Problem 2-3

*(a) Determine the factored axial load or the required axial strength, Pu of a column in an office
building with a regular roof configuration. The service axial loads on the column are as follows*

PD = 200 kips (dead load)

PL = 300 kips (floor live load)

PS = 150 kips (snow load)

PW = ±60 kips (wind load)

PE = ±40 kips (seismic load)

*(b) Calculate the required nominal axial compression strength, Pn of the column.*

1: Pu = 1.4 PD  = 1.4 (200k) = 280 kips

2: Pu = 1.2 PD + 1.6 PL + 0.5 PS

= 1.2 (200) + 1.6 (300) + 0.5 (150) = 795 kips (governs)

3 (a): Pu = 1.2 PD + 1.6 PS + 0.5PL

= 1.2 (200) + 1.6 (150) + 0.5(300) = 630 kips

3 (b): Pu = 1.2 PD + 1.6 PS + 0.8 PW

= 1.2 (200) + 1.6 (150) + 0.8 (60) = 528 kips

4: Pu = 1.2 PD + 1.6 PW + 0.5 PL + 0.5 PS

= 1.2 (200) + 1.6 (60) + 0.5(300) + 0.5 (150) = 561 kips

5: Pu = 1.2 PD + 1.0 PE + 0.5 PL + 0.2 PS

= 1.2 (200) + 1.0 (40) + 0.5 (300) + 0.2 (150) = 460 kips

Note that PD must always oppose PW and PE in load combination 6

6: Pu = 0.9 PD + 1.6 PW

= 0.9 (200) +1.6 (-60) = 84 kips *(no net uplift)*

7: Pu = 0.9 PD + 1.0 PE

= 0.9 (200) + 1.0 (-40) = 140 kips *(no net uplift)*

φPn > Pu

φc = 0.9

(0.9)(Pn) = (795 kips) Pn = 884 kips

6

Problem 2-4

(a) Determine the ultimate or factored load for a roof beam subjected to the following service
loads:

Dead Load = 29 psf (dead load)

Snow Load = 35 psf (snow load)

Roof live load = 20 psf

Wind Load = 25 psf upwards / 15 psf downwards

(b) Assuming the roof beam span is 30 ft and tributary width of 6 ft, determine the factored

moment and shear.

Since, S = 35psf > Lr = 20psf, use S in equations and ignore Lr.

1: pu = 1.4D = 1.4 (29) = 40.6 psf

2: p u = 1.2 D + 1.6 L + 0.5 S

= 1.2 (29) + 1.6 (0) + 0.5 (35) = 52.3 psf

3 (a): p u = 1.2D + 1.6S + 0.8W

= 1.2 (29) + 1.6 (35) + 0.8 (15) = 102.8 psf (governs)

3 (b): p u = 1.2D + 1.6S + 0.5L

= 1.2 (29) + 1.6 (35) + (0) = 90.8 psf

4: p u = 1.2 D + 1.6 W + L + 0.5S

= 1.2 (29) + 1.6 (15) + (0) + 0.5 (35) = 76.3 psf

5: p u = 1.2 D + 1.0 E + 0.5L + 0.2S

= 1.2 (29) + 1.0 (0) + 0.5(0) + 0.2 (35) = 41.8 psf

6: pu = 0.9D + 1.6W (D must always oppose W in load combinations 6 and 7)

= 0.9 (29) + 1.6(-25) (*upward wind load is taken as negative*)

= -13.9 psf *(net uplift)*

7: p u = 0.9D + 1.0E (D must always oppose E in load combinations 6 and 7)

= 0.9 (29) + 1.6(0) (*upward wind load is taken as negative*)

