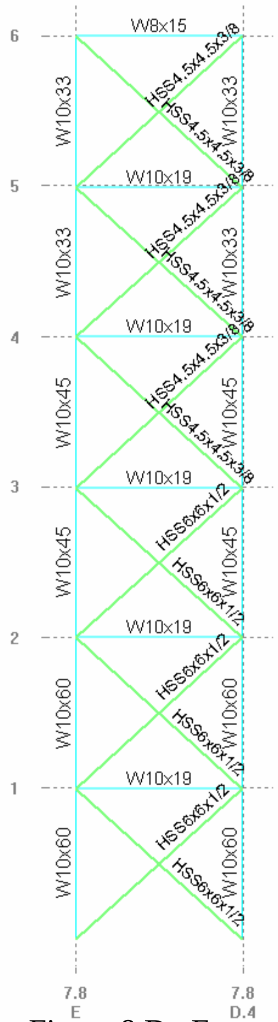


Figure 8.D. Frame 4

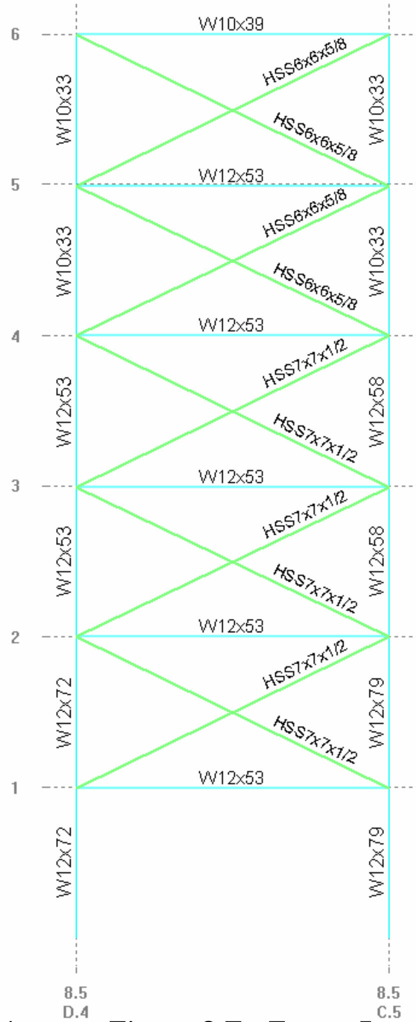


Figure 8.E. Frame 5

Architectural Impact

One of the main objectives of this project was to avoid architectural disruptions by the new lateral system. This was minimized, but unfortunately could not be totally avoided, but. Any conflict, mainly frame 2 on the first floor, can easily be settled by small movements of selected doors and walls. In some cases, frames 1 and 5, the bracing will have to be visible. However this should actually compliment the structure as a whole considering that a precedent of exposed structural elements was previously established by the decorative exterior columns of the front façade.

Breadth

Construction Management

A natural question to ask when comparing different structural designs is that of economy. Which option is cheaper? For this reason a detailed cost estimate was performed for both the existing and redesigned structure. The first step in this process was tabulating extensive take-offs of the materials. This included; beams in the roof and typical floor, the complete column schedule, composite deck including shear studs, and for the redesigned system the cross bracing members. RS Means was then used to estimate the cost of the existing system and the redesigned system. Copies of the full take-offs and calculation spread sheets can be found in appendix D. The results of the calculations are outlined in Figure 9.

Existing System		
Typical Floor (x5)	$	351,851
Roof	$	298,701
Columns	$	360,112
Total	$	2,418,068

Redesigned System		
Typical Floor (x5)	$	265,690
Roof	$	207,827
Columns	$	238,602
Bracing	$	168,848
Total	$	1,943,727

Figure 9.
Cost Comparison

It is apparent that the redesigned system holds advantage over the existing. The cost that was cut by lighter columns and beams outweighed the additional cost of the cross bracing.

Also in the spirit of construction management, a detailed construction schedule has been outlined for the redesigned structure. The data for this also stems from the spread sheets in appendix D. RS Means was again used, this time to calculate the time duration for each component based on the daily output for a typical crew. Components were then grouped and ordered to maximize efficiency of construction. Microsoft Project was then used to assemble the data on a construction schedule shown in Figure 10.

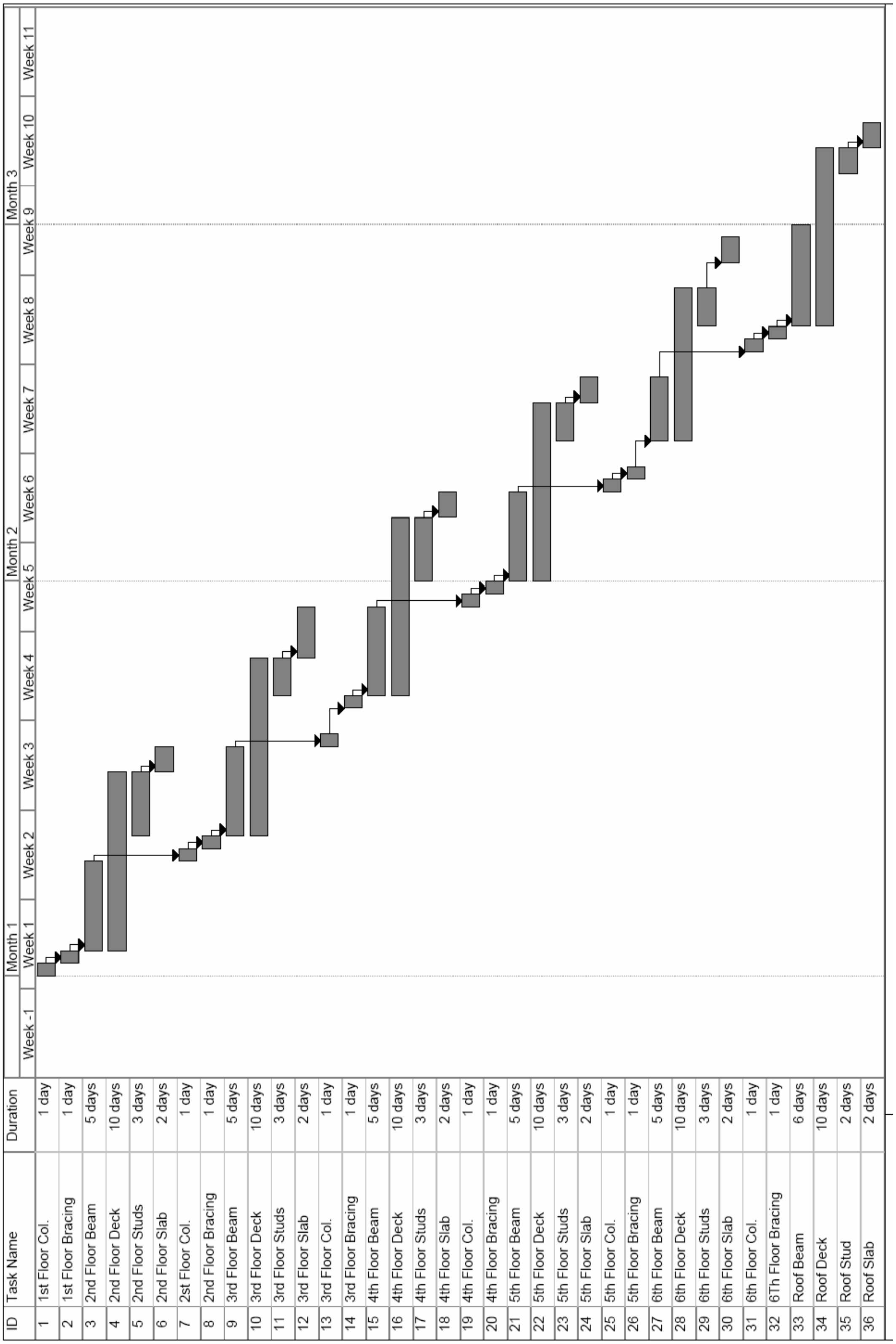


Figure 10. Construction Schedule

Alternative floor

Another intriguing area for suggested structural change is in floor systems. Steel deck and composite steel deck have claimed their place as industry standards for use with traditional steel framing. However, interesting alternatives exist. The alternative investigated in this report is hollow core concrete planks. The advantage brought by this system is that it can span relatively large distances while maintaining a relatively small thickness. Design tables obtained from Nitterhouse Concrete Products, Inc. were utilized to select the proper size. The 8" x 4' – U.L. – J952, with no topping, and strand pattern 4 – ½" was selected. This system has a concrete strength specified as 5 ksi, and a self weight of 57.5 psf. This self weight is very comparable to the composite deck used in the existing and redesigned steel systems, and would produce little effect on seismic or other lateral loads.

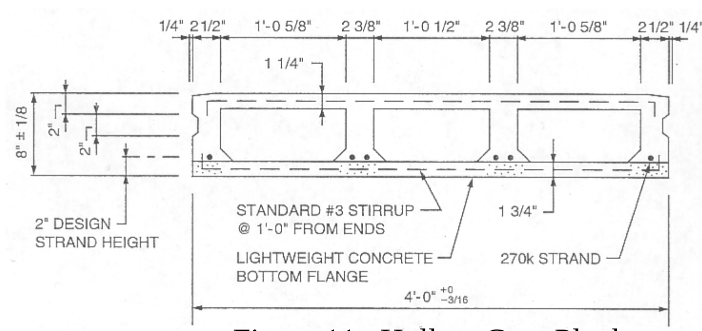


Figure 11. Hollow Core Plank

Under the required floor loads RAM steel was used to analyze a new layout for a typical floor utilizing hollow core planks. The spanning capabilities of the planks allowed the beam spacing to increase from ten feet to fifteen feet. However, this system disables the ability to utilize composite beams. To analyze the effectiveness of this system a cost analysis was performed by comparing a sample strip of the hollow core floor plan to an equal strip of the redesigned floor plan. Full spreadsheets are in Appendix E.

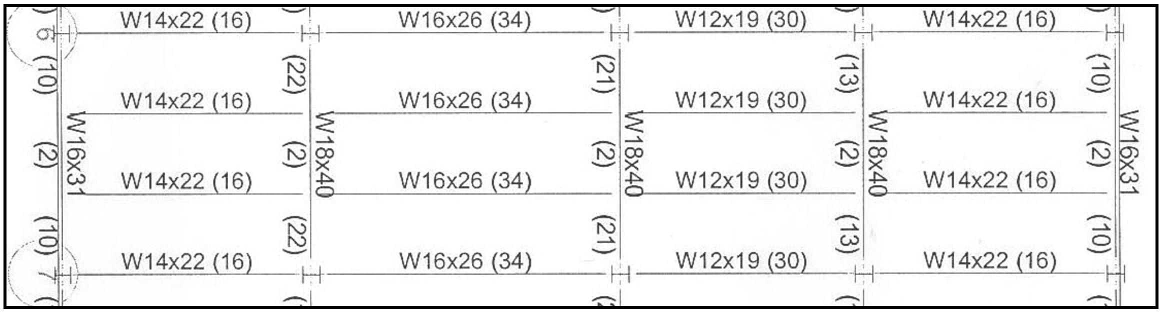


Figure 12.A. Composite Floor Strip

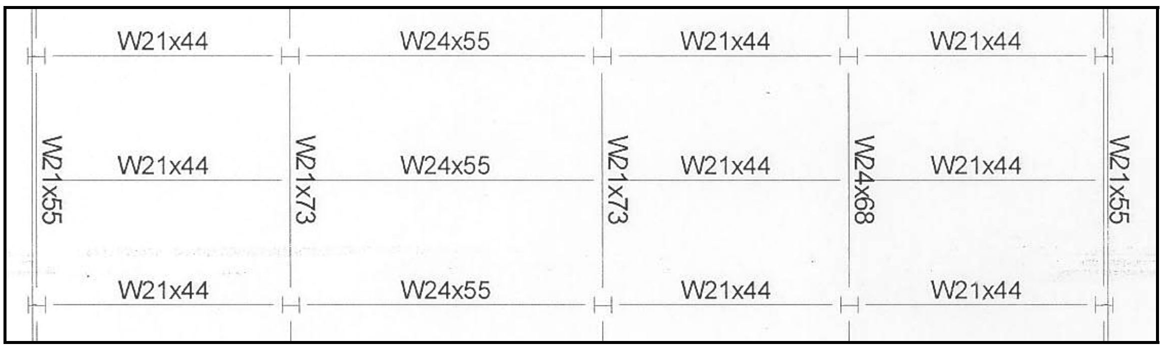


Figure 12.B. Hollow Core Floor Strip

Hollow Core Plank System		
Steel	$	33,844
Slab	$	36,826
Total	$	70,670

Redesigned System		
Steel	$	21,862
Slab	$	13,452
Total	$	35,314

Figure 13.
Floor System
Cost Comparison

The hollow core system is significantly more expensive than the composite. The spanning capabilities of the planks can be deceiving. This also highlights the efficiency and effectiveness of composite floor systems.

Summary & Conclusion

Retro-fitting the structure to accept a braced frame system was a success in all aspects. The new system provided sufficient lateral support and kept drift within acceptable limits. It also alleviated the system as a whole and allowed the sizes of gravity beams and columns to be reduced. Finally, the results of the new system are seen in a sizable cost savings. The existing system of moment connections served its purposes well under the unknown future of the building. However, the braced frame system clearly holds advantage over moment frames.

The use of alternative floor systems is something to be cautious of. Conventional composite steel deck has proven its effectiveness with steal framing.

Acknowledgements

- Tim Jones, J. Gilbert Kaufman, John M. Schneider
    Atlantic Engineering Services
- Brian Whitecap
    The Design Alliance
- Dr. Memari, Professor Parfitt
    Penn State University
- American Eagle Outfitters, Inc.

