2016 PTI Convention
Long Beach, California

Technical Session 1
Bridge Design and Construction

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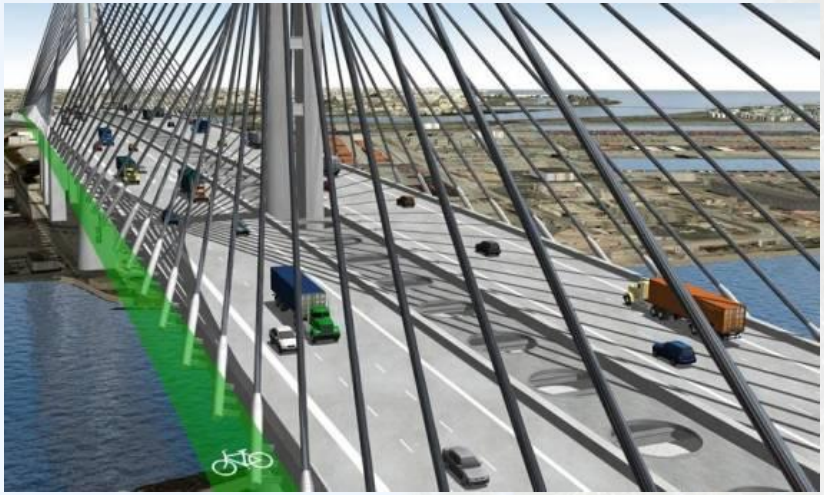
New Gerald Desmond Cable Stay Bridge Replacement

Ken Black-VSL

Presentation Goals:



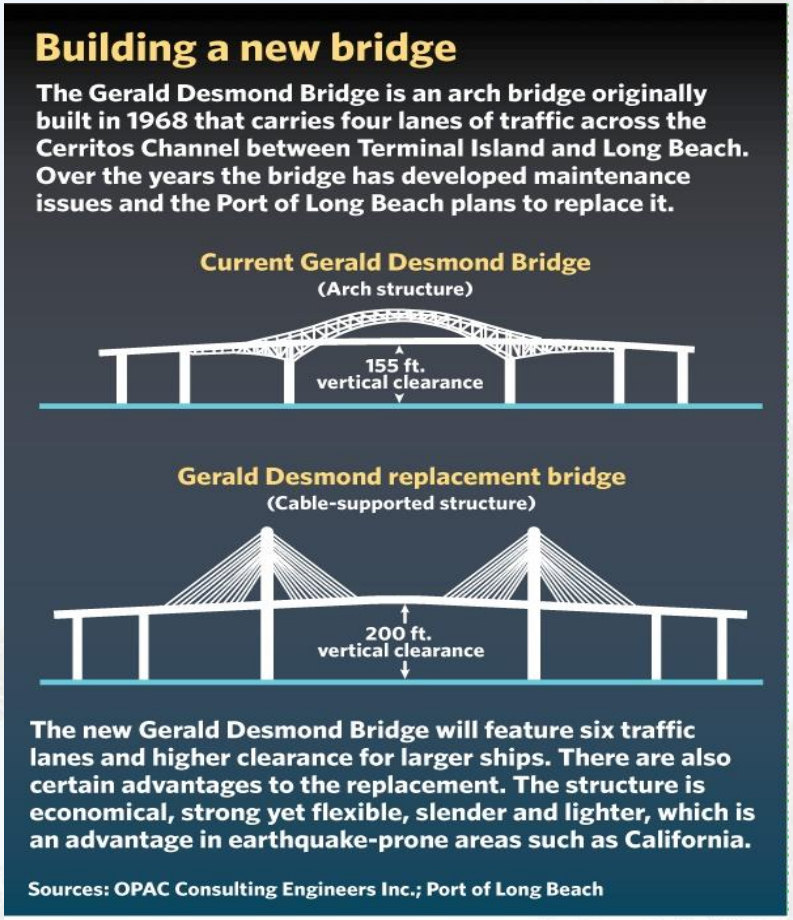
- History of Existing Bridge
- Replacement Bridge
  - New vs. Old
  - Award, Schedule, Cost
  - Design Build
  - New Bridge Details
  - Various Construction Methods
    - Heavy Lifting - Pier Tables
    - Access - Deck & Pylon
    - Foundation Method – Tip Grouting
    - Balanced Cantilever Construction - Main Span
    - MSS (Mobile Scaffolding System) - Approaches

History of Existing Bridge

- Steel Arch Bridge
  - Ground breaking in 1965 & completed in 1968
  - Clearance is 155 Ft
  - Main Span is 410 Ft
- Key link connecting Port of Long Beach to surrounding area and 710 Freeway
- Approximately 15% of nations containerized water cargo crosses the bridge
- Has become unable to accommodate larger container ships underneath its span & the greater traffic across its deck

Building a New Bridge

- New vs. Old
- Ships are now 6 times larger than in 1968
- Affecting other bridges
  - Bayonne Bridge in NY
  - Panama Canal-
    - large containers



