

# Live Loads and Idealization of Structural Members

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# What is a Live Load?

Live Loads are gravity loads that can vary in magnitude and position

Examples:

- People,
- Furniture,
- Vehicles.



Live loads are usually prescribed by codes  
(e.g. IBC Table 1607.1 - floor live loads for buildings)

# Live Loads are Usually Shown on the Structural Drawings From Sheet S001- General Notes

## LIVE LOADS

DESIGN LIVE LOADS PER CBC TABLE 1607.1 AND AS FOLLOWS. LIVE LOADS MAY BE REDUCED IN ACCORDANCE WITH CBC SECTION 1607.9.

ROOF LIVE	20 PSF
FLOOR LIVE	40 PSF

## EARTHQUAKE DESIGN DATA

### SEISMIC FORCE-RESISTING SYSTEM:

$l_p$	1.0
$S_i$	1.5
$S_1$	0.739
SITE CLASS	D
$S_{ds}$	1.050
$S_{d1}$	1.109

### SEISMIC DESIGN CATEGORY

D	
$C_s$	0.175
R	6.5 [LIGHT-FRAME WOOD WALLS SHEATHED WITH WOOD STRUCTURAL PANELS]

ANALYSIS PROCEDURE	EQUIVALENT LATERAL FORCE
REDUNDANCY FACTOR	1.0

## WIND DESIGN DATA

BASIC WIND SPEED, V	110 MPH
$I_w$	1.0 (CATEGORY II)
EXPOSURE	B (URBAN, CLOSELY SPACED CONSTRUCTION)

## MAIN WIND-FORCE RESISTING SYSTEMS

ANALYSIS PROCEDURE	AISC 7-10 CHAPTER 27, DIRECTIONAL PROCEDURE
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## COMPONENTS & CLADDING

ANALYSIS PROCEDURE	AISC 7-10 CHAPTER 30
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Code allows live loads to be reduced  
In some situations

# Approximate Live Load Caused by Human Occupants on a 25 Square Foot Area



Approximately  
150 psf

Approximately  
100 psf

Approximately  
50 psf

# Floor Live Loads

IBC Table 1607.1 gives minimum floor live loads based on use or occupancy of the building

## Examples

Residential Floor:	40 psf
Sidewalk:	250 psf or 8000 lb point load
Schools	
Classrooms:	40 psf or 1000 lb point load
Corridors above first floor:	80 psf or 1000 lb point load
First floor corridors:	100 psf or 1000 lb point load

