Designers Meeting
Minutes
Wednesday, March 23rd, 2011
Conference Room 317 A&B
1:00 - 1:30 PM

Present: Dave Sullivan, Roger Naous, Joel Veilleux, Devan Eaton, Mike Wight, Wayne Frankhauser, Rich Myers, Brian Reeves, Ben Scheurenbrand, Laura Krusinski, Ed Caswell, Bob Bulger, Garrett Gustafson, Rich Nimon

Topic 1: Rebar Details (see handout)

Rich Myers brought forth comments from Ken Sweeney on details showing u-bars in the top of a wingwall. Ken had asked why we are doing this now as it was not used in the past.

Bob B. - Both ACI and LRFD now require bars for temperature and shrinkage.

Brian R. – In the case of Princeton, the return walls were 24" thick, as apposed to 18", and had guardrail mounted on top which required reinforcing in the top of the wall.

Wayne F. – Past bridges did not use u-bars and there are no problems.

I have located the section of LRFD code discussed in the meeting and attached it.

Topic 2: Ultra-high Performance Concrete, UHPC (see handout)

Bob B. recently attended a PCI Northeast conference where UHPC was discussed. He gave a brief overview of some of the technical information and passed around some of the articles and pamphlets distributed at the PCI conference. FHWA has been testing UHPC with steel strand in New York and Virginia with a compressive strength of 20 ksi, though UHPC has the capability of reaching compressive strengths of 35 ksi. There are three mixes that can be used in bridge applications; JS1000 for joints fill solutions, CS1000 for structural solutions, and the BS1000 for structural solutions. If you have any questions or would like to read more material from the conference please see Bob B.

No longitudinal bar or bundle shall be more than 24.0 in., measured along the tie, from a restrained bar or bundle. A restrained bar or bundle is one which has lateral support provided by the corner of a tie having an included angle of not more than 135 degrees. Where the column design is based on plastic hinging capability, no longitudinal bar or bundle shall be farther than 6.0 in. clear on each side along the tie from such a laterally supported bar or bundle and the tie reinforcement shall meet the requirements of Articles 5.10.11.4.1d through 5.10.11.4.1f. Where the bars or bundles are located around the periphery of a circle, a complete circular tie may be used if the splices in the ties are staggered.

Ties shall be located vertically not more than half a tie spacing above the footing or other support and not more than half a tie spacing below the lowest horizontal reinforcement in the supported member.

Columns in Seismic Zones 2, 3, and 4 are designed for plastic hinging. The plastic hinge zone is defined in Article 5.10.11.4.1c. Additional requirements for transverse reinforcement for bridges in Seismic Zones 2, 3, and 4 are specified in Articles 5.10.11.3 and 5.10.11.4.1. Plastic hinging may be used as a design strategy for other extreme events, such as ship collision.

5.10.7—Transverse Reinforcement for Flexural Members

Compression reinforcement in flexural members, except deck slabs, shall be enclosed by ties or stirrups satisfying the size and spacing requirements of Article 5.10.6 or by welded wire fabric of equivalent area.

5.10.8—Shrinkage and Temperature Reinforcement

C5.10.8

Reinforcement for shrinkage and temperature stresses shall be provided near surfaces of concrete exposed to daily temperature changes and in structural mass concrete. Temperature and shrinkage reinforcement to ensure that the total reinforcement on exposed surfaces is not less than that specified herein.

Reinforcement for shrinkage and temperature may be in the form of bars, welded wire fabric, or prestressing tendons.

For bars or welded wire fabric, the area of reinforcement per foot, on each face and in each direction, shall satisfy:

$$A_s \geq \frac{1.30bh}{2(b+h)f_y} \quad (5.10.8\text{-}1)$$

$$0.11 \leq A_s \leq 0.60 \quad (5.10.8\text{-}2)$$

where:

A_s = area of reinforcement in each direction and each face ($in.^2/ft$)

b = least width of component section (in.)

h = least thickness of component section (in.)

f_y = specified yield strength of reinforcing bars ≤ 75 ksi

The comparable equation in ACI was written for slabs with the reinforcement being distributed equally to both surfaces of the slabs.

The requirements of this Article are based on ACI 318 and 207.2R. The coefficient in Eq. 5.10.8-1 is the product of 0.0018, 60 ksi, and 12.0 in./ft and, therefore, has the units kips/in.-ft.

