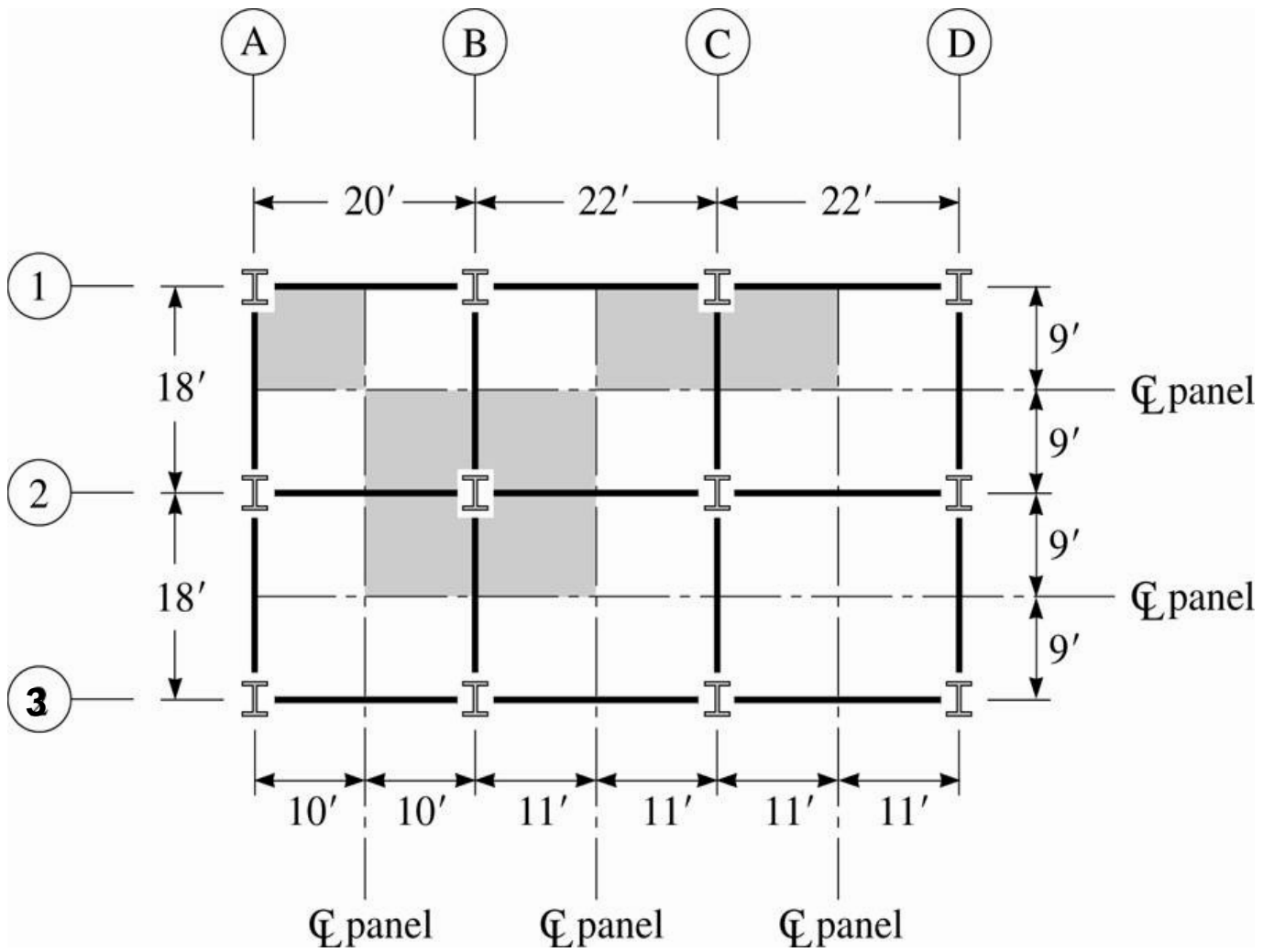


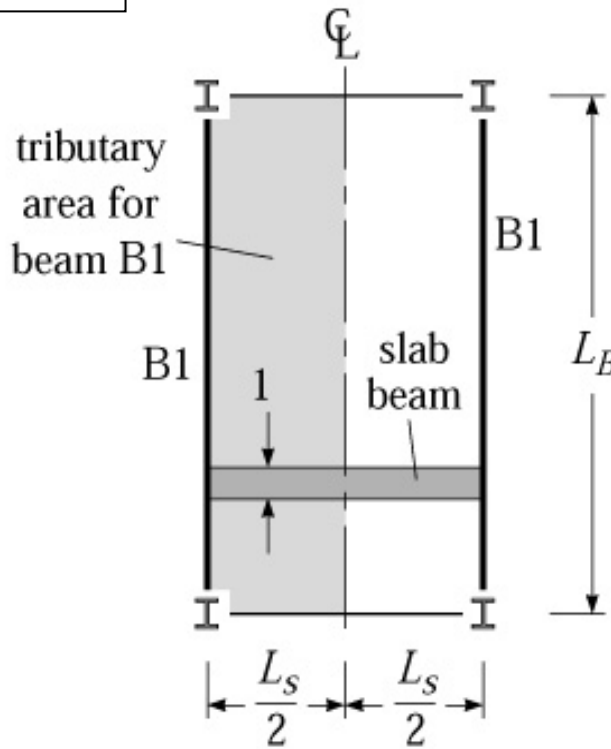
