Design and Construction of the Rockingham Bridges

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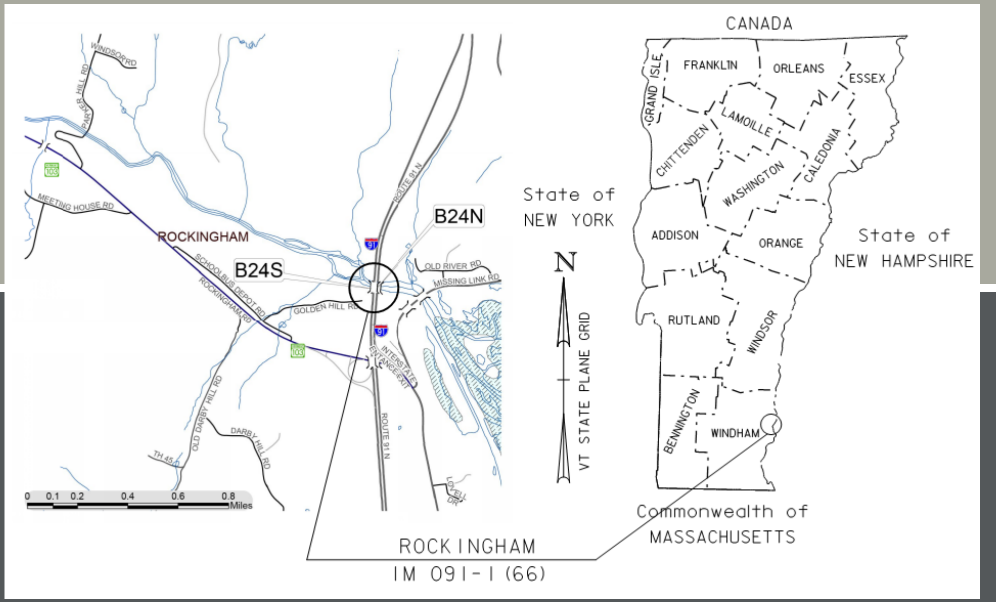
HDR

Topics

- Introduction to the Project
- Project Requirements
- Splice Girder Superstructure
- Substructure
- Design Details
- Design Challenges
- Upcoming Construction

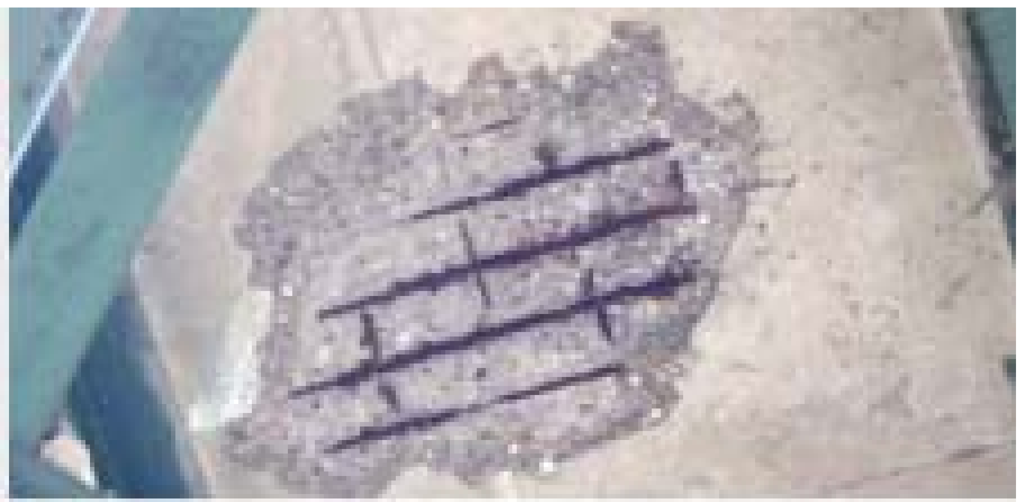
Location

- Project site is Rockingham, VT
- Bridges carry Interstate 91 over the Williams River
- ADT is 6900 in 2017
- ADT of 7000 by 2027



Existing Bridges

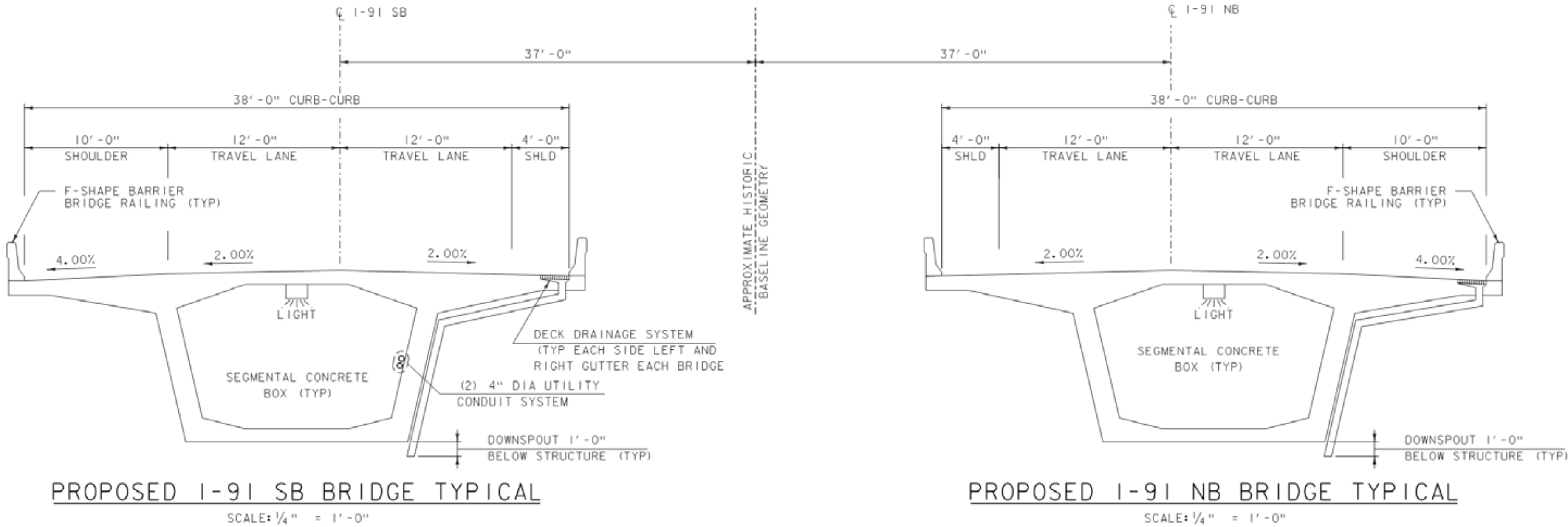
- Existing bridges are twin four span steel deck trusses
- Built in early 1960's
- Two lanes, 30 feet wide, 850 feet long
- Rehabilitated in 1988
- VTrans lists the bridges in poor condition
- Significant spalling in the deck soffitt, columns
- Section loss in the steel