# IBC Table 1607.1

## STRUCTURAL DESIGN

**TABLE 1607.1**  
**MINIMUM UNIFORMLY DISTRIBUTED LIVE LOADS AND MINIMUM CONCENTRATED LIVE LOADS<sup>a</sup>**

OCCUPANCY OR USE	UNIFORM (psf)	CONCENTRATED (lbs.)	OCCUPANCY OR USE	UNIFORM (psf)	CONCENTRATED (lbs.)
1. Apartments (see residential)	—	—	23. Libraries		
2. Access floor systems			Corridors above first floor	80	1,000
Office use	50	2,000	Reading rooms	60	1,000
Computer use	100	2,000	Stack rooms	150 <sup>b</sup>	1,000
3. Armories and drill rooms	150	—	24. Manufacturing		
4. Assembly areas and theaters			Heavy	250	3,000
Fixed seats (fastened to floor)	60	—	Light	125	2,000
Follow spot, projections and control rooms	50	—	25. Marquees	75	—
Lobbies	100	—	26. Office buildings		
Movable seats	100	—	Corridors above first floor	80	2,000
Stages and platforms	125	—	File and computer rooms shall be designed for heavier loads based on anticipated occupancy	—	—
5. Balconies	100	—	Lobbies and first-floor corridors	100	2,000
On one- and two-family residences only, and not exceeding 100 sq ft	60	—	Offices	50	2,000
6. Bowling alleys	75	—	27. Penal institutions		
7. Catwalks	40	300	Cell blocks	40	—
8. Dance halls and ballrooms	100	—	Corridors	100	—
9. Decks	Same as occupancy served <sup>d</sup>	—	28. Residential		
10. Dining rooms and restaurants	100	—	One- and two-family dwellings		
11. Dwellings (see residential)	—	—	Uninhabitable attics without storage <sup>e</sup>	10	—
12. Cornices	60	—	Uninhabitable attics with limited storage <sup>e,f</sup>	20	—
13. Corridors, except as otherwise indicated	100	—	Habitable attics and sleeping areas	30	—
14. Elevator machine room grating (on area of 4 in <sup>2</sup> )	—	300	All other areas except balconies and decks	40	—
15. Finish light floor plate construction (on area of 1 in <sup>2</sup> )	—	200	Hotels and multiple-family dwellings		
16. Fire escapes	100	—	Private rooms and corridors serving them	40	—
On single-family dwellings only	40	—	Public rooms and corridors serving them	100	—
17. Garages (passenger vehicles only)	40	Note a	29. Reviewing stands, grandstands and bleachers		Note c
Trucks and buses	See Section 1607.6	—	30. Roofs		
18. Grandstands (see stadium and arena bleachers)	—	—	All roof surfaces subject to maintenance workers		300
19. Gymnasiums, main floors and balconies	100	—	Awnings and canopies		
20. Handrails, guards and grab bars	See Section 1607.7	—	Fabric construction supported by a lightweight rigid skeleton structure	5	nonreducible
21. Hospitals			All other construction	20	—
Corridors above first floor	80	1,000	Ordinary flat, pitched, and curved roofs	20	—
Operating rooms, laboratories	60	1,000	Primary roof members, exposed to a work floor	20	—
Patient rooms	40	1,000	Single panel point of lower chord of roof trusses or any point along primary structural members supporting roofs		
22. Hotels (see residential)	—	—	Over manufacturing, storage warehouses, and repair garages		2,000
			All other occupancies		300
			Roofs used for other special purposes	Note 1	Note 1
			Roofs used for promenade purposes	60	—
			Roofs used for roof gardens or assembly purposes	100	—

(continued)

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

OCCUPANCY OR USE	UNIFORM (psf)	CONCENTRATED (lbs.)
31. Schools		
Classrooms	40	1,000
Corridors above first floor	80	1,000
First-floor corridors	100	1,000
32. Scuttles, skylight ribs and accessible ceilings	—	200
33. Sidewalks, vehicular driveways and yards, subject to trucking	250 <sup>g</sup>	8,000 <sup>g</sup>
34. Skating rinks	100	—
35. Stadiums and arenas		
Bleachers	100 <sup>g</sup>	—
Fixed seats (fastened to floor)	60 <sup>g</sup>	—
36. Stairs and exits		
One- and two-family dwellings	40	Note f
All other	100	—
37. Storage warehouses (shall be designed for heavier loads if required for anticipated storage)		
Heavy	250	—
Light	125	—
38. Stores		
Retail		
First floor	100	1,000
Upper floors	75	1,000
Wholesale, all floors	125	1,000
39. Vehicle barriers	See Section 1607.7.3	—
40. Walkways and elevated platforms (other than exitways)	60	—
41. Yards and terraces, pedestrians	100	—

# Floor Live Load Reduction

Floor Live Load reduction is permitted in most cases for members with large influence area ( $A_I$ )

**Tributary Area ( $A_T$ )** – Area assumed to load a given member (Lab 3)

**Influence Area ( $A_I$ )** – Total area assumed to influence the loading of a member. In practical situations, loads outside the tributary area may influence the performance of a member.

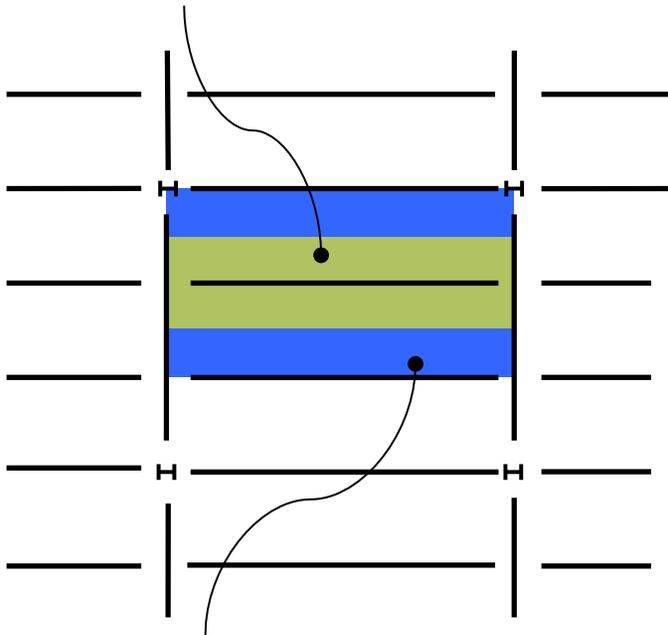
$$A_I = K_{LL} A_T$$

$K_{LL}$  = Live Load Element Factor (IBC Table 1607.9.1)

