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A Plan for Reprofiling a Cable-Stayed Bridge to Provide Increased Navigation Clearance

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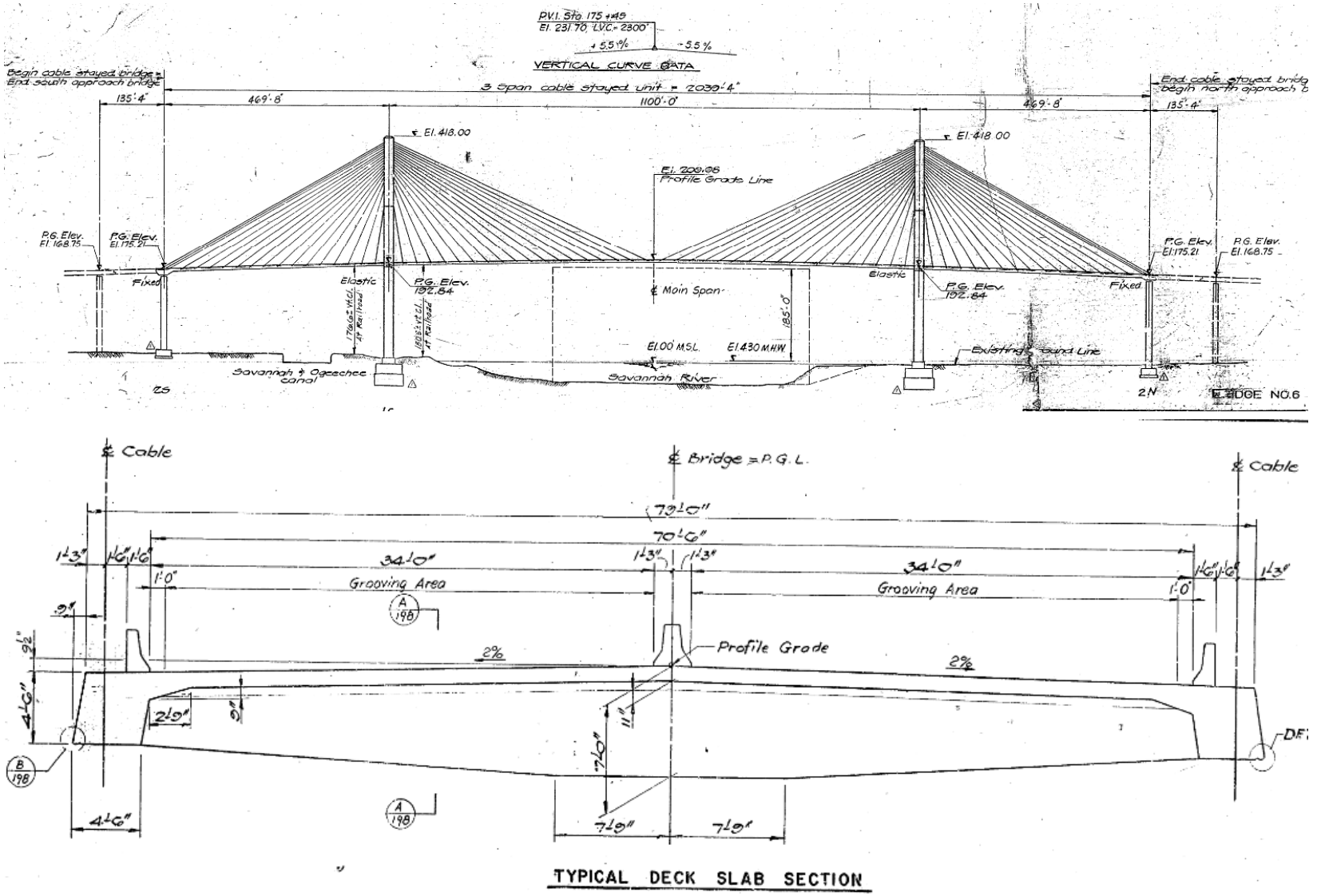
Presentation Overview

- The Need
- The Solution
- The Interim Solution
- Cable Stay Replacement
- Bridge Reprofiling

US 17 / SR 404 Spur (Eugene Talmadge) Bridge

- Opened to traffic 1991
  - Sufficient condition
  - Adequate for traffic needs
- 1100-ft main span
- 2040-ft C/S unit
- CIP concrete superstructure
- Vertical Clearance = 185 ft
- Water depth = 47 ft
- Channel width = 400 ft (but spans the entire river)



Port of Savannah

- Fastest growing port in U.S.
- Major economic driver for Georgia and S.E. U.S.

The statewide economic impact of Georgia's ports in Fiscal Year 2022 includes:

561,087	$140B	$59B	$33B
Full- and part-time jobs	**In Sales**	**In State GDP**	**In Income**
11 percent of Georgia's total employment	12 percent of Georgia's total sales	9 percent of Georgia's total GDP	6 percent of Georgia's total personal income

$7.4B	$2B	$1.8B
In federal taxes	**In state taxes**	**In local taxes**

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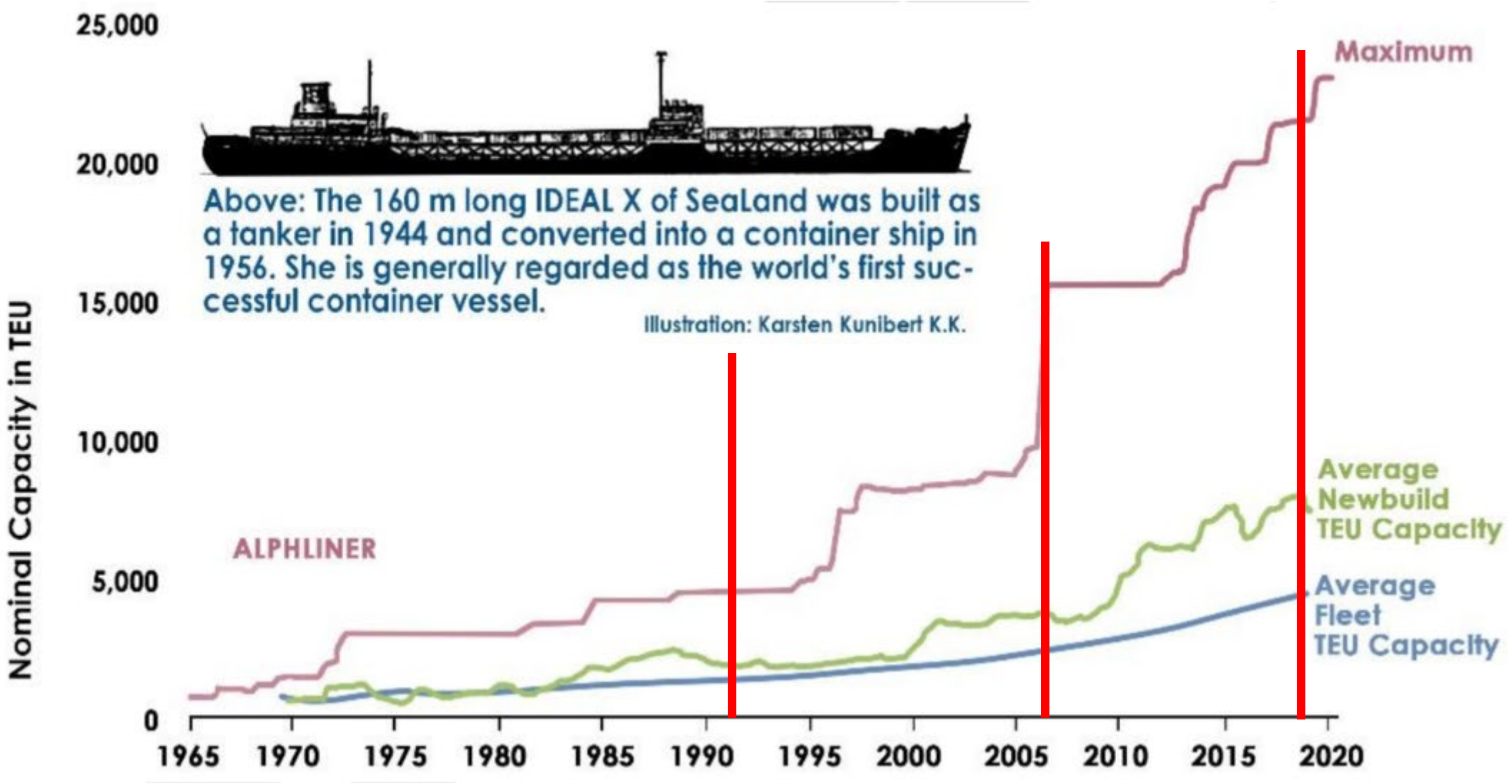
Growth of Container Ship Size 1965-2020



