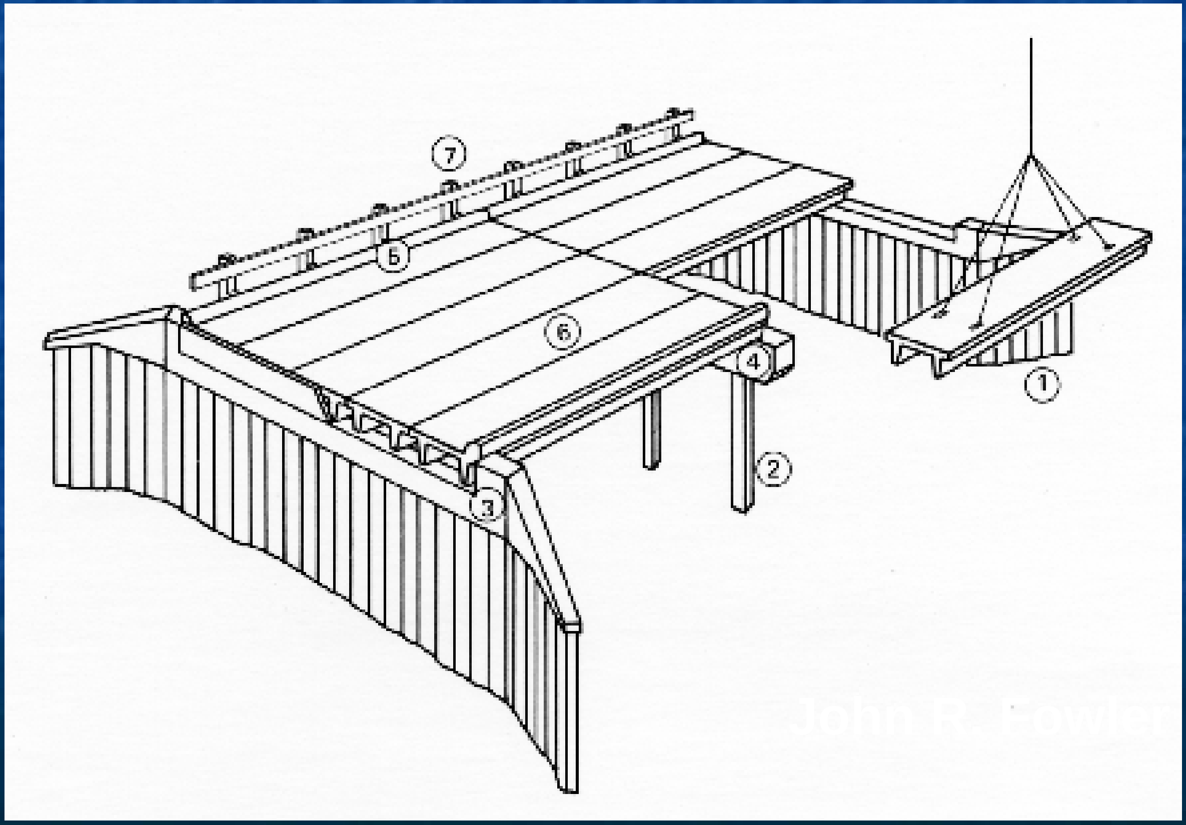
Canadian Precast/Prestressed Concrete Institute

Accelerated Bridge Construction



John R. Fowler

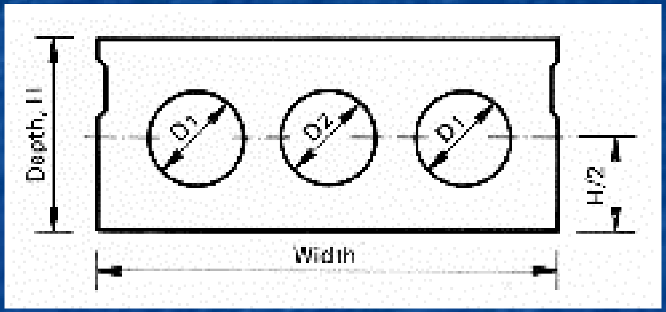
Accelerated Bridge Construction

New ideas are required to address the dual needs of:

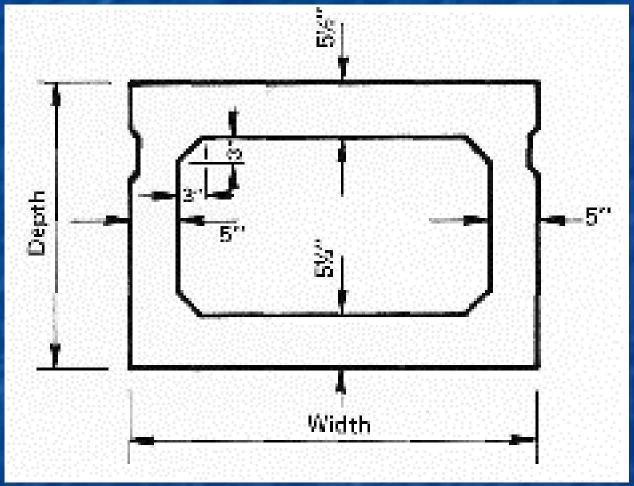
- fast construction
- long service life

Existing Sections

Slab Bridge Sections



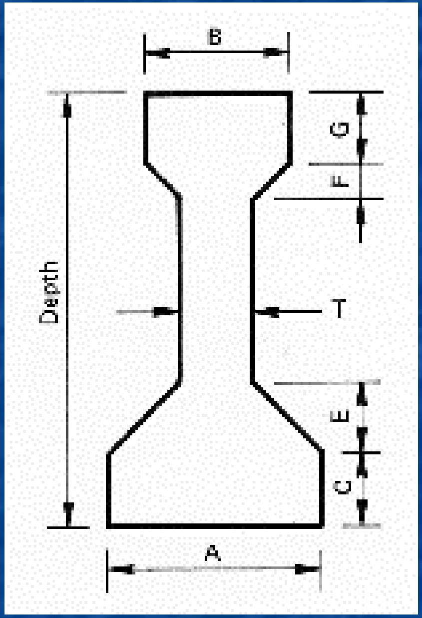
Voided Slab Girder



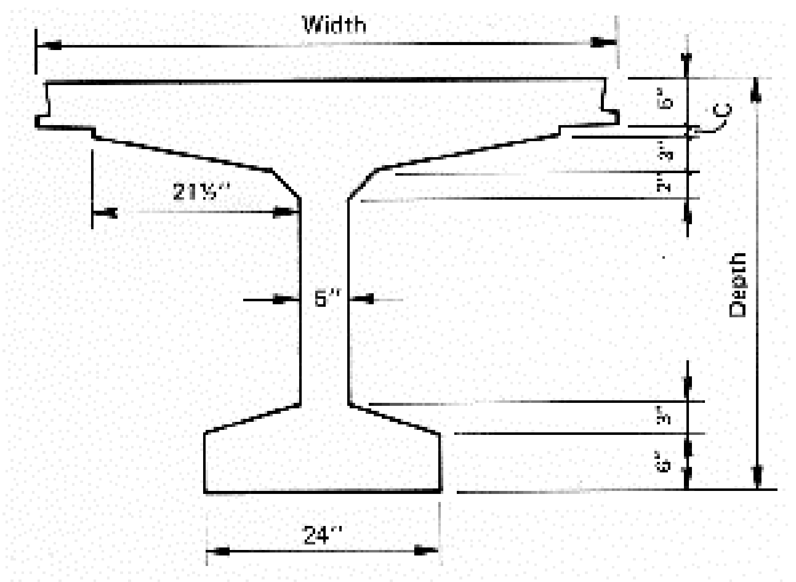
Box Girder

Existing Sections

Girder Bridge Sections



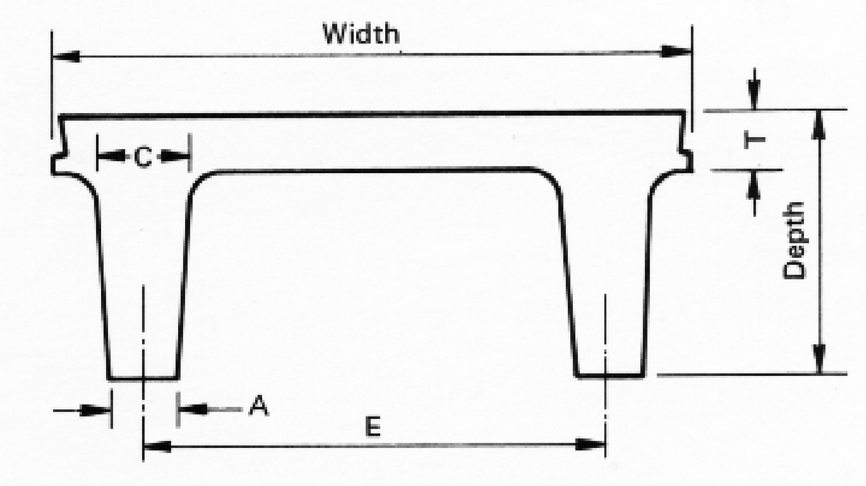
I-Girder

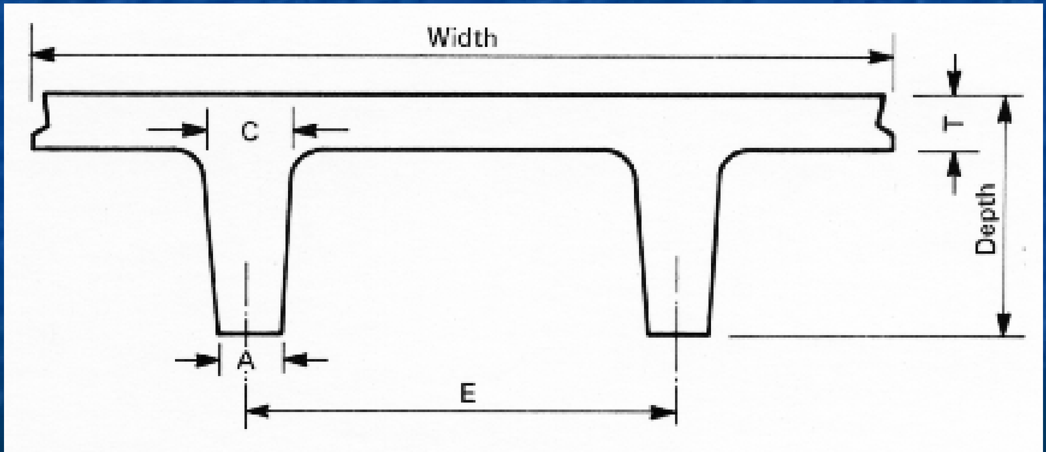


Bulb Tee Girder

Existing Sections

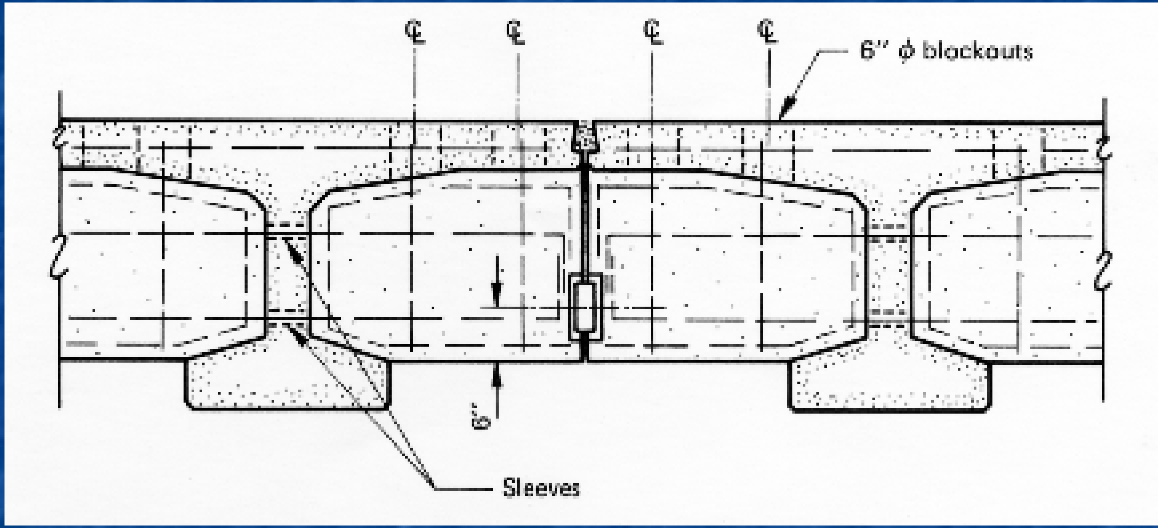
Channel and Double Stemmed Bridge Sections





Existing Sections

Girder Diaphragms

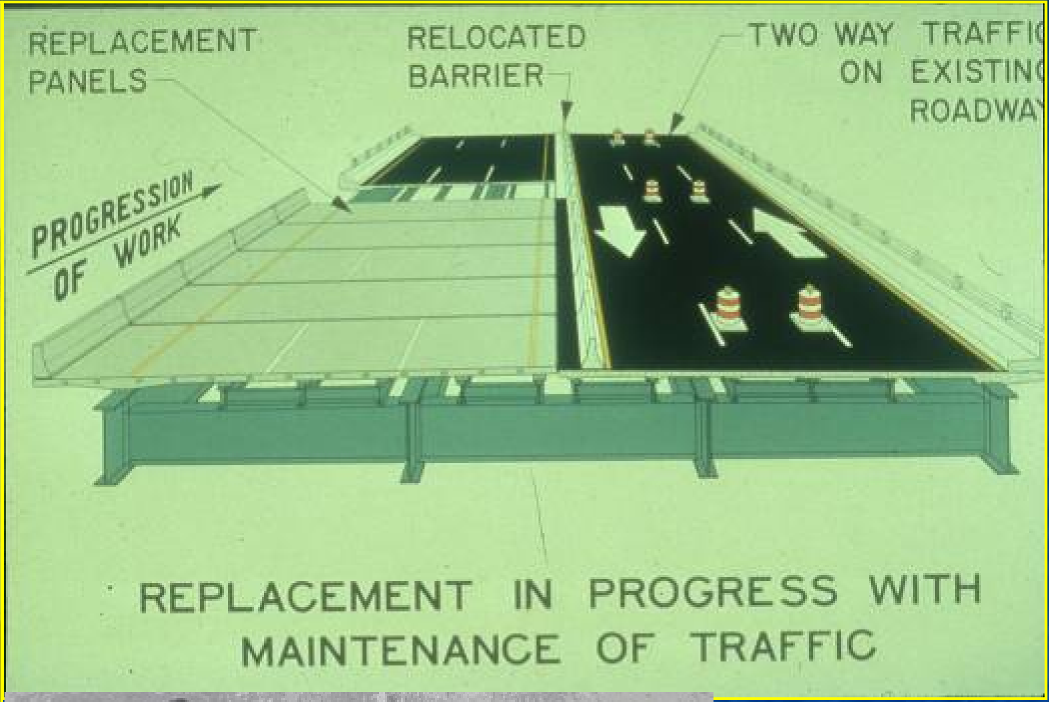


Bulb-Tee bridge half diaphragms can be poured at the precast plant and joined together at the site by welding or post-tensioning.

Bulb-Tee diaphragms can also be structural steel X-bracing.

Precast Concrete Partial Depth Deck Slabs

Full Depth Bridge Deck Replacement



Case Studies

Some case studies from Puerto Rico, United States and Canada offer new ideas on techniques and construction details to achieve the goal of:

Get in.

Get out.

Stay out.