References

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- AISC
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- RS Means
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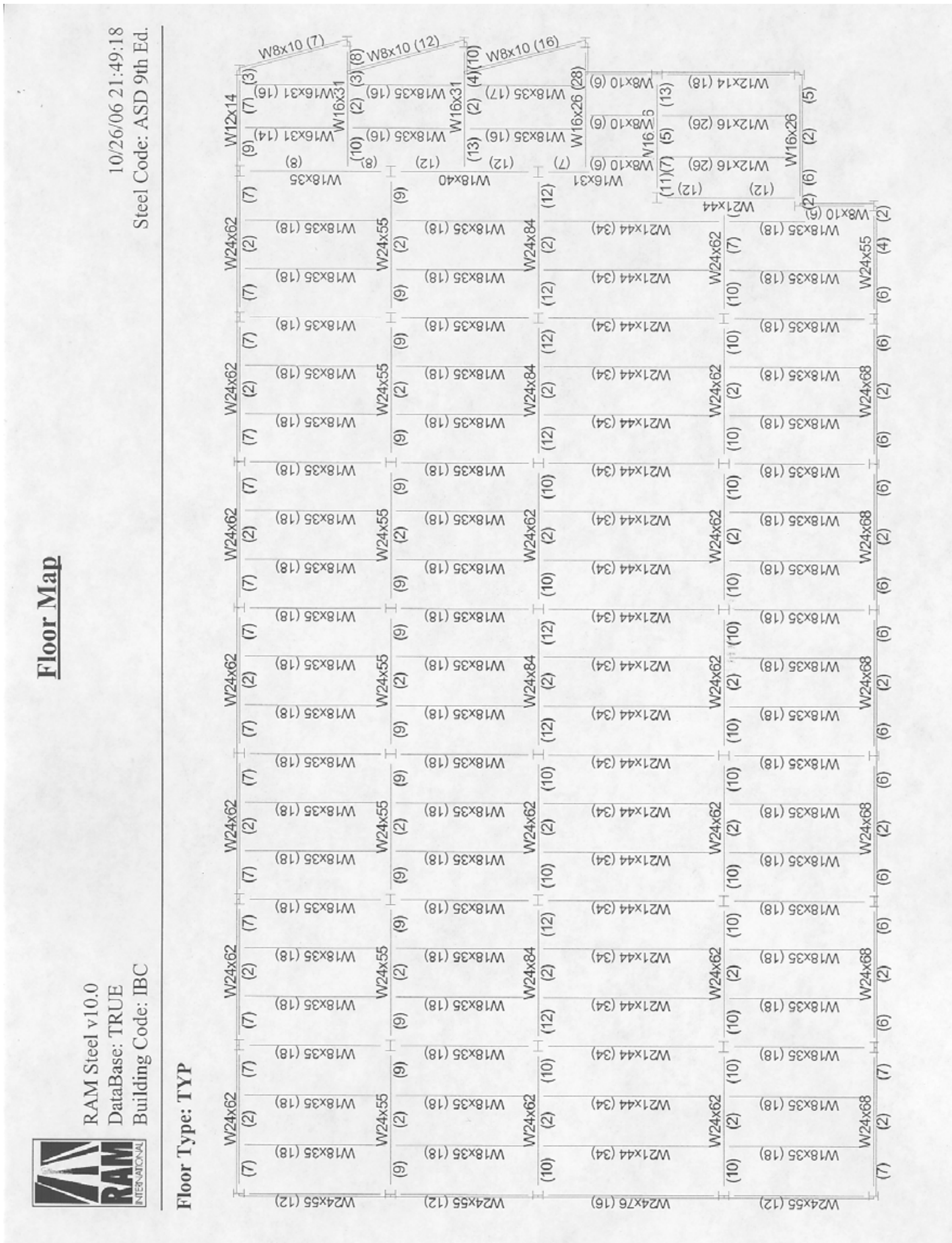
    Building Construction Cost Data, 2007
- Nitterhouse Concrete Products, Inc.
    Hollow Core Plank Design Chart
- Vulcraft
    Steel Roof and Floor Deck, 2001 Edition

Appendix

Appendix A: Existing Structural



Appendix B: Loads

Wind

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ASSIGNMENT: ______
PAGE: ____ of ____

Wind Load $h > 60'$

T 1.1: Occupancy Category III

T 6.1: $I = 1.15$ (non hurricane Region)

F 6-1: $V_0 = 90$ mph

T 6-4: $k_d = 0.85$

eq. 6.3: $k_{zT} = (1 + k_1 \cdot k_2 k_3)^2 = 1$

$k_h = 0.945$ @ (Mean Roof height) = 85'

$k_z =$ height @ specific point

eq. 6-15: $q_h = 0.00256\ k_h \cdot k_{zT} \cdot k_d \cdot V^2 \cdot I\ \left(\frac{lb}{ft^2}\right)$

$q_h = 0.00256\ (0.945)\ 1 \cdot 0.85\ (90mph)^2\ 1.15 =$

$q_h = 19.15462$ psf

$q_z = 0.00256 \cdot k_z \cdot k_{zt} \cdot k_d\ V^2\ I$

$q_z = 0.00256\ k_z \cdot 1 \cdot 0.85\ (90mph)^2\ 1.15 =$

$q_z = 20.26944 \cdot k_z$ psf

Chart q_z's

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CLASS: ____
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PAGE: ____ of ____

Wind Load

T 6-2: (exp. B) $c = 0.3$ $\ell = 320'$ $\bar{\epsilon} = \frac{1}{3.0}$

eq 6-7: $L_{\bar{z}} = \ell \left(\frac{\bar{z}}{33}\right)^{\bar{\epsilon}} = 320 \left(\frac{51}{33}\right)^{\frac{1}{3.0}} = 370$

$\bar{z} = 0.6\,(85') = 51'$

eq 6-6: $Q = \sqrt{1 / 1 + 0.63 \left(\frac{B+h}{L_{\bar{z}}}\right)^{0.63}} = \sqrt{1 / 1 + 0.63 \left(\frac{240' + 85'}{370'}\right)^{0.63}}$

$Q = 0.7954$

eq 6-5: $I_{\bar{z}} = c \left(\frac{33}{\bar{z}}\right)^{\frac{1}{6}} = 0.3 \left(\frac{33}{51}\right)^{\frac{1}{6}} = 0.279$

eq 6-4:

$$G = 0.925 \left(\frac{1 + (1.7 \cdot 3.4)\, I_{\bar{z}}\, Q}{1 + (1.7 \cdot 3.4)\, I_{\bar{z}}}\right)$$

$$G = 0.925 \left(\frac{1 + (1.7 \cdot 3.4)\, 0.279 \cdot 0.7954}{1 + (1.7 \cdot 3.4)\, 0.279}\right) = 0.808$$

F 6-6: $C_p =$
- 0.8 windward
- −0.7 side
- −0.25 NS leeward $L/B = \frac{240'}{132'}$
- −0.5 EW leeward $L/B = \frac{132'}{240'}$

F 6-5: $GC_{pi} = \pm 0.18$ (enclosed building)

eq 6-23: $p = q\,(G \cdot C_p) - q_h\,(GC_{pi})$ $q = q_z$ (windward), $= q_h$ (leeward & side)

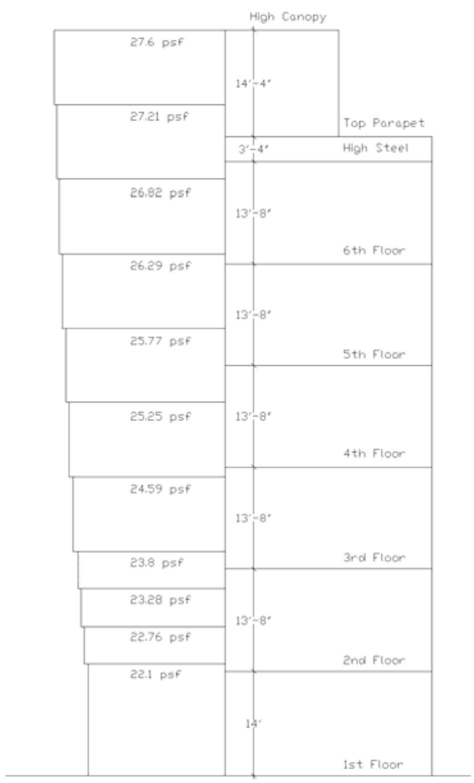
wind $p = q_z\,(0.808 \cdot 0.8) - 19.15\,(-0.18)$

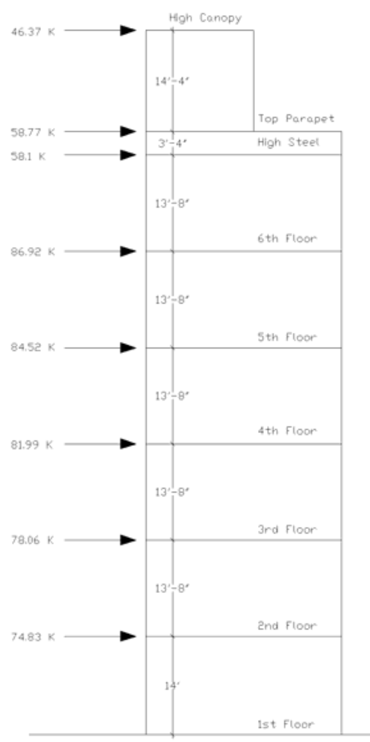
side $p = q_z\,(-0.7 \cdot 0.808) - 19.15\,(0.18)$

EW lee $p = 19.15\,(-0.5 \cdot 0.808) - 19.15\,(0.18)$

NS lee $p = 19.15\,(-0.25 \cdot 0.808) - 19.15\,(0.18)$

z (ft)	Kz (T6-3)	qz	P (psf) Windward	P (psf) Side	P (psf) Leeward EastWast	P (psf) Total
0-15	0.57	11.554	10.916	-9.983	-11.186	22.1020
20	0.62	12.567	11.571	-10.556	-11.186	22.7571
25	0.66	13.378	12.095	-11.014	-11.186	23.2812
30	0.70	14.189	12.619	-11.473	-11.186	23.8053
40	0.76	15.405	13.405	-12.161	-11.186	24.5914
50	0.81	16.418	14.061	-12.734	-11.186	25.2466
60	0.85	17.229	14.585	-13.193	-11.186	25.7706
70	0.89	18.040	15.109	-13.651	-11.186	26.2947
80	0.93	18.851	15.633	-14.110	-11.186	26.8188
90	0.96	19.459	16.026	-14.454	-11.186	27.2119
100	0.99	20.067	16.419	-14.798	-11.186	27.6049





Seismic

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PAGE: ____ of ____

Seismic Loading

T 9.1.3 : Seismic Use Group II (Occ. Cat. III)

T 9.1.4 : $I = 1.25$ (Seis. Use Grp III)

T 9.4.1.2 : Site Class D

F 9.4.1.1 a : $S_S = 0.127$

F 9.4.1.1 b : $S_1 = 0.054$

T 9.4.1.2 a : $F_a = 1.6$

T 9.4.1.2 b : $F_v = 2.4$

eq: 9.4.1.2.4-1 : $F_a \cdot S_s = 1.6 \cdot 0.127 = S_{MS} = 0.203$

eq: 9.4.1.2.4-2 : $F_v \cdot S_1 = 2.4 \cdot 0.054 = S_{M1} = 0.129$

eq: 9.4.1.2.5-1 : $\frac{2}{3} S_{MS} = \frac{2}{3}\, 0.203 = S_{DS} = 0.135$

eq: 9.4.1.2.5-2 : $\frac{2}{3} S_{M1} = \frac{2}{3}\, 0.129 = S_{D1} = 0.086$

T 9.4.2.1 a : Seismic Design Cat. A

T 9.4.2.1 b : Seismic Design Cat. B

T 9.5.2.2 : $R = 3.5$ (Steel Moment Frame)

T 9.5.5.3.2 : $C_T = 0.028$ $x = 0.8$ (Steel)

eq 9.5.5.3.2-1 : $T = C_T h_n^{\,x} = 0.028\,(85')^{0.8} = 0.9788$

$C_S = \frac{S_{DS}}{R/I} = \frac{0.135}{3.5/1.25} = 0.0482 \leftarrow$

$C_{S\,max} = \frac{S_{D1}}{T(R/I)} = \frac{0.086}{0.9788\left(\frac{3.5}{1.25}\right)} = 0.0314$

$k = 1 + \frac{0.632 - 0.5}{2} = 1.07$

$C_{S\,min} = 0.044 \cdot I \cdot S_{DS} = 0.044\,(1.25)\,0.135 = 0.0074$

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Seismic Loading

TYP Floor Area = 31,000 ft^2
TYP perimeter = 770 ft

Calc. Dead Load of Structure

Exterior wall: 20psf × 13'-8" × 770 ft = 210 k

TYP Floor: (2-6) = 31,000 ft $(57+10+5)_{psf}$ · $\frac{1k}{1000p}$ + 210k = 2442 k

Roof: 31,000 ft^2 · $(57+10)_{psf}$ · $\frac{1k}{1000p}$ = 2077 k

1st Floor = (31,000 ft^2 × 4" × $\frac{1'}{12"}$ · 150 pcf) $\frac{1k}{1000p}$ + 210k = 1760 k

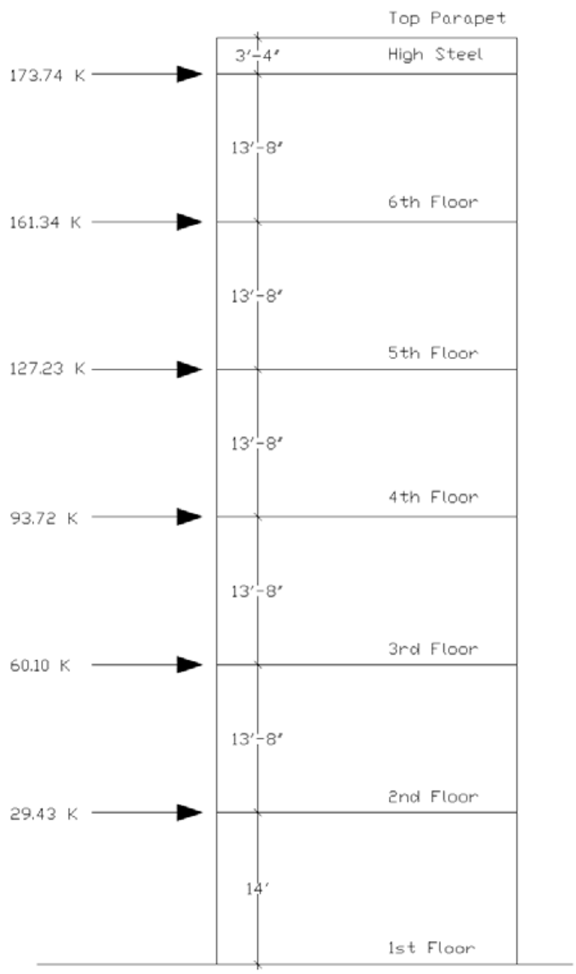
ΣW = 5(2442k) + 2077k + 1760k = ~~[illegible]~~ 16,047 k

~~V = C_s · W = 0.0482 · 13412k~~ =

V = C_s · W = 0.0482 · 16047 k = 773.46 k

Level	Wx (K)	hx (ft)	Wxhx^1.07	Cvx	Fx (K)	Mo (ft-K)
Roof	2077	82.333	397485.39	0.258455	167.0806	13756.24
6	2442	68.666	389225.72	0.253084	163.6087	11234.35
5	2442	55	306955.86	0.19959	129.027	7096.486
4	2442	41.333	226113.02	0.147024	95.04523	3928.504
3	2442	27.666	147153.46	0.095683	61.85506	1711.282
2	2442	14	70997.794	0.046164	29.84349	417.8089
1	1760	0	0	0	0	0
SUM:			1537931.2	1	**646.46**	**38144.68**