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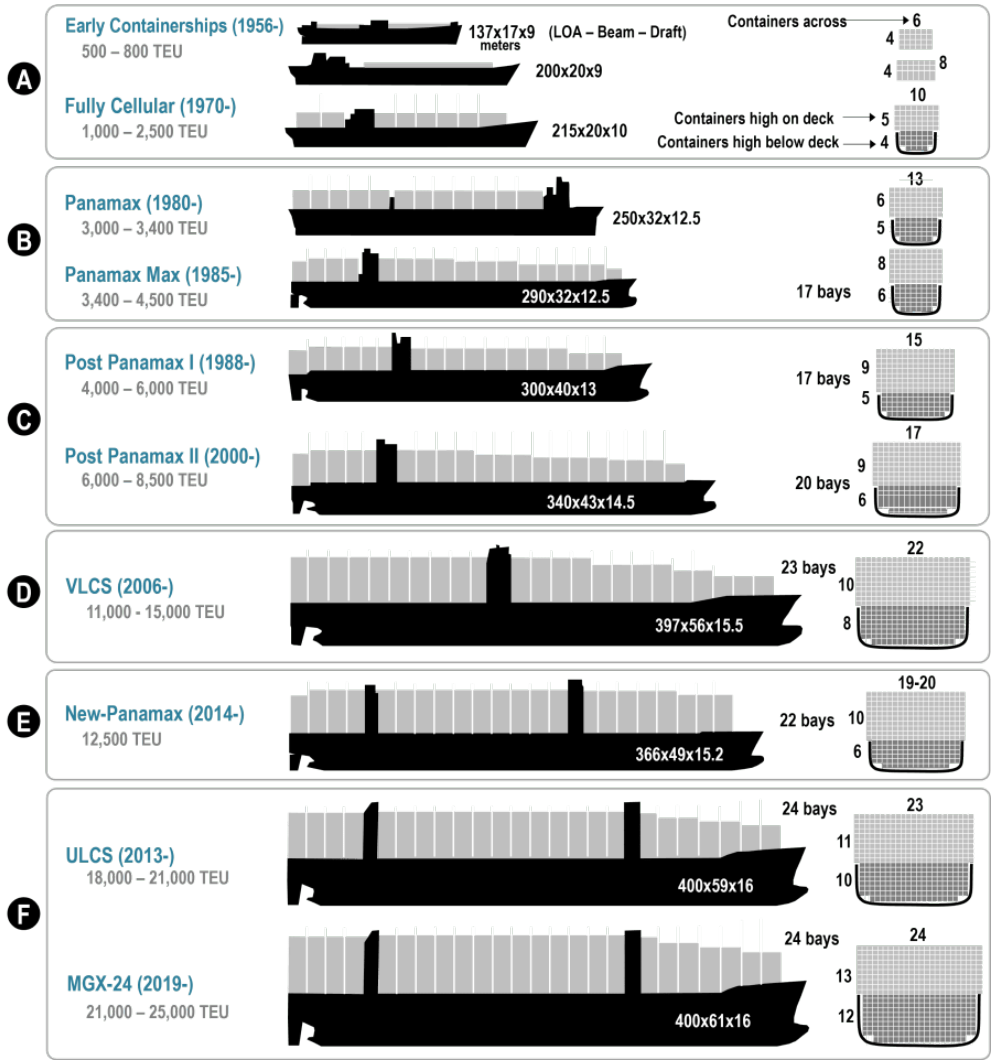
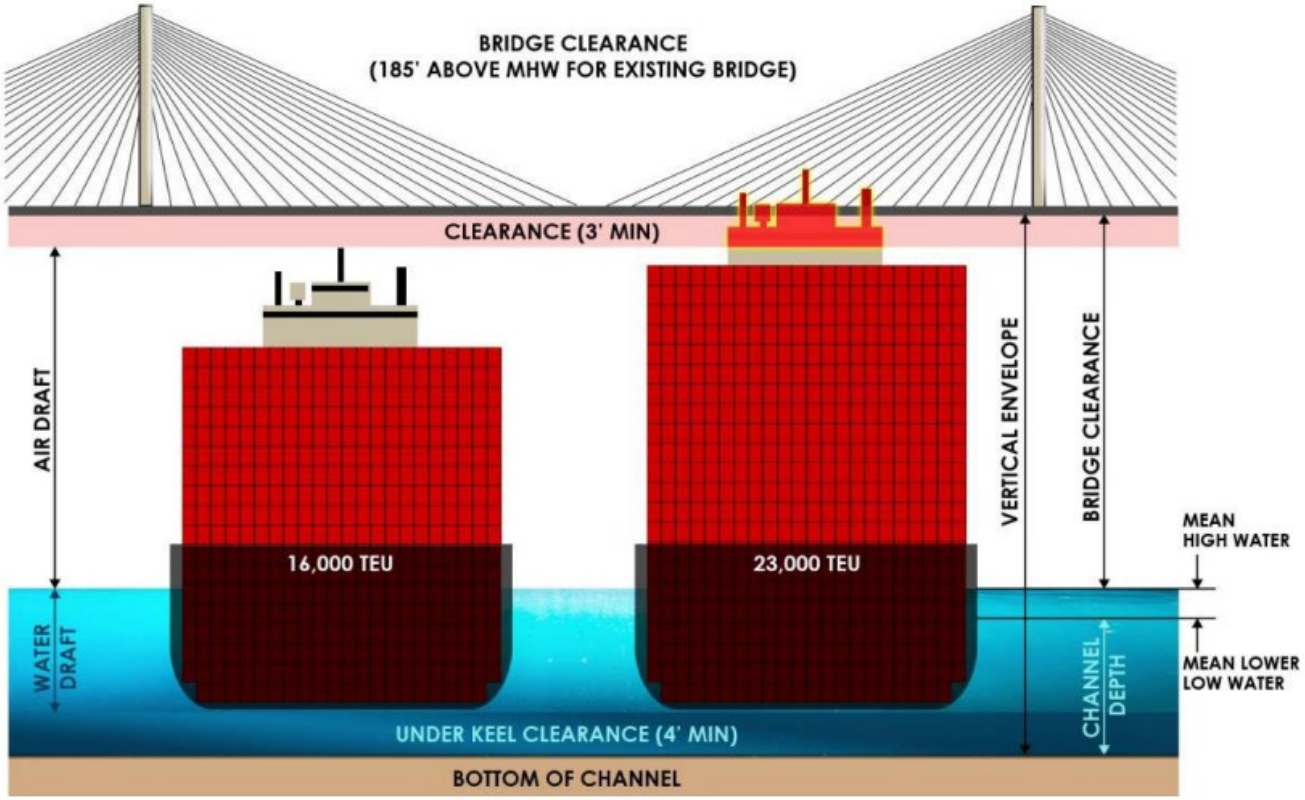
Thus the Problem