Baldorioty Bridges, San Juan, PR

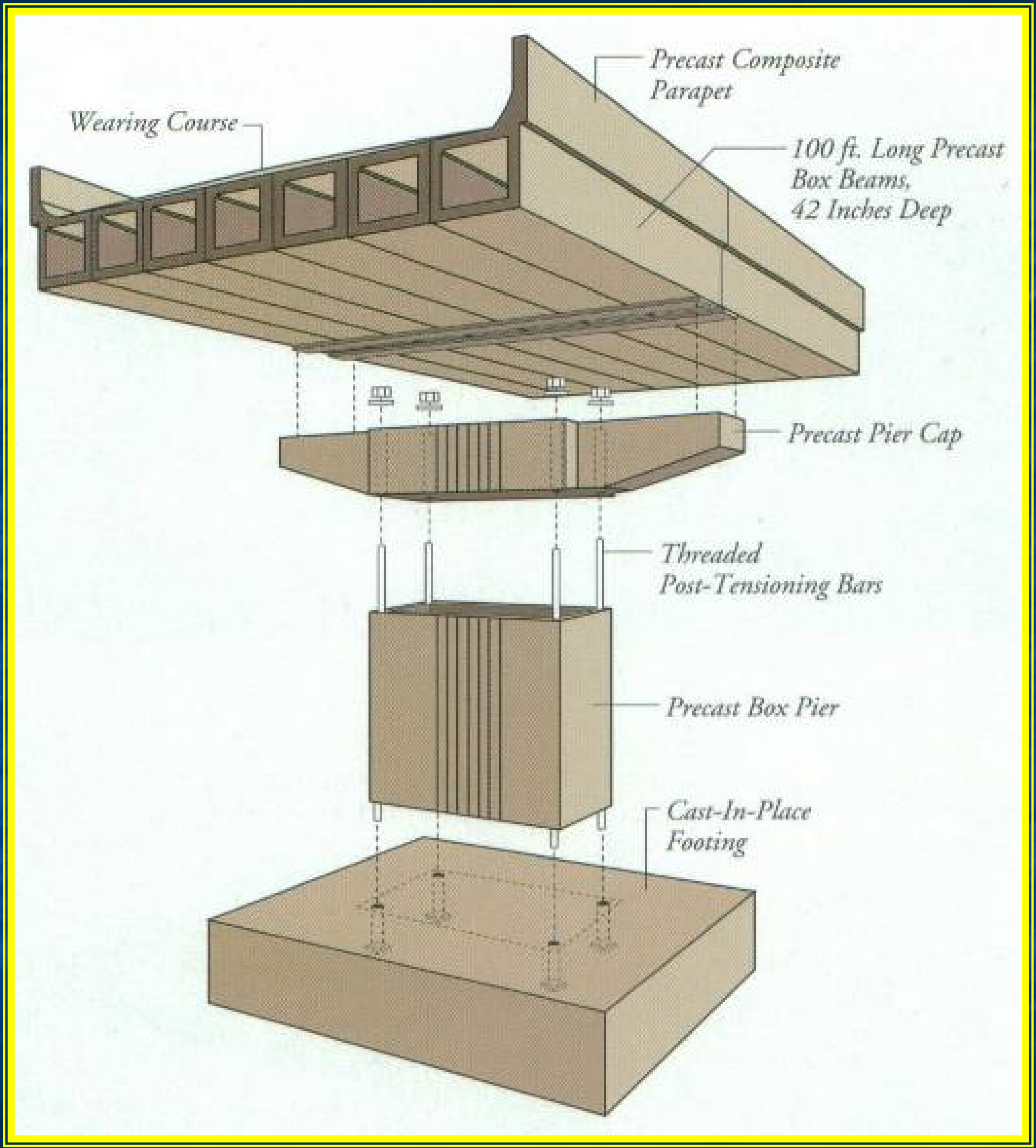
- Create Expressway
  - Separate At-Grade Intersections
  - Two Intersections, Four Bridges
- 100,000 ADT

The Challenge…

- **Design & Build Four Urban Grade Separations**
  - 2 bridges – 900 ft long x 30'- 4" wide
  - 2 bridges – 700 ft long x 30'- 4" wide
- **Maintain Continuous Traffic**
- **Complete each Bridge in Less than**

72 Hours!

Concept



Precast adjacent girders

Precast cap beam

Precast pier

CIP footing

Baldorioty Bridges, San Juan, PR

Actual site in dense urban area

Baldorioty Bridges, San Juan, PR

Precast pier cap installation

Baldorioty Bridges, San Juan, PR

Adjacent box girder installation

Baldorioty Bridges, San Juan, PR

Membrane and asphalt wearing surface

Baldorioty Bridges, San Juan, PR

Completed bridges with traffic

Baldorioty Bridges Construction Report

- 700-ft Bridge – January 1992 – 36 hours
- 900-ft Bridge – March 1992 – 21 hours
- 900-ft Bridge – May 1992 – 23 hours (rain)
- 700-ft Bridge – July 1992 – 22 hours

Ahead of its time – little interest since 1992

Cross Bay Boulevard over the North Channel

Jamaica Bay, New York

Bridge Description

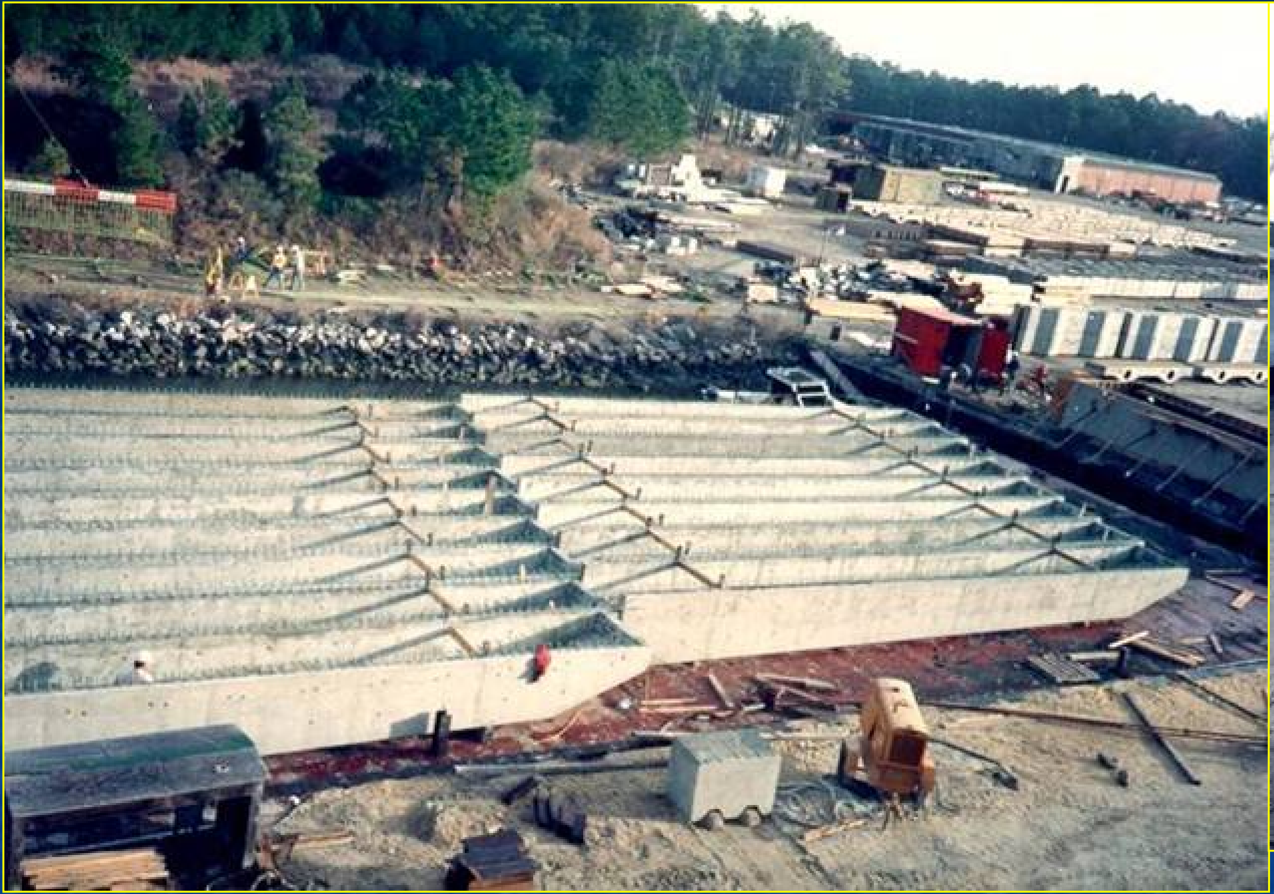
Bridge Length: 2,842 feet, 34 spans, 3 lanes each way plus bicycle lanes, sidewalks and fishing access

Components used:

- Cylinder piles
- Precast pier cap forms
- Prestressed I-Girders
- Precast diaphragm forms
- Prestressed sub-deck panels
- Precast traffic barriers