= 26.1 psf *(no net uplift)`*

wu= (102.8psf)(6ft) = 616.8 plf *(downward)*

wu= (-13.9psf)(6ft) = -83.4 plf *(upward)*

|  |  |
| --- | --- |
| downward | uplift |
| w L (616.8)(30)V = u = = 9252 lb.u2 2 | w L (−83.4)(30)V = u = = 1251 lb.u2 2 |
| 2 2w L (616.8)(30)M = u = = 69.4 ft-kipsu8 8 | 2 2w L (−83.4)(30)M = u = = 9.4 ft-kipsu8 8 |

7

Problem 2-5

|  |  |  |
| --- | --- | --- |
| Occupancy | Uniform Load (psf) | Concentrated Load (lb)\* |
| Library stack rooms | 150 | 1000 |
| Classrooms | 40 | 1000 |
| Heavy storage | 250 | - |
| Light Manufacturing | 125 | 2000 |
| Offices | 50 | 2000 |

\*Note: Generally, the uniform live loads (in psf) are usually more critical for design than the concentrated loads

Problem 2-6

*Determine the tributary widths and tributary areas of the joists, beams, girders and columns in the roof framing plan shown below.*

*Assuming a roof dead load of 30 psf and an essentially flat roof with a roof slope of ¼” per foot for drainage, determine the following loads using the ASCE 7 load combinations. Neglect the rain load, R and assume the snow load, S is zero:*

a. The uniform dead and roof live load on the typical roof beam in Ib/ft

b. The concentrated dead and roof live loads on the typical roof girder in Ib/ft

c. The total factored axial load on the typical interior column, in Ib.

d. The total factored axial load on the typical corner column, in Ib

Member Tributary width (TW) Tributary area (AT)

Interior Beam 24 ft/4 spaces = 6 ft 6 ft x 32 ft = 192 ft2

Spandrel Beam (24 ft/4 spaces)/2 + 0.75’ 3.75 ft x 32 ft = 120 ft2

= 3.75 ft

Interior Girder 32 ft/ 2 + 32 ft/2 = 32 ft 32 ft x 24 ft = 768 ft2

Spandrel Girder 32 ft/2 + 0.75 ft = 16.75 ft 16.75 ft x 24 ft = 402 ft2

Interior Column - 32 ft x 24 ft = 768 ft2

Corner Column - (32 ft/2 + 0.75)(24 ft/2 + 0.75) ft = 214 ft2

R2 = 1.0 (flat roof)

Member R1 Lr

Interior Beam 1.0 20psf

Spandrel Beam 1.0 20psf

Interior Girder 0.6 (0.6)(20) = 12psf

Spandrel Girder 1.2-0.001(402) (0.798)(20) = 15.96psf

= 0.798

Interior Column 0.6 (0.6)(20) = 12psf

Corner Column 1.2-0.001(214) (0.798)(20) = 19.72psf

= 0.986

8

Member pu = 1.2D+1.6Lr wu (plf) Pu (kips)

Interior Beam (1.2)(30)+(1.6)(20) = (68psf)(6ft) = 408plf -

68psf

Spandrel Beam (1.2)(30)+(1.6)(20) = (68psf)(3.75ft) = -

68psf 255plf

Interior Girder (1.2)(30)+(1.6)(12) = - (55.2psf)(6ft)(32ft) = 10.6

55.2psf kips

Spandrel Girder (1.2)(30)+(1.6)(15.96) - (61.5psf)(6ft)(32/2ft) = 5.9

= 61.5psf kips

Interior Column (1.2)(30)+(1.6)(12) = - (55.2psf)(768ft2) = 42.4 kips

55.2psf

Corner Column (1.2)(30)+(1.6)(19.72) - (67.6psf)(214ft2) = 14.5 kips

= 67.6psf

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Problem 2-7

A 3-story building has columns spaced at 18 ft in both orthogonal directions, and is subjected to the roof
and floor loads shown below. Using a column load summation table, calculate the cumulative axial
loads on a typical interior column with and without live load reduction. Assume a roof slope of ¼” per
foot for drainage.

rd

Roof Loads: 2~~nd~~ and 3 Floor Loads:

Dead Load, D roof = 20 psf Dead Load, D floor =40 psf

Snow Load, S = 40 psf Floor Live Load, L = 50 psf

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Member | AT (ft.2) | K LL | Lo (psf) | Live Load Red. Factor0.25 + 15/√(KLL AT) | Design live load, Lor S |
| 3rd floor | N/A | - | - | - | 40 psf(Snow load) |
| 2nd floor | (18)(18) =2324 ft | 4 | 40 psf | ⎡ ⎤15⎢0.25+ ⎥= 0.667⎣ (4)(324)⎦ | (0.667)(50)= 34 psf≥ 0.50 Lo = 25 psf |
| GroundFlr. | 2 floors x(18)(18) =2648 ft | 4 | 40 psf | ⎡ ⎤15⎢0.25+ ⎥= 0.545⎣ (4)(648)⎦ | (0.545)(50)= 28 psf≥ 0.40 Lo = 20 psf |

10

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  | wu1(LC 2) | wu2(LC 3) |  |  |  |  |
| With Floor Live Load Reduction |
| Roof | 324 | 20 | 40 | 40 | 44 | 88 | 14.3 or 28.5 | 14.3 | 28.5 | 28.5 |
| 3rd Flr | 324 | 40 | 50 | 34 | 102.4 | 65 | 33.2 or 21.1 | 47.5 | 49.6 | 49.6 |
| 2nd Flr | 324 | 40 | 50 | 28 | 92.8 | 62 | 30.1 or 20.1 | 77.5 | 69.7 | 77.5 |
| Without Floor Live Load Reduction |
| Roof | 324 | 20 | 40 | 40 | 44 | 88 | 14.3 or 28.5 | 14.3 | 28.5 | 28.5 |
| 3rd Flr | 324 | 40 | 50 | 50 | 128 | 73 | 41.5 or 23.7 | 55.8 | 52.2 | 55.8 |
| 2nd Flr | 324 | 40 | 50 | 50 | 128 | 73 | 41.5 or 23.7 | 97.2 | 75.9 | 97.2 |

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Level

TA (ft2 )

D (psf)

Live Load

Lo (S or Lr or R) psf

Design Live (psf)

Floor: L

Roof: S or Lr or R

Roof: 1.2D +0.5S (psf)

Floor: 1.2D + 1.6L(psf)

Roof: 1.2D + 1.6S (psf)

Floor: 1.2D + 0.5L (psf)

Pu = (TA)(wu1) or

(TA)(wu2) (kips)

ΣP

LC 2 (kips)

ΣP

LC 3 (kips)

Maximum ΣP (kips)

Problem 2-8

(a) Determine the dead load (*with and without partitions*) in psf of floor area for a steel building floor
system with W24x55 beams (weighs 55 Ib/ft) spaced at 6'-0" o.c. and W30x116 girders (weighs 116
Ib/ft) spaced at 35' o.c. The floor deck is 3.5" normal weight concrete on 1.5" x 20 gage composite steel
deck.

•  *Include the weights of 1" light-wt floor finish, suspended acoustical tile ceiling, Mechanical and
 Electrical (assume an industrial building), and partitions.*

•  *Since the beam and girder sizes are known, you must calculate the ACTUAL WEIGHT in psf of
 the beam and girder by dividing their weights in Ib/ft by their tributary widths)*

(b) Determine the dead loads in kips/ft for a typical INTERIOR BEAM and a typical INTERIOR GIRDER. Assume the girder load is uniformly distributed because there are 4 or more beams framing into the girder.

(c) If the floor system in (a) is to be used as a heavy manufacturing plant, determine the controlling factored loads in kips/ft for the design of the typical beam and the typical girder.

• Use the Limit States (LSD) load combinations

• Note that *partition* loads need not be included in the dead load calculations when the floor
 live load is greater than 80 psf.

