CONNECTING PRECAST CONCRETE BRIDGE DECK PANELS WITH ULTRA HIGH PERFORMANCE CONCRETE

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Western Bridge Engineer's Seminar

September 26, 2011

Precast Concrete Decks and Ultra High Performance Concrete: Introduction

- Abrasion Resistant HPC
- HPC Precast Concrete Decks
- UHPC Connections
- FHWA Highways for LIFE Grant
- ODOT Demonstration Project
- FHWA UHPC Research

HPC Precast Concrete Decks

- Abrasion Resistant HPC Deck Concrete
  - Studded Tire Rutting
- Oregon State University Research
  - 8.0 ksi Concrete
  - 7% Silica Fume
- Precasting vs. Casting-In-Place
  - Curing
  - Cracking

Ultra High Performance Concrete (UHPC)

UHPC Characteristics:

- Advanced cementitious material
- High strength, high stiffness
- Exceptional durability
- Internal steel fiber reinforcement
- Self-consolidating

UHPC Properties:

- Compressive Strength
  - 18 to 35 ksi (Controlled Environment – Lab or PC Plant)
  - 16.5 to 19 ksi (Field Curing)
- Modulus of Elasticity – 6200 to 8000 ksi
- Creep Coefficient – 0.3 to 0.8
- Sustained Tensile Capacity – 0.9 to 1.5 ksi
- Freeze/Thaw Resistance – RDM > 95%

Ref.: Ben Graybeal, Et. Al. @ FHWA

Ultra High Performance Concrete Materials

Typical Composition of UHPC Material	Amount	% by Weight
Portland Cement	1200 lb/yd^3	28.5
Silica Fume	390 lb/yd^3	9.3
Ground Quartz	355 lb/yd^3	8.5
Fine Sand	1720 lb/yd^3	41.0
Steel Fibers	263 lb/yd^3	6.3
Superplasticizer	51 lb/yd^3	1.2
Water	218 lb/yd^3	5.2

Ref.: Ben Graybeal, Et. Al. @ FHWA

UHPC On Site Mixing

Ref.: Photos Courtesy of Vic Perry, Et. Al. @ Lafarge

UHPC Transportation Applications

- Precast Prestressed Concrete Girders
  - No traditional shear reinforcement
- Precast Concrete Deck Panels
- Field-Cast Joints and Connections
- Columns
- Fascia Panels, Architectural Treatments
  - Reduced thickness and dead load
- Overlays
- Bridge Repair and Retrofit
  - Regain or add strength with reduced development lengths
  - Improved bridge rail connections to existing decks

U.S. Highway Bridges

π–girders
Jakway Bridge
Buchanan County, Iowa

VDOT BT45 – no shear stirrups
Rt. 624 Cat Point Bridge
(FHWA 9th-span)
Richmond County, Virginia