V = 646.46 K



Snow

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Snow Load

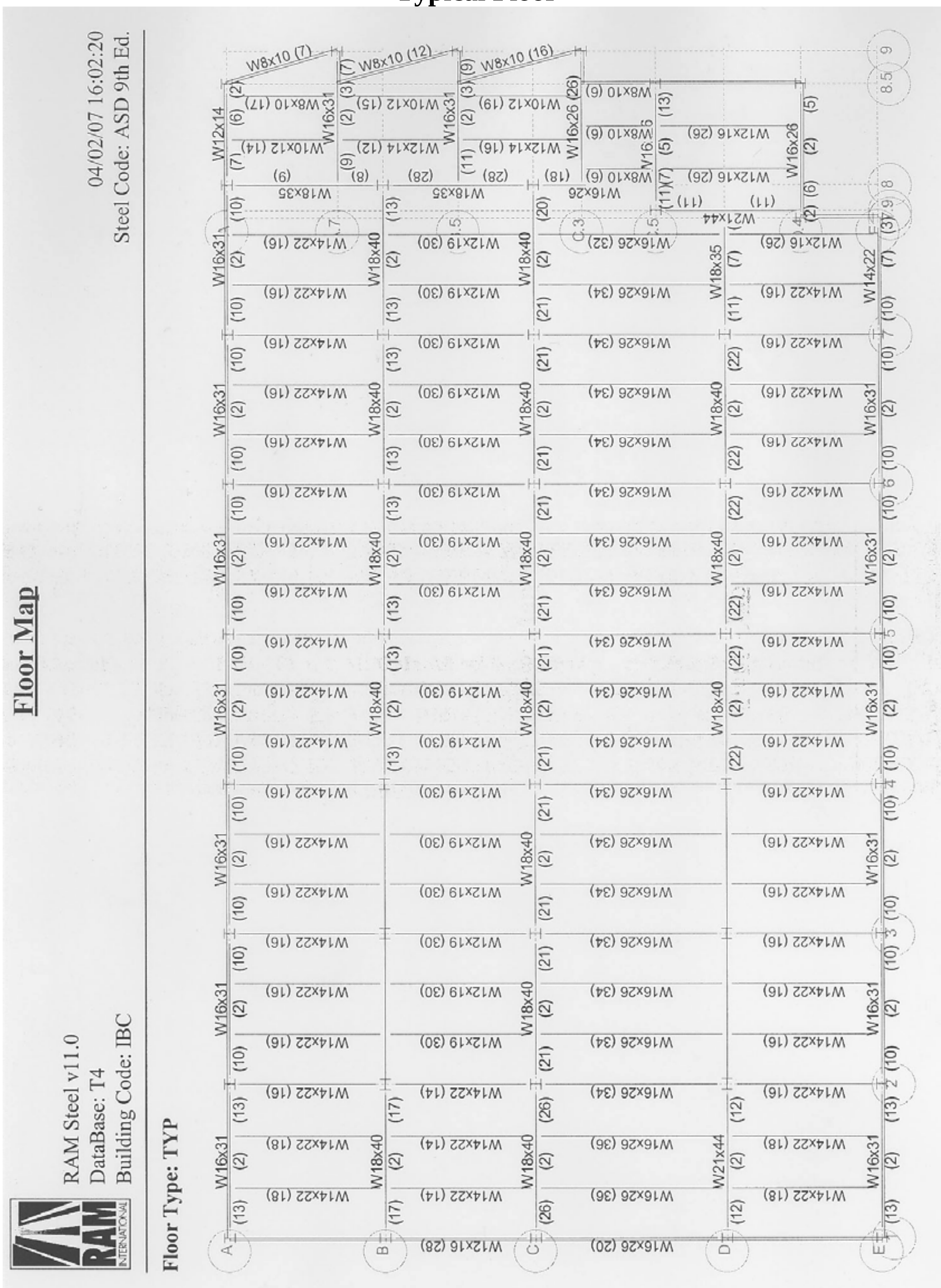
F 7-1: $p_g = 30$ psf

T 7-4: $I = 1.1$ (Category III)
T 7-3: $C_T = 1.0$
T 7-2: $C_e = 0.9$ (Exposure B) (fully exposed)

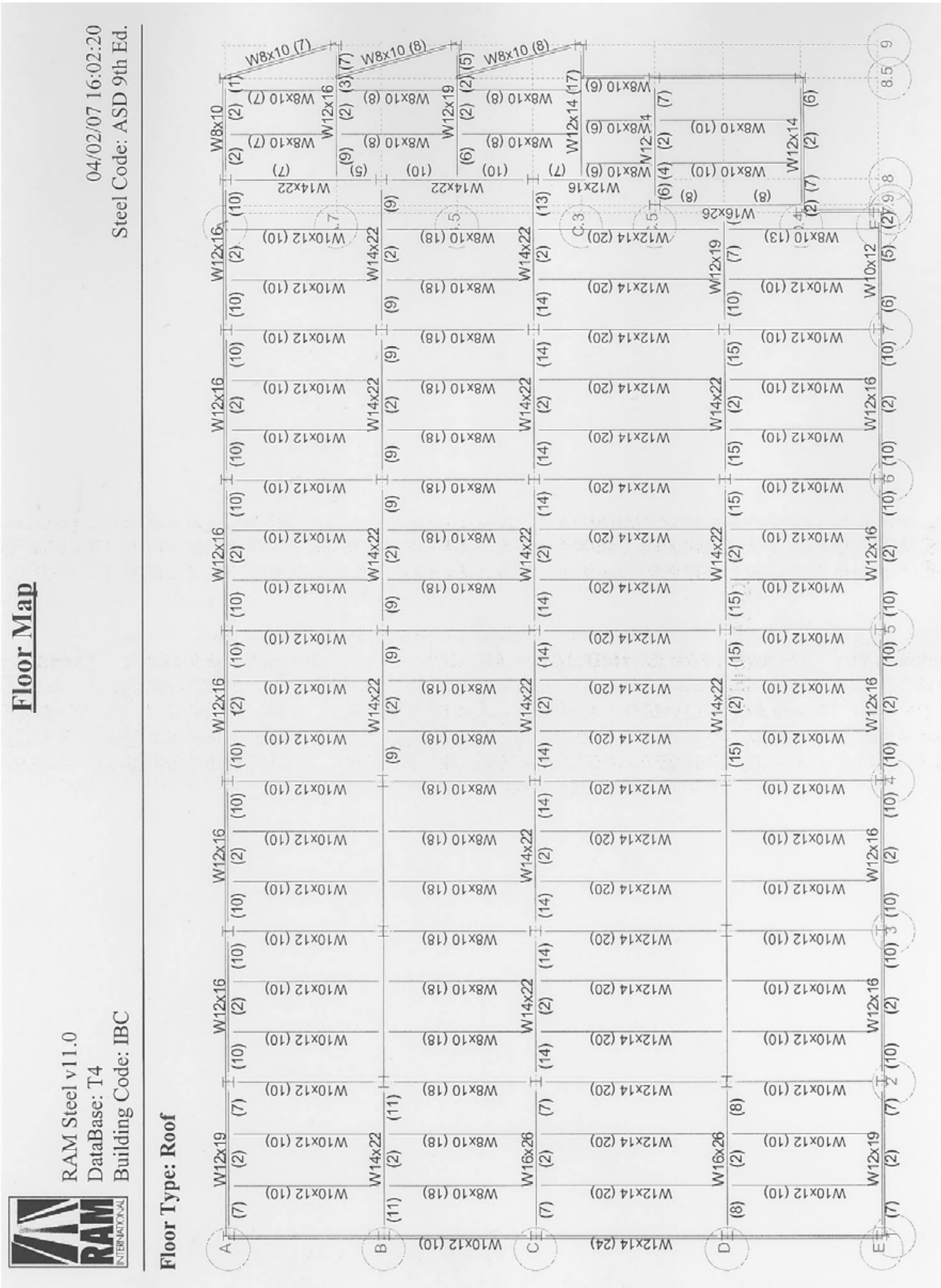
eq 7-1: $p_f = 0.7\ C_e \cdot C_T \cdot I \cdot p_g$
$p_f = 0.7 \cdot 0.9 \cdot 1.0 \cdot 1.1 \cdot 30$ psf
$p_f = 20.79$ psf $\Rightarrow$ 20.8 psf

Appendix C: Depth

Typical Floor



Roof


Floor Map
RAM Steel v11.0
DataBase: T4
Building Code: IBC
04/02/07 16:02:20
Steel Code: ASD 9th Ed.
Floor Type: Roof

Columns Schedule

Gravity Column Design Summary

RAM Steel v11.0
DataBase: T4.6
Building Code: IBC

04/03/07 16:09:09
Steel Code: ASD 9th Ed.

Column Line 1 - C

Level	P	Mx	My	LC	Interaction Eq.	Angle	Fy	Size
Roof	31.3	2.3	8.4	3	0.43 Eq H1-2	90.0	50	W10X33
6th	76.3	2.0	6.8	4	0.64 Eq H1-1	90.0	50	W10X33
5th	117.6	1.9	6.4	4	0.61 Eq H1-1	90.0	50	W10X45
4th	157.2	1.9	6.2	4	0.81 Eq H1-1	90.0	50	W10X45
3rd	197.3	1.8	7.0	4	0.66 Eq H1-1	90.0	50	W10X54
2nd	239.4	0.8	7.0	1	0.82 Eq H1-1	90.0	50	W10X54

Column Line 2 - E

Level	P	Mx	My	LC	Interaction Eq.	Angle	Fy	Size
Roof	22.9	4.2	3.0	10	0.29 Eq H1-3	90.0	50	W10X33
6th	69.0	3.4	2.2	4	0.50 Eq H1-1	90.0	50	W10X33
5th	99.0	3.2	2.0	11	0.59 Eq H1-1	90.0	50	W10X39
4th	135.1	3.1	1.9	11	0.79 Eq H1-1	90.0	50	W10X39
3rd	170.4	3.0	2.1	11	0.61 Eq H1-1	90.0	50	W10X49
2nd	207.5	3.0	2.1	10	0.72 Eq H1-1	90.0	50	W10X49

Column Line 2 - C

Level	P	Mx	My	LC	Interaction Eq.	Angle	Fy	Size
Roof	34.1	2.0	5.9	10	0.45 Eq H1-1	90.0	50	W10X33
6th	110.4	2.7	4.0	4	0.85 Eq H1-1	90.0	50	W10X33
5th	174.9	2.7	4.4	4	0.64 Eq H1-1	90.0	50	W10X49
4th	227.5	2.7	4.4	11	0.88 Eq H1-1	90.0	50	W10X49
3rd	294.1	2.8	4.5	11	0.77 Eq H1-1	90.0	50	W10X68
2nd	360.6	0.8	4.5	10	0.89 Eq H1-1	90.0	50	W10X68

Column Line 2 - A

Level	P	Mx	My	LC	Interaction Eq.	Angle	Fy	Size
Roof	22.9	4.2	3.0	10	0.29 Eq H1-3	90.0	50	W10X33
6th	69.0	3.4	2.2	5	0.50 Eq H1-1	90.0	50	W10X33
5th	99.0	3.2	2.0	10	0.59 Eq H1-1	90.0	50	W10X39
4th	135.1	3.1	1.9	10	0.79 Eq H1-1	90.0	50	W10X39
3rd	170.4	3.0	2.1	10	0.61 Eq H1-1	90.0	50	W10X49
2nd	207.5	3.0	2.1	10	0.72 Eq H1-1	90.0	50	W10X49

Column Line 3 - E

Level	P	Mx	My	LC	Interaction Eq.	Angle	Fy	Size
Roof	22.5	4.1	2.8	6	0.28 Eq H1-3	90.0	50	W10X33
6th	68.2	3.4	2.1	3	0.49 Eq H1-1	90.0	50	W10X33
5th	105.1	3.2	2.0	3	0.58 Eq H1-1	90.0	50	W10X39
4th	133.6	3.1	1.8	6	0.78 Eq H1-1	90.0	50	W10X39
3rd	175.0	3.0	2.0	3	0.60 Eq H1-1	90.0	50	W10X49
2nd	205.0	3.0	2.0	6	0.71 Eq H1-1	90.0	50	W10X49

Gravity Column Design Summary

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Column Line 3 - C

Level	P	Mx	My	LC	Interaction Eq.	Angle	Fy	Size
Roof	33.5	2.0	5.7	7	0.44 Eq H1-1	90.0	50	W10X33
6th	109.1	2.7	3.8	3	0.84 Eq H1-1	90.0	50	W10X33
5th	172.6	2.7	4.2	4	0.63 Eq H1-1	90.0	50	W10X49
4th	224.4	2.7	4.2	6	0.86 Eq H1-1	90.0	50	W10X49
3rd	290.1	2.8	4.3	6	0.76 Eq H1-1	90.0	50	W10X68
2nd	355.8	0.8	4.3	6	0.88 Eq H1-1	90.0	50	W10X68

Column Line 3 - A

Level	P	Mx	My	LC	Interaction Eq.	Angle	Fy	Size
Roof	22.5	4.1	2.8	6	0.28 Eq H1-3	90.0	50	W10X33
6th	68.2	3.4	2.1	2	0.49 Eq H1-1	90.0	50	W10X33
5th	105.1	3.2	2.0	2	0.58 Eq H1-1	90.0	50	W10X39
4th	133.6	3.1	1.8	7	0.78 Eq H1-1	90.0	50	W10X39
3rd	175.0	3.0	2.0	2	0.60 Eq H1-1	90.0	50	W10X49
2nd	205.0	3.0	2.0	10	0.71 Eq H1-1	90.0	50	W10X49

Column Line 4 - E

Level	P	Mx	My	LC	Interaction Eq.	Angle	Fy	Size
Roof	22.5	4.1	2.8	6	0.28 Eq H1-3	90.0	50	W10X33
6th	68.2	3.4	2.1	3	0.49 Eq H1-1	90.0	50	W10X33
5th	105.1	3.2	2.0	3	0.58 Eq H1-1	90.0	50	W10X39
4th	133.6	3.1	1.8	6	0.78 Eq H1-1	90.0	50	W10X39
3rd	175.0	3.0	2.0	3	0.60 Eq H1-1	90.0	50	W10X49
2nd	205.0	3.0	2.0	6	0.71 Eq H1-1	90.0	50	W10X49

Column Line 4 - C

Level	P	Mx	My	LC	Interaction Eq.	Angle	Fy	Size
Roof	33.5	2.0	5.7	7	0.44 Eq H1-1	90.0	50	W10X33
6th	109.1	2.7	3.8	3	0.84 Eq H1-1	90.0	50	W10X33
5th	172.6	2.7	4.2	4	0.63 Eq H1-1	90.0	50	W10X49
4th	224.4	2.7	4.2	6	0.86 Eq H1-1	90.0	50	W10X49
3rd	290.1	2.8	4.3	6	0.76 Eq H1-1	90.0	50	W10X68
2nd	355.8	0.8	4.3	6	0.88 Eq H1-1	90.0	50	W10X68

Column Line 4 - A

Level	P	Mx	My	LC	Interaction Eq.	Angle	Fy	Size
Roof	22.5	4.1	2.8	6	0.28 Eq H1-3	90.0	50	W10X33
6th	68.2	3.4	2.1	2	0.49 Eq H1-1	90.0	50	W10X33
5th	105.1	3.2	2.0	2	0.58 Eq H1-1	90.0	50	W10X39
4th	133.6	3.1	1.8	7	0.78 Eq H1-1	90.0	50	W10X39
3rd	175.0	3.0	2.0	2	0.60 Eq H1-1	90.0	50	W10X49
2nd	205.0	3.0	2.0	10	0.71 Eq H1-1	90.0	50	W10X49

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Steel Code: ASD 9th Ed

Column Line 5 - E

Level	P	Mx	My	LC	Interaction Eq.	Angle	Fy	Size
Roof	22.5	4.1	2.8	6	0.28 Eq H1-3	90.0	50	W10X33
6th	68.2	3.4	2.1	3	0.49 Eq H1-1	90.0	50	W10X33
5th	105.1	3.2	2.0	3	0.58 Eq H1-1	90.0	50	W10X39
4th	133.6	3.1	1.8	6	0.78 Eq H1-1	90.0	50	W10X39
3rd	175.0	3.0	2.0	3	0.60 Eq H1-1	90.0	50	W10X49
2nd	205.0	3.0	2.0	6	0.71 Eq H1-1	90.0	50	W10X49

Column Line 5 - D

Level	P	Mx	My	LC	Interaction Eq.	Angle	Fy	Size
Roof	34.0	2.1	5.7	6	0.44 Eq H1-1	90.0	50	W10X33
6th	110.4	2.7	3.9	2	0.85 Eq H1-1	90.0	50	W10X33
5th	174.8	2.6	4.3	2	0.64 Eq H1-1	90.0	50	W10X49
4th	227.3	2.6	4.3	7	0.88 Eq H1-1	90.0	50	W10X49
3rd	293.8	2.7	4.3	7	0.77 Eq H1-1	90.0	50	W10X68
2nd	360.3	0.8	4.3	10	0.89 Eq H1-1	90.0	50	W10X68