(d) Determine the factored, Vu and the factored moment, Mu for a typical beam and a typical girder.

• Assume the beams and girders are simply supported

• The span of the beam is 35 ft (i.e. the girder spacing)

• The span of the girder is 30 ft.

Part (a): Dead Loads

W24x55 55 plf / 6ft = 9psf

W30x116 116 plf / 35 ft = 3psf

Floor deck

(4.25”/12)(145pcf) = 51psf

metal deck = 3psf

light wt. floor finish = 8psf

susp. ceiling = 2psf

M/E (industrial) = 20psf

Partitions = 20psf

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

ΣDL = 116psf (with partitions)

ΣDL = 96psf (without partitions)

Part (b):

*dead load on interior beam:*

(116 psf)(6’) = 696 plf = 0.70 kips/ft. (with partitions)
(96 psf)(6’) = 576 plf = 0.58 kips/ft. (without partitions)

*dead load on interior girder:*

(116 psf)(35’) = 4060 plf = 4.1 kips/ft. (with partitions)
(96 psf)(35’) = 3360 plf = 3.4 kips/ft. (without partitions)

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Part (d): Heavy Mfr.: Live Load = 250psf

1.4D = (1.4)(96) = 134.4psf

1.2D + 1.6L = (1.2)(96) + (1.6)(250)= 515psf Å controls

*Design Load on Beam:*

(515psf)(6 ft) = 3091 plf = 3.1 kips/ft

*Design Load on Girder:*

(515psf)(35 ft) = 18032 plf = 18.0 kips/ft

Part (e):

w L (515)(35)

Beam: V = u

u

2

w

= = 54 kips

2

2 2

L (515)(35)

M = u

u

=

= 473 ft-kips

8 8

w L (18.0)(30)

Girder: V = u

u

2

w

= = 270 kips

2

2 2

L (18.0)(30)

M = u

u

=

= 2025 ft-kips

8 8

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(i) Problem 2-9

The building with the steel roof framing shown in Figure 2-16 is located in Rochester, New York. Assuming terrain category C and a partially exposed roof, determine the following:

a) The balanced snow load on the lower roof, Pf

b) The balanced snow load on the upper roof, Pf

c) The design snow load on the upper roof, Ps

d) The snow load distribution on the lower roof considering sliding snow from the upper pitched
 roof

e) The snow load distribution on the lower roof considering drifting snow

f) The factored dead plus snow load in Ib/ft for the low roof Beam A shown on plan. *Assume a
 steel framed roof and assuming a typical dead load of 29 psf for the steel roof*

g) The factored moment, Mu and factored shear, Vu for Beam A
 *Note that the beam is simply supported*

h) For the typical interior roof girder nearest the taller building (i.e. the interior girder supporting
 beam “A”, in addition to other beams), draw the dead load and snow load diagrams, showing all
 the numerical values of the loads in Ib/ft for:

a. Dead load and snow drift loads

b. Dead load and sliding snow load

i) For each of the two cases in part (h), determine the unfactored reactions at both supports of the
 simply supported interior girder due to dead load, snow load, and the factored reactions. Indicate
 which of the two snow loads (snow drift or sliding snow) will control the design of this girder.

HINT: Note that for the girder, the dead load is a uniform load, whereas the snow load may be uniformly distributed or trapezoidal in shape depending on whether sliding or drifting snow is being considered.