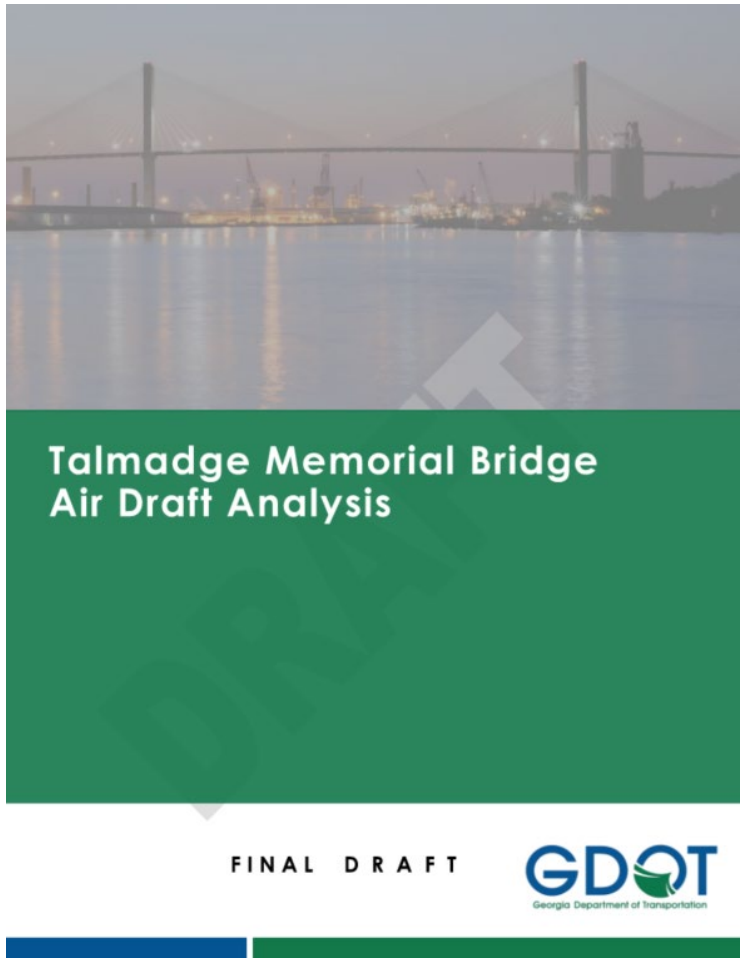


Threading the Needle

On October 13, 2018, the Port of Savannah received a 14,000+ TEU vessel that illustrated this analogy. The vessel was lightly loaded at 57 percent of capacity and was drafting 37.7 feet. The vessel arrived at low tide to clear the 185-foot bridge envelope, which is 192.2 feet at low tide. The mast was 189.3 feet above mean low water, which resulted in a clearance of 2.9 feet (192.2 feet – 189.3 feet). The pilot "threaded the needle" to navigate under the bridge. [21]

The Solution

- 2019 – 2022 GDOT/GPA Air Draft Analysis and Feasibility Study
  - By 2055 > 50% 14,000+ TEU w/o air draft restrictions
  - Options
    - Raise bridge – not feasible
    - Raise roadway – not feasible
    - Replace with draw span – not feasible
    - Locks – not feasible
- New bridge - $1.2 billion
- Tunnel - $2.0 billion



Interim Solution

HNTB recommendation: raise only the superstructure of the cable stayed unit, using the cable stays as strand jacks

- Goals
  - Increase vertical clearance to 205 ft
  - Minimize near term capital investment < $200M
  - Reduce time to enhanced navigation clearance = 5 years
  - Maximize remaining service life of bridge = 40+ years
  - Minimize traffic impacts during construction
  - Avoid impact to approach spans = 70% deck area

- Strategy & Work Elements
  - Replace stay cables w/ ungrouted stays
  - Replace / reconfigure bearings, joints and tie downs
  - Reprofile to achieve navigation clearance envelope

The Case for 205 Feet

Table 5 Air Drafts by Select Port and Limiting Bridge, 2018

Port	Bridge	Air draft in feet
Baltimore	Chesapeake Bay	182
Charleston	Ravenel	185
Jacksonville	Napoleon B. Broward	169
Long Beach	Gerald Desmond	205
Los Angeles	Vincent Thomas	185
New Orleans	Crescent City	150
New York / New Jersey	Bayonne	215
New York / New Jersey	Verrazano-Narrows	215
Philadelphia	Benjamin Franklin	135
Savannah	Talmadge Memorial	185
Seattle	West Seattle	140
Tampa	Sunshine Skyway	180
Wilmington (DE)	Delaware Memorial	188

NOTE: The Delaware Memorial Bridge is also a limiting bridge for the Port of Philadelphia.

SOURCES: U.S. Department of Homeland Security, U.S. Coast Guard, compiled and verified using National Oceanic and Atmospheric Administration (NOAA) Charts. Updated by the U.S. Department of Transportation, Bureau of Transportation Statistics using National Oceanic and Atmospheric Administration Charts, November 2019.

Port Performance Freight Stats 2018, pg 18

- Nearly all major US container ports have air draft limitations
- Top 4 US ports by volume:
  - Los Angeles (West Coast)
  - Long Beach (West Coast)
  - PANYNJ (East Coast)
  - Savannah (East Coast)
- Deepening channels beyond 50 ft would require $10s of billions in USACE investment
- The Panama Canal is the **primary water route** for container ships headed to the US east coast
  - 205 ft air draft / 50 ft channel depth*
- The Suez Canal an **alternative** to Panama Canal
  - 223 ft air draft / 66 ft channel depth*
- Hong Kong to Savannah – Panama Canal
- Vietnam to Savannah – Suez Canal

* Subject to certain conditions at time of passage

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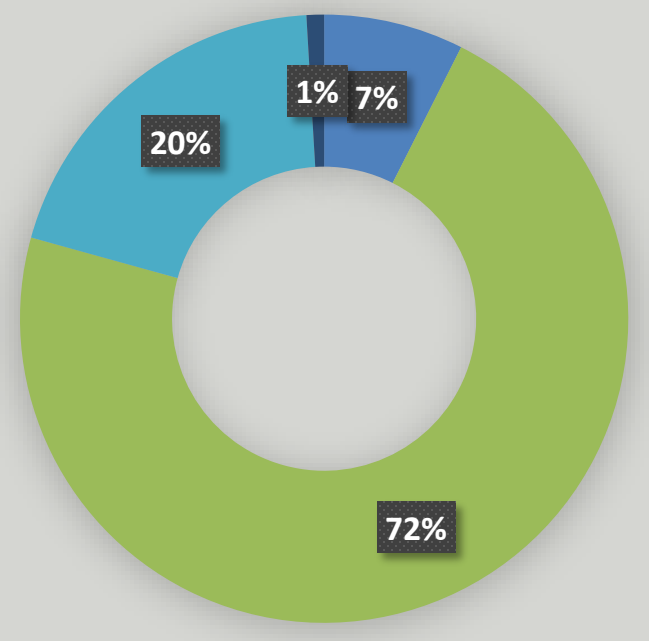
Benefits of Interim Solution

- New cables
  - Extends life of bridge 35 to 40 years
- New bearings – existing vs proposed
- Less maintenance – cables
- Minimum disruptions to traffic
- Opportunity for enhanced inspection

Estimated Cost for Replacing Stay System

Low Range



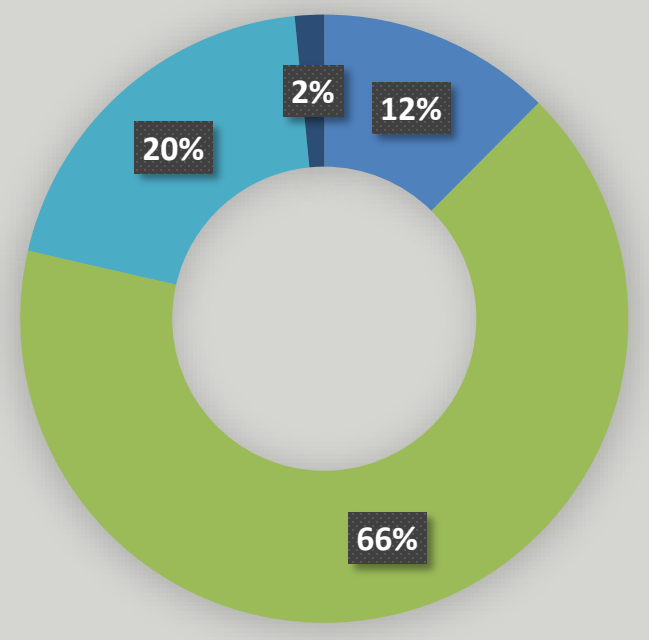
- Equipment - $3.2m
- Manpower - $30.9m
- Material - $8.5m
- Maintenance of Traffic - $400k

Subtotal: $43m

+ Mobilization: $4.3m
+ 25% Contingency: $11.8m

Total: $59.1m

High Range



- Equipment - $6.4m
- Manpower - $34m
- Material - $10.2m
- Maintenance of Traffic - $800k