Column Line 5 - A

Level	P	Mx	My	LC	Interaction Eq.	Angle	Fy	Size
Roof	22.5	4.1	2.8	6	0.28 Eq H1-3	90.0	50	W10X33
6th	68.2	3.4	2.1	2	0.49 Eq H1-1	90.0	50	W10X33
5th	105.1	3.2	2.0	2	0.58 Eq H1-1	90.0	50	W10X39
4th	133.6	3.1	1.8	7	0.78 Eq H1-1	90.0	50	W10X39
3rd	175.0	3.0	2.0	2	0.60 Eq H1-1	90.0	50	W10X49
2nd	205.0	3.0	2.0	10	0.71 Eq H1-1	90.0	50	W10X49

Column Line 6 - E

Level	P	Mx	My	LC	Interaction Eq.	Angle	Fy	Size
Roof	22.5	4.1	2.8	6	0.28 Eq H1-3	90.0	50	W10X33
6th	68.2	3.4	2.1	3	0.49 Eq H1-1	90.0	50	W10X33
5th	105.1	3.2	2.0	3	0.58 Eq H1-1	90.0	50	W10X39
4th	133.6	3.1	1.8	6	0.78 Eq H1-1	90.0	50	W10X39
3rd	175.0	3.0	2.0	3	0.60 Eq H1-1	90.0	50	W10X49
2nd	205.0	3.0	2.0	6	0.71 Eq H1-1	90.0	50	W10X49

Column Line 6 - D

Level	P	Mx	My	LC	Interaction Eq.	Angle	Fy	Size
Roof	34.0	2.1	5.7	6	0.44 Eq H1-1	90.0	50	W10X33
6th	110.4	2.7	3.9	2	0.85 Eq H1-1	90.0	50	W10X33
5th	174.8	2.6	4.3	2	0.64 Eq H1-1	90.0	50	W10X49
4th	227.3	2.6	4.3	7	0.88 Eq H1-1	90.0	50	W10X49
3rd	293.8	2.7	4.3	7	0.77 Eq H1-1	90.0	50	W10X68
2nd	360.3	0.8	4.3	10	0.89 Eq H1-1	90.0	50	W10X68

Gravity Column Design Summary

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Column Line 6 - C

Level	P	Mx	My	LC	Interaction Eq.	Angle	Fy	Size
Roof	33.5	2.0	5.7	7	0.44 Eq H1-1	90.0	50	W10X33
6th	109.1	2.7	3.8	3	0.84 Eq H1-1	90.0	50	W10X33
5th	172.6	2.7	4.2	4	0.63 Eq H1-1	90.0	50	W10X49
4th	224.4	2.7	4.2	6	0.86 Eq H1-1	90.0	50	W10X49
3rd	290.1	2.8	4.3	6	0.76 Eq H1-1	90.0	50	W10X68
2nd	355.8	0.8	4.3	6	0.88 Eq H1-1	90.0	50	W10X68

Column Line 6 - B

Level	P	Mx	My	LC	Interaction Eq.	Angle	Fy	Size
Roof	29.9	2.3	5.1	6	0.39 Eq H1-1	90.0	50	W10X33
6th	98.5	2.0	3.5	2	0.74 Eq H1-1	90.0	50	W10X33
5th	154.1	2.0	3.8	2	0.56 Eq H1-1	90.0	50	W10X49
4th	200.4	2.0	3.8	7	0.76 Eq H1-1	90.0	50	W10X49
3rd	259.0	2.0	3.8	7	0.67 Eq H1-1	90.0	50	W10X68
2nd	317.7	0.1	3.8	6	0.78 Eq H1-1	90.0	50	W10X68

Column Line 6 - A

Level	P	Mx	My	LC	Interaction Eq.	Angle	Fy	Size
Roof	22.5	4.1	2.8	6	0.28 Eq H1-3	90.0	50	W10X33
6th	68.2	3.4	2.1	2	0.49 Eq H1-1	90.0	50	W10X33
5th	105.1	3.2	2.0	2	0.58 Eq H1-1	90.0	50	W10X39
4th	133.6	3.1	1.8	7	0.78 Eq H1-1	90.0	50	W10X39
3rd	175.0	3.0	2.0	2	0.60 Eq H1-1	90.0	50	W10X49
2nd	205.0	3.0	2.0	10	0.71 Eq H1-1	90.0	50	W10X49

Column Line 7 - E

Level	P	Mx	My	LC	Interaction Eq.	Angle	Fy	Size
Roof	24.9	4.2	3.2	4	0.31 Eq H1-3	90.0	50	W10X33
6th	55.8	3.4	2.8	11	0.45 Eq H1-1	90.0	50	W10X33
5th	89.2	3.2	2.6	11	0.66 Eq H1-1	90.0	50	W10X33
4th	121.0	3.1	2.4	11	0.89 Eq H1-1	90.0	50	W10X33
3rd	152.1	3.1	2.4	11	0.73 Eq H1-1	90.0	50	W10X45
2nd	182.8	3.0	2.3	10	0.87 Eq H1-1	90.0	50	W10X45

Column Line 7 - D

Level	P	Mx	My	LC	Interaction Eq.	Angle	Fy	Size
Roof	32.9	2.1	6.3	11	0.42 Eq H1-1	90.0	50	W10X33
6th	91.1	2.7	4.5	10	0.79 Eq H1-1	90.0	50	W10X33
5th	149.7	2.6	5.0	10	0.59 Eq H1-1	90.0	50	W10X49
4th	210.4	2.6	5.0	10	0.80 Eq H1-1	90.0	50	W10X49
3rd	271.3	2.7	5.0	10	0.71 Eq H1-1	90.0	50	W10X68
2nd	332.2	0.8	5.0	10	0.83 Eq H1-1	90.0	50	W10X68

Gravity Column Design Summary

RAM Steel v11.0
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Column Line 7 - C

Level	P	Mx	My	LC	Interaction Eq.	Angle	Fy	Size
Roof	33.5	2.0	5.7	10	0.44 Eq H1-1	90.0	50	W10X33
6th	108.9	2.7	3.8	3	0.84 Eq H1-1	90.0	50	W10X33
5th	172.3	2.7	4.2	3	0.63 Eq H1-1	90.0	50	W10X49
4th	224.1	2.7	4.3	11	0.86 Eq H1-1	90.0	50	W10X49
3rd	289.6	2.8	4.3	11	0.76 Eq H1-1	90.0	50	W10X68
2nd	355.2	0.8	4.3	10	0.88 Eq H1-1	90.0	50	W10X68

Column Line 7 - B

Level	P	Mx	My	LC	Interaction Eq.	Angle	Fy	Size
Roof	29.9	2.3	5.1	6	0.39 Eq H1-1	90.0	50	W10X33
6th	98.5	2.0	3.5	2	0.74 Eq H1-1	90.0	50	W10X33
5th	154.1	2.0	3.8	2	0.56 Eq H1-1	90.0	50	W10X49
4th	200.4	2.0	3.8	7	0.76 Eq H1-1	90.0	50	W10X49
3rd	259.0	2.0	3.8	7	0.67 Eq H1-1	90.0	50	W10X68
2nd	317.7	0.1	3.8	6	0.78 Eq H1-1	90.0	50	W10X68

Column Line 7 - A

Level	P	Mx	My	LC	Interaction Eq.	Angle	Fy	Size
Roof	22.5	4.1	2.8	6	0.28 Eq H1-3	90.0	50	W10X33
6th	68.2	3.4	2.1	2	0.49 Eq H1-1	90.0	50	W10X33
5th	105.1	3.2	2.0	2	0.58 Eq H1-1	90.0	50	W10X39
4th	133.6	3.1	1.8	7	0.78 Eq H1-1	90.0	50	W10X39
3rd	175.0	3.0	2.0	2	0.60 Eq H1-1	90.0	50	W10X49
2nd	205.0	3.0	2.0	10	0.71 Eq H1-1	90.0	50	W10X49

Column Line 7.9 - C.5

Level	P	Mx	My	LC	Interaction Eq.	Angle	Fy	Size
Roof	17.5	7.1	7.2	8	0.43 Eq H1-3	90.0	50	W10X33
6th	67.8	6.3	5.7	5	0.58 Eq H1-1	90.0	50	W10X33
5th	104.9	6.0	5.4	5	0.66 Eq H1-1	90.0	50	W10X39
4th	140.3	5.8	5.2	5	0.87 Eq H1-1	90.0	50	W10X39
3rd	177.7	5.8	6.0	5	0.66 Eq H1-1	90.0	50	W10X49
2nd	216.0	5.8	6.0	1	0.83 Eq H1-1	90.0	50	W10X49

Column Line 8 - C

Level	P	Mx	My	LC	Interaction Eq.	Angle	Fy	Size
Roof	35.8	4.2	7.9	2	0.44 Eq H1-2	90.0	50	W10X33
6th	89.6	3.6	6.2	2	0.73 Eq H1-1	90.0	50	W10X33
5th	138.9	3.4	6.8	2	0.53 Eq H1-1	90.0	50	W10X49
4th	190.6	3.4	6.7	2	0.71 Eq H1-1	90.0	50	W10X49
3rd	243.0	3.4	6.8	2	0.72 Eq H1-1	90.0	50	W10X60
2nd	295.5	0.7	6.8	1	0.88 Eq H1-1	90.0	50	W10X60

Gravity Column Design Summary

RAM Steel v11.0
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Column Line 8 - B

Level	P	Mx	My	LC	Interaction Eq.	Angle	Fy	Size
Roof	37.7	4.8	7.1	2	0.43 Eq H1-2	90.0	50	W10X33
6th	94.0	4.1	5.5	2	0.75 Eq H1-1	90.0	50	W10X33
5th	145.8	3.9	6.1	2	0.55 Eq H1-1	90.0	50	W10X49
4th	200.8	3.9	6.1	2	0.74 Eq H1-1	90.0	50	W10X49
3rd	256.2	4.0	6.1	2	0.65 Eq H1-1	90.0	50	W10X68
2nd	311.5	0.8	6.1	1	0.79 Eq H1-1	90.0	50	W10X68

Column Line 8 - A

Level	P	Mx	My	LC	Interaction Eq.	Angle	Fy	Size
Roof	23.1	5.8	4.1	10	0.34 Eq H1-3	90.0	50	W10X33
6th	58.9	4.7	3.1	10	0.47 Eq H1-1	90.0	50	W10X33
5th	92.7	4.5	2.9	10	0.55 Eq H1-1	90.0	50	W10X39
4th	125.0	4.3	2.8	10	0.72 Eq H1-1	90.0	50	W10X39
3rd	156.6	4.2	3.1	10	0.56 Eq H1-1	90.0	50	W10X49
2nd	188.2	4.1	3.1	10	0.67 Eq H1-1	90.0	50	W10X49

Column Line 8.5 - A

Level	P	Mx	My	LC	Interaction Eq.	Angle	Fy	Size
Roof	12.3	2.4	4.3	1	0.25 Eq H1-3	90.0	50	W10X33
6th	22.0	1.6	3.5	6	0.27 Eq H1-3	90.0	50	W10X33
5th	46.5	1.5	3.3	2	0.35 Eq H1-1	90.0	50	W10X33
4th	61.5	1.5	3.1	2	0.44 Eq H1-1	90.0	50	W10X33
3rd	76.0	1.5	3.0	2	0.52 Eq H1-1	90.0	50	W10X33
2nd	90.1	1.4	2.9	1	0.65 Eq H1-1	90.0	50	W10X33

Column Line 9 - C.3

Level	P	Mx	My	LC	Interaction Eq.	Angle	Fy	Size
Roof	15.8	3.0	5.6	1	0.32 Eq H1-3	90.0	50	W10X33
6th	39.4	2.1	4.6	3	0.33 Eq H1-1	90.0	50	W10X33
5th	60.1	2.0	4.3	3	0.46 Eq H1-1	90.0	50	W10X33
4th	79.7	1.9	4.0	3	0.58 Eq H1-1	90.0	50	W10X33
3rd	98.8	1.9	3.9	3	0.57 Eq H1-1	90.0	50	W10X39
2nd	117.4	1.9	3.8	1	0.71 Eq H1-1	90.0	50	W10X39

Column Line 9 - B.5

Level	P	Mx	My	LC	Interaction Eq.	Angle	Fy	Size
Roof	19.0	2.9	7.4	1	0.40 Eq H1-3	90.0	50	W10X33
6th	47.0	2.0	5.9	3	0.41 Eq H1-1	90.0	50	W10X33
5th	71.7	1.9	5.5	3	0.56 Eq H1-1	90.0	50	W10X33
4th	95.2	1.8	5.3	3	0.72 Eq H1-1	90.0	50	W10X33
3rd	118.1	1.8	5.1	3	0.58 Eq H1-1	90.0	50	W10X45
2nd	140.6	1.8	5.0	1	0.73 Eq H1-1	90.0	50	W10X45

Gravity Column Design Summary

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Column Line 9 - A.7

Level	P	Mx	My	LC	Interaction Eq.	Angle	Fy	Size
Roof	18.0	2.7	7.1	1	0.38 Eq H1-3	90.0	50	W10X33
6th	44.6	1.8	5.7	3	0.39 Eq H1-1	90.0	50	W10X33
5th	68.2	1.7	5.3	3	0.53 Eq H1-1	90.0	50	W10X33
4th	90.5	1.7	5.0	3	0.68 Eq H1-1	90.0	50	W10X33
3rd	112.1	1.7	4.9	3	0.66 Eq H1-1	90.0	50	W10X39
2nd	133.3	1.6	4.8	1	0.84 Eq H1-1	90.0	50	W10X39

Drift

Drift

RAM Frame v11.0
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CRITERIA:

Rigid End Zones: Ignore Effects
Member Force Output: At Face of Joint
P-Delta: Yes Scale Factor: 1.00
Diaphragm: Rigid
Ground Level: Base

LOAD CASE DEFINITIONS:

D	DeadLoad	RAMUSER
Lp	PosLiveLoad	RAMUSER
Sp	PosRoofLiveLoad	RAMUSER
W1	Wind	Wind_IBC03_1_X
W2	Wind	Wind_IBC03_1_Y
W3	Wind	Wind_IBC03_2_X+E
W4	Wind	Wind_IBC03_2_X-E
W5	Wind	Wind_IBC03_2_Y+E
W6	Wind	Wind_IBC03_2_Y-E
W7	Wind	Wind_IBC03_3_X+Y
W8	Wind	Wind_IBC03_3_X-Y
W9	Wind	Wind_IBC03_4_X+Y_CW
W10	Wind	Wind_IBC03_4_X+Y_CCW
W11	Wind	Wind_IBC03_4_X-Y_CW
W12	Wind	Wind_IBC03_4_X-Y_CCW
E1	Seismic	EQ_IBC03_X_+E_F
E2	Seismic	EQ_IBC03_X_-E_F
E3	Seismic	EQ_IBC03_Y_+E_F
E4	Seismic	EQ_IBC03_Y_-E_F

RESULTS:

Location (ft): (213.996, 113.527)

Story	LdC	Displacement		Story Drift		Drift Ratio	
		X	Y	X	Y	X	Y
		in	in	in	in		
Roof	D	-0.0017	0.0104	-0.0005	0.0037	0.0000	0.0000
	Lp	-0.0193	0.0755	-0.0052	0.0231	0.0000	0.0001
	Sp	-0.0012	0.0050	-0.0005	0.0024	0.0000	0.0000
	W1	0.1628	-0.0001	0.0199	-0.0000	0.0001	0.0000
	W2	-0.0576	0.6750	-0.0090	0.1113	0.0001	0.0007
	W3	0.1387	-0.0404	0.0175	-0.0062	0.0001	0.0000
	W4	0.1054	0.0402	0.0124	0.0062	0.0001	0.0000
	W5	-0.1073	0.6617	-0.0165	0.1071	0.0001	0.0006
	W6	0.0210	0.3509	0.0029	0.0598	0.0000	0.0004

