

MAGNUSSON  
KLEMENCIC  
ASSOCIATES

Structural + Civil Engineers

# Embodied Carbon Reduction

## Floor Loading Assumptions – the Low Hanging Fruit

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**MEETING ROOM CAPACITY  
10 PEOPLE**

**11.3 PSF**



**FULL MEETING ROOM CAPACITY  
23 PEOPLE**

**24.6 PSF**



**FULL STANDING CAPACITY  
29 PEOPLE**

**29.2 PSF**



**29 PEOPLE OVER  
96.8 SQUARE FEET**

**48.0 PSF**



**29 PEOPLE OVER  
80.7 SQUARE FEET**

**58.5 PSF**



**29 PEOPLE OVER  
72.6 SQUARE FEET**

**64.7 PSF**



STRUCTURAL DESIGN

TABLE 1607.1  
MINIMUM UNIFORMLY DISTRIBUTED LIVE LOADS,  $L_D$   
AND MINIMUM CONCENTRATED LIVE LOADS<sup>a</sup>

OCCUPANCY OR USE	UNIFORM (psf)	CONCENTRATED (pounds)
1. Apartments (see residential)	—	—
2. Access floor systems		
Office use	50	2,000
Computer use	100	2,000
3. Armories and drill rooms	150 <sup>b</sup>	—
4. Assembly areas		
Fixed seats (fastened to floor)	60 <sup>m</sup>	—
Follow spot, projections and control rooms	50	—
Lobbies	100 <sup>m</sup>	—
Movable seats	100 <sup>m</sup>	—
Stage floors	150 <sup>b</sup>	—
Platforms (assembly)	100 <sup>m</sup>	—
Other assembly areas	100 <sup>m</sup>	—
5. Balconies and decks <sup>b</sup>	1.5 times the live load for the area served, not required to exceed 100	—
6. Catwalks	40	300
7. Cornices	60	—
8. Corridors		
First floor	100	—
Other floors	Same as occupancy served except as indicated	—
9. Dining rooms and restaurants	100 <sup>m</sup>	—
10. Dwellings (see residential)	—	—
11. Elevator machine room and controlroom grating (on area of 2 inches by 2 inches)	—	300
12. Finish light floor plate construction (on area of 1 inch by 1 inch)	—	200
13. Fire escapes	100	—
On single-family dwellings only	40	—
14. Garages (passenger vehicles only)	40 <sup>b</sup>	Note a
Trucks and buses	See Section 1607.7	
15. Handrails, guards and grab bars	See Section 1607.8	
16. Helipads	See Section 1607.6	
17. Hospitals		
Corridors above first floor	80	1,000
Operating rooms, laboratories	60	1,000
Patient rooms	40	1,000
18. Hotels (see residential)	—	—
19. Libraries		
Corridors above first floor	80	1,000
Reading rooms	60	1,000
Stack rooms	150 <sup>b, c</sup>	1,000
20. Manufacturing		
Heavy	250 <sup>b</sup>	3,000
Light	125 <sup>b</sup>	2,000
21. Marquees, except one- and two-family dwellings	75	—
22. Office buildings		
Corridors above first floor	80	2,000
File and computer rooms shall be designed for heavier loads based on anticipated occupancy	—	—
Lobbies and first-floor corridors	100	2,000
Offices	50	2,000

(continued)

TABLE 1607.1—continued  
MINIMUM UNIFORMLY DISTRIBUTED LIVE LOADS,  $L_D$   
AND MINIMUM CONCENTRATED LIVE LOADS<sup>a</sup>