TYPICAL CONCRETE DECK DETERIORATION

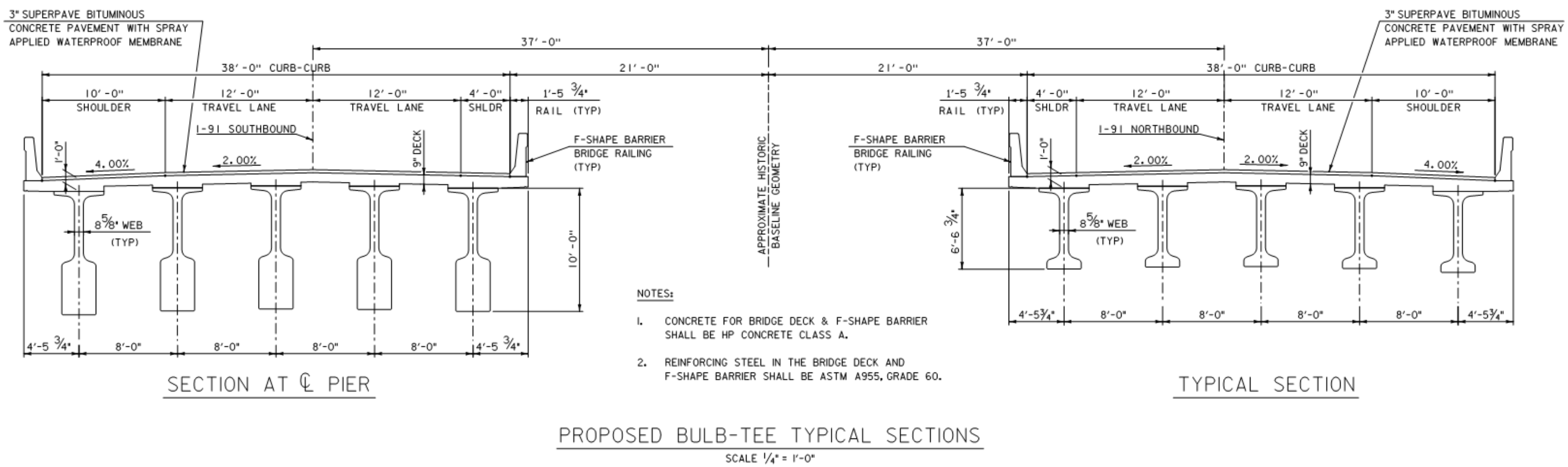
Technical Concept

- Base Technical Concept was a twin segmental box girder design
- With two bridges, traffic can be shifted between structures
- Allows new bridges to be built on the original alignment



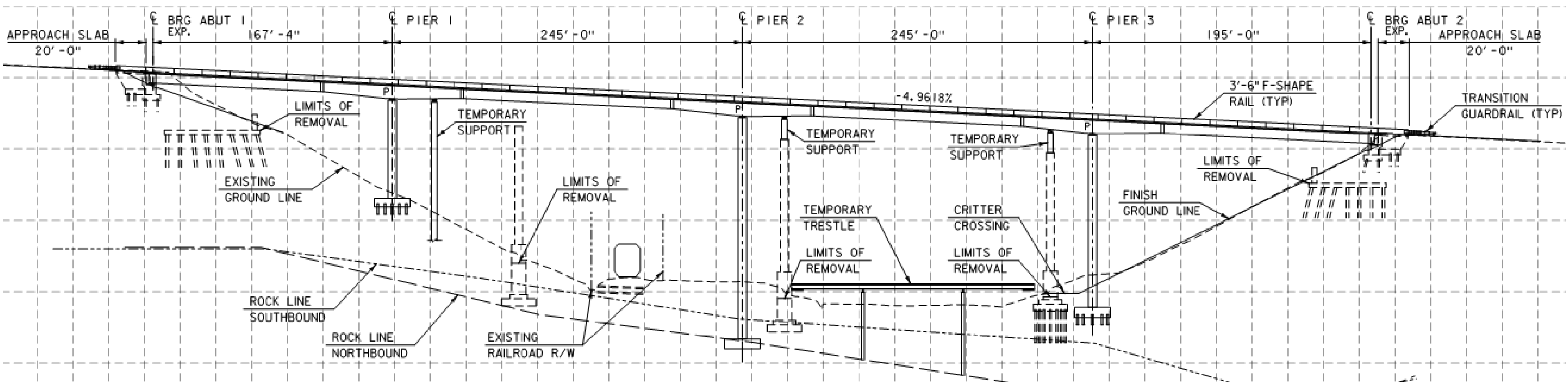
Technical Concept

- Alternate Technical Concept was proposed for twin four span precast post-tensioned splice girder bridges placed on the original alignment
- Channelization is the same as the BTC



Technical Concept

- ATC proposed an unsymmetrical span layout
- Span arrangement allows for use of some existing piers as temporary supports for girder erection.

