Tower Bridge Pedestrian/Bicycle Improvement Project

Tower Bridge Pedestrian/Bicycle Improvement Project

PRESENTATION OUTLINE

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   - Timeline
   - Typical Sections
2. Structure Description
   - Setting
   - Overview
   - West Approach
   - Fixed Truss
   - Lift Truss
   - East Approach

Tower Bridge Pedestrian/Bicycle Improvement Project

PRESENTATION OUTLINE - continued

3. Key Challenges
   - Maintaining Historical Integrity
   - Americans with Disabilities Act (ADA) Safety Improvements
   - Maintaining Navigational Clearance & Minimizing In-River Work
   - New Technology – Fiber Reinforced Polymer (FRP) Deck
   - Locking and Balancing of Lift Span During Construction
4. Conclusion

Tower Bridge Pedestrian/Bicycle Improvement Project

1. PROJECT DESCRIPTION – Project Team

Public Agencies

- Caltrans
- City of Sacramento
- City of West Sacramento

Design Engineer

- Parsons Brinckerhoff

Contractor

- Golden State Bridge

Construction Manager

- TRC

Tower Bridge Pedestrian/Bicycle Improvement Project

1. PROJECT DESCRIPTION - Timeline

Milestone	Date
Initial Study Circulation	2001
Advisory Council on Historic Preservation Approval	Mar 2005
Final Environmental Impact Report (EIR) & Project Report Approval	Jun 2005
PS&E Complete & Project Advertised for Bid	Oct 2006
Construction Contract Awarded & Construction Started	Dec 2006
Project Completed and Opened to Public	Dec 2007

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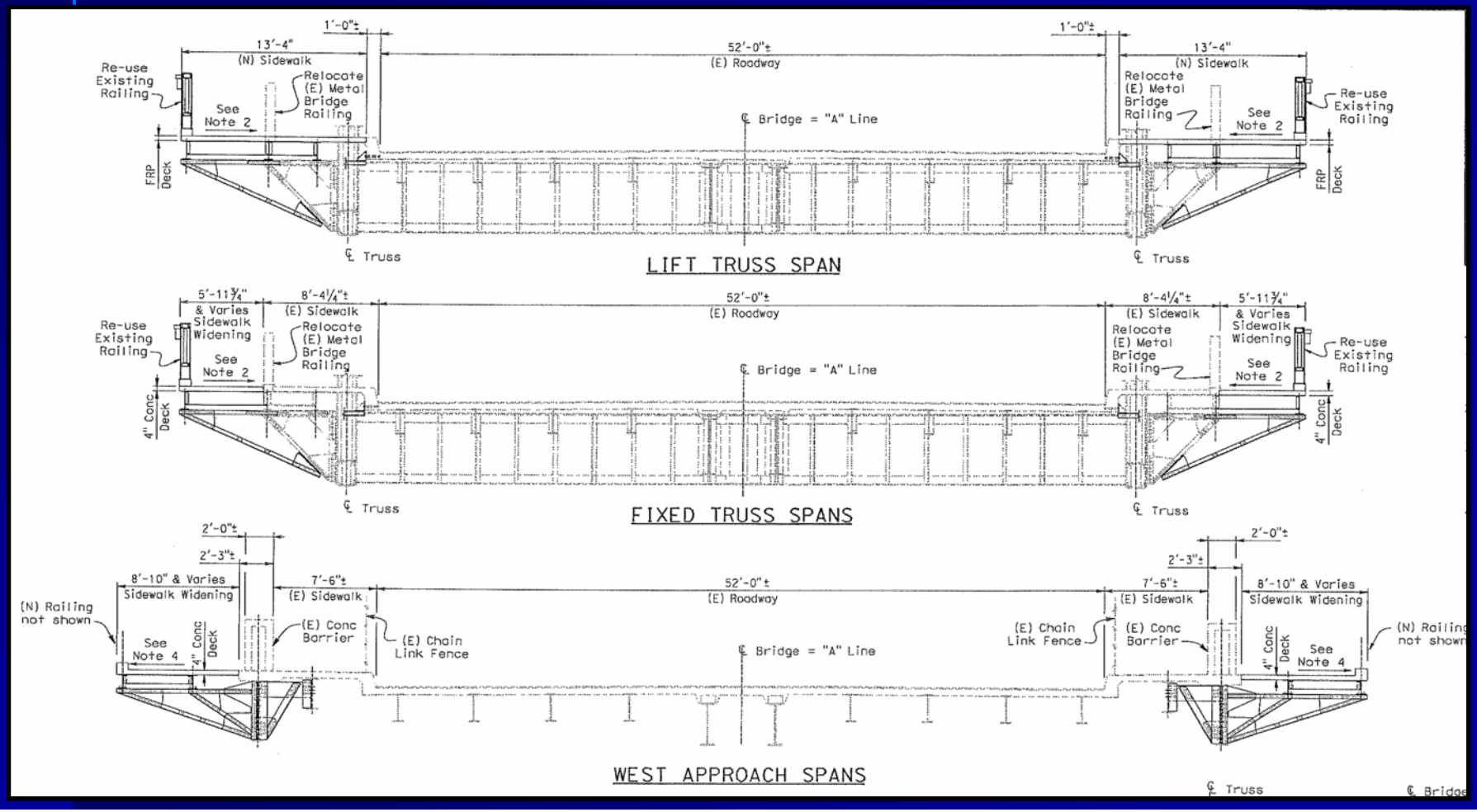
1. PROJECT DESCRIPTION – Typical Sections



