John James Audubon Bridge

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Introduction

Roadways

Approach Bridges

Main Span

John James Audubon Bridge

Introduction

The Project


St. Francisville
61
61
61
964
St Maurice
Towhead
10
10
10
3131
New Roads
1
413
415
Ventress
415
414
68
68
61
Port Hudson

Why build the bridge?

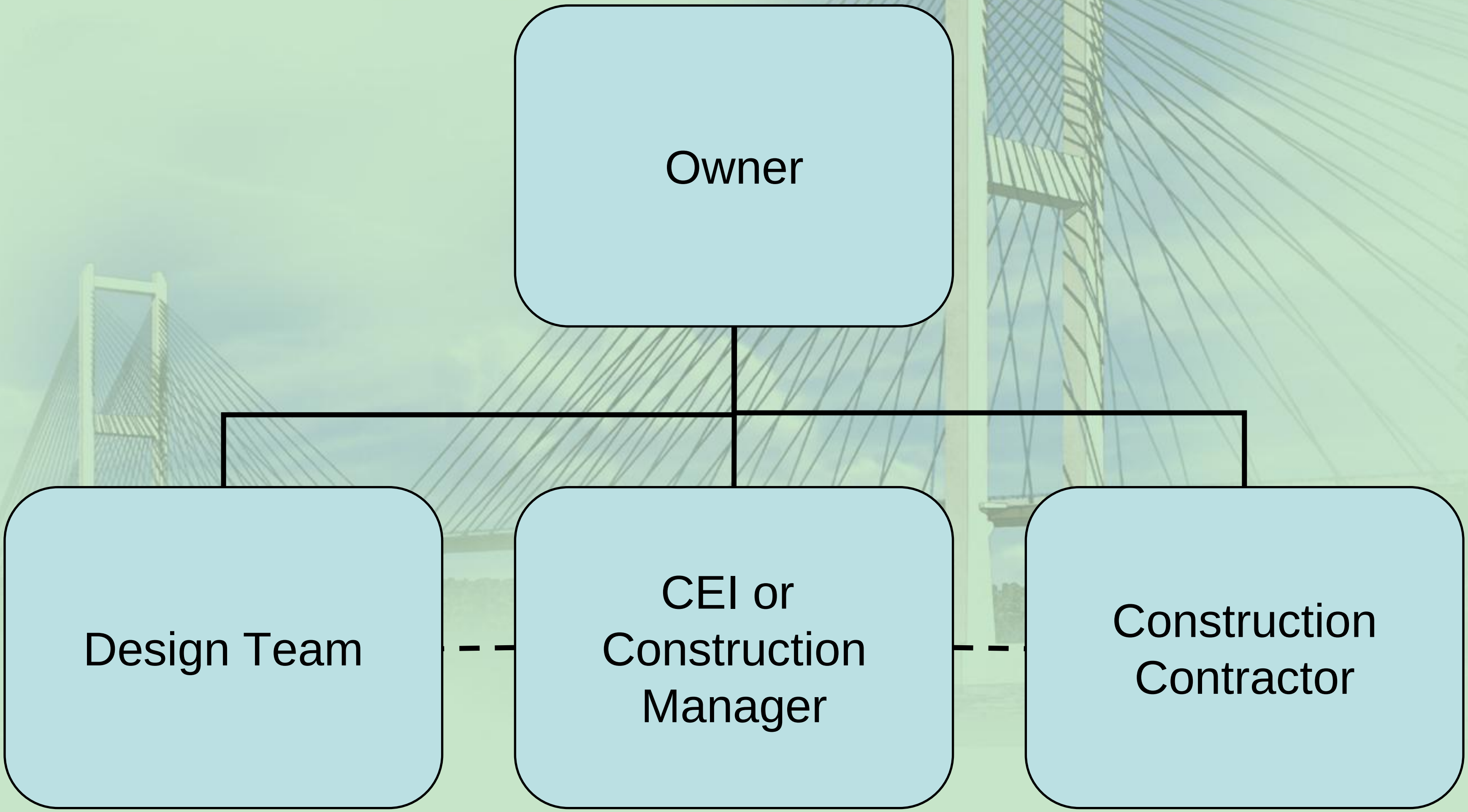
- The bridge--proposed to be the longest cable-stayed bridge in America--will replace an existing ferry between the communities of New Roads and St. Francisville, Louisiana.
- The bridge will also serve as the only bridge structure on the Mississippi River between Natchez, Mississippi and Baton Rouge, Louisiana (approximately 90 river miles).
- The project is part of the Zachary Taylor Parkway, a scenic highway across Louisiana from Mississippi to Texas.
- Economic development for the area.

Data provided by Louisiana 's TIMED Program

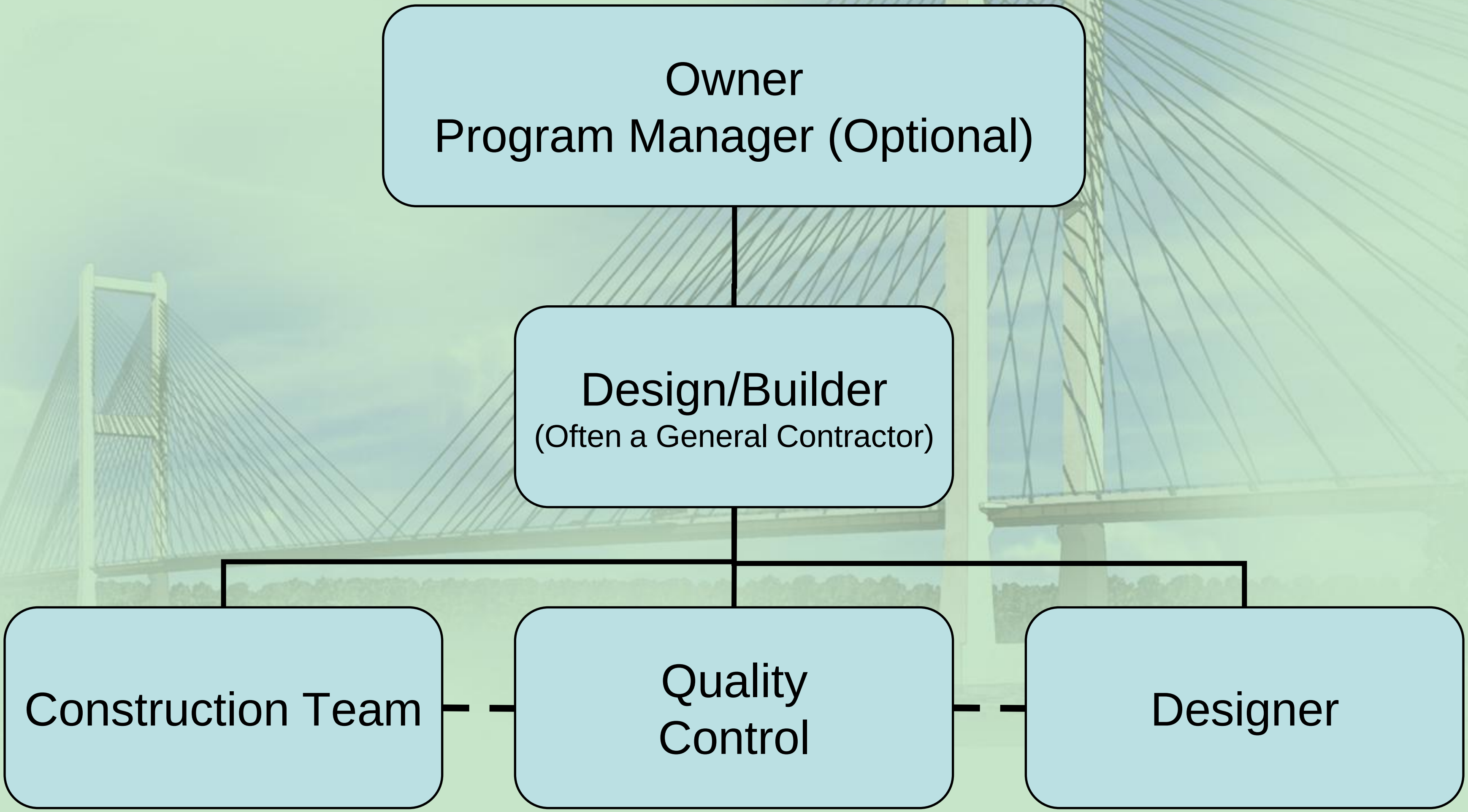
Overall Project Facts

Scheduled Time to Complete	47 Months (February 2010)
Estimated Number of Man-Hours	793,000 MH
Number of Bridges	8
Concrete	99,000 CY
Reinforcing Steel	27,900,000 LBS
Structural Steel	14,500,000 LBS
Stay Cables	1,834,000 LBS
Asphalt	95,000 TON

Design/Bid/Build



Design/Build

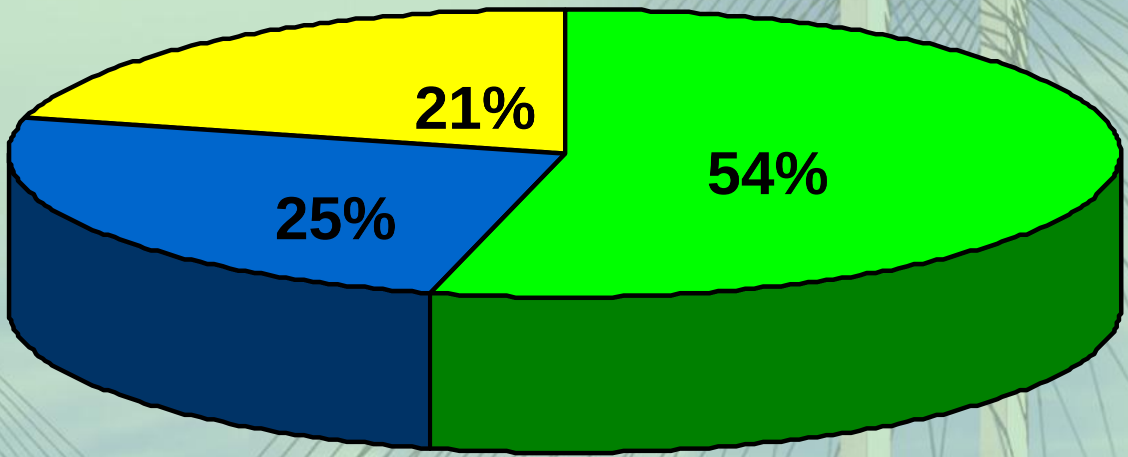


The Joint Venture

The $348 million dollar project is being constructed by Audubon Bridge Constructors, a joint venture consisting of:

- Flatiron Constructors (Longmont, CO)
- Granite Construction Company (Watsonville, CA)
- Parsons Transportation Group, Inc. (Washington, DC)

Audubon Bridge Constructors



- Flatiron Constructors, Inc. (54%)
- Granite Construction Company (25%)
- Parsons Transporation Group, Inc. (21%)

Louisiana Department of Transportation & Development

- LA DOTD is the owner of this bridge and are managing the construction with the Louisiana TIMED Program.

Louisiana TIMED Managers (LTM)

- Louisiana TIMED Managers (LTM) serve as an extension of the Louisiana Department of Transportation & Development (LA DOTD).

Louisiana TIMED Program

TIMED IS NOW!

LTM

A Joint Venture of PB, THE LPA GROUP TRANSPORTATION CONSULTANTS, GEC

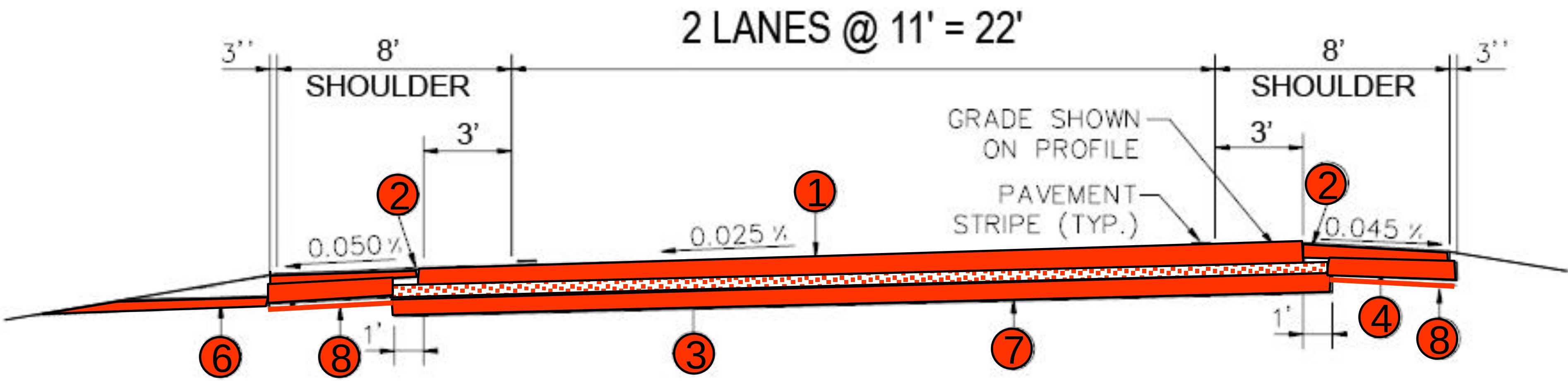
John James Audubon Bridge

Roadways

Roadways: Clearing & Grubbing

Move-in Equipment

Roadways



TYPICAL PAVEMENT SECTION

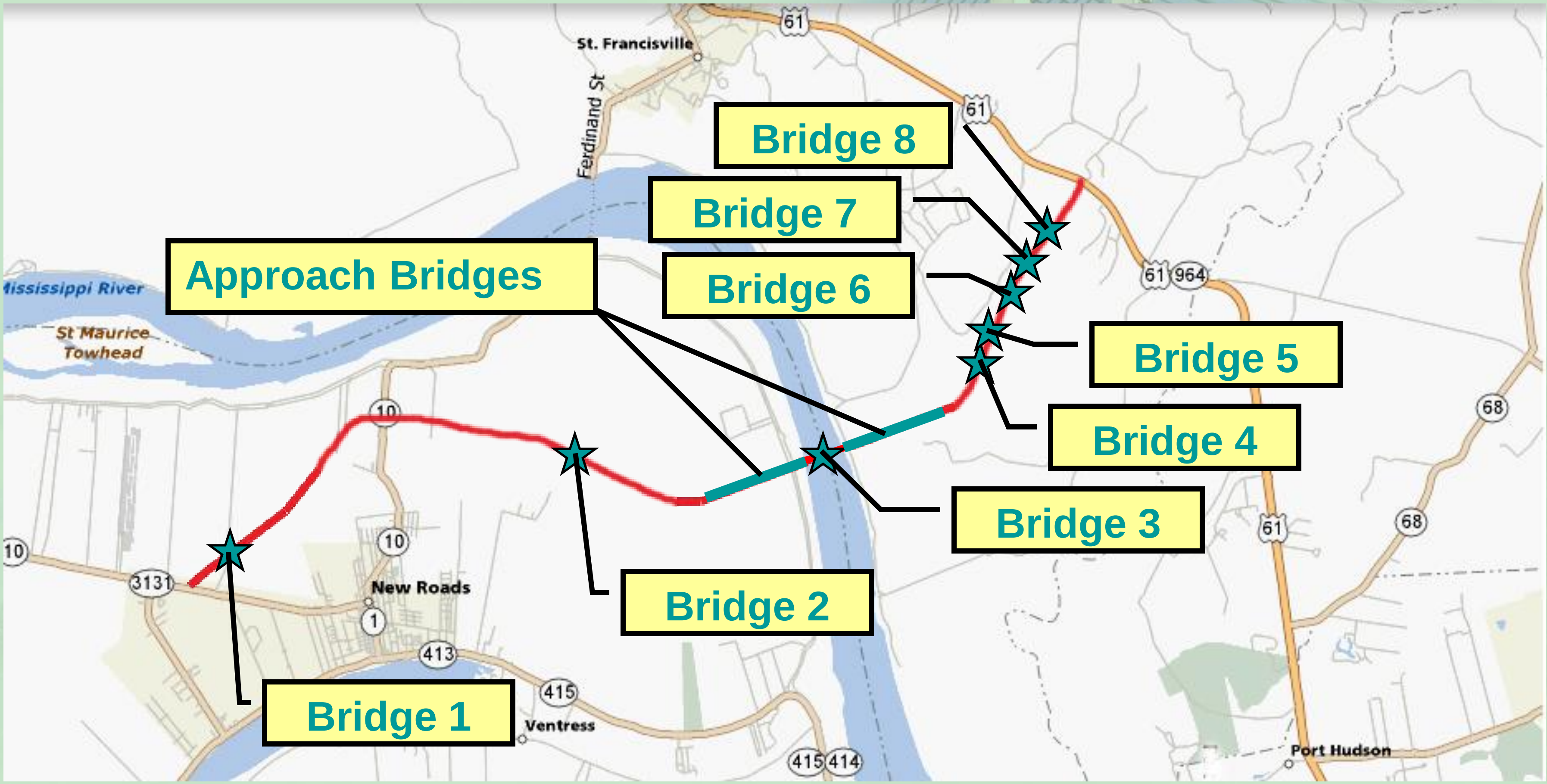
LEGEND:

1. 8" SUPERPAVE ASPHALTIC CONCRETE (LEVEL 2)
   (2" WEARING COURSE)
   (3" BINDER COURSE)
   (3" BASE COURSE)
2. 4" SUPERPAVE ASPHALTIC CONCRETE (LEVEL A)
   (2" WEARING COURSE)
   (2" BINDER COURSE)
3. CLASS II BASE COURSE (4" THICK)
4. CLASS II BASE COURSE (8" THICK)
5. OMIT
6. 4" THICK NON-PLASTIC EMBANKMENT
7. 8" CLASS II BASE COURSE (SOIL CEMENT)
8. GEOTEXTILE FABRIC

John James Audubon Bridge

Approach Structures

The Bridges

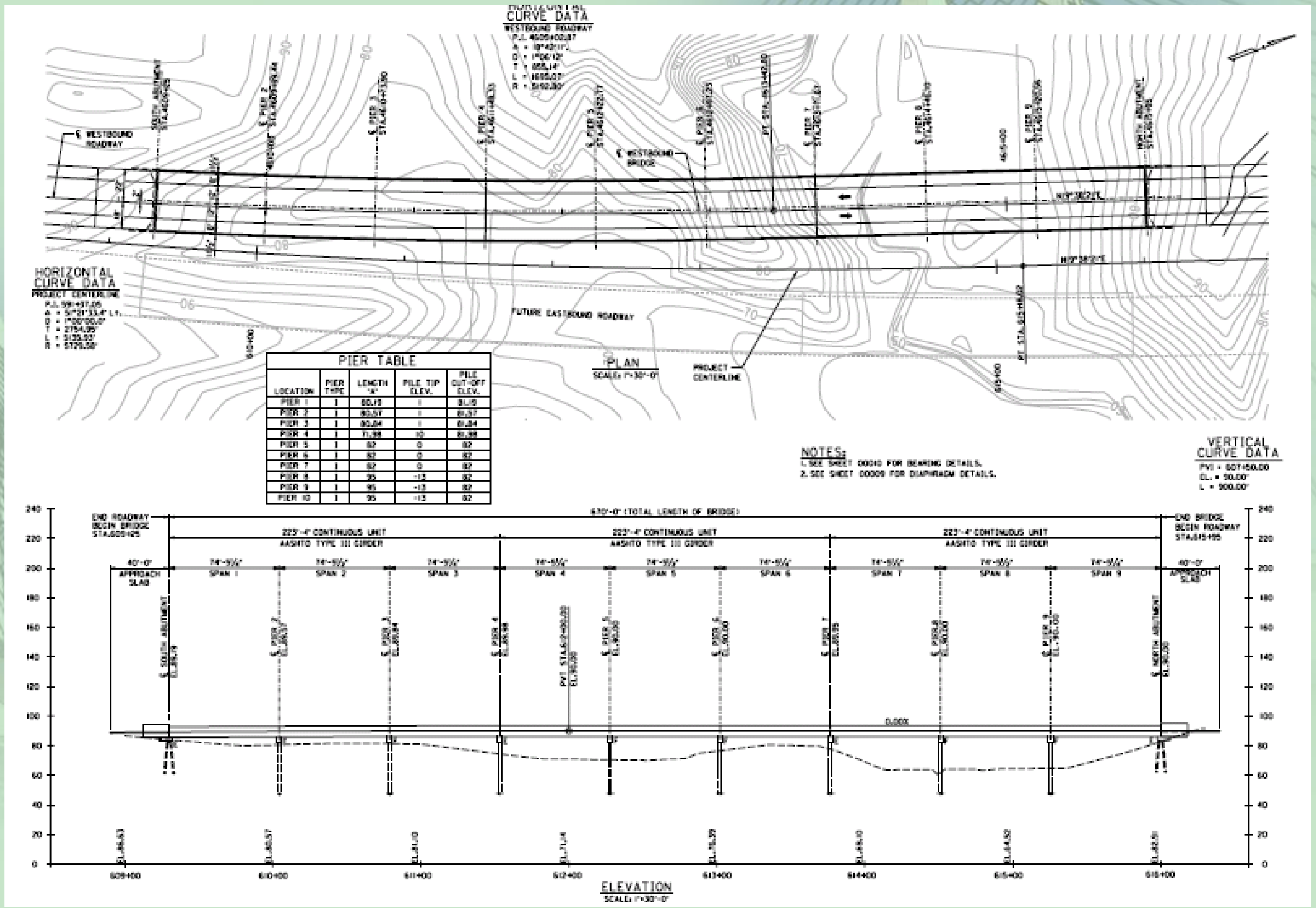


Bridge 8
Bridge 7
Bridge 6
Bridge 5
Bridge 4
Bridge 3
Bridge 2
Bridge 1
Approach Bridges
St. Francisville
Ferdinand St
Mississippi River
St Maurice Towhead
New Roads
Ventress
Port Hudson
61
964
68
10
3131
1
413
415
414

Approach Roadway Bridges

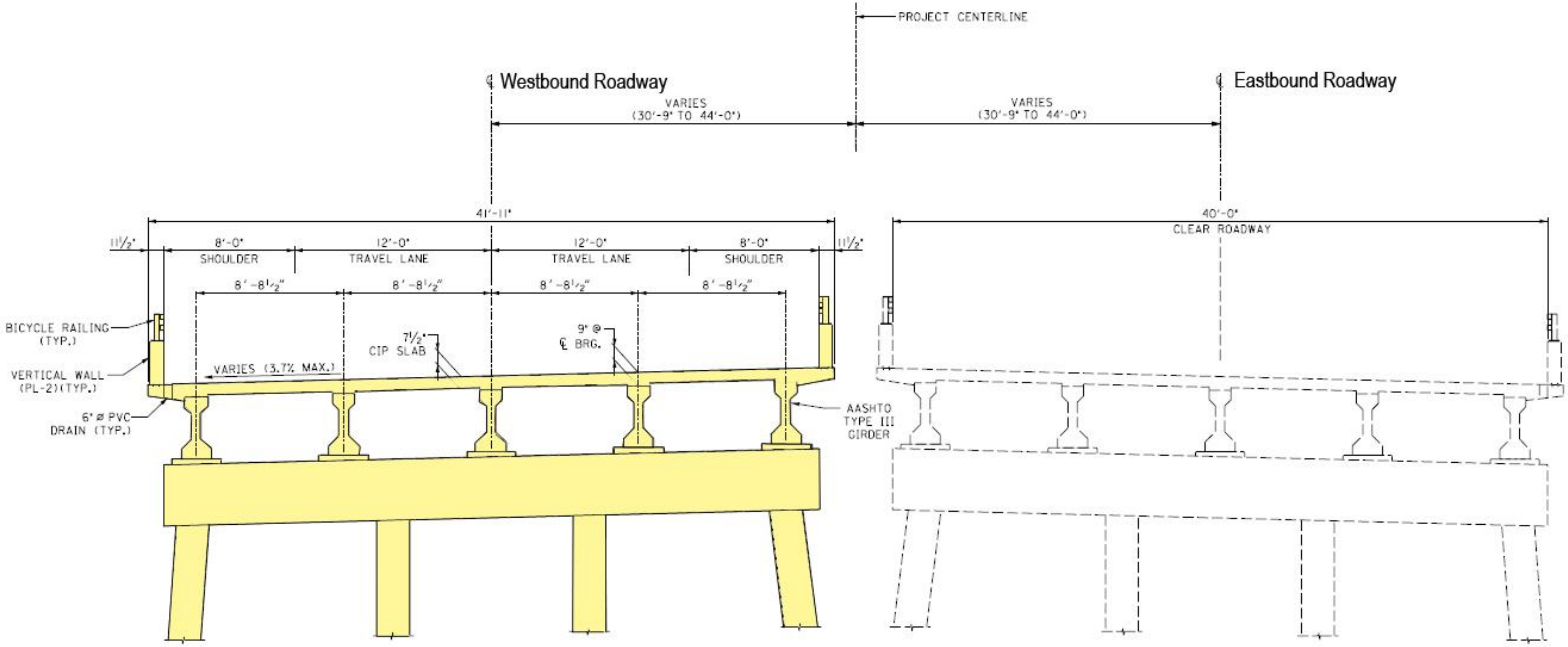
- 2 Lane and 4 Lane Configurations – Future Widening of Approach Roadway and Bridges
- LRFD Design Method
- Conventional Bridge Layouts and Construction Details- Use of Standard LA DOTD Details Such as Expansion Joints, Railing, Approach Slabs, etc.

