# REFERENCE CARDS

**KEYWORDS:** architectural precast concrete; buildings; commercial buildings; columns; construction; design (structural); façade; parking structures; precast concrete; wall panels.

**ABSTRACT:** Precast concrete played a prominent role in building the new multi-million dollar Lazarus Department Store in downtown Pittsburgh, Pennsylvania. The glitzy department store is four stories high with an underground three-level parking structure. Highly articulated precast concrete panels with deep reveals give the building scale and character, and also complement the nearby historic buildings. To speed construction, structural precast concrete columns are used in the parking structure. This article presents the conceptual and architectural design features of the building, design considerations, and erection highlights of the project.

**REFERENCE:** Muse, Gar, and Di Giacomo, Anthony, "Precast Concrete Panels Give Scale and Grandeur to Lazarus Department Store," PCI JOURNAL, V. 45, No. 5, September-October 2000, pp. 20-29.

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**KEYWORDS:** bridges; construction; marine construction; piers; precast concrete; prestressed concrete.

**ABSTRACT:** Precast, prestressed concrete is used at many locations for a multitude of functions throughout the multi-billion dollar Central Artery/Tunnel Project in Boston, Massachusetts. This article describes two bridges and a marine pier where precast, prestressed concrete was selected as the ideal material to span these structures.

**REFERENCE:** Donington, Keith, Towell, Paul, and Chandra, Vijay, "Central Artery/Tunnel Project: Precast/Prestressed Structures Span the Big Dig," PCI JOURNAL, V. 45, No. 5, September-October 2000, pp. 30-33.

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**KEYWORDS:** anchorages; design (structural); edge effects; headed studs; precast concrete; research; shear strength; steel strength.

**ABSTRACT:** The Precast/Prestressed Concrete Institute sponsored a comprehensive research program to assess the shear capacity of headed stud group anchorages. This program was initiated in response to new provisions introduced into the 2002 ACI 318 Building Code. The test program examined headed stud connections loaded toward a free edge, a free edge near a corner, parallel to one free edge, parallel to two free edges, away from a free edge, and in-the-field of a member, such that edge distance was not a factor. The information reported herein addresses the steel capacity failure mode. Test data were obtained when the shear force was directed away from a free edge, in-the-field testing, and from other edge distance tests where steel failure governed the capacity.

**REFERENCE:** Anderson, Neal S., and Meinheit, Donald F., "Design Criteria for Headed Stud Groups in Shear: Part 1 – Steel Capacity and Back Edge Effects," PCI JOURNAL, V. 45, No. 5, September-October 2000, pp. 46-75.

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**KEYWORDS:** building codes; codes; design (structural); International Building Code; model codes; NEHRP Provisions; precast concrete; prestressed concrete; seismic-force-resisting system.

**ABSTRACT:** This is the second in a series of three papers discussing significant modifications expected to be included in the 2000 NEHRP Provisions, dealing with the design of precast, prestressed concrete seismic-force-resisting systems. These modifications are expected to be part of the 2003 International Building Code.

**REFERENCE:** Hawkins, Neil M., and Ghosh, S. K., "Proposed Revisions to 1997 NEHRP Recommended Provisions for Seismic Regulations for Precast Concrete Structures: Part 2 – Seismic-Force-Resisting Systems," PCI JOURNAL, V. 45, No. 5, September-October 2000, pp. 34-44.

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**KEYWORDS:** beams; development length; design (structural); precast concrete; prestressed concrete; prestressing strands; reinforcement; research; semi-lightweight concrete; transfer length.

**ABSTRACT:** In this study, 18 development length tests were carried out on single strand rectangular and multiple strand T-shaped semi-lightweight beams having design compressive strengths of 7000 psi (48 MPa). In the rectangular beam tests, the design moment capacity was exceeded in all specimens. However, in the T-beam tests, bond failures at loads below the design capacity occurred in some specimens immediately after the formation of a flexure-shear crack near the loading point. Additional T-beam tests showed that the bond failure at loads below the design capacity occurred in some specimens immediately after the formation of a flexure-shear crack near the loading point. The authors recommend that the current AASHTO and ACI requirements for strand development should be enforced at a "critical section" that is located a distance $d_p$ from the point of maximum moment towards the free end of the strand, where $d_p$ is the distance from the extreme compression fiber to the centroid of the prestressed reinforcement.

**REFERENCE:** Peterman, Robert J., Ramirez, Julio A., and Olek, Jan, "Influence of Flexure-Shear Cracking on Strand Development Length in Prestressed Concrete Members," PCI JOURNAL, V. 45, No. 5, September-October 2000, pp. 76-94.

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**KEYWORDS:** box girders; beams; camber; development length; design (structural); flexural strength; high strength concrete; high performance concrete; precast concrete; prestressed concrete; prestress losses; prestressing steel; research; transfer length.

**ABSTRACT:** Presents the results of an investigation on the transfer and development lengths required for Grade 270, 0.6 in. (15.2 mm) diameter prestressing strand spaced at 2 in. (51 mm) on center in high performance concrete prestressed box girders. Three 411 in. (10400 mm) long box girders with composite topping slabs were tested. The specified compressive strength of the girder concrete is 10,000 psi (69 MPa). The AASHTO/ACI formulas overestimate the transfer length of the girders by 18 percent and the development length by 53 percent. The average pullout strength attained in strand pullout tests is 48 kips (215 kN). The average strand slip measure right after stress transfer is 0.06 in. (1.52 mm).

**REFERENCE:** Shing, P. Benson, Cooke, Daniel E., Frangopol, Dan M., Leonard, Mark A., McMullen, Michael L., and Hutter, Werner, "Strand Development and Transfer Length Tests on High Performance Concrete Box Girders," PCI JOURNAL, V. 45, No. 5, September-October 2000, pp. 96-109.

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**KEYWORDS:** beams; carbon fiber strands; CFCC strands; CFRP strands; development length; design (structural); double-T beams; precast concrete; prestressed concrete; reinforcement; research; transfer length.

**ABSTRACT:** Presents the results of an experimental investigation addressing the variations in transfer lengths in two types of carbon fiber reinforced (CFRP) prestressing strands. In all, eight double-T (DT) prestressed girders were prestressed with carbon fiber composite cable (CFCC) strands. It is shown that the calculated and measured transfer lengths are in close agreement with those obtained by others in the case of Leadline tendons only. It is also noted that the level of release of prestress has no significant effect on transfer length.

**REFERENCE:** Grace, Nabil F., "Transfer Length of CFRP/CFCC Strands for Double-T Girders," PCI JOURNAL, V. 45, No. 5, September-October 2000, pp. 110-126.