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2. STRUCTURE DESCRIPTION - Setting

- Spans East-West over the Sacramento River
- Connects Cities of West Sacramento & Sacramento

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2. STRUCTURE DESCRIPTION - Overview

- Dedicated on December 15, 1935
- Total Length 738 feet
- 8 Spans

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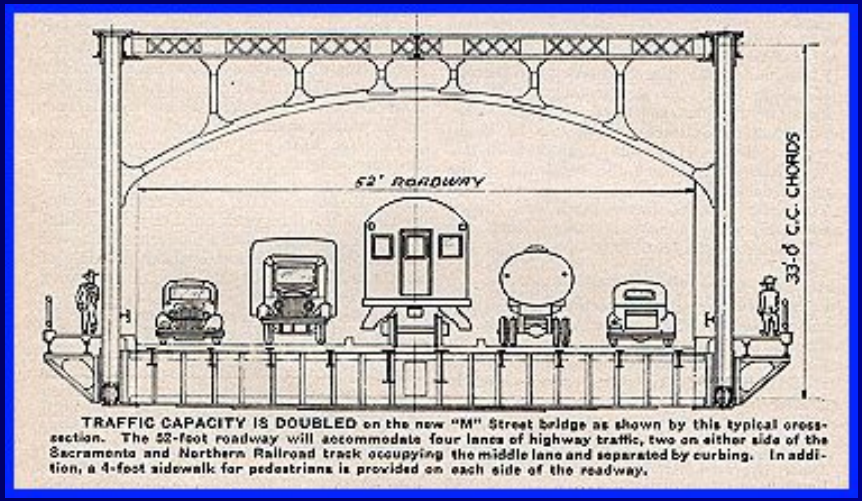
2. STRUCTURE DESCRIPTION - Overview



TRAFFIC CAPACITY IS DOUBLED on the new "M" Street bridge as shown by this typical cross-section. The 52-foot roadway will accommodate four lanes of highway traffic, two on either side of the Sacramento and Northern Railroad track occupying the middle lane and separated by curbing. In addition, a 4-foot sidewalk for pedestrians is provided on each side of the roadway.

- 52 ft Roadway Width
- Original Design:
  - Trolley (Cooper E-50) along centerline
  - 2 Vehicular lanes (H-15 Truck) in each direction
- 4 ft Sidewalk/Bikeway Width along Truss Spans

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2. STRUCTURE DESCRIPTION – West Approach Spans

- Spans 1 through 4
- Built up Plate Girders along Sidewalk
- 36” Stringers along Trolley
- 24” Stringers along Roadway
- Lightweight Concrete Deck

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2. STRUCTURE DESCRIPTION – Fixed Truss Spans

- Steel Floorbeams and Stringers
- Lightweight Concrete Deck
  - Span 5 (192'-6")
  - Span 7 (167'-5")
  - Steel Thru Truss

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2. STRUCTURE DESCRIPTION – Lift Truss Span