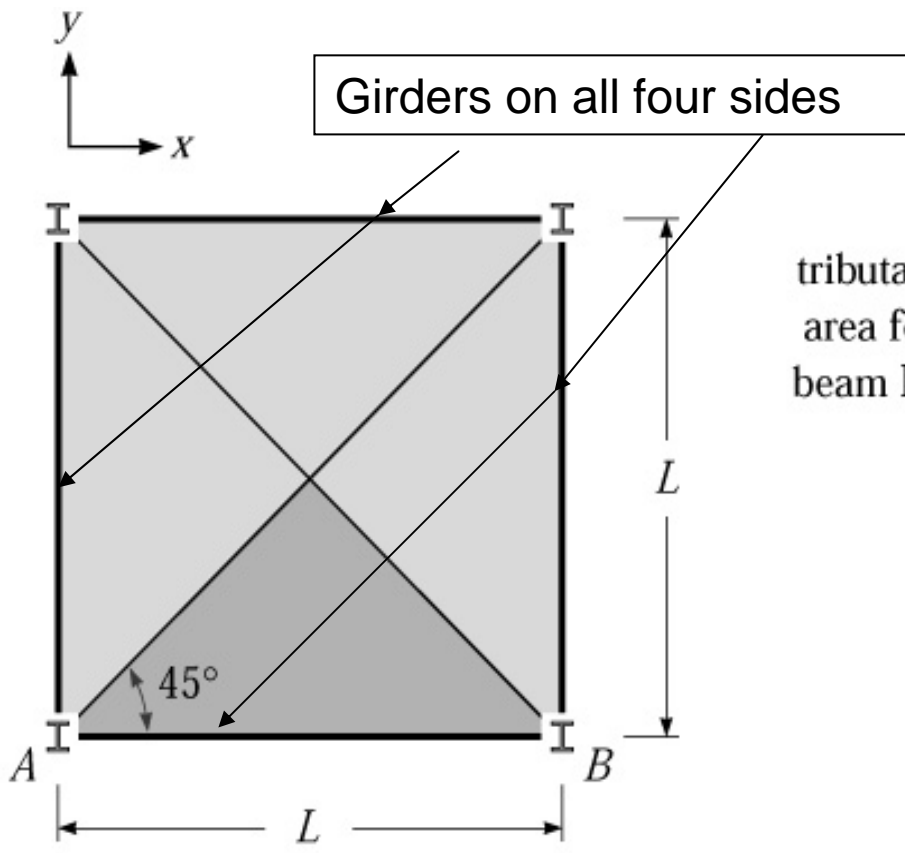
System Loading

