

6-5 REINFORCED CONCRETE PIER WALLS

Piers are defined in *Bridge Design Specifications* (BDS) Article 7.5.1.3 and Commentary. Pier walls shall be designed as columns about the weak axis and as piers about the strong axis (BDS Article 7.5.2) with exception as defined below. See Attachment 1 for a summary of BDS reinforcement criteria applicable to pier walls designed as a column (displacement ductility demand > 4.0). Such piers could be reinforced according to tie criteria, or with multi-spirals (assuming the pier as a row of several individual slender columns).

Pier wall thickness must be sufficient to satisfy slenderness criteria of BDS Article 8.16.5. Longitudinal seismic displacements within the wall height should not exceed $\frac{1}{3}$ the pier thickness. The longitudinal movements should be based on an engineering evaluation considering joint closures and abutment movement, not on computer generated ARS criteria. The thickness must be adequate to allow insertion of a minimum 4-inch concrete placement tube through the network of cross tie tails. If pier walls are loaded below the lesser of $0.1f_c' A_g$ or $0.4P_h$ for Load Group VII, they can be exempt from the stringent confinement requirements of ACI Appendix A and BDS Article 8.18.2. This exemption will apply only if the pier is designed for a ductility displacement demand of four or less. Pier thickness and width dimensions can be adjusted, or a pier(s) added to reduce the axial load to $0.1f_c' A_g$ or $0.4P_h$. When considering such revisions, they should be cost compared to pier walls designed as columns and requiring the severe tie arrangements or multi-spirals to meet confinement specifications.

If the pier wall satisfies the foregoing criteria, reinforcement provided to meet the group moment and shear loads subject to the following minimums will be considered satisfactory for confinement:

$$P_h \geq 0.0025 \text{ (horizontal ties, but not cross-ties)}$$

$$P_n \geq P_h$$

Spacing of all horizontal bars and ties shall not exceed 12 inches in any direction, except vertical spacing shall not exceed 6 inches in plastic hinge zones.

Refer to Attachment 2 for example detailing of a pier wall designed for a displacement ductility demand ≤ 4.0 about the longitudinal axis.

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Cross ties shall have a 135° seismic hook on one end and a 90° hook on the opposite end. Cross ties shall be placed so that 90° and 135° hooks of adjacent ties, horizontally and vertically, shall be alternated.

All piers and their foundations must be analyzed for strength and stability about the strong axis for all load cases, using ARS elastic forces for Group VII. Fusing at the pile/footing interface, sliding, or rocking can be used as an analytical tool to reduce transverse seismic demands in competent soils.

Confinement reinforcement relief allowed in this memo is based partially on test results from U.C. Irvine.

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