- Span 6 (209’-6”)
- Steel Through Truss
- Steel Floor beams and Stringers
- Lightweight Concrete Deck
- Vertical Lift Span

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2. STRUCTURE DESCRIPTION – Lift Truss Span

- Counterweights (1000 kips each) located in Towers at Piers 6 and Pier 7
- Each balance block 100 lbs

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2. STRUCTURE DESCRIPTION – East Approach Span

- Span 8 (30'-9")
- Reinforced Concrete Girder along Roadway and Sidewalks
- 36" Stringers along Trolley
- Lightweight Concrete Deck

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3. KEY CHALLENGES – Maintaining Historical Integrity

- **Re-Used Light Posts and Elements of the Railing**

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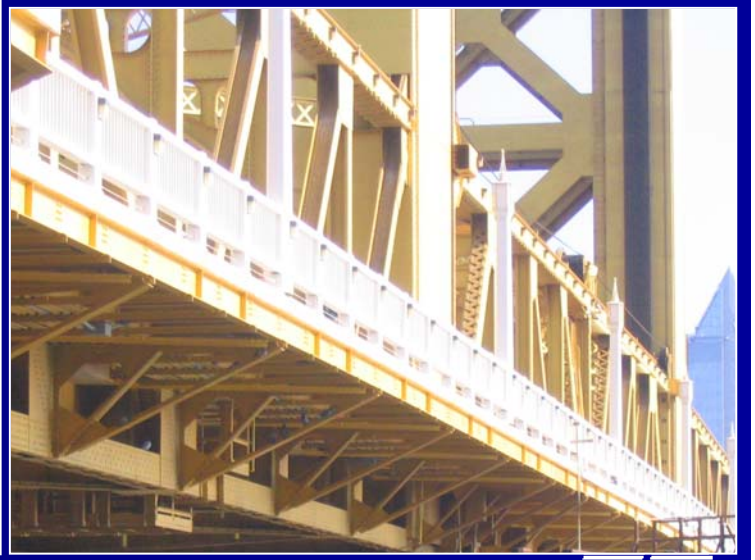
3. KEY CHALLENGES – Maintaining Historical Integrity

- **Extended Sidewalk Supports with Similar Elements**



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3. KEY CHALLENGES – Maintaining Historical Integrity

- **Sidewalk Layout Maintained Existing Walls and Pillars**

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3. KEY CHALLENGES – Maintaining Historical Integrity

- Pedestrian Safety Gates remained
- New Wider Gates Placed Beyond

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3. KEY CHALLENGES - ADA Safety Improvements

- ADA compliant ramps were provided

- Appropriate cane detection barriers were installed at the restricted head room areas on the diagonal truss members

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3. KEY CHALLENGES - ADA Safety Improvements

- BEFORE

- AFTER:

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3. KEY CHALLENGES - Maintaining Navigational Clearance

- Construction on lift span within specific time periods when the bridge was in an uplocked position, clearing navigational requirements

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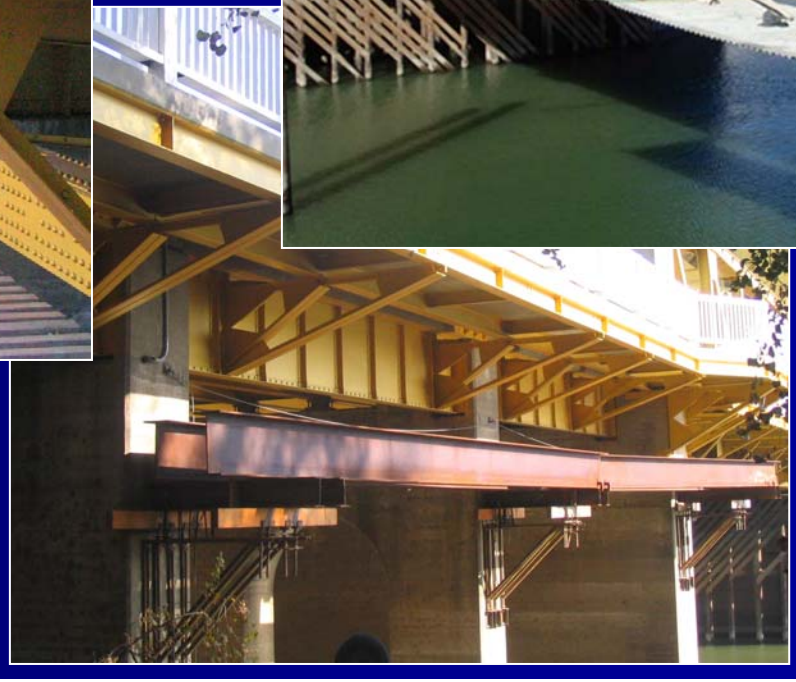
3. KEY CHALLENGES - Minimizing In-River work