The consideration of the influence area in determining the unit live load is based on the probability that high unit loads are more likely to occur over small influence areas and less likely to occur over a large influence area.

# Tributary Area vs. Influence Area for an Interior Beam ( $K_{LL} = 2$ )

**Tributary Area ( $A_T$ )**  
[in yellow]



**Influence Area**  
( $A_I = 2A_T$ )  
[in blue]

TABLE 1607.9.1  
LIVE LOAD ELEMENT FACTOR,  $K_{LL}$

ELEMENT	$K_{LL}$
Interior columns	4
Exterior columns without cantilever slabs	4
Edge columns with cantilever slabs	3
Corner columns with cantilever slabs	2
Edge beams without cantilever slabs	2
Interior beams	2
All other members not identified above including: Edge beams with cantilever slabs Cantilever beams Two-way slabs Members without provisions for continuous shear transfer normal to their span	1

# IBC Floor Live Load Reduction

If  $A_I > 400 \text{ ft}^2$

Then the floor live load is

$$L = L_0 \left( 0.25 + \frac{15}{\sqrt{A_I}} \right)$$

$A_I$  is in units of  $\text{ft}^2$

where

$L_0$  = Basic (unreduced) floor unit live load from IBC Table 1607.1

$A_I = K_{LL} A_T$

$A_T$  = Tributary area of member in  $\text{ft}^2$

$K_{LL}$  = Live Load Element Factor (IBC Table 1607.9.1)

Note:

If  $A_I \leq 400 \text{ ft}^2$  then  $L = L_0$  (no reduction)

If  $L_0 \geq 100 \text{ psf}$  then  $L = L_0$  (no reduction)

$L_{min} = 0.5L_0$  for members supporting one floor (beams)

$L_{min} = 0.4L_0$  for members supporting 2 or more floors (columns)

# Roof Live Load ( $L_r$ )



# Roof Live Load ( $L_r$ )

The IBC Basic Roof Live Load is 20 psf. The basic roof live load is the same for all roofs as it is associated with roof maintenance.

Roof Live Load reduction is permitted for members with large tributary area ( $A_T$ ) and for roof slopes in excess of 4 inches per foot.

$$L_r = 20R_1R_2 \quad \text{where } L_r \text{ is in units of psf}$$

$$R_1 = \begin{cases} 1 & \text{for } A_T \leq 200 \text{ ft}^2 \\ 1.2 - 0.001A_T & \text{for } 200 \text{ ft}^2 < A_T < 600 \text{ ft}^2 \\ 0.6 & \text{for } A_T \geq 600 \text{ ft}^2 \end{cases}$$

$$R_2 = \begin{cases} 1 & \text{for } F \leq 4 \\ 1.2 - 0.05F & \text{for } 4 < F < 12 \\ 0.6 & \text{for } F \geq 12 \end{cases}$$

