Design- Gravity System:

Investigation:

To design the gravity system of Lexington II many types of floor systems were investigated. The system which proved to have the most benefits was then designed in further detail for Lexington II. The design of the gravity system includes floor slab, floor decking, beams, and columns.

Systems investigated for the Lexington II design include one-way slab, one-way joist, non-composite steel, composite steel, and pre-cast concrete with steel beams. These systems were looked at last semester and compared based on the design of an average bay. For most of these systems to be economical, the bay spans were increased from those of the existing two-way slab. Although height restriction was no longer a requirement, thinner floor systems were given preference incase a zoning variance was achievable.

Results of the initial comparison are below:

	Floor Depth	Weight[1]	Fireproofing	Vibration	General Comments	Feasibility
Existing System: Two-Way Flat Plate	8" floor slab with suspended ceiling for MEP space	100psf	No additional fireproofing is required			
One-Way Slab	6.5" slab + 20" beam = 26.5"	112psf	No additional fireproofing is required	Heavier then existing system, will dampen vibrations	• Works with existing column layout. • Rearranging bay sizes may help to reduce beam depth, however bay sizes are already very small • Simple formwork and construction	Increased weight and floor depth make more analysis unnecessary without alternating the column gird.
One-Way Joist	3" slab + 8" ribs =11"	75psf	No additional fireproofing is required	Joists add more stiffness	• Form work is easy to erect • Larger columns and punching shear will result	Should be investigated
Steel with Non-Composite Deck	8" slab + 16" beam = 24"	67.5psf	Additional fireproofing is required	Lighter system may cause vibration issues	• Lateral Bracing required • Complex connections • Possible foundation and lateral system redesign	Possible for investigating, however floor sandwich may become a problem
Composite with Composite Deck	4" slab +1.5" deck + 12" beam =17.5"	35psf	Additional fireproofing required on steel beams	Usually no vibration problems with composite	• No shoring required • Extra cost and labor of shear studs • Possible foundation and lateral system redesign	Should be investigated
Pre-Cast Slab with Steel Beams	4" slab + 18" beam = 22"	54psf	Additional fireproofing is required on beams	Lighter system could cause vibration problems	• Fast to construct, all pieces fabricated offsite	Possible for investigating

Table 3
Comparison of Floor Systems

The final system decided upon for an alternative design of Lexington II was a composite system of composite deck and steel beams. This system has a relatively shallow floor sandwich and should not affect vibration throughout the building. Fire proofing and shear studs will be required and may increase labor costs, but generally speaking steel buildings are considered to be more economical than concrete in a majority of cases.

Loads:

DEAD LOAD: (ASCE 7)

MEP	15 psf
Finishes[1]-luxury	15 psf
Cladding[2]-brick cavity wall	39 psf
TOTAL	30 psf (cladding will be added as a line load to the perimeter)

LIVE LOAD:

Public levels; Lobbies, retail, concourse	100 psf
Residential Levels	60 psf
Partitions	20 psf

Live Load Reduction: $L = Lo\left(.25 + \frac{15}{\sqrt{KAt}}\right)$, can not be determined until tributary area and K is known.

Roof Live Load:

$Lr = 20R_1R_2$

$R_1 = 1.2 - .001A_t$

$R_2 = 1$ for a flat roof

SNOW LOAD:

$P_f = .7CeCtIp_g$

p_g= .25 psf	(ASCE 7, Figure 7-1)
Ce = .9	(ASCE 7, Table 7-2)
Ct = 1	(ASCE 7, Table 7-3)
I = 1	(ASCE 7, Table 7-4)

$P_f = 15.75$ psf

[1] A large load was picked for finishes to account for the luxury materials used in Lexington II, such as limestone, granite, and cherry wood. Finishes also include acoustical ceiling and flooring.

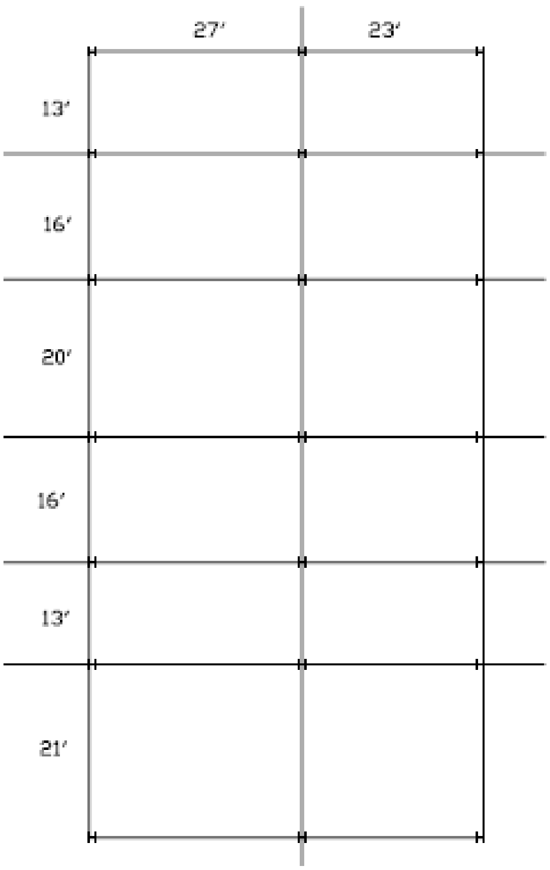
[2] Brick cavity wall with pre-cast trim, loads for 4"clay brick wythe from ASCE7 were used.

Solution:

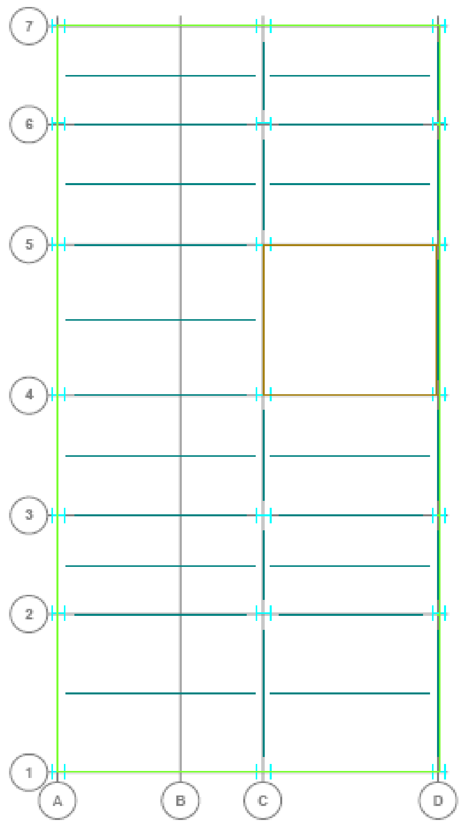
Column Grid:

Before a design was started, the column grid was looked at. The flat plate design of Lexington II used small bays sizes to create a shallow floor slab. Bays sizes as small as used in the flat plate slab design of The Lexington were impractical and uneconomic for alternative floor systems. Another problem with the existing column grid was the large number of offset columns which would create many difficult framing connections when used with a steel system.

When planning a new column grid, working around existing architecture became a main criterion. Many practical and evenly spaced grids placed columns in halls or rooms and therefore were unusable. The final column grid will require some slight change in the window layout along the west face of Lexington II. Other architecture affected by the new column grid is the placement of one closet door. All other columns line up with existing walls or mechanical shafts.