- Suspended and Elevated Work Platforms eliminated the need for Work Barges or Trestles

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3. KEY CHALLENGES – New Technology FRP Deck

- Due to limited lifting machinery capacity, widening could not increase overall weight of Lift Span.
- Entire Concrete deck on Lift Span was replaced by a lighter Fiber Reinforced Polymer (FRP) deck to achieve sidewalk width increase without adding weight

Deck Type Comparison		
Type	Weight (psf)	Pedestrian Load Deflection (inches)
5” Thick Lightweight Concrete (no voids)	42 psf	0.002313”
5” Thick FRP Deck Section	13 psf	0.000145”

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3. KEY CHALLENGES – New Technology FRP Deck

- Fabricator and Installation: Martin Marietta Composites, Inc. (MMC)
- Development of the DuraSpan deck system began in 1992 at Lockheed Martin Corporation
- 1995, Martin Marietta Materials split from Lockheed Martin Co.
- Martin Marietta Materials formed MMC to develop and market composite products
- FRP composite combination of:
  - polymer matrix (resin, fillers, and additives) and
  - reinforcing agent (glass or carbon fabrics)
- FRP constituent elements retain their individual properties but functions as a single element

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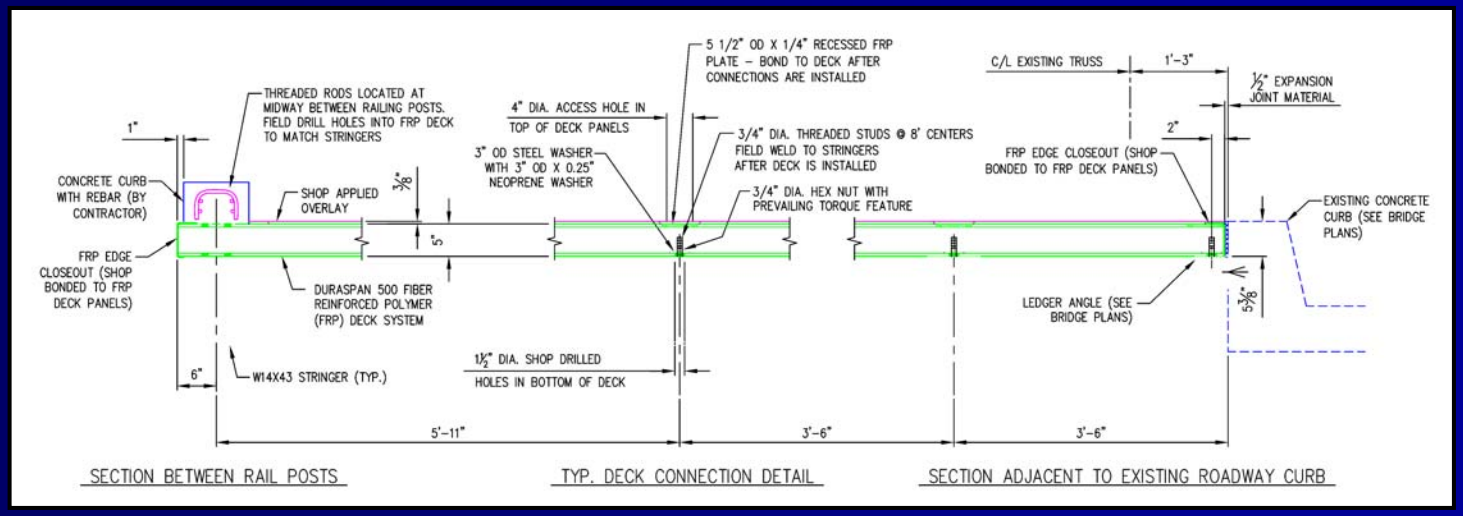
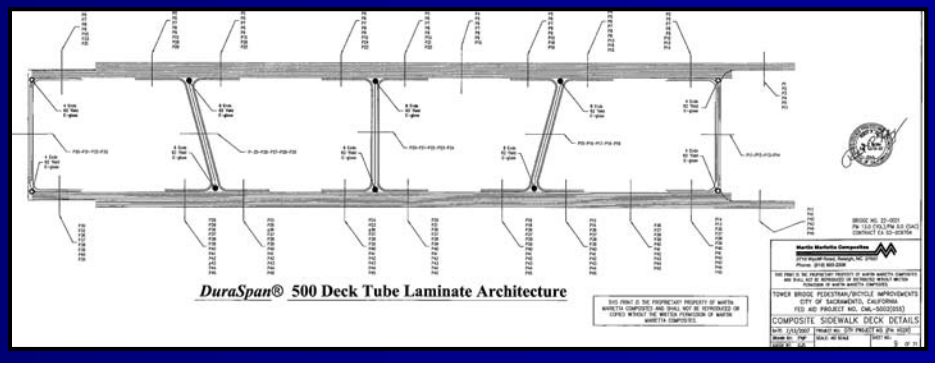
3. KEY CHALLENGES – New Technology FRP Deck