OCCUPANCY OR USE	UNIFORM (psf)	CONCENTRATED (pounds)
23. Penal institutions		
Cell blocks	40	—
Corridors	100	—
24. Recreational uses:		
Bowling alleys, poolrooms and similar uses	75 <sup>m</sup>	—
Dance halls and ballrooms	100 <sup>m</sup>	—
Gymnasiums	100 <sup>m</sup>	—
Ice skating rink	250 <sup>b</sup>	—
Reviewing stands, grandstands and bleachers	100 <sup>c, m</sup>	—
Roller skating rink	100 <sup>m</sup>	—
Stadiums and arenas with fixed seats (fastened to floor)	60 <sup>c, m</sup>	—
25. Residential		
One- and two-family dwellings		
Uninhabitable attics without storage <sup>1</sup>	10	—
Uninhabitable attics with storage <sup>1,3,4</sup>	20	—
Habitable attics and sleeping areas <sup>5</sup>	30	—
Canopies, including marquees	20	—
All other areas	40	—
Hotels and multifamily dwellings		
Private rooms and corridors serving them	40	—
Public rooms and corridors serving them	100	—
26. Roofs		
All roof surfaces subject to maintenance workers		300
Awnings and canopies:		
Fabric construction supported by a skeleton structure	5 <sup>m</sup>	—
All other construction, except one- and two-family dwellings	20	—
Ordinary flat, pitched, and curved roofs (that are not occupiable)	20	—
Primary roof members exposed to a work floor		
Single panel point of lower chord of roof trusses or any point along primary structural members supporting roofs over manufacturing, storage warehouses, and repair garages		2,000
All other primary roof members		300
Occupiable roofs:		
Roof gardens	100	—
Assembly areas	100 <sup>b</sup>	—
All other similar areas	Note 1	Note 1
27. Schools		
Classrooms	40	1,000
Corridors above first floor	80	1,000
First-floor corridors	100	1,000
28. Scuttles, skylight ribs and accessible ceilings	—	200
29. Sidewalks, vehicular driveways and yards, subject to trucking	250 <sup>d, e</sup>	8,000 <sup>f</sup>
30. Stairs and exits		
One- and two-family dwellings	40	300 <sup>f</sup>
All other	100	300 <sup>f</sup>

(continued)

TABLE 1607.1  
MINIMUM UNIFORMLY DISTRIBUTED LIVE LOADS,  $L_p$   
AND MINIMUM CONCENTRATED LIVE LOADS<sup>a</sup>

OCCUPANCY OR USE	UNIFORM (psf)	CONCENTRATED (pounds)
1. Apartments (see residential)	—	—
2. Access floor systems	—	—
Office use	50	2,000
Computer use	100	2,000
3. Armories and drill rooms	150 <sup>b</sup>	—
4. Assembly areas	60 <sup>m</sup>	—
Fixed seats (fastened to floor)	60 <sup>m</sup>	—
Follow spot, projections and control rooms	50	—
Lobbies	100 <sup>m</sup>	—
Movable seats	100 <sup>m</sup>	—
Stage floors	150 <sup>p</sup>	—
Platforms (assembly)	100 <sup>p</sup>	—
Other assembly areas	100 <sup>p</sup>	—
5. Balconies and decks <sup>b</sup>	1.5 times the live load for the area served, not required to exceed 100	—
6. Catwalks	40	300
7. Cornices	60	—
8. Corridors	100	—
First floor	Same as occupancy served except as indicated	—
Other floors	—	—
9. Dining rooms and restaurants	100 <sup>m</sup>	—
10. Dwellings (see residential)	—	—
11. Elevator machine room and controlroom grating (on area of 2 inches by 2 inches)	—	300
12. Finish light floor plate construction (on area of 1 inch by 1 inch)	—	200
13. Fire escapes	100	—
On single-family dwellings only	40	—
14. Garages (passenger vehicles only)	40 <sup>c</sup>	Note a
Trucks and buses	See Section 1607.7	—
15. Handrails, guards and grab bars	See Section 1607.8	—
16. Helipads	See Section 1607.6	—
17. Hospitals	80	1,000
Corridors above first floor	60	1,000
Operating rooms, laboratories	40	1,000
Patient rooms	—	—
18. Hotels (see residential)	—	—
19. Libraries	80	1,000
Corridors above first floor	60	1,000
Reading rooms	150 <sup>b, e</sup>	1,000
Stack rooms	—	—
20. Manufacturing	250 <sup>p</sup>	3,000
Heavy	125 <sup>b</sup>	2,000
Light	—	—
21. Marquees, except one- and two-family dwellings	75	—
22. Office buildings	80	2,000
Corridors above first floor	—	—
File and computer rooms shall be designed for heavier loads based on anticipated occupancy	100	2,000
Lobbies and first-floor corridors	50	2,000
Offices	—	—