AutoCAD Grid with Spacing
Figure 8
Dimensions of Column Grid



RAM column layout
Figure 9
Column Grid with Beams

Flooring:

Once a column grid is established the floor can be designed. As determined earlier, the Lexington II design will feature composite deck. The largest bay size spans 21 feet which is too great a span for the decking. To shorten the decking span, beams were added bisecting each bay. The addition of beams changed the greatest span length to 10.5 feet.

Decking was designed using the *United Steel Deck; Steel Decks for Floors and Roof* design manual and catalog of products. Many various composite decks worked. The decking I chose is at follows:

Residential Levels:	2” Lok-Floor, 22 gage, 4.5” slab depth, unshored
Public Levels:	3” Lok-Floor, 22 gage, 5.5” slab depth, unshored

These designs were chosen because they were the minimum required deck and slab to span the lengths unshored. Had shoring been used, additional costs for the labor, materials, and time needed to shore may affect the construction price. Unshored construction may however require a slight amount of extra concrete to account for the immediate deflection of the slab under its own weight. The extra concrete would be used to even out and create a flat floor.

Beams:

Beams for Lexington II were designed using RAM. The gravity loads, decking, and slab were all input into RAM along with the framing plan of The Lexington. Through finite element analysis RAM is able to calculate the required beam sizes. For the composite construction of Lexington II, RAM is also able to calculate the number of shear studs needed along each beam. All loads entered into RAM complied with ASCE 7, and RAM was set to design all steel in accordance with LRFD 3rd Edition. For full beam summary, see Appendix Table A-4.

Columns:

Columns were also designed using RAM. The column designs in RAM are for the gravity loads, and therefore the column designs given by RAM will only be used for columns that are not a part of the lateral force resisting system.

Full Beam and Column Designs are as follows.

