Interstate 25 Over Yale Avenue, Denver

General Description The completed HPC bridge replaced a four-span cast-in-place T-girder bridge. The HPC bridge solution was to construct a two-span structure using box beams made continuous over the center support. The two spans are 34.5 m (113.3 ft) and 30 m (98.6 ft) long, respectively. The 42-m- (138-ft-) wide bridge was built in phases to permit traffic flow (151,000 average daily traffic) in both directions during construction. The new bridge improved clearances over Yale Avenue without a significant change in the grade of I-25. The Colorado Department of Transportation (CDOT) conducted the project in cooperation with the University of Colorado at Boulder.

Outline of HPC Features The HPC elements and compressive-strength requirements will be:

Element	Compressive Strength
Girders @ Transfer	45 MPa (6500 psi)
Girders @ 56 Days	69 MPa (10,000 psi)
Deck & Substructure @ 28 Days	34 MPa (5000 psi)

HIGH-PERFORMANCE CONCRETE

Concrete with enhanced durability and strength characteristics. Under the Strategic Highway Research Program (SHRP), more than 40 concrete and structural products were developed. To implement the new technology of using High-Performance Concrete (HPC), the Federal Highway Administration (FHWA) has a program underway to showcase bridges constructed with HPC. The objective is to advance the use of HPC to achieve economy of construction and long-term performance.

Pretensioned Beams The pretensioned concrete box beams are 1700 mm (67 in) wide and 750 mm (30 in) deep. The beams utilized 15.2-mm- (0.6-in-) diameter strands at 51-mm (2-in) center-to-center spacing. The University of Colorado performed testing utilizing strand pull-out strength, transfer length, and development length. The results are documented in Report No. CDOT-DTD-R-98-7, Colorado Study on Transfer and Development Length of Prestressing Strand in High-Performance Concrete Box Girders, by Cooke, Shing, and Frangopol.

Substructure The piers, columns, and abutments were constructed with the deck concrete mix. This resulted in some reduction of member sizes and increased durability of low-level elements exposed to spray and splash from Yale Avenue traffic.

Deck The CDOT deck concrete specification at the time of the initiation of the project called for a 28-day strength of 31 MPa (4500 psi), with mix approval based on a 28-day strength of 39 MPa (5625 psi). In comparison, the deck and substructure concrete for this bridge required a 28-day strength of 40 MPa (5800 psi) for mix approval. The actual deck strength after 90 days averaged 41.8 MPa (6061 psi) and the air content averaged 5.5 percent. No fly ash or silica fume was added to the mix.

Concrete Tests In addition to the tests indicated by the properties in the proceeding table, the following concrete properties were measured to establish a database:

Deck*

- Air Content
- 56- & 90-Day Compressive Strength
- Creep
- Shrinkage
- Modulus of Elasticity
- Rapid Chloride Permeability
- Freeze-Thaw

Girders*

- Air Content
- 90-Day Compressive Strength
- Creep
- Shrinkage
- Modulus of Elasticity
- Splitting Tensile Strength
- Modulus of Rupture

*Except for air content, these characteristics were used in confirmation of design assumptions and were not part of the project acceptance criteria for HPC.

Instrumentation The completed bridge was instrumented to measure temperature and strain variations. This was combined with deformation measurements to determine how the bridge behaves in response to creep, shrinkage, temperature changes, dead load, and live load. The first girder camber measurements occurred at prestress transfer and then at each stage of girder loading until the bridge was completed.

Construction The wind and low humidity in Colorado are a problem and can contribute to deck cracking. A membrane-forming curing compound was placed immediately upon finishing and a moist cure was started when the deck concrete could be walked on without damage. The moist cure was continued for 5 days.

Construction on this project began in November 1996 and was completed in June 1998.

Benefits The initial cost benefits are the elimination of two column/pier lines. It is expected that the more durable concrete will provide increased resistance to traffic wear, environmental factors, and the effects of deicing chemicals. ■

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Federal Highway Administration

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