(continued)

TABLE 1607.1—continued  
MINIMUM UNIFORMLY DISTRIBUTED LIVE LOADS,  $L_p$   
AND MINIMUM CONCENTRATED LIVE LOADS<sup>a</sup>

OCCUPANCY OR USE	UNIFORM (psf)	CONCENTRATED (pounds)
23. Penal institutions	40	—
Cell blocks	100	—
Corridors	—	—
24. Recreational uses:	—	—
Bowling alleys, poolrooms and similar uses	75 <sup>m</sup>	—
Dance halls and ballrooms	100 <sup>p</sup>	—
Gymnasiums	100 <sup>p</sup>	—
Ice skating rink	250 <sup>p</sup>	—
Rink for roller skating, figure skating and bleachers	100 <sup>p</sup>	—
Roller skating rink	100 <sup>p</sup>	—
Stadiums and arenas with fixed seats (fastened to floor)	60 <sup>m</sup>	—
25. Residential	—	—
One- and two-family dwellings	—	—
Uninhabitable attics without storage <sup>1</sup>	10	—
Uninhabitable attics with storage <sup>1, 4</sup>	20	—
Habitable attics and sleeping areas <sup>5</sup>	30	—
Canopies, including marquees	40	—
All other areas	40	—
Hotels and multifamily dwellings	—	—
Private rooms and corridors serving them	40	—
Public rooms and corridors serving them	100	—
26. Roofs	—	300
All roof surfaces subject to maintenance workers	—	300
Awnings and canopies:	—	—
Fabric construction supported by a skeleton structure	5 <sup>m</sup>	—
All other construction, except one- and two-family dwellings	20	—
Ordinary flat, pitched, and curved roofs (that are not occupiable)	20	—
Primary roof members exposed to a work floor	—	—
Single panel point of lower chord of roof trusses or any point along primary structural members supporting roofs over manufacturing, storage warehouses, and repair garages	—	2,000
All other primary roof members	—	300
Occupiable roofs:	—	—
Roof gardens	100	—
Assembly areas	100 <sup>p</sup>	—
All other similar areas	Note 1	Note 1
27. Schools	—	—
Classrooms	40	1,000
Corridors above first floor	80	1,000
First-floor corridors	100	1,000
28. Scuttles, skylights, and accessible ceilings	—	200
29. Sidewalk, vehicular driveways and yards, subject to trucking	250 <sup>e, 6</sup>	8,000 <sup>7</sup>
30. Stairs and exits	—	—
One- and two-family dwellings	40	300 <sup>7</sup>
All other	100	300 <sup>7</sup>

(continued)

4. Assembly areas		
Fixed seats (fastened to floor)	60 <sup>m</sup>	
Follow spot, projections and control rooms	50	
Lobbies	100 <sup>m</sup>	—
Movable seats	100 <sup>m</sup>	
Stage floors	150 <sup>n</sup>	
Platforms (assembly)	100 <sup>m</sup>	
Other assembly areas	100 <sup>m</sup>	

m. Live load reduction is not permitted.

22. Office buildings		
Corridors above first floor	80	2,000
File and computer rooms shall be designed for heavier loads based on anticipated occupancy	—	—
Lobbies and first-floor corridors	100	2,000
Offices	50	2,000

(continued)



Design occupancy for office building with 16 floors and 30,000m<sup>2</sup> office area  
Calculations are approximate to illustrate variation between disciplines.

**Ventilation** **3,000 people**

BSRIA Rules of Thumb Guidelines for Building Services 5th Edition, Table 3  
10m<sup>2</sup> per person = 3,000 people



**Space Planning** **3,750 people**

BCO Specification for Offices, 2014  
High Density = 8m<sup>2</sup> per person = 3,750 people  
Low Density = 13m<sup>2</sup> per person = 2,308 people



**Fire Design** **7,500 people**

BS 9999:2017 Table 9, Typical Office Floor Space Factors  
High Density = 4m<sup>2</sup> per person = 7,500 people  
Low Density = 10m<sup>2</sup> per person = 3,000 people