Ref.: Photos Courtesy of Ben Graybeal, Et. Al. @ FHWA

FHWA UHPC Shear Surface

Ref.: Photo Courtesy of Ben Graybeal, Et. Al. @ FHWA

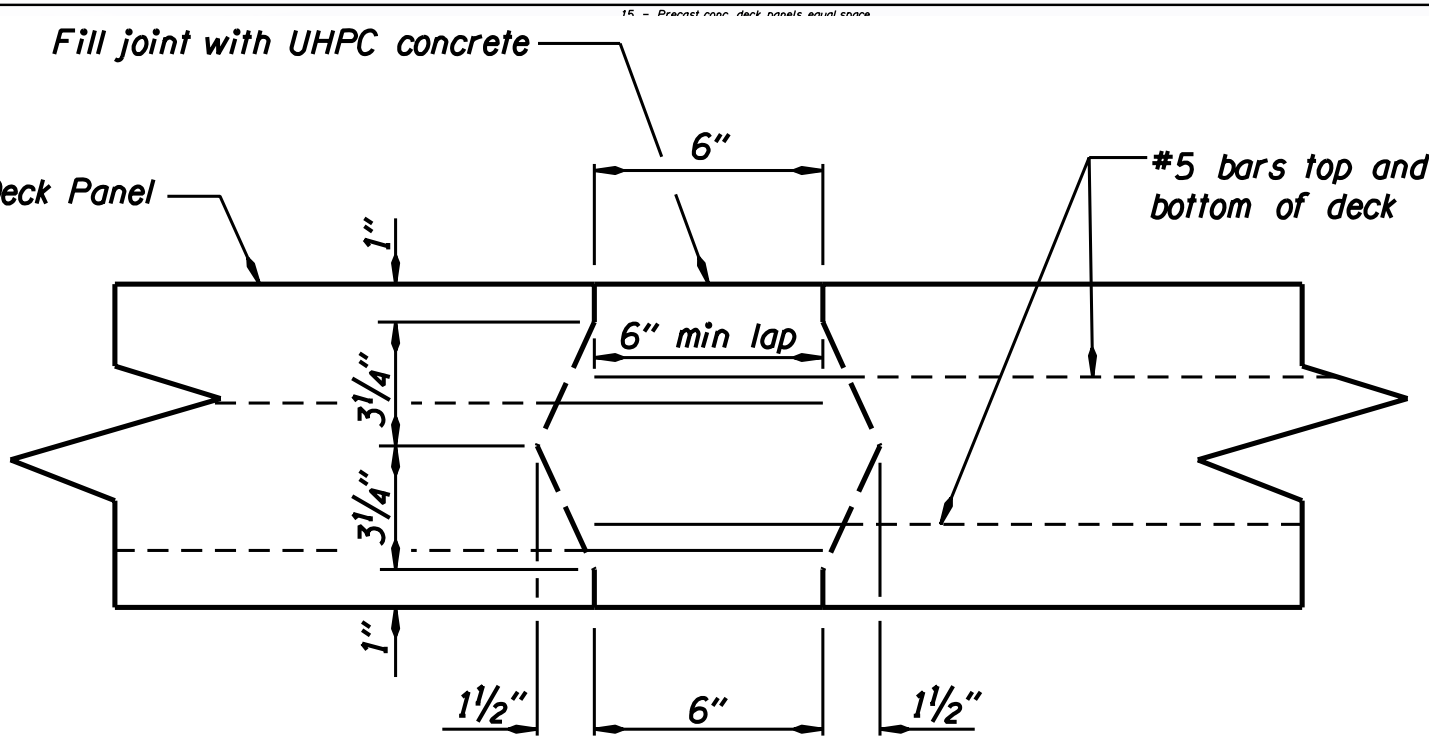
UHPC Precast Prestressed Deck Panel Connections

Ref.: Photo Courtesy of Ben Graybeal, Et. Al. @ FHWA

- Enhanced Durability
- Greater Resilience
- Minimum Development Lengths

- Simplified Construction
- Accelerated Construction
- Reduced Cure Time

Precast Prestressed Concrete Deck Panels



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TRANSVERSE JOINT DETAIL

Scale: ⅛" = 1'-0"