Tributary Areas

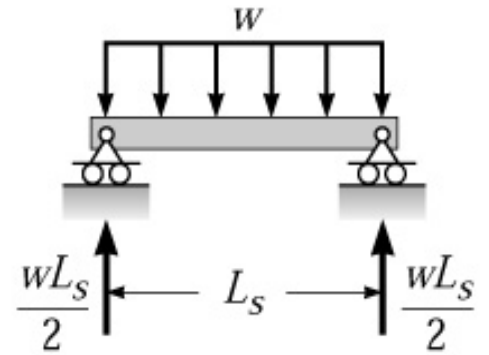
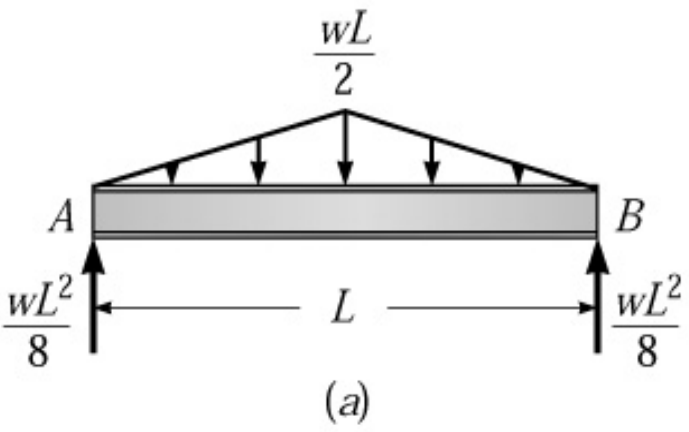
Many floor systems consist of a reinforced concrete slab supported on a rectangular grid of beams. Such a grid of beams reduces the span of the slab and thus permits the designer to reduce the slab thickness. The distribution of floor loads on floor beams is based on the geometric configuration of the beams forming the grid.