Floor Map

RAM Steel v8.1
DataBase: total
Building Code: IBC

Floor Type: resid 2

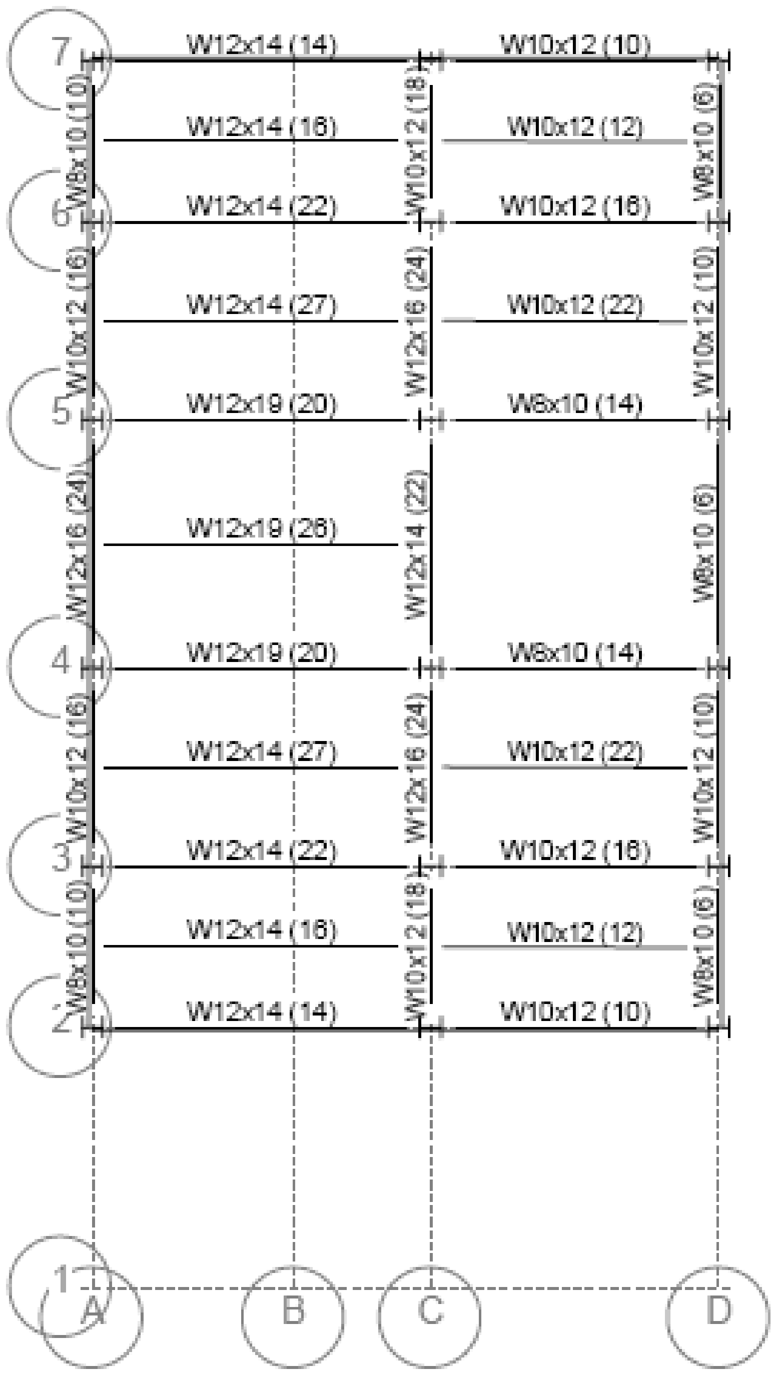


Figure 10
Beam Design for Levels 12-8

Floor Map

RAM Steel v8.1
DataBase: total
Building Code: IBC

Floor Type: resid 1

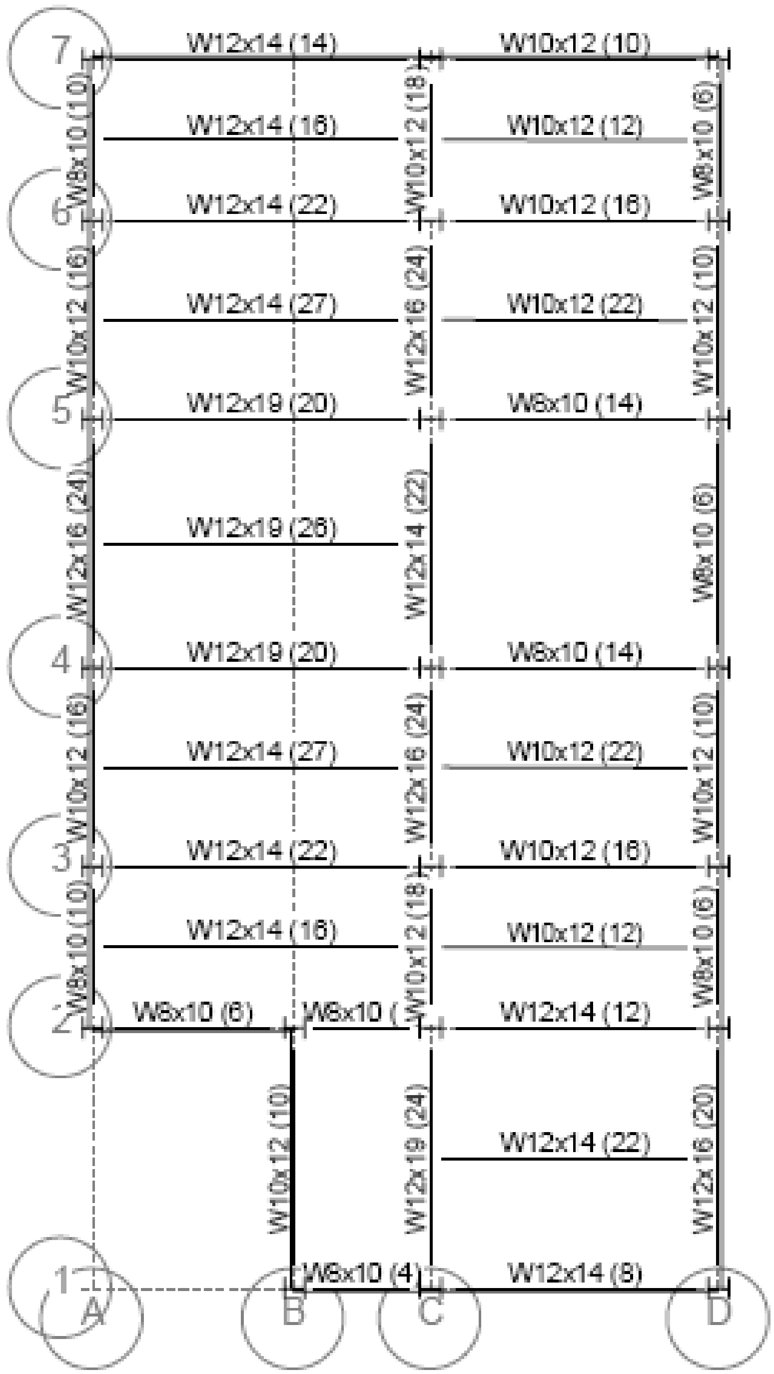


Figure 11
Beam Design for Levels 7-2

Floor Map

RAM Steel v8.1
DataBase: total
Building Code: IBC

Floor Type: Ground

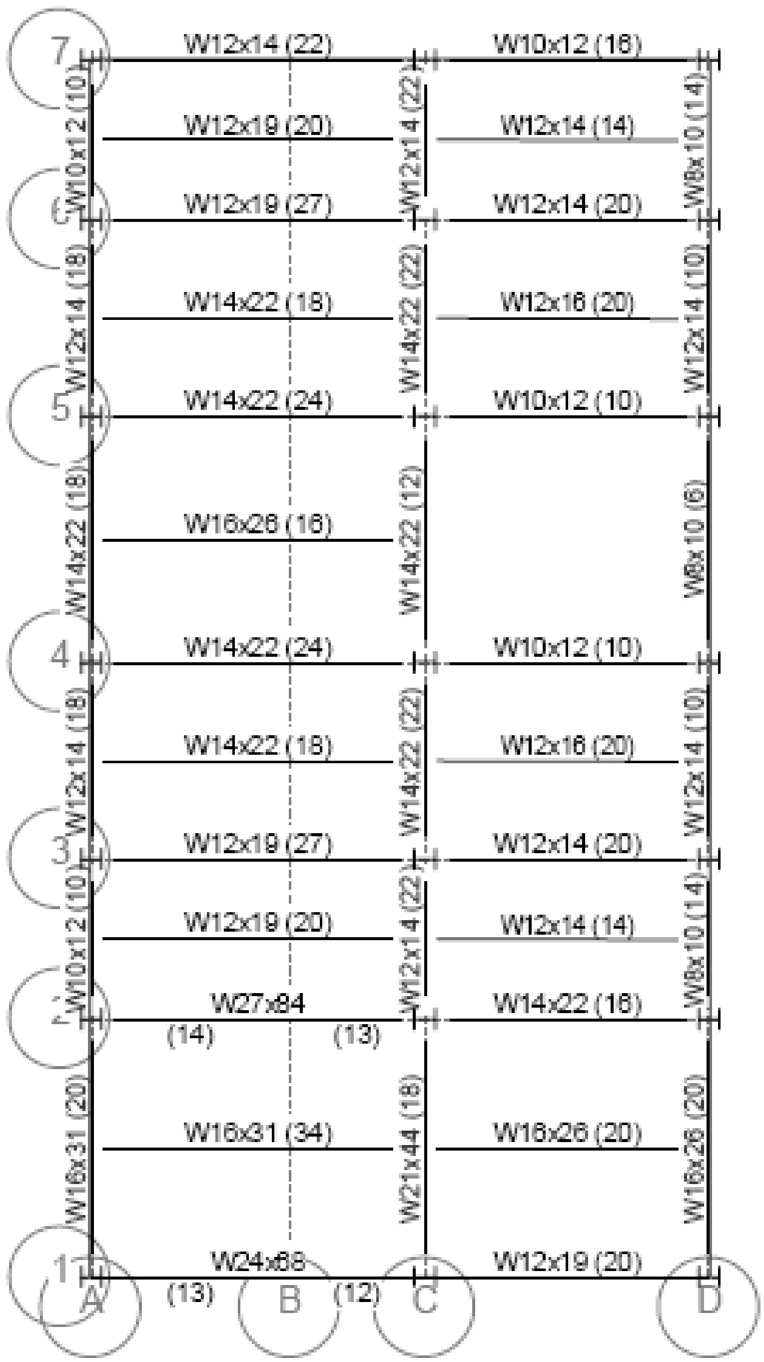


Figure 12
Ground Floor Beam Design

Floor Map

RAM Steel v8.1
DataBase: total
Building Code: IBC

Floor Type: L-1

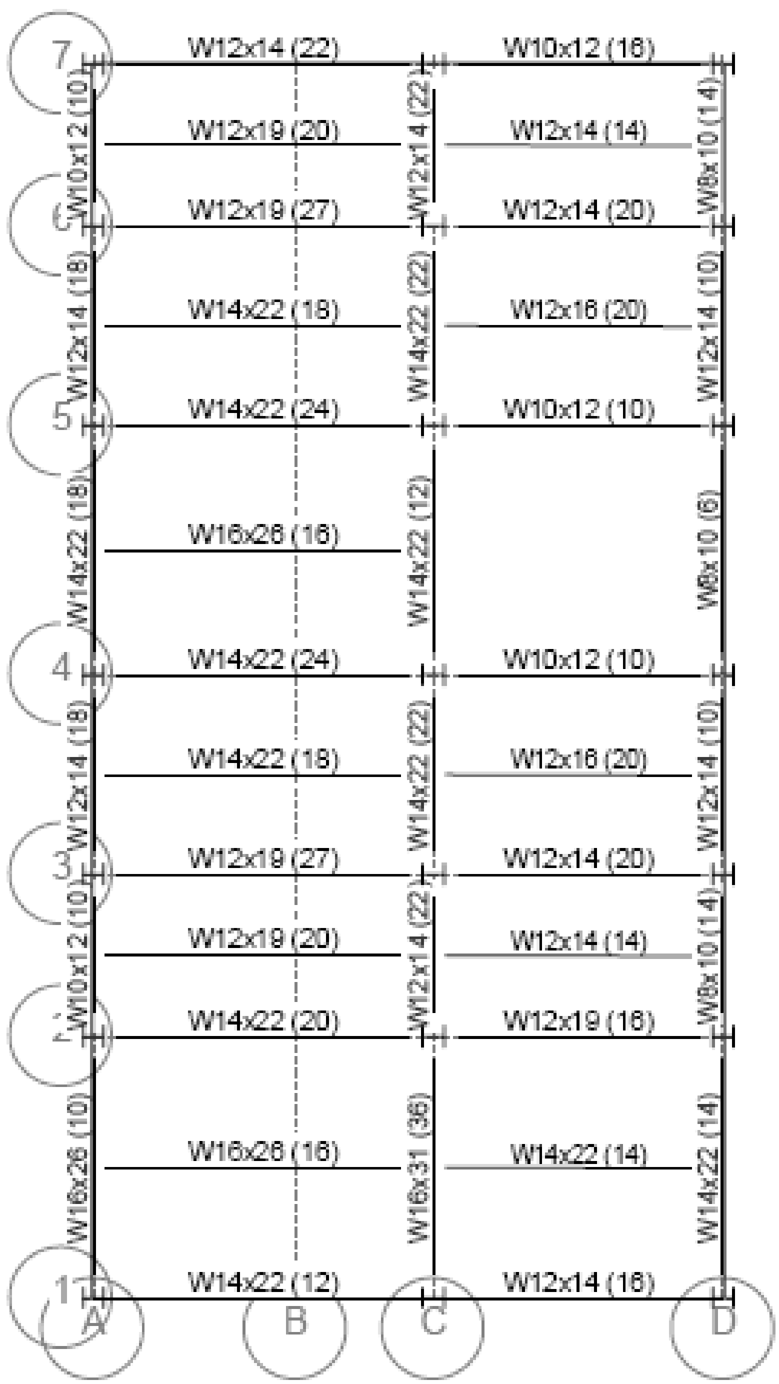


Figure 13
L-1 Beam Design

Floor Map

RAM Steel v8.1
DataBase: total
Building Code: IBC

Floor Type: Concourse

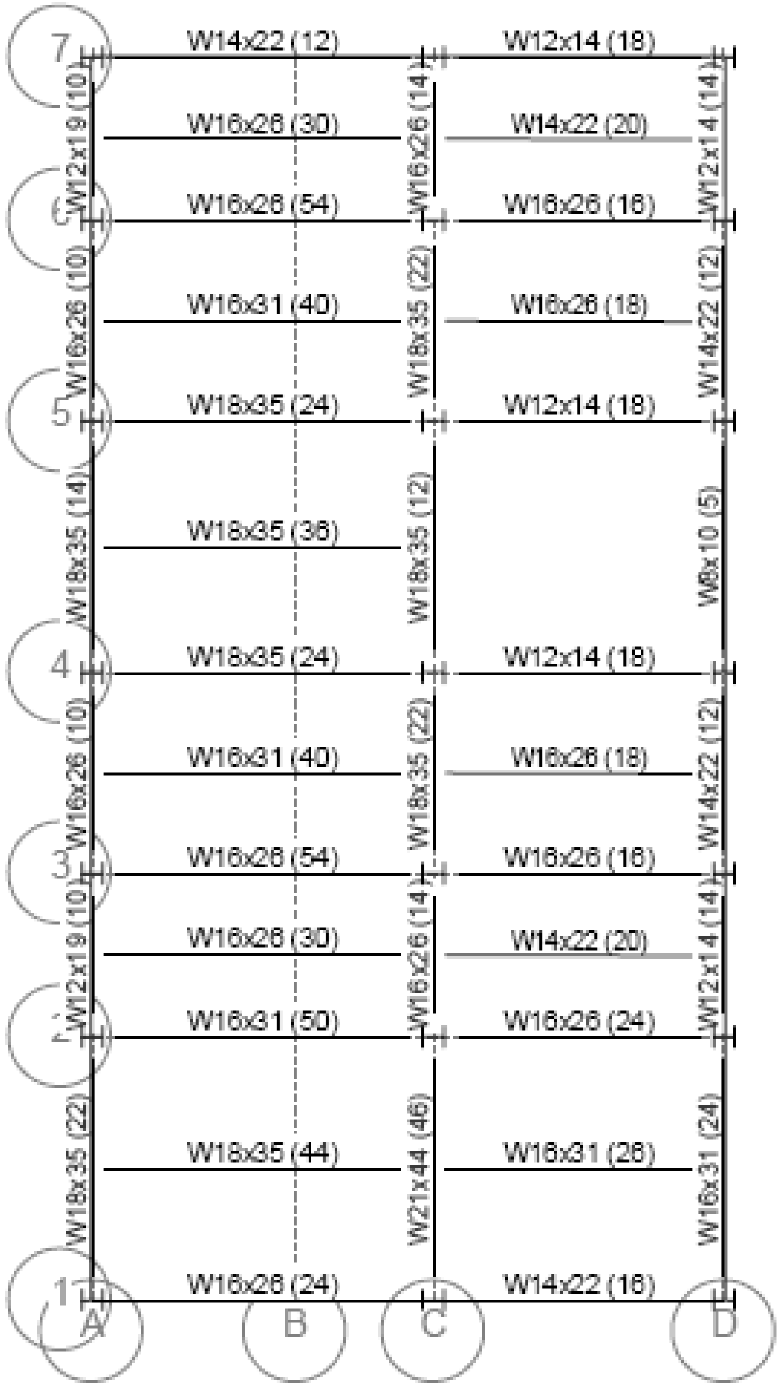


Figure 14
Concourse and P-1 Beam Design

Column Line A - 1

Level	Pu	Mux	Muy	LC	Interaction Eq.	Angle	Fy	Size
