Tutorial N°01 (TD N°01)

Of Chapter I

Exercise N°01:

The floor beam in Fig.1 is used to support the 1.8 m width of a lightweight plain concrete slab having a thickness of 100 mm. The slab serves as a portion of the ceiling for the floor below, and therefore its bottom is coated with plaster. Furthermore, a 3 m-high, 300-mm-thick lightweight concrete block wall is directly over the top flange of the beam. Determine the loading on the beam measured per meter of length of the beam.

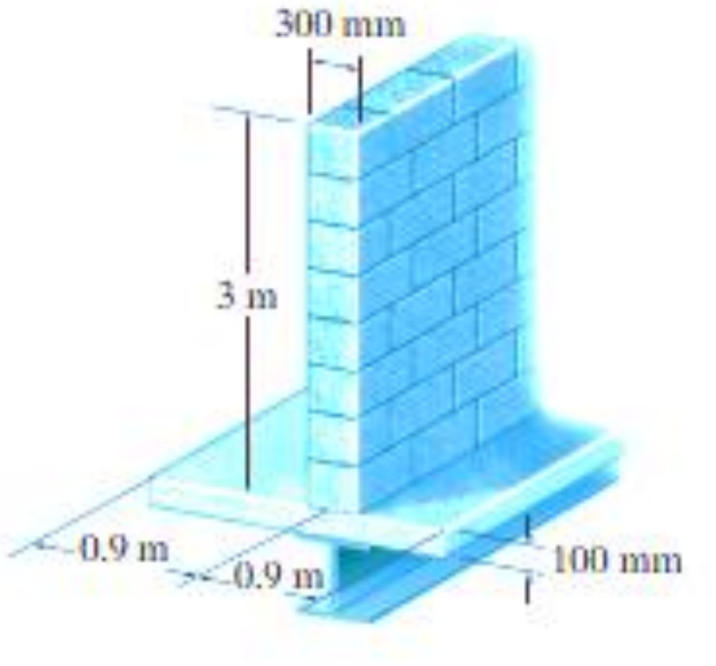


Fig.1

<u>Solution</u>:

Using the data in Tables 1.2 and 1.3 (in the lecture N°01), we have:

Concrete slab: 30.015 $kN/(m^2 . mm)$ x (100 mm) (1.8 m) =	2.70 kN/m
Plaster ceiling: (0.24 kN/m^2) (1.8 m) =	0.43 kN/m
Block wall: (16.5 kN/m^3) (3 m) (0.3 m) =	14.85 kN/m
Total load:	**17.98 kN/m**

Exercise N°02:

The floor of a building, shown in Fig. 2 (a), is subjected to a uniformly distributed load of 3.5 kPa over its surface area. Determine the loads acting on all the members of the floor system.