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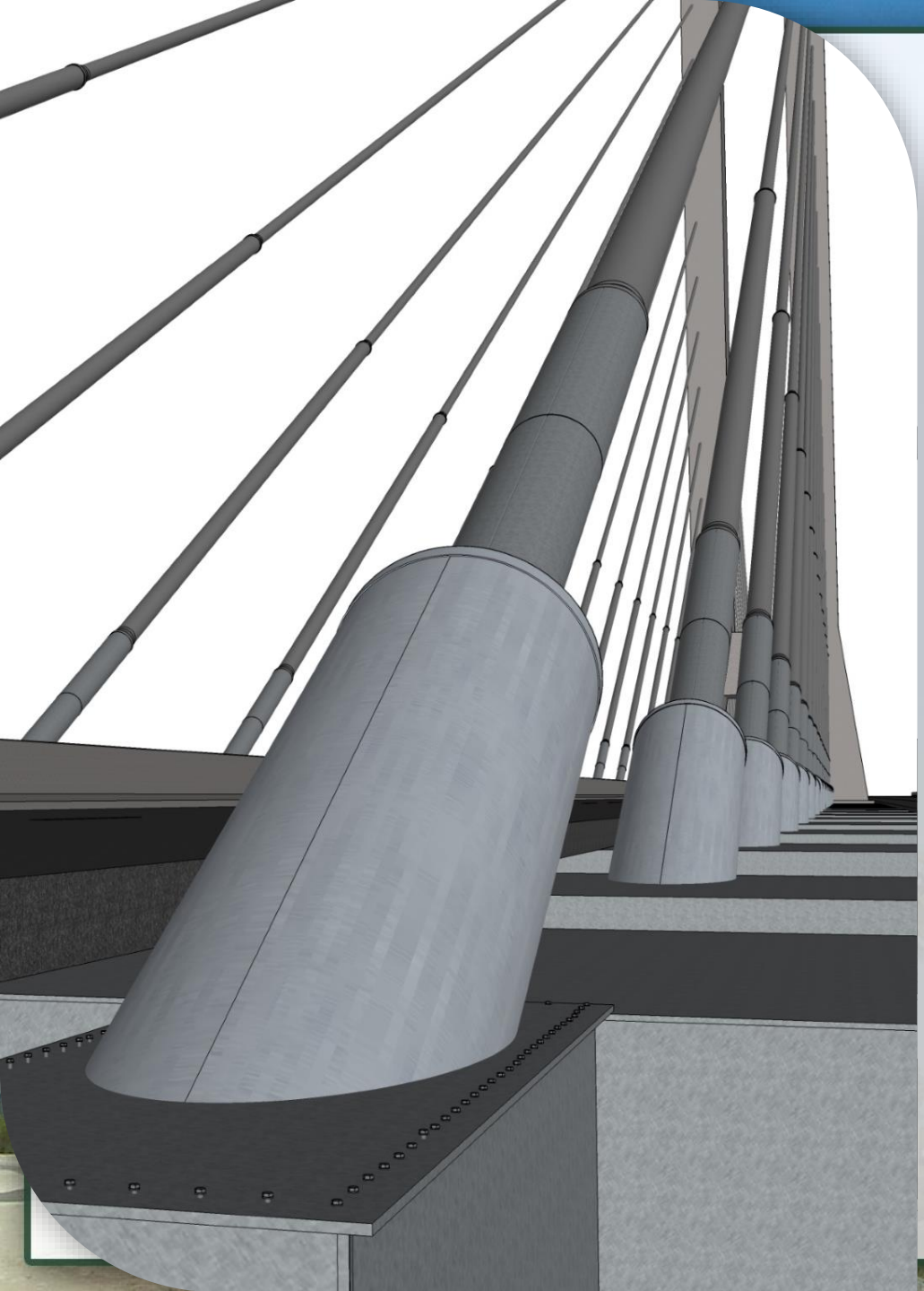
New Bridge Award, Schedule, Cost

- Owner - Port of Long Beach
- Design Build awarded to SFI in 2012
  - Shimmick Construction Co, Inc; FCC Construction; S.A. Impregilo S.P.A.
- Original Completion was 2016
  - Towers were redesigned
- New Completion is now 2018
- Final Cost is anticipated to be around 1.5 billion

New Replacement Bridge Design

- Design Build
- Cable Stays/Armor/Fire Protection
  - Awarded to VSL
    - Scope-
      - Furnish & Install VSL SSI 2000 Cable Stay System
      - Furnish & Install VSL Friction Dampers
      - Furnish & Install VSL/Hardwire Armor & Fire Protection
      - Stay Installation is schedule to begin in November 2016 with completion in June 2017
      - Armoring will begin in June 2017 with completion by Sept



Integrated Stay Cable Solution

Stays | Armor | Fire

VSL

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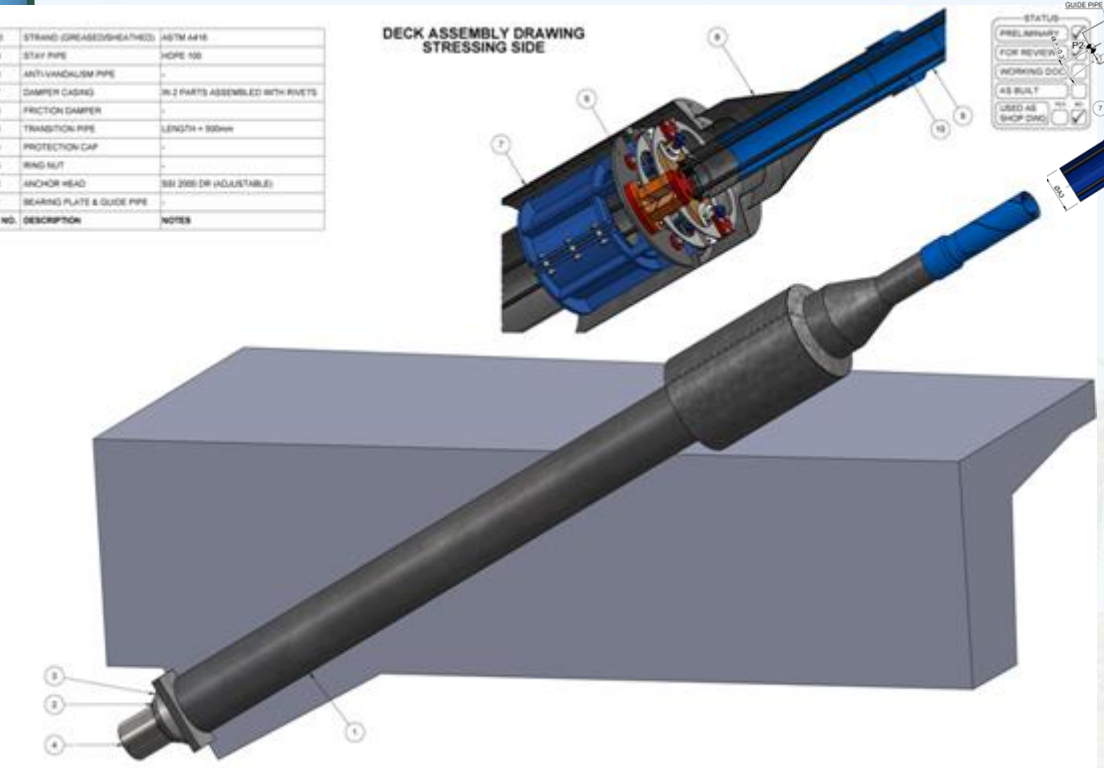
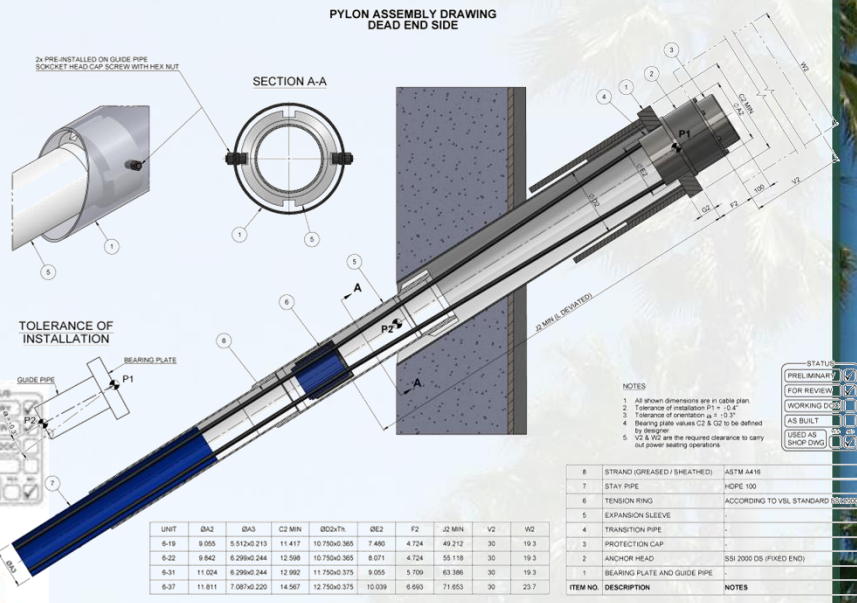
Stays- SSI 2000 System





