# PRESS BRAKE GIRDER BRIDGES

2015 CEAO Bridge Conference
Columbus, Ohio

# OUTLINE

- Basic Girder Section
- Demonstration Project
- Schematic Plans
- Other Innovations
- Research

# BASIC GIRDER SECTION

- Girder depths: (1/2" Plate)
  - 60" plate:    d = 12"
  - 72" plate:    d = 17"
  - 96" plate:    d = 27"
  - 120" plate:  d = 34"

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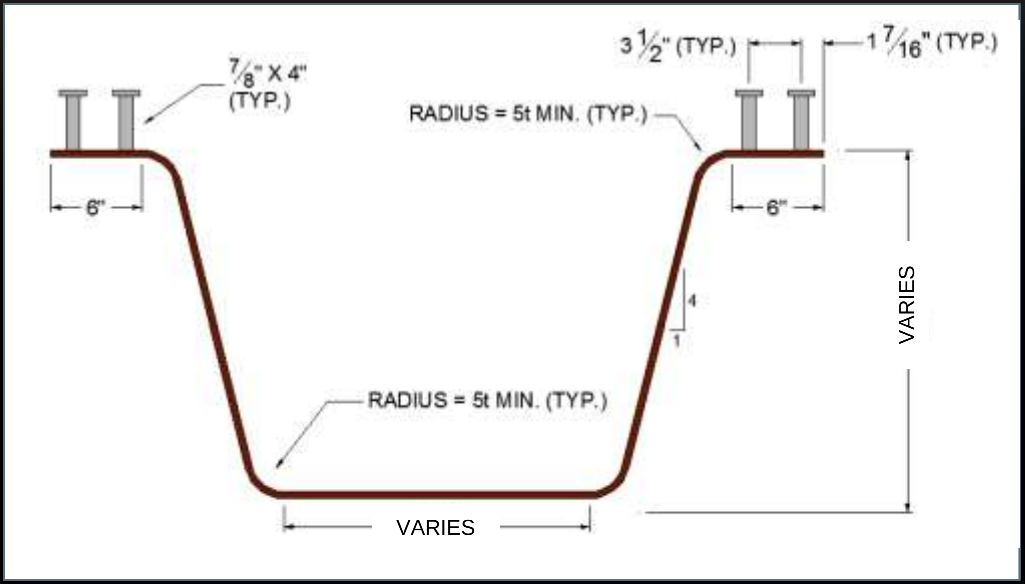
  - A588 Gr50W (Weathering)
  - A572 Gr50 Hot-Dip Galvanized

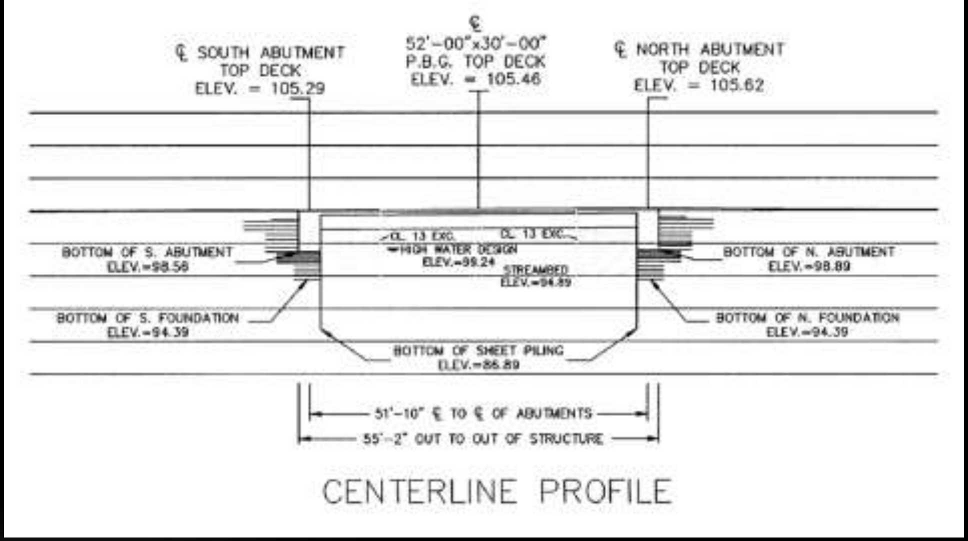


# DEMONSTRATION PROJECT


Dillon Avenue over an unnamed Creek, Fairbank Twp, IA (Buchanan County)

# DEMONSTRATION PROJECT

- FHWA Innovative Bridge Research And Development Program
- 52’-0” Span
- 30’-0” Rail/Rail Width
- 27” Press Brake Steel Plate Girders
- Alt. Bid CIP or P/C Conc. Slab
- MGS Railing
- Monolithic Deck & Backwall
- Crushed Stone Approaches
- Concrete Abutment Seat
- GRS Abutment & Foundation
- Sheet Pile Cut-off Walls



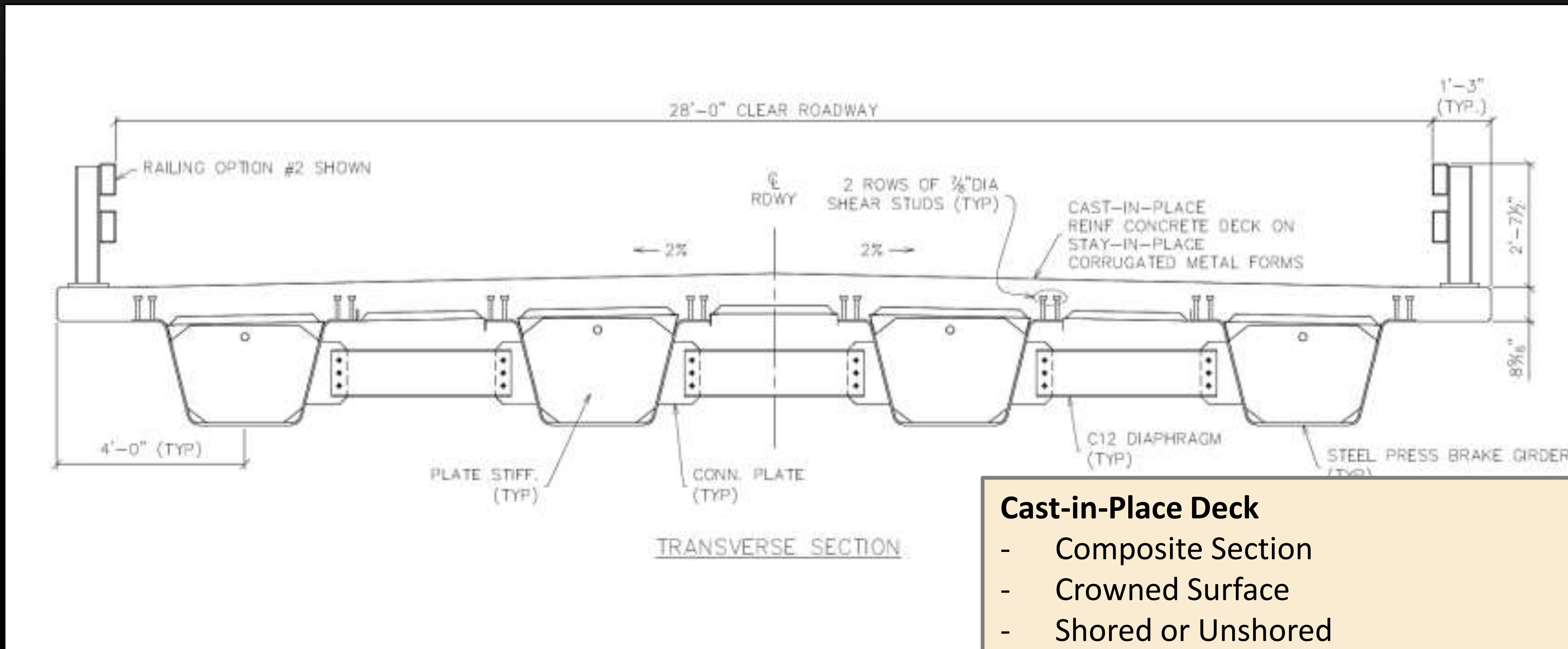

AT&F


10 TON


# SCHEMATIC PLANS

- Deck Slabs & End-of-Bridge Details
  - Cast-in-Place Concrete
  - Precast Concrete (Field Attached)
  - Precast Concrete (Pre-attached)
- Crowned or Uncrowned Surface
- Shored & Unshored Construction / Cambered & Un-cambered
- Internal and External Bracing
- Closure Pours