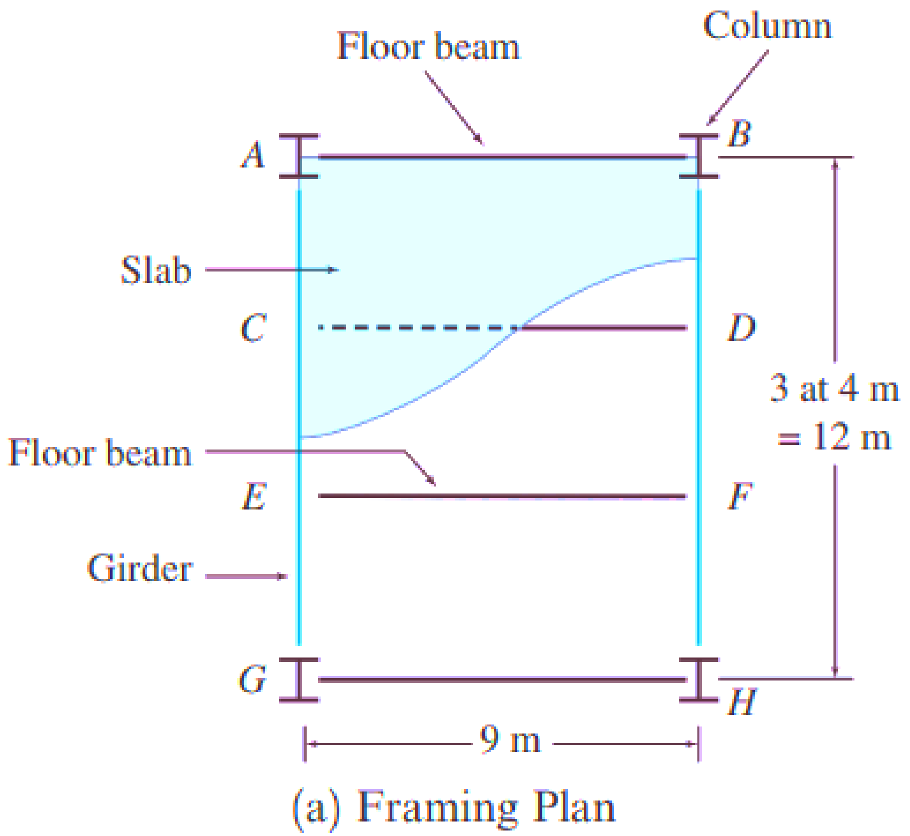
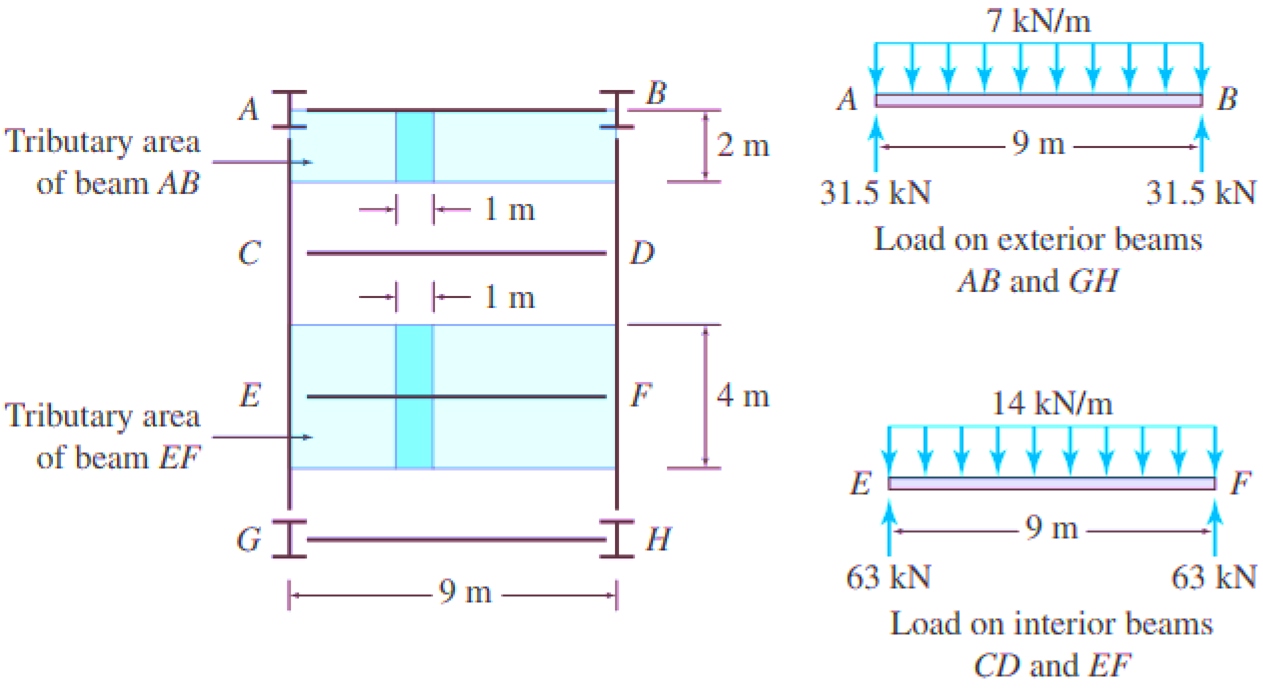


Fig. 2 (a)

<u>Solution</u>:

Beams:

The tributary areas of the exterior beam AB, and the interior beam EF, are shown in Fig. 2 (b). Considering the exterior beam AB first, we can see that each one-meter length of the beam supports the load applied over a strip of the slab area (= 2 m x 1 m) = 2 m^2. Thus, the load transmitted to each one-meter length of the beam AB is:



(b) Load on Beams

Fig. 2 (b)

This 7 kN/m load is uniformly distributed along the length of the beam, as shown in Fig. 2 (b). This figure also shows the reactions exerted by the supporting girders at the beam's ends. As the beam is symmetrically loaded, the magnitudes of the reactions are equal to half of the total load acting on the beam:

RA = RB= (1/2)(7 kN/m)(9 m) = 31.5kN

The load on the interior beam EF is computed in a similar manner. From Fig. 2(b), we see that the load transmitted to each one-meter length of the beam EF is

(3.5 kN/m²)(4 m)(1 m) = 14kN

This load acts as a uniformly distributed load of magnitude 14 kN/m along the beam's length. The reactions of the interior beam are:

RE= RF= (1/2)(14 kN/m)(9 m) = 63kN

Because of the symmetry of the framing plan and loading, the remaining beams CD and GH are subjected to the same loads as the beams EF and AB, respectively.

