Design of Concrete Structures 16th edition Darwin Solutions Manual

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1.1. The building in Fig. P1.1 is used for general office space. The slab is 8 in. thick. The beams are 12 in. wide and have a total depth of 18 in., the bay dimensions are 18.5 ft in the *X* direction and 21 ft in the *Y* direction, and the superimposed service dead load is 18 psf. Calculate the slab service load in psf and the interior beam service load in klf. (**Solution:** q_s = 175 psf, w_s = 3.36 klf.)

SOLUTION

From table 1.1 Office load $q_l := 50 \cdot psf$

Concrete unit weight $\gamma_c := 150 \cdot pcf$

$t := 8 \cdot in$

Slab load $q_d := t \cdot \gamma_c = 100\ psf$

Superimposed dead load $q_{sdl} := 25 \cdot psf$

Service load $q_s := q_l + q_d + q_{sdl} = 175\ psf$

The beam length is 21 feet and the tributary width is 18.5 ft. The beam is 12×18 in. of which 10 in. is below the slab.

$w_{beam} := (18 \cdot in - t) \cdot 12 \cdot in \cdot \gamma_c = 125\ plf$

$w_s := 18.5 \cdot ft \cdot q_l + 18.5 \cdot ft \cdot (q_d + q_{sdl}) + w_{beam} = 3363\ plf$ $\qquad w_s = 3.36\ klf$

1.2. The building in Fig. P1.1 is used for general office space. The slab is 8 in. thick. The beams are 12 in. wide and have a total depth of 18 in., the bay dimensions are 18.5 ft in the *X* direction and 21 ft in the *Y* direction, and the superimposed service dead load is 25 psf. Calculate the factored axial column load transferred to column C3 on the 3 rd floor. (**Solution:** P_u = 92.5 kips.)

SOLUTION $\gamma_c := 150 \cdot pcf$ $q_l := 50 \cdot psf$ $q_{sdl} := 25 \cdot psf$

Slab load $t := 8 \cdot in$ $q_d := t \cdot \gamma_c = 100\ psf$

Tributary area $A_t := 18.5 \cdot ft \cdot 21 \cdot ft = 388.5\ ft^2$

$w_{beam} := (18 \cdot in - t) \cdot 12 \cdot in \cdot \gamma_c = 125\ plf$

$P_u := 1.6 \cdot A_t \cdot q_l + 1.2 \cdot A_t \cdot (q_d + q_{sdl}) + 1.2 \cdot w_{beam} \cdot 21 \cdot ft = 92.5\ kip$

1.3. The building in Fig. P1.1 is used for general office space. The slab is 8 in. thick. The beams are 12 in. wide and have a total depth of 18 in., the bay dimensions are 18.5 ft in the *X* direction and 21 ft in the *Y* direction, and the superimposed service dead load is 25 psf. Calculate the slab factored load in psf and the beam factored load in klf. Comment on your solution in comparison with Problem 1.1.

SOLUTION $\gamma_c := 150 \cdot pcf$ $q_l := 50 \cdot psf$ $q_{sdl} := 25 \cdot psf$

Slab load $t := 8 \cdot in$ $q_d := t \cdot \gamma_c = 100\ psf$

$q_u := 1.6 \cdot q_l + 1.2 \cdot (q_d + q_{sdl}) = 230\ psf$

From Problem 1.1 $\frac{q_u}{q_s} = 1.314$

$w_{beam} := (18 \cdot in - t) \cdot 12 \cdot in \cdot \gamma_c = 125\ plf$

The tributary width is $l := 18.5 \cdot ft$

$w_u := 1.6 \cdot q_l \cdot l + 1.2 \cdot (q_d + q_{sdl}) \cdot l + w_{beam} = 4.38\ klf$

Compare to Problem 1.1 $\frac{w_u}{w_s} = 1.3$

This ratio is between 1.2 and 1.6 and suggests that the majority of the load comes from long term loadings.

1.4. A slab in Fig. P1.1 is used for lobby space. The slab is 10 in. thick. The beams are 14 in. wide and have a total depth of 24 in., the bay dimensions are 21 ft in the *X* direction and 26 ft in the *Y* direction, and the superimposed service dead load is 15 psf. Calculate the slab factored load in psf and the beam factored load in klf.

SOLUTION

$b := 14 \cdot in$ $h := 24 \cdot in$ $t := 10 \cdot in$ $q_{sdl} := 15 \cdot psf$

From Table 1.1 the lobbly live load is $q_l := 100 \cdot psf$ $\gamma_c := 150 \cdot pcf$

$q_{slab} := \gamma_c \cdot t = 125\ psf$

$w_{beam} := (h - t) \cdot b \cdot \gamma_c = 204\ plf$

$q_u := 1.2 \cdot (q_{slab} + q_{sdl}) + 1.6 \cdot q_l = 328\ psf$

The beam tributary width length is $l := 21 \cdot ft$

$w_u := q_u \cdot l + 1.2 \cdot w_{beam} = 7.13\ klf$

1.5. The building in Fig. P1.1 is used for light storage space. The slab is 10 in. thick. The beams are 16 in. wide and have a total depth of 20 in., the bay dimensions are 20 ft in the *X* direction and 25 ft in the *Y* direction, and the superimposed sprinkler dead load is 4 psf. Calculate the slab factored load in psf and the beam factored load in klf.

SOLUTION

$b := 16 \cdot in$ $h := 20 \cdot in$ $t := 10 \cdot in$ $q_{sdl} := 4 \cdot psf$ $\gamma_c := 150 \cdot pcf$

From Table 1.1 the light storage live load is $q_l := 125 \cdot psf$

$q_{slab} := \gamma_c \cdot t = 125\ psf$

$w_{beam} := (h - t) \cdot b \cdot \gamma_c = 167\ plf$

$q_u := 1.2 \cdot (q_{slab} + q_{sdl}) + 1.6 \cdot q_l = 355\ psf$

The beam tributary width length is $l := 20 \cdot ft$

$w_u := q_u \cdot l + 1.2 \cdot w_{beam} = 7.30\ klf$

1.6. The roof on the building in Fig. P1.1 has a slab that is 7 in. thick. The beams are 12 in. wide and have a total depth of 16 in., the bay dimensions are 19 ft in the *X* direction and 21 ft in the *Y* direction, and the superimposed service dead load is 6 psf. Calculate the slab factored load in psf and the beam factored load in klf given the roof snow load is 30 psf.

SOLUTION

$b := 12 \cdot in \qquad h := 16 \cdot in \qquad t := 7 \cdot in \qquad q_{sdl} := 6 \cdot psf$

From Table 1.1 the roof live load is $q_s := 30 \cdot psf \qquad \gamma_c := 150 \cdot pcf$

$q_{slab} := \gamma_c \cdot t = 87.5\ psf$

$w_{beam} := (h - t) \cdot b \cdot \gamma_c = 113\ plf$

$q_u := 1.2 \cdot (q_{slab} + q_{sdl}) + 1.6 \cdot q_s = 160\ psf$

The beam tributary width length is $l := 18.5 \cdot ft$

$w_u := q_u \cdot l + 1.2 \cdot w_{beam} = 3.10\ klf$