Drift

RAM Frame v11.0
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Story	LdC	Displacement		Story Drift		Drift Ratio	
	W7	0.0789	0.5062	0.0082	0.0835	0.0000	0.0005
	W8	0.1652	-0.5064	0.0217	-0.0835	0.0001	0.0005
	W9	0.1198	0.2329	0.0153	0.0402	0.0001	0.0002
	W10	-0.0014	0.5264	-0.0030	0.0850	0.0000	0.0005
	W11	0.1845	-0.5266	0.0254	-0.0850	0.0002	0.0005
	W12	0.0633	-0.2330	0.0071	-0.0403	0.0000	0.0002
	E1	0.4420	-0.0564	0.0729	-0.0106	0.0004	0.0001
	E2	0.4016	0.0412	0.0655	0.0077	0.0004	0.0000
	E3	-0.0960	0.9104	-0.0189	0.1840	0.0001	0.0011
	E4	-0.0222	0.7320	-0.0053	0.1506	0.0000	0.0009
6th	D	-0.0012	0.0067	-0.0003	0.0020	0.0000	0.0000
	Lp	-0.0141	0.0524	-0.0044	0.0165	0.0000	0.0001
	Sp	-0.0007	0.0027	-0.0003	0.0011	0.0000	0.0000
	W1	0.1428	-0.0001	0.0248	-0.0000	0.0001	0.0000
	W2	-0.0486	0.5637	-0.0091	0.1150	0.0001	0.0007
	W3	0.1212	-0.0342	0.0213	-0.0067	0.0001	0.0000
	W4	0.0930	0.0341	0.0158	0.0066	0.0001	0.0000
	W5	-0.0909	0.5546	-0.0175	0.1117	0.0001	0.0007
	W6	0.0180	0.2910	0.0038	0.0607	0.0000	0.0004
	W7	0.0707	0.4227	0.0117	0.0862	0.0001	0.0005
	W8	0.1435	-0.4229	0.0254	-0.0862	0.0002	0.0005
	W9	0.1045	0.1926	0.0189	0.0406	0.0001	0.0002
	W10	0.0016	0.4415	-0.0013	0.0888	0.0000	0.0005
	W11	0.1591	-0.4416	0.0291	-0.0888	0.0002	0.0005
	W12	0.0562	-0.1927	0.0090	-0.0406	0.0001	0.0002
	E1	0.3690	-0.0458	0.0806	-0.0107	0.0005	0.0001
	E2	0.3361	0.0334	0.0729	0.0078	0.0004	0.0000
	E3	-0.0771	0.7263	-0.0181	0.1763	0.0001	0.0010
	E4	-0.0169	0.5814	-0.0040	0.1424	0.0000	0.0008
5th	D	-0.0008	0.0047	-0.0003	0.0016	0.0000	0.0000
	Lp	-0.0096	0.0360	-0.0037	0.0138	0.0000	0.0001
	Sp	-0.0004	0.0015	-0.0002	0.0007	0.0000	0.0000
	W1	0.1181	-0.0001	0.0293	-0.0000	0.0002	0.0000
	W2	-0.0395	0.4488	-0.0092	0.1193	0.0001	0.0007
	W3	0.0999	-0.0276	0.0249	-0.0070	0.0001	0.0000
	W4	0.0772	0.0274	0.0190	0.0070	0.0001	0.0000
	W5	-0.0734	0.4429	-0.0182	0.1163	0.0001	0.0007
	W6	0.0142	0.2303	0.0043	0.0627	0.0000	0.0004
	W7	0.0590	0.3365	0.0150	0.0895	0.0001	0.0005
	W8	0.1181	-0.3367	0.0289	-0.0895	0.0002	0.0005
	W9	0.0856	0.1521	0.0219	0.0418	0.0001	0.0002
	W10	0.0028	0.3527	0.0006	0.0924	0.0000	0.0006
	W11	0.1300	-0.3528	0.0323	-0.0924	0.0002	0.0006

Drift

RAM Frame v11.0
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Steel Code: IB

Story	LdC	Displacement		Story Drift		Drift Ratio	
	W12	0.0472	-0.1522	0.0110	-0.0418	0.0001	0.0002
	E1	0.2884	-0.0351	0.0855	-0.0105	0.0005	0.0001
	E2	0.2632	0.0256	0.0779	0.0077	0.0005	0.0000
	E3	-0.0590	0.5500	-0.0172	0.1706	0.0001	0.0010
	E4	-0.0129	0.4390	-0.0033	0.1374	0.0000	0.0008
4th	D	-0.0006	0.0031	-0.0003	0.0015	0.0000	0.0000
	Lp	-0.0059	0.0222	-0.0031	0.0116	0.0000	0.0001
	Sp	-0.0002	0.0008	-0.0001	0.0005	0.0000	0.0000
	W1	0.0888	-0.0001	0.0295	-0.0000	0.0002	0.0000
	W2	-0.0302	0.3295	-0.0077	0.1111	0.0000	0.0007
	W3	0.0750	-0.0206	0.0250	-0.0066	0.0001	0.0000
	W4	0.0582	0.0205	0.0193	0.0066	0.0001	0.0000
	W5	-0.0552	0.3266	-0.0167	0.1089	0.0001	0.0006
	W6	0.0099	0.1676	0.0053	0.0578	0.0000	0.0003
	W7	0.0439	0.2471	0.0164	0.0833	0.0001	0.0005
	W8	0.0893	-0.2472	0.0279	-0.0833	0.0002	0.0005
	W9	0.0637	0.1103	0.0227	0.0384	0.0001	0.0002
	W10	0.0022	0.2603	0.0019	0.0866	0.0000	0.0005
	W11	0.0977	-0.2604	0.0313	-0.0866	0.0002	0.0005
	W12	0.0362	-0.1104	0.0105	-0.0384	0.0001	0.0002
	E1	0.2030	-0.0246	0.0772	-0.0091	0.0005	0.0001
	E2	0.1854	0.0179	0.0704	0.0067	0.0004	0.0000
	E3	-0.0417	0.3794	-0.0137	0.1461	0.0001	0.0009
	E4	-0.0095	0.3016	-0.0012	0.1172	0.0000	0.0007
3rd	D	-0.0003	0.0016	-0.0002	0.0010	0.0000	0.0000
	Lp	-0.0028	0.0106	-0.0020	0.0075	0.0000	0.0000
	Sp	-0.0001	0.0003	-0.0001	0.0003	0.0000	0.0000
	W1	0.0593	-0.0001	0.0305	-0.0000	0.0002	0.0000
	W2	-0.0226	0.2184	-0.0064	0.0994	0.0000	0.0006
	W3	0.0500	-0.0139	0.0255	-0.0061	0.0002	0.0000
	W4	0.0389	0.0138	0.0202	0.0060	0.0001	0.0000
	W5	-0.0385	0.2177	-0.0150	0.0979	0.0001	0.0006
	W6	0.0046	0.1098	0.0054	0.0512	0.0000	0.0003
	W7	0.0275	0.1637	0.0181	0.0745	0.0001	0.0004
	W8	0.0614	-0.1638	0.0277	-0.0746	0.0002	0.0004
	W9	0.0410	0.0719	0.0232	0.0338	0.0001	0.0002
	W10	0.0003	0.1737	0.0039	0.0780	0.0000	0.0005
	W11	0.0664	-0.1738	0.0304	-0.0780	0.0002	0.0005
	W12	0.0257	-0.0720	0.0112	-0.0339	0.0001	0.0002
	E1	0.1257	-0.0155	0.0696	-0.0074	0.0004	0.0000
	E2	0.1149	0.0112	0.0640	0.0054	0.0004	0.0000
	E3	-0.0280	0.2333	-0.0106	0.1171	0.0001	0.0007
	E4	-0.0083	0.1844	-0.0003	0.0935	0.0000	0.0006

Drift

RAM Frame v11.0
DataBase: T4
Building Code: IBC

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Steel Code: IB

Story	LdC	Displacement		Story Drift		Drift Ratio	
2nd	D	-0.0001	0.0006	-0.0001	0.0006	0.0000	0.0000
	Lp	-0.0008	0.0031	-0.0008	0.0031	0.0000	0.0000
	Sp	-0.0000	0.0001	-0.0000	0.0001	0.0000	0.0000
	W1	0.0288	-0.0001	0.0288	-0.0001	0.0002	0.0000
	W2	-0.0162	0.1190	-0.0162	0.1190	0.0001	0.0007
	W3	0.0245	-0.0079	0.0245	-0.0079	0.0001	0.0000
	W4	0.0187	0.0078	0.0187	0.0078	0.0001	0.0000
	W5	-0.0235	0.1198	-0.0235	0.1198	0.0001	0.0007
	W6	-0.0007	0.0586	-0.0007	0.0586	0.0000	0.0003
	W7	0.0095	0.0892	0.0095	0.0892	0.0001	0.0005
	W8	0.0337	-0.0893	0.0337	-0.0893	0.0002	0.0005
	W9	0.0178	0.0381	0.0178	0.0381	0.0001	0.0002
	W10	-0.0036	0.0957	-0.0036	0.0957	0.0000	0.0006
	W11	0.0360	-0.0958	0.0360	-0.0958	0.0002	0.0006
	W12	0.0145	-0.0381	0.0145	-0.0381	0.0001	0.0002
	E1	0.0562	-0.0080	0.0562	-0.0080	0.0003	0.0000
	E2	0.0510	0.0058	0.0510	0.0058	0.0003	0.0000
	E3	-0.0175	0.1162	-0.0175	0.1162	0.0001	0.0007
	E4	-0.0080	0.0909	-0.0080	0.0909	0.0000	0.0005

Appendix D: Breadth Topic 1
Construction Management

Existing System

Typical Floor Beams

Size	Length (ft)	Quantity	Price ($/lf)	T cost ($)
W24x76	38	1	89.94	3417.72
W24x76	30	2	89.94	5396.40
W24x68	30	6	80.94	14569.20
W24x62	30	20	74.44	44664.00
W24x62	25	3	74.44	5583.00
W24x58	30	1	69.44	2083.20
W24x55	30	12	66.44	23918.40
W24x55	25	3	66.44	4983.00
W21x44	38	20	54.13	41138.80
W18x40	30	1	50.13	1503.90
W18x35	30	62	44.63	83011.80
W18x35	25	4	44.63	4463.00
W18x35	20	1	44.63	892.60
W16x26	27	3	33.31	2698.11
W14x22	15	1	28.45	426.75
W12x16	15	3	22.43	1009.35
			Total = $	239759.23

Roof Beams

Size	Length (ft)	Quantity	Price ($/lf)	T cost ($)
W24x76	30	6	89.94	16189.20
W24x55	30	8	66.44	15945.60
W24x52	30	6	63.44	11419.20
W21x50	25	1	61.13	1528.25
W21x44	38	21	54.13	43195.74
W21x44	25	1	54.13	1353.25
W18x40	30	13	50.13	19550.70
W18x35	30	1	44.63	1338.90
W18x35	25	1	44.63	1115.75
W16x31	30	65	39.23	76498.50
W16x26	30	2	33.31	1998.60
W14x22	15	3	28.45	1280.25
			Total = $	191413.94

Deck

	Size	Quantity (sf/floor)	Price ($/sf)	T cost ($)
Metal Deck	3" 20 Gauge	31000	2.28	70680

	Size	Quantity (Ea/floor)	Price ($/Ea)	T cost ($)
Studs Roof	3/4" Di. 4.5"		1.58	0
Studs TYP	3/4" Di. 4.5"	3041	1.58	4804.78

	Size	Quantity (cy/floor)	Price ($/cy)	T cost ($)
Conc. Slab	Concrete 4ksi	287	108	30996
	Elev. Slab < 6" pumped	287	19.55	5610.85

Columns

	Size	Length (ft)	Quantity	Price ($/lf)	T cost ($)
Floors 1 & 2	W14x145	14	3	168.75	7087.50
	W14x132	14	11	153.95	23708.30
	W14x120	14	7	138.96	13618.08
	W12x96	14	2	114.15	3196.20
	W12x87	14	1	101.87	1426.18
	W12x79	14	3	94.88	3984.96
	W10x100	14	1	121.38	1699.32
	W10x88	14	13	107.50	19565.00
	W10x68	14	3	80.37	3375.54
	W10x60	14	1	75.14	1051.96
	W10x54	14	1	68.20	954.80
	W10x49	14	1	62.42	873.88
				Total = $	80541.72

Floors 3 & 4	W14x99	14	2	116.38	3258.64
	W14x90	14	19	106.14	28233.24
	W12x65	14	2	78.76	2205.28
	W12x58	14	1	70.57	987.98
	W12x53	14	3	64.95	2727.90
	W10x77	14	1	94.80	1327.20
	W10x60	14	13	75.14	13675.48
	W10x49	14	4	62.42	3495.52
	W10x39	14	1	50.85	711.90
	W8x40	14	1	52.00	728.00
				Total = $	57351.14

Floors 5 & 6	W14x68	14	14	81.72	16017.12
	W14x61	14	7	73.80	7232.40
	W12x45	14	2	55.78	1561.84
	W12x40	14	4	50.00	2800.00
	W10x77	14	1	94.80	1327.20
	W10x49	14	1	62.42	873.88
	W10x39	14	14	50.85	9966.60
	W10x33	14	3	43.92	1844.64
	W8x31	14	1	38.52	539.28
				Total = $	42162.96

Redesigned System

Typical Floor Beams

Size	Length (ft)	Quantity	Price ($/lf)	Output (lf/day)	T cost ($)	Time (Day)
W21x44	30	2	54.13	1064	3247.80	0.056
W18x76	30	4	90.98	900	10917.60	0.133
W18x40	30	15	50.13	960	22558.50	0.469
W18x35	30	2	44.63	960	2677.80	0.063
W18x35	25	1	44.63	960	1115.75	0.026
W16x31	30	13	39.23	900	15299.70	0.433
W16x31	25	2	39.23	900	1961.50	0.056
W16x26	38	20	33.31	1000	25315.60	0.760
W16x26	30	2	33.31	1000	1998.60	0.060
W16x26	25	2	33.31	1000	1665.50	0.050
W14x22	30	42	28.45	990	35847.00	1.273
W14x22	25	1	28.45	990	711.25	0.025
W12x65	30	3	78.75	690	7087.50	0.130
W12x53	30	1	64.57	750	1937.10	0.040
W12x19	30	16	25.88	880	12422.40	0.545
W12x16	30	4	22.43	880	2691.60	0.136
W12x14	25	2	20.13	880	1006.50	0.057
W12x14	20	1	20.13	880	402.60	0.023
W10x19	15	1	27.87	600	418.05	0.025
W10x12	25	3	19.9	600	1492.50	0.125
W8x10	27	3	17.65	600	1429.65	0.135
W8x10	15	3	17.65	600	794.25	0.075
W8x10	25	1	17.65	600	441.25	0.042
				Totals	153440.00	5

