Reinforced Concrete Design to ACI 318-11
Vertical Forces - Review Page

Load Combinations (see ACI 318-11 section 9.2):

1. U = 1.4D
2. U = 1.2D + 1.6L + 0.5(L_r or S or R)
3. U = 1.2D + 1.6(L_r or S or R) +(1.0L or 0.5W)
4. U = 1.2D + 1.0W + 1.0L + 0.5(L_r or S or R)
5. U = 1.2D + 1.0E + 1.0L + 0.2S
6. U = 0.9D + 1.0W
7. U = 0.9D + 1.0E

Strength Reduction Factors:

		ϕ
• Tension-controlled		0.90
• Compression-controlled	Tied	0.65
	Spiral	0.75
• Shear and Torsion		0.75
• Bearing on Concrete		0.65

Flexural Moment Capacity:

$$M_n = A_s f_y \left(d - \frac{0.5A_s f_y}{0.85f'_c b}\right)$$

(Approximately, **As = Mu/(4d)**; where As is in^2, d is in inches and Mu is kip-ft)

Shear Design: $\phi V_n = \phi(V_c + V_s) > V_u$

Beam Shear and One-way Shear in Slabs at d from support:

		$V_u \le \phi V_c/2$	$\phi V_c \ge V_u > \phi V_c/2$	$V_u > \phi V_c$
Required area of stirrups, A_v		none	$\frac{50b_w s}{f_{yt}}$	$\frac{(V_u - \phi V_c)s}{\phi f_{yt} d} \ge \frac{50b_w s}{f_{yt}}$
Stirrup spacing s	Required	—	$\frac{A_v f_{yt}}{50b_w}$	$\frac{\phi A_v f_{yt} d}{V_u - \phi V_c} \ge \frac{A_v f_{yt}}{50b_w}$
	Maximum	—	d/2 or 24 in.	d/2 or 24 in. for $(V_u - \phi V_c) \le \phi 4\sqrt{f'_c} b_w d$
				d/4 or 12 in. for $(V_u - \phi V_c) > \phi 4\sqrt{f'_c} b_w d$

Two-Way Shear in Slabs & Footings at d/2 from support (minimum of the following):

$V_c = 4 \sqrt{f'_c}\, b_o\, d$ (upper bound)

$V_c = (2+4/\beta) \sqrt{f'_c}\, b_o\, d$ (column shape: β = ratio of long to short column dimensions)

$V_c = [(\alpha_s\, d)/b_o + 2] \sqrt{f'_c}\, b_o\, d$ (column location: α_s = 40 interior, 30 edge, 20 corner columns)

Short Column Axial Load Design:

Spiral Column: $\phi P_{n,max} = 0.85\, \phi\, [0.85f'_c (A_g - A_{st}) + f_y A_{st}]$

Tied Column: $\phi P_{n,max} = 0.80\, \phi\, [0.85f'_c (A_g - A_{st}) + f_y A_{st}]$

Short Tied Column "*rule of thumb*": $P_u = A_g$ x ½ f'_c at 1% steel (f_y = 60 ksi)