Typical Sections:



- MMC patented trapezoidal core deck tube sections span transversely between steel stringers



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3. KEY CHALLENGES – New Technology FRP Deck Installation:

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3. KEY CHALLENGES – New Technology FRP Deck

Installation:

- **13'-6" Wide x 8'-0" Long Typical Panel Sections**
- **Joints Spliced in Field**

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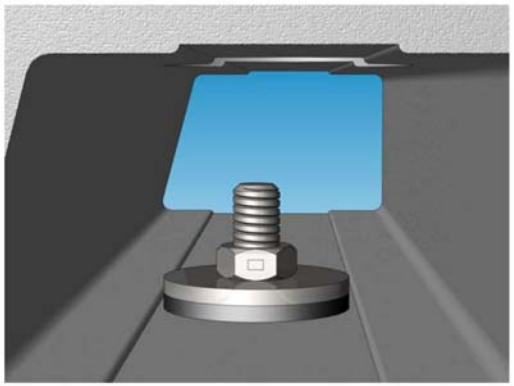
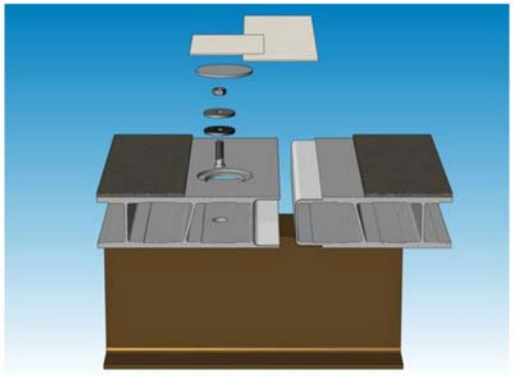
3. KEY CHALLENGES – New Technology FRP Deck

Connections:





- Threaded Studs Field Welded to Steel Support Stringers
- Hex Nut with Oversized Washer
- FRP Cover Plates installed over holes to seal the cavity
- FRP Splice Strip applied over the Bond Lines

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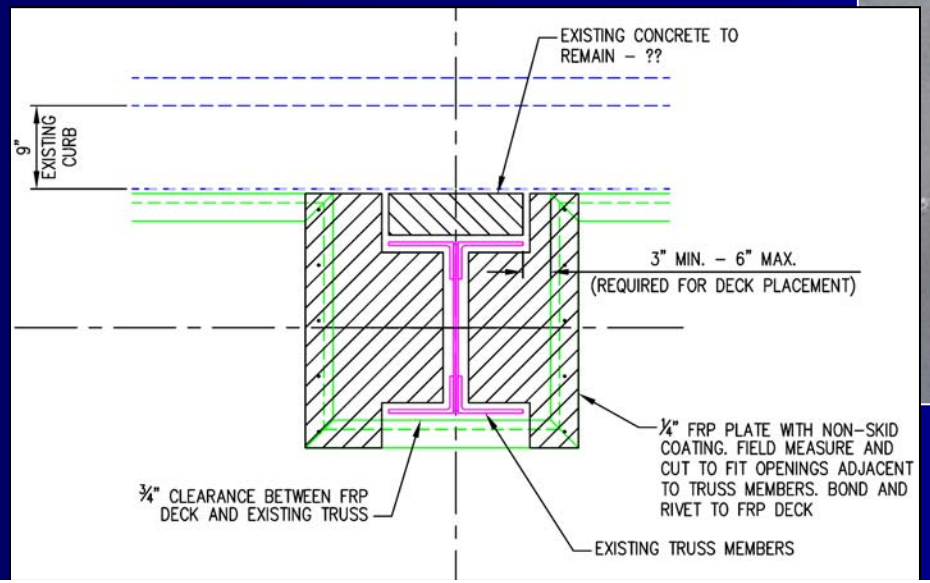
3. KEY CHALLENGES – New Technology FRP Deck