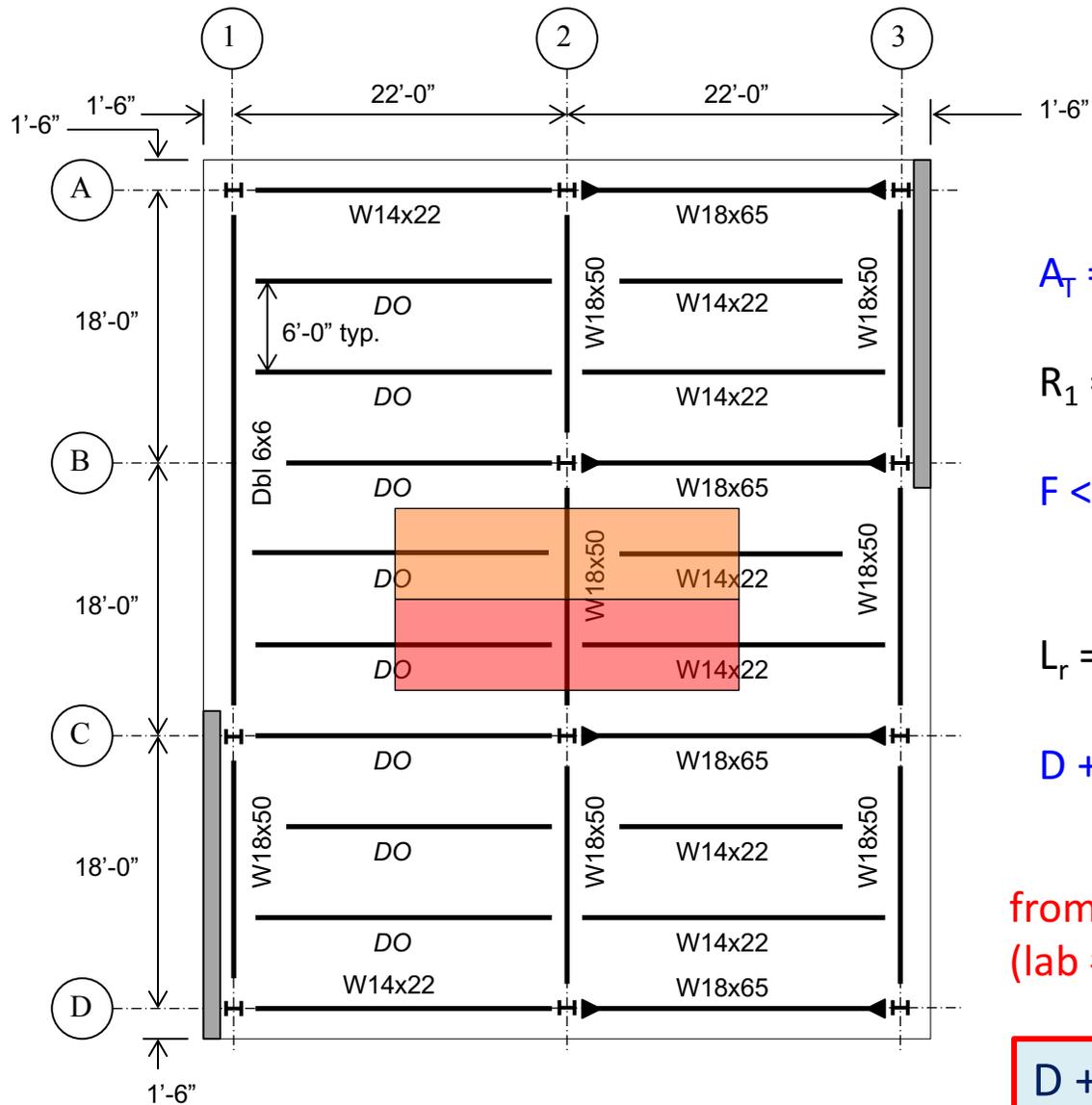
where

$A_T$  = Tributary area of member in  $\text{ft}^2$

$F$  = roof slope in inches of rise per foot

Note: Minimum allowable  $L_r = 12 \text{ psf}$

# Roof Live Load for W18x50 on Line 2



$$A_r = (12 \text{ ft})(22 \text{ ft}) = 264 \text{ ft}^2 > 200 \text{ ft}^2$$

$$R_1 = 1.2 - 0.001(264) = 0.936$$

$$F < 4 \text{ so } R_2 = 1.0$$

$$L_r = 20(0.936)(1.0) = \mathbf{18.72 \text{ psf}}$$

$$D + L_r = 28 + 18.72 = 46.72 \text{ psf}$$

from dead load table for W18x50 (lab #4)