SCALE WARNING

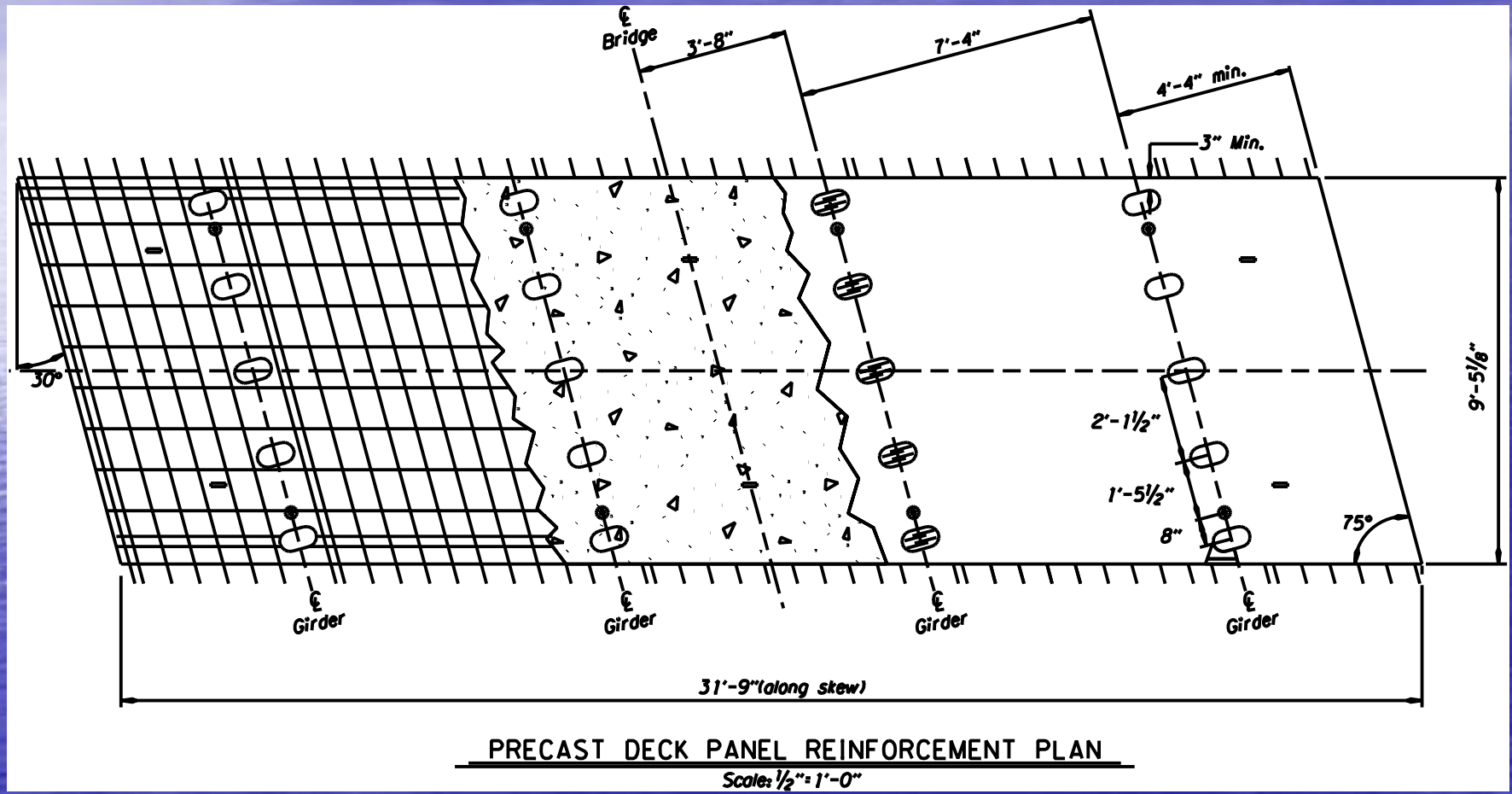
If scale bar doesn't measure one inch then drawing is not to scale

#00700

\\Sn-reg5hq-1\Proj_Dev\Projects\US30_Burnt_River (UPRR) Bridge\Bridge\FINPlans\rbs21252.dgn :: superstructure 4/8/2011 7:46:48 AM hwye90v

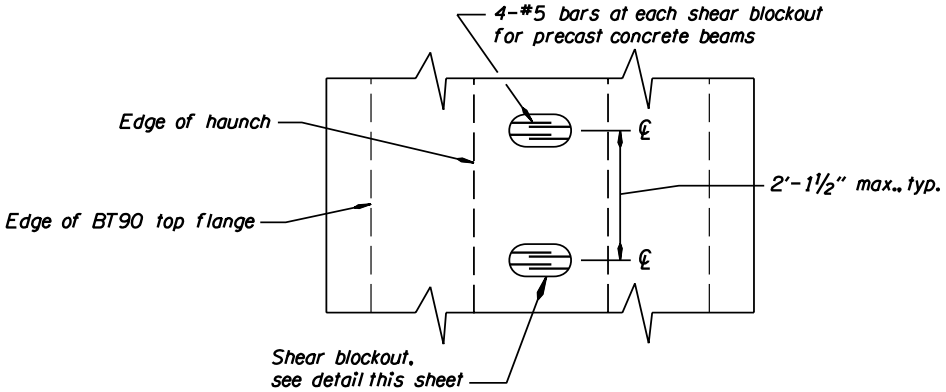
sht 10 1:96 precast deck

Precast Prestressed HPC Concrete Deck Panel Details

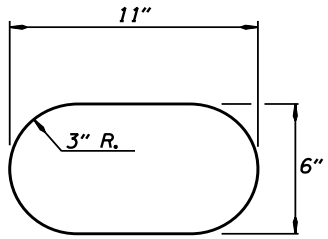


Deck Panel to Girder Connection

y_e	22.77"	22.77"
"h_e"	30"	30"