Solution:

(a) Lower Roof: Balanced Snow Load, Pf

Ground snow load for Rochester, New York, Pg = 40 psf (Building Code of New York State, Figure
1608.2)

Assume:

Category I building Is = 1.0

Terrain Category C & Partially exposed roof Ce = 1.0 (ASCE 7 Table 7-2)

Slope factor (θ ≈ 0 degrees for a flat roof) Cs = 1.0 (ASCE 7 Fig 7-2)

Temperature factor, Ct = 1.0 (ASCE 7 Table 7-3)

Flat roof snow load or Balanced Snow load on lower roof is,

Pf lower = 0.7 Ce Ct Is Pg = 0.7 x 1.0 x 1.0 x 1.0 x 40 psf = 28 psf

(b) Design snow load for lower roof, Ps lower = Pf Cs = 28 psf x 1.0 = 28 psf
 14

(c) Upper Roof: Balanced Snow Load, Pf

Ground snow load, Pg = 40 psf

Assume:

Category I building

Terrain Category C & Partially exposed roof

Roof slope, θ = arc tan (6/12) = 27 degrees Slope factor,

Temperature factor,
Flat roof snow load or Balanced Snow load on *upper* roof is,

Is = 1.0

Ce = 1.0 (ASCE 7 Table 7-2)

Cs = 1.0 (ASCE 7 Fig 7-2)

Ct = 1.0 (ASCE 7 Table 7-3)

Pf upper = 0.7 Ce Ct Is Pg = 0.7 x 1.0 x 1.0 x 1.0 x 40 psf = 28 psf

Design snow load for *upper* roof, Ps upper = Pf Cs = 28 psf x 1.0 = 28 psf

(d) Sliding Snow Load on Lower Roof

W = distance from ridge to eave of sloped roof = 20 ft

Uniform sliding snow load, PSL = 0.4 Pf upper x W / 15’

= 0.4 x 28 psf x 20’/15’ = 15 psf

• This sliding snow load is uniformly distributed over a distance of 15 ft (*Code specified* )

measured from the face of the taller building. This load is added to the balanced snow load on the lower roof.

• Total maximum total snow load, S on the *lower* roof over the *Code specified* 15 ft distance = 28
 psf + 15 psf ≈ 43 psf

• Beyond the distance of 15 ft from the face of taller building, the snow load on the lower roof is a
 uniform value of 28 psf.

Average total snow load, S on beam A = 28 psf (balanced snow) + 15 psf ≈ 43 psf

(e) Drifting Snow Load on Lower Roof

γ = density of snow = 0.13 Pg + 14 = 0.13 x 40 + 14 = 19.2 pcf Hb = Pf (lower)/ γ = 28 psf / 19.2 = 1.46 ft

H = height difference between low roof and eave of higher roof = 15 ft Hc = H - Hb = 13.54 ft

The maximum height of the drifting snow is obtained as follows:
Windward Drift: length of lower roof = 80 ft and μ = 0.75
 15

Hd = μ (0.43 [L]1/3 [Pg + 10]¼ − 1.5)

= 0.75 (0.43 [80]1/3 [40 + 10]¼ − 1.5) = 2.6 ft (governs)

Leeward Drift: length of upper roof = 40 ft and μ = 1.0

Hd =1.0 (0.43 [40]1/3 [40 + 10]¼ − 1.5) = 2.4 ft

The maximum value of the *triangular* snow drift load,

PSD = γ Hd = 19.2 pcf x 2.6 ft = 50 psf

This load must be superimposed on the uniform balanced flat roof snow load, Pf

The length of the *triangular* portion of the snow drift load, w, is given as
follows:

Hd = 2.8 ft ≤ Hc= 13.54 ft, therefore

w = 4 Hd = 4 x 2.6 ft = 10.4 ft (governs) ≤ 8 Hc = 8 x 13.54 = 108 ft

This triangular snow drift load must be superimposed on the uniform balanced snow load on the lower roof.

• Therefore, Maximum *total snow load* = 28 psf + 50 psf = 78 psf.

• The snow load varies from the maximum value of 78 psf to a value of 28 psf (i.e.
 balanced snow load) at a distance of 10.4 ft from the face of the taller building.

• Beyond the distance of 10.4 ft from the face of taller building, the snow load on the lower
 roof is a uniform value of 28 psf.