$$D + L_r = 28 + 18.72 = 46.72 \text{ psf}$$

# Recall Dead Load Table from Lab 4

Load Path →

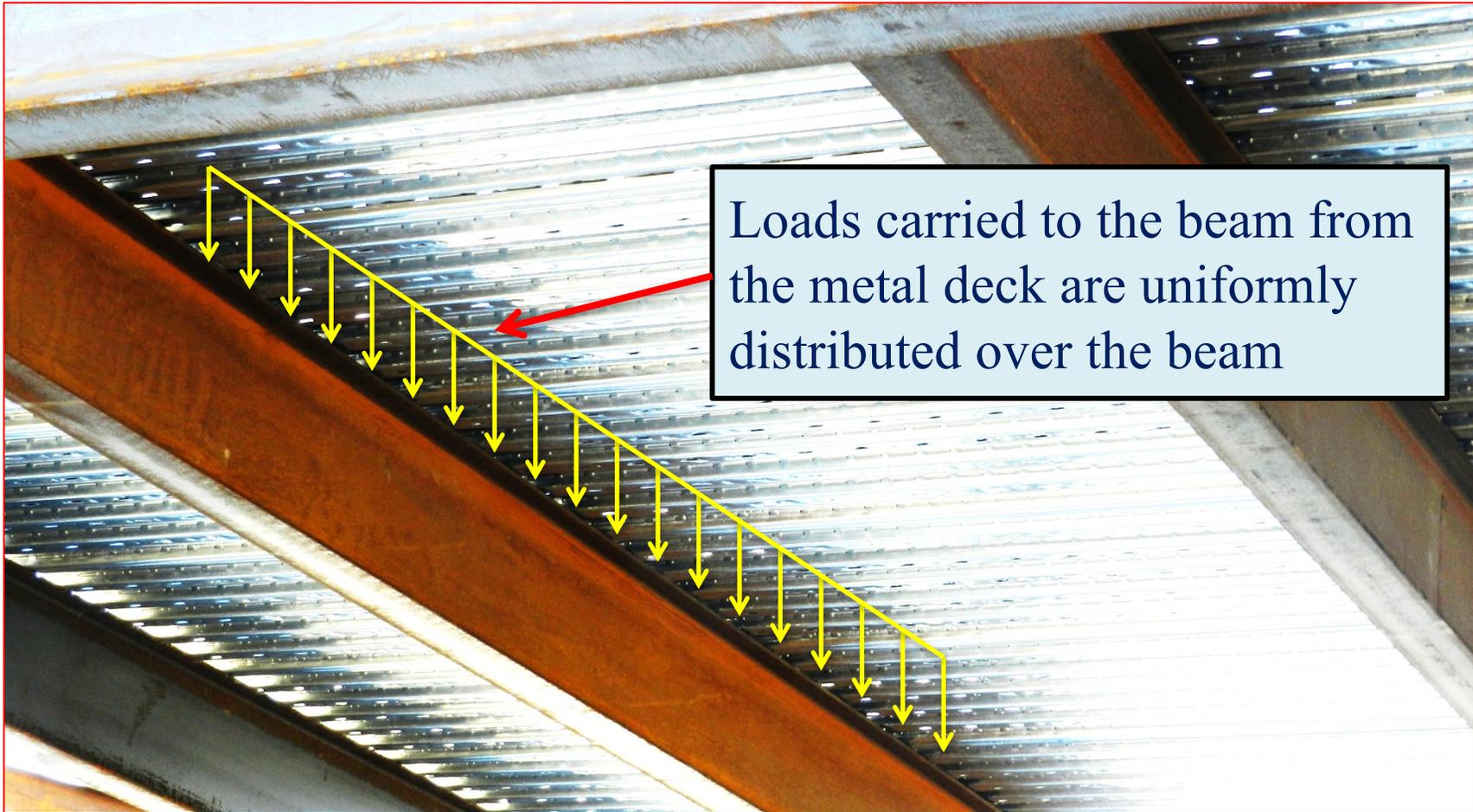
Material	Load Path →			
	To metal deck	To beams (W14x22)	To girders, truss (Lines 1-3)	To columns
1-1/2" 18 gauge metal deck	2.82 (A)	2.82	2.82	2.82
Fireproofing	0.5	0.5	0.5	0.5
2" Rigid fiberglass insulation	3 (B)	3	3	3
3 ply felt tar and gravel roofing	5.5 (B)	5.5	5.5	5.5
Ceiling and Lighting	1 (B)	1	1	1
W14x22 @ 6 ft o.c.		3.7 (C)	3.7	3.7
Mechanical (plumbing, HVAC)		4	4	4
W18x50, truss			4	4
Weight of columns				1
Misc.	3	3	3	3
<b>Total</b>	15.82	23.52	27.52	28.52
<b>Use</b>	<b>16 psf</b>	<b>24 psf</b>	<b>28 psf</b>	<b>29 psf</b>