Sample Bridge General Plan

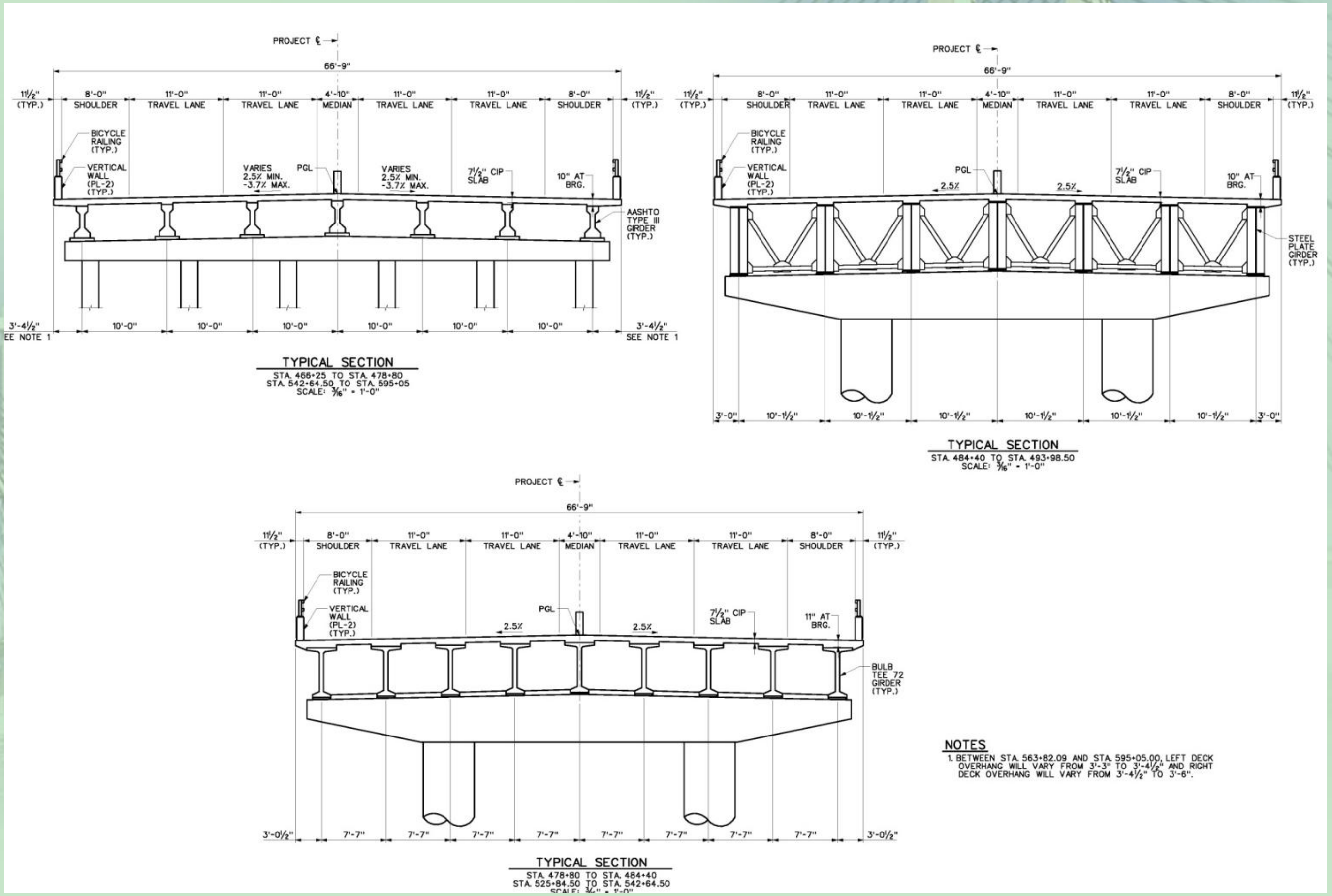


PIER TABLE				
LOCATION	PIER TYPE	LENGTH "A"	PILE TIP ELEV.	PILE CUT-OFF ELEV.
PIER 1	I	80.19	1	81.19
PIER 2	I	80.57	1	81.57
PIER 3	I	80.84	1	81.84
PIER 4	I	71.88	10	81.88
PIER 5	I	82	0	82
PIER 6	I	82	0	82
PIER 7	I	82	0	82
PIER 8	I	95	-13	82
PIER 9	I	95	-13	82
PIER 10	I	95	-13	82

Typical Section – Minor Bridges



Typical Sections
Approach Bridges



Steel Plate Girders Span the Levee

Approach Structures

- West Approaches
  - 2044’-6” long with 15 spans
  - Low Level Approach
    - Supported by PPC driven piles (six bents)
    - AASHTO Type III girders
  - High Level Approach
    - Supported by two 90” dia drilled shafts (nine piers)
    - Spans 3W to 6W utilize steel plate girders
    - Spans 7W to 10W utilize Bulb Tee girders

Approach Structures

- East Approaches
  - – 6780’ long with 80 spans
  - – Low Level Approach
    - Supported by PPC driven piles
    - 68 Spans with AASHTO Type III girders
  - – High Level Approach
    - Supported by two 90” dia drilled shafts (twelve piers)
    - Bulb Tee girders for all spans

Deliver Piles by Truck


Drive Piles
with Diesel Impact Hammer

Two-Level Template

Cutoff Piles

Static Load Tests

Construct Pile Cap

Form for Pile Cap

More to come . . .

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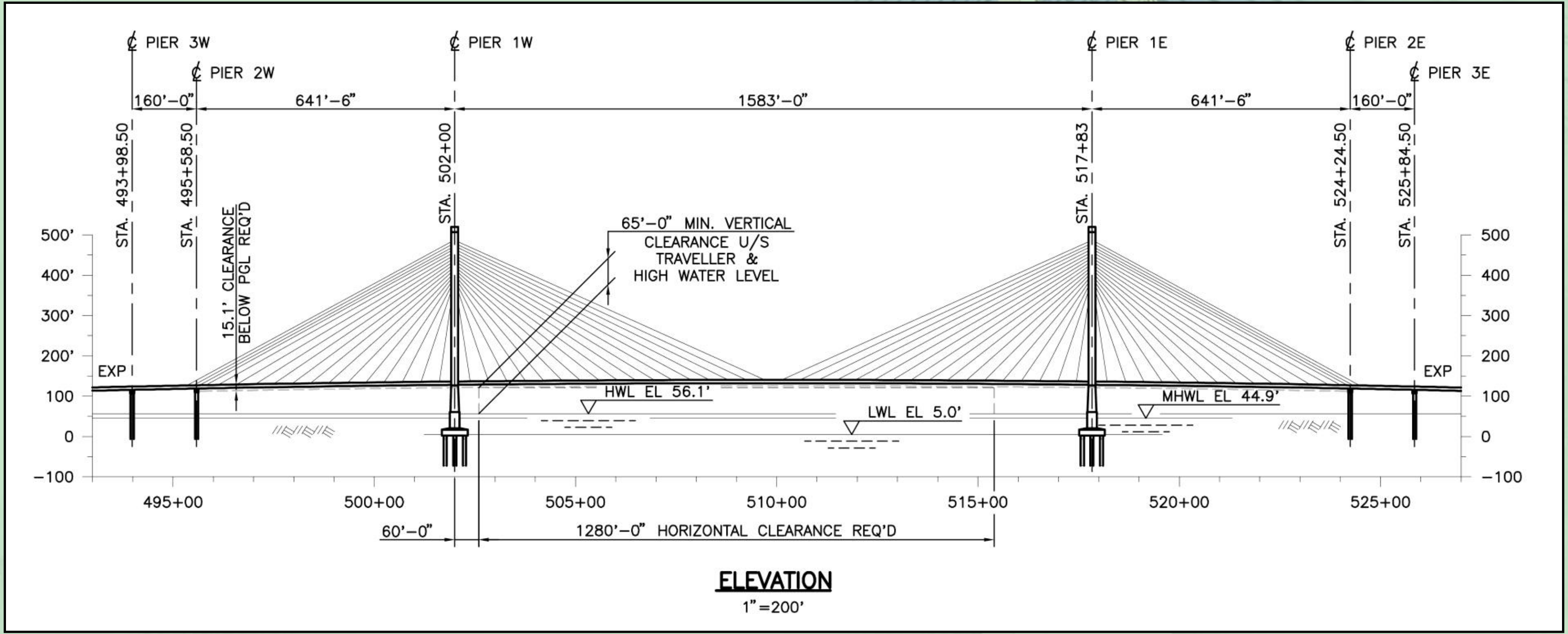
Main Span

Cable-Stayed Bridge

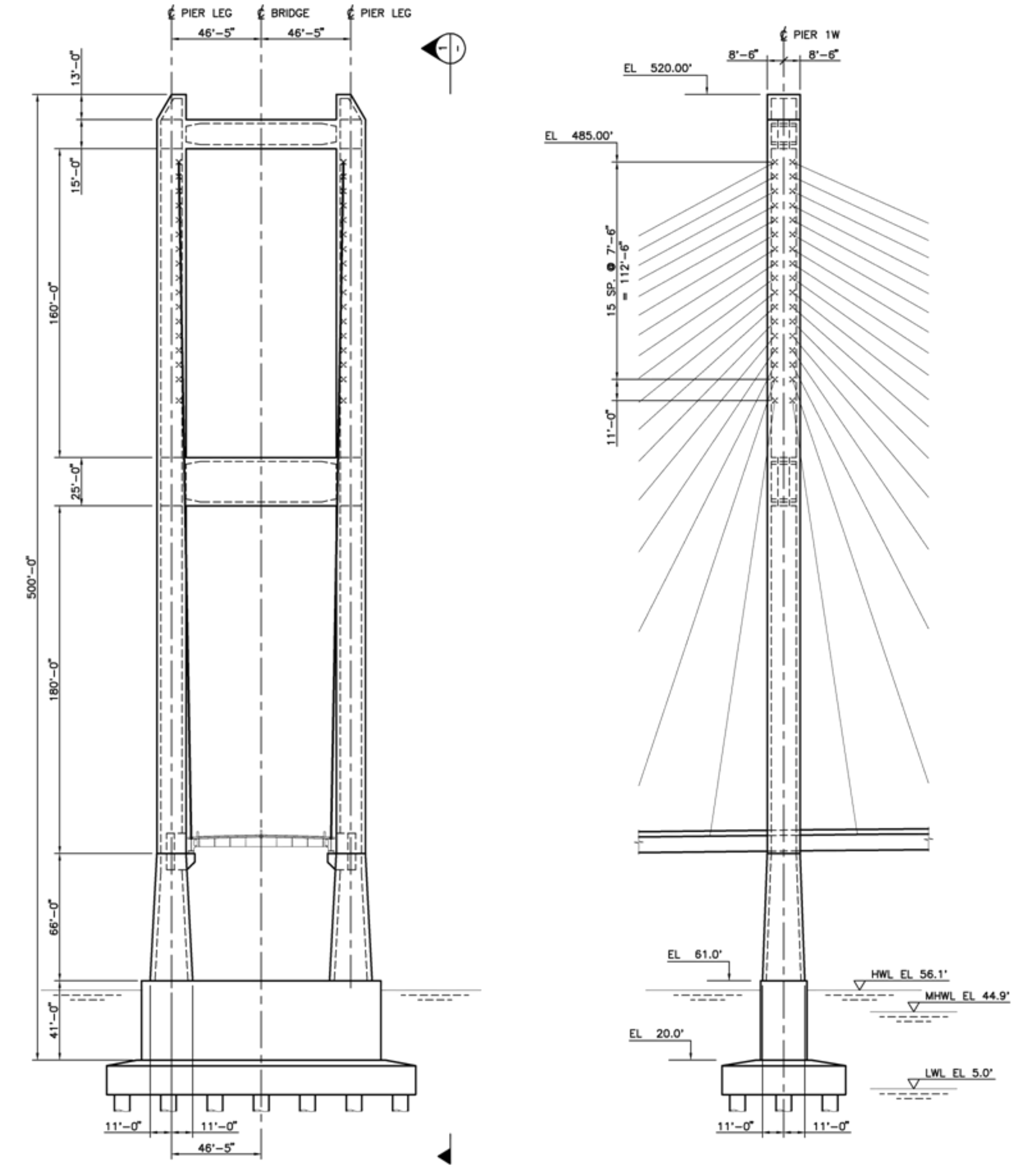
General Arrangement



- 1583 ft main span
- 1463 ft navigational clearance provided

Towers:

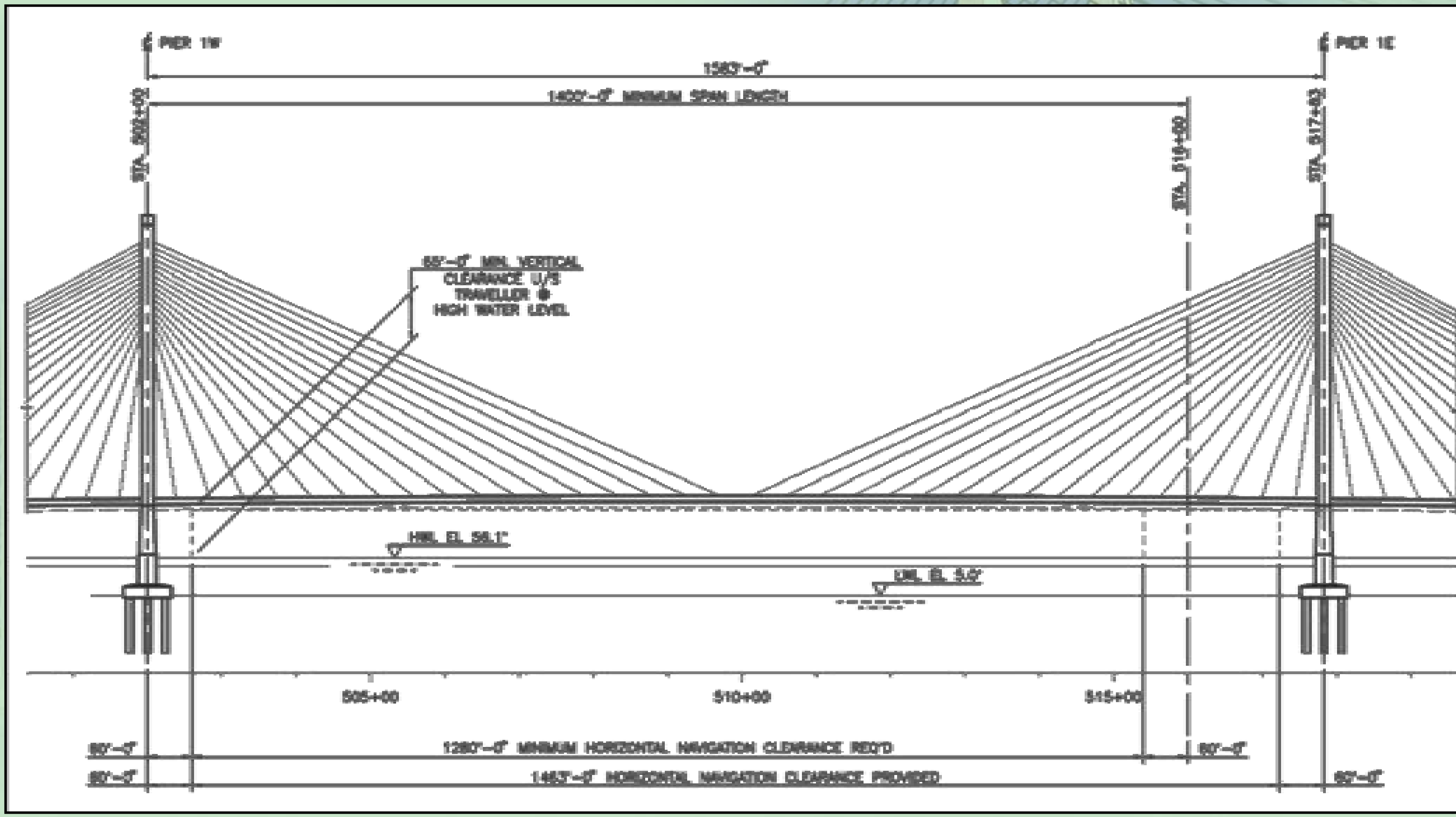
- 500' high
- 136 cable stays
- Two crossbeams
- Tower top is Elev. 520
- Deck is Elev.130



Key Design Features

- Light superstructure supported by 136 stay cables
- Minimum loads on foundations
- Durability
  - Beneficial deck compression from stay cables and deck post-tensioning
  - 2 “ LTM overlay
  - 8000psi HPC precast deck panels
  - 50ksi weathering steel protected by deck

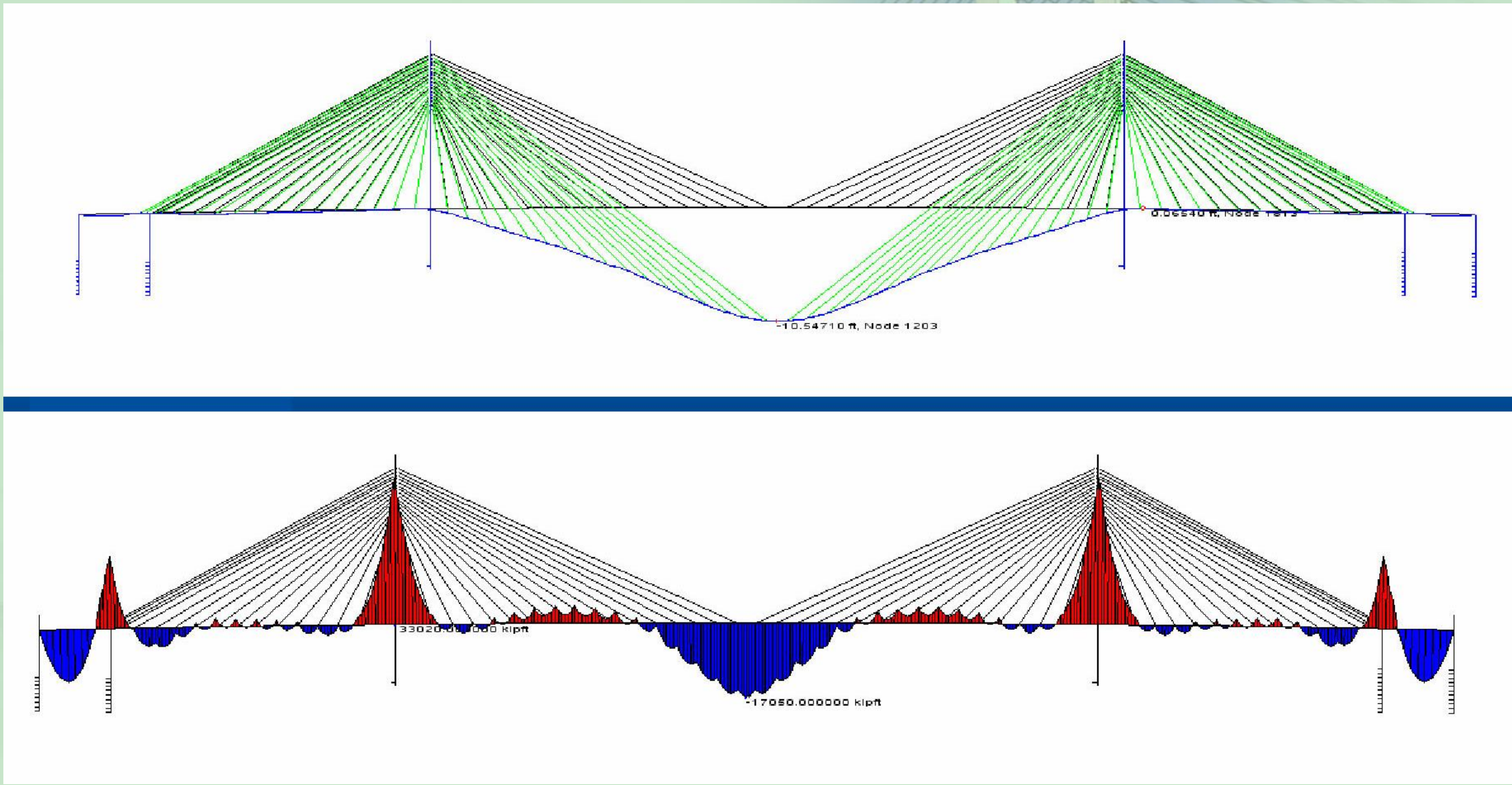
Main Span


PIER 1W
1400'-0" MINIMUM SPAN LENGTH
PIER 1E
65'-0" MIN. VERTICAL CLEARANCE U/S TRAVELLER @ HIGH WATER LEVEL
LWL EL 5.0'
505+00
510+00
515+00
1280'-0" MINIMUM HORIZONTAL NAVIGATION CLEARANCE REQ'D
1463'-0" HORIZONTAL NAVIGATION CLEARANCE PROVIDED
60'-0"

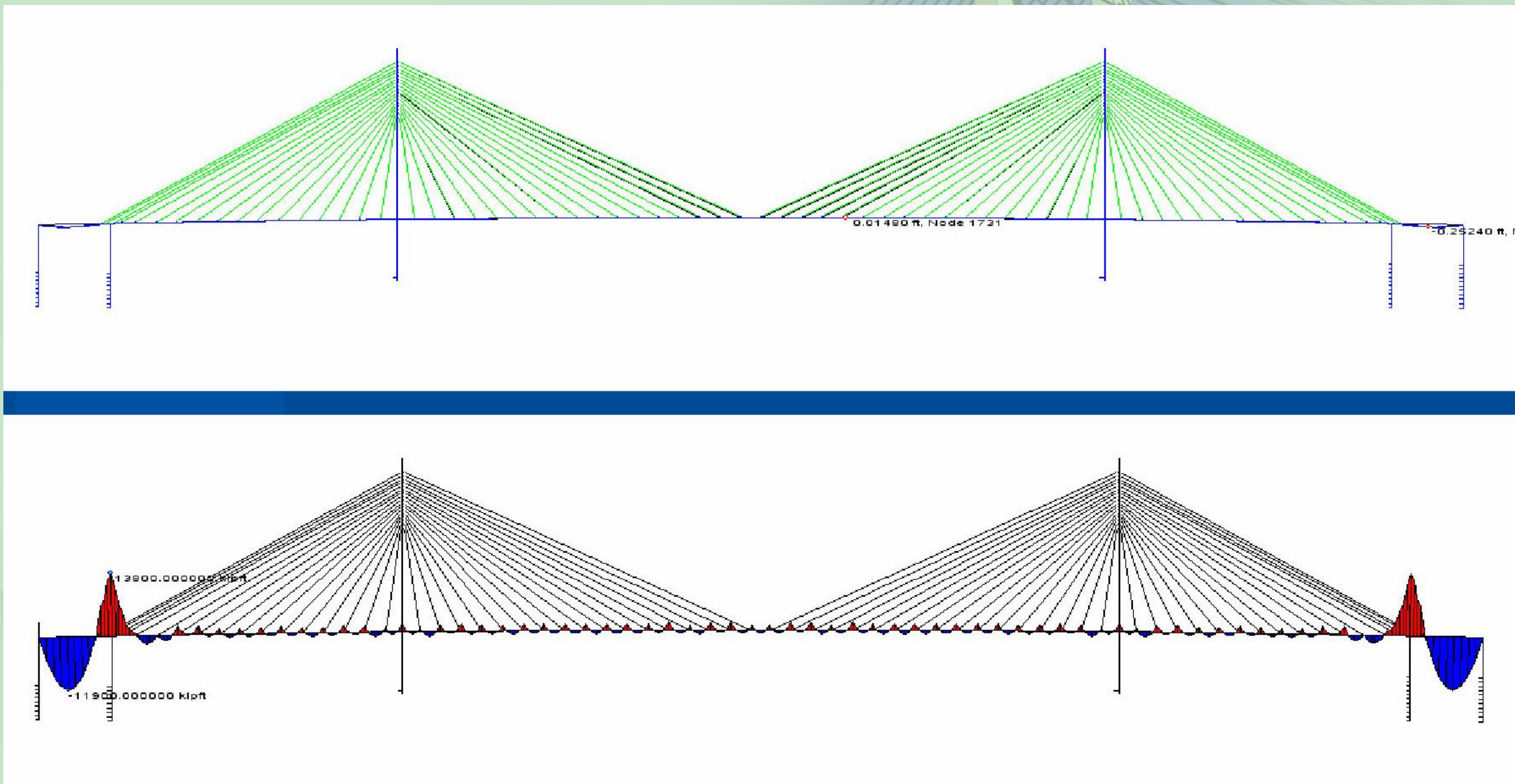
Dead Load Analysis

- Dead load analysis is non-linear
  - Non-linear cable elements
  - Non-linear beam elements
  - Non-linear soil springs
- Structure is "tuned" for dead loads
  - Towers built tall to compensate for shortening
  - Deck built long to compensate for shortening
  - Cables installed short to compensate for stretch