Roof Beams

Size	Length (ft)	Quantity	Price ($/lf)	Output (lf/day)	T cost ($)	Time (Day)
W16x26	30	3	33.31	1000	2997.90	0.090
W14x43	30	4	53.2	810	6384.00	0.148
W14x22	30	16	28.45	990	13656.00	0.485
W12x19	30	1	25.88	880	776.40	0.034
W12x19	25	1	25.88	880	647.00	0.028
W12x16	30	11	22.43	880	7401.90	0.375
W12x16	25	1	22.43	880	560.75	0.028
W12x14	38	20	20.13	880	15298.80	0.864
W12x14	30	2	20.13	880	1207.80	0.068
W10x45	30	3	57.8	550	5202.00	0.164
W10x39	30	1	50.85	550	1525.50	0.055
W10x12	30	40	19.9	600	23880.00	2.000
W10x12	25	1	19.9	600	497.50	0.042
W8x15	15	1	23.25	600	348.75	0.025
W8x10	30	22	17.65	600	11649.00	1.100
W8x10	25	6	17.65	600	2647.50	0.250
W8x10	27	3	17.65	600	1429.65	0.135
W8x10	15	3	17.65	600	794.25	0.075
W8x10	20	1	17.65	600	353.00	0.033
				Totals	97257.70	6

Deck

	Size	Quantity (sf/floor)	Price ($/sf)	Output (sf/Day)	T cost ($)	Time (Day)
Metal Deck	3" 20 Gauge	31000	2.28	3000	70680	10

	Size	Quantity (Ea/floor)	Price ($/Ea)	Output (Ea/Day)	T cost ($)	Time (Day)
Studs Roof	3/4" Di. 4.5"	2077	1.58	930	3281.66	2
Studs TYP	3/4" Di. 4.5"	3141	1.58	930	4962.78	3

	Size	Quantity (cy/floor)	Price ($/cy)	Output (cy/Day)	T cost ($)	Time (Day)
Conc. Slab	Concrete 4ksi	287	108		30996	
	Elev. Slab < 6" pumped	287	19.55	140	5610.85	2

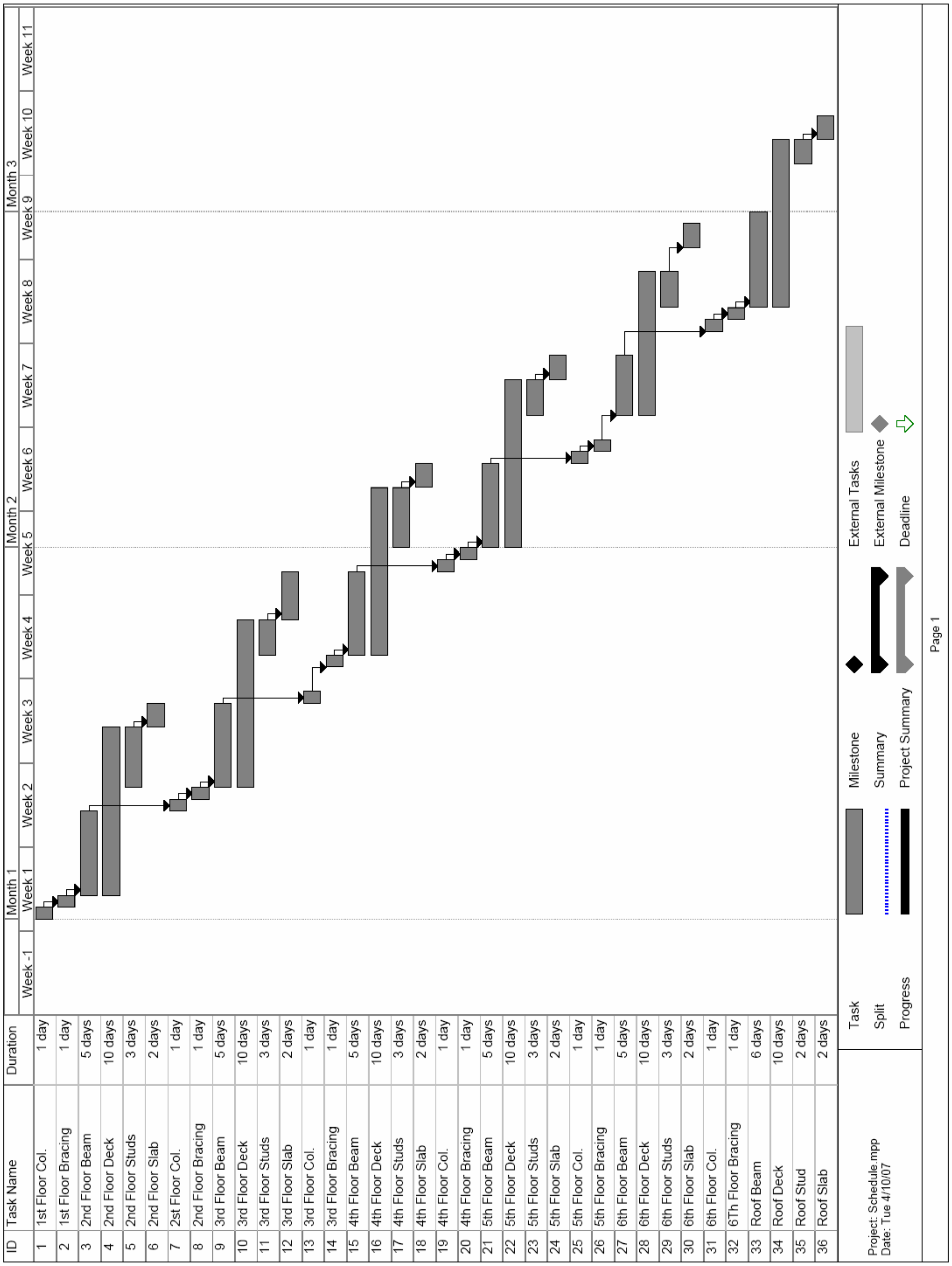
Columns

	Size	Length (ft)	Quantity	Price ($/lf)	Output (lf/Day)	T cost ($)	Time (Day)
Floors 1 & 2	W12x96	14	2	114.15	977	3196.20	0.02866
	W12x87	14	4	101.87	984	5704.72	0.05691
	W12x79	14	1	94.88	994	1328.32	0.01408
	W12x72	14	1	86.95	1003	1217.30	0.01396
	W12x65	14	2	78.76	1012	2205.28	0.02767
	W12x58	14	4	70.57	1022	3951.92	0.05479
	W10x68	14	11	80.37	984	12376.98	0.15650
	W10x60	14	3	75.14	1000	3155.88	0.04200
	W10x54	14	1	68.20	1013	954.80	0.01382
	W10x49	14	13	62.42	1024	11360.44	0.17773
	W10x45	14	2	54.19	1032	1517.32	0.02713
	W10x39	14	2	50.85	1044	1423.80	0.02682
	W10x33	14	1	43.92	1057	614.88	0.01325
					Totals	49007.84	1
Floors 3 & 4	W12x72	14	6	86.95	1003	7303.80	0.08375
	W10x68	14	2	80.37	984	2250.36	0.02846
	W10x60	14	4	75.14	1000	4207.84	0.05600
	W10x58	14	1	72.83	1004	1019.62	0.01394
	W10x53	14	1	67.00	1015	938.00	0.01379
	W10x49	14	12	62.42	1024	10486.56	0.16406
	W10x45	14	3	54.19	1032	2275.98	0.04070
	W10x39	14	13	50.85	1044	9254.70	0.17433
	W10x33	14	5	43.92	1057	3074.40	0.06623
					Totals	40811.26	1
Floors 5 & 6	W10x39	14	6	50.85	1044	4271.4	0.08046
	W10x33	14	41	43.92	1057	25210.08	0.54305
					Totals	29481.48	1

Bracing

Floor	Size	Length (ft)	Quantity	Price ($/lf)	Output (lf/Day)	T cost ($)	Time (Day)
1	HSS 8x8x5/8	33	2	67.40	912	4448.4	0.07237
	HSS 8x8x1/2	33	8	57.13	960	15082.32	0.27500
	HSS 7x7x1/2	33	4	50	810	6600	0.16296
	HSS 6x6x1/2	20	2	43.92	550	1756.8	0.07273
					Totals	27887.52	1
2	HSS 8x8x5/8	33	2	67.40	912	4448.4	0.07237
	HSS 8x8x1/2	33	8	57.13	960	15082.32	0.27500
	HSS 7x7x1/2	33	6	50	810	9900	0.24444
	HSS 6x6x1/2	20	2	43.92	550	1756.8	0.07273
					Totals	31187.52	1
3	HSS 8x8x5/8	33	2	67.40	912	4448.4	0.07237
	HSS 8x8x1/2	33	8	57.13	960	15082.32	0.27500
	HSS 7x7x1/2	33	6	50	810	9900	0.24444
	HSS 6x6x1/2	20	2	43.92	550	1756.8	0.07273
					Totals	31187.52	1
4	HSS 7x7x5/8	33	2	58.97	805	3892.02	0.08199
	HSS 7x7x1/2	33	14	50	810	23100	0.57037
	HSS 4.5x4.5x3/8	20	2	25.88	880	1035.2	0.04545
					Totals	28027.22	1
5	HSS 7x7x5/8	33	2	58.97	805	3892.02	0.08199
	HSS 7x7x1/2	33	12	50	810	19800	0.48889
	HSS 6x6x5/8	33	2	50	810	3300	0.08148
	HSS 4.5x4.5x3/8	20	2	25.88	880	1035.2	0.04545
					Totals	28027.22	1
6	HSS 6x6x5/8	33	6	50	810	9900	0.24444
	HSS 6x6x1/2	33	8	43.92	550	11594.88	0.48000
	HSS 4.5x4.5x3/8	20	2	25.88	880	1035.2	0.04545
					Totals	22530.08	1

Construction Schedule



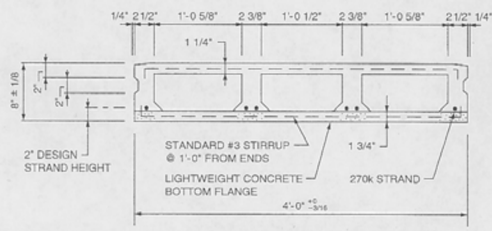
Appendix E: Breadth Topic 2
Alternative Floor System

Hollow Core Plank

Prestressed Concrete
8" x 4' SpanDeck – U.L. – J952
(NO TOPPING)

PHYSICAL PROPERTIES
Precast

A = 199 in.^{2}		S_b = 332 in.^{3}	
I = 1370 in.^{4}		S_t = 354 in.^{3}	
Y_b = 4.13 in.		Wt. = 230 PLF	
Y_t = 3.87 in.		Wt. = 57.5 PSF	
e = 2.13 in.			



8" SPANDECK CROSS SECTION
UL FIRE RATED J952

DESIGN DATA
1. Precast Strength @ 28 days = 5000 PSI.
2. Precast Strength @ release = 3000 PSI.
3. Precast Density = 150 PCF (Top and Webs)
   = 115 PCF (Soffit)
4. Strand = 1/2"ø, 270 K Lo-Relaxation.
5. Strand Height = 2.00 in.
6. Ultimate moment capacities (when fully developed) . . .
   4 – 1/2"ø, 270K = 68.0'K
   6 – 1/2"ø, 270K = 96.3'K
7. Maximum bottom tensile stress is $6\sqrt{f'c}$ = 424 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. Shear values are the maximum allowable before shear reinforcement is required.
11. Deflection limits were not considered when determining allowable loads in this table.
12. All values in this table are based on ultimate strength and are not governed by service stress.

8" SPANDECK W/O TOPPING		ALLOWABLE SUPERIMPOSED LOAD (PSF)																					
STRAND PATTERN	SPAN (FEET)																						
	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Flexure 4 – 1/2"ø	565	510	460	420	361	309	265	231	199	175	152	133	118	105	91	80	71	62	54	47	41	35	X
Shear 4 – 1/2"ø	429	383	345	313	286	263	241	225	209	195	177	159	143	130	118	110	104	95	88	79	72	66	X
Flexure 6 – 1/2"ø	825	745	675	619	531	456	395	344	302	265	236	209	186	167	149	134	120	107	96	86	78	70	63
Shear 6 – 1/2"ø	446	398	359	326	298	274	253	234	218	204	191	179	169	159	150	138	126	115	106	97	89	82	76

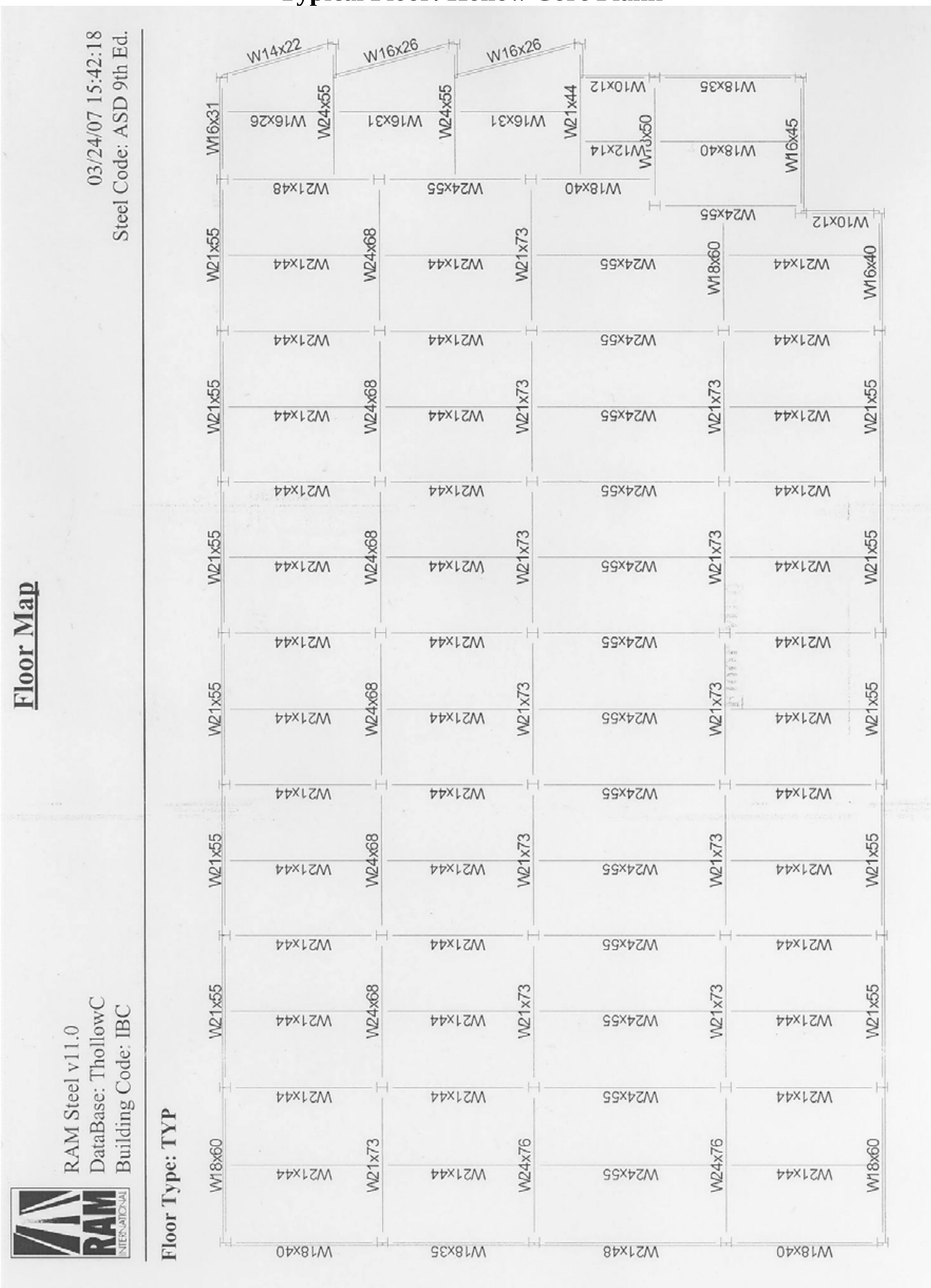
NITTERHOUSE
CONCRETE PRODUCTS

This table is for simple spans and uniform loads. Design data for any of these span-load conditions is available on request. Individual designs may be furnished to satisfy unusual conditions of heavy loads, concentrated loads, cantilevers, flange or stem openings and narrow widths.