Subtotal: $51.4m

+ Mobilization: $5.1m
+ 25% Contingency: $14.1m

Total: $70.6m

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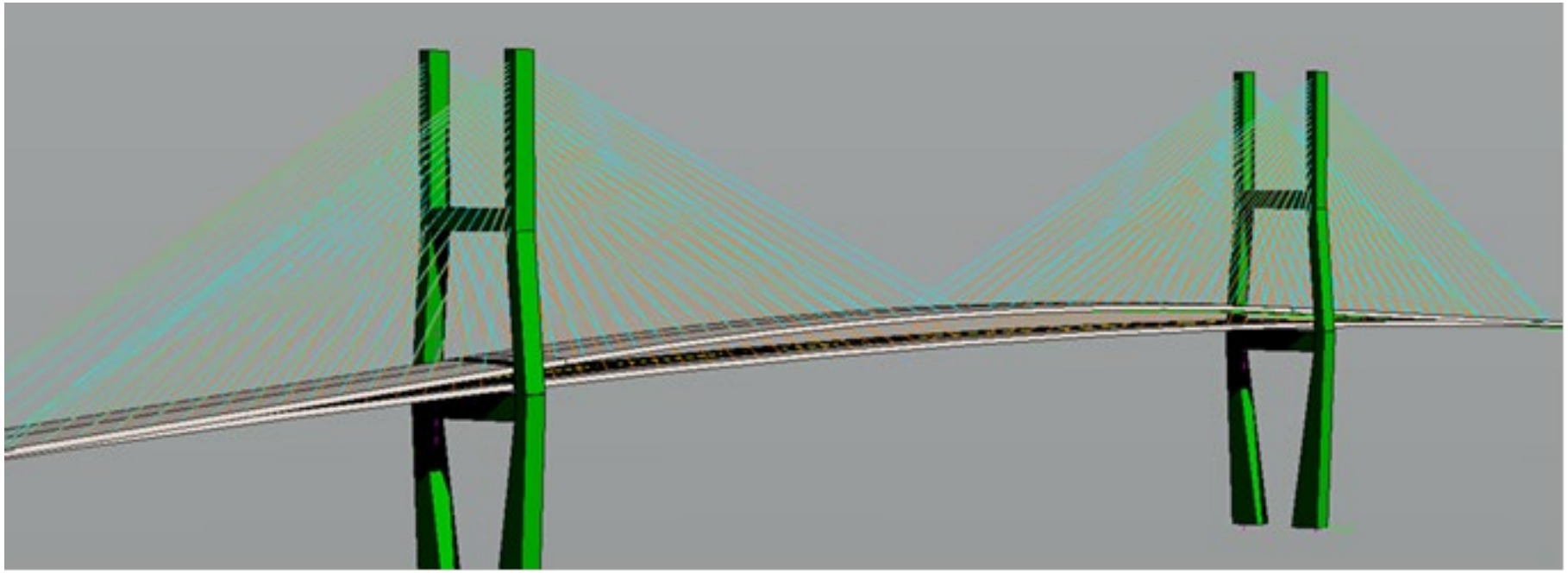
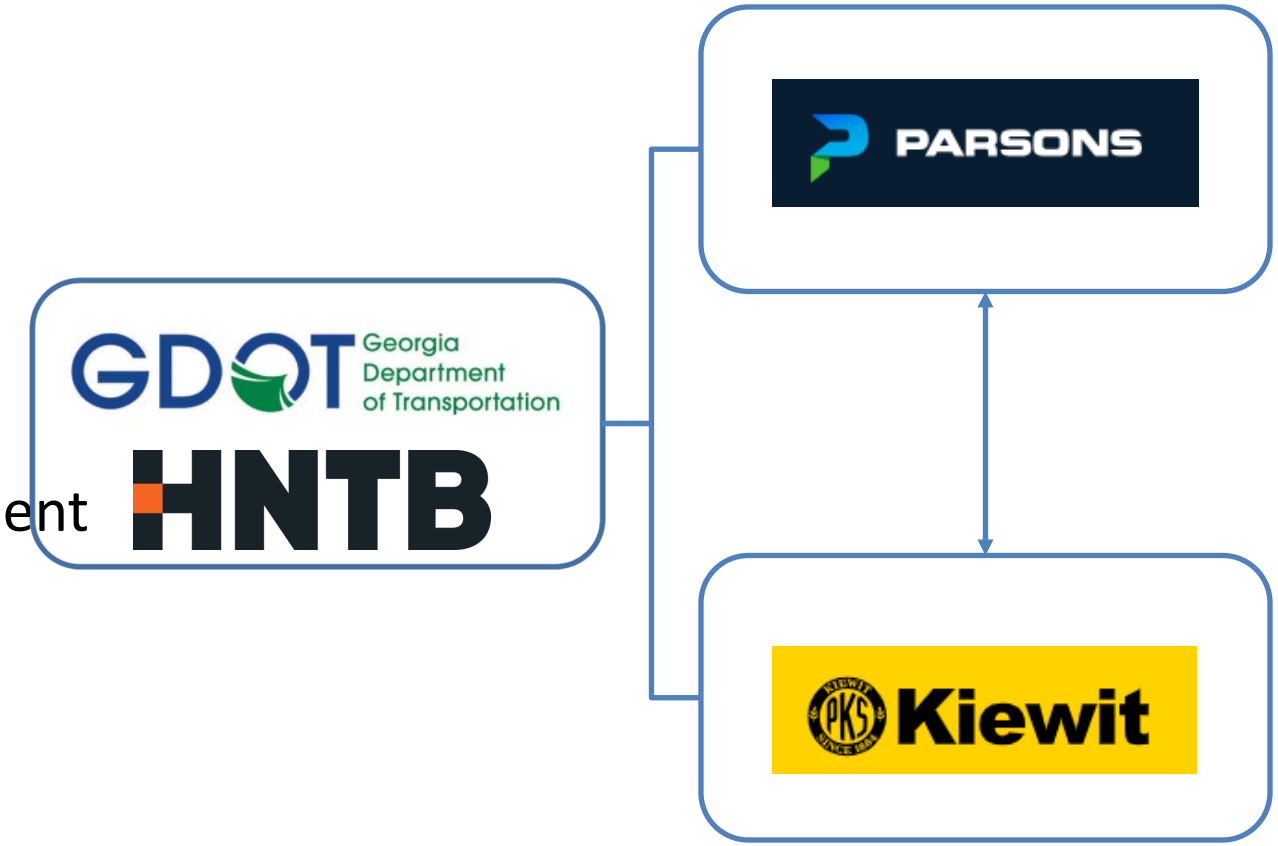
Reprofiling Meets GDOT Roadway Standards

- Increase grade from 5.5% to 6%
- Shorten vertical curve from 2300 ft to 1008 ft
- Reduce speed to 45 mph
- 0.5% grade breaks
  - Split into 0.25% at each end of simply supported approach span



Project Delivery

- CMGC Method – Construction Manager/General Contractor
  - Enhanced collaboration
  - Early contractor involvement
  - Risk management
- HNTB as Program Manager/Independent Design Review
- Parsons as Designer of Record
- Kiewit as CM GC



First Things First – Replace Stay Cables

- Old Technology - Prior to 1998
  - Grouted stays, 0.6” strand,
  - Large multistrand jacks
  - In service for 30 years
- New Technology – Since 1998
  - Ungrouted stays, 0.62" strand
  - Individual waxed/sheathed strand
  - Strand-by-strand installation w/ calibrated load cells
  - Coextruded HDPE with helical fillet