# DECK SLAB CONSTRUCTION

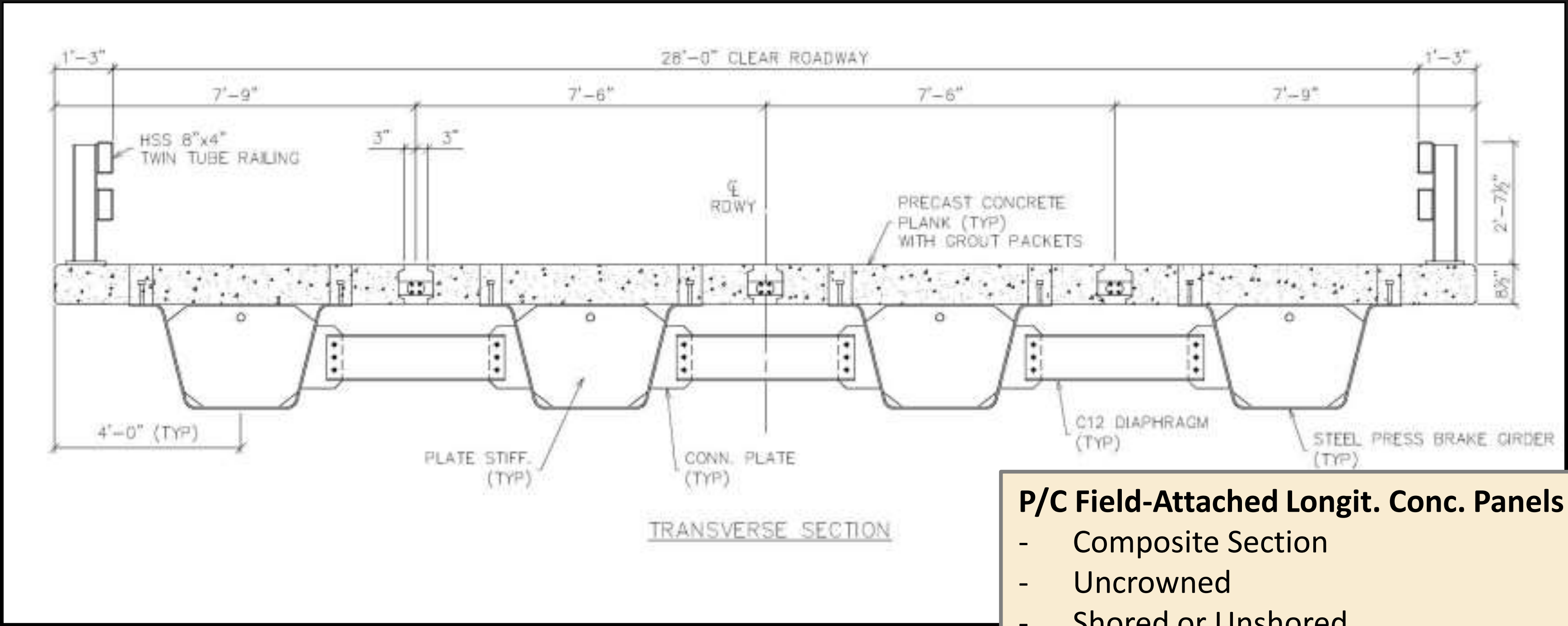



**Cast-in-Place Deck**

- Composite Section
- Crowned Surface
- Shored or Unshored
- SIP forms brace for local buckling
- Diaphragms req'd for unshored const.
- Internal Form supports attach'd & HDG
- Method used for Iowa pilot project

Cast-in-Place Concrete Deck Slab

# DECK SLAB CONSTRUCTION

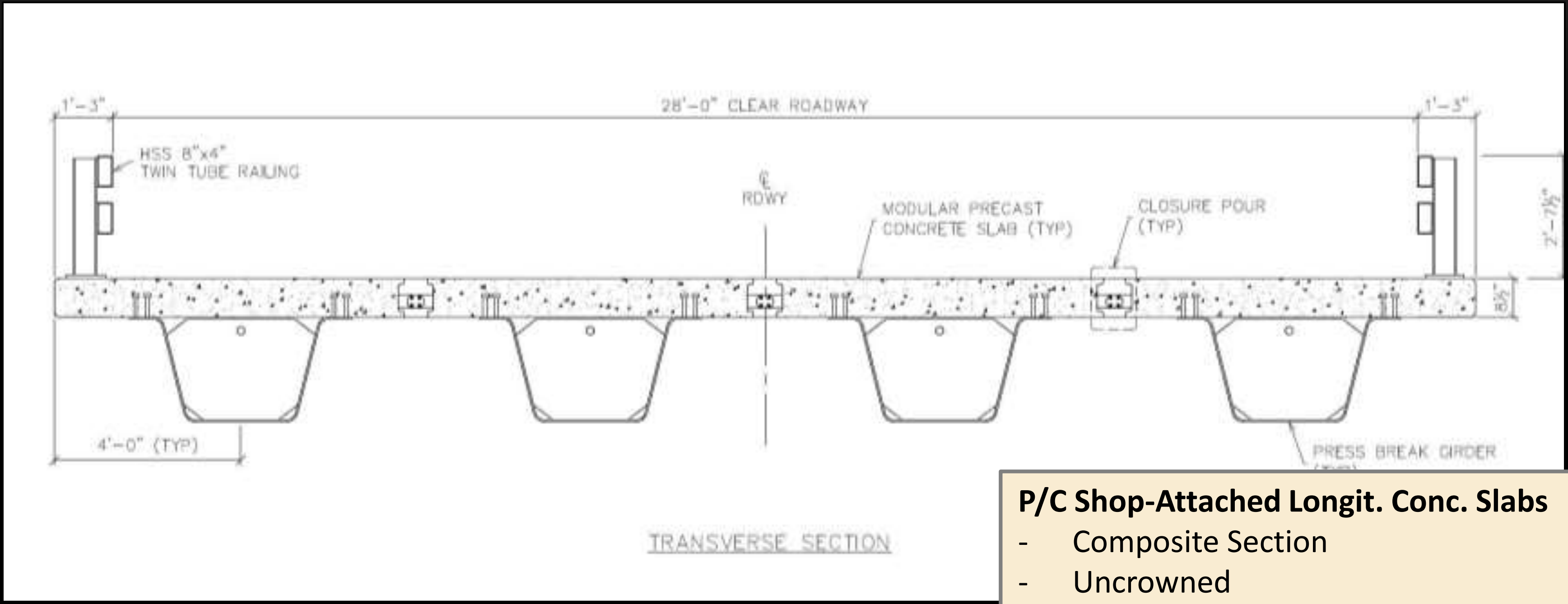



**P/C Field-Attached Longit. Conc. Panels**

- Composite Section
- Uncrowned
- Shored or Unshored
- Diaphragms req'd for unshored const.
- Grout Pocket Attachment
- Closure Pours

