

# Punch through 1



Areas subject to punch in decks will be assumed far from the ends, and supported by surrounding concrete.

Reinforcement := 1      1 if simple (opposed side to load)  
   2 if both sides

Area := 1      1 if rectangle  
   2 if circle

$$\phi_1 := \frac{4}{8} \cdot \text{in}$$

$$s := 12 \cdot \text{in}$$

$$t := 8 \cdot \text{in}$$

$$c_1 := 3 \cdot \text{in}$$

$$d := t - c_1$$

dimensions immediately below

$$b_L := 8 \cdot \text{in}$$

$$h_L := 8 \cdot \text{in}$$

dimensions of  
rectangular loaded area  
causing punching

square reinforcement mesh

in each reinforced face (1 in simply  
supported and 2 in fixed) and both directions  
geometrical reinforcement ratio is

$$\rho := \frac{\pi \cdot \frac{\phi_1^2}{4}}{s \cdot t}$$

$$\rho = 0.002$$

$$r_L := 9 \cdot \text{in}$$

radius of circular loaded  
area causing punching

$f_{c28} := 4000 \cdot \text{psi}$       specified strength

$\beta_0 := 45 \cdot \text{deg}$       must be bigger than or equal to 30 deg

$$f_y := 60 \cdot \text{ksi}$$

$$\phi_b := 0.9$$

moment strength  
reduction factor

$$E_s := 200000 \cdot \text{MPa}$$

$$\beta_0 = 45 \text{ deg}$$

angle (from surface) at which  
punching failure is assumed to  
happen

- angles bigger than 30 deg will give less conservative assumptions of punching failure
- For 30 deg, failure load will be that of pure shear punching failure at reference cone 30 deg



$P = 152.96 \text{ kip}$       predicted punching failure load

$P_S = 214.49 \text{ kip}$       cone at 30 deg failing in pure shear at  $f_{ct}$  (till then perfectly undamaged state in shear)

$P_F = 115.03 \text{ kip}$       yield lines ultimate load failure, so quite damaged when attaining this load