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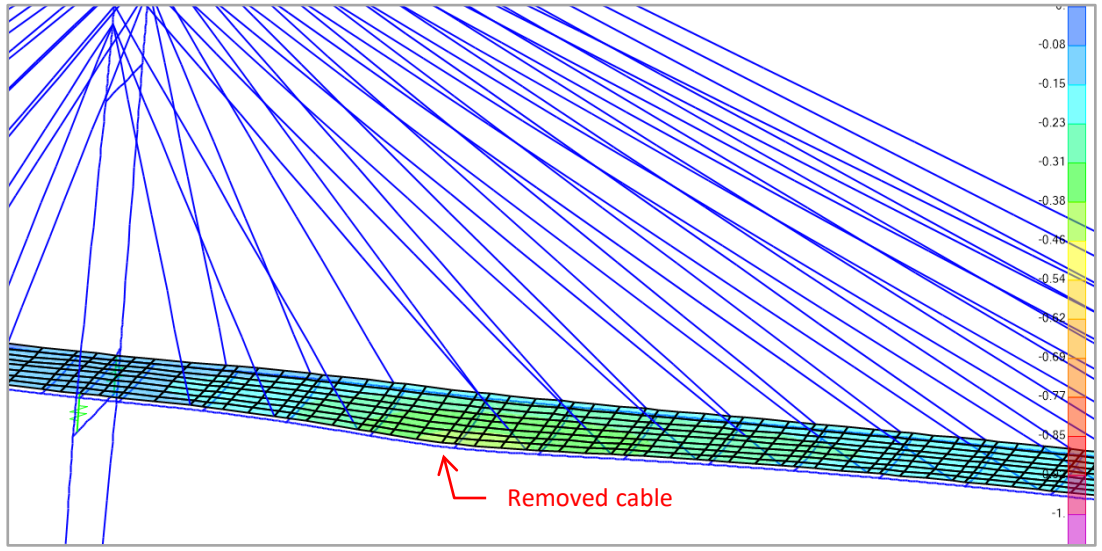
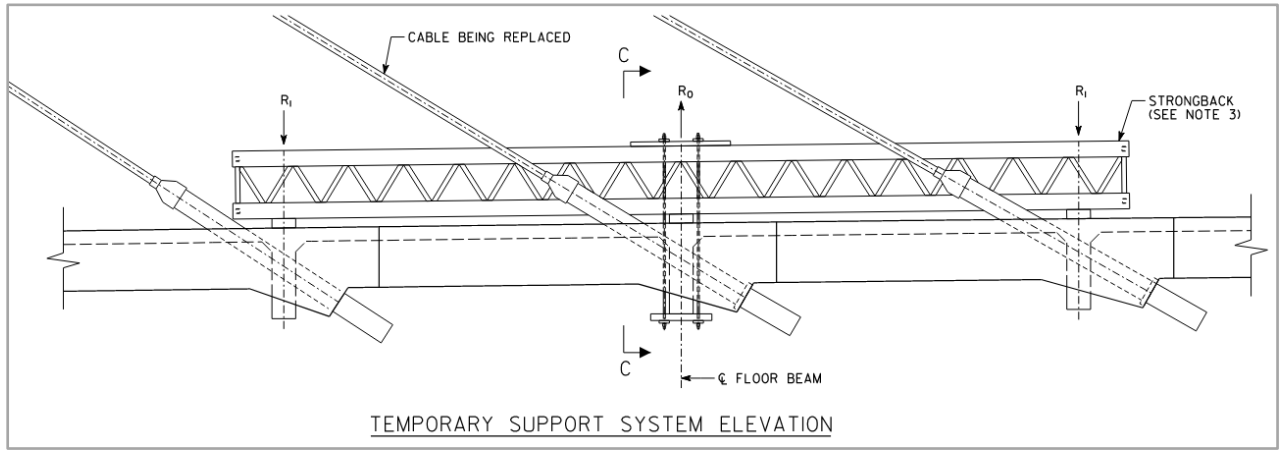
Cable Replacement

- Work will be performed under live traffic (2 lanes)
- PTI requires design for cable replacement and fractured cable (sudden dynamic loss)
- Bridge does not appear to have been designed for cable replacement under LL
- High superstructure demands
- WIM study and MOT
- Unknown condition of cables
  - Strongback
  - Temporary stay



Displacement contours – single cable removal under live load



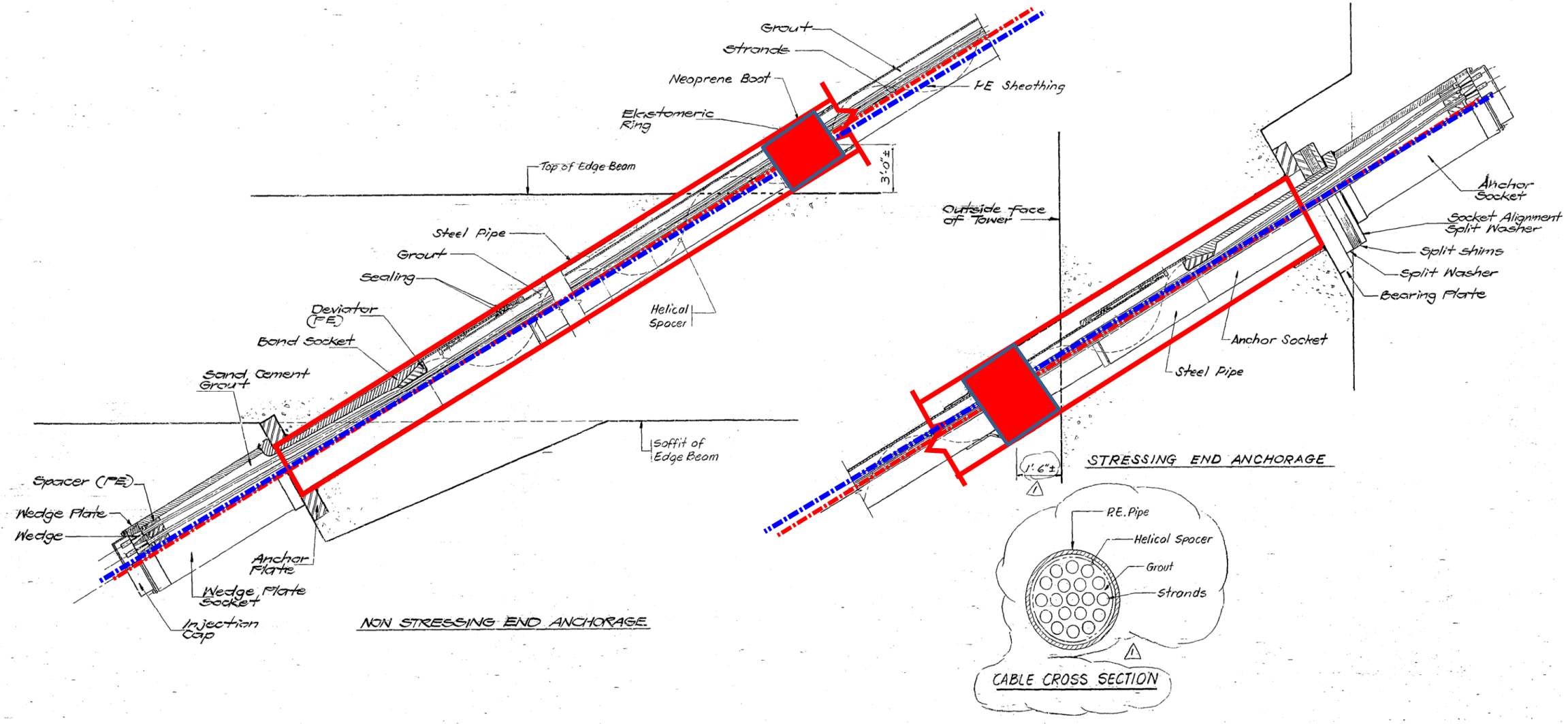
Parsons

Proposed Cable Replacement Approach

- Stay replacement progresses from the shortest to the longest
- Four replacement crews will be required: one for each tower and one for each plane of stays
- Six de-stressing assemblies: two for 61-43 strands; two for 40-26 strands; and two for 24-17 strands
- One crane with a 260-foot boom to set upper tower platforms and derricks
- Mobilizations: mob/demob equipment on NW and SW tower. Mob/Demob equipment on NE and SE tower
- Removed under single lane closures…no complete bridge closures
- Existing stays will be destressed using an approved method
- Construction sequence will progress on four headings simultaneously

Structural Technologies/VSL

Cable Replacement



Strand by Strand Installation

- Use Monostrand Jacks
- Install first strand with load cell to specified force
- Install subsequent strands one at a time and match force in jack to load cell in first strand
- Jacks are portable and weigh less than 50 pounds