**Tributary area of columns A1,
B2 and C1 shown shaded**

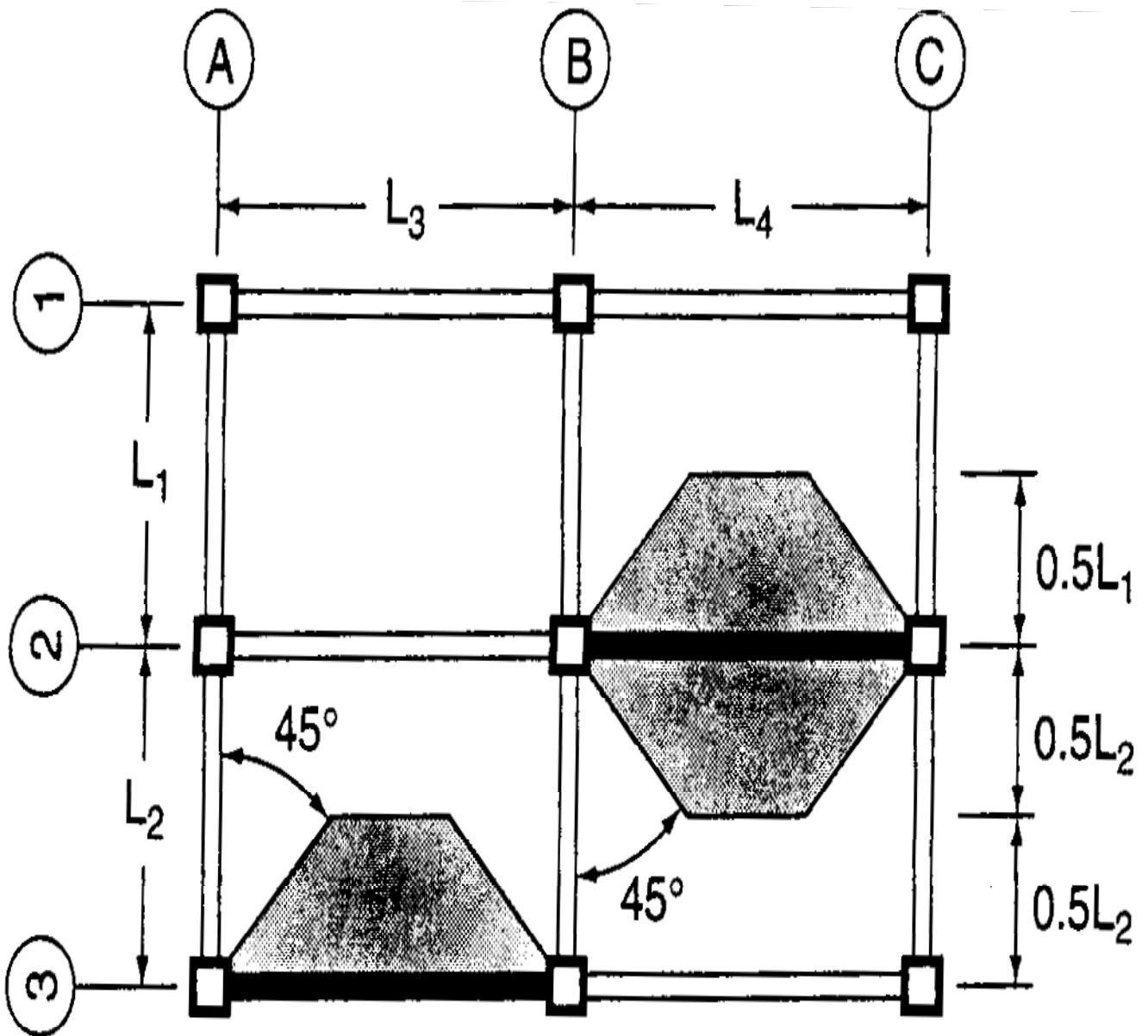


(b)

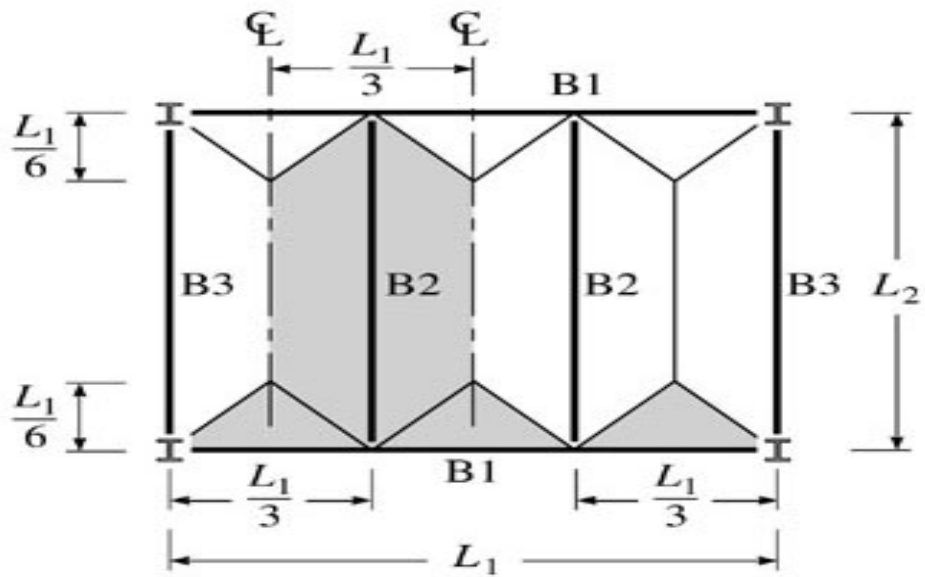


(c)

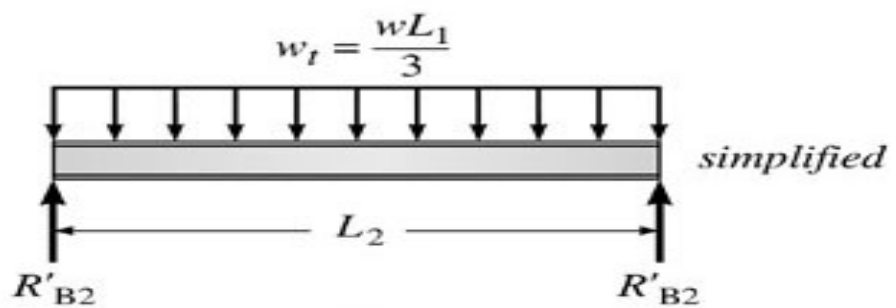
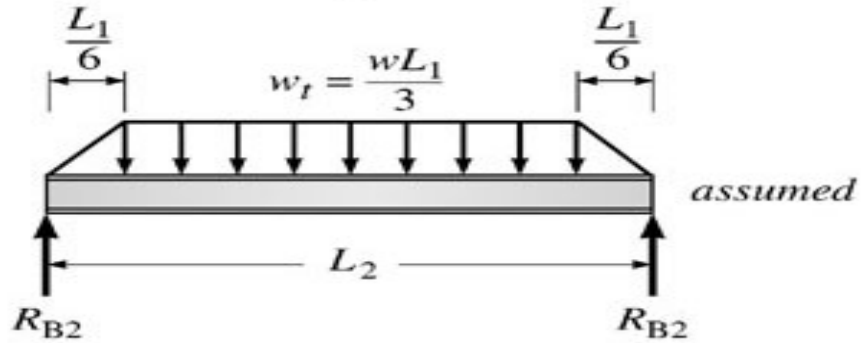
Theoretical Tributary Areas