Untuned Structure



Tuned Structure



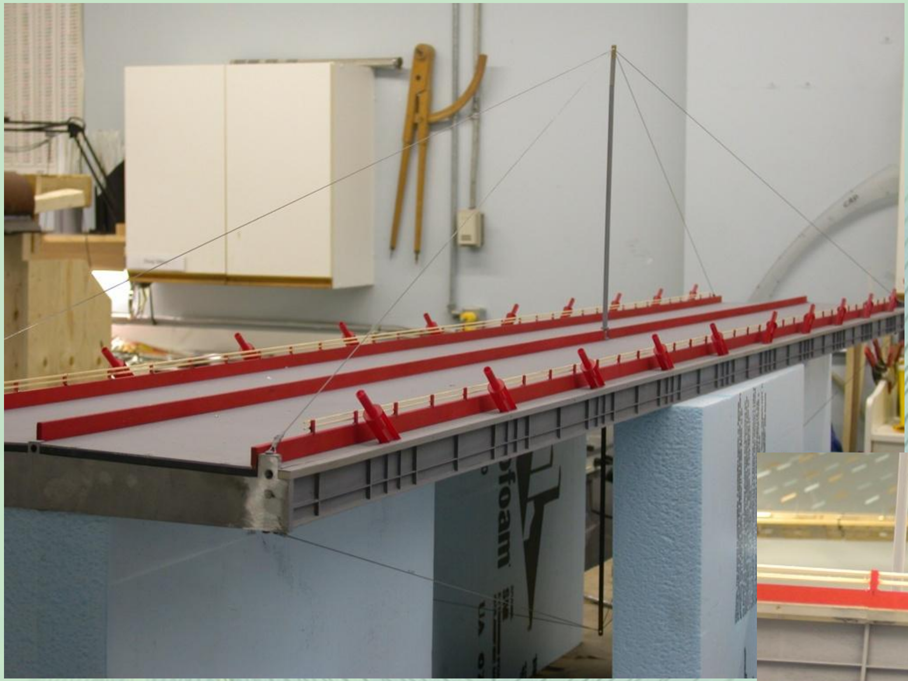
Stage-by-Stage Analysis

- Structure built one segment at a time
- Precisely captures locked-in effects
- Models time-dependent effects during construction
- Required for tracking bridge geometry during construction
- Performed prior to bridge construction

Wind Loads

- AASHTO static wind load pressures not appropriate for long-span structures
- Three components to wind loads
  - Mean static
  - Background
  - Dynamic (Buffeting)
  - Dynamic component obtained from buffeting analysis provided by wind specialists

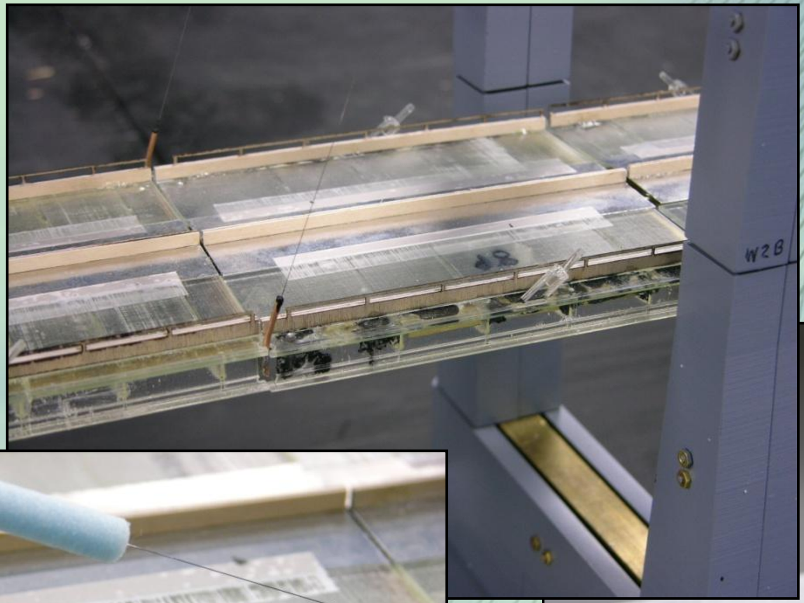
Sectional Model Tests

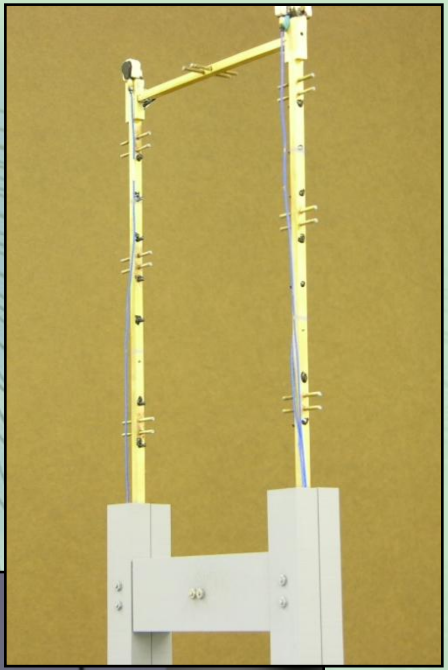


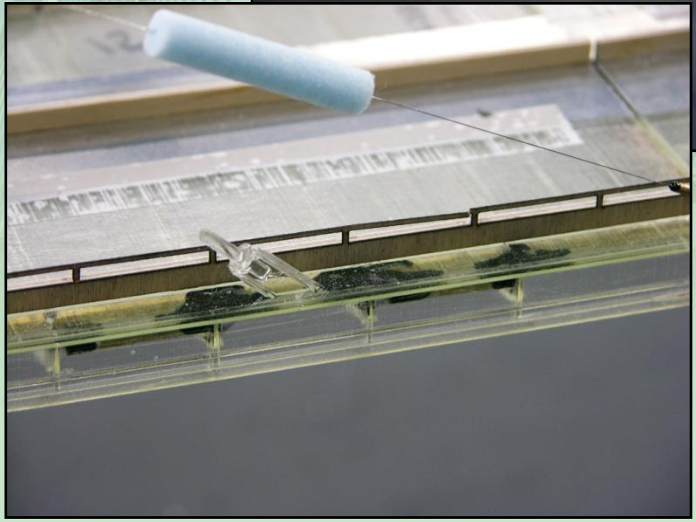
Sectional Model in Wind Tunnel

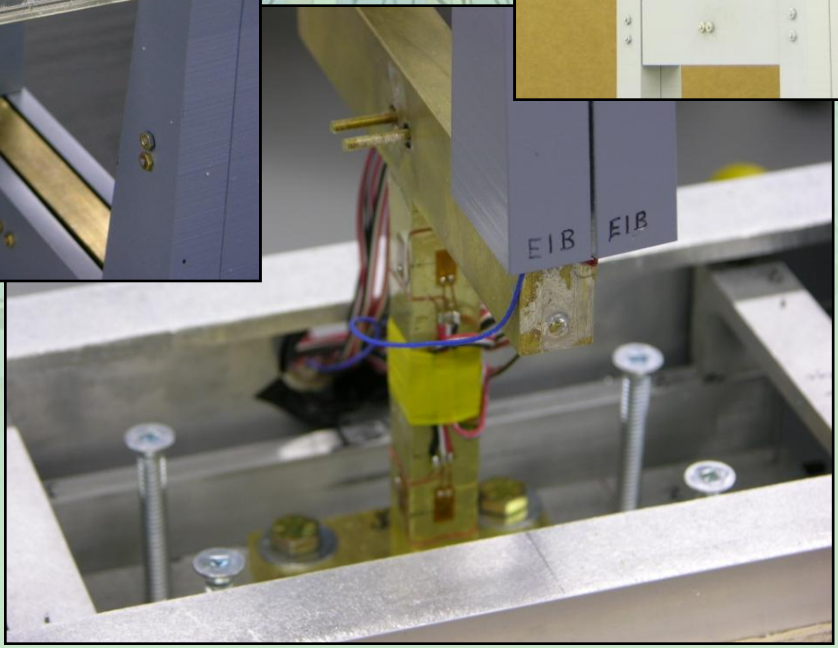
Aeroelastic Model in Wind Tunnel

Aeroelastic Model Details



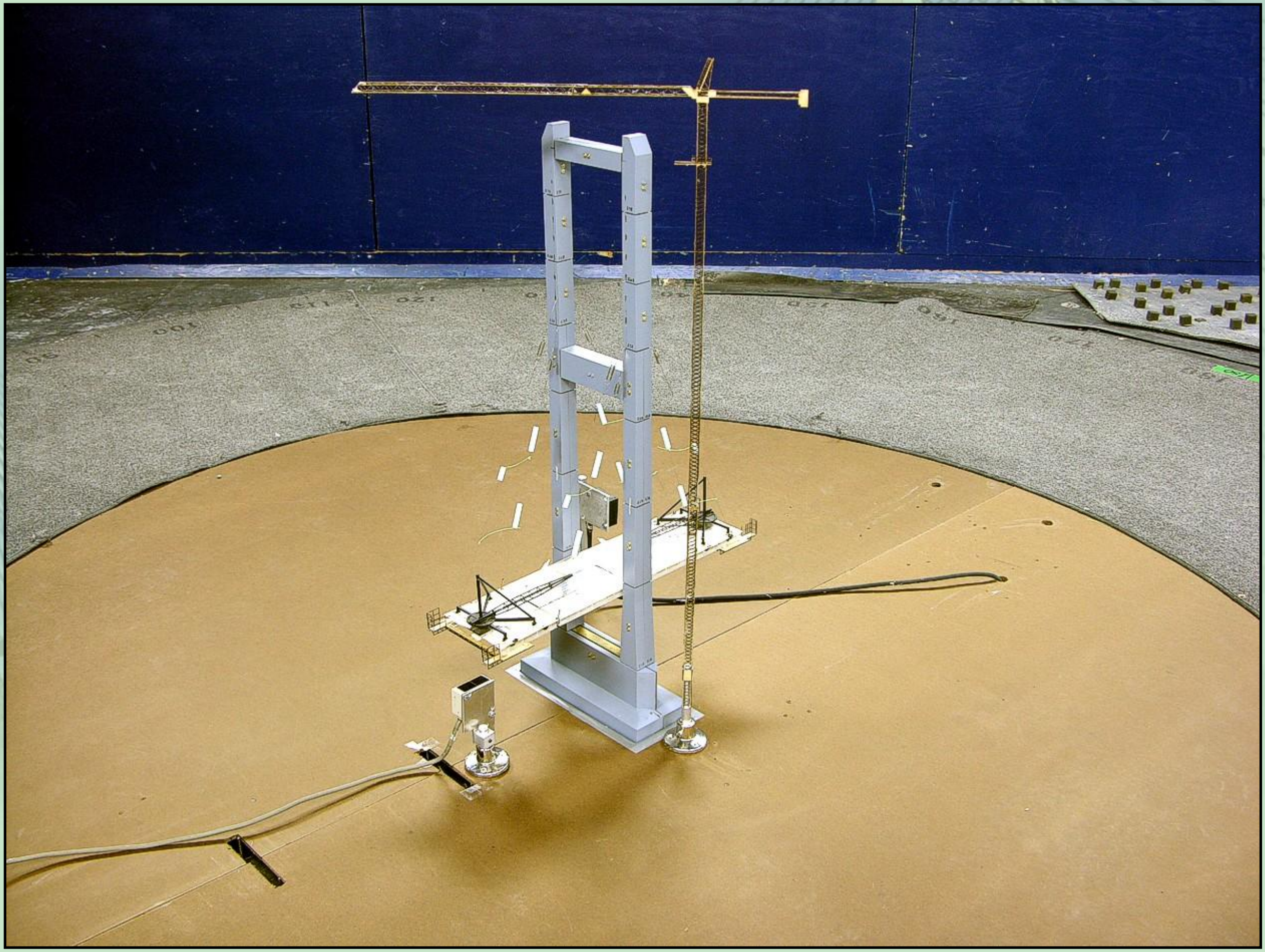






Construction Stage Modeling

Construction Stage Modeling



Buffeting

- Dynamic response of structure from uneven loading due to turbulence in natural wind
- Buffeting induces vibration in the bridge’s natural modes of vibration
- The resulting forces which included dynamic inertial forces can exceed those calculated using simple static wind pressures

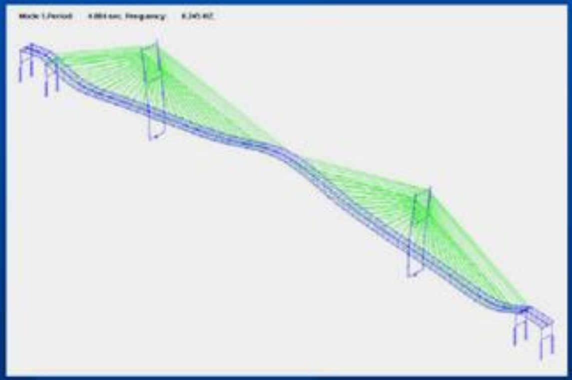
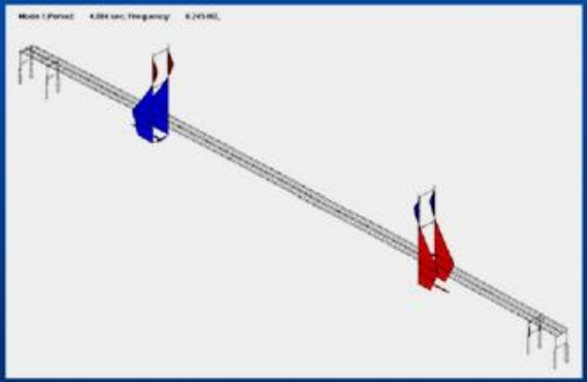
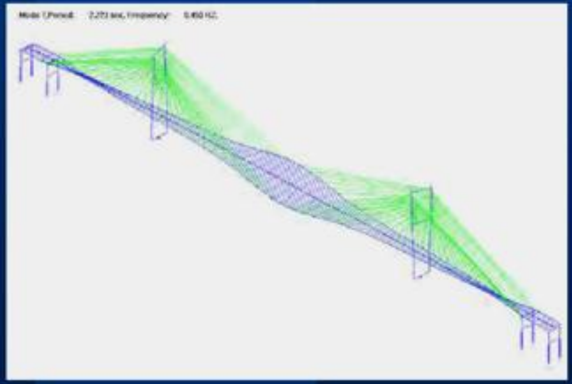
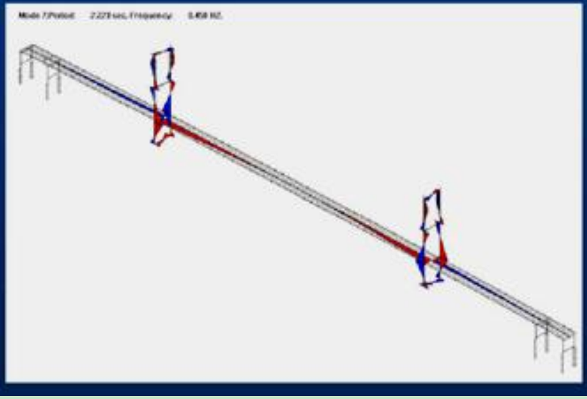
Buffeting Analysis

- Determine peak resonant response for each mode of vibration
- Input includes
  – Aerodynamic force coefficients
  – Structure dynamic properties (i.e. stiffness, mass, natural modes of vibration)
  – Structure damping
  – Wind turbulence properties

Buffeting Analysis

- Alternative to aeroelastic testing
- Obtain results faster
- Verify by measured response at limited positions during aeroelastic testing
- Requires modal superposition to determine peak response

Buffeting Demands

Input: Modes	RWDI Output: Scaling Factors	Result: Demands
	→ 0.51 →	
	→ 0.27 →	

Buffeting Demands

Mode	Force Demand
1	1,100
2	200
3	50
4	650
…	…
n	21
$\sqrt{m_1^2 + m_2^2 + \ldots + m_n^2}$	1,350 (RMS Total)

Wind Load Combinations

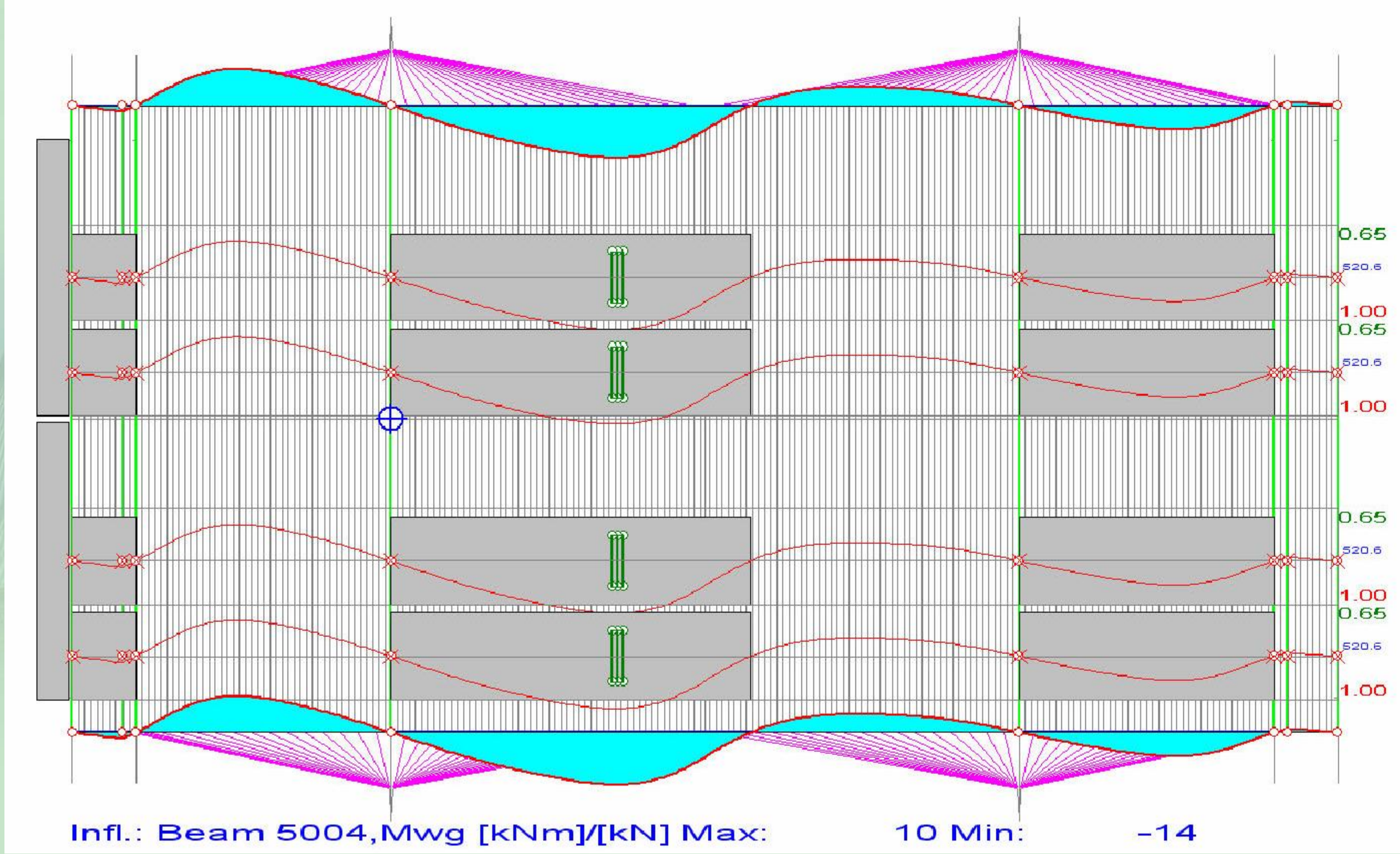
Case	Transverse Wind	Longitudinal Wind
1	100%	50%
2	50%	100%
3	70%	70%

Wind Load = Static + Background + Buffeting

Live Load Analysis

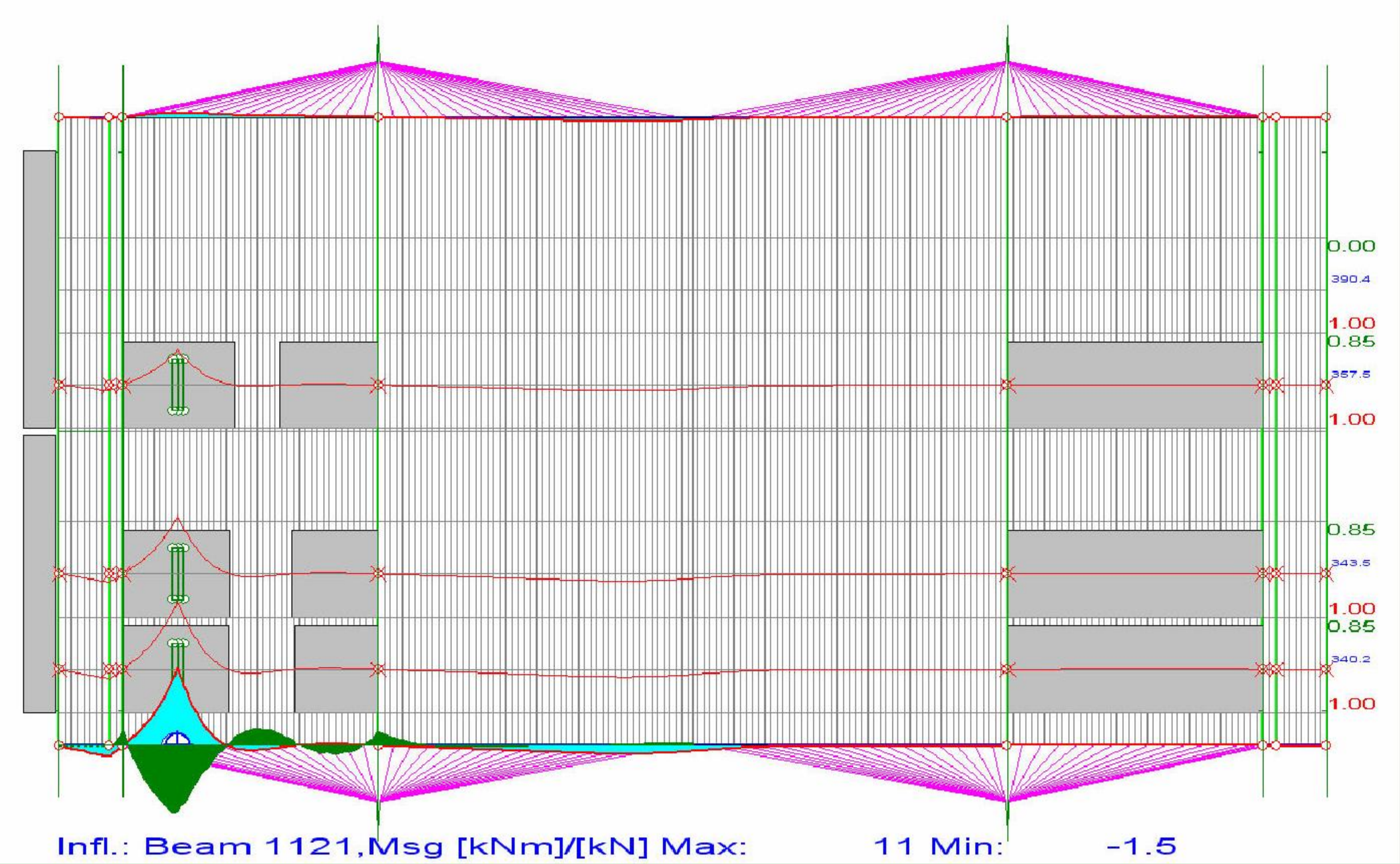
- HL-93 Live Load per AASHTO LRFD:
  - – Truck Load (HS-20, 72 kips)
  - – Tandem Load (50 kips)
  - – Lane Load (640 plf)
- Four design lanes
- Demands obtained through influence surface loading