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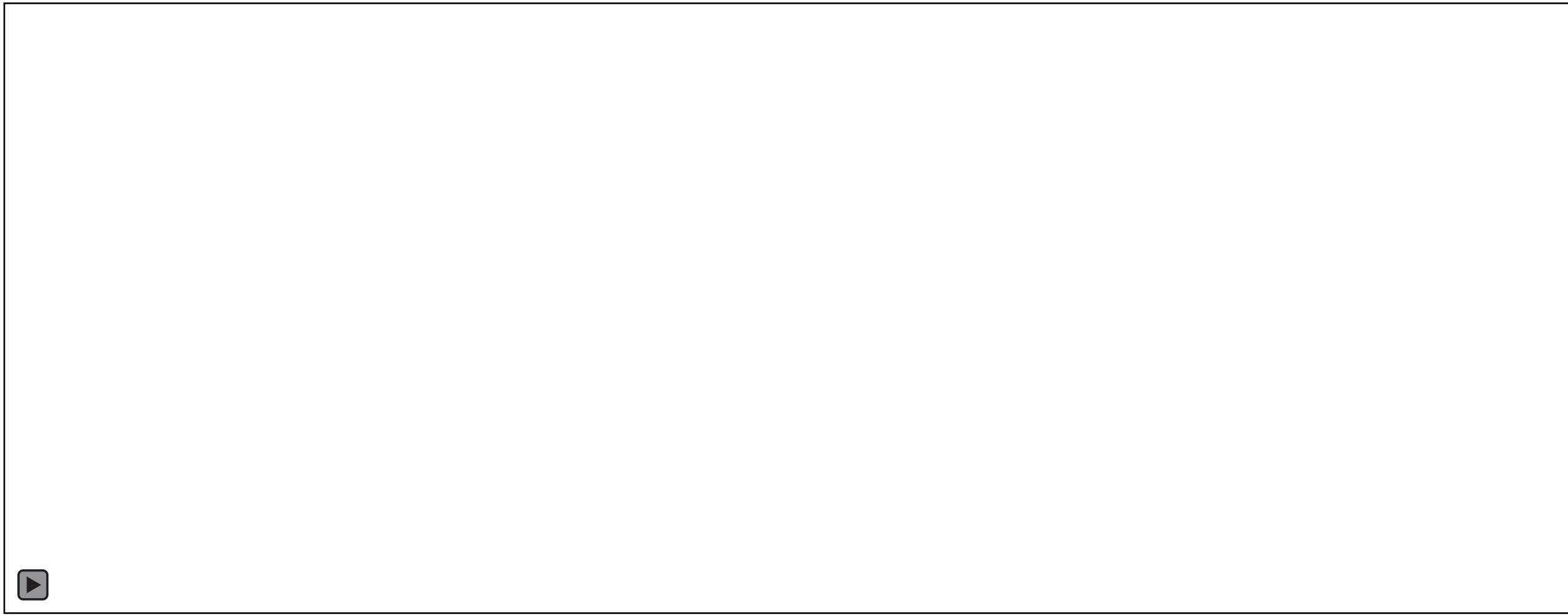
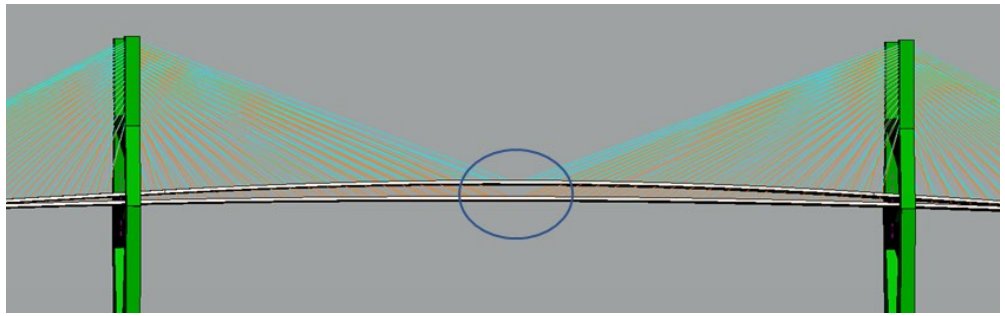
Reprofile Animation

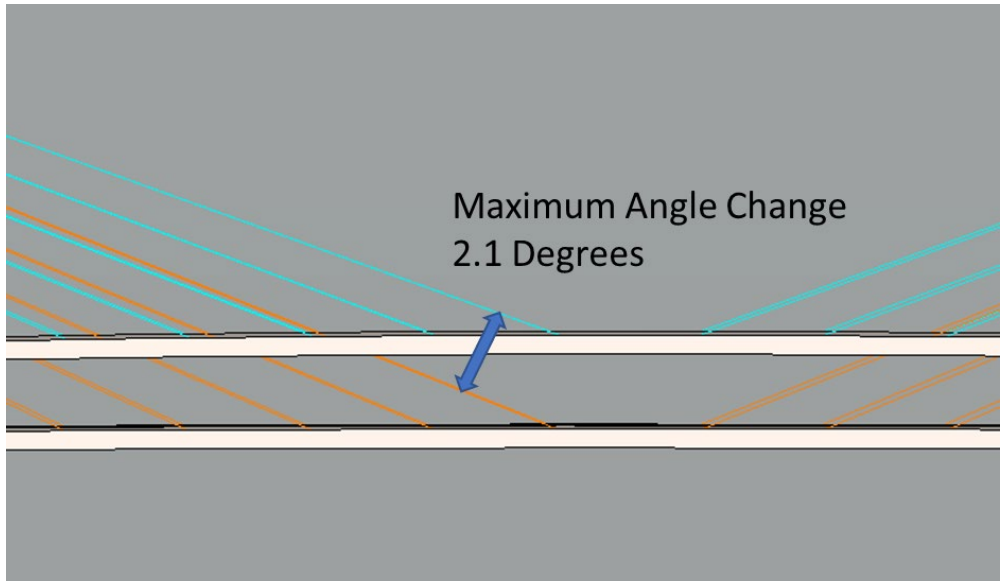


Where has this been done before?

