Past, Present and Future of Precast Prestressed Concrete Bridges in the U.S.

First Brazilian Meeting on Integration of Research-Design-Production in the Field of Precast Concrete

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Types of Bridge Girders in Brazil

I Girders
seção trapezoidal

Box Girder

a) tipos de elementos

CML

b) arranjo dos elementos
Types of Precast Concrete Bridges Built in the US

- Double Tee and Multi-stem (20 m)
- Inverted Tee (30 m)
- AASHTO Box (36 m)
- AASHTO I-Beam (45 m)
- New I-Beam shapes (65 m)
- Spliced New I-Beams (96 m)
Introduced in Nebraska 1996 for Shallow Bridges with spans to 30 meters, span/depth = 30-33
Also used in Kansas, Iowa, North Carolina, Florida, and Australia
Standardized Precast Segmental Overpass, Post-Tensioned Voided and Ribbed Slabs

- 3-Span Continuous
- Typical Span 24 – 37 m
- Typical Span/Depth Ratio 30
Overpasses with Reduced Vertical Clearance
Channel Bridge, **Upstate, New York, USA**

Utilizes the parapet as a structural element, thereby minimizing the structural depth.
NU (Nebraska University)
I- GIRDER
NU GIRDER

900 to 2000

1225

R = 200

150

140

135

975

NU GIRDER
Standard American Association of State Highway and Transportation Officials (AASHTO) Beams and Nebraska University I-Beams
Features:
• Adaptable to high strength concrete
• Hard metric dimensions
• Stable during shipping and erection
• Aesthetically appealing
• Accepts Welded Wire Reinforcement
• Accepts internal post-tensioning
Welded Wire Reinforcement

- Economy
- Reinforcement spacing is accurate
- Higher Strength
Lifting Device
Applications Outside Nebraska

• New England Bulb Tee (6 states)
• Michigan I-Girder
• Washington Super Girder
• Utah
• Minnesota
• Wisconsin
• Iowa
• Mexico
• Panama
• India
Washington state 2.1 m deep, 47.2 m long for construction over the Yakima River
Standard Design: Eleven AASHTO Girder Lines, Concrete Strength = 35 MPa (350 kg/cm²)

NE TYPE 3A Girder

1 m

10 spaces @ 2.4m

1 m

Typical Cross Section

AASHTO Girder section Design
Optimized Design: Seven NU I-Girder Lines, concrete strength = 84 MPa (840 kg/cm²)

Typical Cross Section

NU Section Girder Design
Precast Concrete Girders
Made Continuous for Deck Weight
Threaded Rod Continuity

Advantages:

1. *For the same prestressing and strength level*, span capacity can be increased by about 15%

2. *Better structural performance*: Distress at pier diaphragm is eliminated at deck placement and over service life
Platte River East Bridge
Threaded Rod Connection
US-75 / N-92 Clarks Viaduct

1st High Performance Concrete Bridge to Use the Threaded Rod Continuity System
Modified Haunched Girder Threaded Rod System, for Improved Aesthetics
Spliced Precast Post-Tensioned I-Girder Bridges

- Pretension short segments in precast concrete plant
- Post-tension the segments at the site to create long continuous spans
- This system is less expensive in the US than segmental box girder bridges (exception: California!)
• 174 Total Bridges in USA
• 32 States
• 67 Bridges in Canada
Dodge Street (US 6) over 204th Street (N31)
Skyline Spliced Girder Bridge Data

- Span = 63 m
- Clear Roadway = 16.9 m
- Girder Concrete = 70 MPa (700 kg/cm²)
- Cast-in-place Slab = 30 MPa (300 kg/cm²)
- Strands: Pretension: 46-15.2 mm, Post-tension: 3-15-15.2 mm (each 15 strand tendon in 89 mm duct)
- Auxiliary reinforcement: Welded Wire Fabric
- Span-to-girder depth ratio: 30.7
- Span-to-superstructure depth ratio: 27.8
Bow River Bridge, AB

– Built in 2002
– 4 spans: 2 at 174 ft, 2 at 213 ft
– One segment per span
– 211 ft beams weighed 268,000 lb.
– Beams 9.2 ft deep with 6.9 in. web
– 11.65 ft beam spacing
– Very high live load requirements
– Concrete saved 10% over steel girders
Con-Force Structures Limited
Calgary, Alberta

NU Girder 65m (210 ft)
December 2001
U “Tub” Girders
Washington State Standard U “Tub” Girder

**Benefits of “U” girders:**
- Aesthetics
- Minimal span-depth ratio
- Mimics other box girder type construction
- Eliminates lines of girders
- Stable for shipment

**Disadvantages:**
- Heavy weight
- Complicated fabrication
- Difficult field forming of deck
Curved Spliced Precast Post-Tensioned I-Girder Bridges
Arbor Road Bridge

Bridge Cross Section

- Precast U-Girder
- 4 Girder Lines @ 9’-4”
- Precast Deck Panel w/ 1 ½” Concrete Overlay
Bridge at Philadelphia Airport
Produced by Schuylkill Company
Precast Concrete Substructures
Post Tensioning:  
P.T. bars are 35 mm inch, Grade 1050 MPa (10500 kg/cm², 75 mm diameter galvanized steel ducts
Segments are Match Cast
Hammerhead Segments Ready for Shipping
In fully erected pier: PT rods are inserted, jack stresses bars, and ducts are injected with grout
Precast Pier Caps
Precast Concrete Deck/Barrier System
Panels Stacked up in Precast Yard
Panel Shipping
Precast Concrete Full Bridge Superstructure
The Challenge...

- Design & Build Four Urban Grade Separations
  - 2 – 300 m long x 10 m wide
  - 2 – 210 m long x 10 m wide
- Maintain Continuous Traffic
- Complete each Bridge in Less than 72 Days
- 72 HOURS! (3 Days)
- $100,000 Penalty, per day, beyond 72 hours
Concept

Precast girders

Precast pier & cap

CIP footing
Richmond-San Rafael Bridge, San Francisco, CA

Existing Cross Section

Proposed Cross Section
Typical Section

1.17m

3 @ 3.6 = 10.8m

Varies

3 @ 3.6 = 10.8m

1.17m
Concrete Filled Steel Tube Arches
Ravenna Arch Bridge Model, Ravenna, Nebraska
Self Consolidating concrete used to fill the hollow steel elements

- Bottom Chord fill mix
  - 30 in. spread
  - Glenium 30/30
  - Easy to pump
  - Self leveling in tube
THANK YOU