Interface with Truss Members:

- ¼" Thick FRP Plate used at Interface with Truss Members



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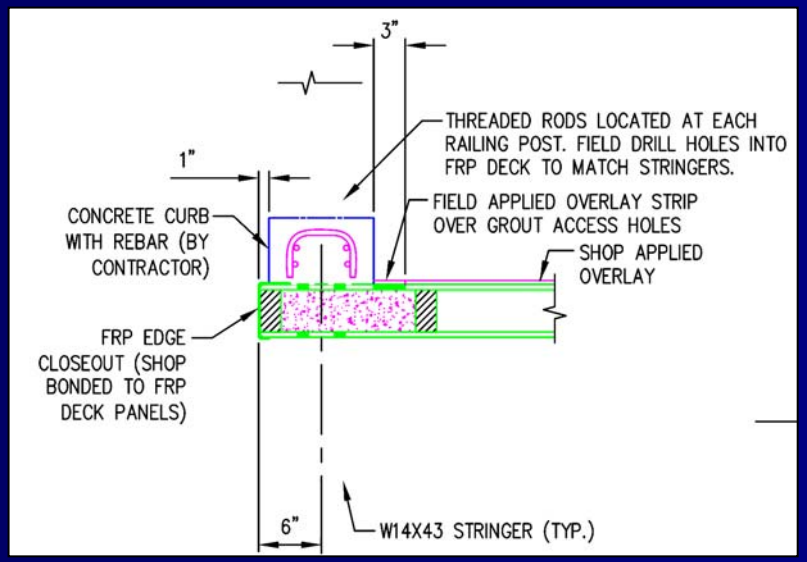
3. KEY CHALLENGES – New Technology FRP Deck

Post and Railing Connections:



- Threaded Rods Connect Rail/Lamp Post Directly to Steel Stringers
- Reinforced Concrete Curb Cast on FRP Deck
- Grouted Cavity Below Post

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3. KEY CHALLENGES – New Technology FRP Deck

Overlay:

- FRP Deck Surface sanded in shop to receive overlay
- Kwik Bond Polymer Concrete Overlay field applied

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3. KEY CHALLENGES – Locking and Balancing of Lift Span During Construction

Project Specifications Required Contractor to:

- Design and Furnish Temporary Locking System Independent of the Bridge Machinery and Braking Systems
- Develop and Submit a Balancing Monitoring Plan for each Construction Stage

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3. KEY CHALLENGES – Locking and Balancing of Lift Span

Temporary Locking System: Active Restraint

- W14 attached to Tower and 4x4 Structural Tubing lock Counterweight upward movement
- Channels and Rods lock Counterweight downward movement

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3. KEY CHALLENGES – Locking and Balancing of Lift Span

Temporary Locking System: Passive Restraint

- Cables and K-Rail prevent upward movement of Counterweights
- Cables attached to Towers prevent downward movement of Counterweights

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3. KEY CHALLENGES – Locking and Balancing of Lift Span

Develop and Submit a Balancing Monitoring Plan

- As Equipment/Material is added to Span, Blocks are added to Counterweight to Maintain overall Span-Counterweight Balance