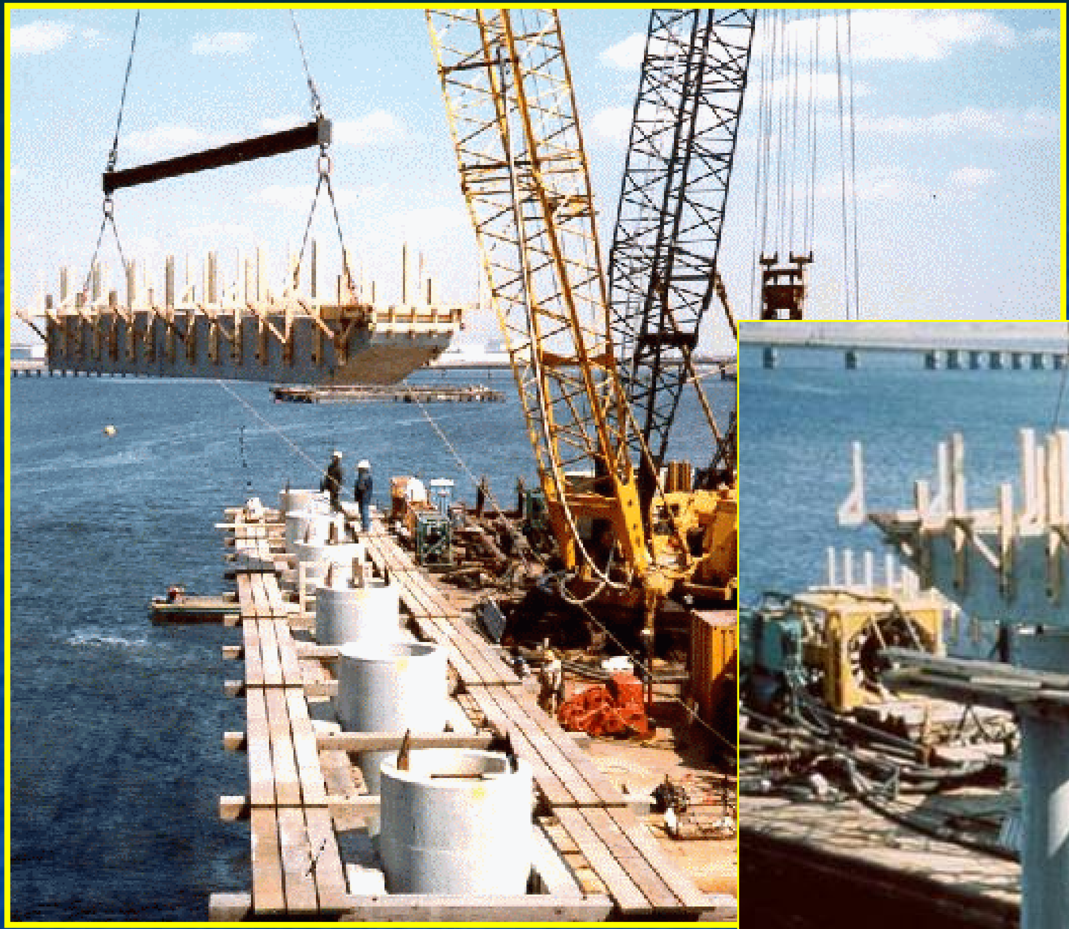
Cylinder piles

Cross Bay Boulevard over North Channel



Precast pier caps

Cross Bay Boulevard over North Channel



Pier cap construction

Cross Bay Boulevard over North Channel

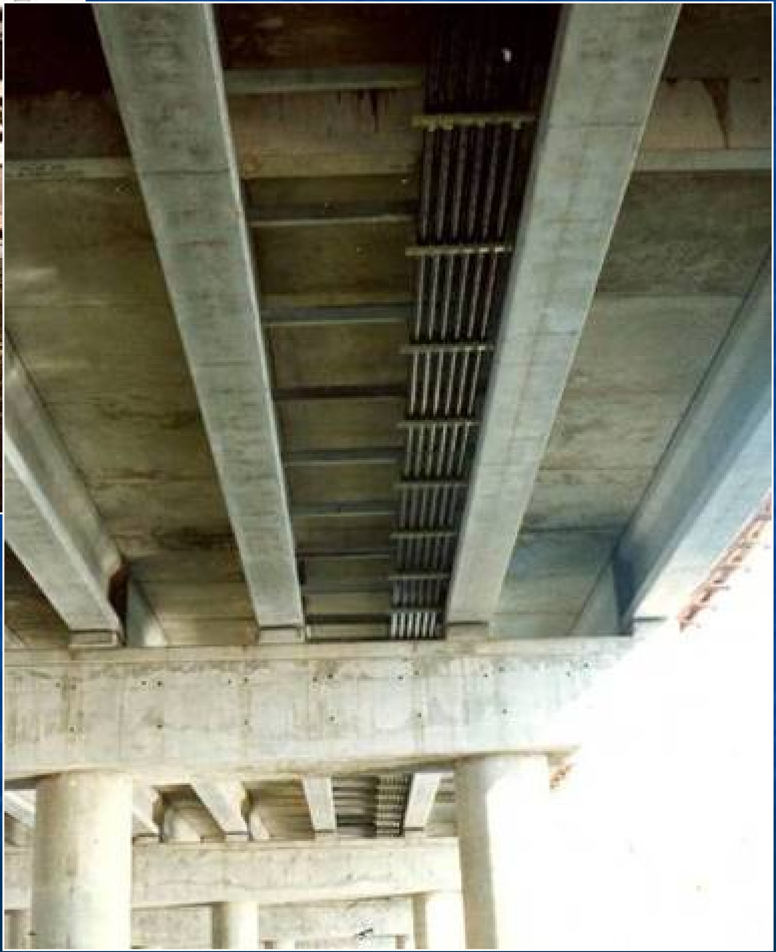
Precast diaphragms

Cross Bay Boulevard over North Channel

Cross Bay Boulevard over North Channel

Beams in place
Precast diaphragm forms installed

Cross Bay Boulevard over North Channel



Precast deck slab placement