Precast Field Attached Longitudinal Concrete Panels

# DECK SLAB CONSTRUCTION




**P/C Shop-Attached Longit. Conc. Slabs**

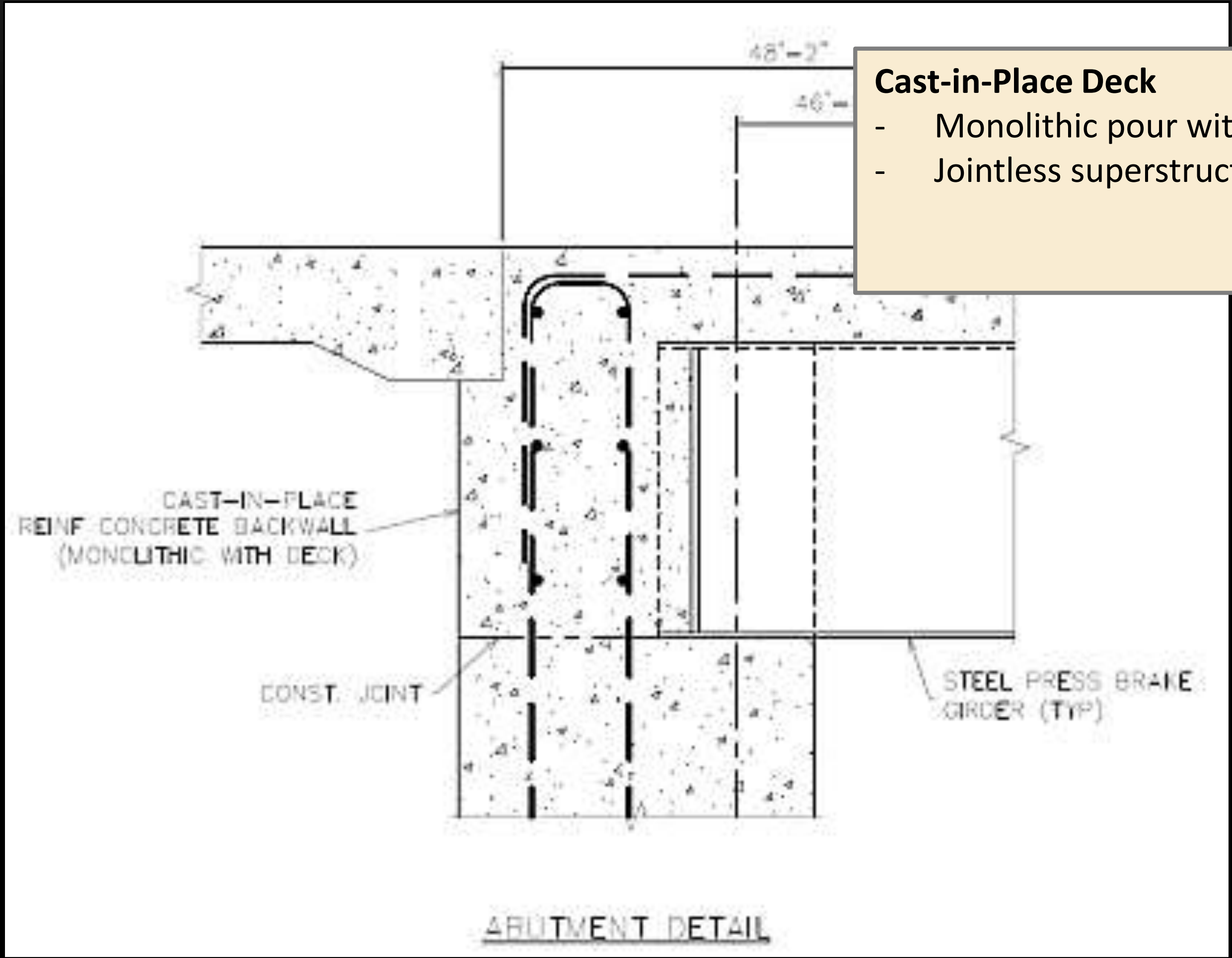
- Composite Section
- Uncrowned
- Shored
- Diaphragms are not req'd
- Closure Pours and Diamond Grinding

Precast Shop Attached Longitudinal Concrete Slabs

# END OF BRIDGE DETAILS

- Deck Slabs & End-of-Bridge Details
  - Cast-in-Place Concrete
  - Precast Concrete (Field Attached)
  - Precast Concrete (Pre-attached)
- Expansion Joints or Jointless