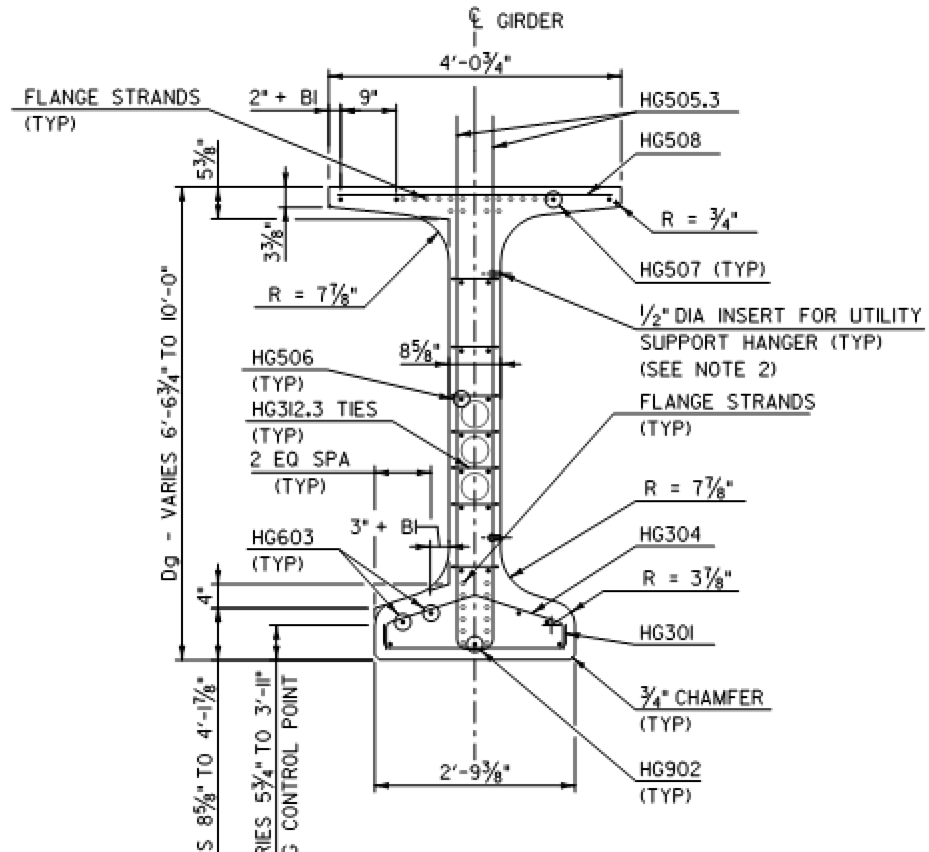


Project Criteria

- RFP included several special requirements for the bridge design
- 100 year bridge design life
- Stainless Steel Reinforcement Requirements
  - All Deck Reinforcement
  - All Bridge Rail Reinforcement
  - Any Girder Stirrups Extending into the Deck
  - Pier Cap Reinforcement
- Stainless Steel Deck Drains
- 9 inch thick deck; 3 inches of asphalt
- Utilities Not Permitted to be Anchored in the Deck Soffitt