2655 Molly Pitcher Hwy. South, Box N
Chambersburg, PA 17201-0813
717-267-4505 • FAX: 717-267-4518

REVISED 12/93

Typical Floor: Hollow Core Plank



Hollow Core Cost Estimate

Size	Length (ft)	Quantity	Price ($/lf)	T cost ($)
W24x68	30	1	80.94	2428.2
W24x55	38	3	66.44	7574.16
W21x73	30	2	86.98	5218.8
W21x55	30	2	66.8	4008
W21x44	30	9	54.13	14615.1
			Total = $	33844.26

	Quantity (sf)	Price ($/sf)	T cost ($)
H.C. Plank	3840	9.59	36825.6
		Total = $	70669.86

Composite Deck Cost Estimate

Size	Length (ft)	Quantity	Price ($/lf)	T cost ($)
W18x40	30	3	50.13	4511.7
W16x31	30	2	39.23	2353.8
W16x26	38	4	33.31	5063.12
W14x22	30	8	28.45	6828
W12x19	30	4	25.88	3105.6
			Total = $	21862.22

	Size	Quantity (sf/floor)	Price ($/sf)	T cost ($)
Metal Deck	3" 20 Gauge	3840	2.28	8755.2

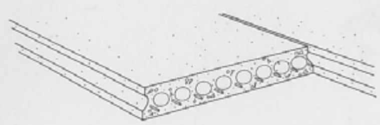
	Size	Quantity (Ea/floor)	Price ($/Ea)	T cost ($)
Shear Studs	3/4" Di. 4.5"	546	1.58	862.68

	Size	Quantity (cy/floor)	Price ($/cy)	T cost ($)
Conc. Slab	Concrete 4ksi	35.5	108	3834
	Elev. Slab < 6" pumped	35.5	19.55	694.025
			Total = $	35314.1

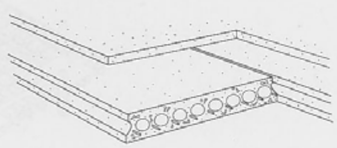
Appendix F: RS Means Charts

B10 Superstructure

B1010 Floor Construction



Precast Plank with No Topping



Precast Plank with 2″ Concrete Topping

B1010 229 Precast Plank with No Topping

	SPAN (FT.)	SUPERIMPOSED LOAD (P.S.F.)	TOTAL DEPTH (IN.)	DEAD LOAD (P.S.F.)	TOTAL LOAD (P.S.F.)	COST PER S.F. MAT.	COST PER S.F. INST.	COST PER S.F. TOTAL
0720	10	40	4	50	90	5.40	2.98	8.38
0750		75	6	50	125	6.95	2.56	9.51
0770		100	6	50	150	6.95	2.56	9.51
0800	15	40	6	50	90	6.95	2.56	9.51
0820		75	6	50	125	6.95	2.56	9.51
0850		100	6	50	150	6.95	2.56	9.51
0950	25	40	6	50	90	6.95	2.56	9.51
0970		75	8	55	130	7.35	2.24	9.59
1000		100	8	55	155	7.35	2.24	9.59
1200	30	40	8	55	95	7.35	2.24	9.59
1300		75	8	55	130	7.35	2.24	9.59
1400		100	10	70	170	7.70	1.99	9.69
1500	40	40	10	70	110	7.70	1.99	9.69
1600		75	12	70	145	8.75	1.79	10.54
1700	45	40	12	70	110	8.75	1.79	10.54

B1010 230 Precast Plank with 2″ Concrete Topping

	SPAN (FT.)	SUPERIMPOSED LOAD (P.S.F.)	TOTAL DEPTH (IN.)	DEAD LOAD (P.S.F.)	TOTAL LOAD (P.S.F.)	COST PER S.F. MAT.	COST PER S.F. INST.	COST PER S.F. TOTAL
2000	10	40	6	75	115	6.35	4.64	10.99
2100		75	8	75	150	7.90	4.22	12.12
2200		100	8	75	175	7.90	4.22	12.12
2500	15	40	8	75	115	7.90	4.22	12.12
2600		75	8	75	150	7.90	4.22	12.12
2700		100	8	75	175	7.90	4.22	12.12
3100	25	40	8	75	115	7.90	4.22	12.12
3200		75	8	75	150	7.90	4.22	12.12
3300		100	10	80	180	8.30	3.90	12.20
3400	30	40	10	80	120	8.30	3.90	12.20
3500		75	10	80	155	8.30	3.90	12.20
3600		100	10	80	180	8.30	3.90	12.20
4000	40	40	12	95	135	8.65	3.65	12.30
4500		75	14	95	170	9.70	3.45	13.15
5000	45	40	14	95	135	9.70	3.45	13.15

05 12 Structural Steel Framing

05 12 23 – Structural Steel for Buildings

05 12 23.75 Structural Steel Members		Crew	Daily Output	Labor-Hours	Unit	Material	Labor	Equipment	Total	Total Incl O&P
						2007 Bare Costs				
0100	W 6 x 9	E-2	600	.093	L.F.	10.15	3.77	2.58	16.50	20.50
0120	x 16		600	.093		18.05	3.77	2.58	24.40	29
0140	x 20		600	.093		22.50	3.77	2.58	28.85	34.50
0300	W 8 x 10		600	.093		11.30	3.77	2.58	17.65	21.50
0320	x 15		600	.093		16.90	3.77	2.58	23.25	28
0350	x 21		600	.093		23.50	3.77	2.58	29.85	35.50
0360	x 24		550	.102		27	4.11	2.81	33.92	40
0370	x 28		550	.102		31.50	4.11	2.81	38.42	44.50
0500	x 31		550	.102		35	4.11	2.81	41.92	48.50
0520	x 35		550	.102		39.50	4.11	2.81	46.42	53.50
0540	x 48		550	.102		54	4.11	2.81	60.92	69.50
0600	W 10 x 12		600	.093		13.55	3.77	2.58	19.90	24
0620	x 15		600	.093		16.90	3.77	2.58	23.25	28
0700	x 22		600	.093		25	3.77	2.58	31.35	37
0720	x 26		600	.093		29.50	3.77	2.58	35.85	42
0740	x 33		550	.102		37	4.11	2.81	43.92	51
0900	x 49		550	.102		55.50	4.11	2.81	62.42	71
1100	W 12 x 14		880	.064		15.80	2.57	1.76	20.13	23.50
1300	x 22		880	.064		25	2.57	1.76	29.33	34
1500	x 26		880	.064		29.50	2.57	1.76	33.83	39
1520	x 35		810	.069		39.50	2.79	1.91	44.20	50.50
1560	x 50		750	.075		56.50	3.01	2.06	61.57	69.50
1580	x 58		750	.075		65.50	3.01	2.06	70.57	79.50
1700	x 72		640	.088		81	3.53	2.42	86.95	98.50
1740	x 87		640	.088		98	3.53	2.42	103.95	117
1900	W 14 x 26		990	.057		29.50	2.28	1.56	33.34	38
2100	x 30		900	.062		34	2.51	1.72	38.23	43
2300	x 34		810	.069		38.50	2.79	1.91	43.20	49
2320	x 43		810	.069		48.50	2.79	1.91	53.20	60.50
2340	x 53		800	.070		60	2.82	1.93	64.75	72.50
2360	x 74		760	.074		83.50	2.97	2.04	88.51	99.50
2380	x 90		740	.076		101	3.05	2.09	106.14	120
2500	x 120		720	.078		135	3.14	2.15	140.29	157
2700	W 16 x 26		1000	.056		29.50	2.26	1.55	33.31	38
2900	x 31		900	.062		35	2.51	1.72	39.23	44.50
3100	x 40		800	.070		45	2.82	1.93	49.75	56.50
3120	x 50		800	.070		56.50	2.82	1.93	61.25	69
3140	x 67		760	.074		75.50	2.97	2.04	80.51	90.50
3300	W 18 x 35	E-5	960	.083		39.50	3.40	1.73	44.63	51.50
3500	x 40		960	.083		45	3.40	1.73	50.13	57.50
3520	x 46		960	.083		52	3.40	1.73	57.13	65
3700	x 50		912	.088		56.50	3.58	1.82	61.90	70.50
3900	x 55		912	.088		62	3.58	1.82	67.40	76.50
3920	x 65		900	.089		73.50	3.63	1.85	78.98	89
3940	x 76		900	.089		85.50	3.63	1.85	90.98	103
3960	x 86		900	.089		97	3.63	1.85	102.48	115
3980	x 106		900	.089		120	3.63	1.85	125.48	139
4100	W 21 x 44		1064	.075		49.50	3.07	1.56	54.13	61.50
4300	x 50		1064	.075		56.50	3.07	1.56	61.13	69
4500	x 62		1036	.077		70	3.15	1.60	74.75	84.50
4700	x 68		1036	.077		76.50	3.15	1.60	81.25	92
4720	x 83		1000	.080		93.50	3.27	1.66	98.43	111
4740	x 93		1000	.080		105	3.27	1.66	109.93	123

103

05 12 Structural Steel Framing

05 12 23 – Structural Steel for Buildings

05 12 23.75 Structural Steel Members		Crew	Daily Output	Labor-Hours	Unit	Material	2007 Bare Costs Labor	Equipment	Total	Total Incl O&P
4760	x 101	E-5	1000	.080	L.F.	114	3.27	1.66	118.93	133
4780	x 122		1000	.080		138	3.27	1.66	142.93	159
4900	W 24 x 55		1110	.072		62	2.94	1.50	66.44	75
5100	x 62		1110	.072		70	2.94	1.50	74.44	84
5300	x 68		1110	.072		76.50	2.94	1.50	80.94	91.50
5500	x 76		1110	.072		85.50	2.94	1.50	89.94	101
5700	x 84		1080	.074		94.50	3.03	1.54	99.07	111
5720	x 94		1080	.074		106	3.03	1.54	110.57	124
5740	x 104		1050	.076		117	3.11	1.58	121.69	136
5760	x 117		1050	.076		132	3.11	1.58	136.69	152
5780	x 146		1050	.076		165	3.11	1.58	169.69	188
5800	W 27 x 84		1190	.067		94.50	2.75	1.40	98.65	110
5900	x 94		1190	.067		106	2.75	1.40	110.15	123
5920	x 114		1150	.070		129	2.84	1.45	133.29	148
5940	x 146		1150	.070		165	2.84	1.45	169.29	188
5960	x 161		1150	.070		182	2.84	1.45	186.29	207
6100	W 30 x 99		1200	.067		112	2.72	1.39	116.11	129
6300	x 108		1200	.067		122	2.72	1.39	126.11	140
6500	x 116		1160	.069		131	2.82	1.43	135.25	151
6520	x 132		1160	.069		149	2.82	1.43	153.25	171
6540	x 148		1160	.069		167	2.82	1.43	171.25	191
6560	x 173		1120	.071		195	2.92	1.48	199.40	222
6580	x 191		1120	.071		215	2.92	1.48	219.40	244
6700	W 33 x 118		1176	.068		133	2.78	1.41	137.19	152
6900	x 130		1134	.071		147	2.88	1.47	151.35	168
7100	x 141		1134	.071		159	2.88	1.47	163.35	182
7120	x 169		1100	.073		191	2.97	1.51	195.48	217
7140	x 201		1100	.073		227	2.97	1.51	231.48	256
7300	W 36 x 135		1170	.068		152	2.79	1.42	156.21	173
7500	x 150		1170	.068		169	2.79	1.42	173.21	192
7600	x 170		1150	.070		192	2.84	1.45	196.29	218
7700	x 194		1125	.071		219	2.90	1.48	223.38	248
7900	x 230		1125	.071		259	2.90	1.48	263.38	292
7920	x 260		1035	.077		293	3.16	1.61	297.77	325
8100	x 300		1035	.077		340	3.16	1.61	344.77	375
8490	For projects 75 to 99 tons, add					10%				
8492	50 to 74 tons, add					20%				
8494	25 to 49 tons, add					30%	10%			
8496	10 to 24 tons, add					50%	25%			
8498	2 to 9 tons, add					75%	50%			
8499	Less than 2 tons, add					100%	100%			

05 12 23.77 Structural Steel Projects		Crew	Daily Output	Labor-Hours	Unit	Material	Labor	Equipment	Total	Total Incl O&P
0010	STRUCTURAL STEEL PROJECTS									
0020	Shop fab'd for 100-ton, 1-2 story project, bolted conn's.									
1300	Industrial bldgs., 1 story, beams & girders, steel bearing R050521-20	E-5	12.90	6.202	Ton	2,050	253	129	2,432	2,825
1400	Masonry bearing	"	10	8	"	2,050	325	166	2,541	3,000
1500	Industrial bldgs., 1 story, under 10 tons,									
1510	steel from warehouse, trucked	E-2	7.50	7.467	Ton	2,450	300	206	2,956	3,450
1600	1 story with roof trusses, steel bearing	E-5	10.60	7.547		2,425	310	157	2,892	3,375
1700	Masonry bearing	"	8.30	9.639		2,425	395	200	3,020	3,550
1900	Monumental structures, banks, stores, etc., minimum	E-6	13	9.846		2,050	405	139	2,594	3,125
2000	Maximum		9	14.222		3,400	580	201	4,181	5,000

05 12 Structural Steel Framing

05 12 23 – Structural Steel for Buildings

05 12 23.17 Columns, Structural		Crew	Daily Output	Labor-Hours	Unit	Material (2007 Bare Costs)	Labor (2007 Bare Costs)	Equipment (2007 Bare Costs)	Total (2007 Bare Costs)	Total Incl O&P
4500	Structural tubing, sq, 4" x 4" x 1/4" x 12'-0"	E-2	58	.966	Ea.	169	39	26.50	234.50	283
4550	6" x 6" x 1/4" x 12'-0"		54	1.037		277	42	28.50	347.50	410
4600	8" x 8" x 3/8" x 14'-0"		50	1.120		600	45	31	676	775
4650	10" x 10" x 1/2" x 16'-0"		48	1.167		1,100	47	32	1,179	1,350
5100	Structural tubing, rect, 5" to 6" wide, light section		8000	.007	Lb.	1.03	.28	.19	1.50	1.83
5200	Heavy section		12000	.005		1.03	.19	.13	1.35	1.60
5300	7" to 10" wide, light section		15000	.004		1.03	.15	.10	1.28	1.50
5400	Heavy section		18000	.003		1.03	.13	.09	1.25	1.44
5500	Structural tubing, rect, 5" x 3" x 1/4" x 12'-0"		58	.966	Ea.	164	39	26.50	229.50	277
5550	6" x 4" x 5/16" x 12'-0"		54	1.037		256	42	28.50	326.50	385
5600	8" x 4" x 3/8" x 12'-0"		54	1.037		375	42	28.50	445.50	515
5650	10" x 6" x 3/8" x 14'-0"		50	1.120		600	45	31	676	775
5700	12" x 8" x 1/2" x 16'-0"		48	1.167		1,100	47	32	1,179	1,350
6800	W Shape, A992 steel, 2 tier, W8 x 24		1080	.052	L.F.	27	2.09	1.43	30.52	35
6850	W8 x 31		1080	.052		35	2.09	1.43	38.52	43.50
6900	W8 x 48		1032	.054		54	2.19	1.50	57.69	65
6950	W8 x 67		984	.057		75.50	2.30	1.57	79.37	88.50
7000	W10 x 45		1032	.054		50.50	2.19	1.50	54.19	61.50
7050	W10 x 68		984	.057		76.50	2.30	1.57	80.37	90
7100	W10 x 112		960	.058		126	2.35	1.61	129.96	145
7150	W12 x 50		1032	.054		56.50	2.19	1.50	60.19	67.50
7200	W12 x 87		984	.057		98	2.30	1.57	101.87	114
7250	W12 x 120		960	.058		135	2.35	1.61	138.96	155
7300	W12 x 190		912	.061		214	2.48	1.70	218.18	242
7350	W14 x 74		984	.057		83.50	2.30	1.57	87.37	97.50
7400	W14 x 120		960	.058		135	2.35	1.61	138.96	155
7450	W14 x 176		912	.061		198	2.48	1.70	202.18	224
8090	For projects 75 to 99 tons, add				All	10%				
8092	50 to 74 tons, add					20%				
8094	25 to 49 tons, add					30%	10%			
8096	10 to 24 tons, add					50%	25%			
8098	2 to 9 tons, add					75%	50%			
8099	Less than 2 tons, add					100%	100%			