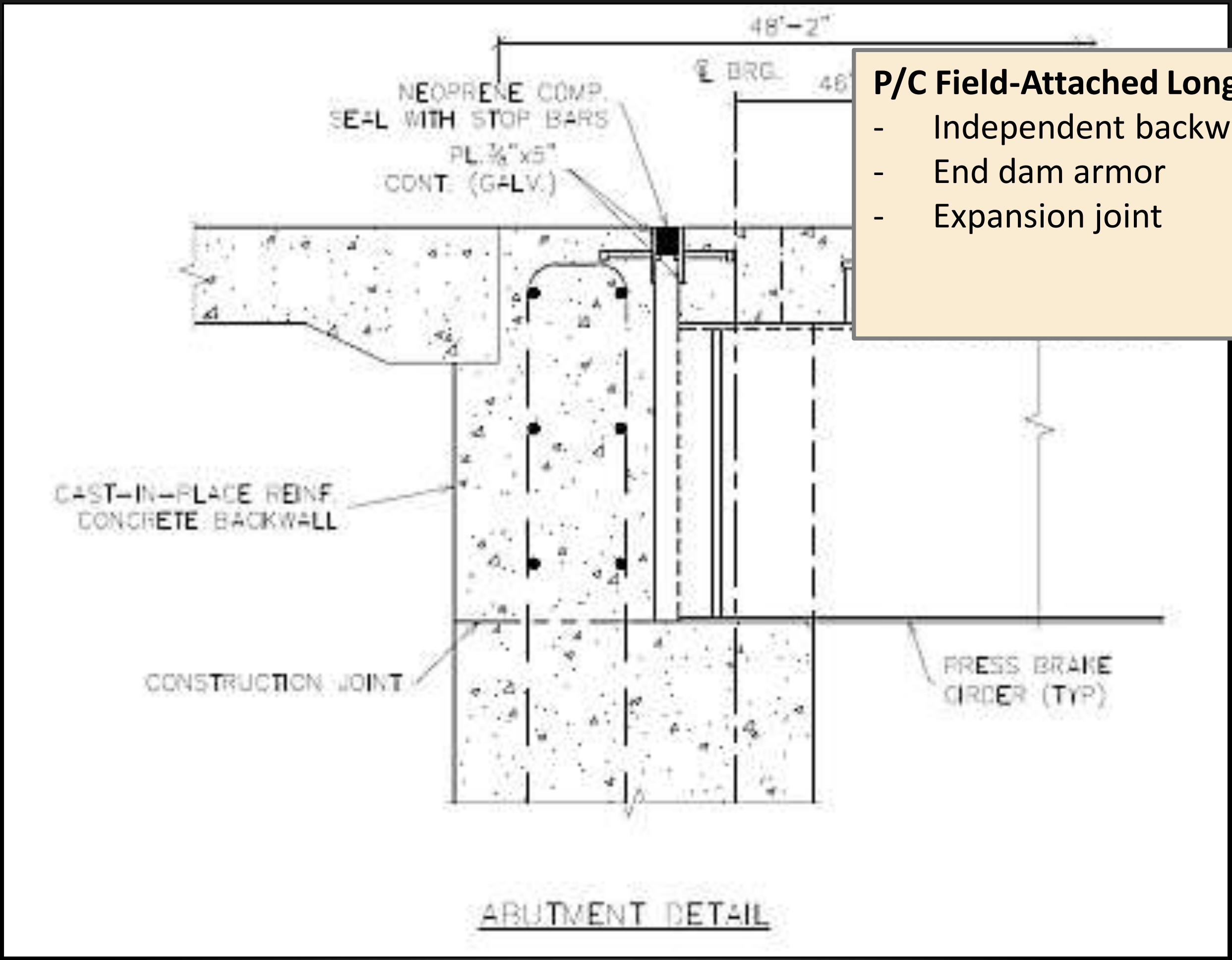
# END OF BRIDGE DETAILS




**Cast-in-Place Deck**

- Monolithic pour with backwall
- Jointless superstructure

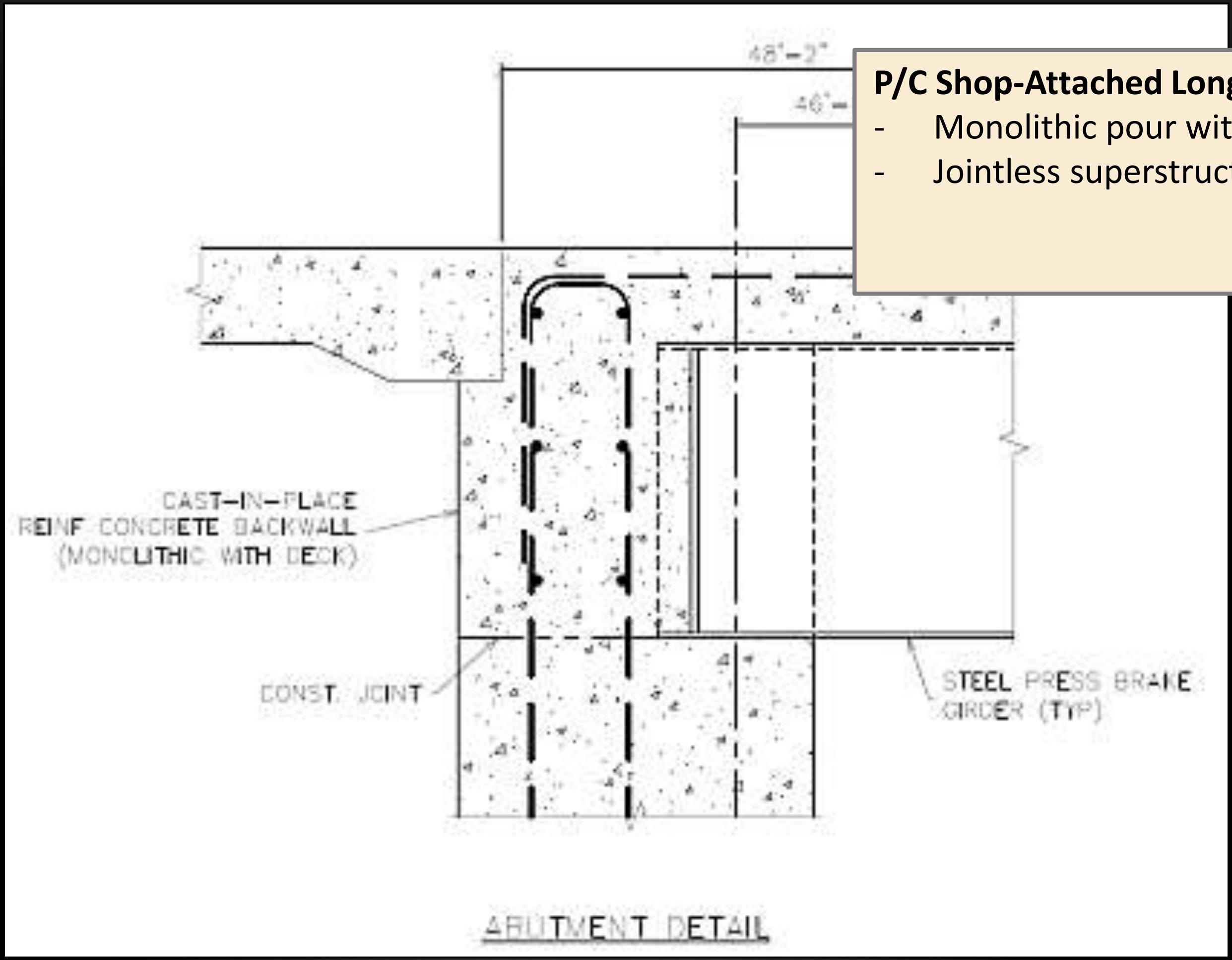
# END OF BRIDGE DETAILS




**P/C Field-Attached Longit. Conc. Panels**

- Independent backwall pour
- End dam armor
- Expansion joint

# END OF BRIDGE DETAILS




**P/C Shop-Attached Longit. Conc. Slabs**

- Monolithic pour with backwall
- Jointless superstructure


TPL
TPL
TPL
photo by Con-Struct

# EDGE OF BRIDGE DETAILS

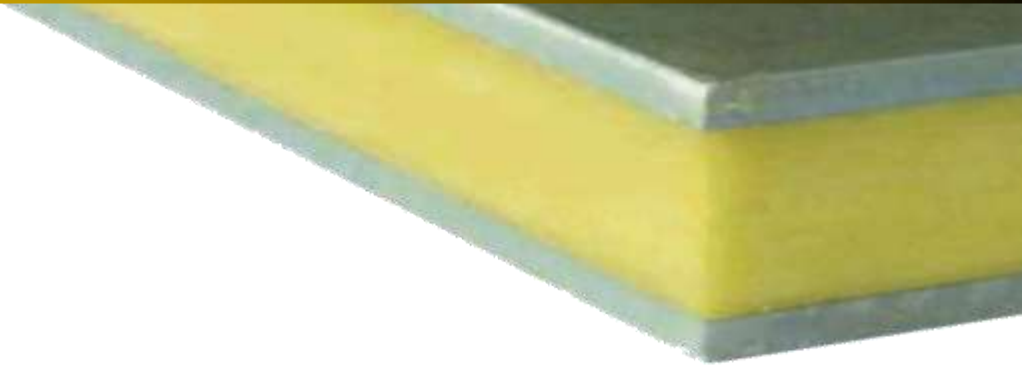
- Top of Slab / Base Plate Mounted Rail
- Side of Slab / Embed. Plate Mounted Rail
- MGS Flexible Rail System


photo by Con-Struct

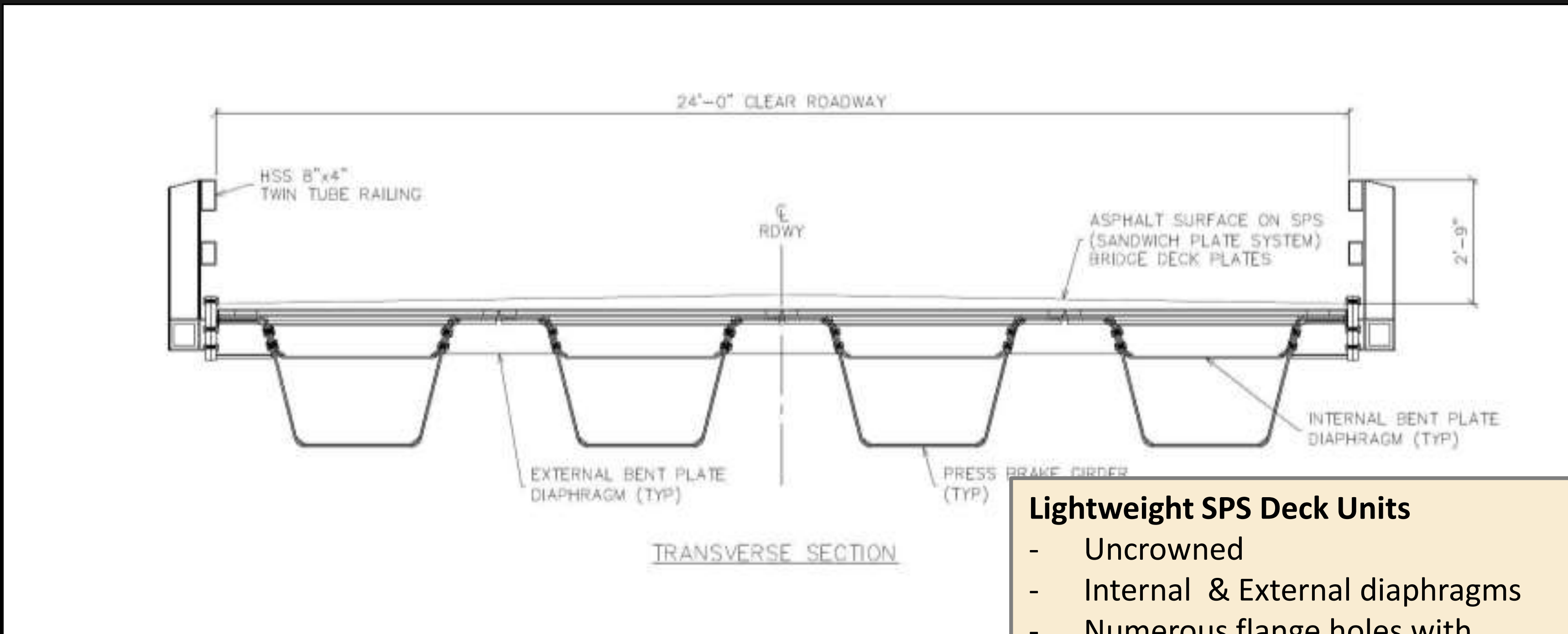

photo by Con-Struct


photo by SSSBA

# SANDWICH PANEL SYSTEM



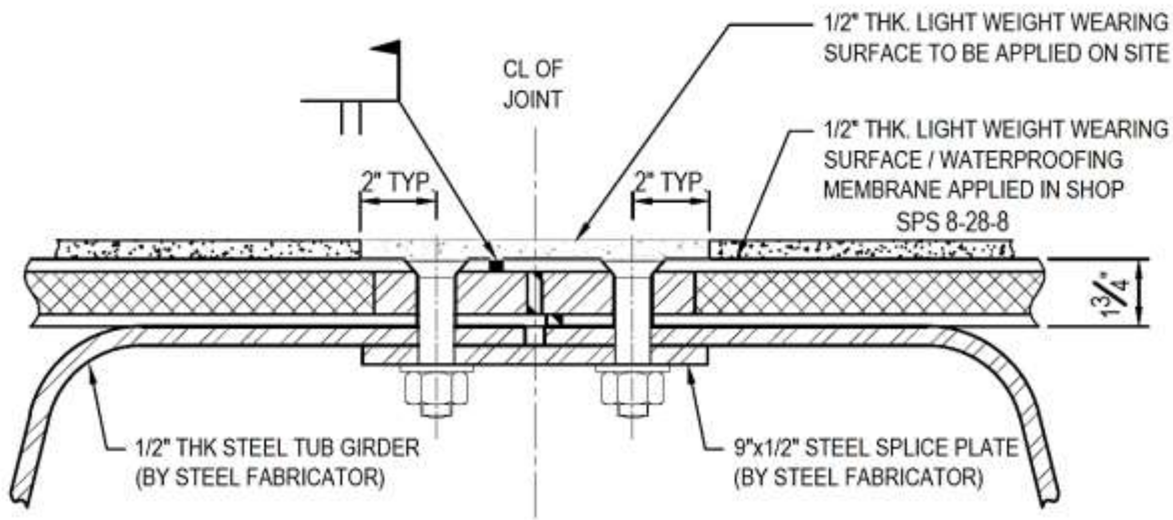
# SANDWICH PANEL SYSTEM (SPS) UNITS




**Lightweight SPS Deck Units**

- Uncrowned
- Internal & External diaphragms
- Numerous flange holes with countersunk bolt holes and backer plates
- Potential blind and hard-to-get to connections