Ground	88.4	38.8	13.3	1	0.77 Eq H1-1a	0.0	50	W10X33
L-1	121.5	7.7	6.6	1	0.70 Eq H1-1a	0.0	50	W10X33
Concourse	171.3	9.1	7.7	1	0.81 Eq H1-1a	0.0	50	W10X33

Column Line A - 2

Level	Pu	Mux	Muy	LC	Interaction Eq.	Angle	Fy	Size
12	25.1	8.4	5.9	1	0.21 Eq H1-1b	0.0	50	W10X33
11	48.2	4.2	2.9	1	0.16 Eq H1-1b	0.0	50	W10X33
10	69.1	3.9	2.7	1	0.28 Eq H1-1a	0.0	50	W10X33
9	89.7	3.8	2.6	1	0.34 Eq H1-1a	0.0	50	W10X33
8	110.0	3.7	2.6	1	0.40 Eq H1-1a	0.0	50	W10X33
7	125.5	2.2	2.5	1	0.43 Eq H1-1a	0.0	50	W10X33
6	141.0	2.2	2.5	1	0.48 Eq H1-1a	0.0	50	W10X33
5	156.4	2.2	2.5	1	0.53 Eq H1-1a	0.0	50	W10X33
4	171.8	2.1	2.5	1	0.57 Eq H1-1a	0.0	50	W10X33
3	187.0	2.1	2.4	1	0.62 Eq H1-1a	0.0	50	W10X33
2	202.3	27.4	4.8	2	0.86 Eq H1-1a	0.0	50	W10X33
Ground	301.2	20.8	2.9	2	0.87 Eq H1-1a	0.0	50	W10X45
L-1	344.1	8.4	4.4	2	0.87 Eq H1-1a	0.0	50	W10X49
Concourse	401.3	10.1	5.3	6	0.91 Eq H1-1a	0.0	50	W10X49