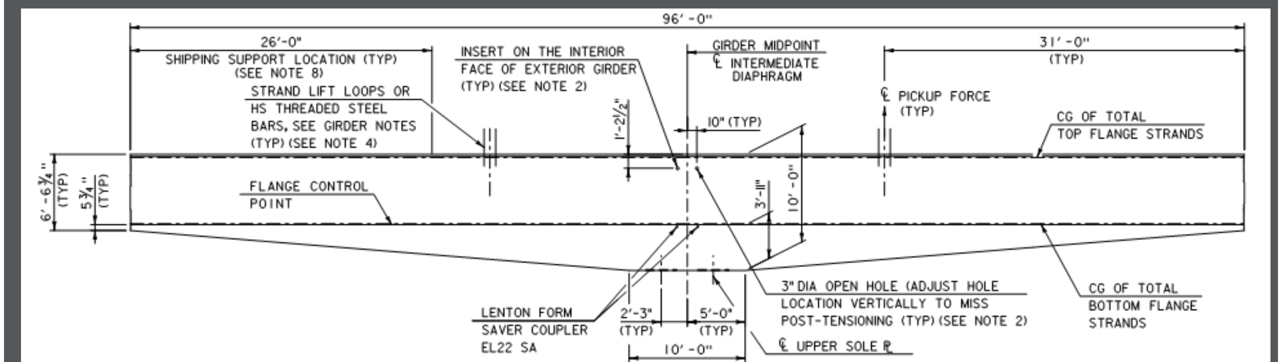
Girders

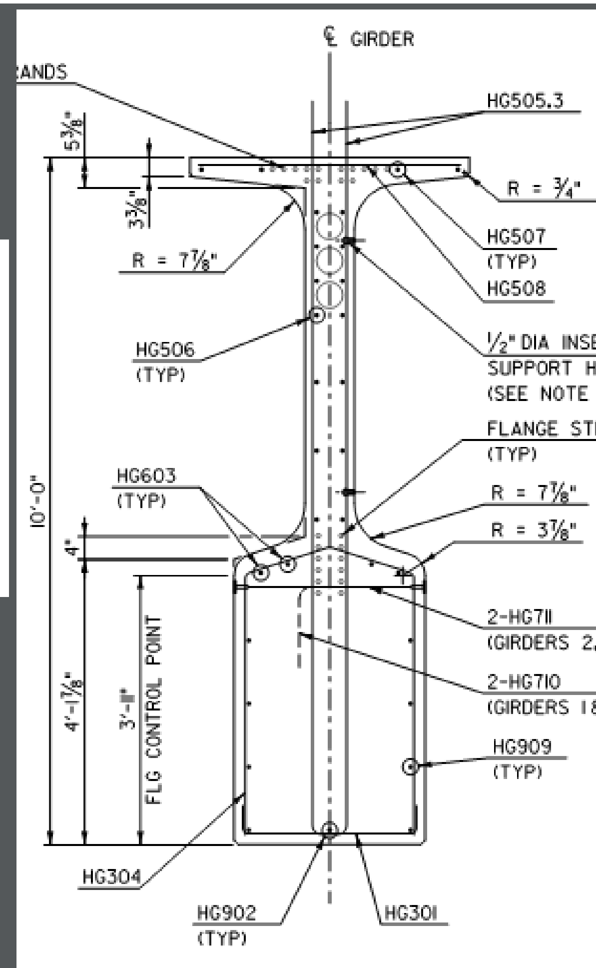
- New England Bulb Tee's were modified for use on the project
  - Thickened webs to accommodate 4 inch ID PT ducts
  - Hammerhead Segments were made variable depth
- Three 19 strand tendons were used; DSI is the PT supplier
- Precast Fabricator imposed limitations on girder segments
  - 180 kip limit
  - 10 feet height limit



SECTION B-B

SCALE ¾" = 1'-0"





SECTION C-C

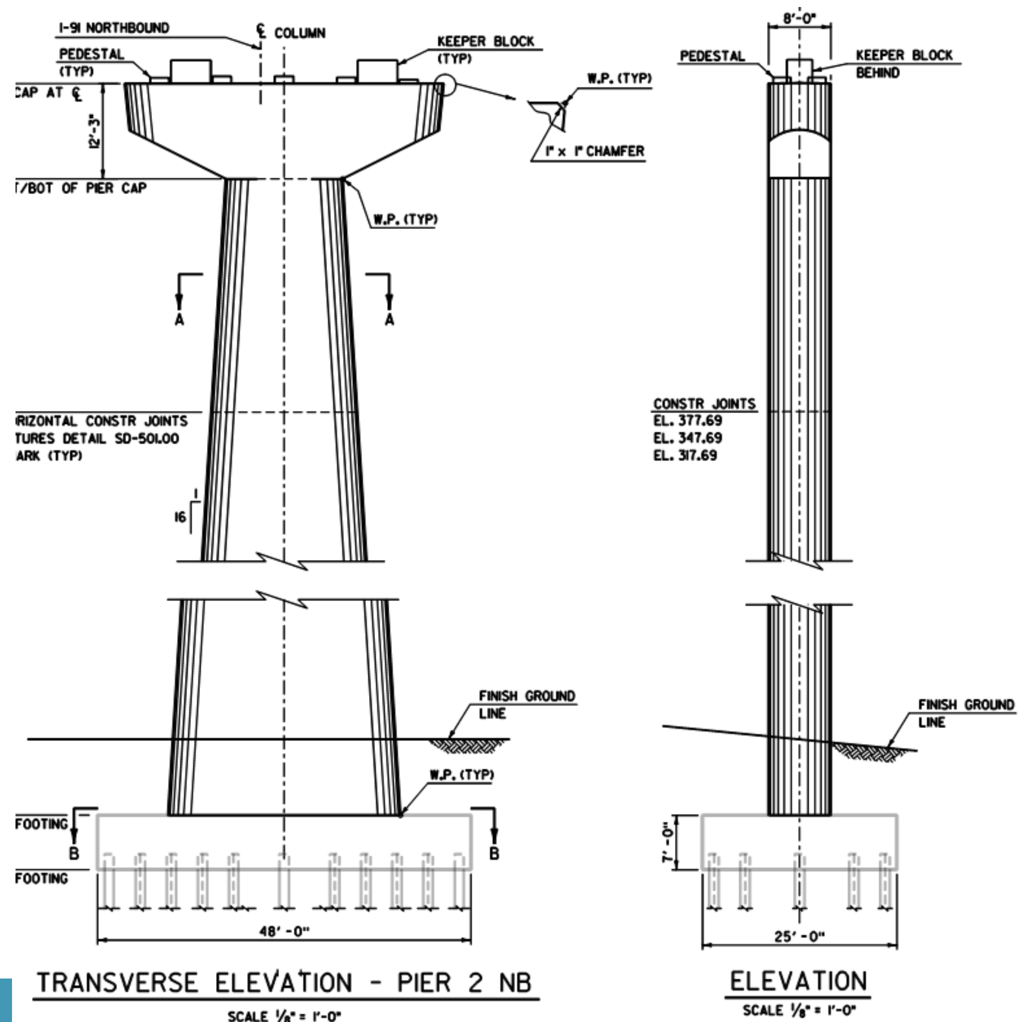
SCALE ¾" = 1'-0"

Girder Design

- PGSplice component of the Bridgelink suite used for design of girders
- New version of the PGSplice – a giant leap forward
  - Handles multi-span splice girder bridges
  - Handles variable depth sections
  - Time dependent analysis
- Design began while program was still in Beta testing phase
- Various design checks at different stages – Casting bed to 100 years
- Load rating
- Limitations and Future
  - Inability to stage the deck pours; important for camber
  - Strand elongation estimates not available directly
  - Temporary support reactions