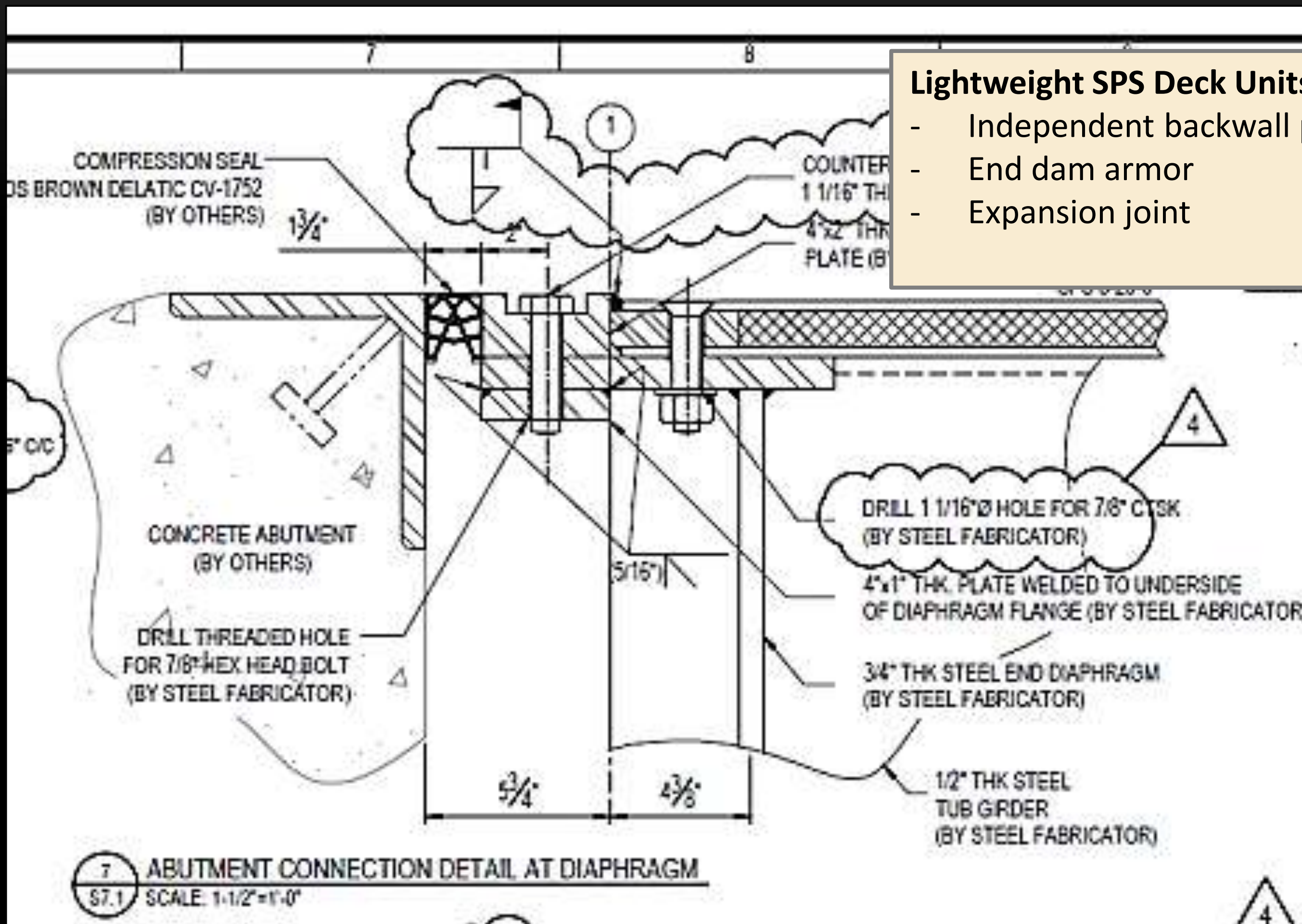
Lightweight SPS Deck Units




SPS CONNECTION DETAIL

SCALE: 1-1/2"=1'-0"

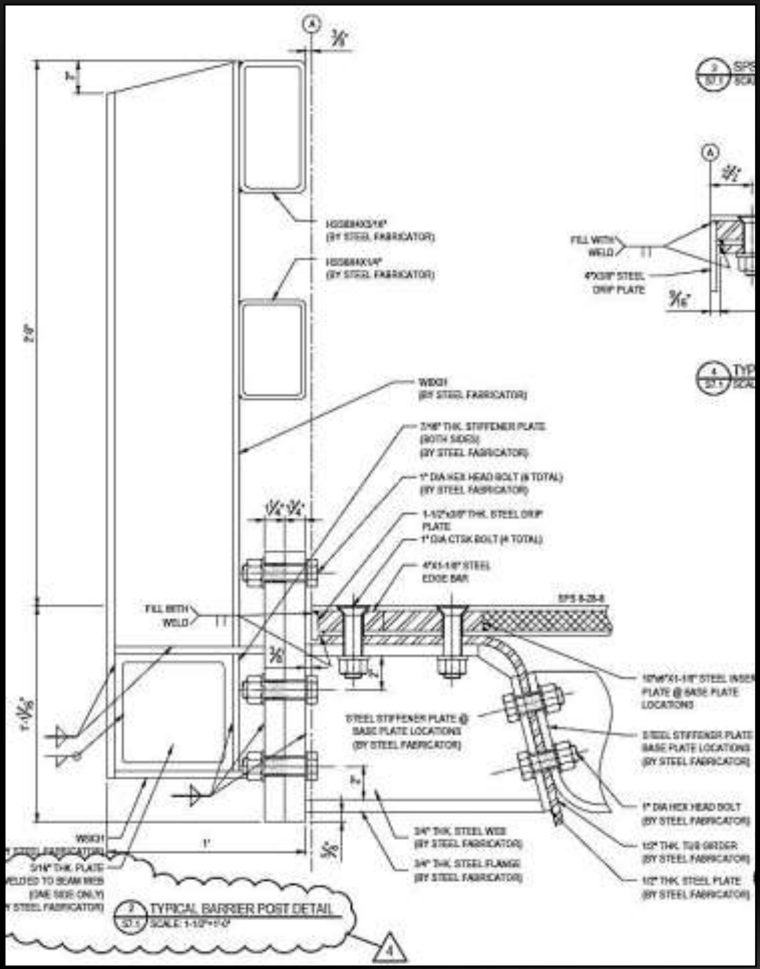
# END OF BRIDGE DETAILS

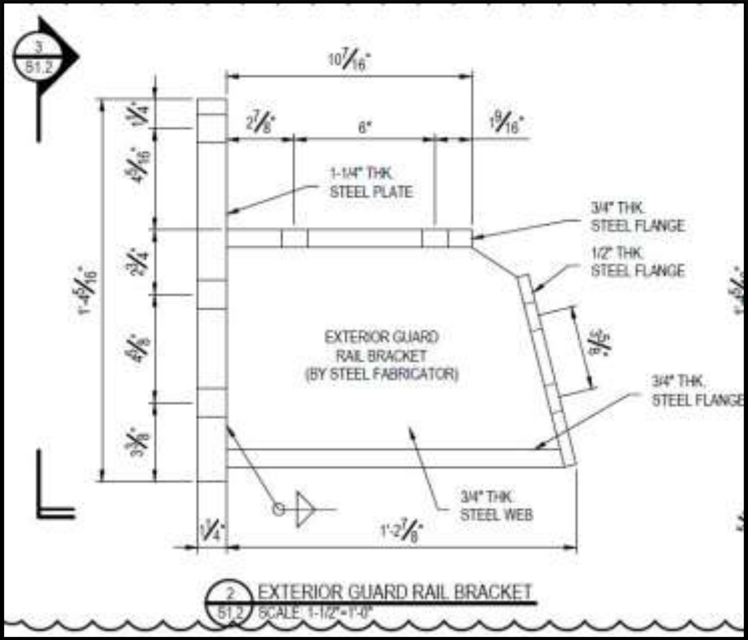



**Lightweight SPS Deck Units**

- Independent backwall pour
- End dam armor
- Expansion joint

# EDGE OF BRIDGE DETAILS



# MORE CONSIDERATIONS

- Steel Grades & Corrosion Protection
  - HPS Steels (50, 70 & 100 ksi)
  - A1010 Infrastructure Grade Stainless Steel

**TECHBRIEF**

# Improved Corrosion-Resistant Steel for Highway Bridge Construction

FHWA Publication No.: FHWA-HRT-11-061

FHWA Contact: Paul Virmani, HRDI-60, (202) 493-3052, paul.virmani@dot.gov

This document is a technical summary of the Federal Highway Administration report, *Improved Corrosion-Resistant Steel for Highway Bridge Construction* (FHWA-HRT-11-062).