UNIT	ØA2	ØA3	C2 MIN	ØD2xTh	ØE2	F2	J2 MIN	V2	W2
6-19	9.055	5.512x0.213	11.417	10.750x0.365	7.480	4.724	49.212	30	19.3
6-22	9.842	6.299x0.244	12.598	10.750x0.365	8.071	4.724	55.118	30	19.3
6-31	11.024	6.299x0.244	12.992	11.750x0.375	9.055	5.709	63.386	30	19.3
6-37	11.811	7.087x0.220	14.567	12.750x0.375	10.039	6.693	71.653	30	23.7

ITEM NO.	DESCRIPTION	NOTES
8	STRAND (GREASED / SHEATHED)	ASTM A416
7	STAY PIPE	HDPE 100
6	TENSION RING	ACCORDING TO VSL STANDARD
5	EXPANSION SLEEVE	-
4	TRANSITION PIPE	-
3	PROTECTION CAP	-
2	ANCHOR HEAD	SSI 2000 DS (FIXED END)
1	BEARING PLATE AND GUIDE PIPE	-

NO.	DESCRIPTION	NOTES
	STRAND (GREASED/SHEATHED)	ASTM A416
	STAY PIPE	HDPE 100
	ANTI-VANDALISM PIPE	-
	DAMPER CASING	IN 2 PARTS ASSEMBLED WITH RIVETS
	FRICTION DAMPER	-
	TRANSITION PIPE	LENGTH = 500mm
	PROTECTION CAP	-
	RING NUT	-
	ANCHOR HEAD	SSI 2000 DP (ADJUSTABLE)
	BEARING PLATE & GUIDE PIPE	-

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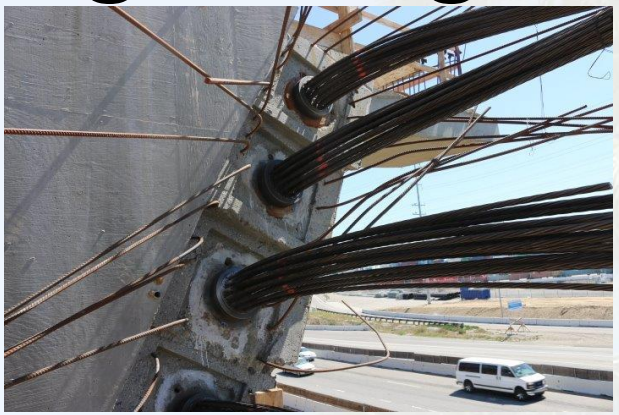
Armor/Fire Protection

- VSL will design, fabricate and install armor and fire protection on GDB
- This is becoming more of standard for cable supported bridges - 3 under contract presently
- PTI now requires fire protection on all cable stay bridges
- Protection starts at the roadway and terminates at a certain height above the deck

New Replacement Bridge Design



- Multi-strand Post-Tensioning
  - Awarded to DSI
  - Approaches
    - Longitudinal & Bent Cap Tendons- 27 x 0.6” strands
    - Transverse tendons in Deck – 4 x 0.6” strands
  - Main Span Precast Tendons – 12 x 0.6” strands

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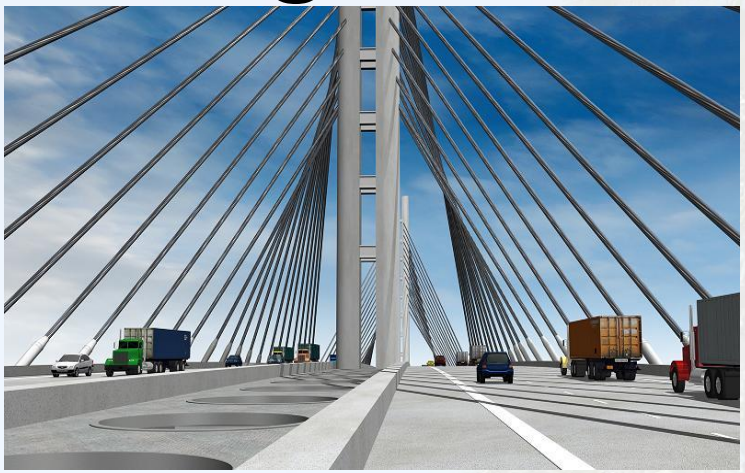
New Replacement Bridge Details

- Cable Stay Bridge Details
  - 205 Ft. of clearance off water
    - 40 Ft. higher than existing bridge
  - Main Span is 1000 Ft. long (two towers)
    - Stay support length is 2000 Ft
  - Longer approaches to accommodate increased height
  - Towers are 310 Ft high from deck

New Replacement Bridge Details

- 80 Stays Total
- Longest stay- 572 ft
- Shortest stay- 236 ft
- Sizes range from 6-43 to 6-85



- Bike & pedestrian path on one side of bridge
- Scenic overlook
- Six lanes vs. four lanes on existing bridge
- Main Span is steel box girder with steel floor beams with precast panels.
- Steel field sections to be fully assembled and brought in by barge and erected with lifters supplied by Deal