Live Load Analysis
Tower Foundation, M_{long}



Live Load Analysis

Edge Girder, M_{long}



Cable Loss Analysis

- Extreme limit state
- Cable loss in accordance with PTI Recommendations
- 1.1DC+1.35 DW+0.75LLI+1.1Cable Loss

Cable Loss Design Philosophy

- Structural Elements Design to prevent structural instability
  - Prevention of progressive collapse
  - Member yielding and load redistribution permitted
  - Fully plastic behavior permitted
  - Brittle failure mechanisms prohibited

Cable Replacement

- Strength limit state
- In accordance with PTI Recommendations
- 1.2DC+1.4 DW+1.5LLI+Cable Exchange
- Adjust traffic pattern to control live load
- Limit areas where cable replacement governs

Non-Linear Behavior

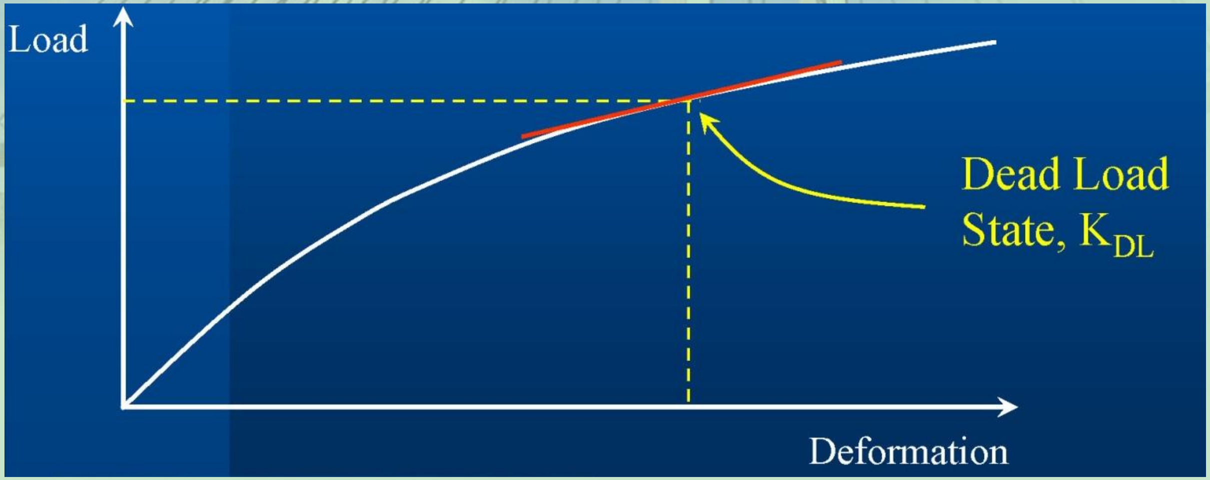
- Flexible suspended structure (geometric)
- Cable stiffness due to sag
- Material properties at strength and extreme limit states
- Soil properties

Geometric Non-Linearities

- Non-linear beam elements
- 3-D beam elements with stability functions to capture P-delta effects
- Stability functions to account for stiffening and softening of structure under axial load

Non-Linear Performance

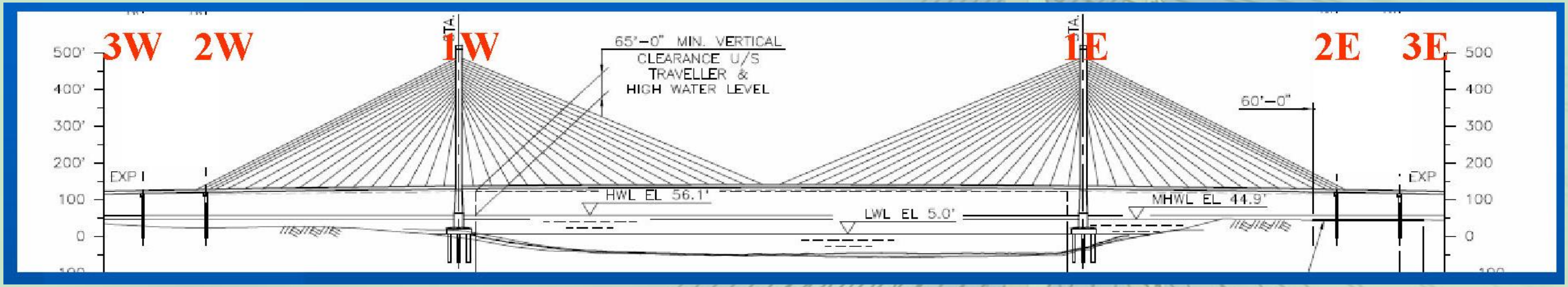
- Most significant non-linear performance is under dead load analysis
- Non-linear behavior due to superimposed loads are typically small



Non-Linear Analysis

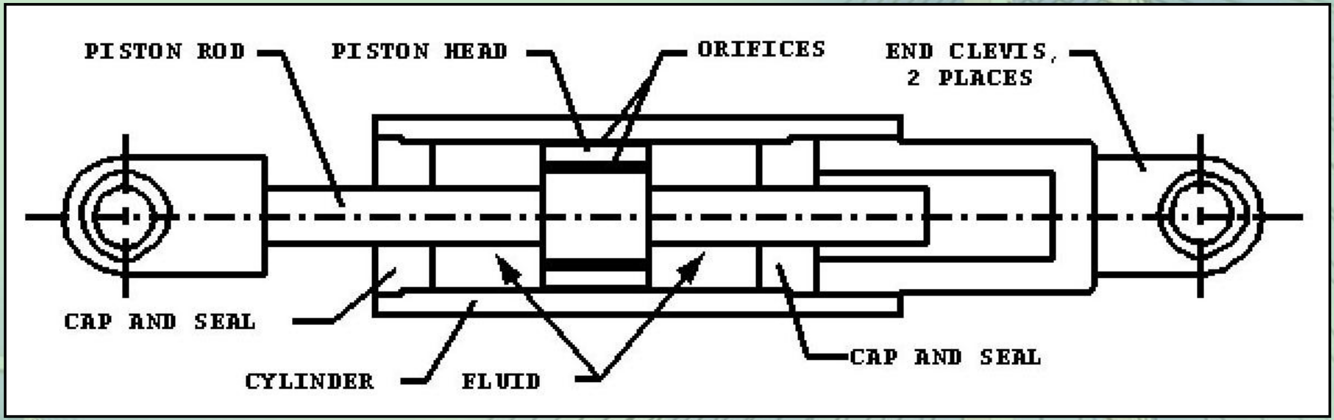
- Geometric
  - Dead load analysis
  - Live load analysis for verification only
- Geometric and Material
  - Wind load analysis for critical cases
  - Construction stage analysis for critical cases
  - Cable loss analysis

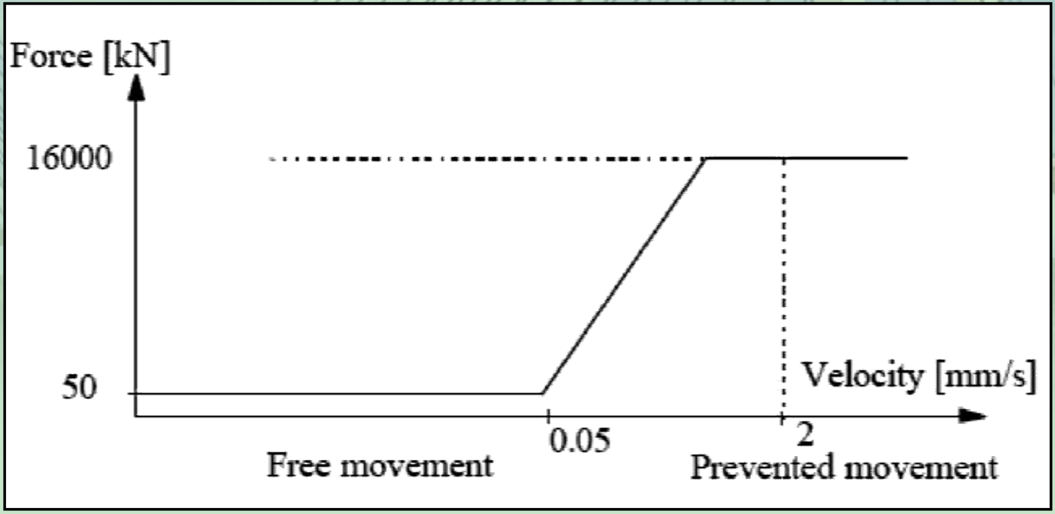
Deck/Tower Articulation



- Longitudinal Fixity
  - Pier 1W & 2W – Fixed Bearing
  - Pier 1E – Lockup Device
  - Pier 2E – Sliding Bearing
- Advantages
  - Maintain flexibility for temperature movements
  - Spread longitudinal shear from wind to both towers

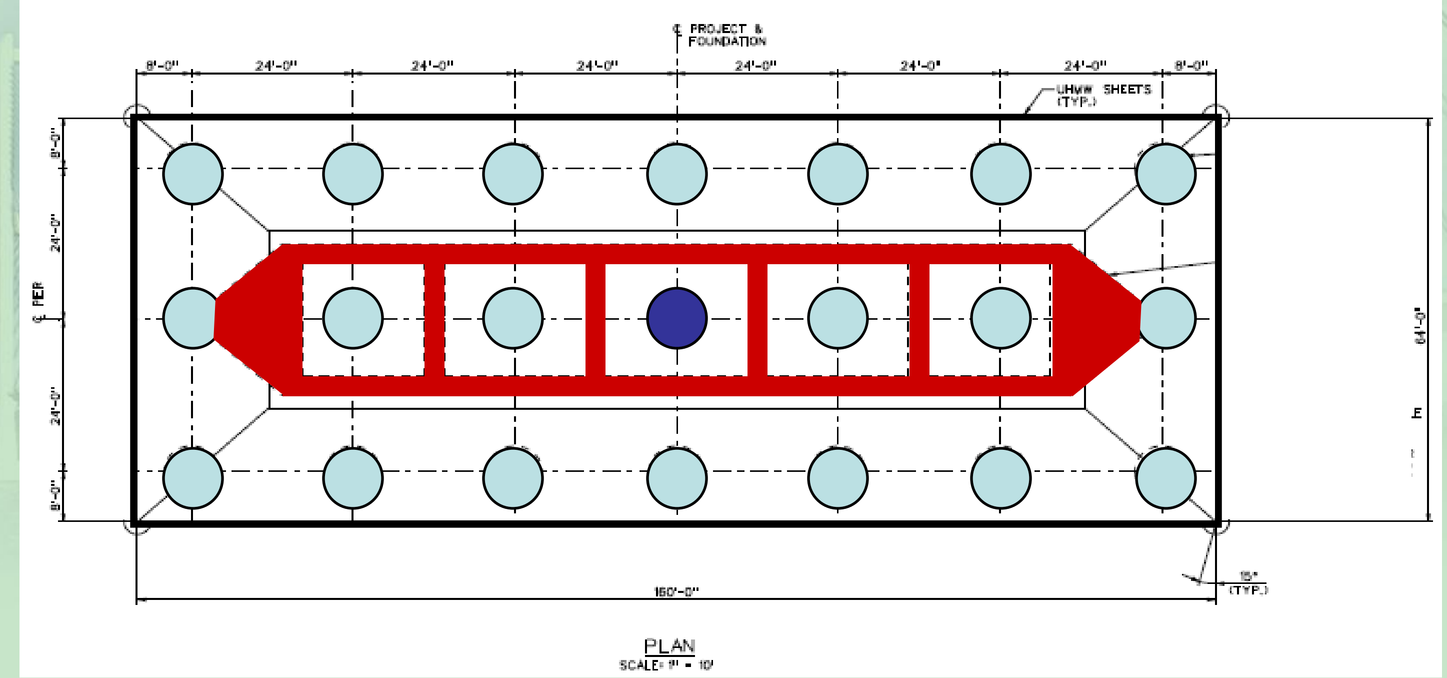
Lock Up Devices





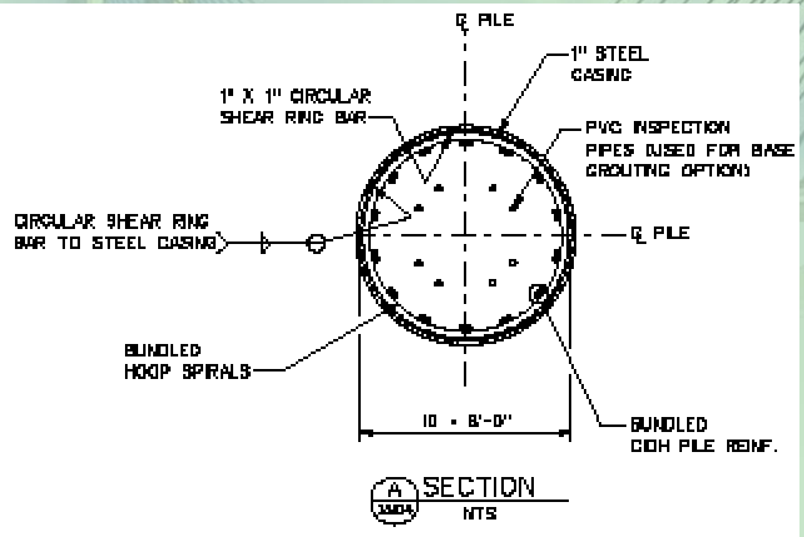
Tower Foundations 1W & 1E

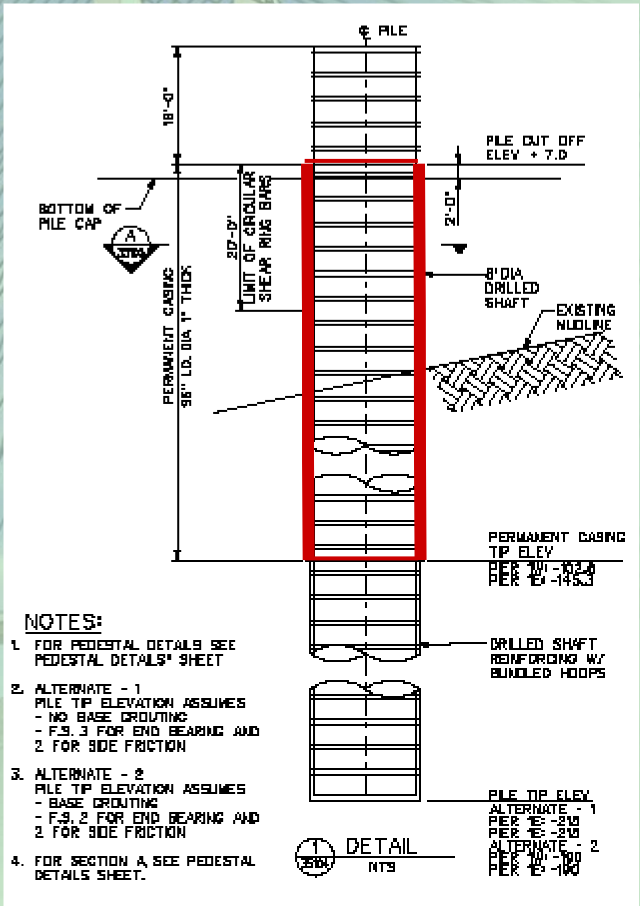
- 160’ x 64’ x 15’ Cap
- 7 by 3 pile group – 1 test pile
- 8’-0” diameter shafts

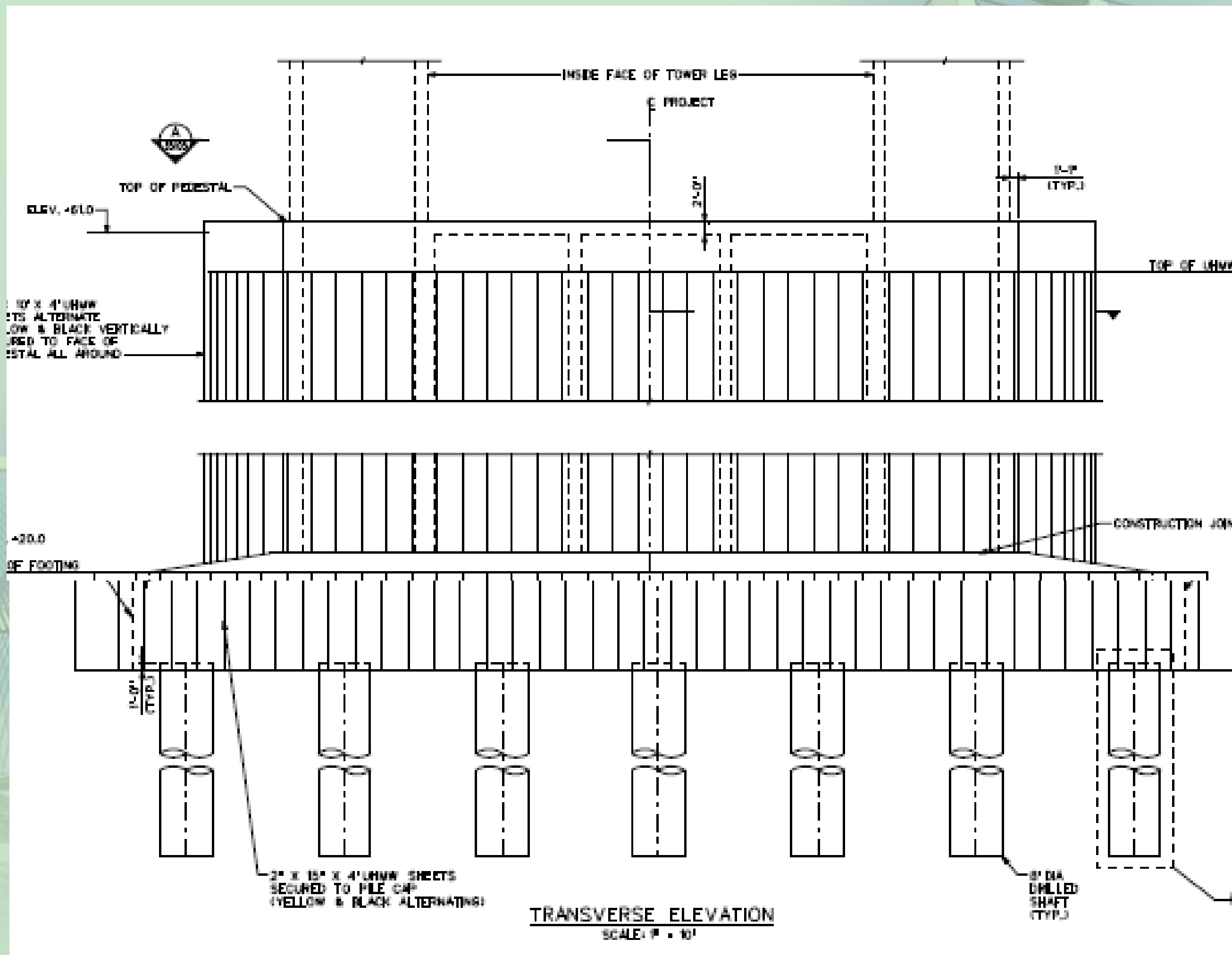


Tower Shafts

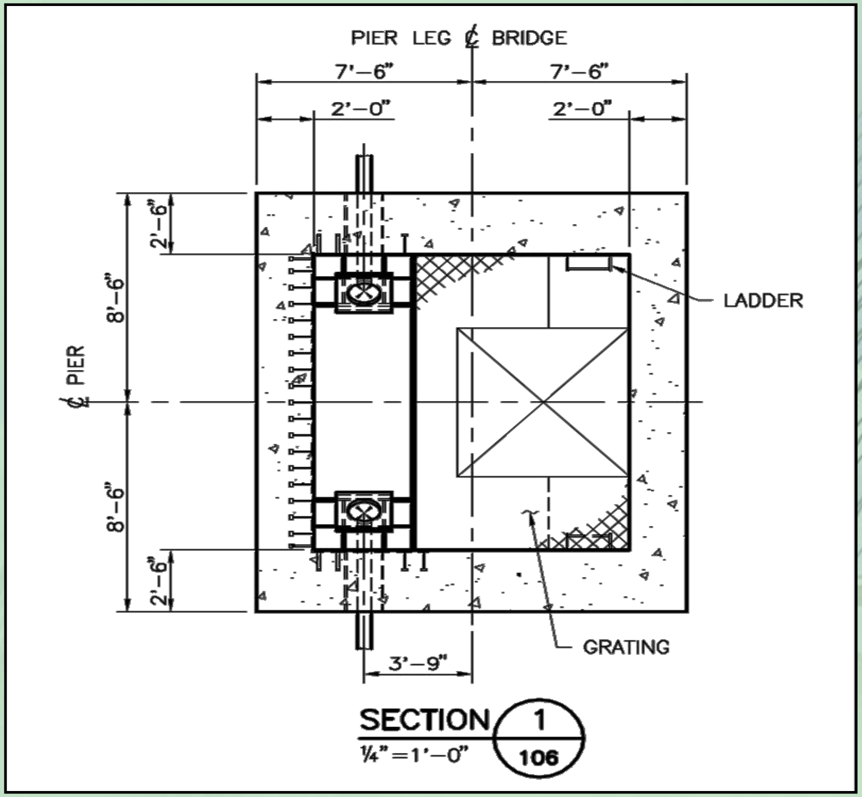
- •96” dia permanent casing
- •90” dia drilled shaft
- •Pile tip Elev. -175 to -180
- •Tip grouting





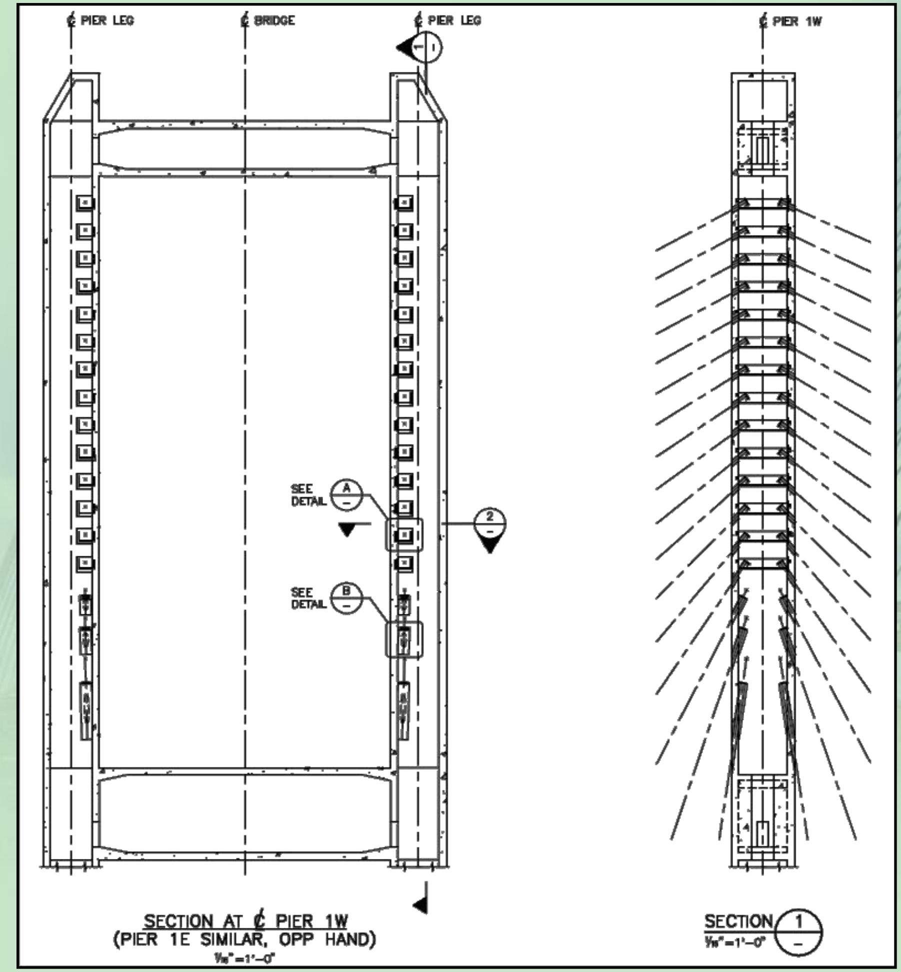

INSIDE FACE OF TOWER LEG
TOP OF PEDESTAL
TOP OF UHMW
CONSTRUCTION JOINT
2" X 15" X 4' UHMW SHEETS SECURED TO PILE CAP (YELLOW & BLACK ALTERNATING)
8' DIA DRILLED SHAFT (TYP.)
TRANSVERSE ELEVATION