## Introduction

Plate girder bridges are usually fabricated from painted carbon steels or unpainted weathering steels. Weathering steels, including the modern high-performance steels, offer the lowest life-cycle cost (LCC) over the design life of the bridge because, in most service environments, ongoing maintenance due to steel deterioration is not necessary. However, where the bridge is subject to high time-of-wetness or high chloride exposures—coastal areas and areas that use large quantities of deicing salt—weathering steels are not effective because the protective patina does not develop and the steel has a high corrosion rate.[1] In these conditions, structural stainless steel ASTM A1010 (UNS S41003) provides sufficient corrosion protection so that painting is not necessary and the bridge structure is maintenance free over its design life.[2] The initial cost of stainless steel is more than twice the cost of carbon or weathering steel. Reducing the cost of stainless steel would improve the LCC of bridges in severe corrosion service conditions. This study identifies steels with lower potential cost than ASTM A1010 that could be candidates for bridge construction while still providing low corrosion rates.

## Approach

The alloy steel design selected to reduce the cost of ASTM A1010—that contains 11 percent chromium (Cr)—was to reduce the Cr content to 9, 7, and 5 percent. To compensate for the diminished corrosion resistance from lower Cr, additions of 2 percent silicon (Si), 2 percent aluminum (Al), or a combination of 2 percent Si plus 2 percent Al were made in the lower Cr experimental steels. After making and hot rolling the steels, the resulting plates were heat treated. These were tested for strength and impact resistance to determine which steels can meet the steel specifications for steel bridges.[3] The corrosion resistance of the alloyed steels was studied in the laboratory using accelerated test methods. In addition to measuring the corrosion rates, the corrosion products that developed on each of the steels were identified. Several steels were studied further by exposing them for 1 year on an existing weathering steel bridge that has a high corrosion rate due to deicing salt use.

Additionally, a LCC analysis was conducted to examine the benefits of using maintenance-free, corrosion-resistant steel in place of regularly repainting conventional steel. Both deterministic and probabilistic LCC

U.S. Department of Transportation
**Federal Highway Administration**

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Turner-Fairbank Highway Research Center
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http://www.fhwa.dot.gov/research/

MERIT AWARD—Short Span
SUSTAINABILITY COMMENDATION

**DODGE CREEK BRIDGE, ELKTON-SOUTHERLIN HIGHWAY, ORE.**

One of the Oregon Department of Transportation's (ODOT) chief concerns is the increasing need for rehabilitation on the state's older bridges.

And a chief concern in bridge design and construction is the need for spans that are cost-effective and are environmental friendly—which is where superior materials like weathering steel come in. Weathering steel performs well in parts of Oregon that meet the requirements of the Federal Highway Administration Technical Advisory T5140. However, the state of Oregon was curious about steel types that could reduce steel bridge lifecycle costs in the coastal portion of the State. High-performance steel (HPS) is an important step in increasing toughness and provides a slight increase to the corrosion index compared to weathering steel. However, HPS may still be vulnerable in corrosive and high humidity environments or coastal climates.

One conventional way to provide corrosion protection of bridge steels is to apply protective paint coatings and periodically recoat the bridge during its service life. But the life-cycle cost of this design choice can be much higher than the initial cost of the bridge. An alternative to weathering steel, HPS and painted steel girders is corrosion-resistant ASTM A1010 Grade 50 steel that needs no corrosion protection coating and has better toughness that supersedes toughness properties of Grade HPS 50W. ASTM A1010 is a low-cost stainless steel with 10.5-12%Cr that can perform for 125 years in coastal environment without a need to maintain for corrosion.

Based on encouraging research and development results, ODOT went ahead with a trial project to design and fabricate of the first public ASTM A1010 steel plate girder bridge in the nation, and ArcelorMittal USA agreed to provide the steel plate. The bridge, with a total length of 132 ft, 6 in. and a width of 42 ft, 8 in., uses just over 80 tons of structural steel. FHWA supported ODOT's proposal by awarding an Innovative Bridge Research and Deployment grant to cover the extra cost for design and fabrication of the first steel plate girders bridge for public use using ASTM A1010 corrosion-resistant steel in the nation.

**Owner and Engineer**
Oregon Department of Transportation, Salem

**General Contractor**
Concrete Enterprises, Inc., Salem

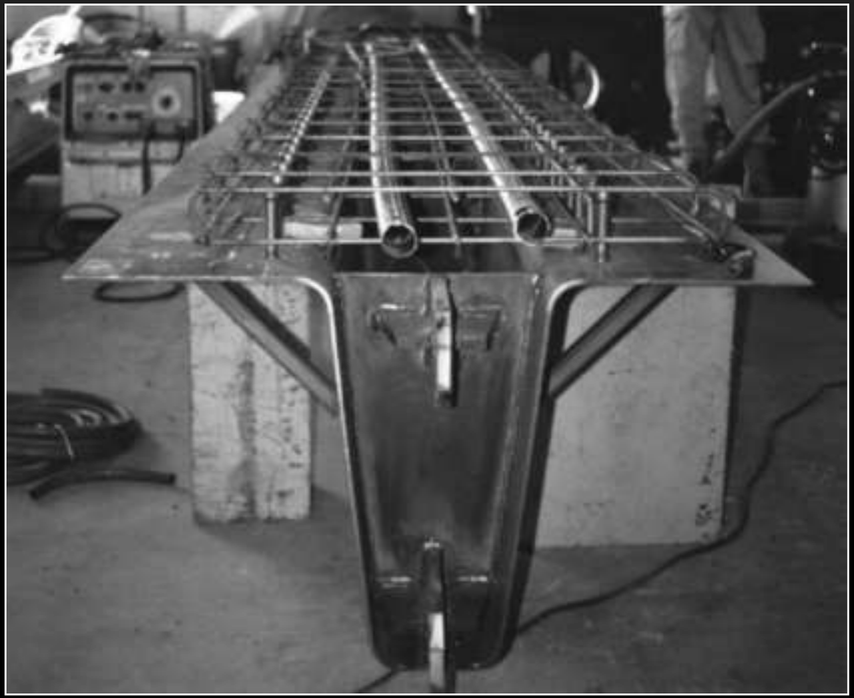
**Steel Team**

**Fabricator**
Fought & Company, Tigard, Ore. (AISC Member/NSBA Member/AISC Certified Fabricator)

**Detailer**
Carlson Detailing Service, Fort Worth, Texas (AISC Member)

# CONCEPT

- Cold Formed Steel
- Since the 1970's
- AISC Engineering Journal, Taly & GangaRao, 1979
- Speed of production
- Economic sections
- Modular capability
- Shorter spans