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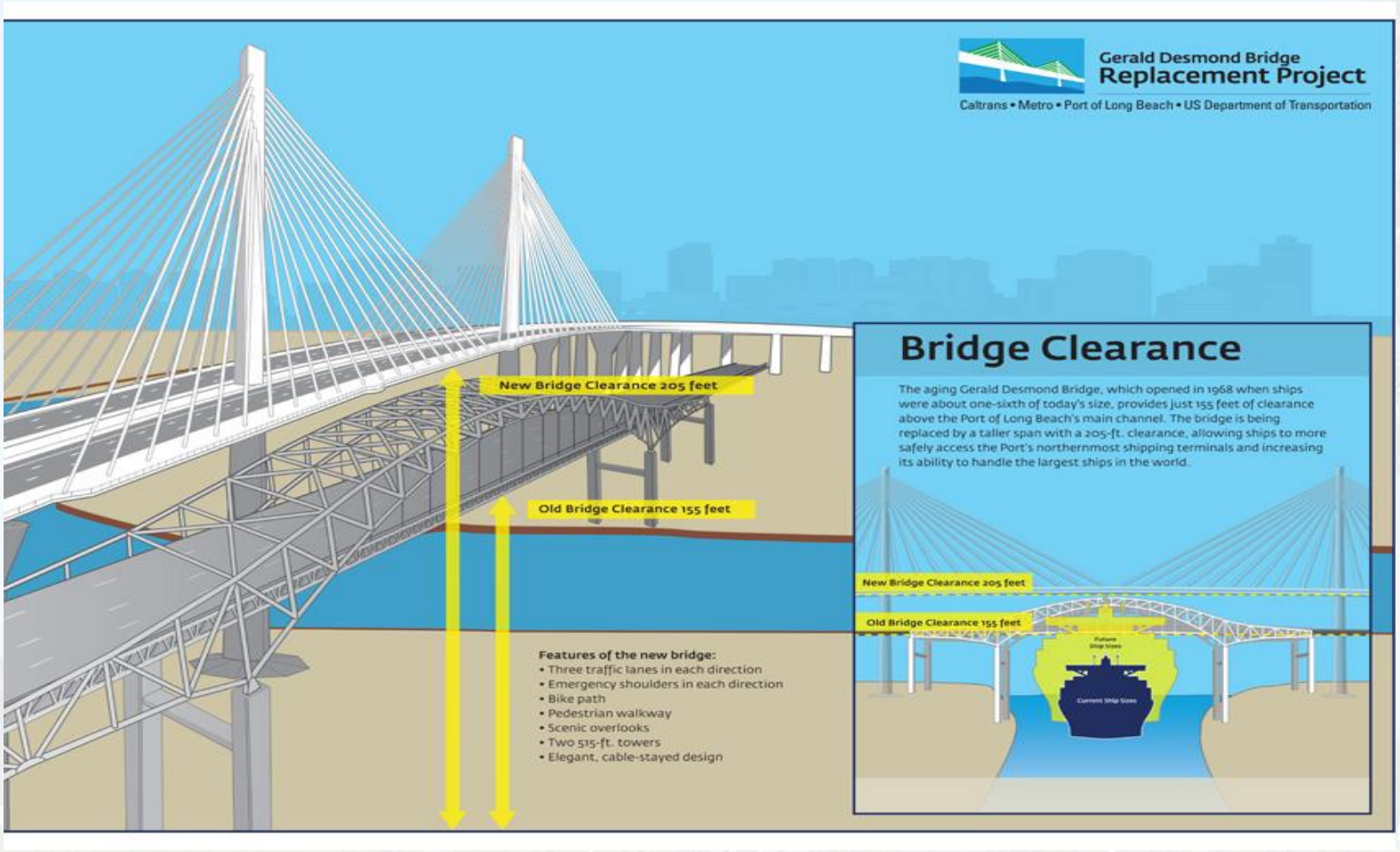
New Replacement Bridge Details



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New Bridge Construction Methods

- Balanced cantilevered construction- Main Span – (one segment out of balance)
- Strand by Strand Installation
- AMS (Automatic Stressing)

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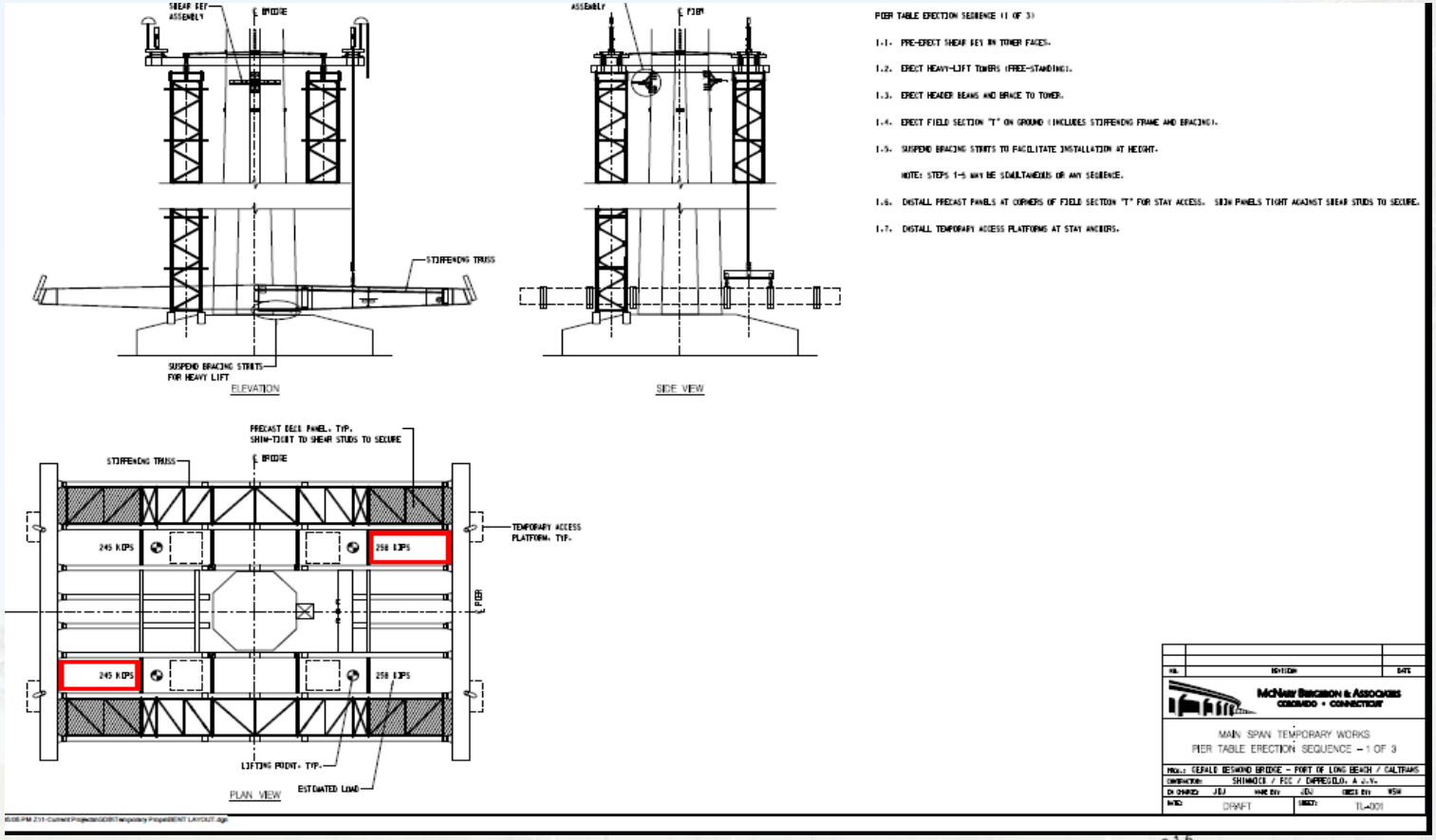
New Bridge Construction Methods