Tower Cross Section



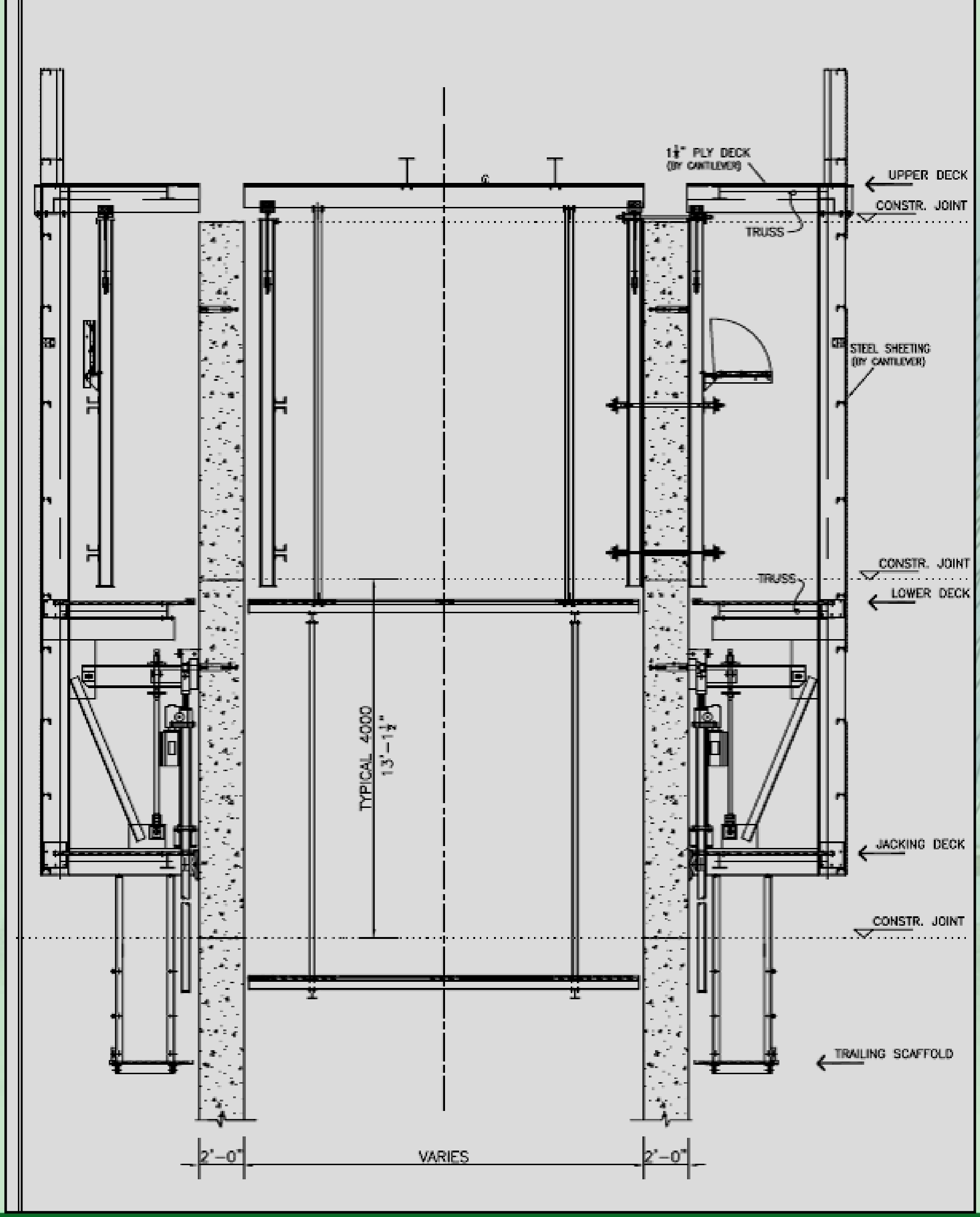
- Box sections for simple jump forming
- Cable anchorage on inside tower wall

Tower Cable Anchorages

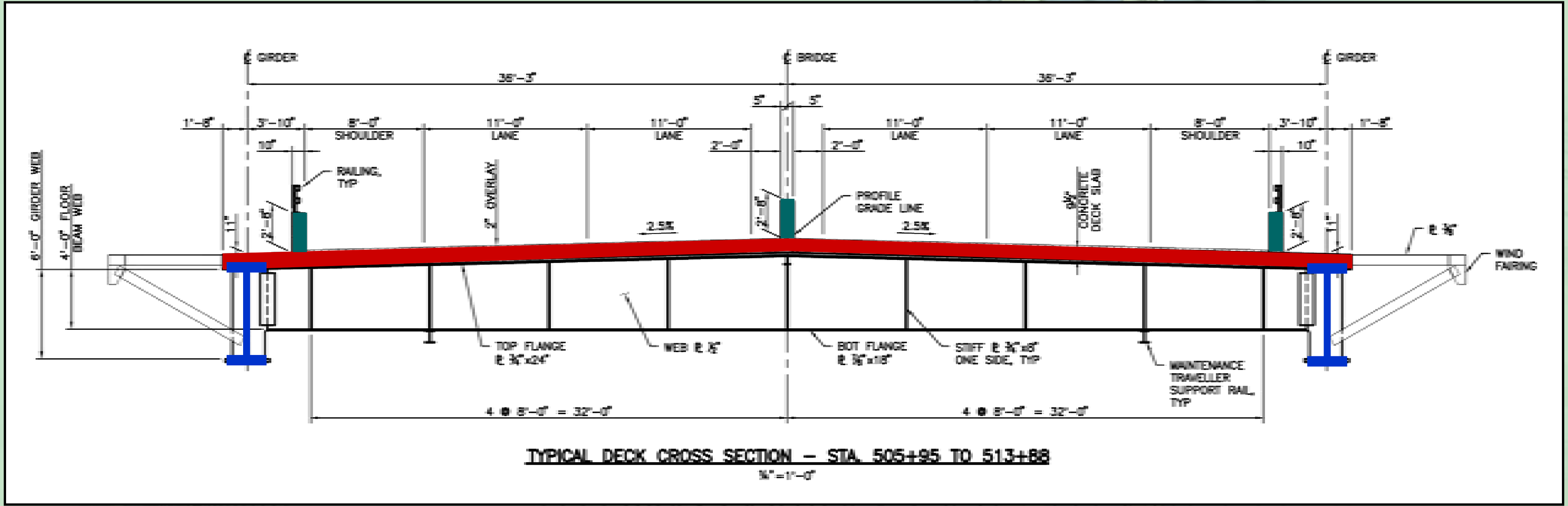


- Steel anchorage trays for upper stays
- Concrete corbels for lower steep cables
- Crossbeams connected clear of anchorage zone

Tower Form System

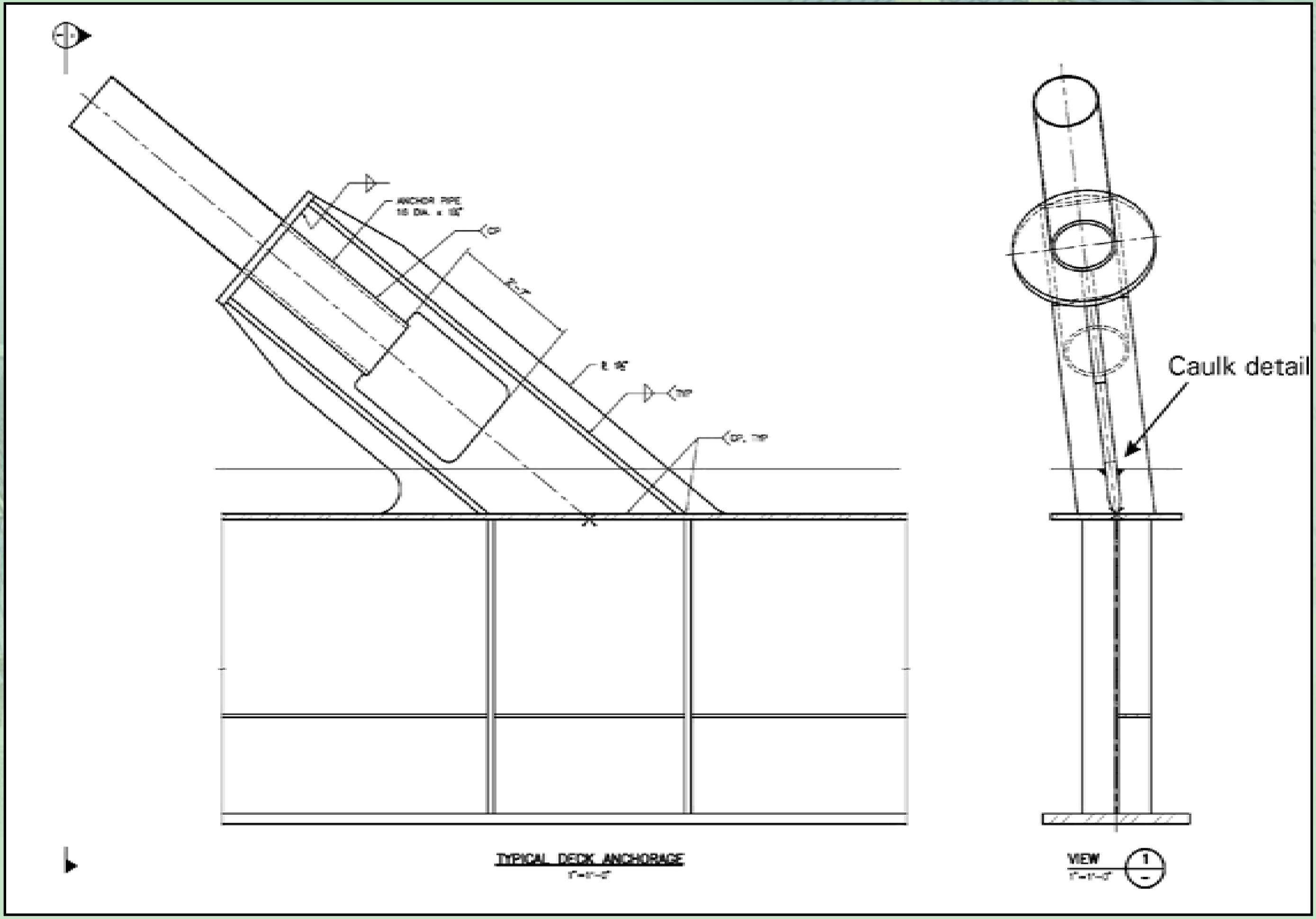


Composite Deck Cross-Section



- Economy, simplicity and constructability
- Durability
- Accessibility
- Low maintenance

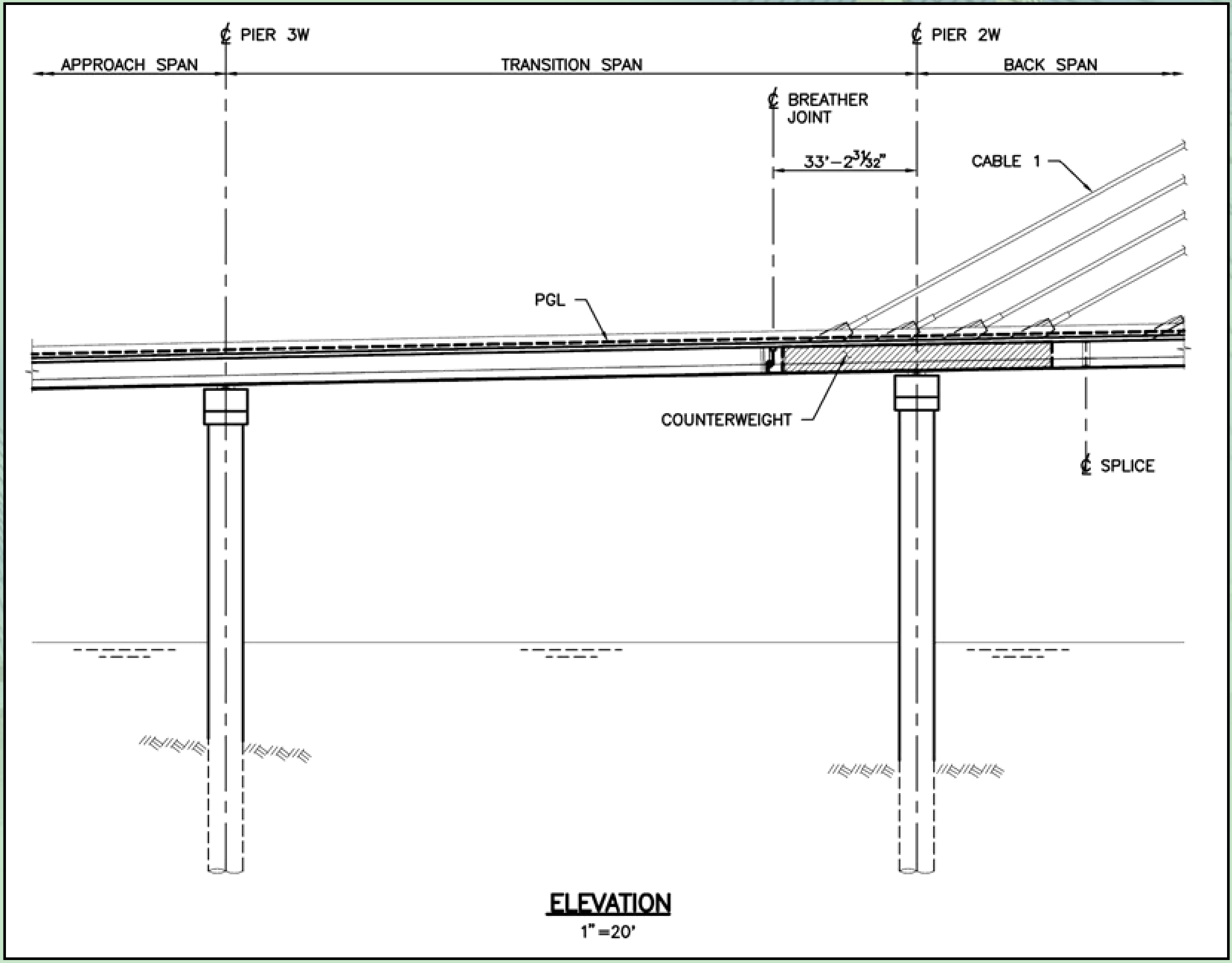
Deck Anchorage



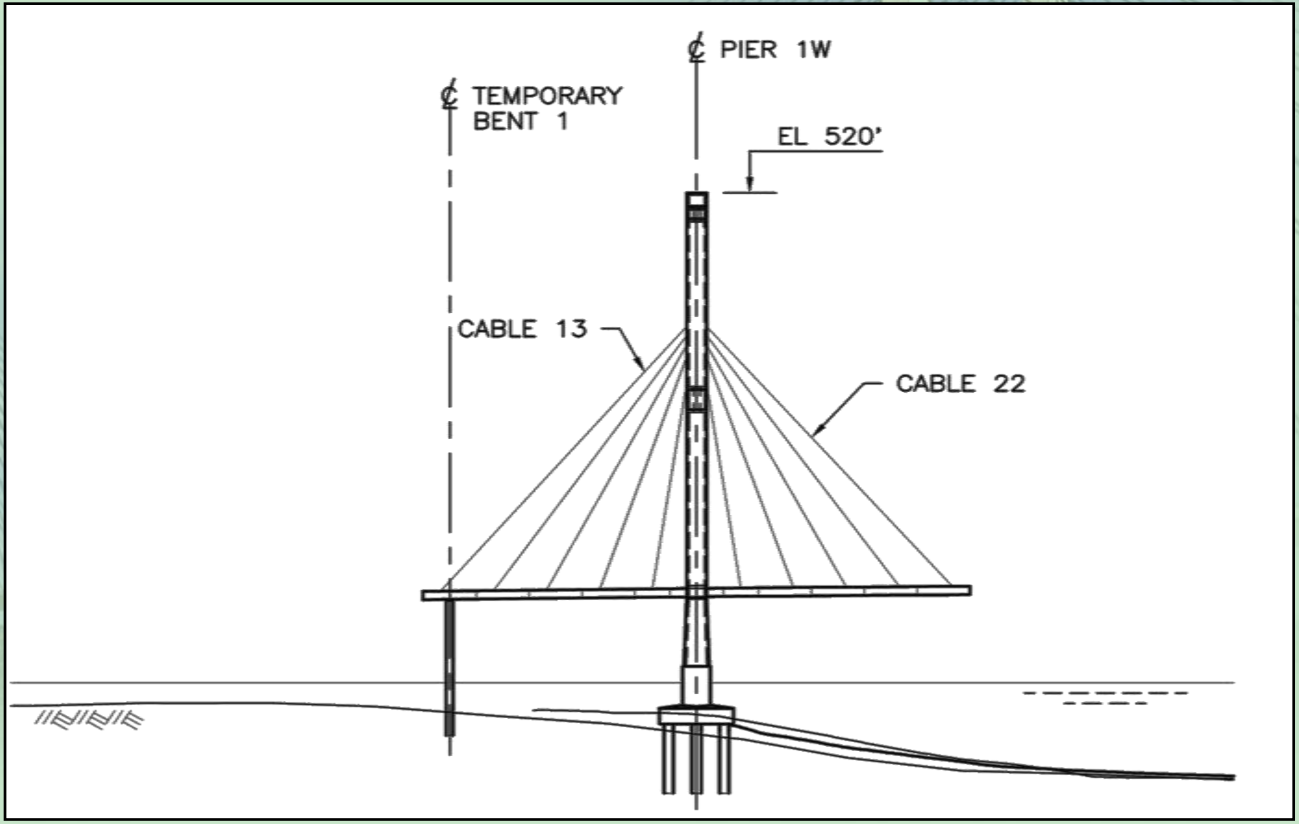
Stay System

- 7-Wire parallel strand
- Monostrand Jacking
- State-of-the-Art Corrosion Protection
  - Galvanizing
  - Grease
  - Strand PE
  - Coextruded HDPE Pipe
- Vibration suppression