Eq. 5.10.8-1 is written to show that the total required reinforcement, $A_s = 0.0018bh$, is distributed uniformly around the perimeter of the component. It provides a more uniform approach for components of any size. For example, a 30.0 ft high × 1.0 ft thick wall section requires 0.126 $in.^2/ft$ in each face and each direction, a 4.0 ft × 4.0 ft component requires 0.260 $in.^2/ft$ in each face and each direction, and a 5.0 ft × 20.0 ft footing requires 0.520 $in.^2/ft$ in each face and each direction. For circular or other shapes the equation becomes:

$$A_s \geq \frac{1.3A_g}{Perimeter\,(f_y)} \quad (C5.10.8\text{-}1)$$

Where the least dimension varies along the length of wall, footing, or other component, multiple sections should be examined to represent the average condition at each section. Spacing shall not exceed:

- 3.0 times the component thickness, or 18.0 in.
- 12.0 in. for walls and footings greater than 18.0 in. thick
- 12.0 in. for other components greater than 36.0 in. thick

For components 6.0 in. or less in thickness the minimum steel specified may be placed in a single layer. Shrinkage and temperature steel shall not be required for:

- End face of walls 18 in. or less in thickness
- Side faces of buried footings 36 in. or less in thickness
- Faces of all other components, with smaller dimension less than or equal to 18.0 in.

If prestressing tendons are used as steel for shrinkage and temperature reinforcement, the tendons shall provide a minimum average compressive stress of 0.11 ksi on the gross concrete area through which a crack plane may extend, based on the effective prestress after losses. Spacing of tendons should not exceed either 72.0 in. or the distance specified in Article 5.10.3.4. Where the spacing is greater than 54.0 in., bonded reinforcement shall be provided between tendons for a distance equal to the tendon spacing.

Permanent prestress of 0.11 ksi is equivalent to the resistance of the steel specified in Eq. 5.10.8-1 at the strength limit state. The 0.11 ksi prestress should not be added to that required for the strength or service limit states. It is a minimum requirement for shrinkage and temperature crack control.

The spacing of stress-relieving joints should be considered in determining the area of shrinkage and temperature reinforcement.

Surfaces of interior walls of box girders need not be considered to be exposed to daily temperature changes.

See also Article 12.14.5.8 for additional requirements for three-sided buried structures.

5.10.9—Post-Tensioned Anchorage Zones

5.10.9.1—General

Anchorages shall be designed at the strength limit states for the factored jacking forces as specified in Article 3.4.3.

For anchorage zones at the end of a component or segment, the transverse dimensions may be taken as the depth and width of the section but not larger than the longitudinal dimension of the component or segment. The longitudinal extent of the anchorage zone in the direction of the tendon shall not be less than the greater of the transverse dimensions of the anchorage zone and shall not be taken as more than one and one-half times that dimension.

For intermediate anchorages, the anchorage zone shall be considered to extend in the direction opposite to the anchorage force for a distance not less than the larger of the transverse dimensions of the anchorage zone.

C5.10.9.1

With slight modifications, the provisions of Article 5.10.9 are also applicable to the design of reinforcement under high-load capacity bearings.

The anchorage zone is geometrically defined as the volume of concrete through which the concentrated prestressing force at the anchorage device spreads transversely to a more linear stress distribution across the entire cross-section at some distance from the anchorage device.

Within the anchorage zone, the assumption that plane sections remain plane is not valid.

The dimensions of the anchorage zone are based on the principle of St. Venant. Provisions for components with a length smaller than one of its transverse dimensions were included to address cases such as transverse prestressing of bridge decks, as shown in Figure C5.10.9.1-1.

Ductal®

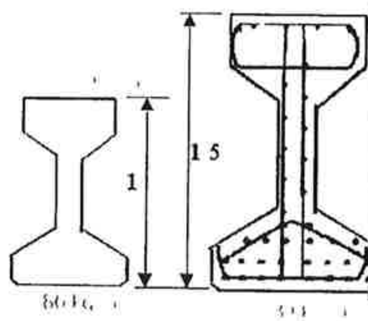
PROJECT PROFILE:

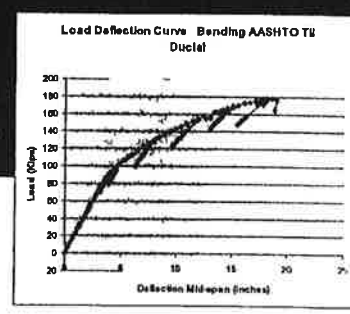
FHWA Bridge Beam Load Testing

Under the sponsorship of the Virginia Department of Transportation, full scale 80' (24 m) Ductal bridge girders were load tested at the Turner Fairbanks laboratory of the Federal Highway Administration in McLean, Virginia

Flexural and shear tests revealed that the girder deflected 19 in (480 mm) before it fractured At 170% of the ultimate failure predicted, the beam was much tougher than expected At 12 in (300 mm) of deflection, cracks could not be seen, even with a magnifying glass (see photo at right)

The standard design for a girder similar in shape would span only 45 ft (14 m) The test girder was nearly twice as long and withstood more than **10 times** the deflection allowed in an approved girder of that type ***The Ductal beam did not require any reinforcing bars!***





Ductal® is a revolutionary, ultra-high performance material that provides:

•Strength •Ductility
•Durability •Aesthetics

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Greater capacity to deform and support flexural and tensile loads, even after initial cracking!