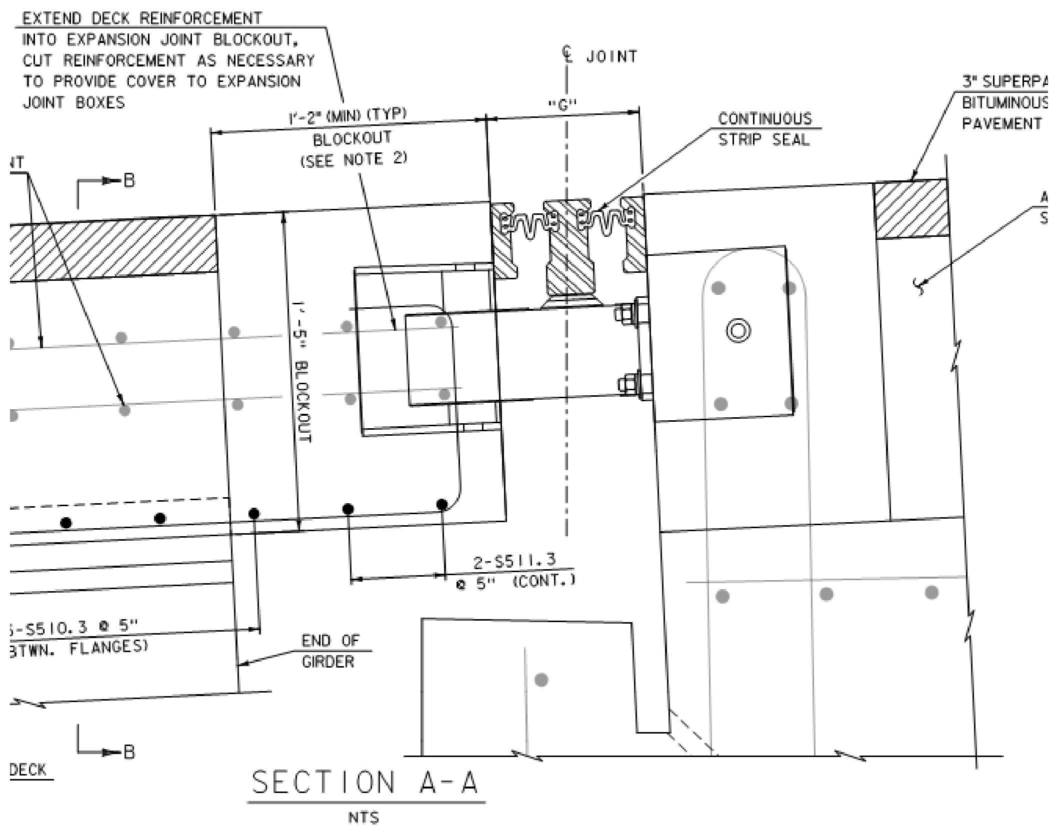
Substructure - Piers

- All piers founded on driven H-pile supported foundations
- Interior piers over 100 feet tall
- Pier shape was requested by the Contractor
  - Allowed re-use of forms on hand
  - Constant 8 foot thickness
  - Width varies with height
- RFP required max. slenderness of 80
  - Adjusted k by providing two bearing lines
  - Modified k from 2.0 to be closer to 1.4
  - No change to pier shape



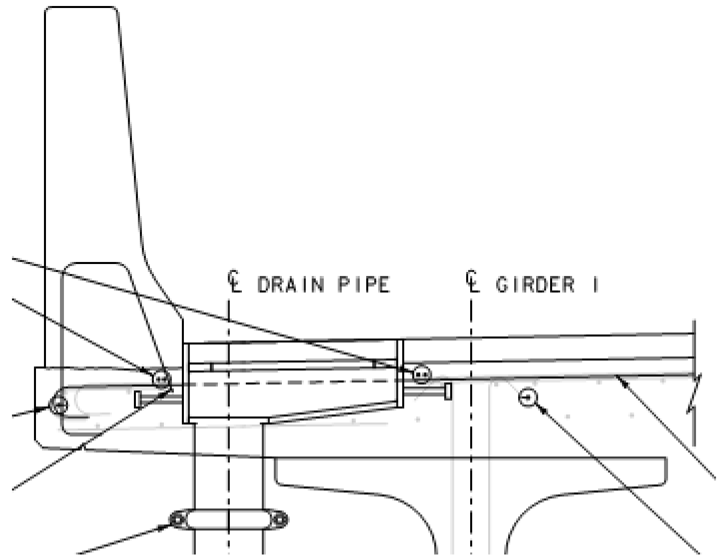
Substructure - Abutments

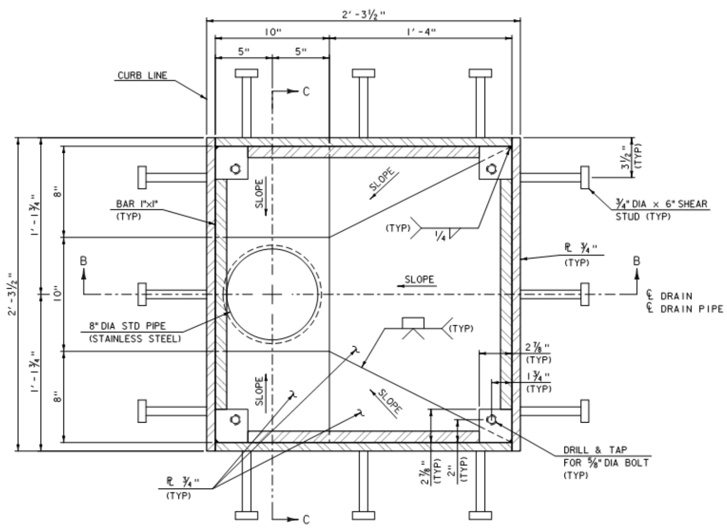
- Typical L-abutment layout supported by driven H-piles
- Unique trough detail at joint
  - Vtrans expressed concern over leaking seals allowing water to get to bearings
  - HDR proposed a modified MassDOT detail
  - Any water leaking past the seals will collect in the trough
  - Troughed drained by under-drain
  - Some challenges utilizing this with a modular joint; an edge beam was employed