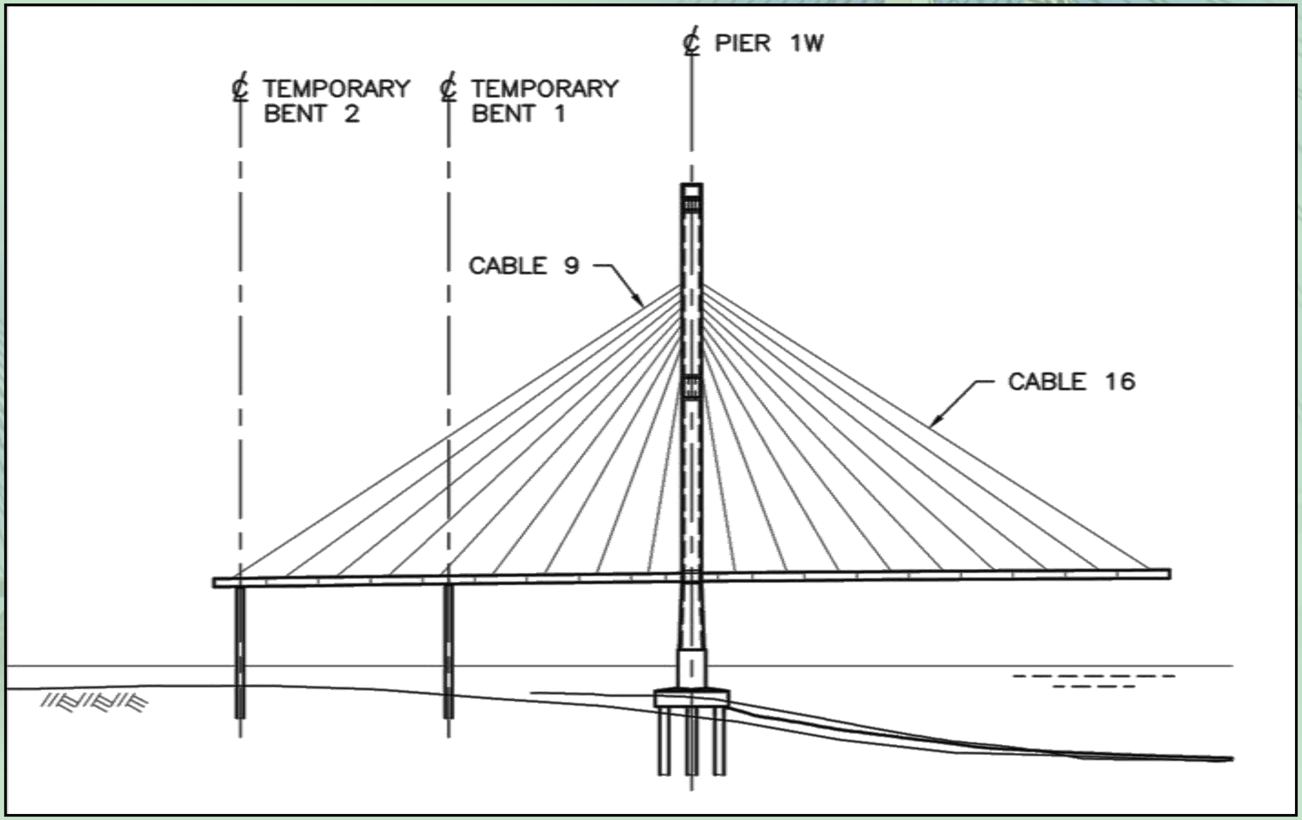
Counterweight



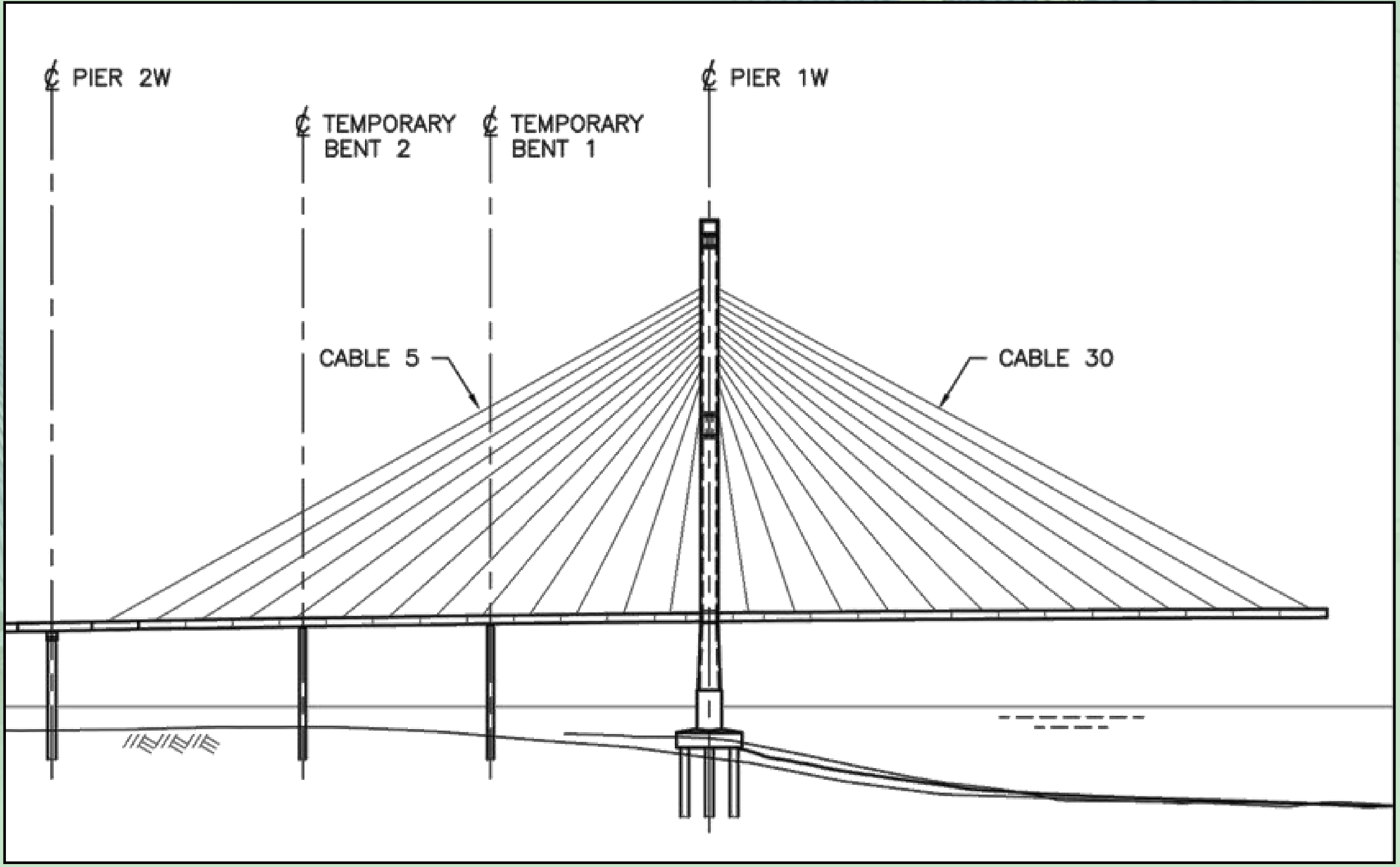
Bridge Construction



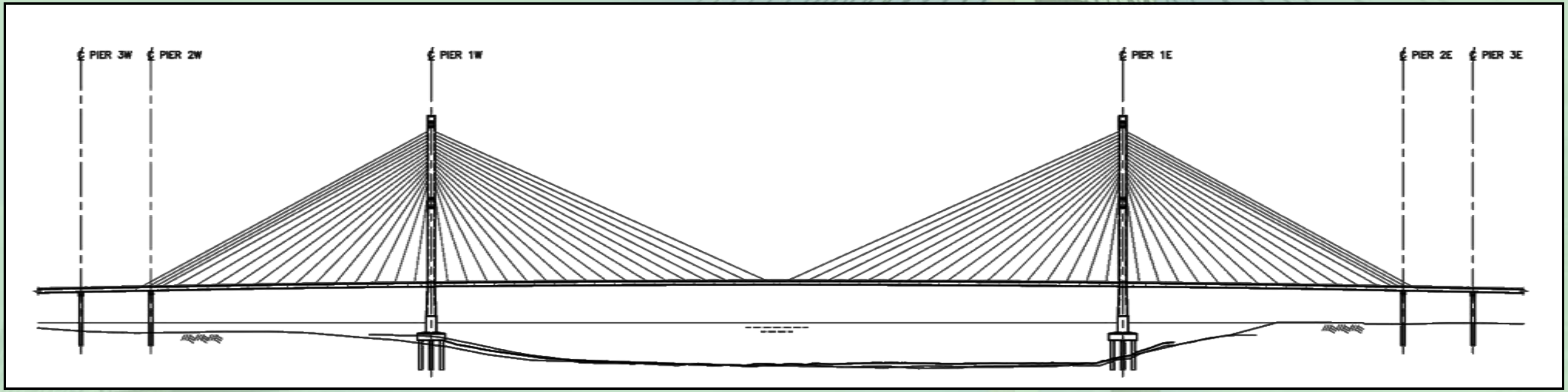
Bridge Construction



Bridge Construction



Bridge Construction



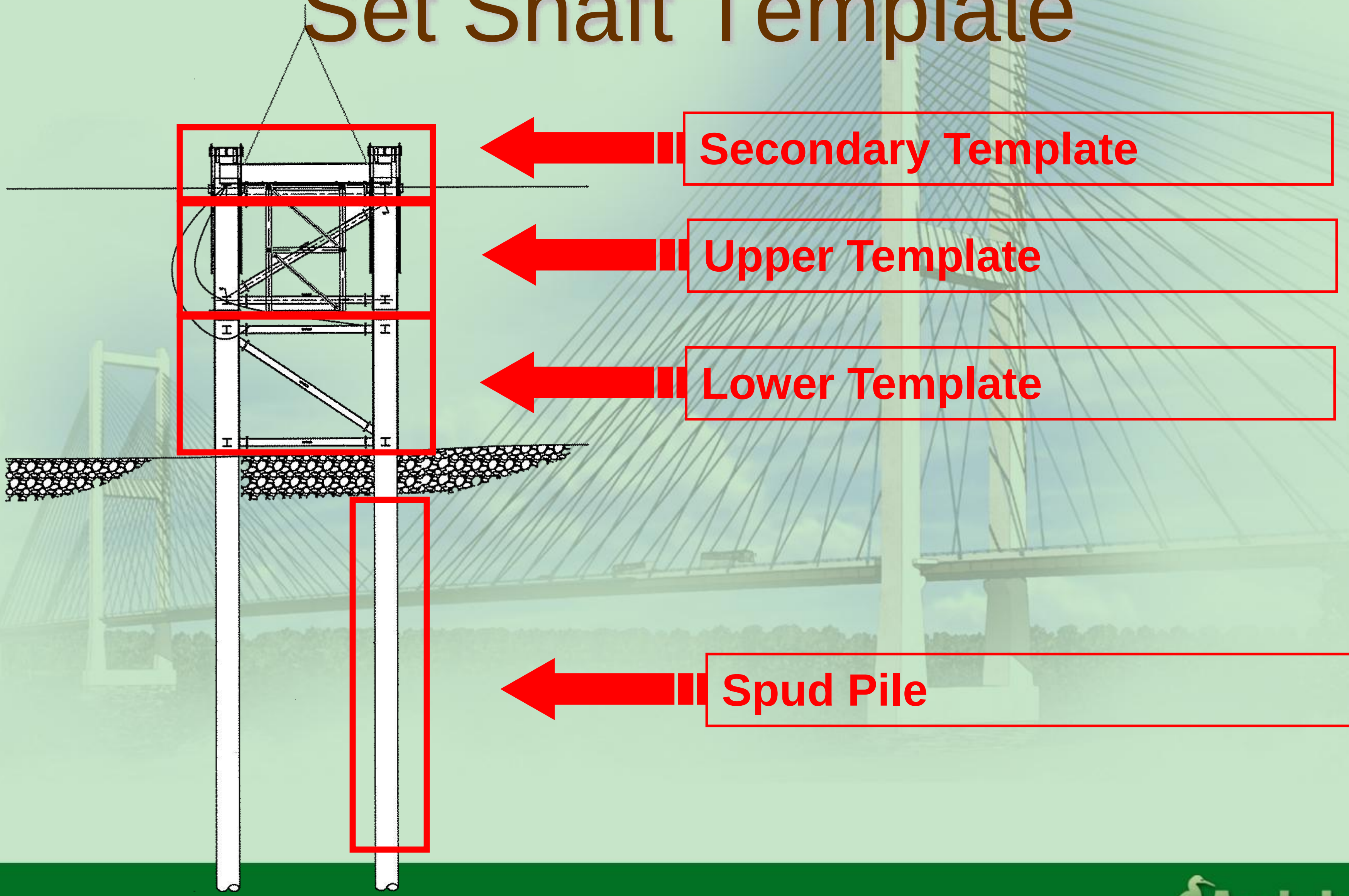
Foundation Construction

Installation of Drilled Shafts

Drilled Shaft Installation

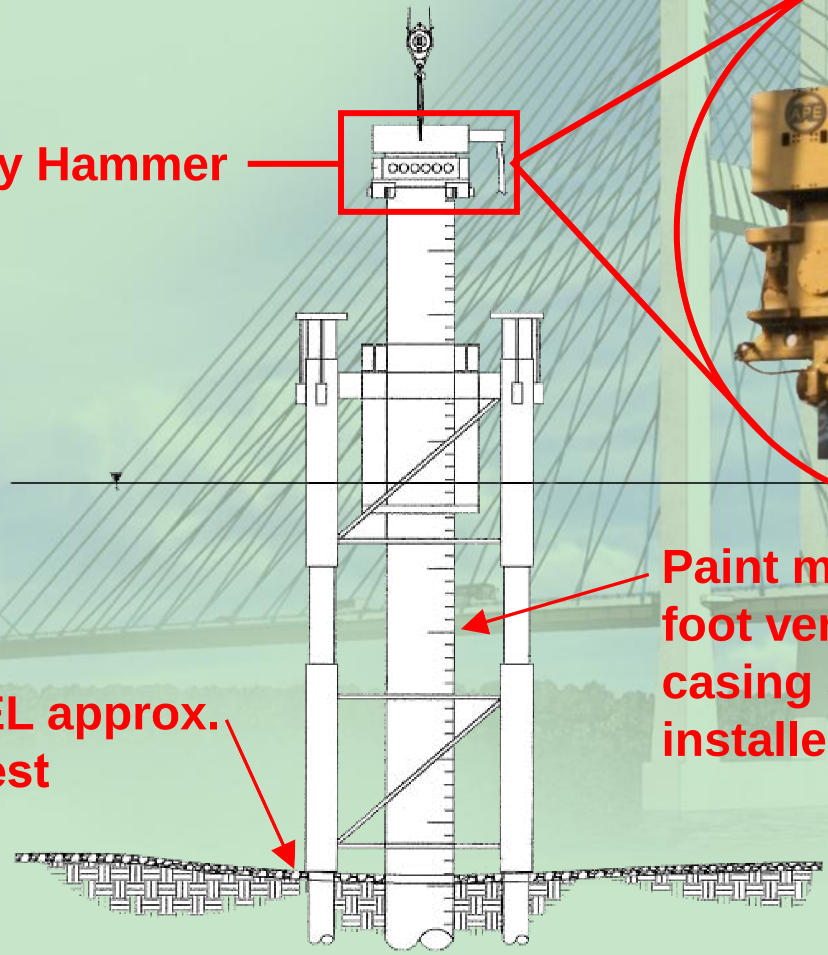
- Set shaft template
- Drive permanent casing using vibro hammer
- Excavation of permanent casing
- Installation of temporary casing by oscillator
- Excavation of temporary casing
- Install reinforcing cage
- Pour tremie concrete while removing temporary casing

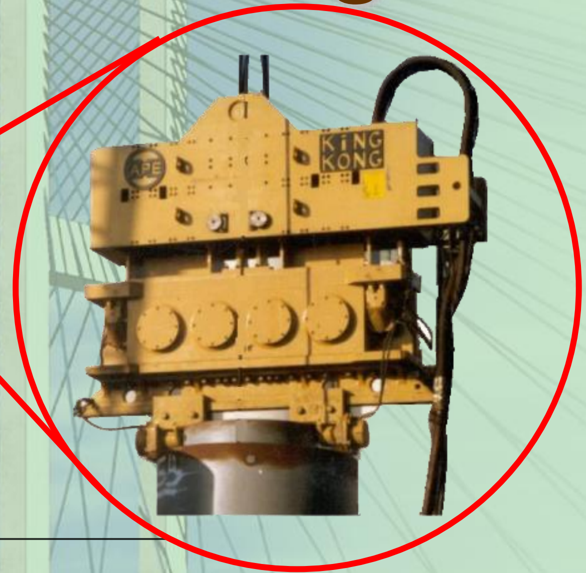
Set Shaft Template



Drive Permanent Casing

APE 400B Vibratory Hammer



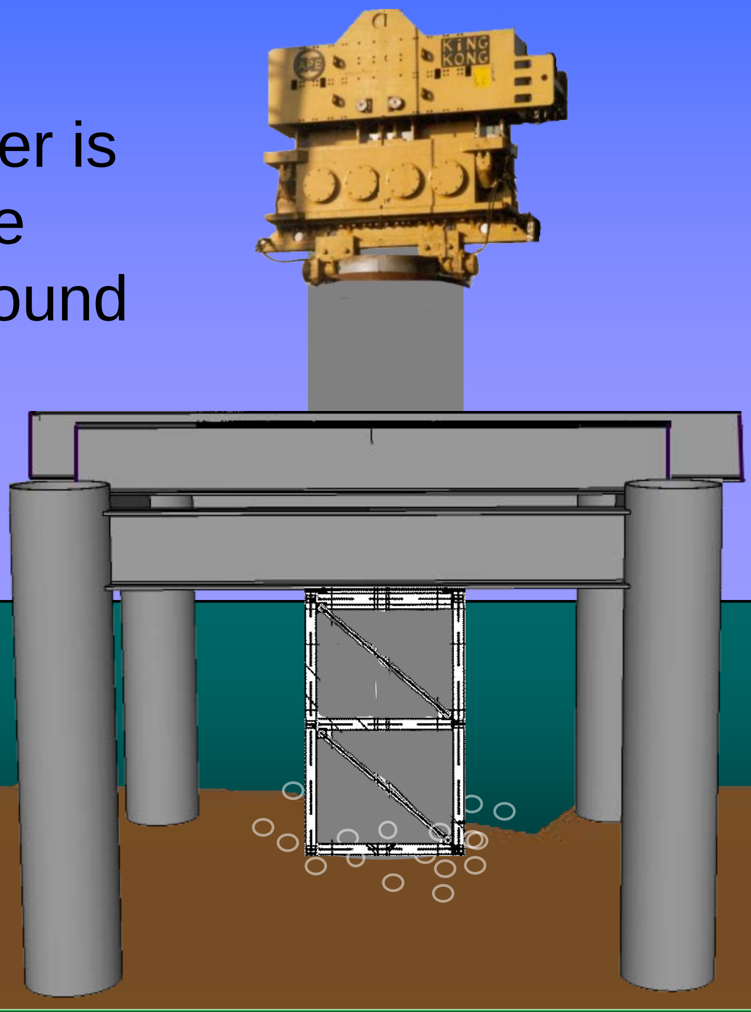


Paint markings at each foot verify depth of casing as it is being installed.

River bottom EL approx. -40’ East, 5’ West

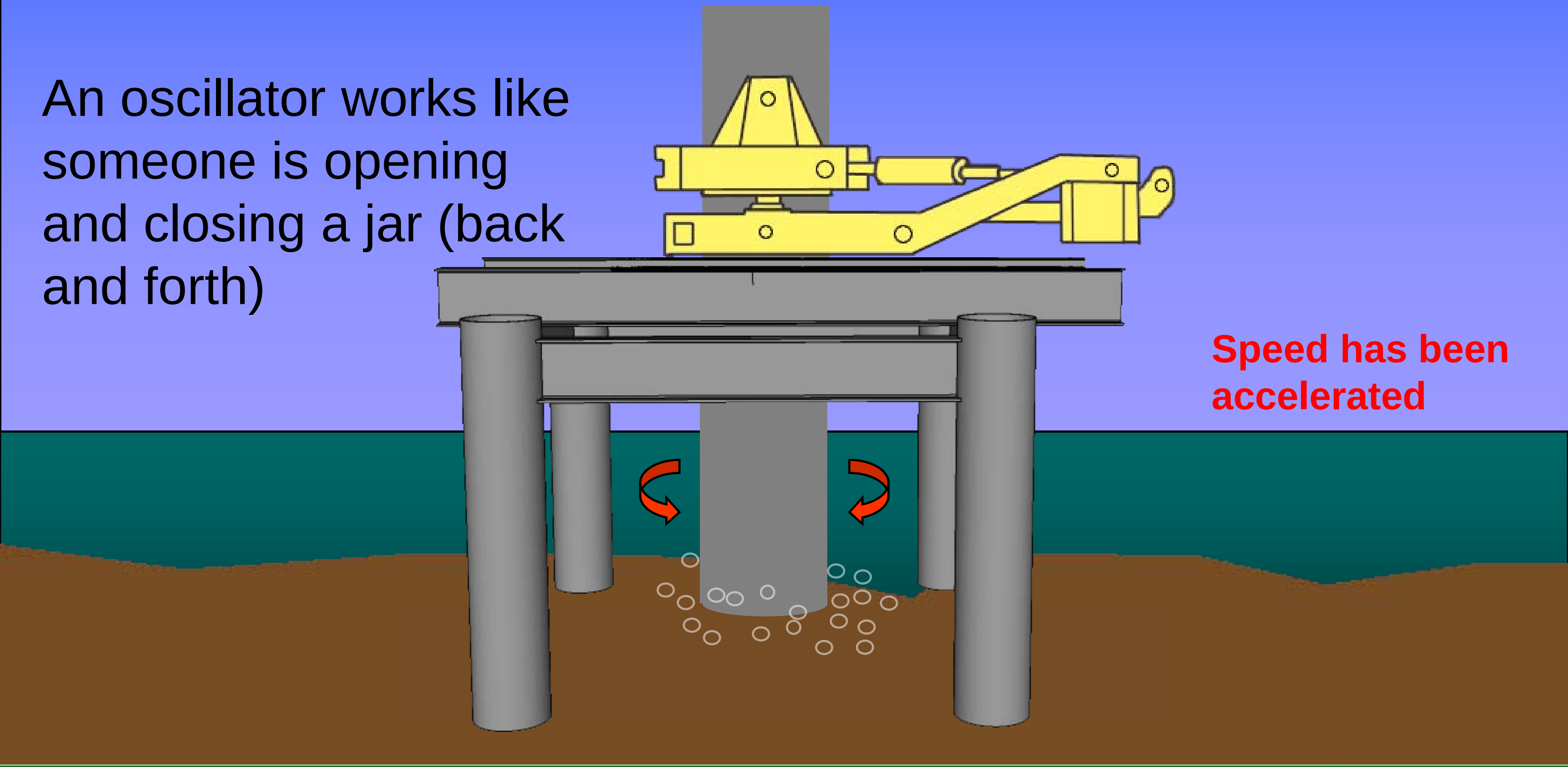
Drive Permanent Casing

A vibratory hammer is used to vibrate the casing into the ground



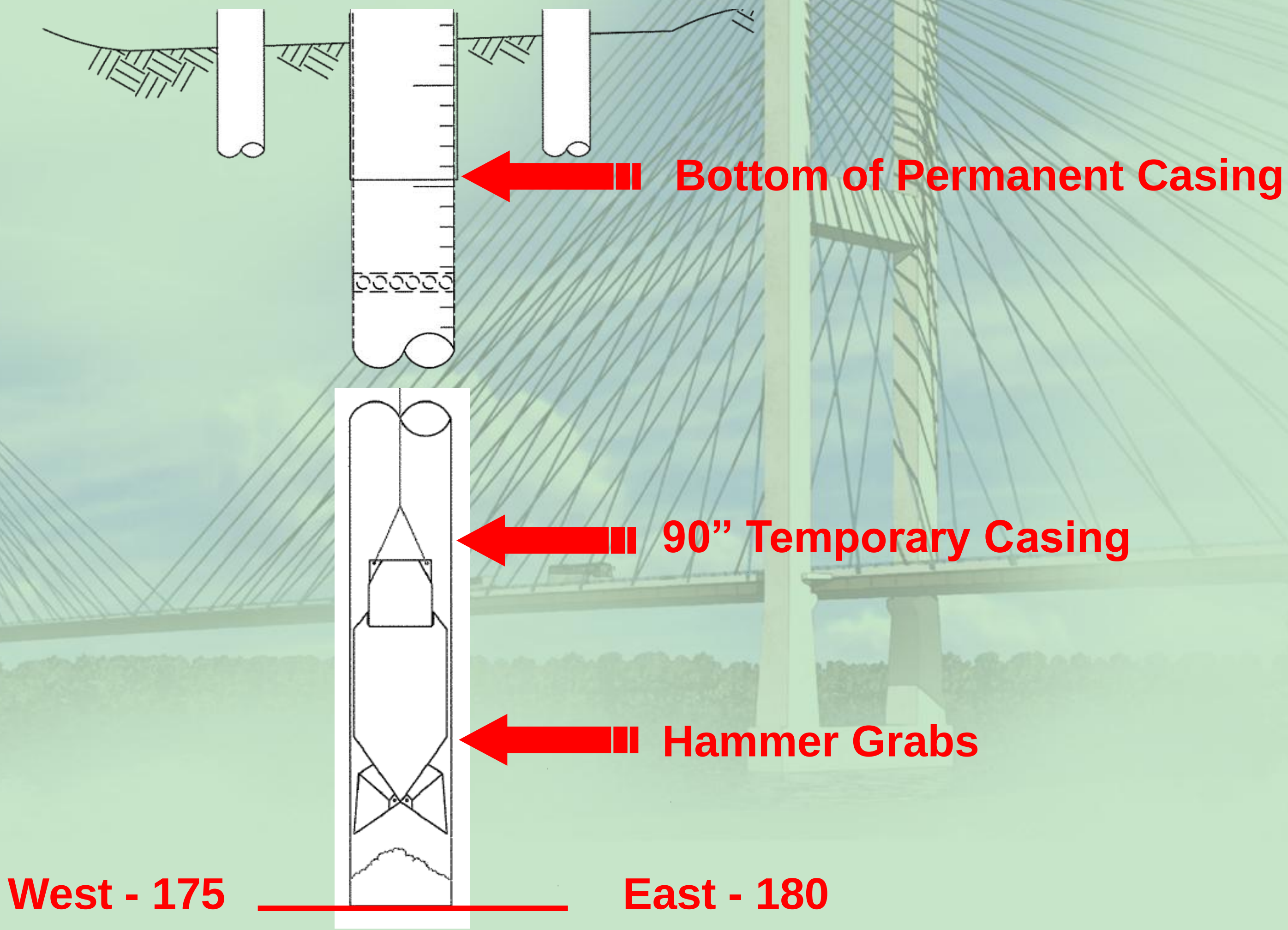
Drive Temporary Casing

An oscillator works like someone is opening and closing a jar (back and forth)



Speed has been accelerated

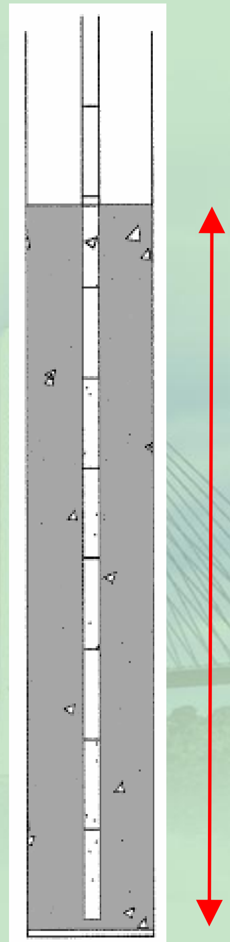
Excavate Temporary Casing



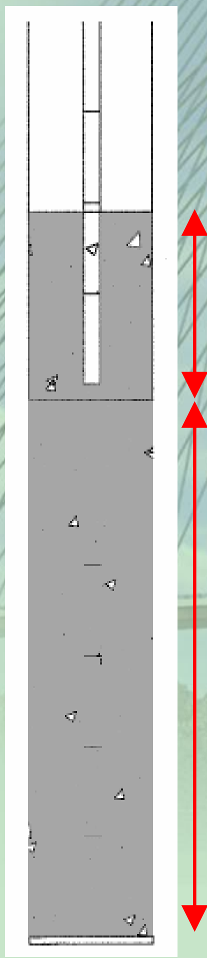
Install Reinforcing Cage


LEFFER
C0354

Pour Tremie Concrete



41.8’



