ATTACHMENT 1

Percentage and Spacing (1) 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
Vertical Reinforcement		
Percentage, ρ_n	$\rho_n > \rho_\ell$; $0.25 \leq \rho_n < 4.00$ (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		
Lateral Ties		
Percentage, ρ_ℓ	$0.25 \leq \rho_\ell$	$0.25 \leq \rho_\ell$
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_ℓ		
Cross Ties		
Percentage, ρ_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, $1^1/_2 \times$ maximum aggregate size, $1^1/_2 \times$ one vertical bar diameter}.
6. $s_{\min \ell}$ = the larger of {33 mm, $1^1/_3 \times$ 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 $6_{d\ell}$ nor $^1/_5$ 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.