05 12 23.20 Curb Edging		Crew	Daily Output	Labor-Hours	Unit	Material	Labor	Equipment	Total	Total Incl O&P
0010	**CURB EDGING**									
0020	Steel angle w/anchors, on forms, 1" x 1", 0.8#/L.F.	E-4	350	.091	L.F.	1.72	3.83	.33	5.88	9.20
0100	2" x 2" angles, 3.92#/L.F.		330	.097		5.55	4.06	.35	9.96	13.85
0200	3" x 3" angles, 6.1#/L.F.		300	.107		8.80	4.46	.38	13.64	18.15
0300	4" x 4" angles, 8.2#/L.F.		275	.116		11.35	4.87	.42	16.64	22
1000	6" x 4" angles, 12.3#/L.F.		250	.128		16.40	5.35	.46	22.21	28.50
1050	Steel channels with anchors, on forms, 3" channel, 5#/L.F.		290	.110		6.90	4.62	.40	11.92	16.40
1100	4" channel, 5.4#/L.F.		270	.119		7.40	4.96	.43	12.79	17.55
1200	6" channel, 8.2#/L.F.		255	.125		11.35	5.25	.45	17.05	22.50
1300	8" channel, 11.5#/L.F.		225	.142		15.45	5.95	.51	21.91	28.50
1400	10" channel, 15.3#/L.F.		180	.178		20	7.45	.64	28.09	36
1500	12" channel, 20.7#/L.F.		140	.229		26.50	9.55	.82	36.87	48
2000	For curved edging, add					35%	10%			

05 12 23.40 Lightweight Framing		Crew	Daily Output	Labor-Hours	Unit	Material	Labor	Equipment	Total	Total Incl O&P
0010	**LIGHTWEIGHT FRAMING**									
0400	Angle framing, field fabricated, 4" and larger	E-3	440	.055	Lb.	.59	2.29	.26	3.14	5.10
0450	Less than 4" angles		265	.091		.62	3.81	.43	4.86	8.05
0600	Channel framing, field fabricated, 8" and larger		500	.048		.62	2.02	.23	2.87	4.58

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05 31 Steel Decking

05 31 13 – Steel Floor Decking

05 31 13.50 Floor Decking		Crew	Daily Output	Labor-Hours	Unit	2007 Bare Costs Material	Labor	Equipment	Total	Total Incl O&P
4200	16 gauge	E-4	1930	.017	S.F.	5.45	.69	.06	6.20	7.35
4300	14 gauge		1860	.017		7.05	.72	.06	7.83	9.10
4500	7-1/2" deep, long span, 18 gauge		1690	.019		8.05	.79	.07	8.91	10.35
4600	16 gauge		1590	.020		6	.84	.07	6.91	8.20
4700	14 gauge	↓	1490	.021	↓	7.75	.90	.08	8.73	10.20
4800	For painted instead of galvanized, deduct					2%				
5000	For acoustical perforated, with fiberglass, add				S.F.	1.05			1.05	1.16
5200	Non-cellular composite deck, galv., 2" deep, 22 gauge	E-4	3860	.008		1.47	.35	.03	1.85	2.28
5300	20 gauge		3600	.009		1.63	.37	.03	2.03	2.50
5400	18 gauge		3380	.009		2.07	.40	.03	2.50	3.03
5500	16 gauge		3200	.010		2.59	.42	.04	3.05	3.65
5700	3" deep, galv., 22 gauge		3200	.010		1.60	.42	.04	2.06	2.56
5800	20 gauge		3000	.011		1.79	.45	.04	2.28	2.82
5900	18 gauge		2850	.011		2.20	.47	.04	2.71	3.31
6000	16 gauge	↓	2700	.012	↓	2.94	.50	.04	3.48	4.18

05 31 23 – Steel Roof Decking

05 31 23.50 Roof Decking		Crew	Daily Output	Labor-Hours	Unit	Material	Labor	Equipment	Total	Total Incl O&P
0010	**ROOF DECKING**									
2100	Open type, galv., 1-1/2" deep wide rib, 22 gauge, under 50 squares	E-4	4500	.007	S.F.	1.55	.30	.03	1.88	2.27
2400	Over 500 squares		5100	.006		1.11	.26	.02	1.39	1.72
2600	20 gauge, under 50 squares		3865	.008		1.82	.35	.03	2.20	2.66
2700	Over 500 squares		4300	.007		1.31	.31	.03	1.65	2.03
2900	18 gauge, under 50 squares		3800	.008		2.36	.35	.03	2.74	3.26
3000	Over 500 squares		4300	.007		1.70	.31	.03	2.04	2.46
3050	16 gauge, under 50 squares		3700	.009		3.17	.36	.03	3.56	4.17
3100	Over 500 squares	↓	4200	.008	↓	2.28	.32	.03	2.63	3.12

05 31 33 – Steel Form Decking

05 31 33.50 Form Decking		Crew	Daily Output	Labor-Hours	Unit	Material	Labor	Equipment	Total	Total Incl O&P
0010	**FORM DECKING**									
6100	Slab form, steel, 28 gauge, 9/16" deep, uncoated	E-4	4000	.008	S.F.	1.03	.33	.03	1.39	1.77
6200	Galvanized		4000	.008		.91	.33	.03	1.27	1.64
6220	24 gauge, 1" deep, uncoated		3900	.008		1.12	.34	.03	1.49	1.88
6240	Galvanized		3900	.008		1.32	.34	.03	1.69	2.10
6300	24 gauge, 1-5/16" deep, uncoated		3800	.008		1.20	.35	.03	1.58	1.99
6400	Galvanized		3800	.008		1.41	.35	.03	1.79	2.22
6500	22 gauge, 1-5/16" deep, uncoated		3700	.009		1.50	.36	.03	1.89	2.34
6600	Galvanized		3700	.009		1.53	.36	.03	1.92	2.37
6700	22 gauge, 2" deep uncoated		3600	.009		1.98	.37	.03	2.38	2.89
6800	Galvanized	↓	3600	.009	↓	1.94	.37	.03	2.34	2.84
7000	Sheet metal edge closure form, 12" wide with 2 bends, galv									
7100	18 gauge	E-14	360	.022	L.F.	3.19	.96	.32	4.47	5.60
7200	16 gauge	"	360	.022	"	4.33	.96	.32	5.61	6.85

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05 05 Common Work Results for Metals

05 05 23 – Metal Fastenings

05 05 23.80 Vibration Pads		Crew	Daily Output	Labor-Hours	Unit	2007 Bare Costs Material	Labor	Equipment	Total	Total Incl O&P
1000	1" thick	2 Sswk	20	.800	S.F.	22	33		55	84
1200	Felt surfaced vinyl pads, cork and sisal, 5/8" thick		24	.667		28.50	27.50		56	81
1300	1" thick		20	.800		51.50	33		84.50	117
1600	3/32" layer		24	.667		73	27.50		100.50	131
1800	Bonded to 10 ga. stainless steel, 1/32" layer		24	.667		86.50	27.50		114	146
1900	3/32" layer		24	.667		112	27.50		139.50	174
2100	Circular machine leveling pad & stud				Kip	7.10			7.10	7.80
05 05 23.85 Welded Shear Connectors										
0010	**WELDED SHEAR CONNECTORS**									
0020	3/4" diameter, 3-3/16" long	E-10	960	.017	Ea.	.43	.71	.31	1.45	2.10
0030	3-3/8" long		950	.017		.45	.71	.32	1.48	2.14
0200	3-7/8" long		945	.017		.49	.72	.32	1.53	2.19
0300	4-3/16" long		935	.017		.51	.72	.32	1.55	2.22
0500	4-7/8" long		930	.017		.57	.73	.32	1.62	2.31
0600	5-3/16" long		920	.017		.59	.74	.33	1.66	2.34
0800	5-3/8" long		910	.018		.60	.74	.33	1.67	2.37
0900	6-3/16" long		905	.018		.66	.75	.33	1.74	2.45
1000	7-3/16" long		895	.018		.82	.76	.34	1.92	2.64
1100	8-3/16" long		890	.018		.89	.76	.34	1.99	2.73
1500	7/8" diameter, 3-11/16" long		920	.017		.70	.74	.33	1.77	2.46
1600	4-3/16" long		910	.018		.75	.74	.33	1.82	2.53
1700	5-3/16" long		905	.018		.85	.75	.33	1.93	2.67
1800	6-3/16" long		895	.018		.95	.76	.34	2.05	2.79
1900	7-3/16" long		890	.018		1.06	.76	.34	2.16	2.91
2000	8-3/16" long		880	.018		1.15	.77	.34	2.26	3.04
05 05 23.87 Welded Studs										
0010	**WELDED STUDS**									
0020	1/4" diameter, 2-11/16" long	E-10	1120	.014	Ea.	.28	.61	.27	1.16	1.70
0100	4-1/8" long		1080	.015		.26	.63	.28	1.17	1.74
0200	3/8" diameter, 4-1/8" long		1080	.015		.30	.63	.28	1.21	1.78
0300	6-1/8" long		1040	.015		.39	.65	.29	1.33	1.93
0400	1/2" diameter, 2-1/8" long		1040	.015		.29	.65	.29	1.23	1.81
0500	3-1/8" long		1025	.016		.35	.66	.29	1.30	1.90
0600	4-1/8" long		1010	.016		.41	.67	.30	1.38	1.99
0700	5-5/16" long		990	.016		.50	.68	.30	1.48	2.12
0800	6-1/8" long		975	.016		.54	.70	.31	1.55	2.20
0900	8-1/8" long		960	.017		.76	.71	.31	1.78	2.46
1000	5/8" diameter, 2-11/16" long		1000	.016		.50	.68	.30	1.48	2.11
1010	4-3/16" long		990	.016		.61	.68	.30	1.59	2.24
1100	6-9/16" long		975	.016		.80	.70	.31	1.81	2.48
1200	8-3/16" long		960	.017		1.07	.71	.31	2.09	2.80
05 05 23.90 Welding Rod										
0010	**WELDING ROD**									
0020	Steel, type 6011, 1/8" dia, less than 500#				Lb.	1.99			1.99	2.19
0100	500# to 2,000#					1.79			1.79	1.97
0200	2,000# to 5,000#					1.68			1.68	1.85
0300	5/32" diameter, less than 500#					1.91			1.91	2.10
0310	500# to 2,000#					1.72			1.72	1.89
0320	2,000# to 5,000#					1.62			1.62	1.78
0400	3/16" dia, less than 500#					1.93			1.93	2.12
0500	500# to 2,000#					1.74			1.74	1.91
0600	2,000# to 5,000#					1.64			1.64	1.80

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03 31 Structural Concrete

03 31 05 – Normal Weight Structural Concrete

03 31 05.30 Concrete, Field Mix		Crew	Daily Output	Labor-Hours	Unit	Material	2007 Bare Costs Labor	Equipment	Total	Total Incl O&P
0010	**CONCRETE, FIELD MIX**									
0015	FOB forms 2250 psi				C.Y.	92.50			92.50	102
0020	3000 psi				"	96.50			96.50	106
03 31 05.35 Normal Weight Concrete, Ready Mix										
0010	**NORMAL WEIGHT CONCRETE, READY MIX**									
0012	Includes local aggregate, sand, portland cement, and water									
0015	Excludes all additives and treatments R033105-20									
0020	2000 psi				C.Y.	99.50			99.50	110
0100	2500 psi					101			101	111
0150	3000 psi					104			104	114
0200	3500 psi					106			106	116
0300	4000 psi					108			108	119
0350	4500 psi					110			110	121
0400	5000 psi					114			114	125
0411	6000 psi					130			130	143
0412	8000 psi					212			212	233
0413	10,000 psi					300			300	330
0414	12,000 psi					365			365	400
1000	For high early strength cement, add					10%				
1010	For structural lightweight with regular sand, add					25%				
1300	For winter concrete, add					5.50			5.50	6.05
1400	For hot weather concrete, add					6.90			6.90	7.60
1500	For Saturday delivery, add					8.50			8.50	9.35
2000	For all lightweight aggregate, add				▼	45%				
4000	Flowable fill: ash, cement, aggregate, water									
4100	40 - 80 psi				C.Y.	70			70	77
4150	Structural: ash, cement, aggregate, water & sand									
4200	50 psi				C.Y.	75			75	82.50
4250	140 psi					78			78	86
4300	500 psi					81.50			81.50	89.50
4350	1000 psi					86			86	94.50
5000	For hot water, add				▼	5.50			5.50	6.05
03 31 05.70 Placing Concrete										
0010	**PLACING CONCRETE**									
0020	Includes labor and equipment to place and vibrate									
0050	Beams, elevated, small beams, pumped	C-20	60	1.067	C.Y.		33	12.50	45.50	65
0100	With crane and bucket	C-7	45	1.600			50	25	75	105
0200	Large beams, pumped	C-20	90	.711			22	8.35	30.35	43
0250	With crane and bucket	C-7	65	1.108			35	17.25	52.25	72.50
0400	Columns, square or round, 12" thick, pumped	C-20	60	1.067			33	12.50	45.50	65
0450	With crane and bucket	C-7	40	1.800			56.50	28	84.50	118
0600	18" thick, pumped	C-20	90	.711			22	8.35	30.35	43
0650	With crane and bucket	C-7	55	1.309			41	20.50	61.50	85.50
0800	24" thick, pumped	C-20	92	.696			21.50	8.15	29.65	42
0850	With crane and bucket	C-7	70	1.029			32.50	16	48.50	67
1000	36" thick, pumped	C-20	140	.457			14.20	5.35	19.55	28
1050	With crane and bucket	C-7	100	.720			22.50	11.20	33.70	47
1400	Elevated slabs, less than 6" thick, pumped	C-20	140	.457			14.20	5.35	19.55	28
1450	With crane and bucket	C-7	95	.758			24	11.80	35.80	49.50
1500	6" to 10" thick, pumped	C-20	160	.400			12.40	4.70	17.10	24.50
1550	With crane and bucket	C-7	110	.655			20.50	10.20	30.70	42.50
1600	Slabs over 10" thick, pumped	C-20	180	.356	▼		11.05	4.17	15.22	21.50

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