10’ Min.
Embed

30’ of temp.
casing removed

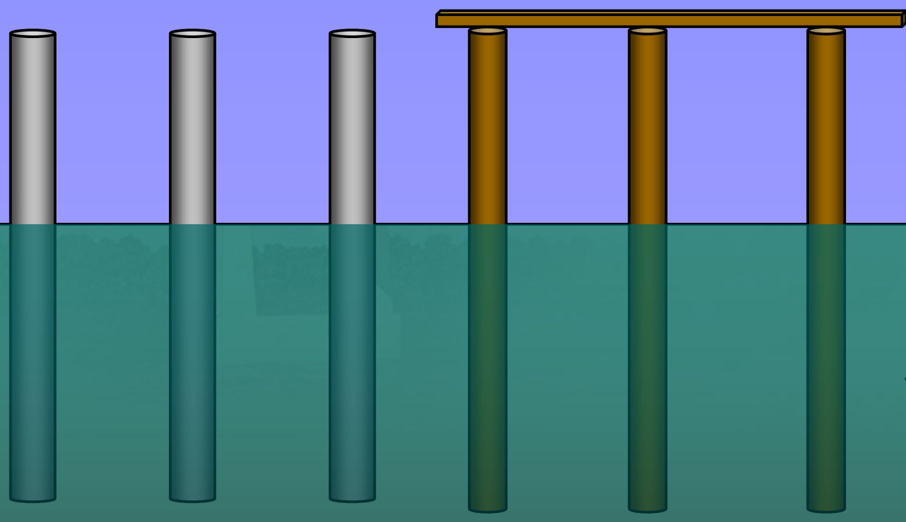
Maintain 4” Slump for
Duration of Pour (~8 hours)


C0354

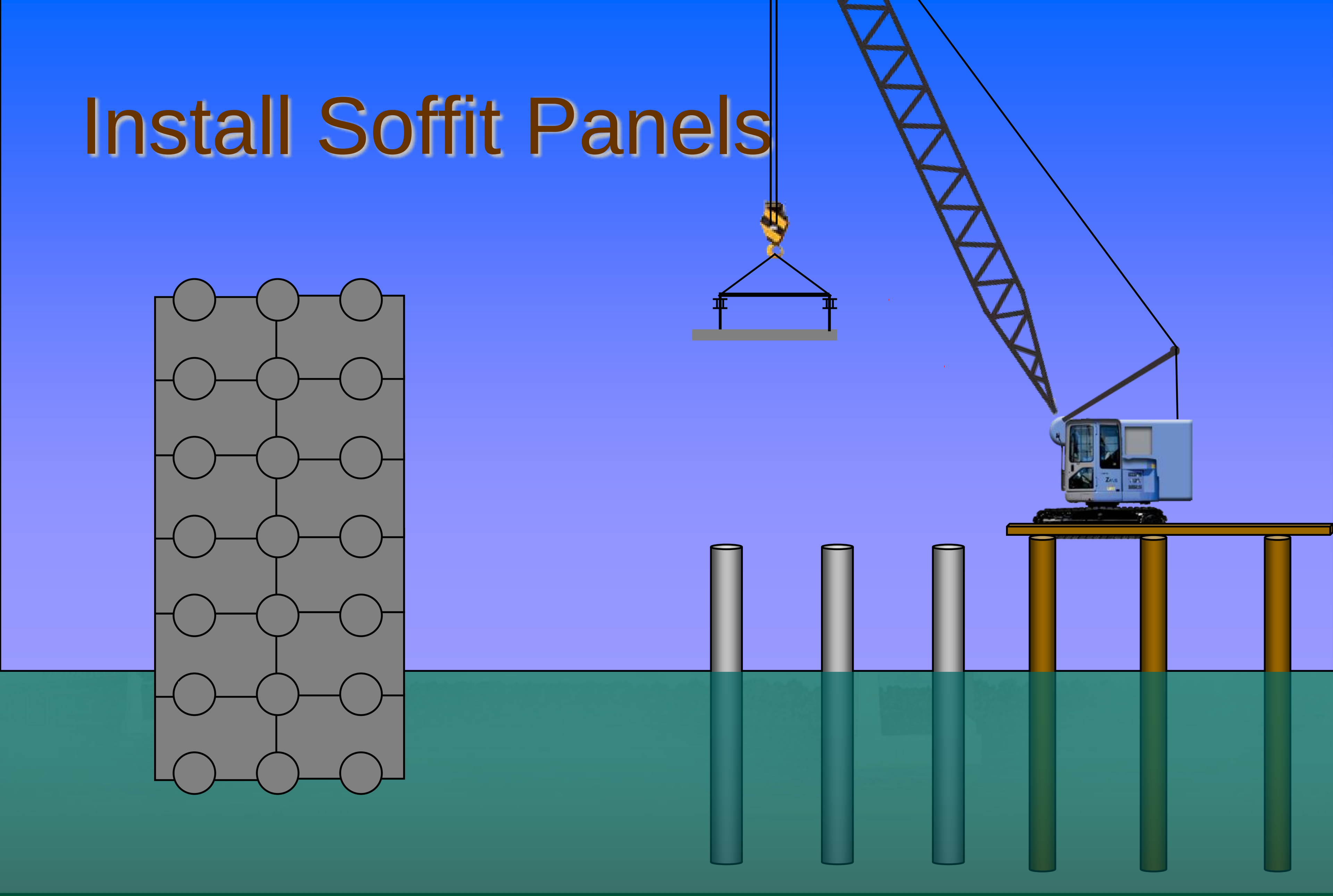
Base Grouting

Footing Cofferdam Structure

Piles and trestle are installed

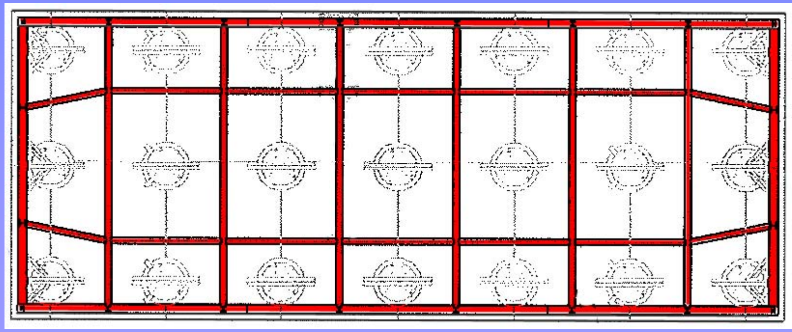


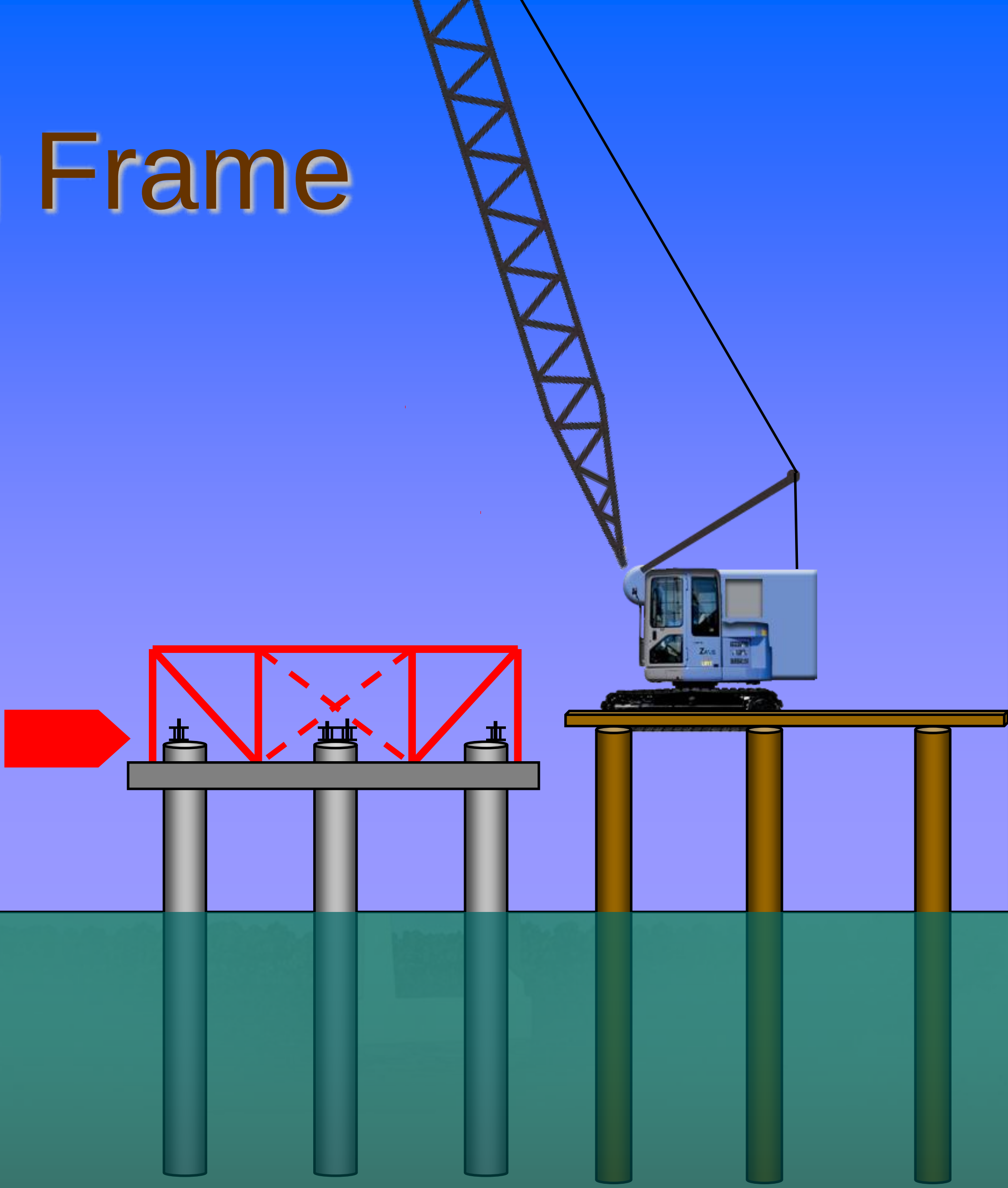
Install Soffit Panels



Install Bracing Frame

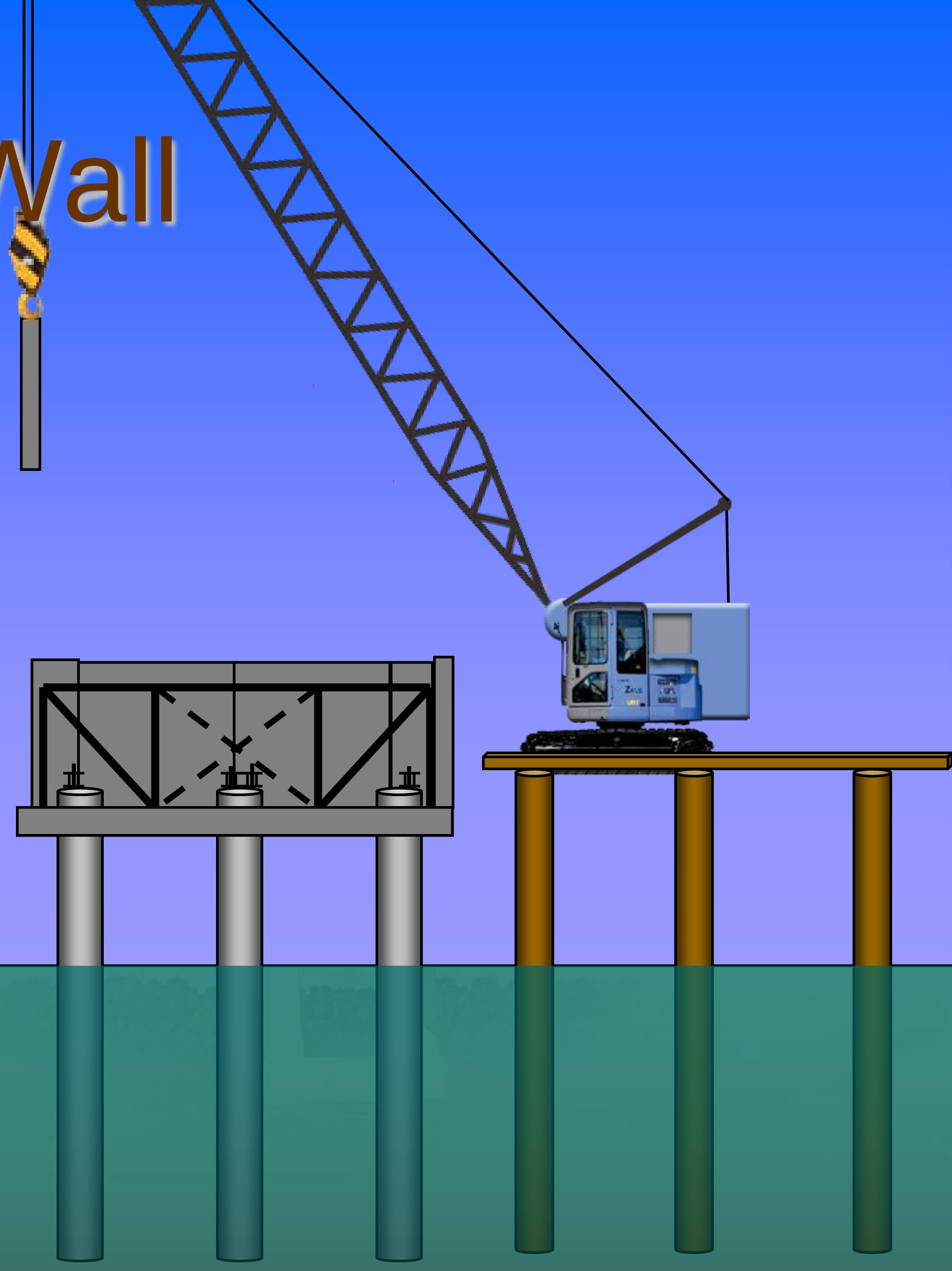
- Install first tier of brace frame





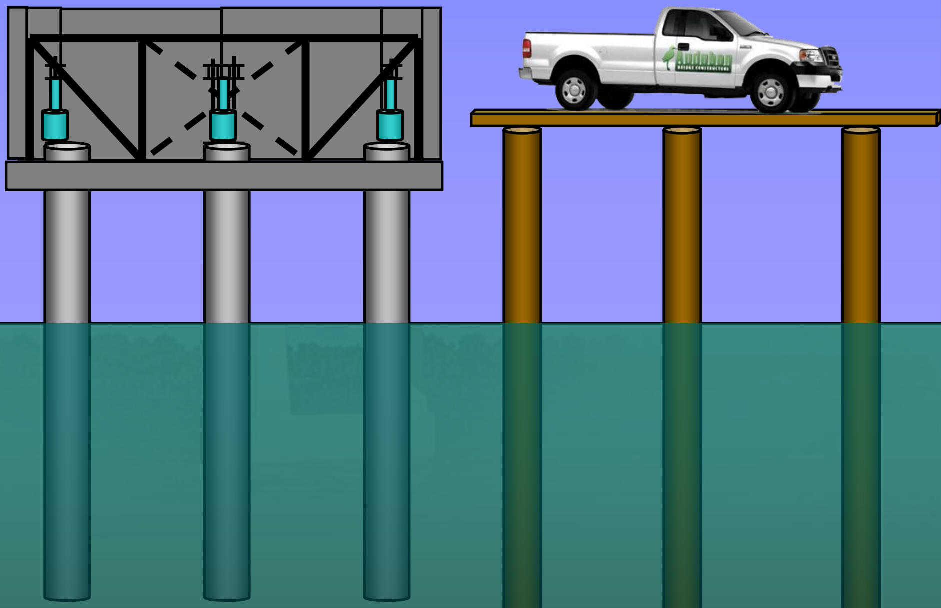
Erect Pre-Cast Wall

- Install pre-cast walls
- Connect to soffit panels and first tier brace frame



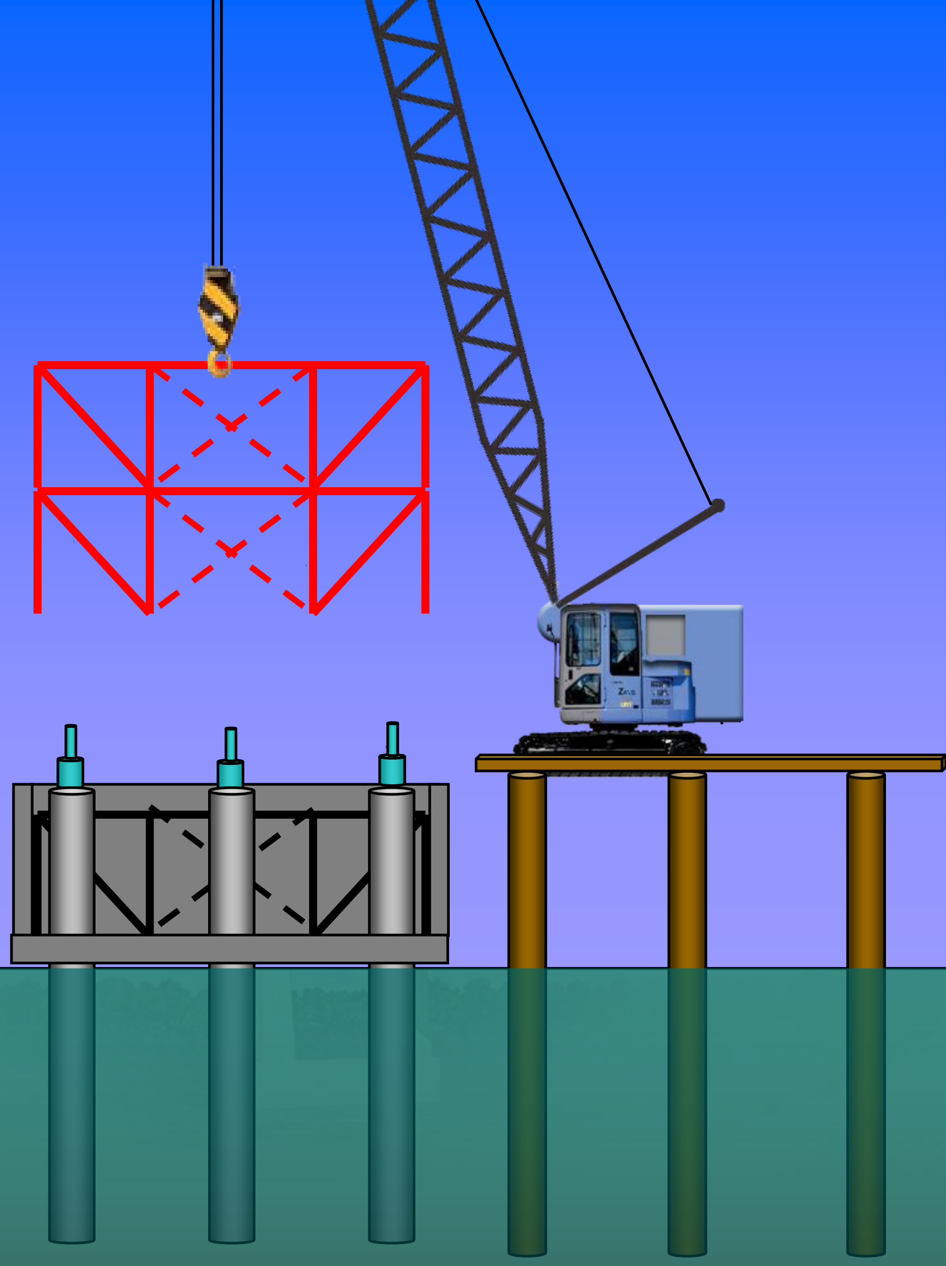
Install Jacking System

- Install jacking system with permanent hangers
- Lower structure to facilitate 2nd & 3rd tier bracing installation



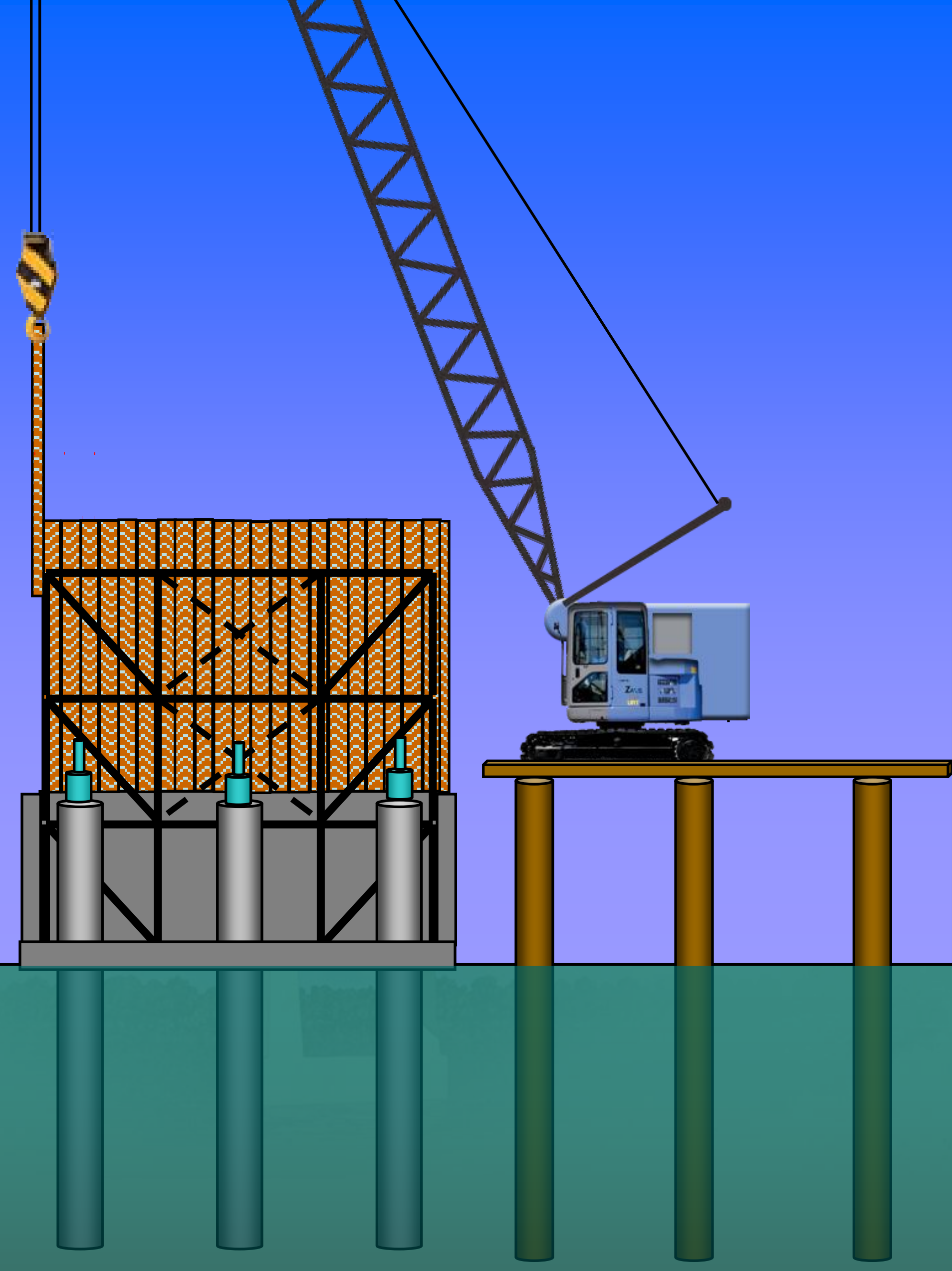
Install Additional Brace Frames

- Install 2nd and 3rd tier brace frame.