(f) Factored Dead + Live Load on Low Roof Beam A

From geometry, the *average* snow drift load on the low roof beam A is found using similar
triangles:

(50 psf / 10.4 ft) = SDaverage /(10.4 ft - 4 ft)

SDaverage = 31 psf = average “uniform” snow drift load on beam A

Average total snow load, S on beam A = 28 psf (balanced snow) + 31 psf = 59 psf

NOTE: This average total snow load is greater than the value of 43 psf for *sliding snow* obtained in part (d). Therefore, the S value for snow drift is more critical and therefore governs!

Roof Dead Load = 29 psf (given)

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Using the ASCE 7 strength load combinations, the factored load on the roof is:

wu roof = 1.2 x 29 psf + 1.6 x 59 psf = 129.2 psf

Tributary width of beam A = 4 ft (see roof plan)

Factored load on beam, w u = wu roof x Beam Tributary width

= 129.2 psf x 4 ft = 517 lb/ft

(g) Factored Moment and Shear for the Low Roof Beam A

Span of beam = 20 ft

2

Mu = wu L2/8 = (517 lb/ft) x (20 ft) /8 = 25.9 ft-kips

V u = wuL/2 = (517 lb/ft) x (20 ft)/2 = 5.2 kips

(h) Loading diagram for Typical Interior Low roof Girder that frames into the Taller Building
 column

Consider both the snow drift and sliding snow loads and then determine which of these loads is more critical for this girder

(1) Snow drift on *typical interior girder*

Using principles from statics, we can calculate the girder reactions as follows:

R1 D = 580 Ib/ft x (20’/2) = 5800 Ib = 5.8 kips

R2 D = 580 Ib/ft x (20’/2) = 5800 Ib = 5.8 kips

R 1 L = 560 lb/ft x (20’) x (20’/2) + ½ x 1000 Ib/ft x 10.4’ x (10.4’/3)

17

20’

= 6501 lb = 6.5 kips

R 2 L = 560 lb/ft x (20’) + ½ x 1000 Ib/ft x 10.4’ - R 1 LL

= 9899 Ib = 9.9 kips

The factored reactions are calculated using the factored load combinations from the course text,

R1 u = 1.2 R1 D + 1.6 R1 L = 1.2 x 5.8 kip + 1.6 x 6.5 kip = 17.4 kips

R2 u = 1.2 R2 D + 1.6 R2 L = 1.2 x 5.8 kip + 1.6 x 9.9 kip = 22.8 kips

(2) Sliding snow on typical interior girder

Using principles from statics, we can calculate the girder reactions as follows:

R1 DL = 580 Ib/ft x (20’/2) = 5800 Ib = 5.8 kips

R2 DL = 580 Ib/ft x (20’/2) = 5800 Ib = 5.8 kips

R 1 LL = 560 lb/ft x (20’) x (20’/2) + 300 Ib/ft x 15’ x (15’/2)

20’

= 7288 Ib = 7.3 kips

R 2 LL = 560 lb/ft x (20’) + 300 lb/ft x 15’ - R 1 LL

= 8412 Ib = 8.4 kips

The factored reactions are calculated using the factored load combinations from the course text,

R1 u = 1.2 R1 D + 1.6 R1 L = 1.2 x 5.8 kip + 1.6 x 7.3 kip = 18.6 kips

R2 u = 1.2 R2 D + 1.6 R2 L = 1.2 x 5.8 kip + 1.6 x 8.4 kip = 20.4 kips

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Problem 2-10

An eight-story office building consists of columns located 30 ft apart in both orthogonal directions. The roof and typical floor gravity loads are given below:

Roof loads:

Dead Load (RDL) = 80 psf;
Snow Load (SL) = 40 psf

Floor Loads:

Floor Dead Load (FDL) = 120 psf
Floor Live Load (FLL) = 50 psf

(a) Using the column tributary area and a column load summation table, determine the total

unfactored and factored vertical loads in a typical interior column in the first story neglecting live load reduction.