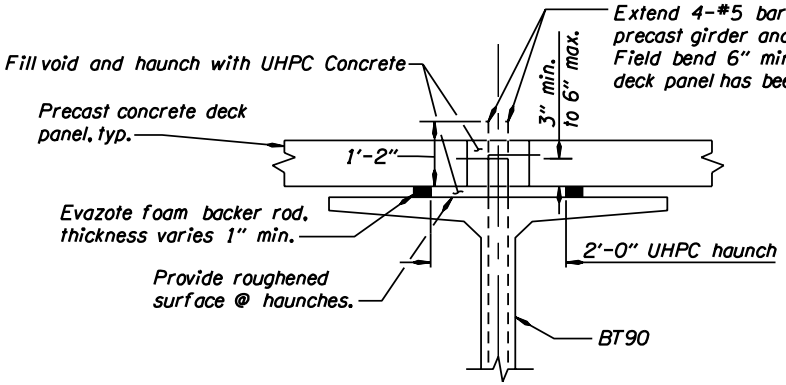


PLAN



SHEAR BLOCKOUT DETAIL

NOT TO SCALE



ELEVATION
PANEL CONNECTION

Notes:

Temporary midspan diaphragms not required if permanent diaphragms are used.

Provide temporary bracing from top flange to top flange at midspan until permanent diaphragms are installed.

Provide inserts or other connection devices. Do not use girder reinforcement as part of temporary bracing connections.

Transport and place precast members in accordance with Section 00550.49 of the Standard Specifications for Highway Construction.

For BT90 Girder general details, see dwg. 85693

Provide Evazote compressible foam backer Rod or approved equal per UHPC manufacterer's recommendation.

Install Evazote Backer Rod to form a tight seal between girder and precast panels to accomodate girder camber.

SCALE WARNING

If scale bar doesn't measure one inch then drawing is not to scale

Extg. structure #00700

FHWA Ultra-High Performance Concrete Cyclic Load Tests

Ref.: Video Courtesy of Ben Graybeal, Et. Al. @ FHWA

UHPC Placing

Ref.: Photos Courtesy of Ben Graybeal, Et. Al. @ FHWA

UHPC QA/QC

Specifications:

- Slump Flow Test
  - Mini-slump cone
  - Flow 7” to 10”
- Compressive Strength
  - 3” x 6” Cylinders
  - Ends cut and machined to < 0.5º
  - Field Strength Requirements
    - 14,000 psi @ 14-days
    - 17,000 psi @ 28-days
- Mix Design
  - ODOT Std Spec 02001.33
  - Recommend 02001.33(b) (Standard Deviation Formula)
- Manufacturer’s Recommendations

Accelerated Bridge Construction (ABC) Benefits of Precast Deck Panels & UHPC Connections

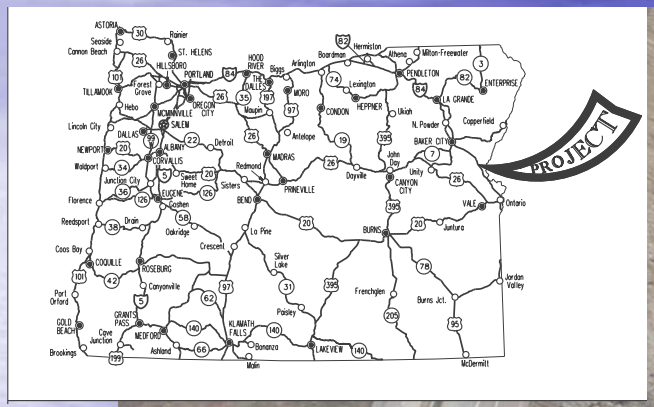
Time Saving Features:

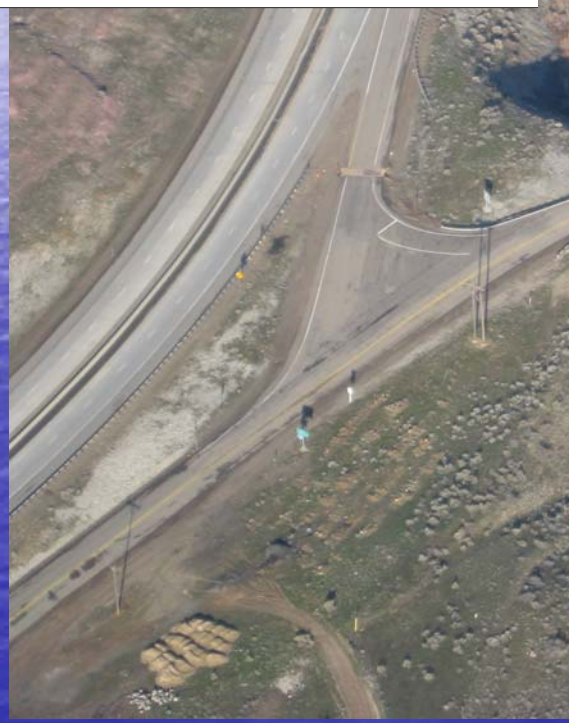
- Precast Prestressed Deck vs. Traditional Cast-in-Place Deck
- Steel Midspan Diaphragms
- UHPC Connections
  - Cure time
- Cost Considerations
  - Additional expenses
  - Savings

THINGS TO CONSIDER

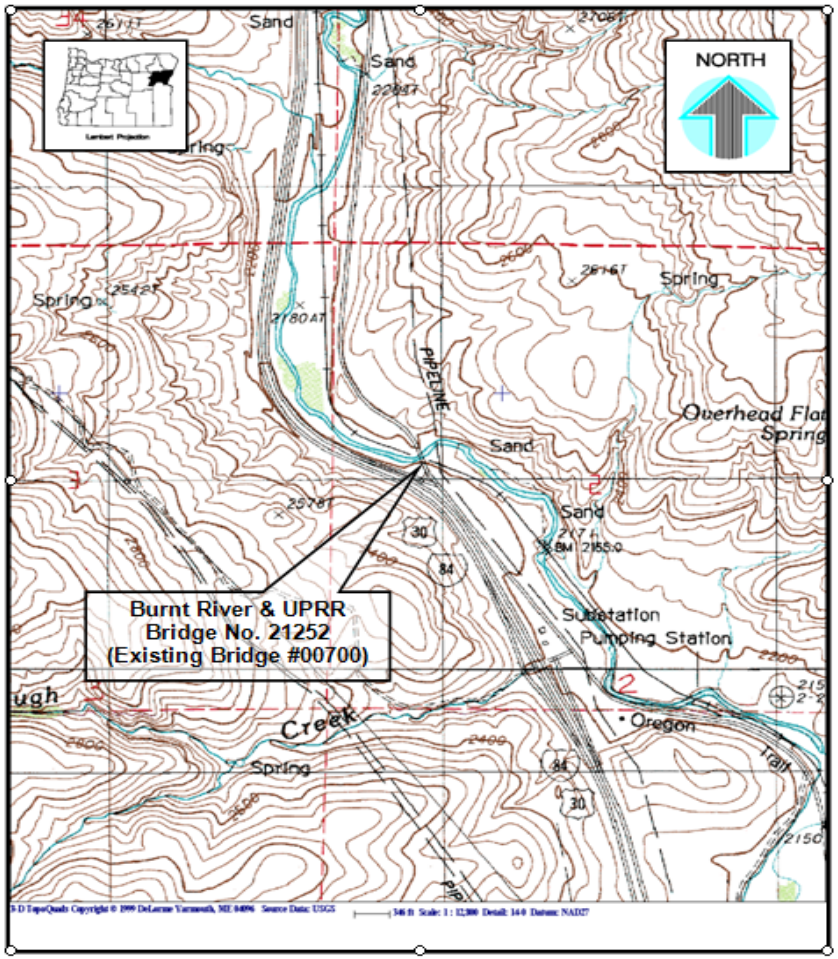
- Buy America Clause – Waiver
- Currently no design codes
- Talk to FHWA and other State DOT's when considering new or experimental designs
- Reliance on Supplier Recommendations

US30: Burnt River & UPRR Bridge





Burnt River & UPRR Bridge No. 21252
Huntington Highway #449 (US 30) @ MP 2.75
Baker County, Oregon
T. 14 S., R. 44 E., Section 2, W. M.



Existing Structure & Site Conditions

Ultra High Performance Concrete: Contact Information

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Questions?

Thank you,

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