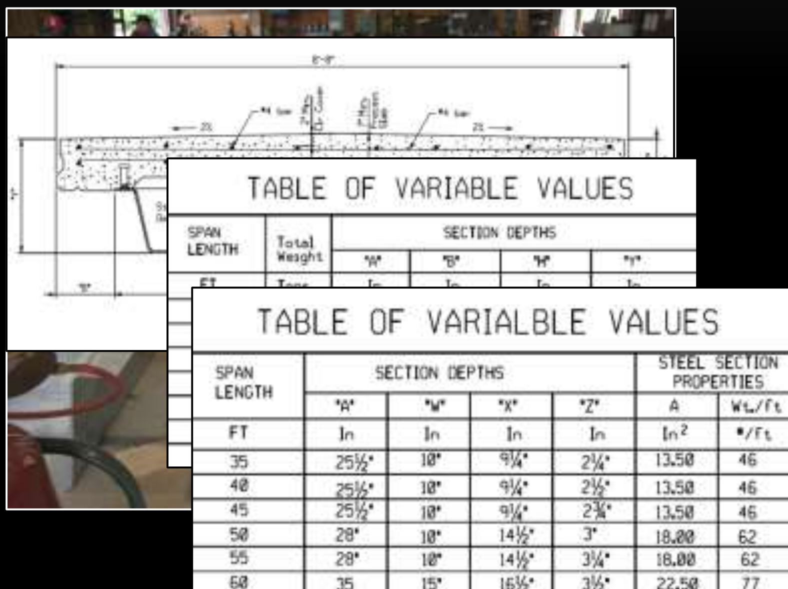
# SYSTEMIZED TECHNOLOGIES

## Con-Struct Bridge Systems

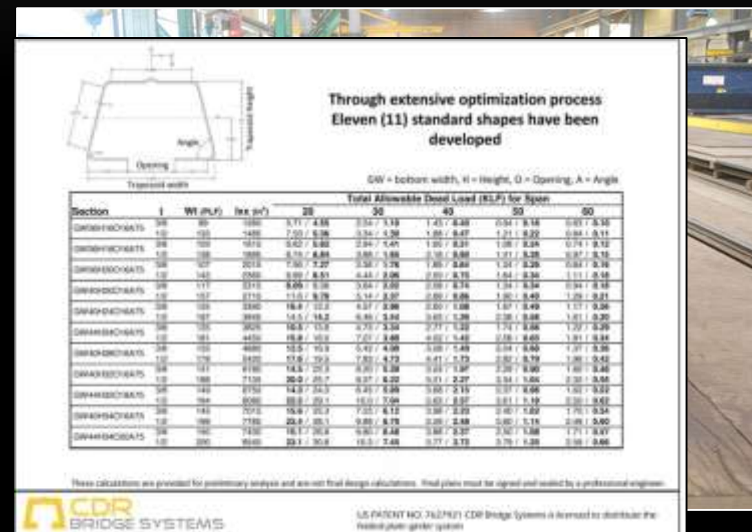

## CDR Bridge Systems

# SYSTEMIZED TECHNOLOGIES

## Con-Struct Bridge Systems

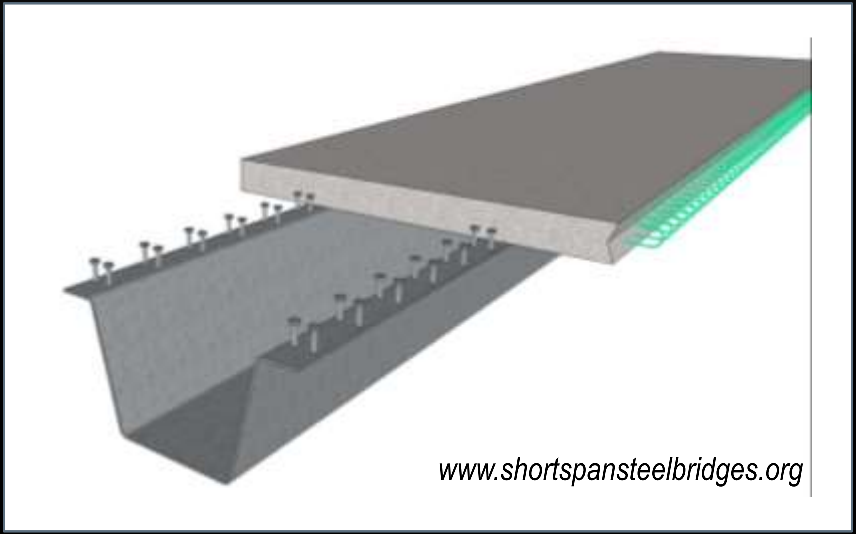



## CDR Bridge Systems FSPGS



# PRESS BRAKE GIRDER BRIDGES

- Bridge Technology Center
- New Concept (slightly)
- Efficient
- Modular
- Industry Collaboration
- “Open Platform”

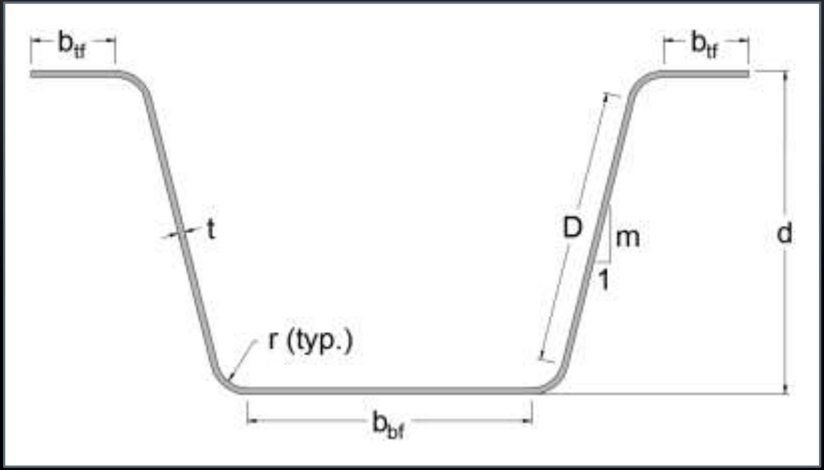


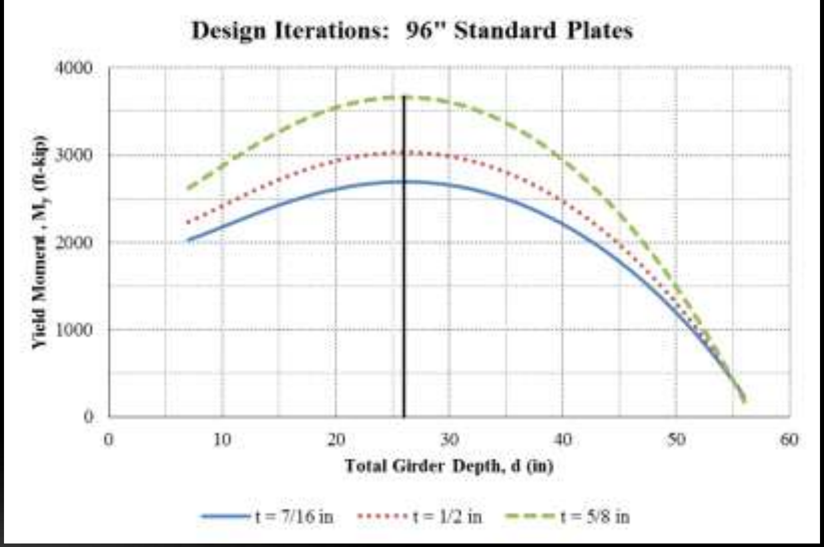
# CURRENT RESEARCH

- WVU Structures Lab
- Karl Barth, PhD. (WVU), Michael Barker, PhD. (UW) and Greg Michaelson, PhD. (Marshall)
- Precast slab
- Weathering steel & Hot dip galvanizing

# DESIGN METHODOLOGY

- Goal: utilize standard plate widths
  - 84”, 96”, etc.
- Maintain 1:4 web slope, “5t” radii, and 6” $b_{tf}$
  - Consistent w/ AASHTO Spec.
- Optimize girder dimensions to attain maximum capacity

