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ABSTRACT

Behavior and Design of Anchorages for Unbonded PT Strands in Seismic Regions

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This paper is on the behavior and design of anchorages for unbonded post-tensioning (PT) strands for seismic regions. Research conducted since the 1990s has shown that unbonded post-tensioned frame and wall structures offer significant benefits for use in seismic regions.[1-3] These structures use high-strength PT strands between beam, column, and wall members to achieve the lateral resistance needed under seismic loading. The PT tendons are unbonded over their length and are connected to the structure only at end anchorages where the entire PT force is transferred. The maximum strand stresses and strains in an unbonded post-tensioned structure depend on the unbonded length and initial stress of the strands, as well as the lateral displacements of the structure during an earthquake. While current design guidelines for these structures require that the strands remain essentially linear-elastic under the "Design Basis Earthquake," significant post-yield strand stresses can develop under the "Maximum Considered Earthquake." Thus, the use of unbonded post-tensioning for seismic resistance puts the anchorages under extreme demands, where premature strand wire fractures can occur and have been observed in laboratory subassembly experiments, limiting the lateral ductility capacity of the entire structure.

This paper describes the results from a comprehensive experimental study on the behavior of strand/anchorage systems, considering a large number of design and construction parameters that can affect the performance of a strand inside an anchor. The parameters investigated include: (1) post-yield cyclic loading history (which can reduce strand ductility due to cyclic "biting" of anchor wedges into the strand wires); (2) initial stress in the strands (which can affect how the anchor wedges are initially seated around the strand); (3) eccentricity between the strand ends (which can occur due to accidental misalignment during construction as well as due to relative displacements of the strand ends as the structure is displaced laterally); (4) anchor/wedge condition during construction (e.g., poor seating of anchor wedges, presence of grease between strand and wedges); and (5) strand size and anchor type (e.g., cast type and barrel type anchors). ACI-318 requires that anchors used in unbonded post-tensioned construction are capable of developing 2% strand elongation and 95% of the nominal strength of the strand. This paper describes the effect of the parameters investigated on the capability of anchor/strand assemblies in achieving these requirements.

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