Theoretical Tributary Beam Areas

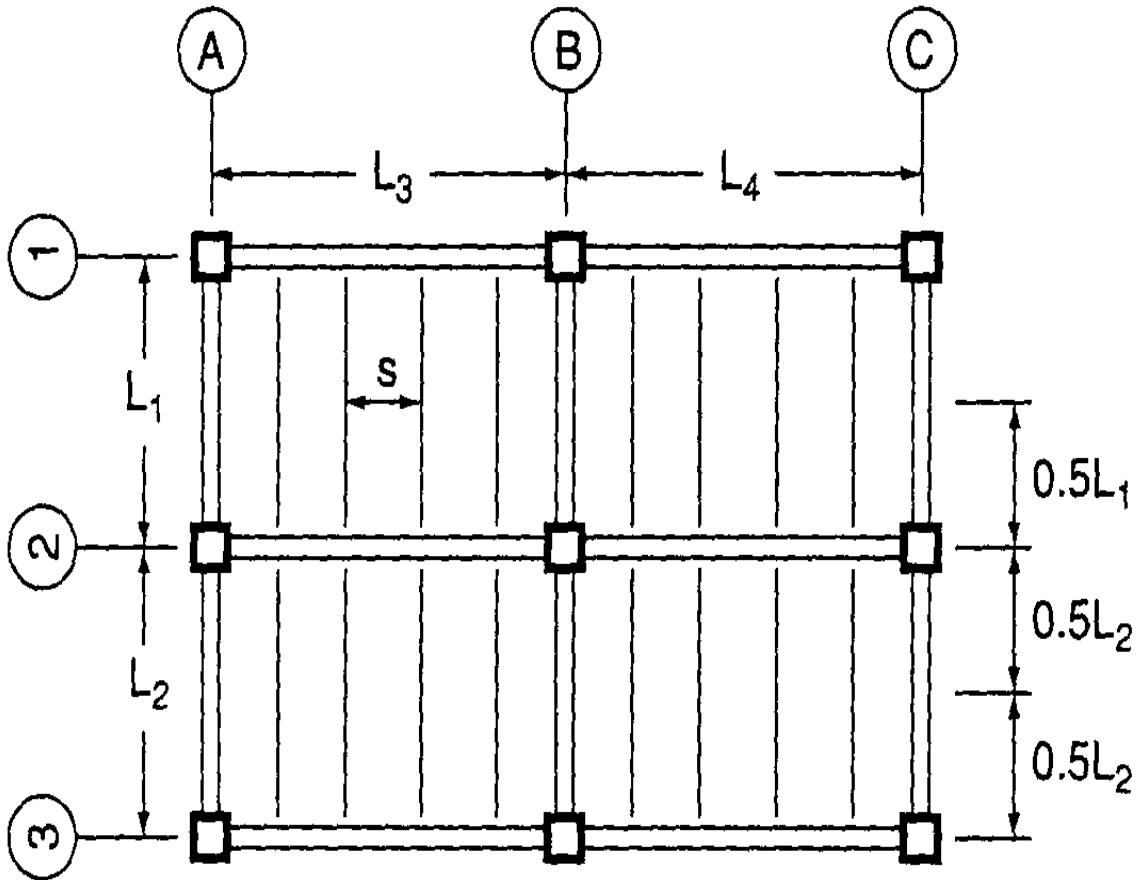


(d)