Cross Bay Boulevard over North Channel

Finished bridge

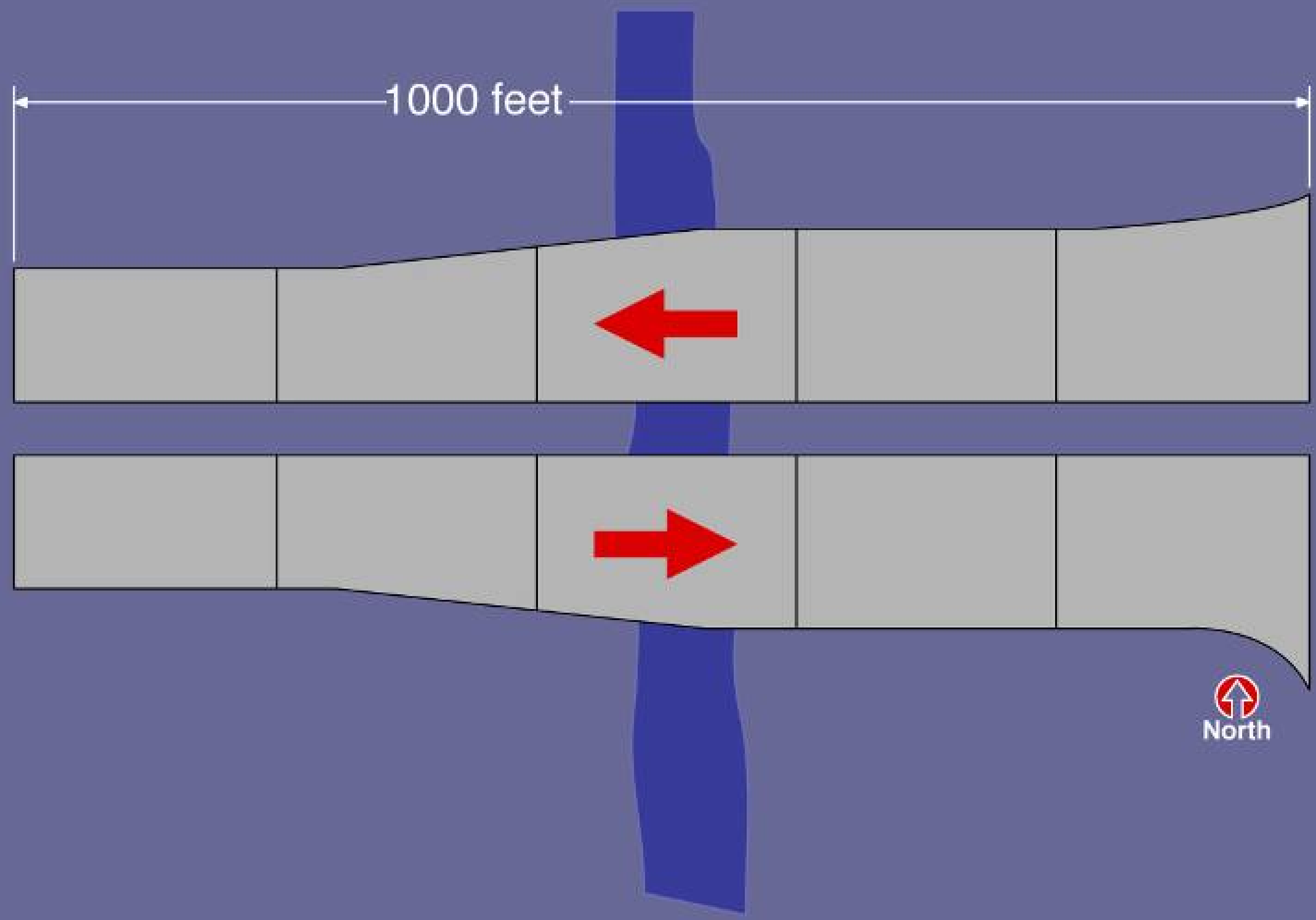
Cross Bay Boulevard over North Channel

Reedy Creek Bridge

Disney World Orlando, Florida

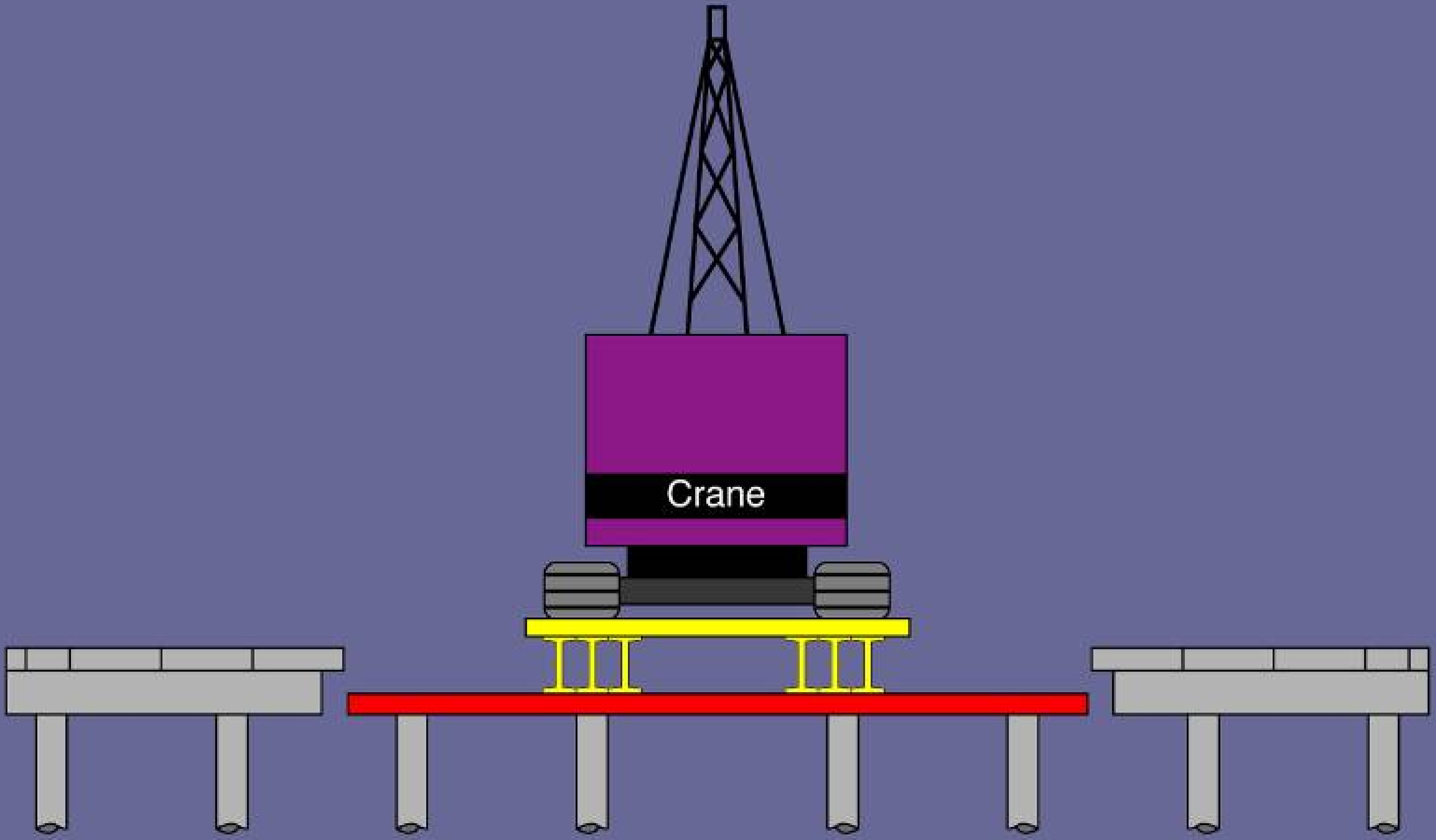
- **The Environment**
  Reedy Creek Wetlands
- **The Need**
  Provide vehicular access to the new Animal Kingdom theme park
- **The Solution**
  A precast prestressed concrete slab bridge constructed using top down construction

