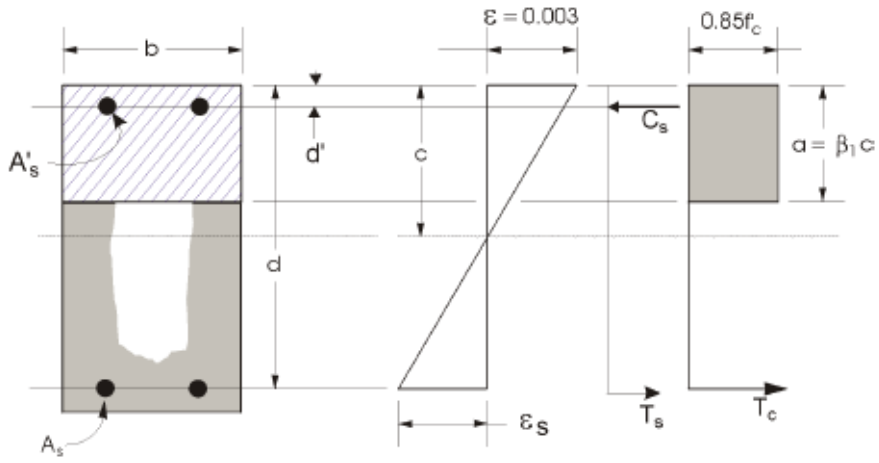
DESIGN OF REINFORCED CONCRETE SLAB
Flexural Reinforcement (ACI 318-95)

*adapted from CSI SAFE(TM) Design Manual

Data:



Thickness,
$h := 6.0\ in$

Depth of tensile reinf.,
$d_c := 1\ in$

Effective depth,
$d := 5\ in$

Depth of comp. reinf.,
$d' := 1\ in$

Concrete strength,
$f'_c := 4.0\ ksi$

Yield strength of steel,
$f_y := 60.0\ ksi$

Elasticity modulus of steel,
$E_s := 29000\ ksi$

Strength reduction factor,
$\varphi_b := 0.90$

Strip width,
$b := 12.0\ in$

Minimun steel reinfocement,

$$A_{s;min} := 0.0018 \cdot b \cdot h \cdot \frac{60000\ psi}{f_y} \qquad A_{s;min} = 0.1296\ in^2$$

Concrete stress block factors,

$$\beta_{1;calc} := 0.85 - 0.05 \cdot \left(\frac{f'_c - 4000\ psi}{1000\ psi} \right) \qquad \beta_{1;calc} = 0.85$$

$$\beta_1 := \begin{cases} \text{if } \beta_{1;calc} < 0.65 \\ \quad 0.65 \\ \text{else} \\ \quad \text{if } \beta_{1;calc} > 0.85 \\ \quad\quad 0.85 \\ \quad \text{else} \\ \quad\quad \beta_{1;calc} \end{cases} \qquad \beta_1 = 0.85$$

Neutral axis depth at balanced,

$$c_b := \frac{87000\ psi}{87000\ psi + f_y} \cdot d \qquad c_b = 2.959\ in$$

$$a_{max} := 0.75 \cdot \beta_1 \cdot c_b \qquad a_{max} = 1.886\ in$$

Bending moment,
$M_u := 317.952\ kip\ in$

Depth of the compression block,

$$a := d - \sqrt{d^2 - \frac{2 \cdot |M_u|}{0.85 \cdot f'_c \cdot \varphi_b \cdot b}} \qquad a = 2.2283\,in$$

$$msg = \text{"CASE(1) a > a_max, Doubly Reinforcemenet"}$$

CASE(2) a > a_max

Compressive force developed in concrete alone,

$$C := 0.85 \cdot f'_c \cdot b \cdot a_{max} \qquad C = 76.968\,kip$$

Moment resisted by concrete compression and tensile steel,

$$M_{uc} := C \cdot \left(d - \frac{a_{max}}{2}\right) \cdot \varphi_b \qquad M_{uc} = 281.018\,kip\,in$$

$$M_{us} := M_u - M_{uc} \qquad M_{us} = 36.934\,kip\,in$$

Stress in the compression steel,

$$f'_{s;calc} := 0.003 \cdot E_s \cdot \left(\frac{\frac{a_{max}}{\beta_1} - d'}{\frac{a_{max}}{\beta_1}}\right) \qquad f'_{s;calc} = 47.8\,ksi$$

$$f'_s := \begin{cases} f'_{s;calc} & \text{if } f'_{s;calc} \le f_y \\ f_y & \text{else} \end{cases} \qquad f'_s = 47.8\,ksi$$

Area of required compression steel,

$$A_{s1} := \frac{M_{uc}}{f_y \cdot \left(d - \frac{a_{max}}{2}\right) \cdot \varphi_b} \qquad A_{s1} = 1.2828\,in^2$$

Tensile steel for balancing the compression in steel,

$$A_{s2} := \frac{M_{us}}{f_y \cdot (d - d') \cdot \varphi_b} \qquad A_{s2} = 0.171\,in^2$$

Total area of tensile steel,

$$A_s := A_{s1} + A_{s2} \qquad A_s = 1.4538\,in^2$$