Notes:

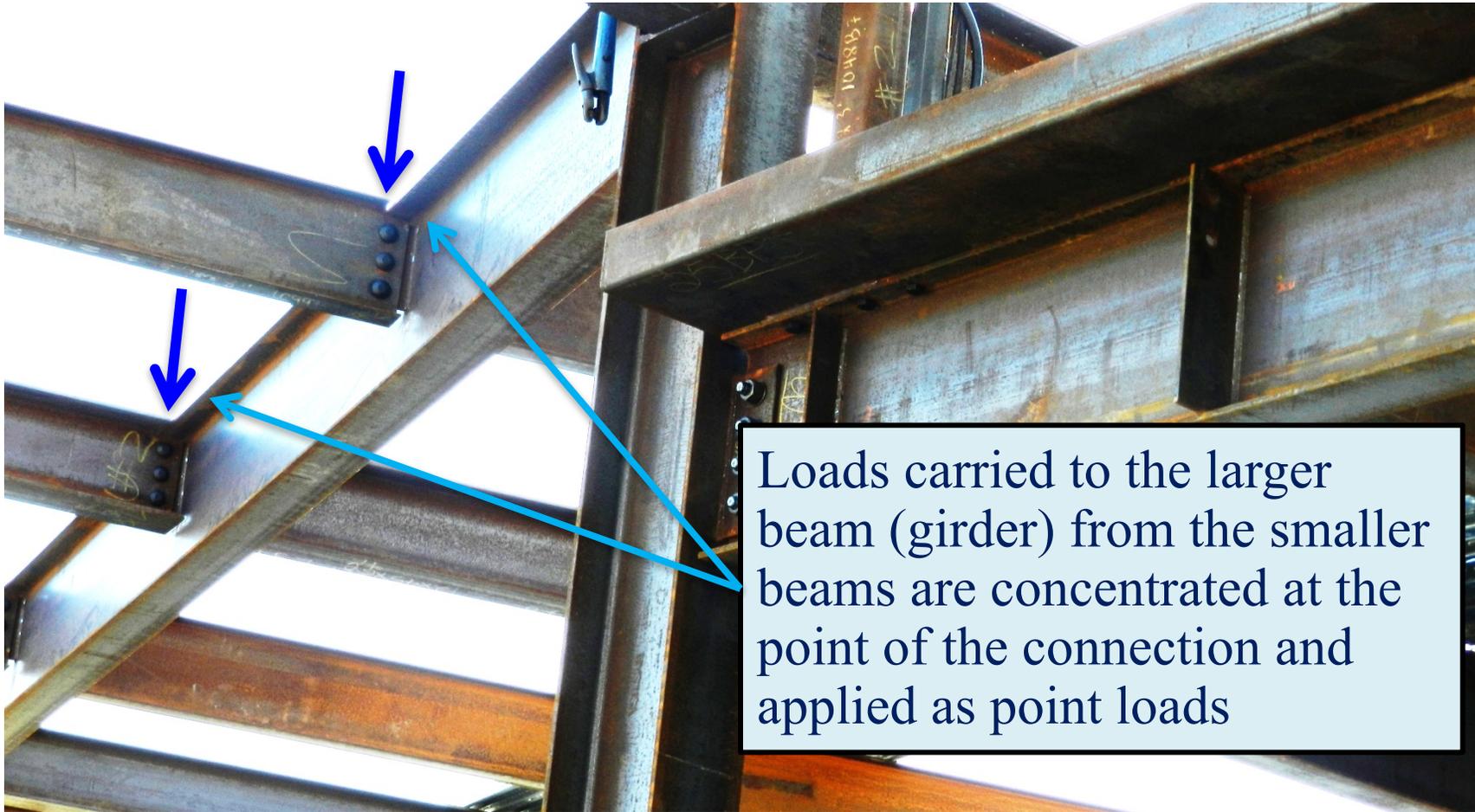
- A. From Vulcraft deck catalog.
- B. From AISC steel manual "Weights of Building Materials".
- C. W14x22:  $(22 \text{ lb/ft}) / (6 \text{ ft}) = 3.7 \text{ psf}$ .