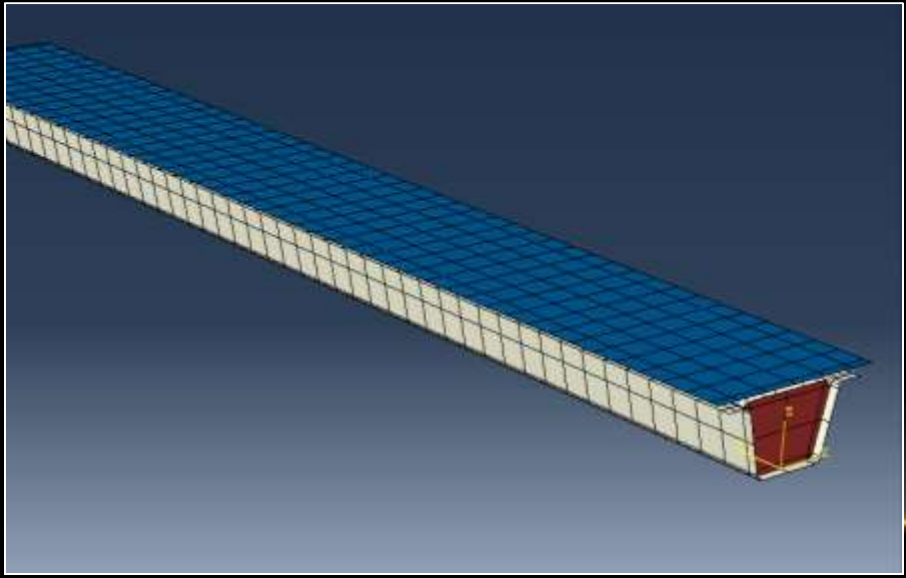


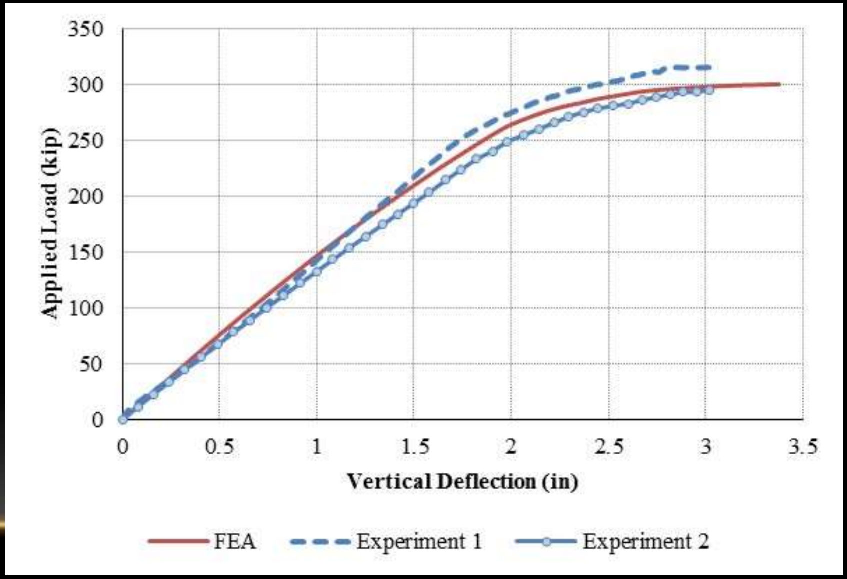



# EXPERIMENTAL TESTING AT WVU

# ANALYTICAL METHODS

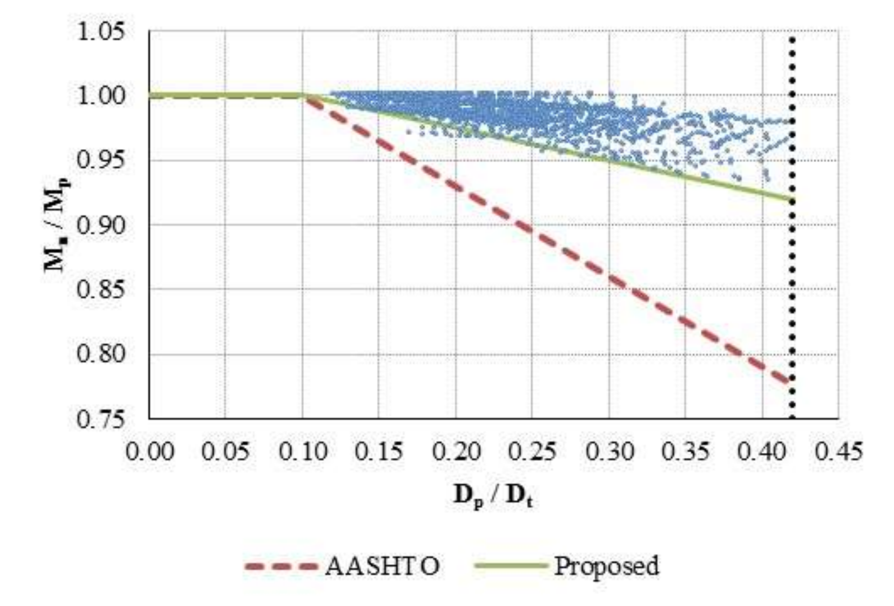
- FEA was completed using Abaqus v.6.10-EF2
  - S4R shell elements were employed to simulate the girder and deck
  - von Mises material laws governed steel behavior
  - A smeared cracking model incorporating tension stiffening was employed for concrete behavior





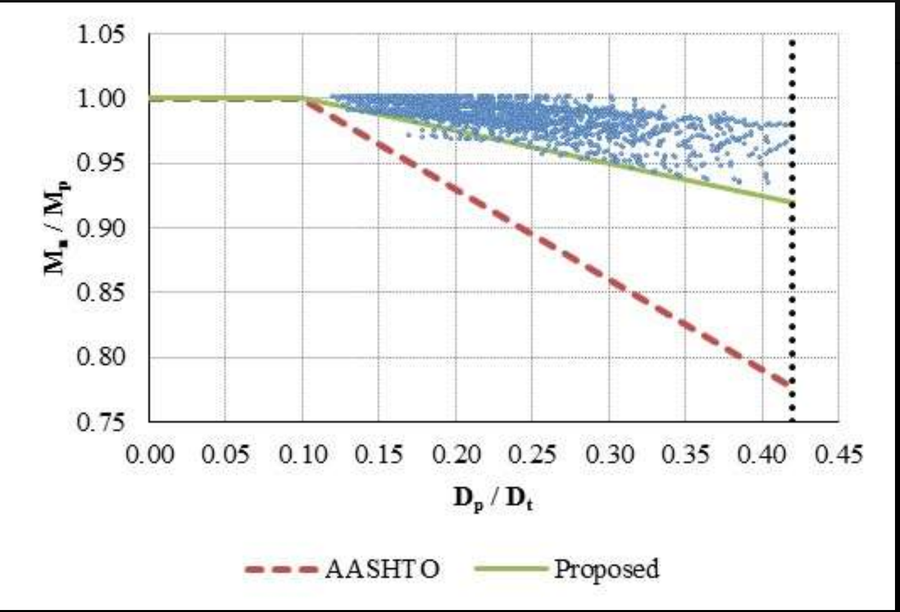
# AASHTO FLEXURAL CAPACITY

- In order to evaluate the applicability of AASHTO Specifications, a parametric matrix of composite girders was developed (resulting in 900 girders):
  - 18 girders (previously described)
  - 50-ksi and 70-ksi steel employed
  - 25 deck options
    - 5 deck thicknesses (7" to 11" in 1" increments)
    - 5 deck widths (defined based on out-to-out width of the girder



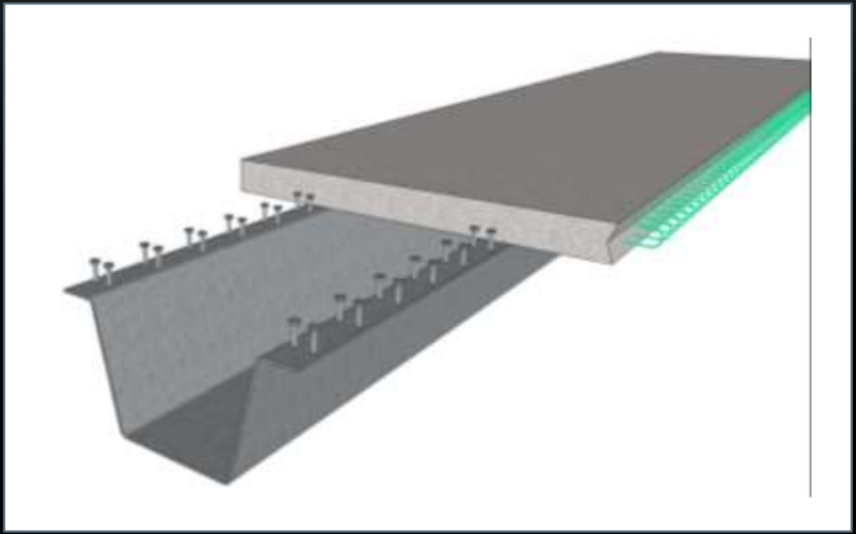
# AASHTO FLEXURAL CAPACITY

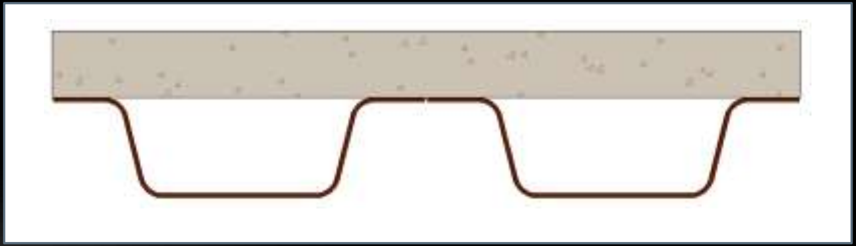
- AASHTO Applicability
- Parametric matrix of composite girders
- 900 girders
- Including the 18 girders previously described
- 50-ksi and 70-ksi steel employed
- 25 deck options
  - 5 deck thicknesses (7” to 11” in 1” increments)
  - 5 deck widths, based on out-to-out width of the girder



# STANDARDIZATION (CONT'D)

- Therefore, based on plate availability and feasibility assessments, the following standardized girders are proposed:
  - PL 72" × 1/2" >> 17" deep girder
    - Applicable for spans up to 40 ft
  - PL 96" × 1/2" >> 26" deep girder
    - Applicable for spans up to 60 ft
  - PL 120" × 5/8" >> 34" deep girder
    - Applicable for spans up to 80 ft
  - Double PL 60" × 1/2"
    - Applicable for spans up to 65 ft





# DESIGN METHODS & GUIDANCE

- Design Methods & Guidance

# DEMONSTRATION PROJECT RESULTS

# THANK YOU