Deck Drains

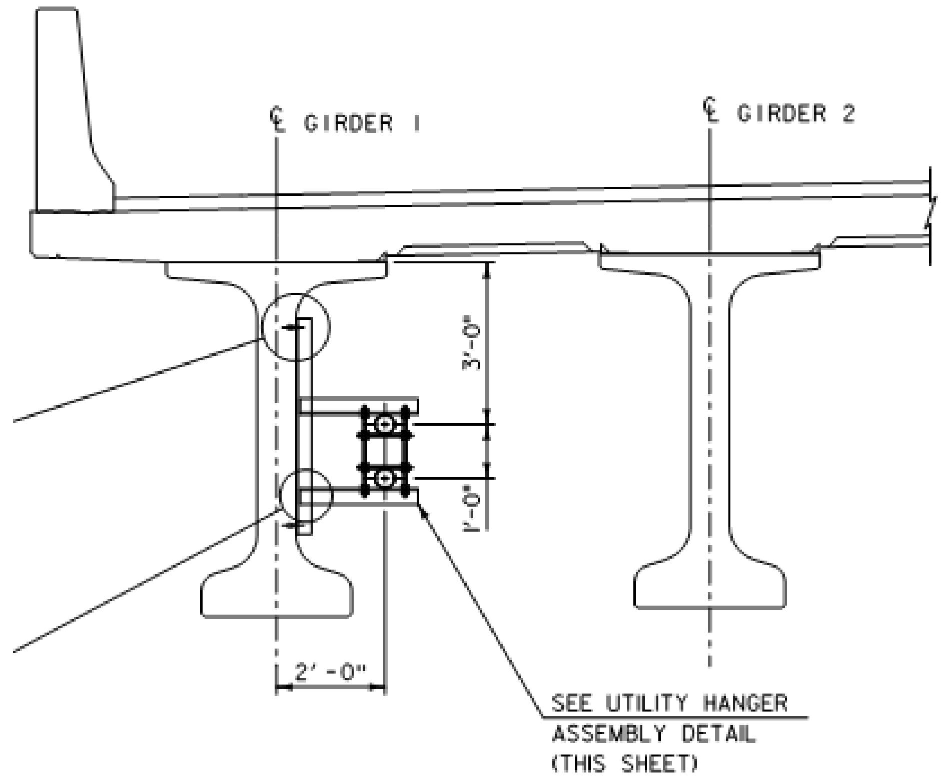
- RFP required all deck drains to be made entirely from stainless steel
- No off-the-shelf SS drains available
- 24 in. square w/ 8 inch drain pipe
- Vermont allows discharge directly into the river





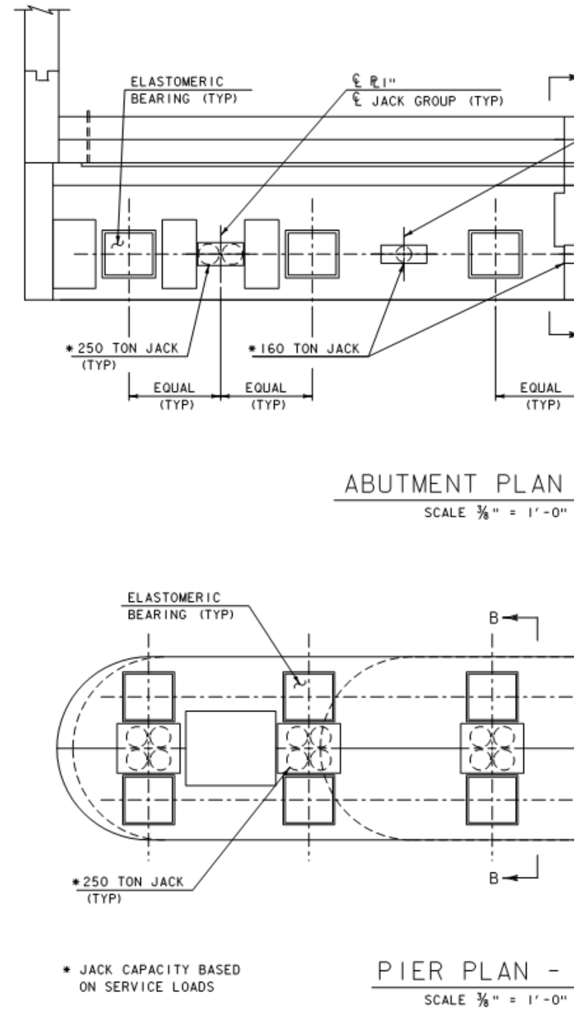
Utilities

- RFP required that a multi-duct conduit system be installed on one of the bridges
- No attachments allowed to the soffitt
- Brackets made from angles are attached with inserts to the girders
- Vertical member has a slotted hole to simplify fabrication but allow for adjustment of the inserts around the PT