- Heavy Lifting of Pier Tables



New Bridge Construction Methods

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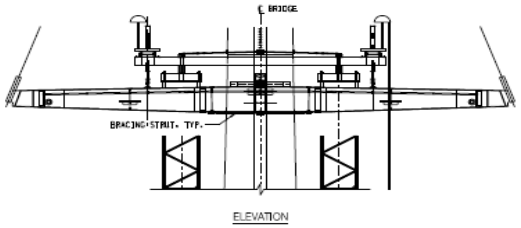
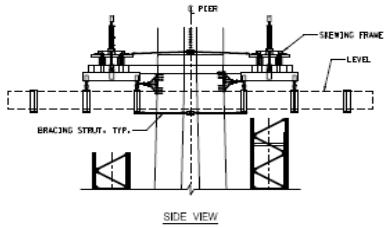


ELEVATION



SIDE VIEW

PIER TABLE ERECTION SEQUENCE (2 OF 3)

2.1. USE STRAND JACKS TO LIFT FIELD SECTION "T" (LEVEL).

NOTE: REFER TO SHEET TM-003 FOR CAMBER / ELEVATION ADJUSTMENTS.

2.2. INSTALL SAFETY BARS.

2.3. INSTALL BRACING STRUTS.

2.4. PERFORM SURVEY. LOOSEN BRACING STRUTS AND USE SKEWING FRAME TO ADJUST FOR LINE AND LONGITUDINAL OFFSET.

2.5. TIGHTEN BRACING STRUTS AFTER ANY ADJUSTMENT.

2.6. PERFORM CONFIRMATION SURVEY.

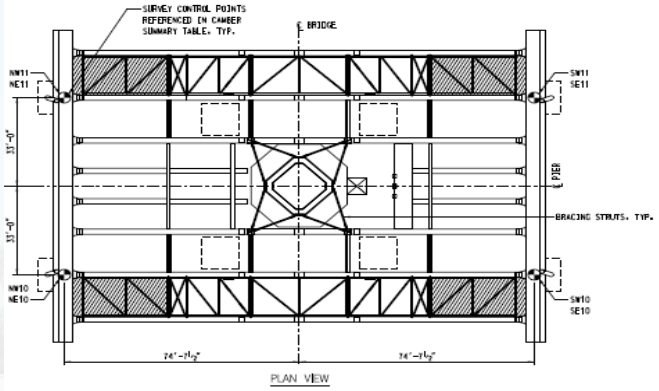
2.7. INSTALL AND STRESS CABLE PAIRS 10 AND 11 PER THE STAY STRESSING SCHEDULE (THIS SHEET).

NOTE: RE-CHECK AND TIGHTEN BRACING STRUTS DURING STAY STRESSING.

2.8. RELEASE ANY REMAINING LOAD IN THE LIFTING JACKS.

2.9. REMOVE SAFETY BARS.

2.10. CUT OFF PADEYES.



PLAN VIEW

STAY STRESSING SCHEDULE

PHASE	PIER 16 / PIER 17	NW10 / NE10	SW10 / SE10	NW11 / NE11	SW11 / SE11
2.7. STRESS STAYS (INITIAL) (STRESS TO FORCE – GRADUATED INCREMENTS)					
TOTAL FORCE (KIPS)		265	271	265	271
NO. STRANDS		42	44	42	44
1ST STRAND (KIPS)		18.60	19.05	18.60	19.05
INCREMENT (KIPS)		-0.30	-0.30	-0.30	-0.30
LAST STRAND (KIPS)		6.31	6.16	6.31	6.16
AVG. / STRAND (KIPS)		6.31	6.16	6.31	6.16
3.4. PLACE PRECAST DECK PANELS (PASSIVE LOADING)					
TOTAL FORCE (KIPS)		607	614	607	614
AVG. / STRAND (KIPS)		14.45	13.95	14.45	13.95
3.5. RE-STRESS STAYS 11 FOR GRADE * (STRESS TO ELONGATION: 8 PASSES @ 2.78" = 22.20")					
TOTAL FORCE (KIPS)		607	614	607	614
AVG. / STRAND (KIPS)		14.45	13.95	14.45	13.95
3.7. RE-STRESS STAYS 10 & 11 * (STRESS FOR GEOMETRY: NOMINAL STROKE = 1.50")					
TOTAL FORCE (KIPS)		607	614	607	614
AVG. / STRAND (KIPS)		14.45	13.95	14.45	13.95

* FOR NOTED PHASES, STRESS ALL STRANDS TO THE SAME ELONGATION.
MAXIMUM UNBALANCE FOR NORTH AND SOUTH STAYS = 2 STRANDS.

NO.	REVISION	DATE

McNARY BERGERON & ASSOCIATES
COLORADO • CONNECTICUT

MAIN SPAN TEMPORARY WORKS
PIER TABLE ERECTION SEQUENCE – 2 OF 3

PROJECT: GERALD DESMOND BRIDGE – PORT OF LONG BEACH / CALTRANS
CONTRACTOR: SHIMMICK / FCC / IMPREGILO, A J.V.
IN CHARGE: JBJ MADE BY: JBJ CHECK BY: WSH
DATE: DRAFT SHEET: TL-002

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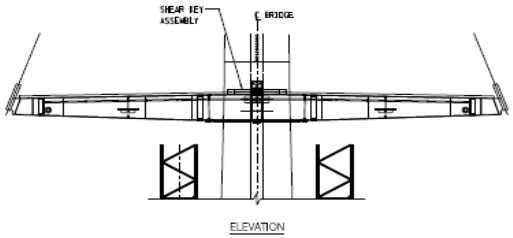
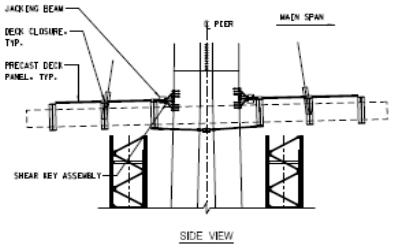
New Bridge Construction Methods