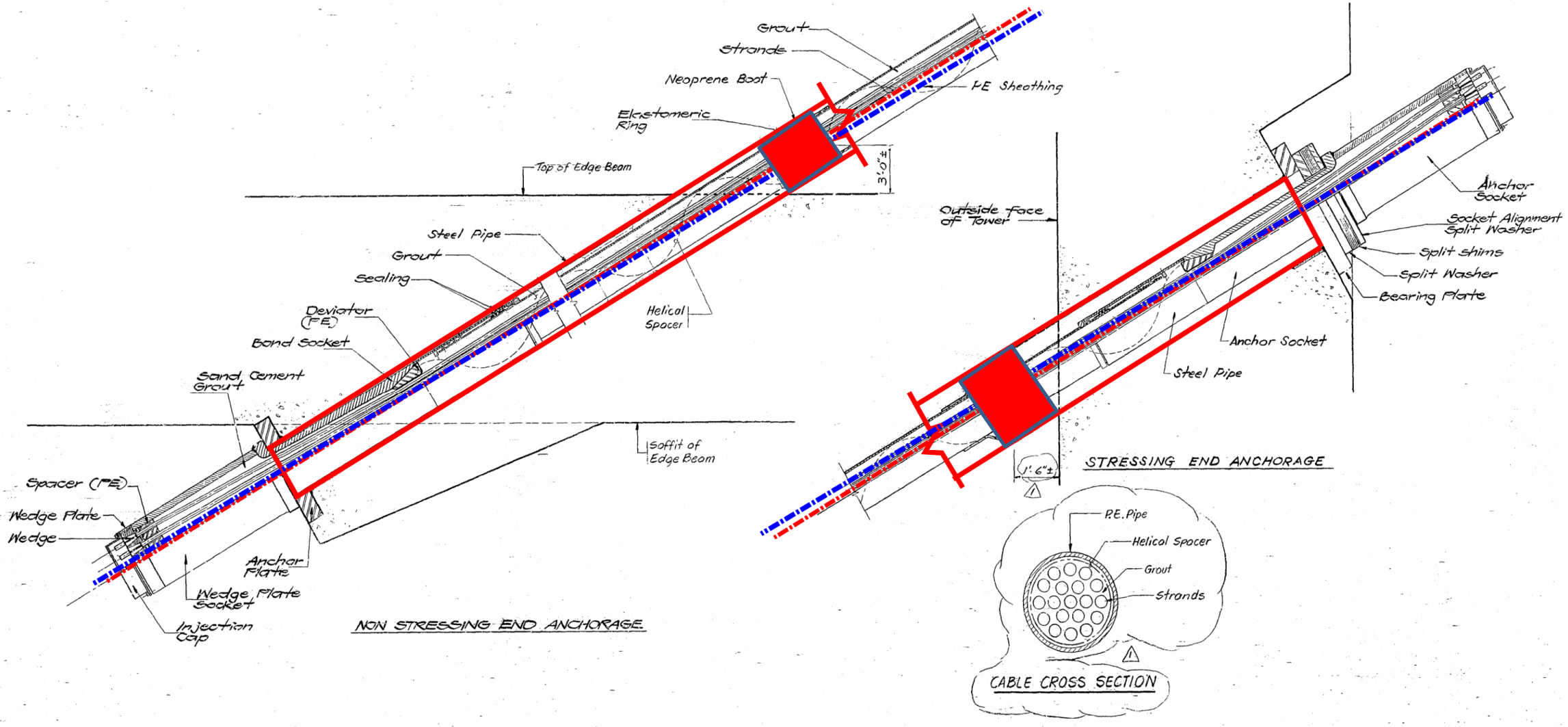
Conceptual Reprofile Approach

- Reprofile the bridge through stay cable adjustments
- Stay cable adjustment progressed in three waves:
  - Mid-span to the end
  - End back to mid-span
  - Mid-span back to the end
- Four adjustment crews will be required: one for each tower and one for each plane of stays.
- May be performed with monostrand jack or multi-strand jack
- Adjustments made from the tower
- Adjustments made under single lane closures…no complete bridge closures





Accommodating the Bridge Raise



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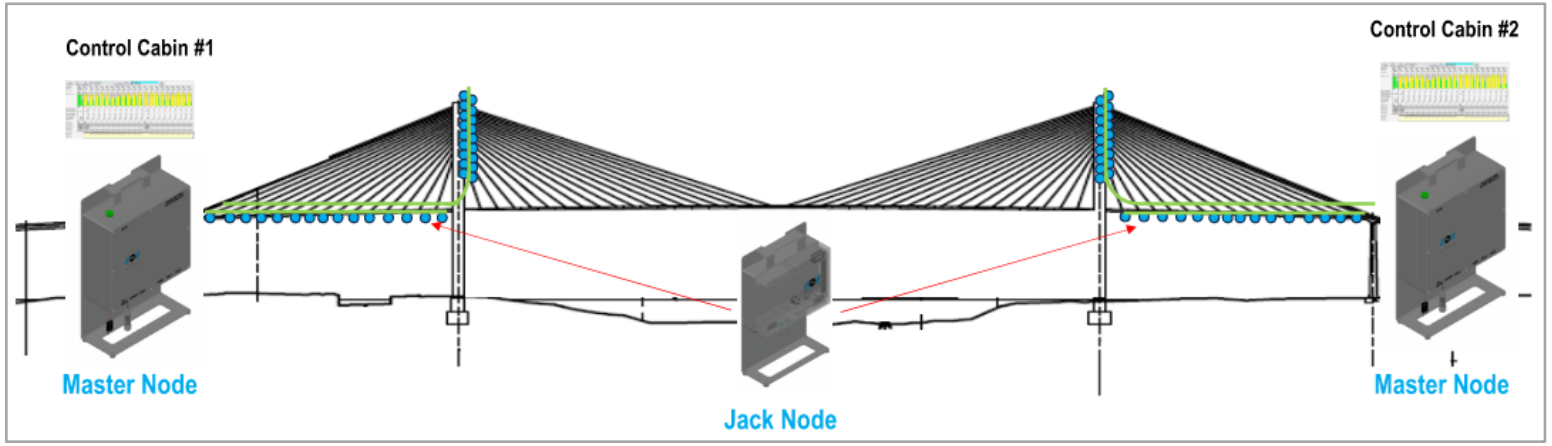
Alternatives Being Considered

- Monostrand jacking vs. synchronized lift
  - Current monostrand proposal = 15 passes → ~55,000 “touches”
  - Synchronized lift = 148 multistrand jacks x 4 operations



all images ST/VSL

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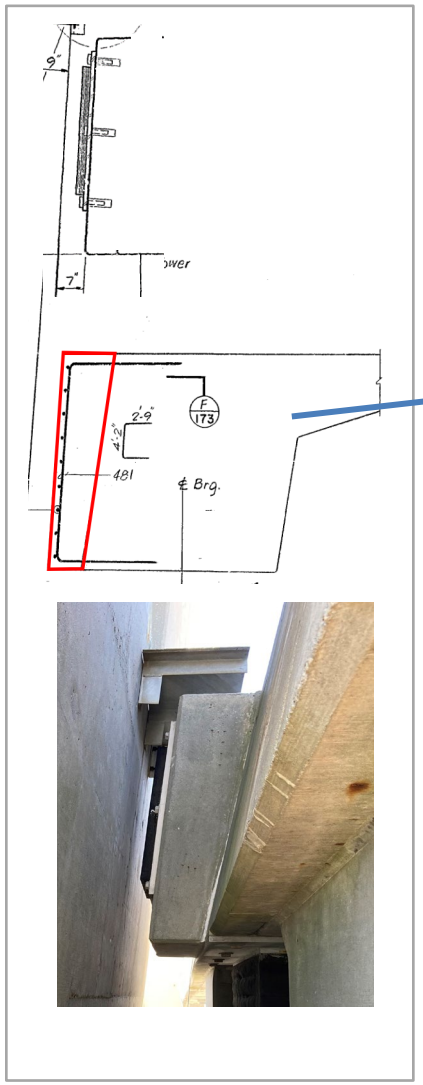
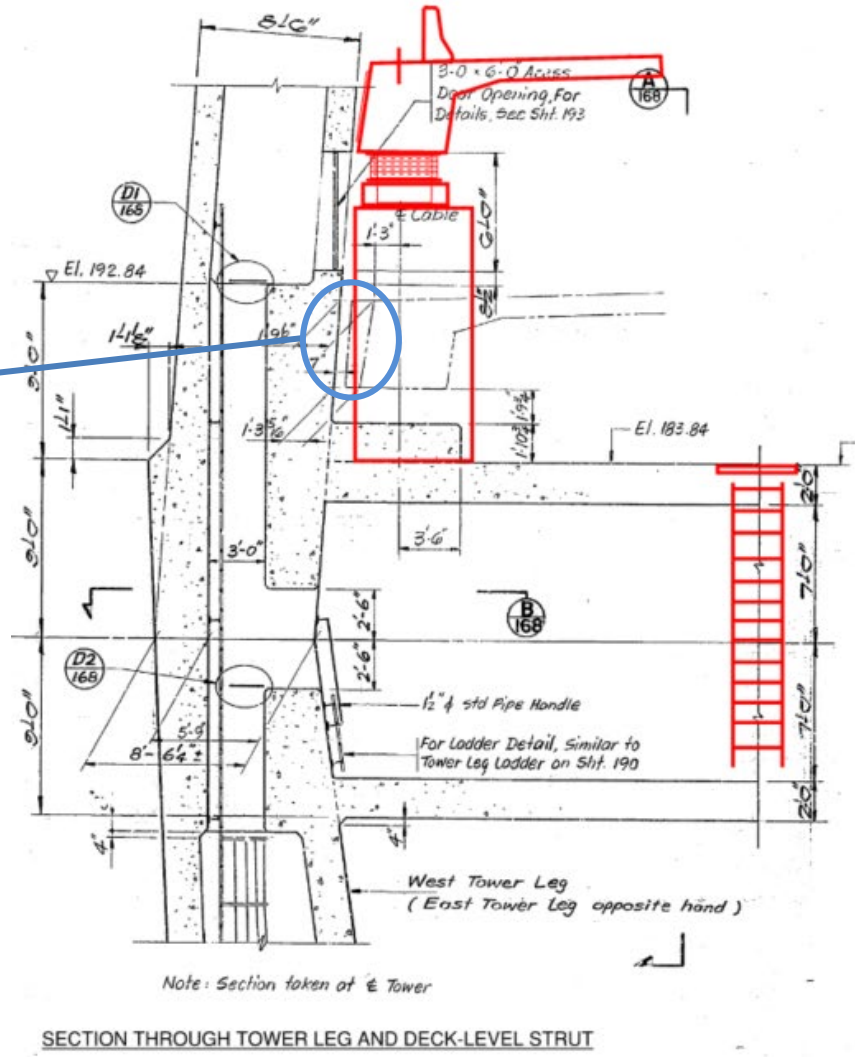
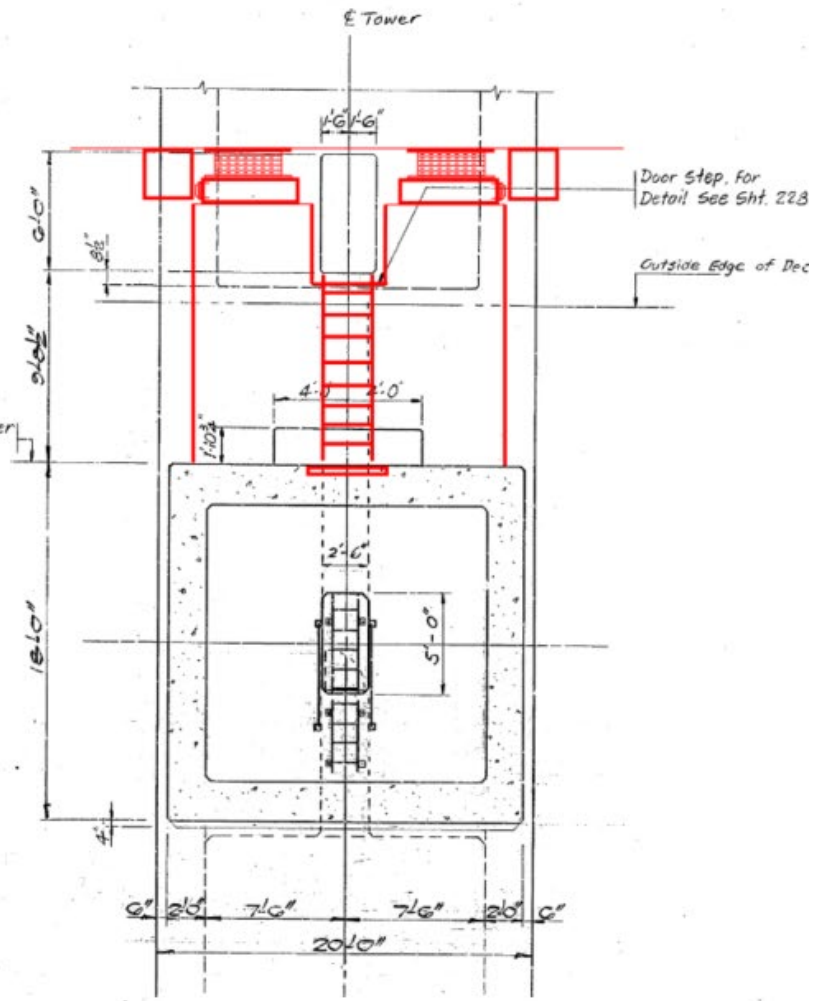
Accommodating the Bridge Raise – Tower Details