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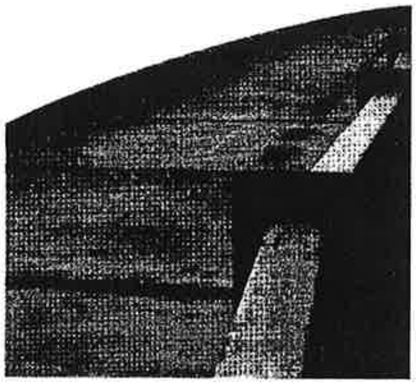


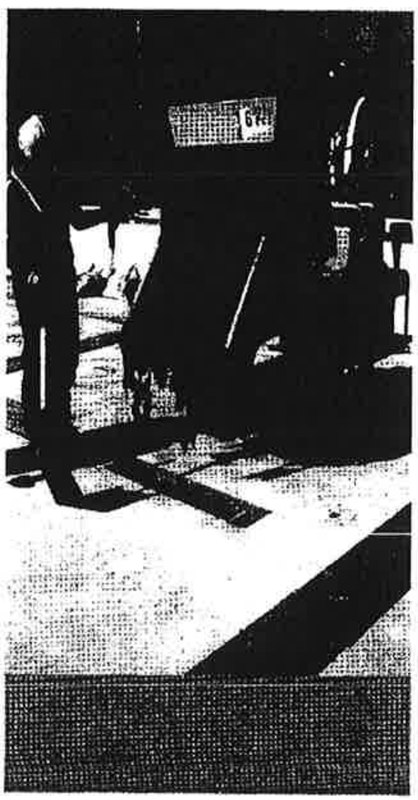
JS1000

field-cast joint fill solutions for precast deck panel bridges

[illegible] durability, fluidity and increased bond capacity. By utilizing these superior properties in conjunction with precast deck panels, engineers can create optimized solutions for advanced precast bridge deck systems – with simplified fabrication and installation processes.

[illegible] Ductal® JS1000 is significantly stronger than conventional concrete and performs better in terms of abrasion and chemical resistance, freeze-thaw, carbonation and chloride ion penetration.

[illegible] Ductal® is also denser than conventional concrete. This "denseness", along with nanometer sized non-connected pores throughout its cementitious matrix, attributes to its remarkable imperviousness and durability against adverse conditions or aggressive agents.



PHYSICAL PROPERTIES

Characteristic Values for Design						
	Test Data					
	Mean		Standard Deviation		Design Values	
	MPa	psi	MPa	psi	MPa	psi
Compression	140	20,000	10	1,400	100	14,500
Flexural	30	4,300	5	700	-	-
Direct Tension f_{tj}	8	1,160	1	145	5	725
	GPa	ksi	GPa	ksi	GPa	ksi
Youngs Modulus	50	7,200	2	300	45	6,500

JS1000

DURABILITY

• Carbonation penetration depth	<0.5 mm
• Freeze/thaw (after 300 cycles)	100%
• Salt-scaling	<0.10 g/m²

OTHER PROPERTIES

• Density	2.4 – 2.6 S.G.
• Capillary porosity (>10mm)	<1%
• Total porosity	2 – 6%
• Creep coefficient	0.2-0.5

COMPONENTS

A) Premix	- silica fume, ground quartz, sand, cement
B) High tensile steel fibers	- 0.2 mm (0.008 in) diameter x 14 mm (0.5 in) long (>2000 MPa/ 290 ksi)
C) Admixture	- high range water reducer/ 3rd generation

+ Water and/or ice

BATCHING

High shear mixers and an ambient temperature above 16°C (60°F) are recommended to successfully produce Ductal® JS1000. Onsite technical assistance by a Lafarge representative is recommended.

PLACING

Ductal® JS1000 can be placed by pouring with the use of a bucket, wheelbarrow or buggy. Any exposed Ductal® surfaces should be covered with poly or vapor barriers to prevent surface dehydration.

JOINT REINFORCING

To minimize any corrosion potential of the reinforcing between the precast panel and joints, non-corrosive rebar (such as GFRP or stainless steel) may be used. Black rebar reinforcement may also be utilized for bottom mat connection.

DESIGN

The high strength of Ductal® JS1000 allows for reduced joint widths. When designing a joint using Ductal® JS1000, the characteristic design values can be reached within 96 hours of casting -- as long as ambient temperatures above 16°C (60°F) are ensured. Please contact a Lafarge representative when designing joints with Ductal® JS1000.

Add value with Ductal® JS1000

LAFARGE

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