Girders:

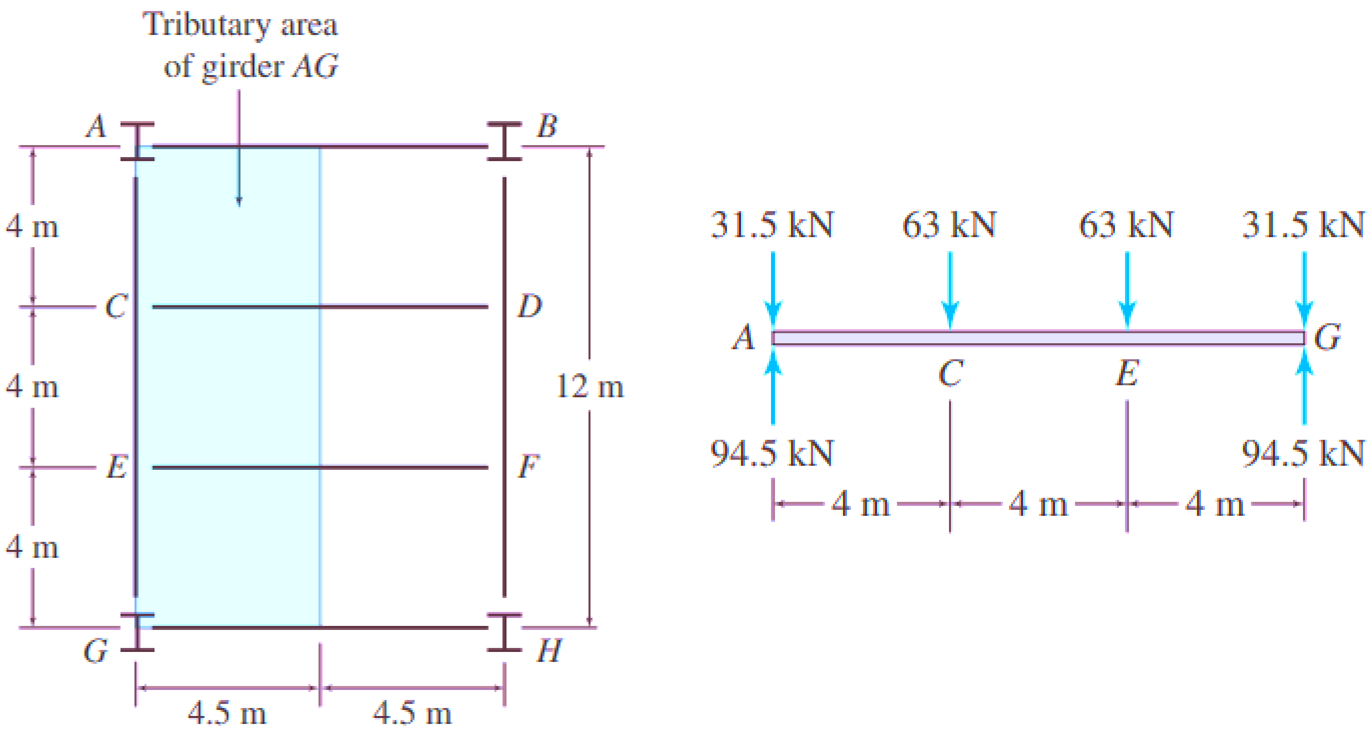
The girder loads can be conveniently obtained by applying the beam reactions as concentrated loads (in reverse directions) at their corresponding support (connection) points on the girder. As shown in Fig. 2(c), since girder AG supports exterior beams AB and GH at points A and G, the reactions (31.5 kN) of the two exterior beams are applied at these points. Similarly, the reactions of two interior beams (CD and EF) are applied at points C and E, where these interior beams are supported on the girder. Note that the sum of the magnitudes of all four concentrated loads applied to the girder equals its tributary area (4.5 m x 12m) multiplied by the floor load intensity (3.5 kN/m²), that is (see Fig. 2(c))

$$31.5\ \text{kN} + 63\ \text{kN} + 63\ \text{kN} + 31.5\ \text{kN} = (3.5\ \text{kN/m}^2)\,(4.5\ \text{m})(12\ \text{m}) = 189\ \text{kN}$$