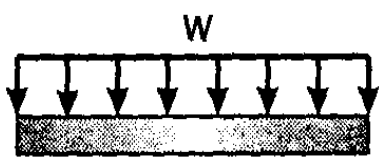


(e)

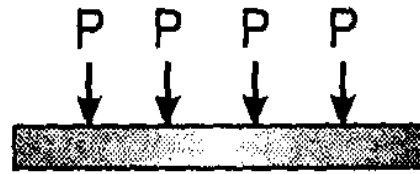
Theoretical Tributary Beam Areas



Typical Floor Framing System



Floor Beam



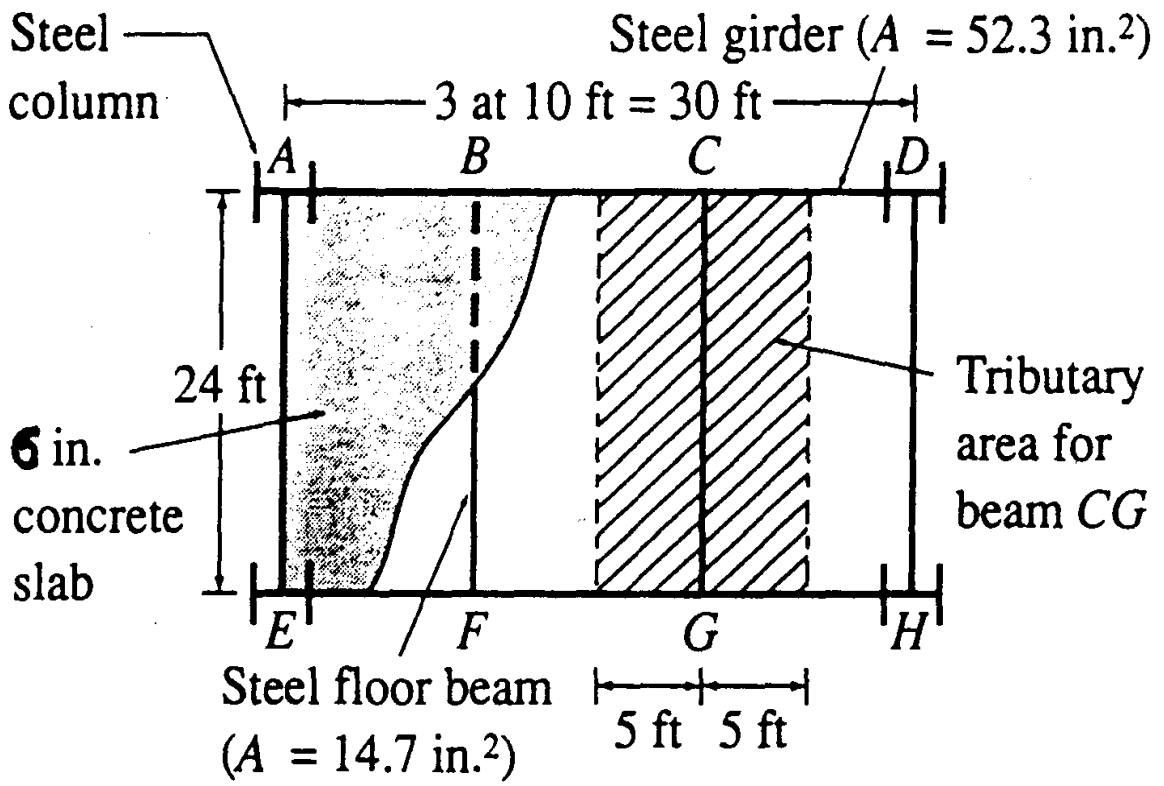
Girder

Simplified Floor Beam and Girder Loadings

Example Load Distribution Problem

The floor system of a library consists of a 6-in thick reinforced concrete slab resting on four floor steel beams, which in turn are supported by two steel girders. Cross-sectional areas of the floor beams and girders are 14.7 in^2 and 52.3 in^2 , respectively as shown on the next page figure.