- Heavy Lifting of Pier Tables





PIER TABLE ERECTION SEQUENCE (3 OF 3)

3.1. REMOVE HEADER BEAMS AND TOWER SECTIONS THAT EXTEND ABOVE DECK LEVEL.

3.2. PERFORM SURVEY. MAKE FINAL ADJUSTMENTS FOR LINE AND LONGITUDINAL OFFSET USING BRACING STRUTS.

3.3. INSTALL PRECAST PANELS PER THE PANEL PLACING SEQUENCE (THIS SHEET).

NOTE: AFTER PLACING FIRST PANEL, MAKE 1/8" GAP AT BACK-SPAN BRACING STRUTS. VERIFY GAP AFTER EVERY PANEL IS PLACED.

3.4. REINFORCE AND CAST DECK CLOSURES.

3.5. RE-STRESS STAY PAIR 11 PER THE STAY STRESSING SCHEDULE (TM-002).

NOTE: RE-CHECK AND TIGHTEN BRACING STRUTS DURING STAY STRESSING.

3.6. PERFORM SURVEY.

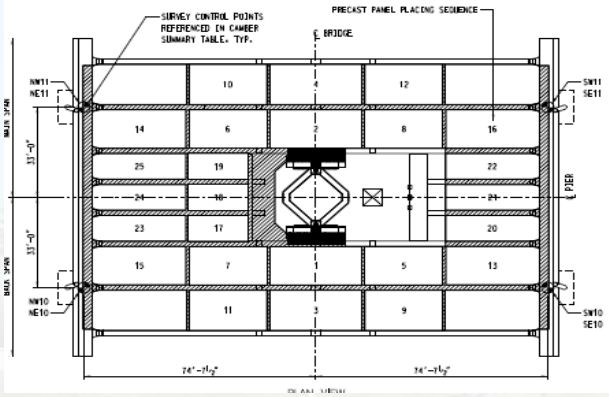
3.7. RESTRESS ALL STAYS PER THE STAY STRESSING SCHEDULE FOR REDUCED ERECTION ELEVATIONS (NOMINAL STROKE = 1.5").

3.8. FORM AND REINFORCE JACKING BEAM / SHEAR KEY.

3.9. AFTER JACKING BEAM / SHEAR KEY CONCRETE REACHES 4000 PSI, RELEASE AND REMOVE BRACING STRUTS.

3.10. PROCEED WITH DECK ERECTION.

3.11. AFTER ERECTING ADJACENT FIELD SECTIONS AND CASTING DECK CLOSURES, THE STIFFENING TRUSSES MAY BE REMOVED.



CAMBER SUMMARY		INCREMENTAL DEFLECTIONS (FT)				ELEVATION ADJUSTMENTS (FT)			
PHASE	PIER 16 PIER 17	NW10 NE10	SW10 SE10	NW11 NE11	SW11 SE11	NW10 NE10	SW10 SE10	NW11 NE11	SW11 SE11
2.1. LIFT STEEL		-0.400	-0.417	-0.400	-0.417	-0.025	-0.053	-1.792	-1.793
2.7. STRESS STAYS (INITIAL)		+0.400	+0.417	+0.400	+0.417	+0.375	+0.364	-1.392	-1.377
3.4. PLACE PRECAST DECK PANELS		-0.270	-0.259	-0.270	-0.259	+0.104	+0.105	-1.662	-1.635
3.5. RE-STRESS STAYS 11 FOR GRADE		0.000	0.000	+1.740	+1.740	+0.104	+0.105	+0.078	+0.104
3.7. RE-STRESS STAYS 10 & 11		+0.118	+0.118	+0.118	+0.118	+0.222	+0.222	+0.195	+0.222
—— SUPERIMPOSED DEFLECTIONS		-0.222	-0.222	-0.195	-0.222	0.000	0.000	0.000	0.000
TOTAL		-0.375	-0.364	+1.392	+1.377				
CAMBER		+0.375	+0.364	-1.392	-1.377				

NO.	REVISION	DATE

McNARY BERGERON & ASSOCIATES
COLORADO • CONNECTICUT

MAIN SPAN TEMPORARY WORKS
PIER TABLE ERECTION SEQUENCE – 3 OF 3

PROJECT: GERALD DESMOND BRIDGE – PORT OF LONG BEACH / CALTRANS
CONTRACTOR: SHIMMICK / FCC / DAPREGLIO, A J.V.
DESIGNED: JBJ MADE BY: JBJ CHECKED BY: WSM

