

Percentage and Spacing<sup>(1)</sup> Requirements for Pier Wall Reinforcement

Designed as a Column about Weak Axis (Displacement ductility demand exceeds 4.0)

	Regular Detailing	Ductile Detailing Plastic Hinge Zone
<b>Vertical Reinforcement</b>		
Percentage, $\rho_n$	$\rho_n > \rho_i$ ; $0.25 \leq \rho_n < 4.00$ (Note 4)	$0.25 \leq \rho_n \leq 4.00$ (Note 4)
Spacing, $s_{nh}$	$d_n + s_{\min n}$ (Note 5) $\leq s_{nh} < 300$	$d_n + s_{\min n}$ (Note 5) $\leq s_{nh} \leq 200$
Diameter, $d_n$		
<b>Lateral Ties</b>		
Percentage, $\rho_\ell$	$0.25 \leq \rho_\ell$	$0.25 \leq \rho_\ell$
Spacing, $s_{\ell v}$	$d_\ell + s_{\min \ell}$ (Note 6 & 12) $\leq s_{\ell v} \leq 300$	$50$ (Note 7) $\leq s_{\ell v} \leq 200$ (Note 8)
Diameter, $d_\ell$		
<b>Cross Ties</b>		
Percentage, $\rho_c$ (Note 9)	$0.25 \leq \rho_c$	$0.25 \leq \rho_c$
Vertical Spacing, $s_{cv}$	$d_c + s_{\min \ell}$ (Note 6 & 12) $\leq s_{cv} \leq 300$ (Note 10) or $s_{\ell v}$	$50$ (Note 7) $\leq s_{cv} \leq 200$ (Note 8)
Horizontal Spacing, $s_{ch}$	$d_c + s_{\min n}$ (Note 5) $\leq s_{ch} \leq 150$ (Note 11)	$d_c + s_{\min n}$ (Note 5) $\leq s_{ch} \leq 150$ (Note 11)
Diameter, $d_c$		

Notes:

1. All dimensions in millimeters.
4. Maximum vertical reinforcement percentage limited by practical steel placement.
5.  $s_{\min n}$  = the largest of {38 mm,  $1\frac{1}{2} \times$  maximum aggregate size,  $1\frac{1}{2} \times$  one vertical bar diameter}.
6.  $s_{\min \ell}$  = the larger of {33 mm,  $1\frac{1}{3} \times$  maximum aggregate size}.
7. Based on minimum vertical spacing of lateral tie reinforcement in plastic hinge zone = 50 mm.
8. Maximum lateral tie vertical spacing in plastic hinge zone = 200 mm, but not greater than  $6d_\ell$  nor  $\frac{1}{5}$  the least pier dimension.
9.  $\rho_c = A_{sc}/(s_c h_{co})$  in which  $A_{sc}$  = area of cross tie reinforcing;  $h_{co}$  = overall horizontal dimension of pier wall core concrete.
10. Based on maximum vertical spacing of cross ties in pier walls = 300 mm; Assumes that 135° cross tie ends hook over alternate lateral tie/vertical bar joints.
11. Based on maximum horizontal spacing of cross ties in pier walls = 150 mm; Assumes that 135° cross tie ends hook over alternate lateral tie/vertical bar joints.
12. The quantities  $d_\ell + s_{\min \ell}$  and  $d_c + s_{\min \ell}$  shall not be less than 50 mm.