Determine the floor loads on the floor beams, girders, and columns.



Floor Slab – Floor Beam – Girder – Column Schematic

Building Live Load Reduction

Recognizing that the probability of supporting a large, fully loaded tributary area is small; building codes permit reductions in the **standard (L_0) design live loads** when the ***influence area* ($A_I = K_{LL}A_T$)** is larger than 400 ft² (37.2 m²) as given in the following formulas:

$$L = L_0 \left(0.25 + \frac{15}{\sqrt{K_{LL} A_T}} \right) \quad \text{US Units}$$

$$L = L_0 \left(0.25 + \frac{4.57}{\sqrt{K_{LL} A_T}} \right) \quad \text{SI Units}$$

L \equiv reduced live load

$$0.50 L_0 \leq L \leq L_0$$

for single floor members

$$0.40 L_0 \leq L \leq L_0$$

for multi-floor members

A_T \equiv tributary area ft² (m²)

K_{LL} - element live load factors
(IBC2000 – Table 1607.9.1)

Type of Element	K_{LL}
Interior column	4
Exterior column 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 beams	1

Load Combinations for Strength Design

The forces (e.g., axial force, moment, and shear) produced by various combinations of loads need to be combined in a proper manner and increased by a load factor in order to provide a level of safety or safety factor.

Combined loads represent the minimum strength for which members need to be designed, also referred to as *required factored strength*. ASCE 7-98 has specified the following load combinations:

$$(1): 1.4 D$$

$$(2): 1.2 (D + F + T) + 1.6 (L + H) \\ + 0.5 (Lr \text{ or } S \text{ or } R)$$

$$(3): 1.2 D + 1.6 (Lr \text{ or } S \text{ or } R) \\ + (0.5 L \text{ or } 0.8 W)$$

$$(4): 1.2 D + 1.6 W + 0.5 L \\ + 0.5 (Lr \text{ or } S \text{ or } R)$$

$$(5): 1.2 D + 1.0 E + 0.5 L \\ + 0.2 S$$

$$(6): 0.9 D + 1.6 W + 1.6 H$$

$$(7): 0.9 D + 1.0 E + 1.6 H$$

The load multipliers are based on the probability of the load combination occurring as well as the accuracy with which the design load is known.