**Structural Design** **85,500 people**

BS EN 1990, BS EN 1991-1-1  
Ultimate Limit State,  $\gamma_q = 1.5$  (partial factor for live load),  $\alpha_n = 0.5$  (reduction factor >10 storeys)  
 $q_k = 3\text{kN/m}^2$  over 95% of floor area (Typical value not including partitions or 5% more heavily loaded areas)  
Total load ( $\gamma_q \alpha_n q_k A$ ) = 64MN. Assuming each occupant = 0.75kN = **85,500 people**  
Without area reduction  $\alpha_n$  = 171,000 people

Serviceability Limit State,  $\gamma_q = 1.0$  (partial factor for live load),  $\alpha_n = 0.5$  (reduction factor for multi-storey)  
Total load ( $\gamma_q \alpha_n q_k A$ ) = 43MN. Assuming single occupant 0.75kN = **57,000 people**  
Without area reduction  $\alpha_n$  = 114,000 people







# Comparison

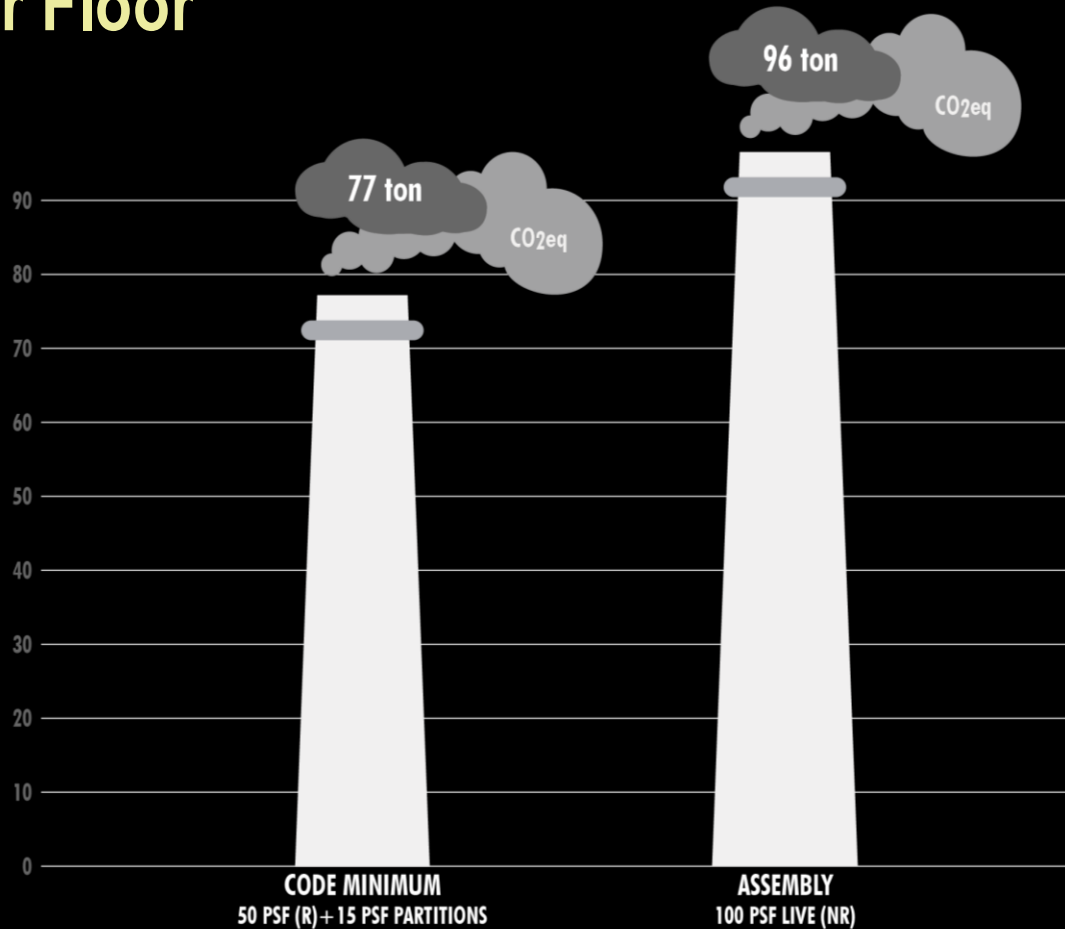
Load Level	Tons per Floor	$\Delta$ Tons per Floor	GWP per Floor	$\Delta$ GWP per Floor
Code Minimum 50psf Live (R) + 15psf Partitions	85 tons	--	77 ton CO <sub>2</sub> eq	--
Assembly 100psf Live (NR)	106 tons	21 tons	96 ton CO <sub>2</sub> eq	19 ton CO <sub>2</sub> eq