Dead load for W18x50

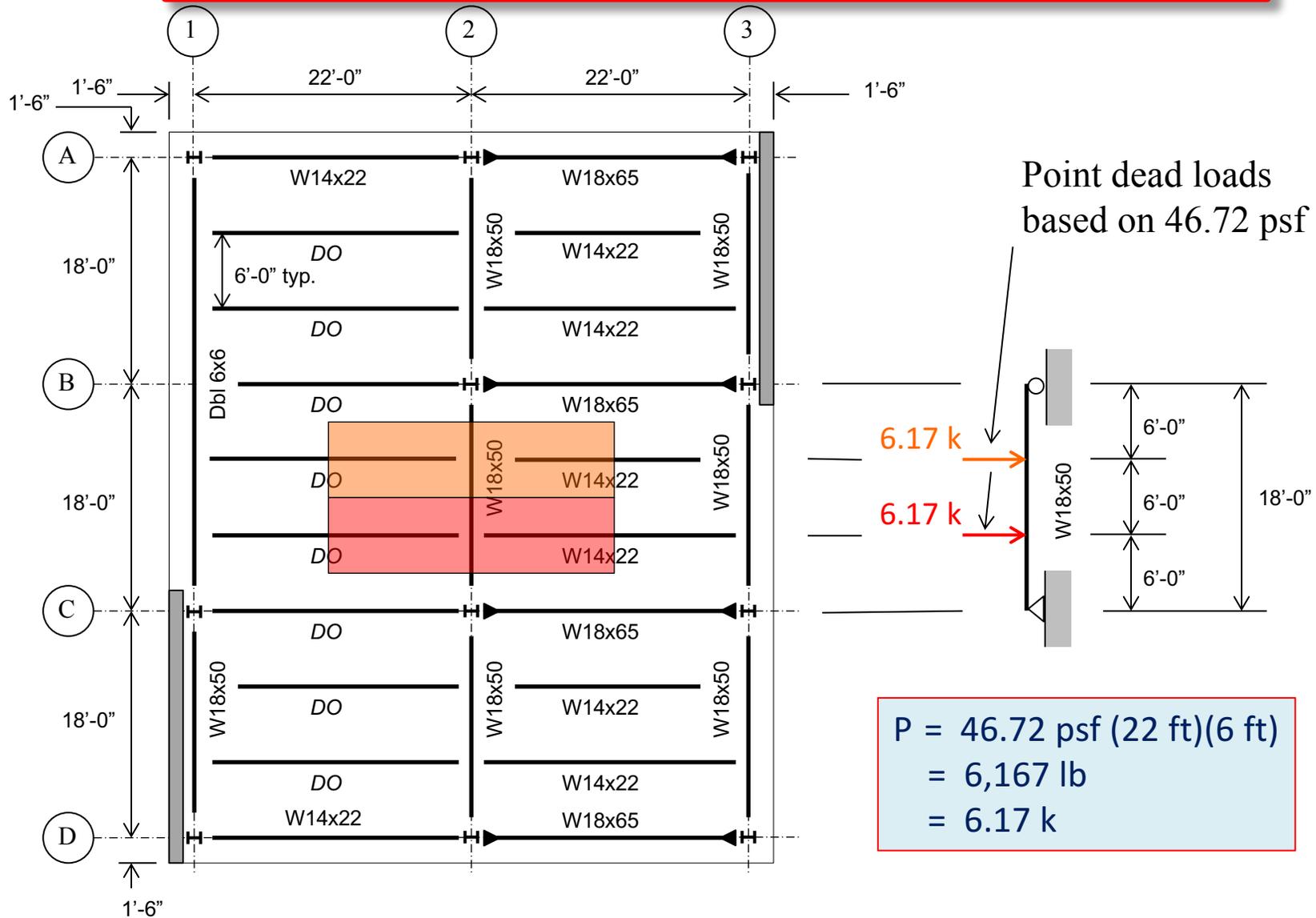
## Deck Carries Uniform Load to Beams



## Vertical (Gravity) Load Path



# Idealization for W18x50 Loaded with Dead Load and Roof Live Load



$$\begin{aligned}
 P &= 46.72 \text{ psf} (22 \text{ ft})(6 \text{ ft}) \\
 &= 6,167 \text{ lb} \\
 &= 6.17 \text{ k}
 \end{aligned}$$

# Idealization of W10x33 Column at C-1 Loaded with Dead Load and Roof Live Load