SECTION THROUGH TOWER LEG AND DECK-LEVEL STRUT



SECTION THROUGH DECK-LEVEL STRUT

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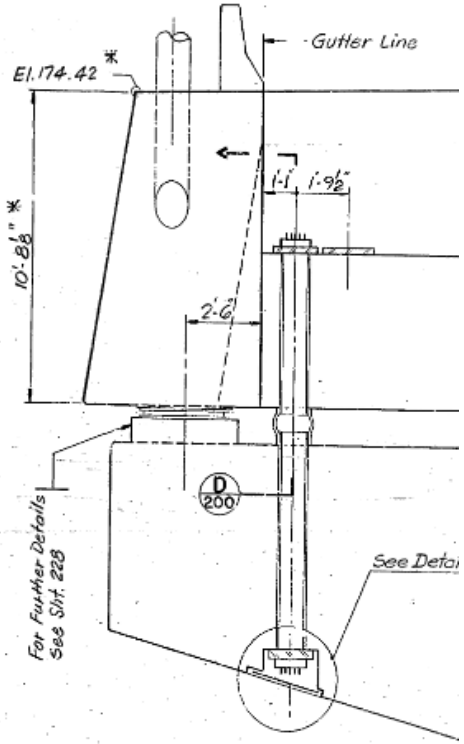
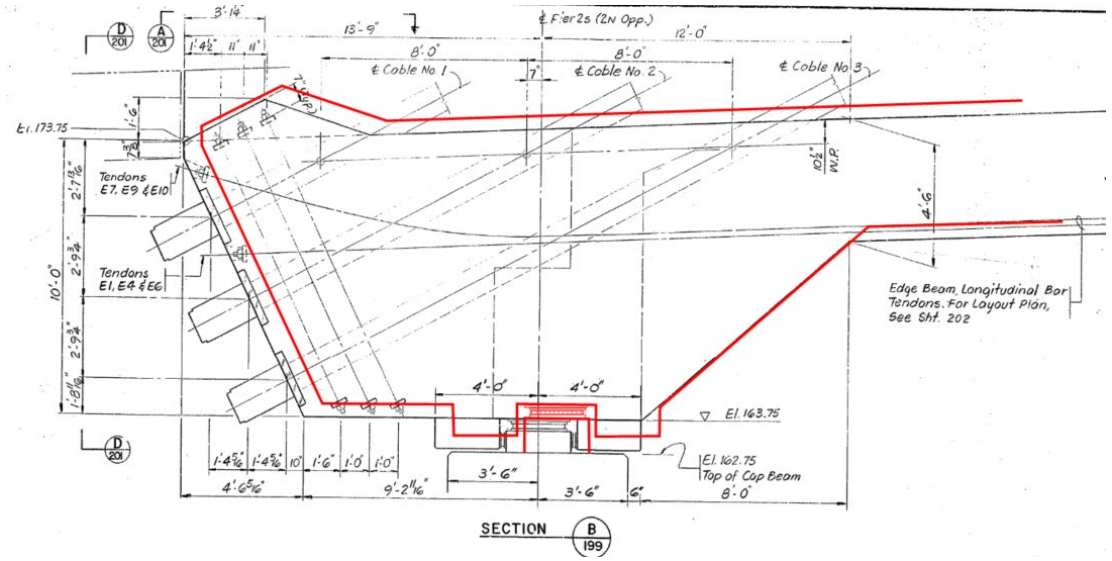
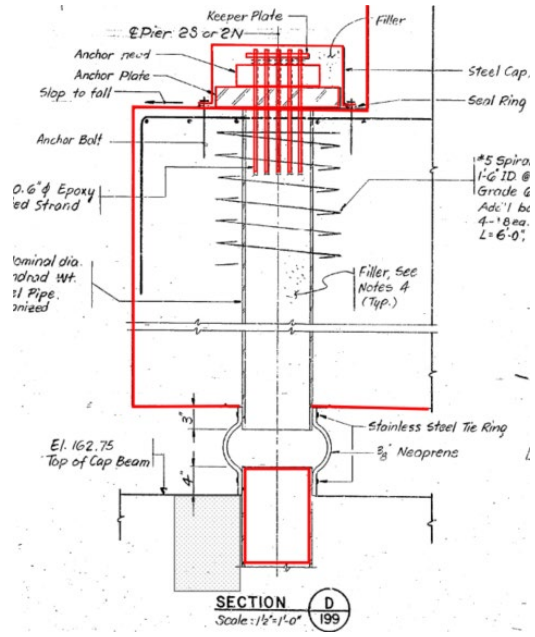
Accommodating the Bridge Raise – Anchor Pier Details



DETAIL AT ANCHOR PIER



SECTION THROUGH ANCHOR PIER BEARNG



SECTION THROUGH ANCHOR PIER TIE DOWN

Final Thoughts

- Interim solution
- Remaining service life = 20 years
- Unique approach
- Possible only because of the original details

It looks like this bridge was almost designed to allow reprofiling!

Questions

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