Simplified Procedure for Seismic Analysis of Reinforced-Concrete Piles in Marine Oil Terminals

By

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The Marine Oil Terminals in California are designed for two earthquake levels: Level 1 and Level 2. The return period of the design earthquake for each level depends on the risk level: for high risk terminals, Level 1 and Level 2 design earthquakes have return periods of 72 and 475 years, respectively. Currently, the design acceptance criteria of piles in Marine Oil Terminals depend on the strains in concrete and reinforcing steel, which are specified for each design level. This investigation examined the possibility of using displacement ductility capacity of reinforced-concrete piles, instead of strain limits, as the acceptance criteria. It is shown that the displacement ductility capacity is a robust parameter: it is essentially independent of the pile length, cross sectional properties (i.e., pile cross sectional dimensions, longitudinal reinforcement, and transverse reinforcement), axial load, and P-Delta effects. It only depends on the acceptable strain limits. Based on theoretical analysis and parametric simulations, lower bound values of acceptable displacement ductility of reinforced-concrete piles are proposed. Finally, a simplified procedure is presented for seismic analysis of such piles. This procedure eliminated the often cumbersome need to monitor strains in concrete and steel during the moment-curvature analysis and/or pushover analysis.