As shown in Fig. 2(c), the end reactions of the girder are:

$$R_A = R_G = (1/2)\,[2(31.5) + 2(63)] = 94.5\ \text{kN}$$

Because of symmetry, the load on girder BH is the same as on girder AG



(c) Load on Girders *AG* and *BH*

Fig. 2 (c)

Columns:

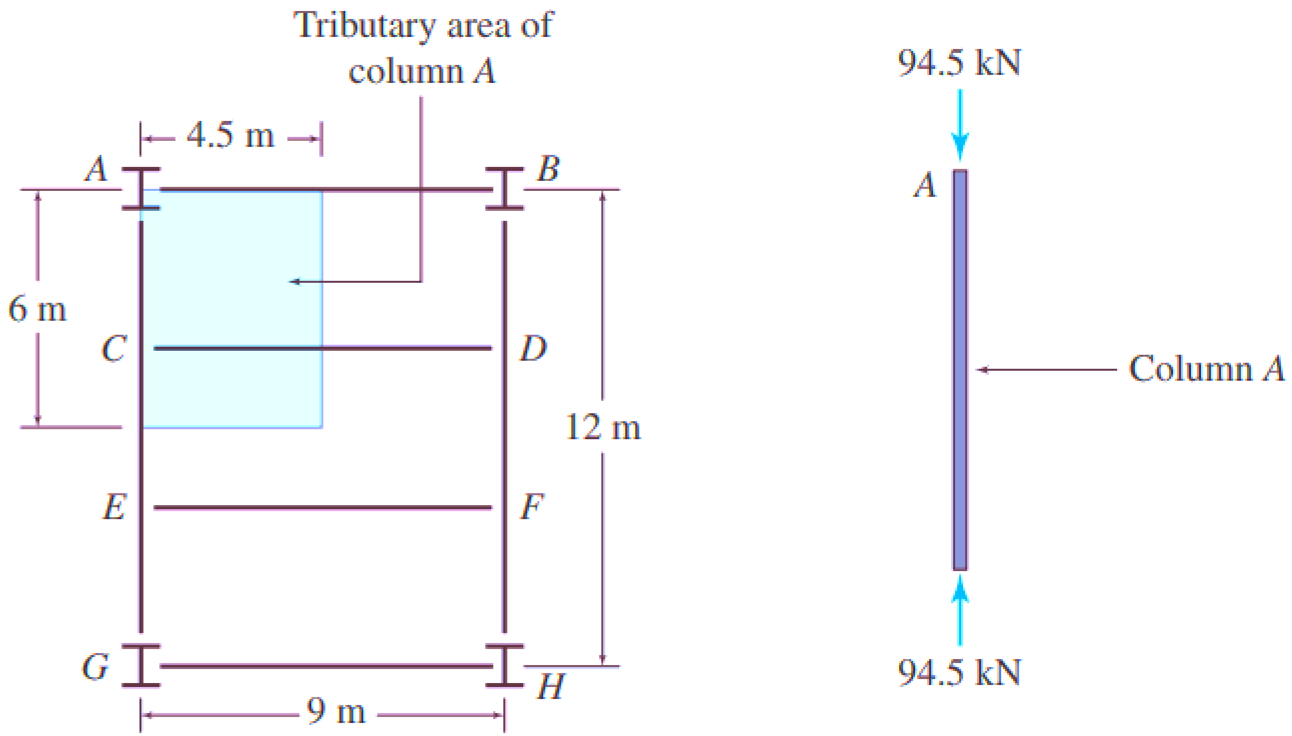
As shown in Fig. 2(d), the axial load on column A is obtained by applying the reaction RA (= 94.5 kN) of girder AG on the column with its direction reversed. This column axial load can also be evaluated by multiplying the tributary area (4.5 m x 6 m) of column A by the floor load intensity (3.5 kN/m 2), that is (see Fig. 2(d))

$$(3.5\ kN/m^2)(4.5m)(6m) = 94.5\ kN$$

Because of symmetry, the three remaining columns are subjected to the same axial compressive load as column A.

Finally, the sum of the axial loads carried by all four columns must be equal to the product of the total surface area of the floor, times the floor load intensity:

$$4(94.5\ kN) = (3.5\ kN/m^2)\ (9\ m)(12m) = 378\ kN$$



(d) Compressive Axial Load on Columns *A*, *B*, *G*, and *H*

Fig. 2 (d)

References:

Hibbeler, R C. 2020. Structural Analysis. Tenth Edition in SI Unites, Pearson Education, Inc.

Kassimali, A. 2015. Structural Analysis. Fifth Edition, Timothy Anderson, USA.