(b) Using the column tributary area and a column load summation table, determine the total
 unfactored and factored vertical loads in a typical interior column in the first story
 considering live load reduction.

(c) Develop a spread sheet to solve parts (a) and (b) and verify your results.
Solution:

Column load summation table using tributary area

GIVEN: 8-story building; Typical Interior Column Tributary Area per floor = 30 ft x 30 ft = 900 ft2

Roof Loads: D = 80 psf S = 40 psf

Typical floor loads: D = 120 psf L = 50 psf

Floor Live Load Calculation Table

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Member | Levelssupported | AT(summationof floor TA) | KLL | UnreducedFloor liveload, Lo (psf) | Design live load\*,L |
| 8th floorColumn(i.e. columnbelow roof) | Roof only | Floor live loadreductionNOTapplicable toroofs!!! | - | 40 psf (snow) | 40 psf (snow) |
| 7th floorcolumn(i.e. columnbelow 8thfloor) | 1 floor +roof(i.e. supportsthe roof andthe 8th floor) | 1 floor x 900ft2 = 900 ft2 | 4KLL AT = 3600 >400 ft2 ⇒Live Loadreductionallowed | 50 psf | 0.5 x 50 =25 psf≥ 0.50 Lo =25 psf |

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|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 6th floorcolumn(i.e. columnbelow 7thfloor) | 2 floors +roof (i.e.supports theroof, 8th and7th floors) | 2 floors x 900ft2 = 1800 ft2 | 4KLL AT = 7200 >400 ft2 ⇒Live Loadreductionallowed | 50 psf | 0.43 x 50 =22 psf≥ 0.40 Lo =20 psf |
| 5th floorcolumn(i.e. columnbelow 6thfloor) | 3 floors +roof(i.e. supportsthe roof, 8th ,7th and 6thfloors) | 3 floors x 900ft2 = 2700 ft2 | 4KLL AT = 10800>400 ft2 ⇒Live Loadreductionallowed | 50 psf | 0.394 x 50 =20 psf≥ 0.40 Lo =20 psf |
| 4th floorcolumn(i.e. columnbelow 5thfloor) | 4 floors +roof(i.e. supportsthe roof, 8th ,7th , 6th and5th floors) | 4 floor x 900ft2 = 3600 ft2 | 4KLL AT = 14400>400 ft2 ⇒Live Loadreductionallowed | 50 psf | 0.375 x 50 = 19psf≥ 0.40 Lo =20 psf |
| 3rd floorcolumn(i.e. columnbelow 4thfloor) | 5 floors +roof(.e. supportsthe roof, 8th,7th, 6th, 5thand 4thfloors) | 5 floor x 900ft2 = 4500 ft2 | 4KLL AT = 18000>400 ft2 ⇒Live Loadreductionallowed | 50 psf | 0.362 x 50 = 18psf≥ 0.40 Lo =20 psf |
| 2nd floorcolumn(i.e. columnbelow 3rdfloor) | 6 floors +roof(i.e. supportsthe roof, 8th,7th, 6th, 5th,4th and 3rdfloors) | 6 floor x 900ft2 = 5400 ft2 | 4KLL AT = 21600>400 ft2 ⇒Live Loadreductionallowed | 50 psf | 0.352 x 50 = 18psf≥ 0.40 Lo =20 psf |
| Ground or1st floorcolumn(i.e. columnbelow 2ndfloor) | 7 floors +roof (i.e.supports theroof, 8th, 7th,6th, 5th, 4th,3rd and 2ndfloors) | 7 floors x 900ft2 = 6300 ft2 | 4KLL AT = 25200>400 ft2 ⇒Live Loadreductionallowed | 50 psf | 0.344 x 50 = 17.3psf≥ 0.40 Lo =20 psf |

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\*L = Lo [ 0.25 + {15 / [KLL AT]0.5 } ]

≥ 0.50 Lo for members supporting one *floor* (e.g. slabs, beams, girders or columns)
 ≥ 0.40 Lo for members supporting two or more *floors* (e.g. columns)
 Lo = unreduced design live load from the Code (ASCE 7-02 Table 4-1)
KLL = live load factor (ASCE 7-02 Table 4-2)

AT = summation of the floor tributary area in ft2 supported by the member, excluding the roof area and floor areas with NON-REDUCIBLE live loads.