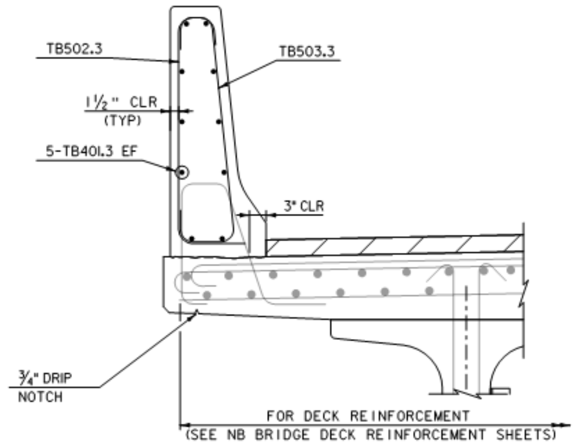
Future Bearing Replacement

- RFP required that the design allow for future bearing replacement
- Due to space limitations, this was challenging
- Seat width limitations meant that the jacks had to be placed under the diaphragms at the abutments
- End diaphragms are designed with lifting in mind.



Design Challenges

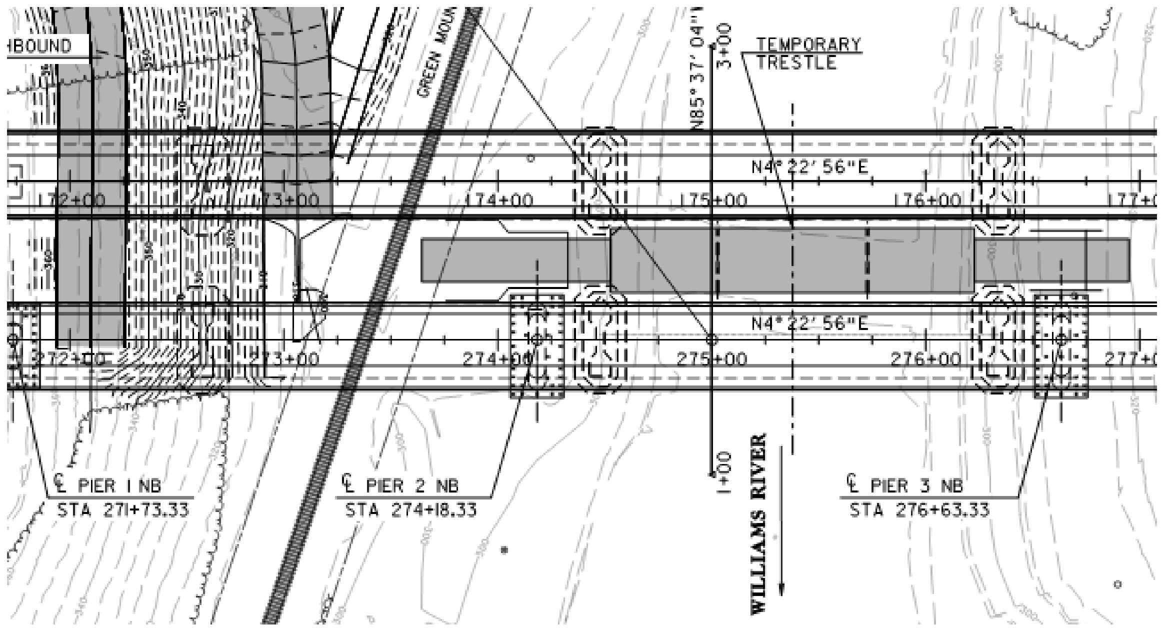
- Design-Build allowed for collaboration between the girder fabricator and designers
- Numerous changes made to girder design between 90% and 100%
  - Optional shop bends for girder stirrups allowed to reduce shipping height
  - Bunk points changed from what was assumed based on actual trucking availability
  - Stay-In-Place forms were added at a late point in the design
  - Bridge rail changed at a late point in the design



F-SHAPE RAIL DETAIL
SCALE 1"=1'-0"
(SHOWING RAIL REINFORCEMENT)