Reedy Creek Bridge - Plan

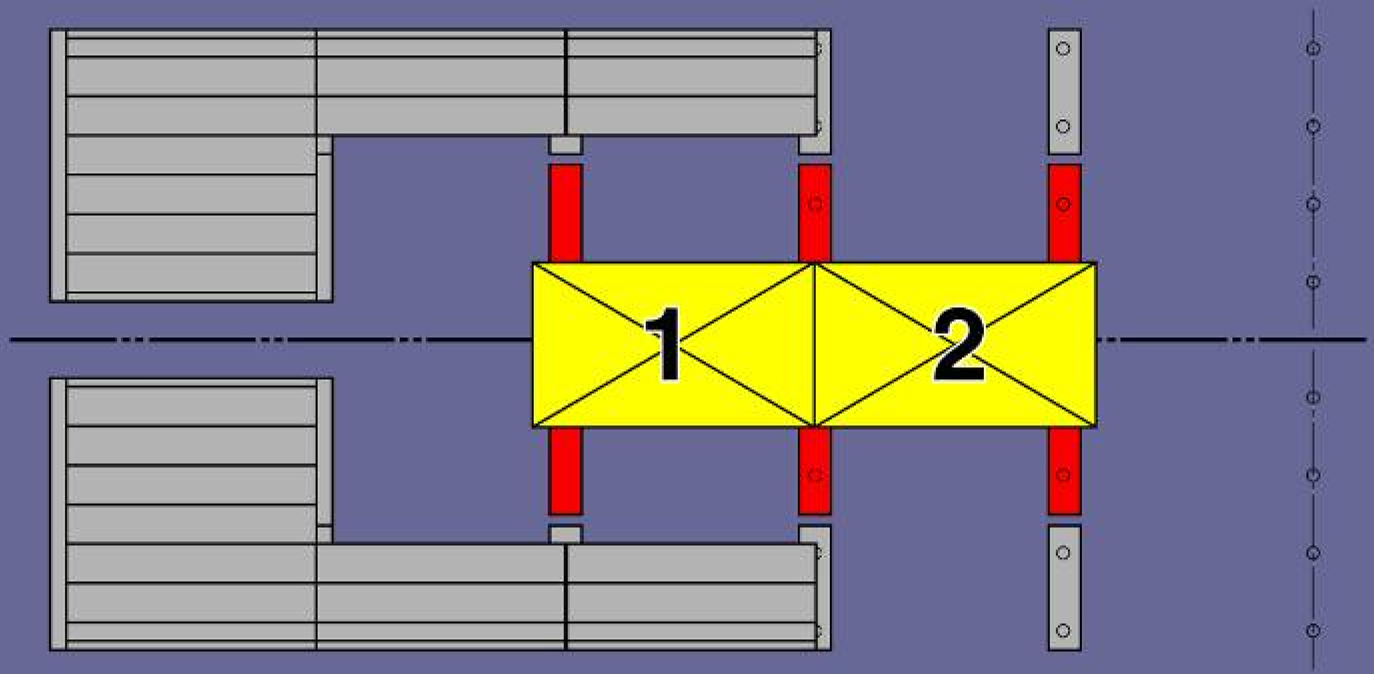


5 continuous segments at 200 ft = 1000 ft
Each segment = 5 spans at 40 ft

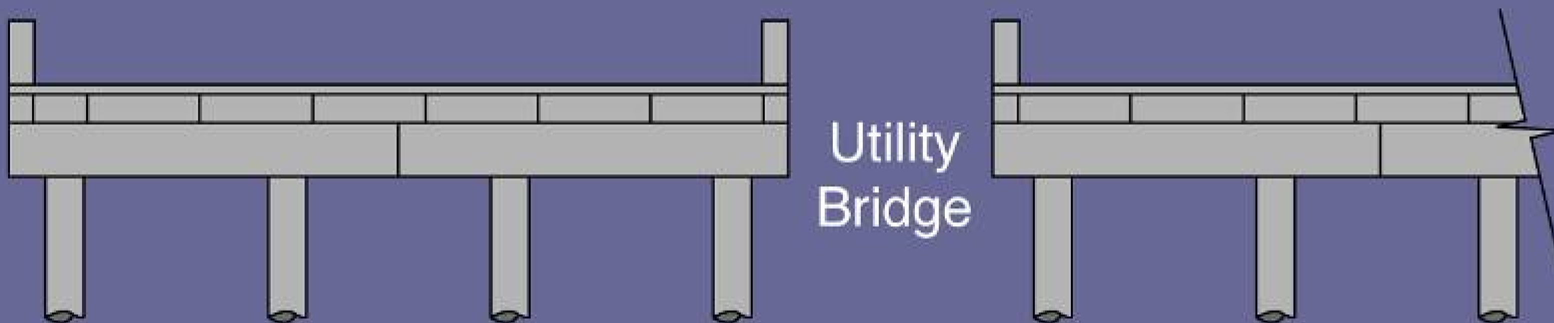
Construction Concept - Section



Construction Concept - Plan View



Cross Section



Construction Schedule

- Original Design – cast-in-place construction
- VE proposal used precast components in the same configuration
- The precast alternate saved both cost and time

Reedy Creek Bridge

Deck construction used 405 haunched slabs in two sizes

Reedy Creek Bridge

Reedy Creek Bridge

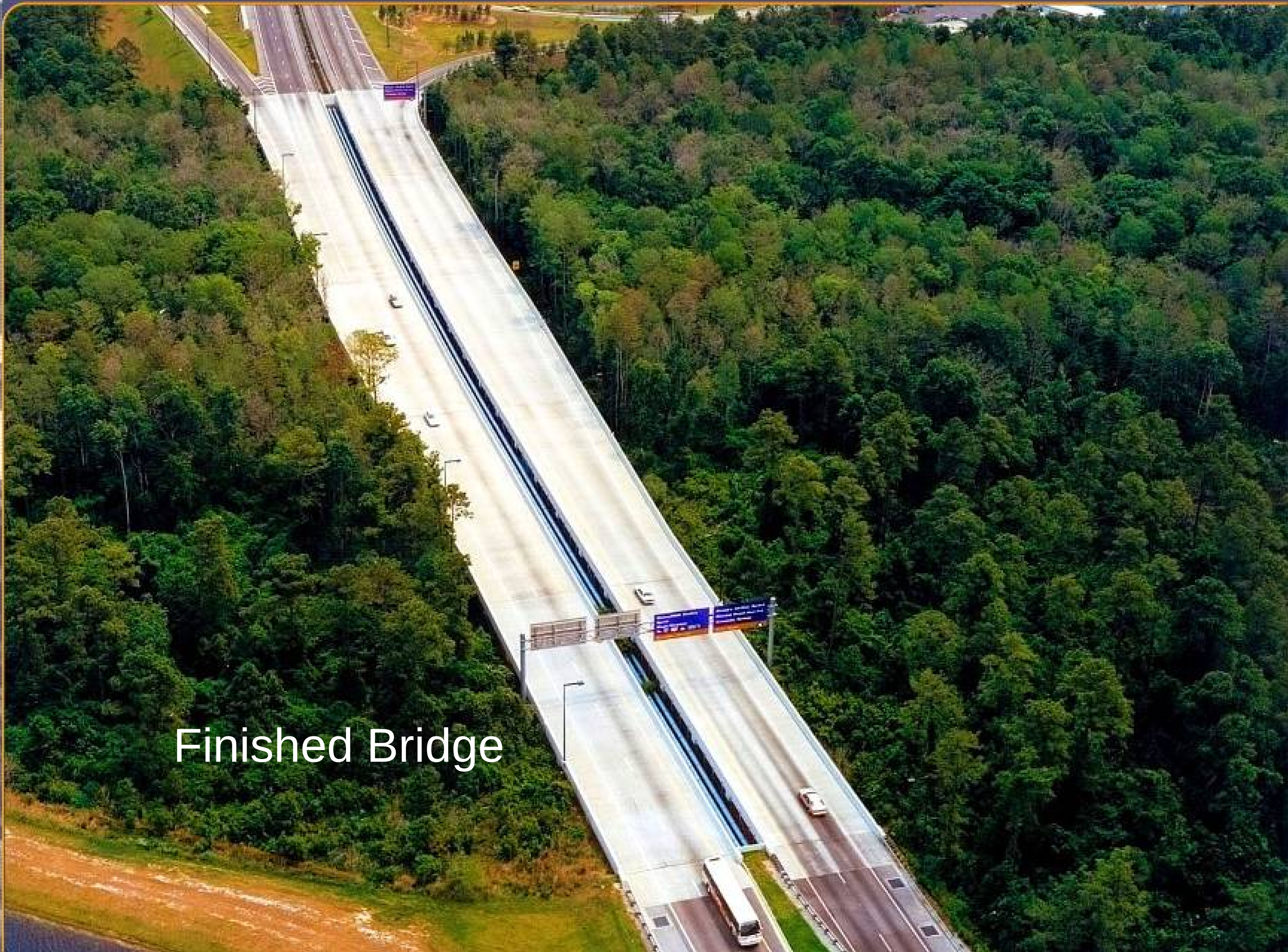
Reedy Creek Bridge

Reedy Creek Bridge

Reedy Creek Bridge

Reedy Creek Bridge

Reedy Creek Bridge



Robert Moses Causeway over Great South Bay

Long Island, NY

South-bound bridge description

Bridge length: approximately 2 miles long

2 lanes wide, 153 spans

Components Used

Original Contract:

- Rehabilitate Superstructure girder and truss spans. Replace 122 stringer spans with spread P/S Box Beams. Replace deck.

VE Proposal:

- Substitute full-width quad-Tee span segments for spread box-girder spans.