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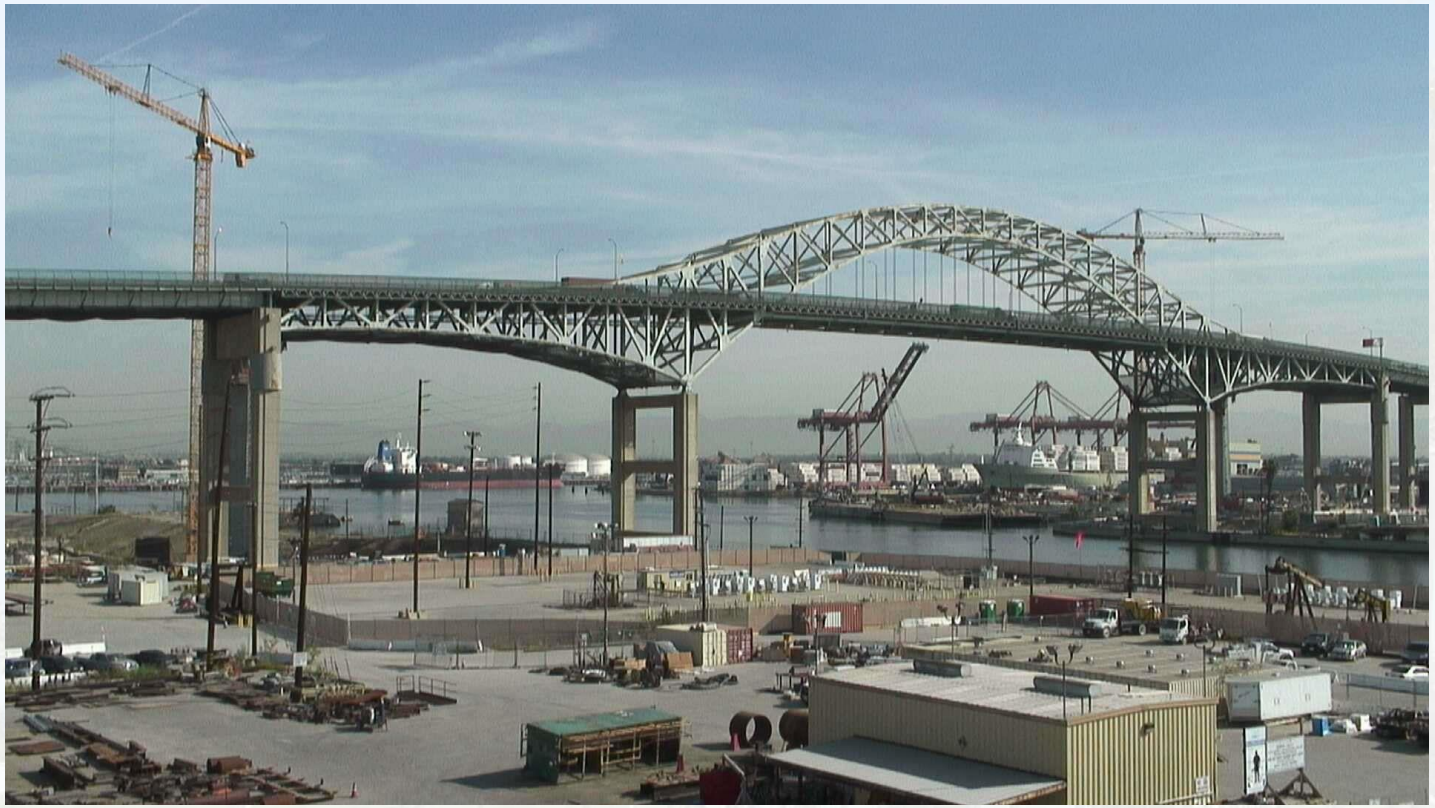
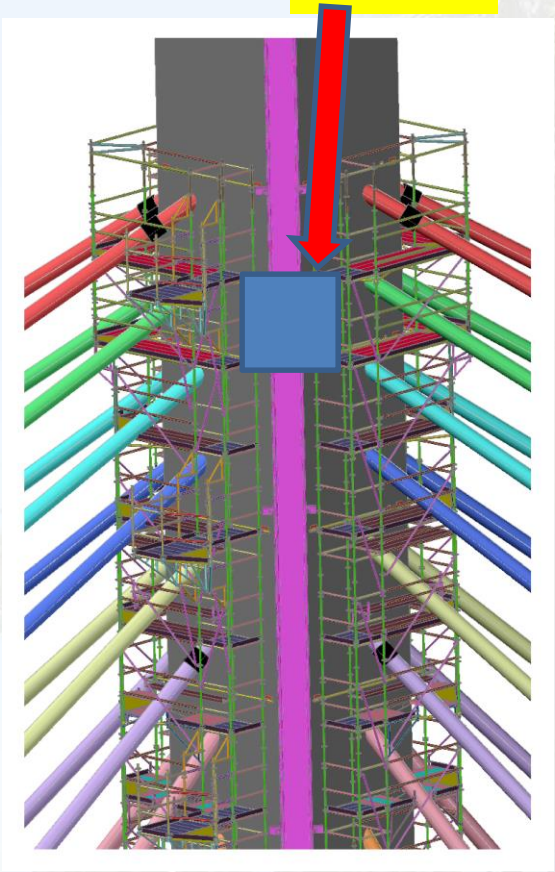
New Bridge Construction Methods

- Tower Crane at Each Pier - Access



New Bridge Construction Methods

- Fully Scaffold Towers - Access
  - with elevator for stay install



New Bridge Construction Methods

- Foundations
  - 3200 yards of concrete in pier foundations
  - Continuous pour for 24 hours

New Bridge Construction Methods

- Tip Grouting on Foundations
  - Not common on Caltrans Projects
  - Used on approximate 6 projects in US
    - John James Audubon Bridge
      - » Article by Steven Dapp, Ph.D., P.E.
      - » Dan Brown, Ph.D., P.E.

- Benefits of Tip Grouting
  - Increases the ultimate tip capacity
  - Tip is able to contribute to useful capacity
  - Provides proof load of capacity for all shafts on site

New Bridge Construction Methods

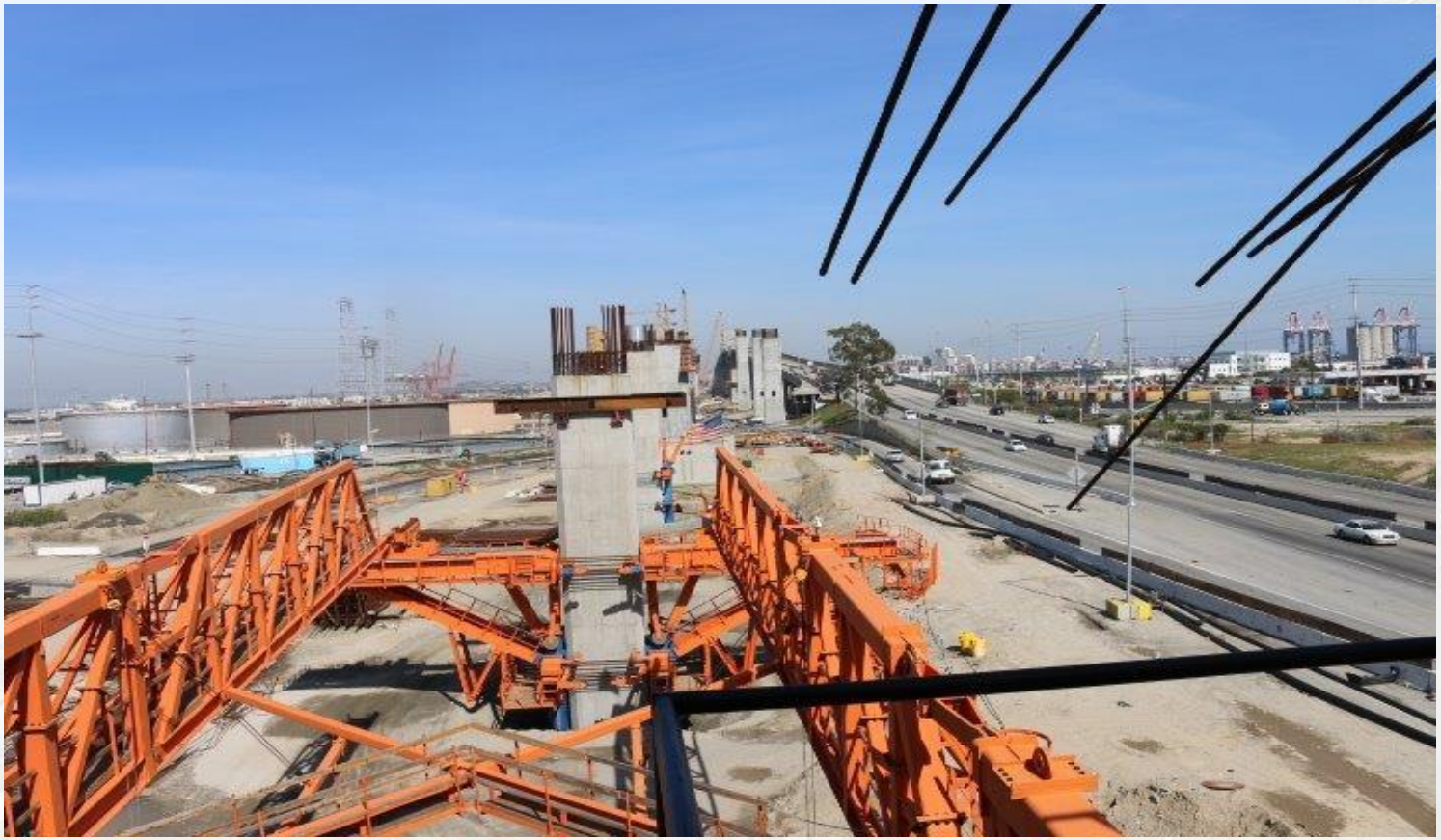
- When to Consider Tip Grouting
  - Sandy bearing stratum
  - Shaft tip is difficult to clean or keep clean
  - Increase reliability- proof load every shaft
  - Gaining acceptance in US
- Mass Concrete Pours
  - Majority of foundation and bent cap pours utilized a cooling system