Column Line A - 3

Level	Pu	Mux	Muy	LC	Interaction Eq.	Angle	Fy	Size
12	35.9	10.2	3.1	10	0.19 Eq H1-1b	0.0	50	W10X33
11	72.7	4.8	1.3	4	0.27 Eq H1-1a	0.0	50	W10X33
10	105.1	4.5	1.2	5	0.36 Eq H1-1a	0.0	50	W10X33
9	137.0	4.3	1.2	4	0.46 Eq H1-1a	0.0	50	W10X33
8	168.6	4.3	1.1	4	0.55 Eq H1-1a	0.0	50	W10X33
7	199.9	4.2	1.1	4	0.65 Eq H1-1a	0.0	50	W10X33
6	231.1	4.1	1.1	4	0.74 Eq H1-1a	0.0	50	W10X33
5	262.1	4.1	1.0	4	0.83 Eq H1-1a	0.0	50	W10X33
4	293.0	4.1	1.0	4	0.92 Eq H1-1a	0.0	50	W10X33
3	323.9	4.1	1.0	4	0.85 Eq H1-1a	0.0	50	W10X39
2	354.7	5.5	1.6	5	0.94 Eq H1-1a	0.0	50	W10X39
Ground	390.7	5.5	1.8	5	0.82 Eq H1-1a	0.0	50	W10X49
L-1	427.4	6.8	2.7	5	0.95 Eq H1-1a	0.0	50	W10X54
Concourse	476.0	8.4	3.3	10	0.95 Eq H1-1a	0.0	50	W10X54

Column Line A - 4

Level	Pu	Mux	Muy	LC	Interaction Eq.	Angle	Fy	Size
12	43.6	12.3	3.8	10	0.22 Eq H1-1b	0.0	50	W10X33
11	88.4	5.8	1.6	4	0.33 Eq H1-1a	0.0	50	W10X33
10	128.2	5.4	1.5	5	0.44 Eq H1-1a	0.0	50	W10X33

9	167.5	5.3	1.5	4	0.56 Eq H1-1a	0.0	50	W10X33
8	206.3	5.2	1.4	4	0.68 Eq H1-1a	0.0	50	W10X33
7	244.9	5.1	1.4	4	0.79 Eq H1-1a	0.0	50	W10X33
6	283.4	5.1	1.3	4	0.91 Eq H1-1a	0.0	50	W10X33
5	321.7	5.1	1.3	4	0.86 Eq H1-1a	0.0	50	W10X39
4	359.9	5.1	1.3	4	0.95 Eq H1-1a	0.0	50	W10X39
3	398.1	5.1	1.3	4	0.90 Eq H1-1a	0.0	50	W10X45
2	437.8	6.8	2.3	5	0.86 Eq H1-1a	0.0	50	W10X49
Ground	484.1	6.9	2.3	5	0.93 Eq H1-1a	0.0	50	W10X54
L-1	530.8	8.7	3.4	5	0.92 Eq H1-1a	0.0	50	W10X68
Concourse	591.4	10.7	4.2	10	0.93 Eq H1-1a	0.0	50	W10X68

Column Line A - 5

Level	Pu	Mux	Muy	LC	Interaction Eq.	Angle	Fy	Size
12	43.6	12.3	3.8	6	0.22 Eq H1-1b	0.0	50	W10X33
11	88.4	5.8	1.6	2	0.33 Eq H1-1a	0.0	50	W10X33
10	128.2	5.4	1.5	2	0.44 Eq H1-1a	0.0	50	W10X33
9	167.5	5.3	1.5	2	0.56 Eq H1-1a	0.0	50	W10X33
8	206.3	5.2	1.4	2	0.68 Eq H1-1a	0.0	50	W10X33
7	244.9	5.1	1.4	2	0.79 Eq H1-1a	0.0	50	W10X33
6	283.4	5.1	1.3	2	0.91 Eq H1-1a	0.0	50	W10X33
5	321.7	5.1	1.3	2	0.86 Eq H1-1a	0.0	50	W10X39
4	359.9	5.1	1.3	2	0.95 Eq H1-1a	0.0	50	W10X39
3	398.1	5.1	1.3	2	0.90 Eq H1-1a	0.0	50	W10X45
2	437.8	6.8	2.3	2	0.86 Eq H1-1a	0.0	50	W10X49
Ground	484.1	6.9	2.3	2	0.93 Eq H1-1a	0.0	50	W10X54
L-1	530.8	8.7	3.4	2	0.92 Eq H1-1a	0.0	50	W10X68
Concourse	591.4	10.7	4.2	6	0.93 Eq H1-1a	0.0	50	W10X68

Column Line A - 6

Level	Pu	Mux	Muy	LC	Interaction Eq.	Angle	Fy	Size
12	35.9	10.2	3.1	6	0.19 Eq H1-1b	0.0	50	W10X33
11	72.7	4.8	1.3	2	0.27 Eq H1-1a	0.0	50	W10X33
10	105.1	4.5	1.2	2	0.36 Eq H1-1a	0.0	50	W10X33
9	137.0	4.3	1.2	2	0.46 Eq H1-1a	0.0	50	W10X33
8	168.6	4.3	1.1	2	0.55 Eq H1-1a	0.0	50	W10X33
7	199.9	4.2	1.1	2	0.65 Eq H1-1a	0.0	50	W10X33
6	231.1	4.1	1.1	2	0.74 Eq H1-1a	0.0	50	W10X33
5	262.1	4.1	1.0	2	0.83 Eq H1-1a	0.0	50	W10X33
4	293.0	4.1	1.0	2	0.92 Eq H1-1a	0.0	50	W10X33
3	323.9	4.1	1.0	2	0.85 Eq H1-1a	0.0	50	W10X39
2	354.7	5.5	1.6	2	0.94 Eq H1-1a	0.0	50	W10X39
Ground	390.7	5.5	1.8	2	0.82 Eq H1-1a	0.0	50	W10X49
L-1	427.4	6.8	2.7	2	0.95 Eq H1-1a	0.0	50	W10X54
Concourse	476.0	8.4	3.3	6	0.95 Eq H1-1a	0.0	50	W10X54

Figure 15

Gravity Column Design Summary

RAM Steel v8.1
DataBase: total
Building Code: IBC

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Steel Code: AISC LRFD

Column Line A - 7

Level	Pu	Mux	Muy	LC	Interaction Eq.	Angle	Fy	Size
12	25.1	8.4	5.9	1	0.21 Eq H1-1b	0.0	50	W10X33
11	48.2	4.2	2.9	1	0.16 Eq H1-1b	0.0	50	W10X33
10	69.1	3.9	2.7	1	0.28 Eq H1-1a	0.0	50	W10X33
9	89.7	3.8	2.6	1	0.34 Eq H1-1a	0.0	50	W10X33
8	110.0	3.7	2.6	1	0.40 Eq H1-1a	0.0	50	W10X33
7	130.1	3.7	2.5	1	0.46 Eq H1-1a	0.0	50	W10X33
6	150.1	3.6	2.5	1	0.52 Eq H1-1a	0.0	50	W10X33
5	169.9	3.6	2.5	1	0.58 Eq H1-1a	0.0	50	W10X33
4	189.7	3.6	2.4	1	0.63 Eq H1-1a	0.0	50	W10X33
3	209.4	3.6	2.4	1	0.69 Eq H1-1a	0.0	50	W10X33
2	229.1	4.4	3.1	1	0.77 Eq H1-1a	0.0	50	W10X33
Ground	251.3	4.4	3.1	1	0.95 Eq H1-1a	0.0	50	W10X33
L-1	269.5	4.8	3.5	1	0.91 Eq H1-1a	0.0	50	W10X45
Concourse	300.4	5.9	4.3	1	0.85 Eq H1-1a	0.0	50	W10X45