D = Dead load

L = Live load

L_r = Roof Live load

W = Wind load

E = Earthquake load

S = Snow load

R = Rain load

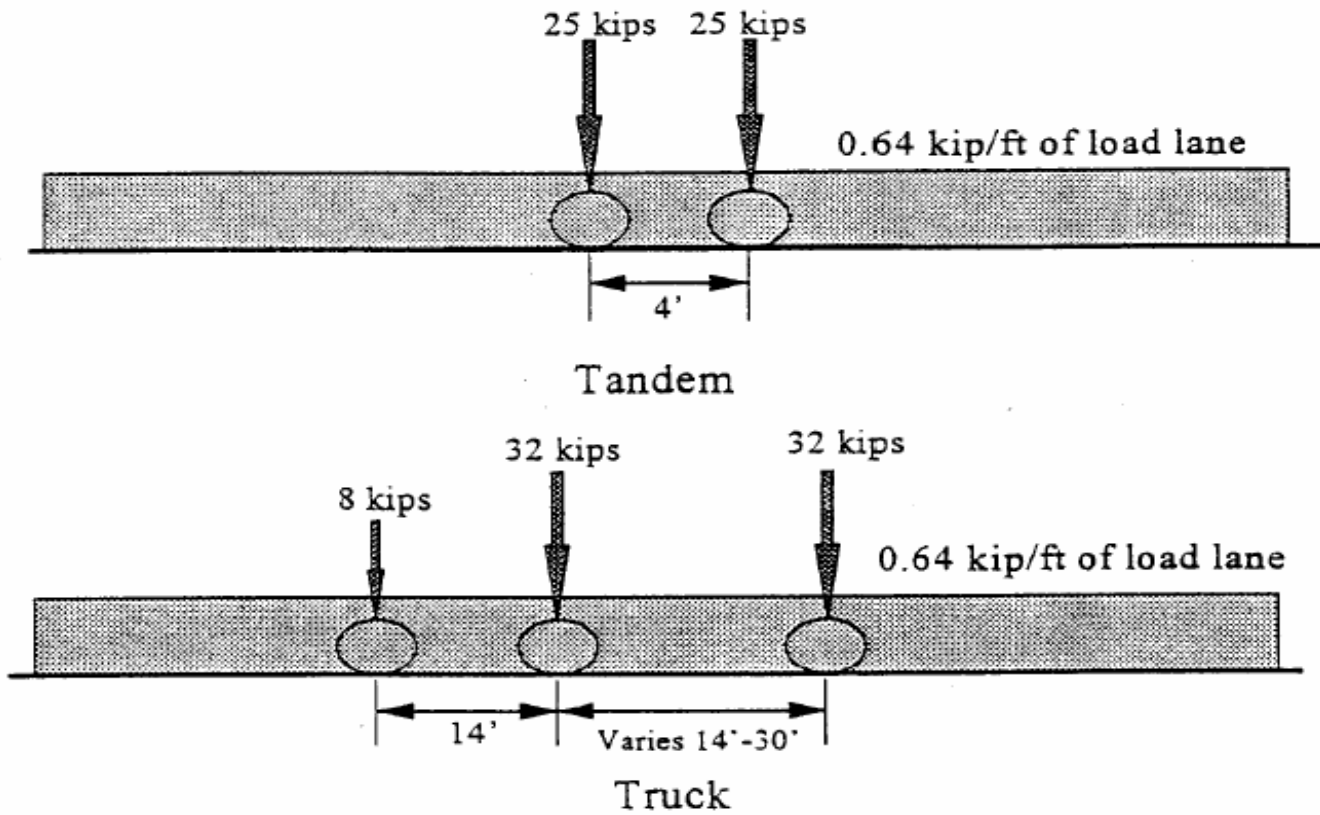
F = Flood load

T = Temperature or self-strain load

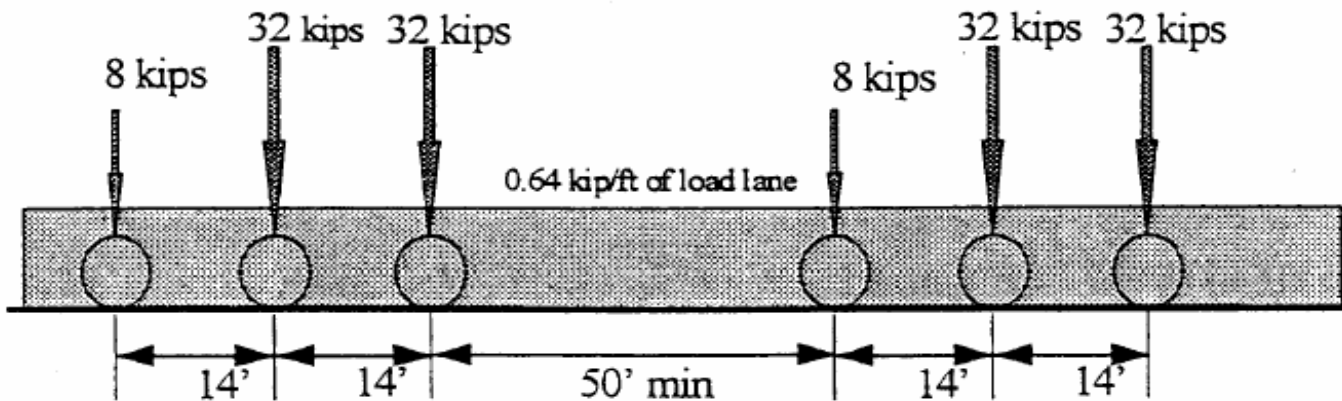
H = Hydrostatic pressure load

Design of a member or of a segment of a member must be based on the load case that produces the largest force /stress/displacement value.

HL93 Design Live Load



Negative Moment and Interior Reaction Load*



*90% of total effect

AASHTO LRFD Loading

Force Envelope

Forces in a particular structural component are caused by (1) loads acting on the structure and (2) load location. **Force envelope** is a plot of the maximum and minimum force responses along the length of a member due to any proper placement of loading for any specified design load combination.