Quad-Tee full width
deck segments
at the precast plant

Robert Moses Causeway over Great South Bay

Robert Moses Causeway over Great South Bay

Finished bridge

Robert Moses Causeway over Great South Bay

MOOSE CREEK BRIDGE

Total Precast Concrete Bridge Structure

Near Timmins, Ontario

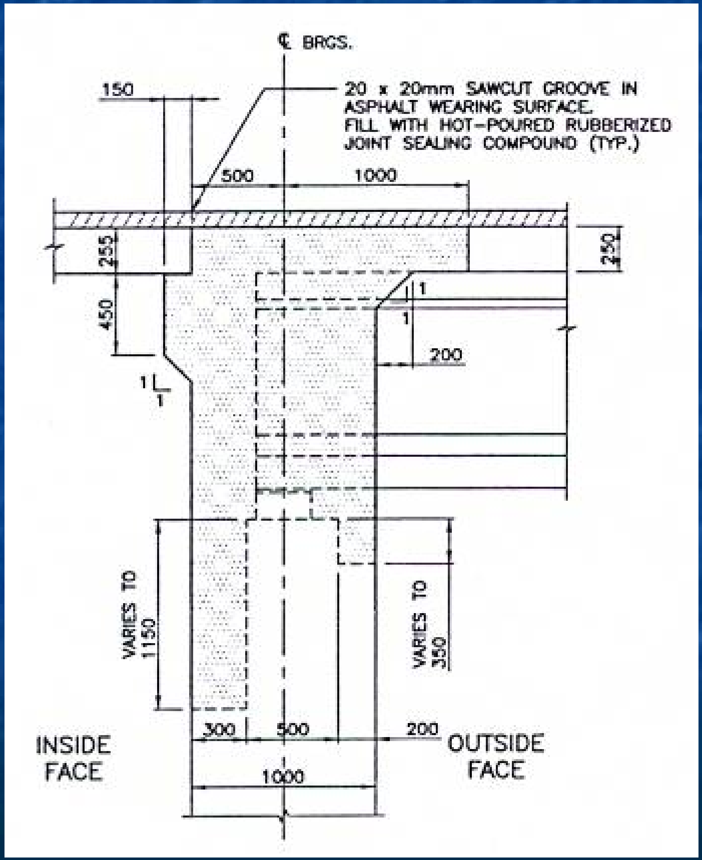
Summer 2004

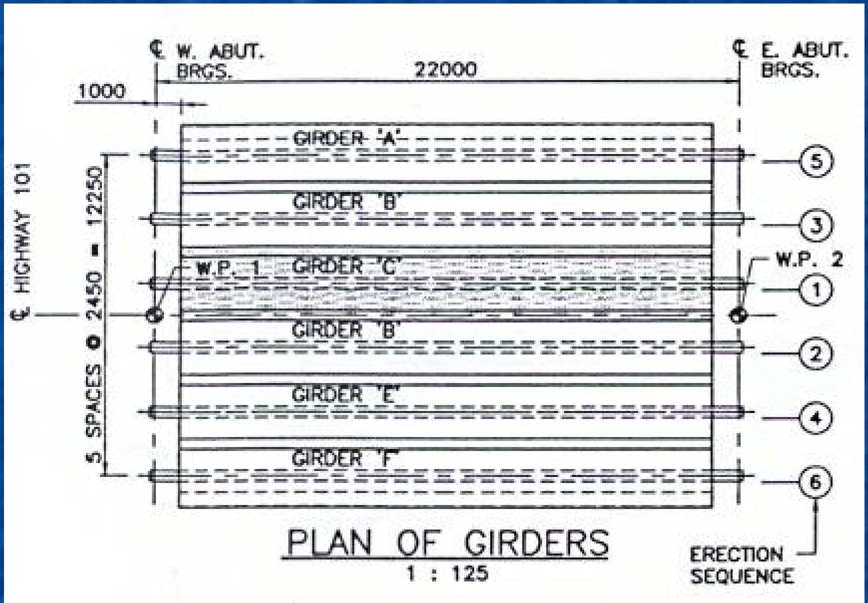
Owner: MTO - Engineer: Stantec Consulting

Contractor: Miller Paving - Precast: Pre-Con Inc.

Precast Elements

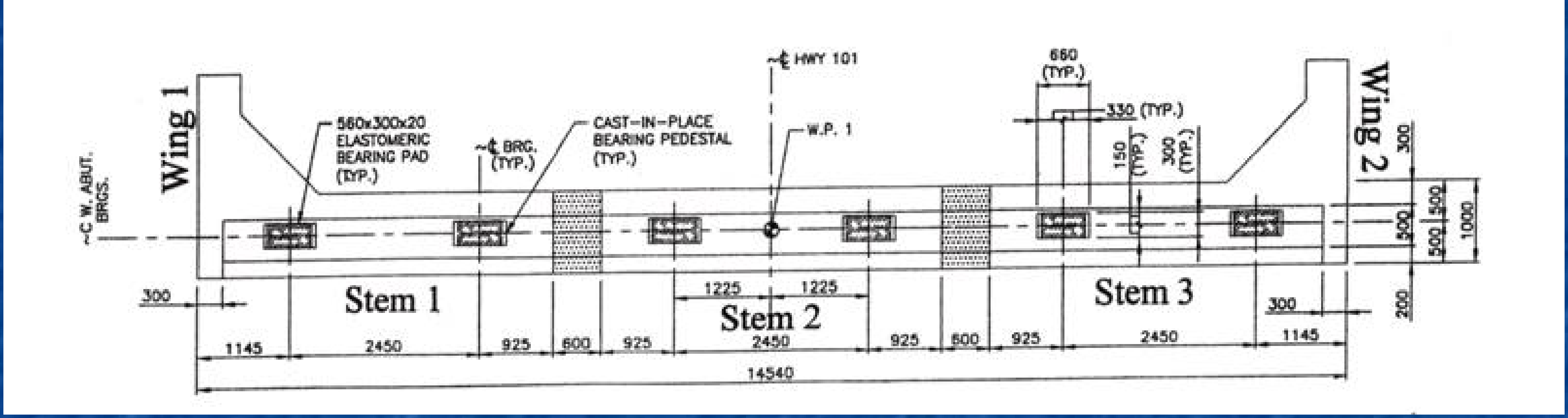
- Precast Superstructure:
  - 6 CPCI 1200 I-girders precast with a monolithic deck