Column Line B - 1

Level	Pu	Mux	Muy	LC	Interaction Eq.	Angle	Fy	Size
7	17.5	1.3	8.1	1	0.19 Eq H1-1b	0.0	50	W10X33
6	35.0	0.7	4.0	1	0.14 Eq H1-1b	0.0	50	W10X33
5	50.6	0.7	3.9	1	0.16 Eq H1-1b	0.0	50	W10X33
4	65.5	0.7	3.7	1	0.20 Eq H1-1b	0.0	50	W10X33
3	80.2	0.7	3.7	1	0.31 Eq H1-1a	0.0	50	W10X33
2	94.7	0.7	3.6	1	0.35 Eq H1-1a	0.0	50	W10X33

Column Line B - 2

Level	Pu	Mux	Muy	LC	Interaction Eq.	Angle	Fy	Size
7	25.0	3.9	8.0	12	0.22 Eq H1-1b	0.0	50	W10X33
6	49.1	1.8	3.7	3	0.16 Eq H1-1b	0.0	50	W10X33
5	70.7	1.7	3.5	3	0.28 Eq H1-1a	0.0	50	W10X33
4	92.0	1.7	3.5	3	0.35 Eq H1-1a	0.0	50	W10X33
3	113.1	1.6	3.4	3	0.41 Eq H1-1a	0.0	50	W10X33
2	134.0	1.3	3.3	1	0.47 Eq H1-1a	0.0	50	W10X33

Column Line C - 1

Level	Pu	Mux	Muy	LC	Interaction Eq.	Angle	Fy	Size
7	37.5	7.9	10.9	8	0.32 Eq H1-1b	0.0	50	W10X33
6	69.6	3.6	5.0	2	0.32 Eq H1-1a	0.0	50	W10X33
5	100.6	3.5	4.8	2	0.41 Eq H1-1a	0.0	50	W10X33
4	131.2	3.4	4.6	2	0.49 Eq H1-1a	0.0	50	W10X33
3	161.4	3.4	4.5	2	0.58 Eq H1-1a	0.0	50	W10X33
2	191.4	21.2	9.6	4	0.87 Eq H1-1a	0.0	50	W10X33
Ground	308.2	14.8	7.3	1	0.91 Eq H1-1a	0.0	50	W10X45
L-1	358.7	3.6	9.6	4	0.93 Eq H1-1a	0.0	50	W10X49

Gravity Column Design Summary

RAM Steel v8.1
DataBase: total
Building Code: IBC

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Steel Code: AISC LRFD

Level	Pu	Mux	Muy	LC	Interaction Eq.	Angle	Fy	Size
Concourse	432.8	1.2	11.6	1	1.00 Eq H1-1a	0.0	50	W10X49

Column Line C - 2

Level	Pu	Mux	Muy	LC	Interaction Eq.	Angle	Fy	Size
12	35.4	3.2	7.7	12	0.23 Eq H1-1b	0.0	50	W10X33
11	71.7	1.3	3.6	3	0.29 Eq H1-1a	0.0	50	W10X33
10	103.9	1.2	3.3	4	0.38 Eq H1-1a	0.0	50	W10X33
9	135.6	1.2	3.2	3	0.47 Eq H1-1a	0.0	50	W10X33
8	167.1	3.8	3.5	2	0.59 Eq H1-1a	0.0	50	W10X33
7	208.5	3.7	2.3	2	0.69 Eq H1-1a	0.0	50	W10X33
6	249.4	3.6	2.3	2	0.81 Eq H1-1a	0.0	50	W10X33
5	290.0	3.5	2.2	2	0.93 Eq H1-1a	0.0	50	W10X33
4	330.4	3.5	2.2	2	0.88 Eq H1-1a	0.0	50	W10X39
3	370.7	3.5	2.1	2	0.98 Eq H1-1a	0.0	50	W10X39
2	412.6	30.1	7.5	3	0.95 Eq H1-1a	0.0	50	W10X49
Ground	572.0	21.9	4.8	2	0.91 Eq H1-1a	0.0	50	W10X68
L-1	641.6	5.4	6.9	3	0.98 Eq H1-1a	0.0	50	W10X77
Concourse	737.1	1.6	8.6	6	0.88 Eq H1-1a	0.0	50	W10X88

Column Line C - 3

Level	Pu	Mux	Muy	LC	Interaction Eq.	Angle	Fy	Size
12	47.1	4.6	4.3	16	0.19 Eq H1-1b	0.0	50	W10X33
11	106.6	2.0	1.9	4	0.36 Eq H1-1a	0.0	50	W10X33
10	154.5	1.8	1.7	4	0.51 Eq H1-1a	0.0	50	W10X33
9	201.8	1.7	1.6	4	0.65 Eq H1-1a	0.0	50	W10X33
8	248.6	1.7	1.6	4	0.79 Eq H1-1a	0.0	50	W10X33
7	295.1	1.6	1.5	4	0.92 Eq H1-1a	0.0	50	W10X33
6	341.7	1.6	1.5	4	0.89 Eq H1-1a	0.0	50	W10X39
5	390.6	1.6	1.5	4	0.87 Eq H1-1a	0.0	50	W10X45
4	439.6	1.6	1.5	4	0.98 Eq H1-1a	0.0	50	W10X45
3	488.5	1.6	1.8	4	0.93 Eq H1-1a	0.0	50	W10X49
2	537.5	2.7	2.9	4	0.94 Eq H1-1a	0.0	50	W10X54
Ground	596.5	2.8	3.0	4	0.88 Eq H1-1a	0.0	50	W10X68
L-1	655.9	4.5	4.7	4	0.99 Eq H1-1a	0.0	50	W10X77
Concourse	735.8	1.3	5.8	10	0.99 Eq H1-1a	0.0	50	W10X77

Column Line C - 4

Level	Pu	Mux	Muy	LC	Interaction Eq.	Angle	Fy	Size
12	46.9	8.9	4.9	15	0.23 Eq H1-1b	0.0	50	W10X33
11	101.0	4.0	2.1	3	0.37 Eq H1-1a	0.0	50	W10X33
10	146.3	3.8	2.0	3	0.50 Eq H1-1a	0.0	50	W10X33
9	190.9	3.7	1.9	3	0.63 Eq H1-1a	0.0	50	W10X33
8	235.2	3.7	1.9	3	0.76 Eq H1-1a	0.0	50	W10X33
7	279.1	3.6	1.8	3	0.89 Eq H1-1a	0.0	50	W10X33
6	322.9	3.6	1.8	3	0.86 Eq H1-1a	0.0	50	W10X39

Figure 16

Gravity Column Design Summary

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Building Code: IBC

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Level	Pu	Mux	Muy	LC	Interaction Eq.	Angle	Fy	Size
5	368.1	3.6	1.8	3	0.97 Eq H1-1a	0.0	50	W10X39
4	414.2	3.6	1.8	3	0.93 Eq H1-1a	0.0	50	W10X45
3	460.3	3.6	2.1	3	0.88 Eq H1-1a	0.0	50	W10X49
2	506.5	5.2	3.3	3	0.99 Eq H1-1a	0.0	50	W10X49
Ground	561.5	5.3	3.3	3	0.96 Eq H1-1a	0.0	50	W10X60
L-1	617.0	7.4	5.0	3	0.94 Eq H1-1a	0.0	50	W10X77
Concourse	692.6	6.6	6.2	6	0.95 Eq H1-1a	0.0	50	W10X77

