Notes regarding reinforcement details.

In the following problems, the reinforcement details are compressed to clarify the problem solutions. The reinforcement details are noted by the line:

Reinforcement details

Reinforcement is shown by bar size. Thus a No. 9 (No. 29) bar is A_{s9}. Expansion of the "Reinforcement details" line gives all bar sizes and diameters, thus:

Reinforcement details

Area of Reinforcing Bars

$A_{s3} := 0.11\,in^2$ $A_{s7} := 0.60\,in^2$ $A_{s11} := 1.56\,in^2$

$A_{s4} := 0.20\,in^2$ $A_{s8} := 0.79\,in^2$ $A_{s14} := 2.25\,in^2$

$A_{s5} := 0.31\,in^2$ $A_{s9} := 1.00\,in^2$ $A_{s18} := 4.00\,in^2$

$A_{s6} := 0.44\,in^2$ $A_{s10} := 1.27\,in^2$

Diameter of reinforcing bars

$d_{b3} := 0.375\,in$ $d_{b7} := 0.875\,in$ $d_{b11} := 1.410\,in$

$d_{b4} := 0.500\,in$ $d_{b8} := 1.000\,in$ $d_{b14} := 1.693\,in$

$d_{b5} := 0.625\,in$ $d_{b9} := 1.128\,in$ $d_{b18} := 2.257\,in$

$d_{b6} := 0.750\,in$ $d_{b10} := 1.27\,in$

Reinforcement details

1.1 The building in figure P.1 is used for general office space. The slab is 8 in. thick on a beam 12 in. wide by 18 in. deep, the bay dimensions are 18'-6" in the x direction and 21'-0" in the y direction and the superimposed service dead load is 12 psf. Calculate the slab service load in psf and the beam service load in klf.. (**Solution:** *qs* = 162 psf, *wu* = 3.12 klf).

SOLUTION

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

Concrete unit weight $\gamma_c := 150pcf$

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

Superimprosed dead load $q_{sdl} := 12psf$

Service load $q_s := q_l + q_d + q_{sdl} = 162\ psf$

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

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

$w_s := 18.5ft \cdot q_l + 18.5ft \cdot (q_d + q_{sdl}) + w_{beam} = 3122\ plf$ $\quad w_s = 3.12\ klf$

1.2 The building in figure P.1 is used for general office space. The slab is 8 in. thick on a 12 in. wide x 18 in. deep beam, the bay dimensions are 18'-6" in the x direction and 21'-0" in the y direction and the superimposed service dead load is 12 psf. Calculate the factored column load transferred to column C3 on the 3rd floor. (**Solution:** P_u = 86.4 kips).

SOLUTION $\gamma_c := 150pcf$ $q_l := 50psf$ $q_{sdl} := 12psf$

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

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

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

$P_u := 1.6 \cdot A_t \cdot q_l + 1.2 \cdot A_t \cdot (q_d + q_{sdl}) + 1.2 \cdot w_{beam} \cdot 21ft = 86.4\ kip$

1.3 The building in figure P.1 is used for general office space. The slab is 8 in. thick on beams 12 in. wide x 18 in. deep, the bay dimensions are 18'- 6" in the x direction and 21'- 0" in the y direction and the superimposed service dead load is 12 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 $\gamma_c := 150pcf$ $q_l := 50psf$ $q_{sdl} := 12psf$

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

$q_u := 1.6 \cdot q_l + 1.2 \cdot \left(q_d + q_{sdl}\right) = 214.4\ psf$

From problem 1.1 $\frac{q_u}{q_s} = 1.323$

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

The tributaty width is . $l := 18.5ft$

$w_u := 1.6 \cdot q_l \cdot l + 1.2 \cdot \left(q_d + q_{sdl}\right) \cdot l + w_{beam} = 4.09\ klf$

Compare to problem 1.1 $\frac{w_u}{w_s} = 1.31$

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 figure P.1 is used for lobby space. The slab is 10 in. thick on a 14 in. wide x 24 in. deep beam, the bay dimensions are 21'- 0" in the x direction and 26'- 0" 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

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

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

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

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

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

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

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

1.5 The building in figure P.1 is used for light storage space. The slab is 10 in. thick on a 16 in. wide x 20 in. deep beam, the bay dimensions are 20'- 0" in the x direction and 25'- 0" 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

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

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

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

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

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

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

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

1.6 The roof on the building in figure P.1 has a slab 7 in. thick on a 12 in. wide x 16 in. deep beam, the bay dimensions are 19'- 0" in the x direction and 21'- 0" 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.

SOLUTION

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

From Table 1.1 the roof live load is $q_l := 20psf$ $\gamma_c := 150pcf$

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

$w_{beam} := (h - t) \cdot b \cdot \gamma_c = 112\ plf$

$q_u := 1.2 \cdot (q_{slab} + q_{sdl}) + 1.6 \cdot q_l = 144\ psf$

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

$w_u := q_u \cdot l + 1.2 w_{beam} = 2.80\ klf$