The COLUMN LOAD SUMMATION TABLES are shown on the following pages for the two cases:

1. Live load reduction ignored

2. Live load reduction considered

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|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  | wu1(LC 2) | wu2(LC 3) |  |  |  |  |
| (b) With Floor Live Load Reduction |
| Roof | 900 | 80 | 40 | 40 | 116.0 | 160.0 | 104.4 or144.0 | 104.4 | 144.0 | 144.0 |
| 8th Flr | 900 | 120 | 50 | 25 | 184.0 | 156.5 | 165.6 or140.9 | 270 | 284.9 | 284.9 |
| 7th Flr | 900 | 120 | 50 | 22 | 179.2 | 155.0 | 161.3 or139.5 | 431.3 | 424.4 | 431.3 |
| 6th Flr | 900 | 120 | 50 | 20 | 176.0 | 154.0 | 158.4 or138.6 | 589.7 | 563.0 | 589.7 |
| 5th Flr | 900 | 120 | 50 | 20 | 176.0 | 154.0 | 158.4 or138.6 | 748.1 | 701.6 | 748.1 |
| 4th Flr | 900 | 120 | 50 | 20 | 176.0 | 154.0 | 158.4 or138.6 | 906.5 | 840.2 | 906.5 |
| 3rd Flr | 900 | 120 | 50 | 20 | 176.0 | 154.0 | 158.4 or138.6 | 1064.9 | 978.8 | 1064.9 |
| 2nd Flr | 900 | 120 | 50 | 20 | 176.0 | 154.0 | 158.4 or138.6 | 1223.3 | 1117.4 | 1223.3 |
| (a) Without Floor Live Load Reduction |
| Roof | 900 | 80 | 40 | 40 | 116 | 160 | 104.4 or144.0 | 104.4 | 144.0 | 144.0 |
| 8th Flr | 900 | 120 | 50 | 50 | 224 | 169 | 201.6 or152.1 | 306.0 | 296.1 | 306.0 |
| 7th Flr | 900 | 120 | 50 | 50 | 224 | 169 | 201.6 or152.1 | 507.6 | 448.2 | 507.6 |
| 6th Flr | 900 | 120 | 50 | 50 | 224 | 169 | 201.6 or152.1 | 709.2 | 600.3 | 709.2 |
| 5th Flr | 900 | 120 | 50 | 50 | 224 | 169 | 201.6 or152.1 | 910.8 | 752.4 | 910.8 |
| 4th Flr | 900 | 120 | 50 | 50 | 224 | 169 | 201.6 or152.1 | 1112.4 | 904.5 | 1112.4 |
| 3rd Flr | 900 | 120 | 50 | 50 | 224 | 169 | 201.6 or152.1 | 1314.0 | 1056.6 | 1314.0 |
| 2nd Flr | 900 | 120 | 50 | 50 | 224 | 169 | 201.6 or152.1 | 1515.6 | 1208.7 | 1515.6 |

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Level

TA (ft2 )

D (psf)

Live Load

Lo (S or Lr or R) psf

Design Live (psf)

Floor: L

Roof: S or Lr or R

Roof: 1.2D +0.5S (psf)

Floor: 1.2D + 1.6L(psf)

Roof: 1.2D + 1.6S (psf)

Floor: 1.2D + 0.5L (psf)

Pu = (TA)(wu1) or

(TA)(wu2) (kips)

ΣP

LC 2 (kips)

ΣP

LC 3 (kips)

Maximum ΣP (kips)