Column Line C - 5

Level	Pu	Mux	Muy	LC	Interaction Eq.	Angle	Fy	Size
12	46.9	8.9	4.9	16	0.23 Eq H1-1b	0.0	50	W10X33
11	101.0	4.0	2.1	4	0.37 Eq H1-1a	0.0	50	W10X33
10	146.3	3.8	2.0	4	0.50 Eq H1-1a	0.0	50	W10X33
9	190.9	3.7	1.9	4	0.63 Eq H1-1a	0.0	50	W10X33
8	235.2	3.7	1.9	4	0.76 Eq H1-1a	0.0	50	W10X33
7	279.1	3.6	1.8	4	0.89 Eq H1-1a	0.0	50	W10X33
6	322.9	3.6	1.8	4	0.86 Eq H1-1a	0.0	50	W10X39
5	368.1	3.6	1.8	4	0.97 Eq H1-1a	0.0	50	W10X39
4	414.2	3.6	1.8	4	0.93 Eq H1-1a	0.0	50	W10X45
3	460.3	3.6	2.1	4	0.88 Eq H1-1a	0.0	50	W10X49
2	506.5	5.2	3.3	4	0.99 Eq H1-1a	0.0	50	W10X49
Ground	561.5	5.3	3.3	4	0.96 Eq H1-1a	0.0	50	W10X60
L-1	617.0	7.4	5.0	4	0.94 Eq H1-1a	0.0	50	W10X77
Concourse	692.6	6.6	6.2	10	0.95 Eq H1-1a	0.0	50	W10X77

Column Line C - 6

Level	Pu	Mux	Muy	LC	Interaction Eq.	Angle	Fy	Size
12	47.1	4.6	4.3	15	0.19 Eq H1-1b	0.0	50	W10X33
11	106.6	2.0	1.9	3	0.36 Eq H1-1a	0.0	50	W10X33
10	154.5	1.8	1.7	3	0.51 Eq H1-1a	0.0	50	W10X33
9	201.8	1.7	1.6	3	0.65 Eq H1-1a	0.0	50	W10X33
8	248.6	1.7	1.6	3	0.79 Eq H1-1a	0.0	50	W10X33
7	295.1	1.6	1.5	3	0.92 Eq H1-1a	0.0	50	W10X33
6	341.7	1.6	1.5	3	0.89 Eq H1-1a	0.0	50	W10X39
5	390.6	1.6	1.5	3	0.87 Eq H1-1a	0.0	50	W10X45
4	439.6	1.6	1.5	3	0.98 Eq H1-1a	0.0	50	W10X45
3	488.5	1.6	1.8	3	0.93 Eq H1-1a	0.0	50	W10X49
2	537.5	2.7	2.9	3	0.94 Eq H1-1a	0.0	50	W10X54
Ground	596.5	2.8	3.0	3	0.88 Eq H1-1a	0.0	50	W10X68
L-1	655.9	4.5	4.7	3	0.99 Eq H1-1a	0.0	50	W10X77
Concourse	735.8	1.3	5.8	6	0.99 Eq H1-1a	0.0	50	W10X77

Column Line C - 7

Level	Pu	Mux	Muy	LC	Interaction Eq.	Angle	Fy	Size
12	35.4	3.2	7.7	12	0.23 Eq H1-1b	0.0	50	W10X33

Gravity Column Design Summary

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DataBase: total
Building Code: IBC

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Level	Pu	Mux	Muy	LC	Interaction Eq.	Angle	Fy	Size
11	71.7	1.3	3.6	3	0.29 Eq H1-1a	0.0	50	W10X33
10	103.9	1.2	3.3	3	0.38 Eq H1-1a	0.0	50	W10X33
9	135.6	1.2	3.2	3	0.47 Eq H1-1a	0.0	50	W10X33
8	167.1	1.1	3.2	3	0.56 Eq H1-1a	0.0	50	W10X33
7	198.3	1.1	3.1	3	0.66 Eq H1-1a	0.0	50	W10X33
6	229.4	1.1	3.1	3	0.75 Eq H1-1a	0.0	50	W10X33
5	260.3	1.1	3.1	3	0.84 Eq H1-1a	0.0	50	W10X33
4	291.1	1.0	3.0	3	0.93 Eq H1-1a	0.0	50	W10X33
3	321.9	1.0	3.0	3	0.86 Eq H1-1a	0.0	50	W10X39
2	352.7	1.5	4.1	3	0.95 Eq H1-1a	0.0	50	W10X39
Ground	387.5	1.5	4.7	3	0.82 Eq H1-1a	0.0	50	W10X49
L-1	422.5	2.3	5.8	3	0.95 Eq H1-1a	0.0	50	W10X54
Concourse	472.0	0.9	7.1	1	0.94 Eq H1-1a	0.0	50	W10X54

Column Line D - 1

Level	Pu	Mux	Muy	LC	Interaction Eq.	Angle	Fy	Size
7	31.2	9.5	8.2	1	0.27 Eq H1-1b	0.0	50	W10X33
6	57.6	4.4	3.8	1	0.19 Eq H1-1b	0.0	50	W10X33
5	83.2	4.2	3.7	1	0.34 Eq H1-1a	0.0	50	W10X33
4	108.4	4.1	3.6	1	0.41 Eq H1-1a	0.0	50	W10X33
3	133.4	4.1	3.5	1	0.49 Eq H1-1a	0.0	50	W10X33
2	158.2	6.6	5.8	1	0.62 Eq H1-1a	0.0	50	W10X33
Ground	194.9	5.1	4.5	1	0.78 Eq H1-1a	0.0	50	W10X33
L-1	223.0	5.9	5.1	1	0.92 Eq H1-1a	0.0	50	W10X39
Concourse	263.5	7.1	6.4	1	0.92 Eq H1-1a	0.0	50	W10X39

Column Line D - 2

Level	Pu	Mux	Muy	LC	Interaction Eq.	Angle	Fy	Size
12	21.8	7.2	5.3	1	0.18 Eq H1-1b	0.0	50	W10X33
11	42.6	3.6	2.6	1	0.14 Eq H1-1b	0.0	50	W10X33
10	61.0	3.4	2.4	1	0.18 Eq H1-1b	0.0	50	W10X33
9	79.1	3.3	2.4	1	0.30 Eq H1-1a	0.0	50	W10X33
8	96.9	4.8	2.5	3	0.36 Eq H1-1a	0.0	50	W10X33
7	128.0	4.4	1.9	2	0.44 Eq H1-1a	0.0	50	W10X33
6	160.8	4.3	1.8	3	0.54 Eq H1-1a	0.0	50	W10X33
5	193.2	4.2	1.8	2	0.64 Eq H1-1a	0.0	50	W10X33
4	225.5	4.2	1.8	2	0.73 Eq H1-1a	0.0	50	W10X33
3	257.5	4.1	1.7	2	0.83 Eq H1-1a	0.0	50	W10X33
2	289.5	6.9	3.6	3	0.97 Eq H1-1a	0.0	50	W10X33
Ground	334.4	5.7	2.5	3	0.88 Eq H1-1a	0.0	50	W10X45
L-1	371.6	6.9	3.7	3	0.92 Eq H1-1a	0.0	50	W10X49
Concourse	420.7	8.4	4.5	6	0.94 Eq H1-1a	0.0	50	W10X49

Column Line D - 3

Level	Pu	Mux	Muy	LC	Interaction Eq.	Angle	Fy	Size

Figure 17

Gravity Column Design Summary

RAM Steel v8.1
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Building Code: IBC