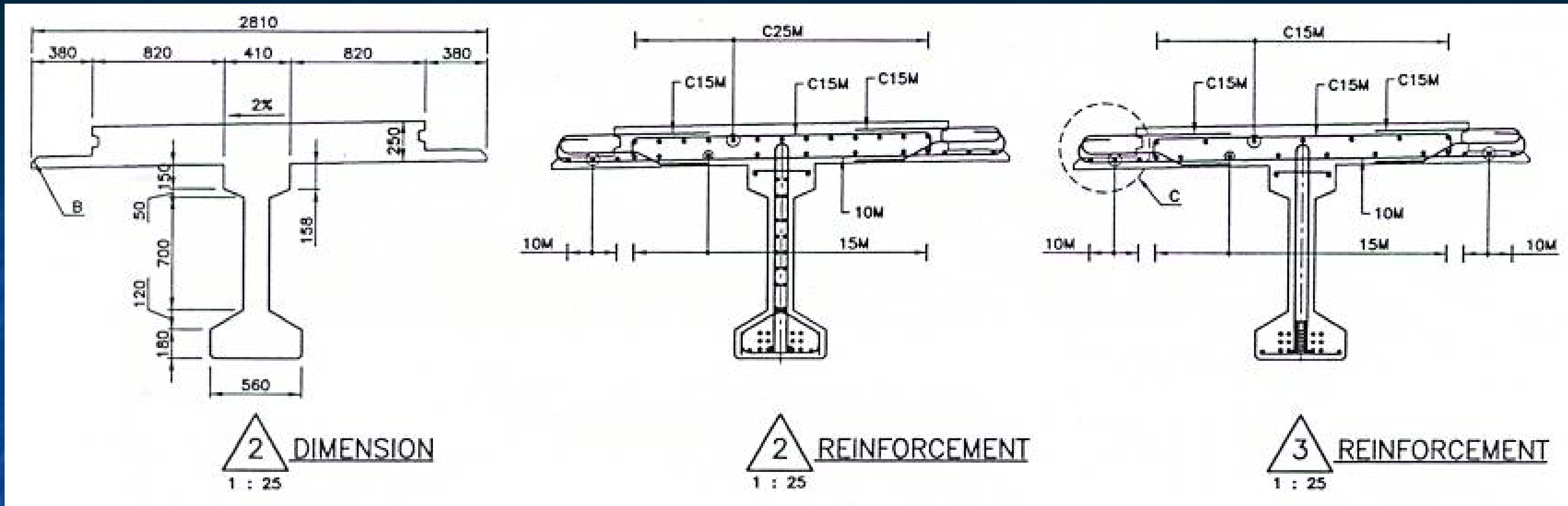


Precast Elements

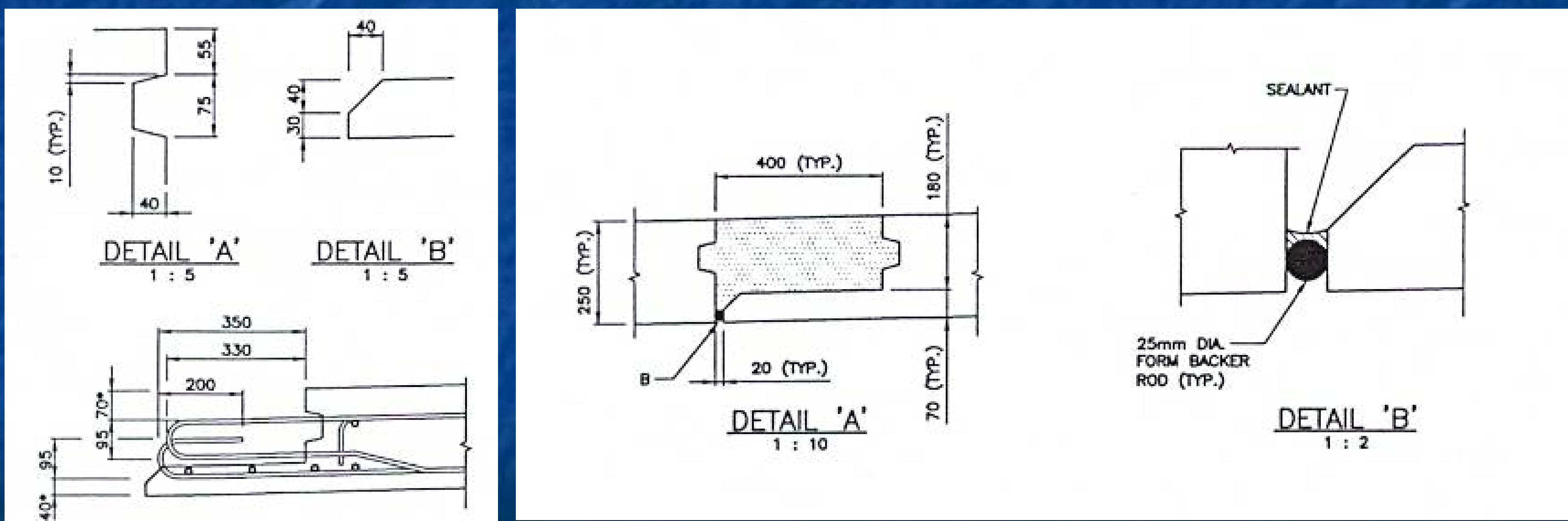
- Precast Substructure:
  - 10 Abutment Elements
    - 3 Stem units per abutment
    - 2 Wingwall units per abutment



Precast Stem & Wingwall Plan (Hatched Area-CIP Concrete)



Deck Girder Details



Deck Joint Details

Girder/Deck Production

- Units were prestressed and conventionally reinforced - similar to typical CPCI girders…

Girder/Deck Production

- ...with the bridge deck cast monolithically on top

Wood forms were used for these prototype deck girders

Girder/Deck Production

- The girder deck was formed with a parabolic shape in elevation and cross slope in section to account for camber and cross fall

Stem/Wingwall Installation

- Precast was erected in two mobilizations; first - stems and wingwalls beginning July 28/04
- Stem and wingwall units were shipped flat

Stem Unit


Wingwall Units

Stem/Wingwall Installation

- Steel piles and HSS knee bracing system were installed by the General Contractor

Stem/Wingwall Installation

- System also acted as temporary lateral support for abutment stem units

Stem/Wingwall Installation

- For stability, the outer abutment stem units were erected first…

Stem/Wingwall Installation

- Wingwall is set on a steel pile…

Stem/Wingwall Installation

- Wingwall end reinforcing is threaded through the reinforcing of the end stem units

Side View

End View

Stem/Wingwall Installation

- Installation of the stem and wingwall units took place over two days
- Cast-in-place bearing seats and closure strips between stem units was cast by Contractor after installation complete
- Lateral bracing was removed when concrete reached minimum strength

Girder/Deck Installation

- The deck girders were erected 3 weeks after the stem and wingwalls, on August 19/04

Girder/Deck Installation

- Girders were erected from a temporary bridge adjacent to the site


Girder/Deck Installation

- Middle girders were placed first and braced temporarily to the stem unit for stability before adding the permanent steel diaphragms

Girder/Deck Installation

- Installation continued outwards until complete
- Bracing from middle unit to stem was then removed

Girder/Deck Installation

- Girder installation progressed quickly and was completed within one day

Moose Creek Bridge Opening

The bridge opened to traffic on October 27, 2004

Davis Narrows Bridge

Brooksville-Penobscot, ME

Precast Components

- 4 abutments
- 4 wing walls
- 8 box girders
- 4 approach slabs

Designer/Owner: Maine DOT
General Contractor: Reed & Reed Inc.
Precaster: Strescon Limited, Saint John, NB

Abutments and Wing Walls

Davis Narrows Bridge

Abutments and Wing Walls

Transverse
Post-tensioning

Box Girder Erection

Box Girders

<u>8 GIRDERS</u>

27.1 m (89 ft) long

1220 mm (4 ft) wide

915 mm (3 ft) deep

Weight 45 t

Approach slab installation

Bridge Deck Membrane

Bridge Deck Paving

- Project was finished with only one month of road closure.

The Faster the Better

Projects such as the Moose Creek and Davis Narrows Bridges are part of a North American initiative - looking at ways to speed up bridge construction to minimize costs and inconvenience to the public.

<u>ISSUES</u>

- Collaboration
- Pricing
- Standard Sections
- Future Markets
- Constructability
- Tolerances
- Research

Conclusions

- The structural precast concrete industry has extensive knowledge and over 50 years of experience in the manufacturing, delivery and installation of precast bridge components.

- The industry is ready and willing to work with ministries of transport, bridge consultants and contractors under certain conditions:

Conclusions

- Standard tender methods are not conducive to innovative solutions. In many cases, precast manufacturers are reluctant to share their expertise and ideas with others prior to bidding.
- As voluntary alternates are not considered unless the contractor is the low bidder, new ideas and value engineering may not be worth the risk or effort. *The precaster generally has no access to the designer during the tender period to answer technical questions.*

Conclusions

- Require that precast concrete elements, manufactured in precast plants, be certified in accordance with CSA Standard A23.4 and provincial standards prior to tenders being issued.
- This will prevent the possibility of poor or unacceptable results due to unqualified fabricators.
- CPCI members have access to the latest bridge design and technology throughout North America. *In some cases the Contractors are encouraged to bid the precast work - placing the precast industry is in a situation where they are supplying their tendered number and ideas directly to their competition.*

Conclusions

- Standard bridge details should be revised or relaxed if they become barriers to innovation and new ways of construction.
- Use large precast components to speed up the construction.
- *Consult with precast manufacturers regarding constructability, shippable sizes and weights and erection equipment required to install the large pieces at the jobsite.*

Conclusions

- Industry standard tolerances are given in CSA Standard A23.4.
- Do not require unnecessary tolerances.
- Design details that can accommodate the length and out-of-square tolerances in large precast members.
- *New sections, if developed, need standard tolerances as their camber behavior is only theoretical.*

Conclusions

- Construction management contracts should be used, initially on a trial basis, to team all trades including precast contractors with forward looking engineers to find new ways to accelerate construction without sacrificing the design life of structures. *The quality control in certified precast plants can be used to everyone's advantage.*
- If the idea is to speed up construction, put a value on the reduced time and require guaranteed schedules.

Conclusions

- Scope and contracts should be performance related and clearly outline all functional requirements of a structure.
- Don’t be afraid to try new ideas. Keep an open mind. Not everything will work as expected. Some ideas will exceed expectation.
- *There has to be a reward to promote innovation and incur risk.*

Conclusions

PROTOTYPES

- Use prototypes to try out new techniques on a smaller scale.
- Be prepared to pay a premium for these trials.
- *If the prototypes are successful and/or require modifications, proper tooling up and formwork can be purchased when these prototypes become standard construction methods for future projects.*

Thank you

Canadian Precast/Prestressed Concrete Institute

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