Reinforced Concrete Beam Analysis

Bar #	Diameter (in.)	As (in.^{2})
3	0.375	0.11
4	0.500	0.20
5	0.625	0.31
6	0.750	0.44
7	0.875	0.60
8	1.000	0.79
9	1.128	1.00
10	1.270	1.27
11	1.410	1.56

$$P_{tension} = \frac{A_s f_y}{4}\left(d - \frac{a}{2}\right) \quad \text{or} \quad \frac{A_s f_y}{4}\left(d - 0.59\frac{A_s f_y}{f'_c b}\right)$$

$$P_{shear} = 2\left(\frac{A_v f_y d}{s} + 2\sqrt{f'_c}bd\right)$$

$$a = \frac{A_s f_y}{0.85 f'_c b}$$

$$a = \beta_1 c$$

$$P_{compression} = \frac{A_s}{4}\left(\frac{d-c}{c}\right)\left(d - \frac{a}{2}\right)87{,}000\,psi$$

$f'_c \le 4000\ psi \quad \Rightarrow \quad \beta_1 = 0.85$

$f'_c \ge 4000\ psi$

$$\beta_1 = 0.85 - 0.05\left(\frac{f'_c - 4000}{1000}\right) \ge 0.65$$

$$\rho = \frac{A_s}{bd} \qquad \rho = 0.85\beta_1 \frac{c}{d}\frac{f'_c}{f_y}$$

$\frac{c}{d} > 0.600$	Beam failure is controlled by ***compression***
$0.375 < \frac{c}{d} < 0.600$	Transition between tension and compression control
$\frac{c}{d} < 0.375$	Beam failure is controlled by ***tension***

For compression model $f_{steel} = 87{,}000\,psi\left(\frac{d-c}{c}\right) < f_y$