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Level	Pu	Mux	Muy	LC	Interaction Eq.	Angle	Fy	Size
12	32.0	8.9	2.8	10	0.16 Eq H1-1b	0.0	50	W10X33
11	64.6	4.2	0.5	1	0.19 Eq H1-1b	0.0	50	W10X33
10	93.3	3.8	1.1	4	0.32 Eq H1-1a	0.0	50	W10X33
9	121.5	3.7	1.0	4	0.41 Eq H1-1a	0.0	50	W10X33
8	149.4	3.7	1.0	4	0.49 Eq H1-1a	0.0	50	W10X33
7	177.0	3.6	1.0	4	0.57 Eq H1-1a	0.0	50	W10X33
6	204.5	3.6	1.0	4	0.65 Eq H1-1a	0.0	50	W10X33
5	231.9	3.5	0.9	4	0.74 Eq H1-1a	0.0	50	W10X33
4	259.2	3.5	0.9	4	0.82 Eq H1-1a	0.0	50	W10X33
3	286.4	3.5	0.9	4	0.90 Eq H1-1a	0.0	50	W10X33
2	313.5	4.7	1.4	4	1.00 Eq H1-1a	0.0	50	W10X33
Ground	345.1	4.8	1.4	4	0.89 Eq H1-1a	0.0	50	W10X45
L-1	376.7	5.9	2.4	4	0.93 Eq H1-1a	0.0	50	W10X49
Concourse	417.7	7.2	2.9	10	0.91 Eq H1-1a	0.0	50	W10X49

Column Line D - 4

Level	Pu	Mux	Muy	LC	Interaction Eq.	Angle	Fy	Size
12	25.7	5.7	4.3	6	0.16 Eq H1-1b	0.0	50	W10X33
11	49.5	2.7	1.9	1	0.15 Eq H1-1b	0.0	50	W10X33
10	71.0	2.5	1.8	3	0.26 Eq H1-1a	0.0	50	W10X33
9	92.1	2.4	1.8	2	0.32 Eq H1-1a	0.0	50	W10X33
8	112.9	2.3	1.7	2	0.38 Eq H1-1a	0.0	50	W10X33
7	133.5	2.3	1.7	2	0.44 Eq H1-1a	0.0	50	W10X33
6	154.0	2.3	1.6	2	0.50 Eq H1-1a	0.0	50	W10X33
5	174.3	2.2	1.6	2	0.57 Eq H1-1a	0.0	50	W10X33
4	194.6	2.2	1.6	2	0.63 Eq H1-1a	0.0	50	W10X33
3	214.8	2.2	1.6	2	0.69 Eq H1-1a	0.0	50	W10X33
2	234.9	2.9	2.2	3	0.76 Eq H1-1a	0.0	50	W10X33
Ground	257.3	2.9	2.2	3	0.94 Eq H1-1a	0.0	50	W10X33
L-1	279.9	3.7	3.0	3	0.93 Eq H1-1a	0.0	50	W10X45
Concourse	312.0	4.5	3.8	6	0.87 Eq H1-1a	0.0	50	W10X45

Column Line D - 5

Level	Pu	Mux	Muy	LC	Interaction Eq.	Angle	Fy	Size
12	25.7	5.7	4.3	10	0.16 Eq H1-1b	0.0	50	W10X33
11	49.5	2.7	1.9	1	0.15 Eq H1-1b	0.0	50	W10X33
10	71.0	2.5	1.8	4	0.26 Eq H1-1a	0.0	50	W10X33
9	92.1	2.4	1.8	4	0.32 Eq H1-1a	0.0	50	W10X33
8	112.9	2.3	1.7	4	0.38 Eq H1-1a	0.0	50	W10X33
7	133.5	2.3	1.7	4	0.44 Eq H1-1a	0.0	50	W10X33
6	154.0	2.3	1.6	4	0.50 Eq H1-1a	0.0	50	W10X33
5	174.3	2.2	1.6	4	0.57 Eq H1-1a	0.0	50	W10X33
4	194.6	2.2	1.6	4	0.63 Eq H1-1a	0.0	50	W10X33
3	214.8	2.2	1.6	4	0.69 Eq H1-1a	0.0	50	W10X33
2	234.9	2.9	2.2	4	0.76 Eq H1-1a	0.0	50	W10X33

Gravity Column Design Summary

RAM Steel v8.1
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Level	Pu	Mux	Muy	LC	Interaction Eq.	Angle	Fy	Size
Ground	257.3	2.9	2.2	4	0.94 Eq H1-1a	0.0	50	W10X33
L-1	279.9	3.7	3.0	4	0.93 Eq H1-1a	0.0	50	W10X45
Concourse	312.0	4.5	3.8	10	0.87 Eq H1-1a	0.0	50	W10X45

Column Line D - 6

Level	Pu	Mux	Muy	LC	Interaction Eq.	Angle	Fy	Size
12	32.0	8.9	2.8	6	0.16 Eq H1-1b	0.0	50	W10X33
11	64.6	4.2	0.5	1	0.19 Eq H1-1b	0.0	50	W10X33
10	93.3	3.8	1.1	3	0.32 Eq H1-1a	0.0	50	W10X33
9	121.5	3.7	1.0	2	0.41 Eq H1-1a	0.0	50	W10X33
8	149.4	3.7	1.0	2	0.49 Eq H1-1a	0.0	50	W10X33
7	177.0	3.6	1.0	2	0.57 Eq H1-1a	0.0	50	W10X33
6	204.5	3.6	1.0	2	0.65 Eq H1-1a	0.0	50	W10X33
5	231.9	3.5	0.9	2	0.74 Eq H1-1a	0.0	50	W10X33
4	259.2	3.5	0.9	2	0.82 Eq H1-1a	0.0	50	W10X33
3	286.4	3.5	0.9	2	0.90 Eq H1-1a	0.0	50	W10X33
2	313.5	4.7	1.4	3	1.00 Eq H1-1a	0.0	50	W10X33
Ground	345.1	4.8	1.4	3	0.89 Eq H1-1a	0.0	50	W10X45
L-1	376.7	5.9	2.4	3	0.93 Eq H1-1a	0.0	50	W10X49
Concourse	417.7	7.2	2.9	6	0.91 Eq H1-1a	0.0	50	W10X49

Column Line D - 7

Level	Pu	Mux	Muy	LC	Interaction Eq.	Angle	Fy	Size
12	21.8	7.2	5.3	1	0.18 Eq H1-1b	0.0	50	W10X33
11	42.6	3.6	2.6	1	0.14 Eq H1-1b	0.0	50	W10X33
10	61.0	3.4	2.4	1	0.18 Eq H1-1b	0.0	50	W10X33
9	79.1	3.3	2.4	1	0.30 Eq H1-1a	0.0	50	W10X33
8	96.9	3.2	2.3	1	0.35 Eq H1-1a	0.0	50	W10X33
7	114.5	3.2	2.3	1	0.40 Eq H1-1a	0.0	50	W10X33
6	132.0	3.1	2.2	1	0.45 Eq H1-1a	0.0	50	W10X33
5	149.4	3.1	2.2	1	0.51 Eq H1-1a	0.0	50	W10X33
4	166.7	3.1	2.2	1	0.56 Eq H1-1a	0.0	50	W10X33
3	184.0	3.1	2.2	1	0.61 Eq H1-1a	0.0	50	W10X33
2	201.2	3.8	2.8	1	0.68 Eq H1-1a	0.0	50	W10X33
Ground	220.7	3.8	2.8	1	0.83 Eq H1-1a	0.0	50	W10X33
L-1	240.2	4.2	3.2	1	0.95 Eq H1-1a	0.0	50	W10X39
Concourse	263.3	5.0	4.0	1	0.87 Eq H1-1a	0.0	50	W10X39

Figure 18