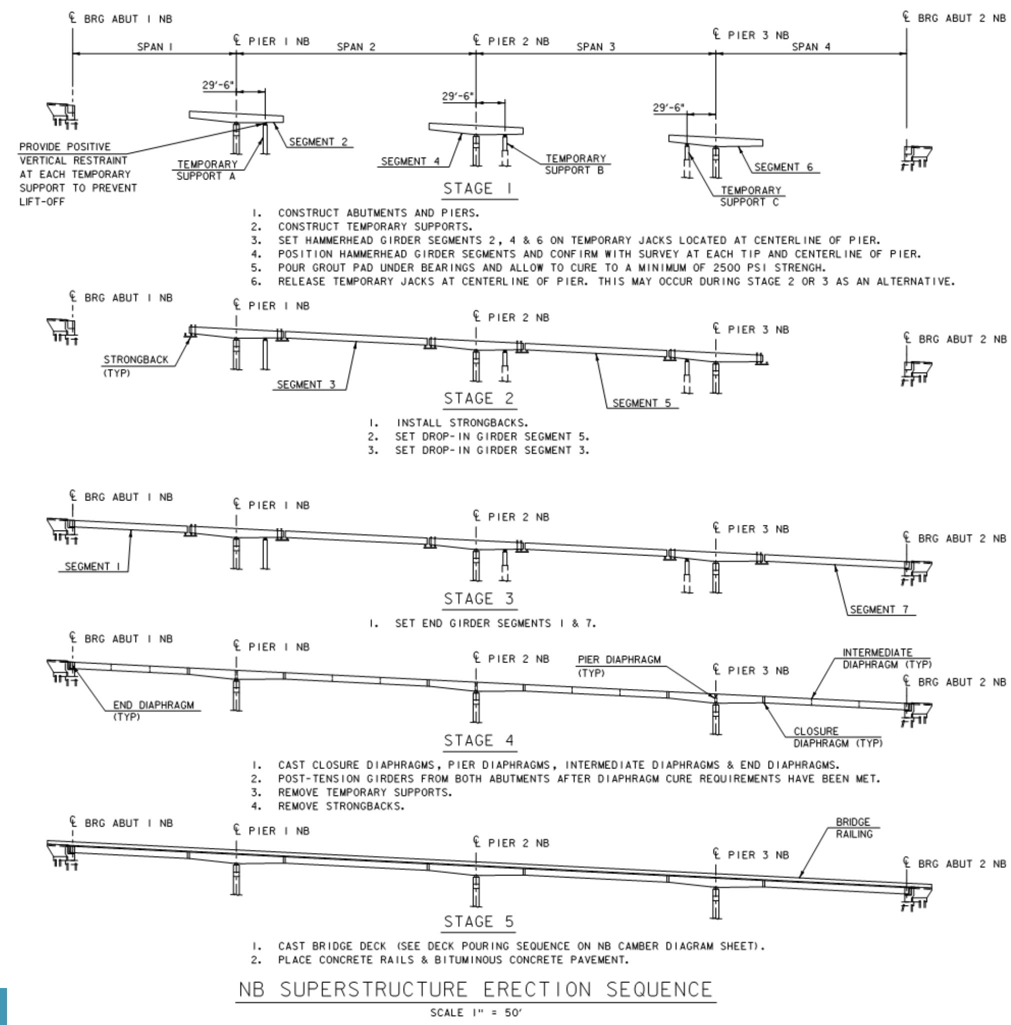
Temporary Work Access

- A work bridge will be built between the two existing bridges
- Demolition handled from the work bridge; trusses are removed from below roadway
- Girders are erected from below the roadway; little interference with traffic



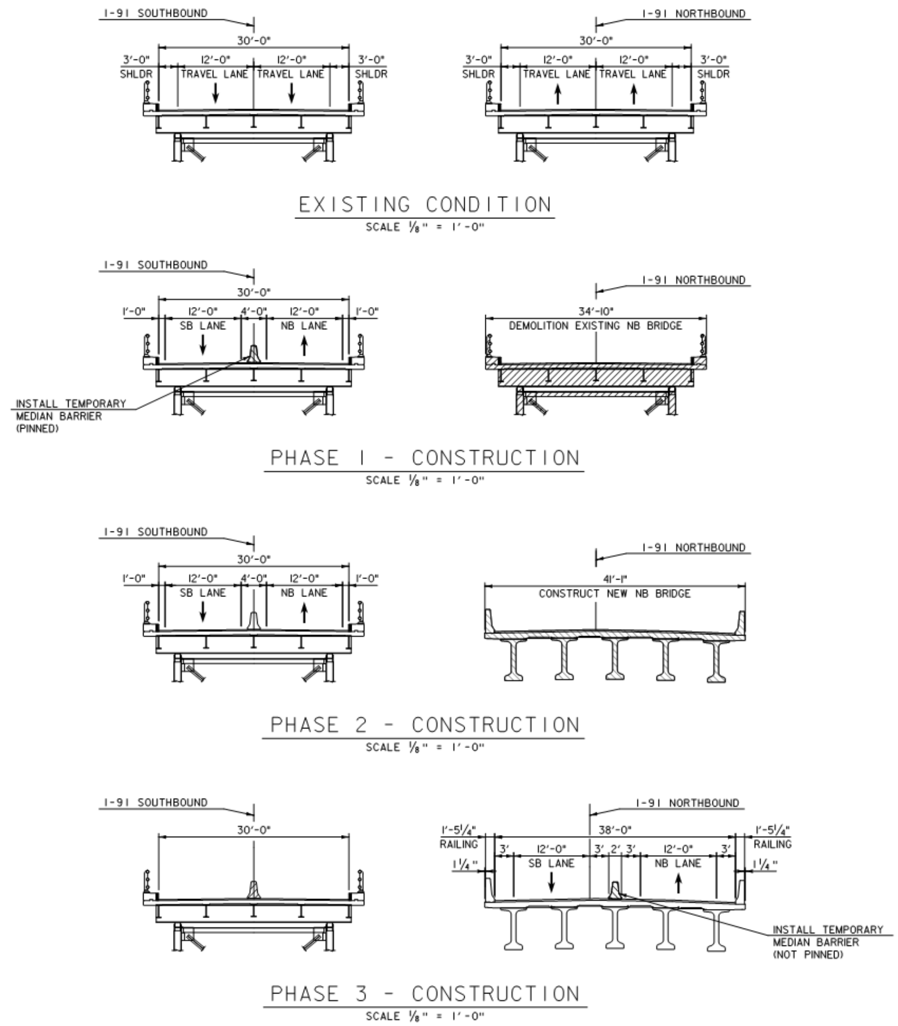
Erection

- Closures are wet cured for 10 days prior to post-tensioning
- Girders are post-tensioned prior to deck placement
- Facilitates future deck replacement



Construction Staging

- Having parallel structures allows convenient staging during construction
  - Northbound bridge to be built first
  - Two way traffic during construction is facilitated by placement of temporary barriers
  - Temporary barrier on the new bridges is not pinned to protect deck integrity



Credits

- Tom French – Project Manager/Engineer-of-Record
- Chester Werts – Superstructure Design Lead
  - Nick Rodda – Superstructure Design
  - Doug Nelson – Diaphragm Design
  - Steve Couture – CAD
  - Jimin Huang – QC
- June Wu – Substructure Design Lead
  - RJ Xu
  - Pat McAlpine
  - Dave Dougherty
- Reed & Reed - Contractor

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