New Bridge Construction Methods

- MSS (Mobile Scaffolding System)

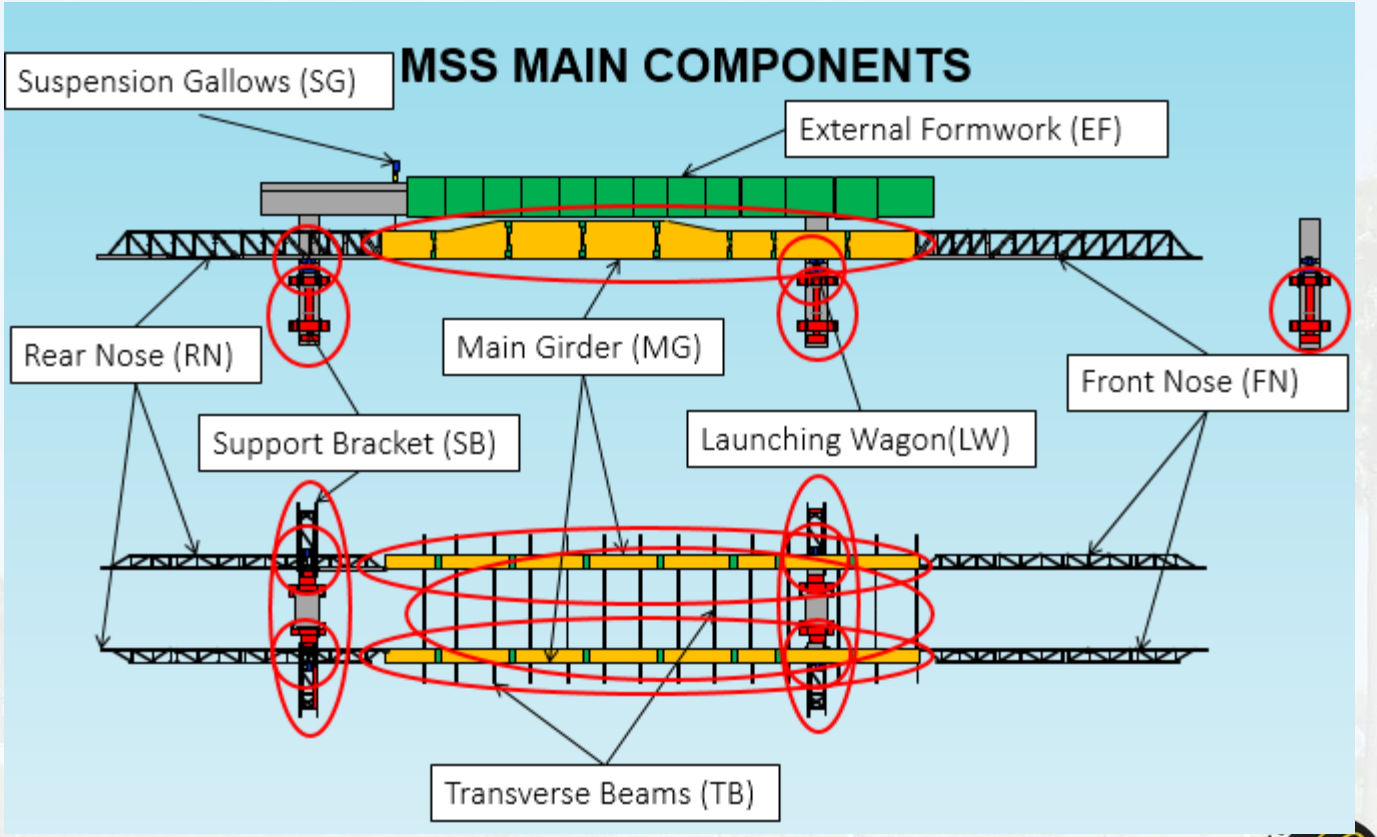
New Bridge Construction Methods

- MSS – Used on E&W Approaches



New Bridge Construction Methods

- MSS



New Bridge Construction Methods

- MSS

Before
August, 2015

After
December, 2015

New Bridge Construction Methods

- **Movable Scaffolding System MSS**
- MSS replaces conventional falsework means and methods when constructing in unsuitable ground conditions and heights greater than 150 feet
- Approximately 50,000 bolts per MSS, 22,000 of the total are torqued
- Approximately 14,200 pieces, each marked with their own unique I.D.

New Bridge Construction Methods

- MSS – first time used in North America
- MSS Video for First Launch

MSS First Lanch A2-A3.MPG

Project Team

- Project Team:
  - Owner — Port of Long Beach
  - General Contractor — SFI JV
  - Design Engineer — Arup
  - Construction Engineer — Arup/McNary Bergeron
  - Stays — VSL
  - PT — DSI

Thank You!

Questions ?

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