**GWP = Global Warming Potential**

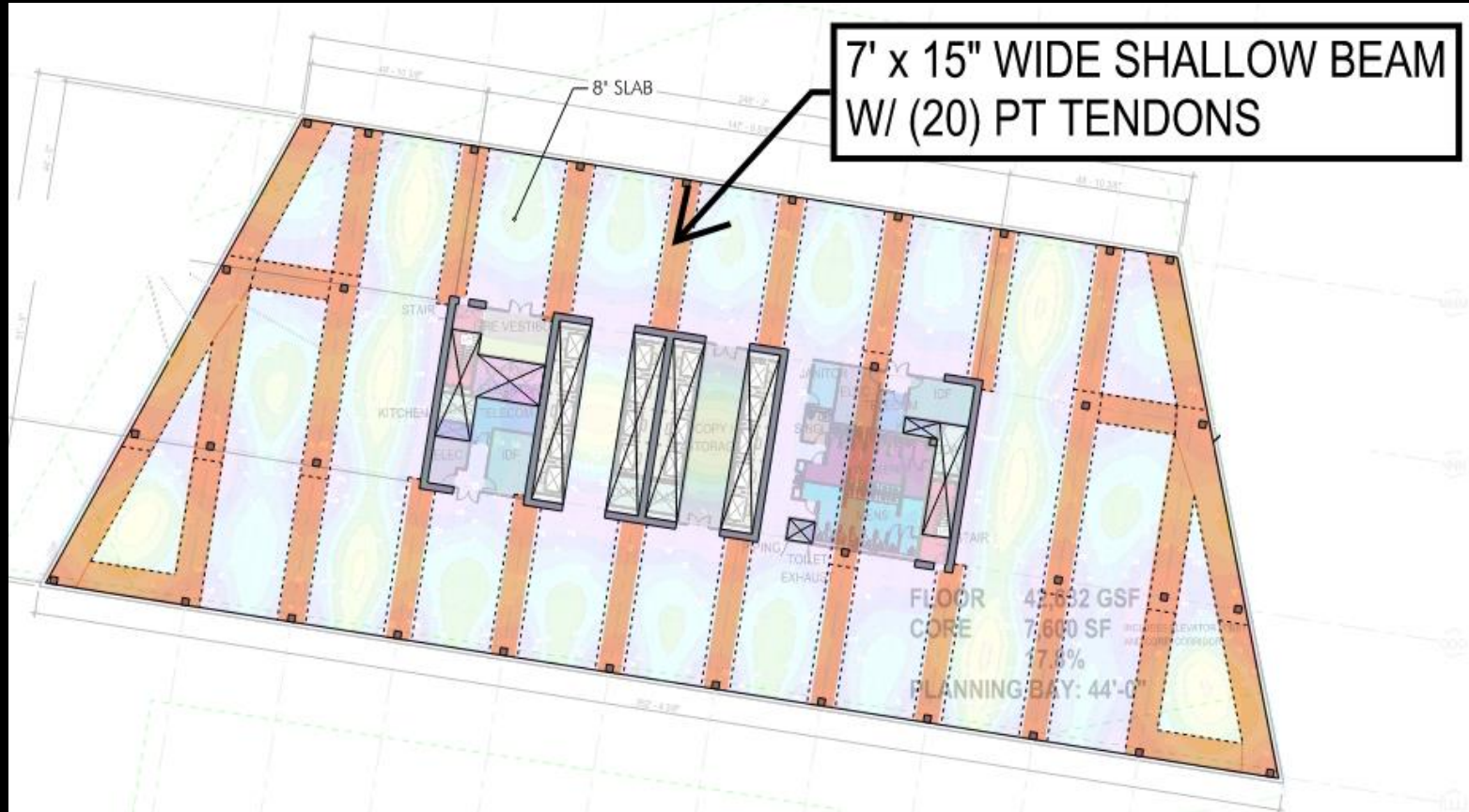
**R = Reducible**

**NR = Non-reducible**

# GWP Per Floor

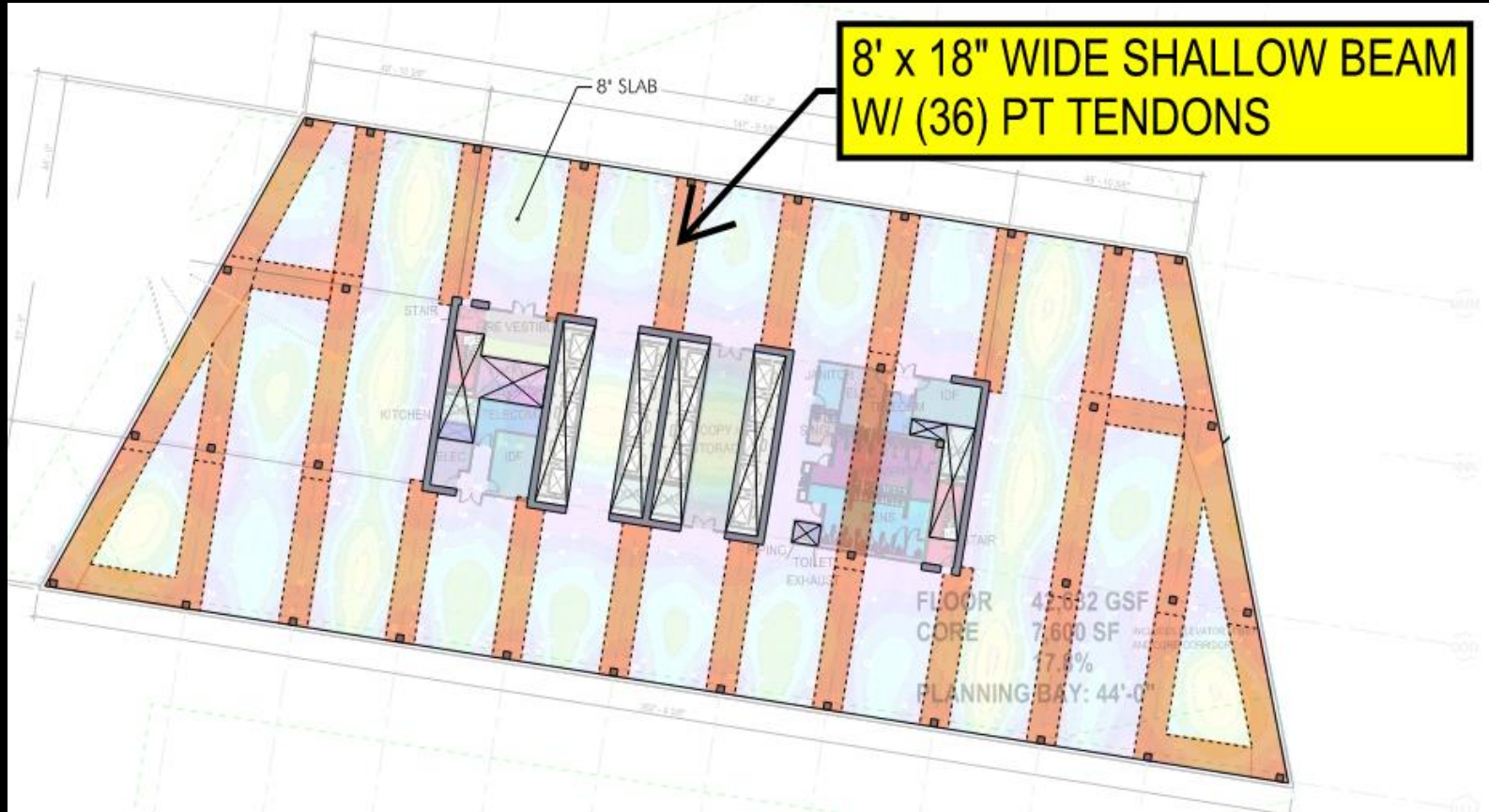


# Office Loading Design





# Assembly Loading Design



# Comparison

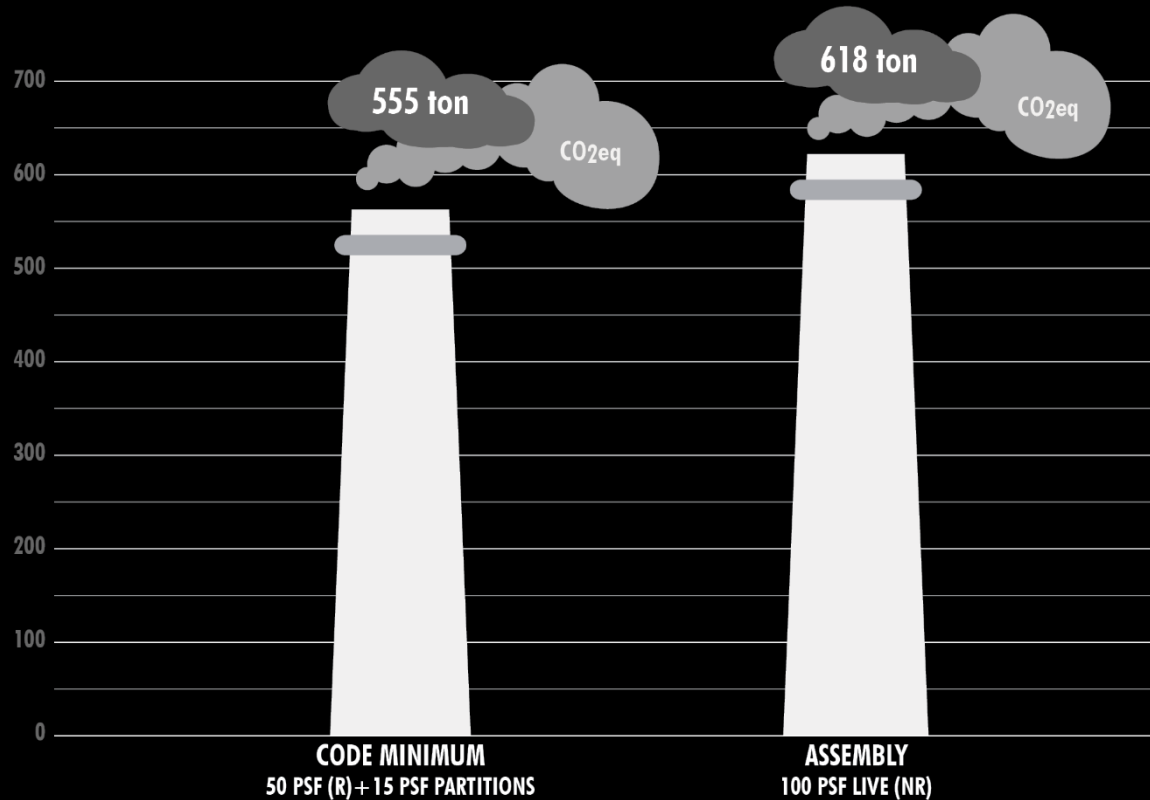
Load Level	Tons per Floor	$\Delta$ Tons per Floor	GWP per Floor	$\Delta$ GWP per Floor
Code Minimum 50psf Live (R) + 15psf Partitions	81 tons (rebar) 6.4 tons (PT) 1,300 cy (conc)	--	555 ton CO <sub>2</sub> eq	--
Assembly 100psf Live (NR)	93 tons (rebar) 12.1 tons (PT) 1,390 cy (conc)	13 tons (rebar) 6 tons (PT) 105 cy (conc)	618 ton CO <sub>2</sub> eq	63 ton CO <sub>2</sub> eq

**GWP = Global Warming Potential**

**R = Reducible**

**NR = Non-reducible**

# GWP Per Floor





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