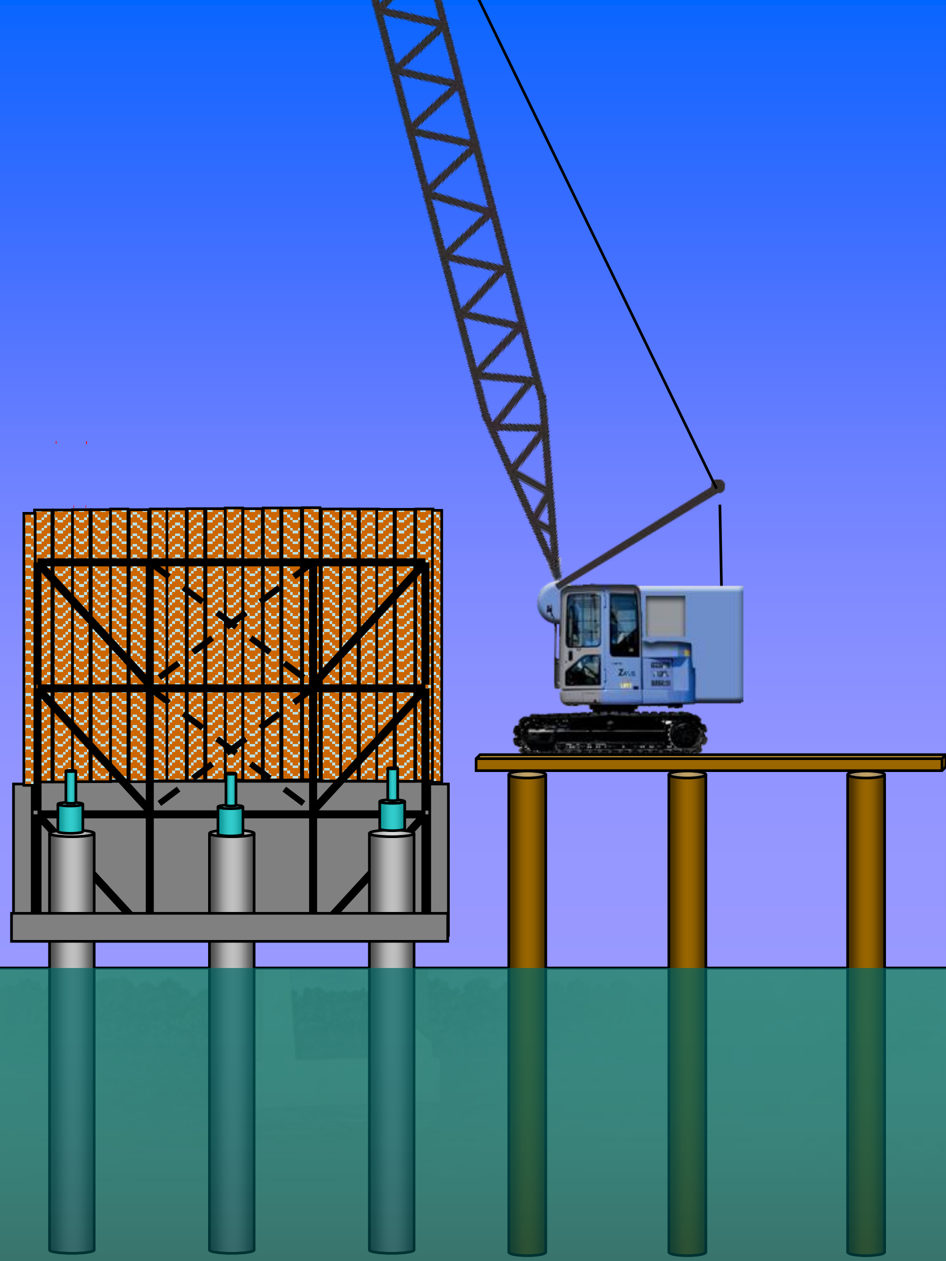
Install Follower Sheeting

- Install sheet pile



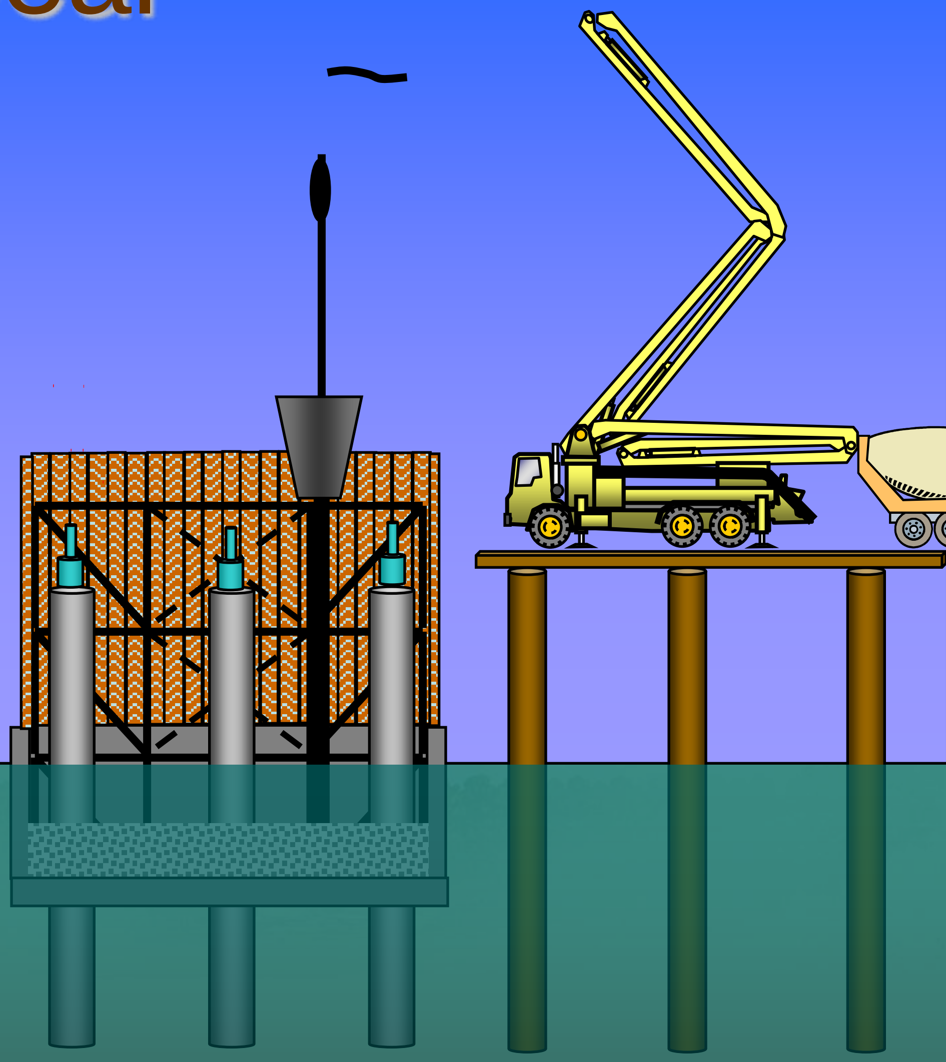
Lower Structure

- Lower structure to final elevation
- Lock off hangers



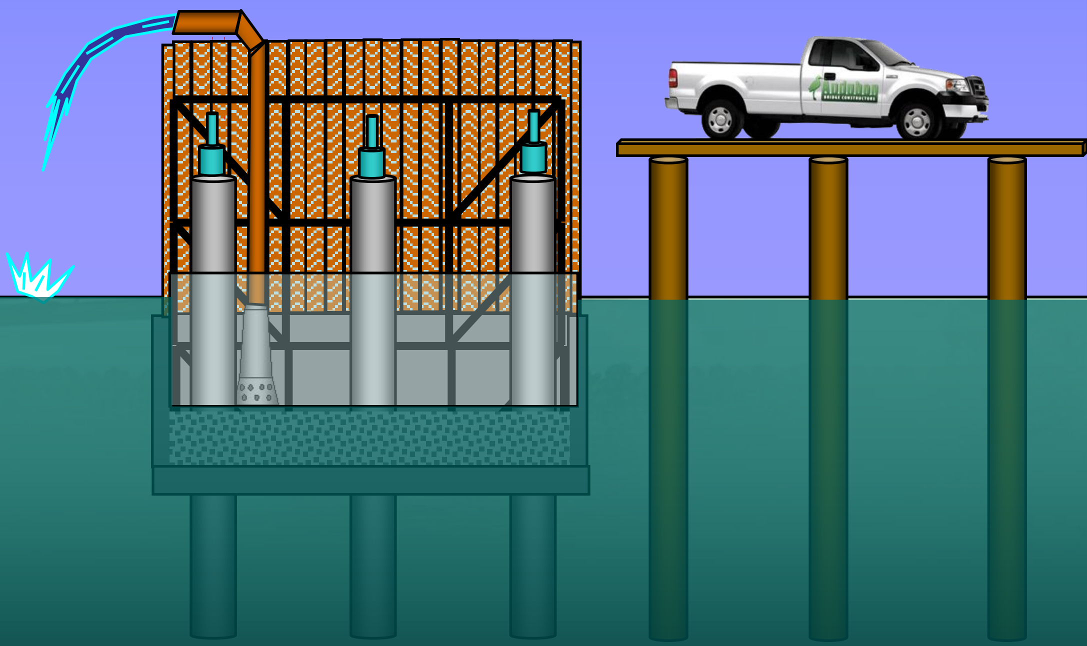
Pour Concrete Seal

- Install 8 foot concrete seal



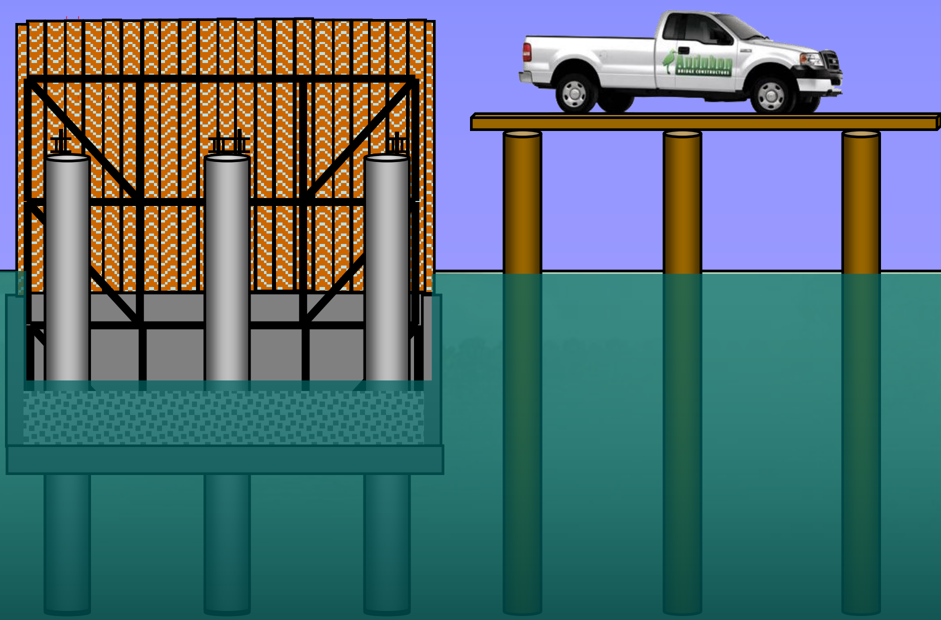
Dewater Structure

- Install pump.
- Remove water



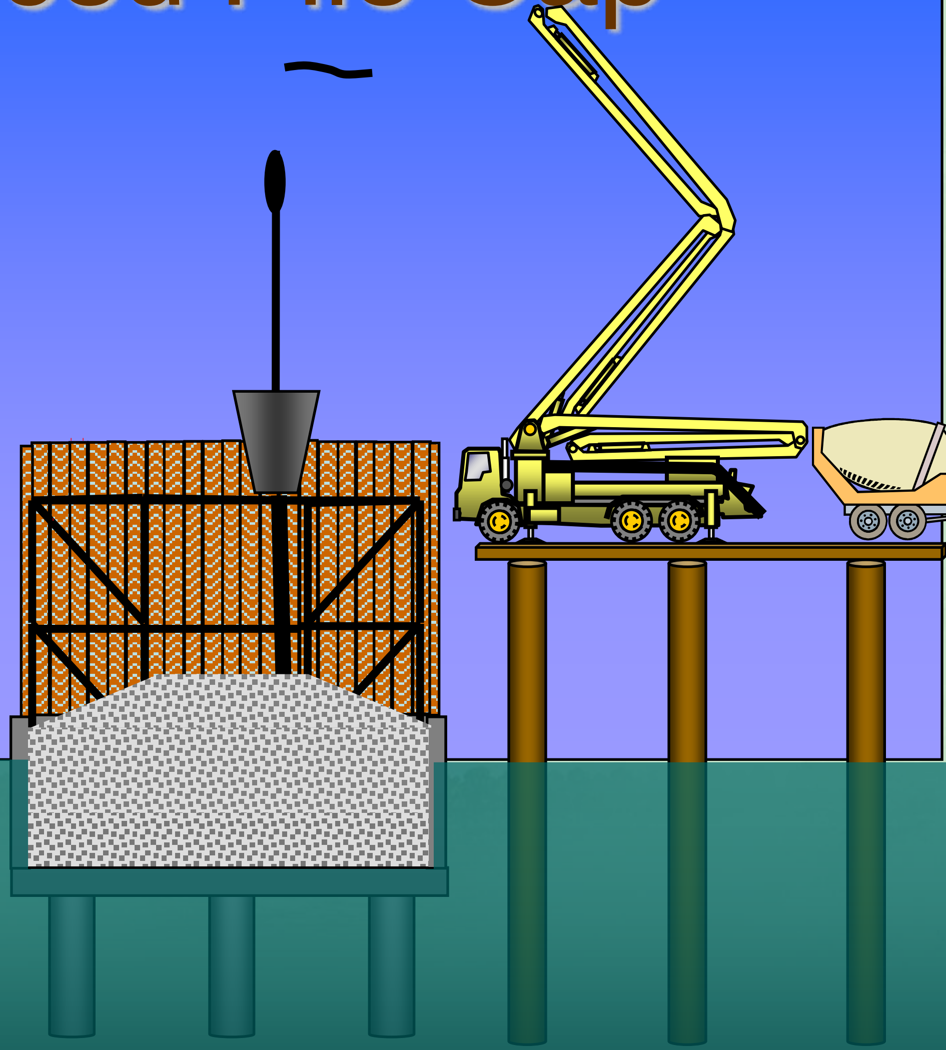
Remove Hangers and Cut Casing

- Remove hangers
- Cut casing



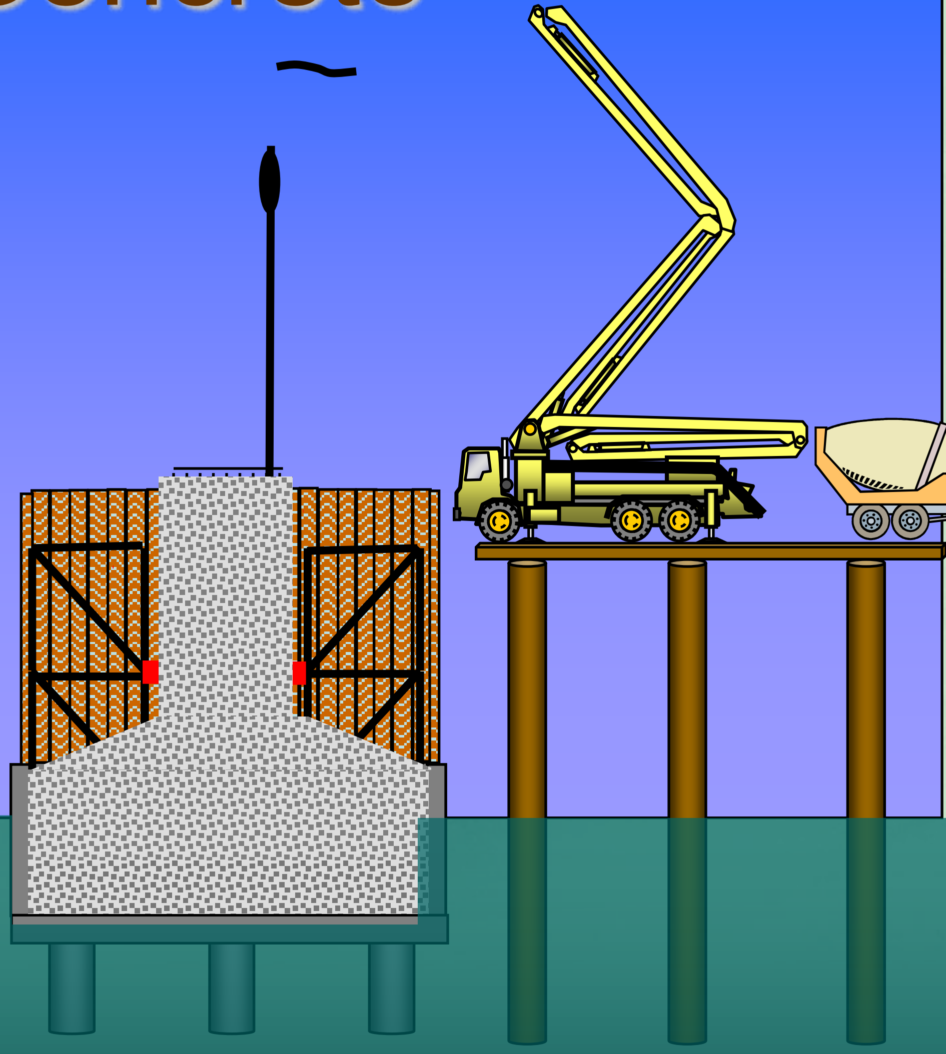
Place Reinforced Pile Cap

- Place reinforced pile cap concrete



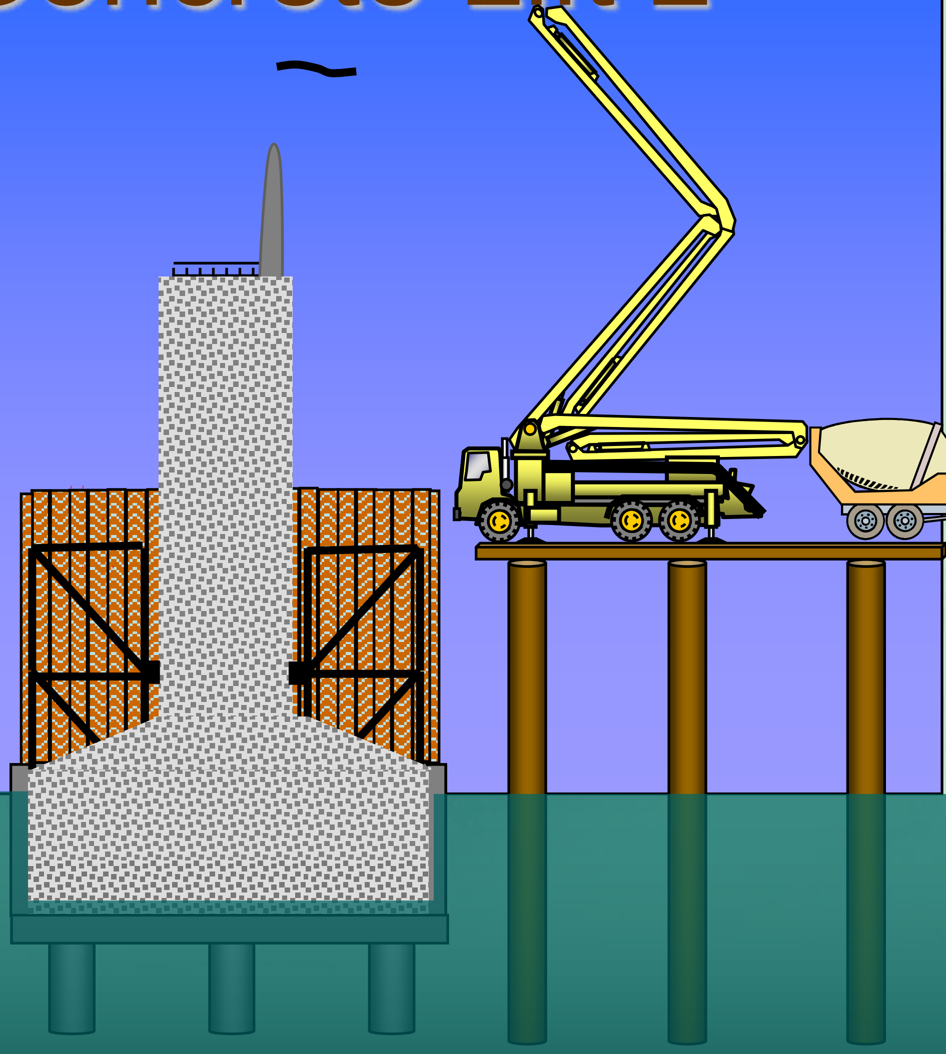
Place Pedestal Concrete

- Place pedestal reinforcing and concrete lift 1
- Restrut as required



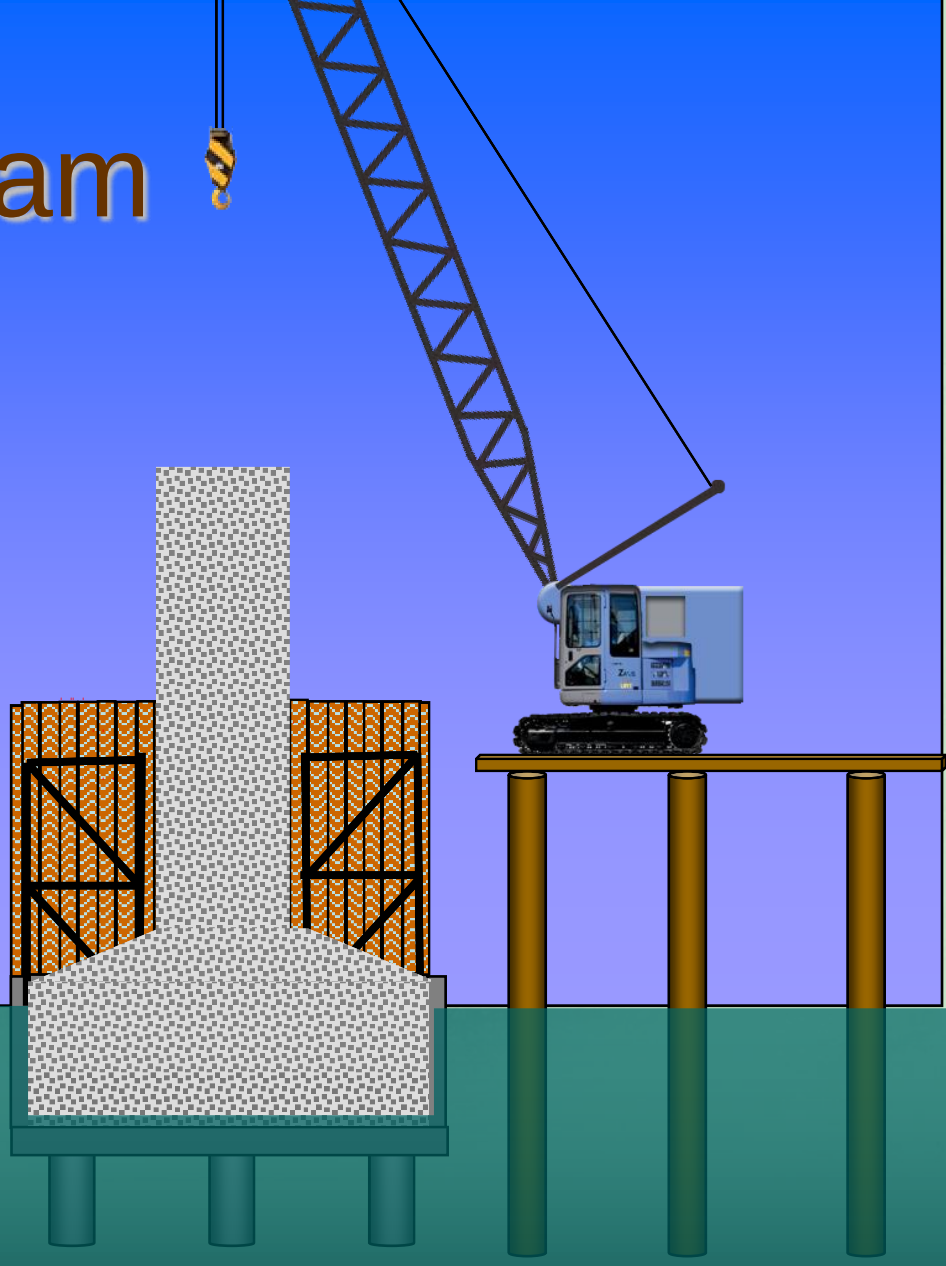
Place Pedestal Concrete Lift 2

- Place pedestal concrete lift 2



Remove Cofferdam

- Remove sheeting
- Remove Bracing
- Patch blockouts



LADOTD

Audubon
BRIDGE CONSTRUCTORS

Audubon Bridge Links

http://flatironcorp.oxblue.com/jjab/

http://www.timedla.com/bridge/audubon/overview/

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