Milestone	Description of Work Related to Weight Change	GSB Weight										
		North Side			South Side			Out of North-South Balance lbs	Span Condition	Cumulative Added to Bridge lbs	Cumulative Added to Counterweight lbs	Out of Bridge - Counterweight Balance
		Bridge lbs	Counterweight lbs	cumulative lbs	Bridge lbs	Counterweight lbs	cumulative lbs					
	Distribute Safespan	6000		6000	6000		6000	0	heavy	12000	0	12000
	Distribute Demolition Shield	4500		10500	4500		10500	0	heavy	21000	0	21000
Balance Safespan & Demolition Shield	Move Blocks from Tower to Counterweight		-10500	0		-10500	0	0	heavy		21000	0
	Place Construction Equipment on Bridge	8000		8000	8000		8000	0	heavy	37000	0	37000
	Place Permanent Construction Material	82940		90940	82940		90940	0	heavy	202880	0	202880
	Remove Guard Rail	-12072		78868	-12072		78868	0	heavy	178736	0	178736
	Remove Demolished Concrete	-74368		4500	-74368		4500	0	heavy	30000	0	30000
	Remove Demolition Shield	-4500		0	-4500		0	0	heavy	21000	0	21000
	Erect FRP North	31000		31000			0	31000	heavy	52000	0	52000
	Remove Existing Stringers North	-11000		20000			0	20000	heavy	41000	0	41000
1	Add New Blocks to Counterweight		-20000	0			0	0	heavy		41000	0
	Erect FRP South			0	31000		31000	31000	heavy	72000	0	72000
	Remove Existing Stringers South			0	-11000		20000	20000	heavy	61000	0	61000
2	Add New Blocks to Counterweight			0		-20000	0	0	heavy		61000	0
	Build New Curb North	11141		11141			0	11141	heavy	72141	0	72141
	Finish Paint North	1000		12141			0	12141	heavy	73141	0	73141
3	Add New Blocks to Counterweight		-12000	141			0	141	heavy		73000	141
	Re-install Handrail North	150		291			0	291	heavy	73291	0	73291
	Build New Curb South			291	11141		11141	10850	heavy	84432	0	84432
	Finish Paint South			291	1000		12141	11850	heavy	85432	0	85432
4	Add New Blocks to Counterweight			291		-9800	2341	2050	heavy		82800	2632
	Install Head Room Safety Railing North	1160		1451			2341	890	heavy	86592	0	86592
	Re-install Handrail South			1451	150		2491	1040	heavy	86742	0	86742
	Install Head Room Safety Railing South			1451	1160		3651	2200	heavy	87902	0	87902
	Remove Equipment and Material	-2500		-1049	-2500		1151	2200	heavy	82902	0	82902
	Remove Crane	-8000		-9049	-8000		-6849	2200	*light*	66902	0	66902
	Remove Remaining Existing Structural Steel	-8572		-17621	-8572		-15421	2200	*light*	49758	0	49758
	Re-install Guard Rail	12072		-5549	12072		-3349	2200	*light*	73902	0	73902
Balance Equipment Removal & Guard Rail	Ruturn Blocks from Couterweight to Tower		4500	-1049		4500	1151	2200	heavy		73800	102
Fine Tuning			-51	-1100		-51	1100		heavy		73902	0
	Remove Safespan	-6000		-7100	-6000		-4900	2200	*light*	61902	0	61902
Balance Safespan Removal	Ruturn Blocks from Couterweight to Tower		6000	-1100		6000	1100	2200	heavy		61902	0

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3. KEY CHALLENGES – Locking and Balancing of Lift Span

Develop and Submit a Balancing Monitoring Plan

Static Balance Monitoring:

- Contractor continuously tracked the weight of material added to or removed from Lift Span
- Weights measured using certified jobsite scales
- Load cells used to measure restraining forces on the Counterweights

Dynamic Balance Monitoring:

- Initial Dynamic Balance measurements established by Caltrans prior to start of work
- Upon Completion of Work and Operational Transfer, up-haul and down-haul power measured using watt-meter

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4. CONCLUSIONS

- Outstanding example of a context-sensitive and sustainable design approach to a very difficult set of technical problems
- Provides an improved vital link for pedestrians and bicyclists between the Cities of Sacramento and West Sacramento

Tower Bridge Pedestrian/Bicycle Improvement Project

Recognitions:

- **2008 California Transportation Foundation TRANNY Award**
- **2009 CALTRANS Excellence in Transportation Award**
- **2009 SACOG – Special Recognition for Government Collaboration**
- **McGraw-Hill (ENR) – California Construction Best of 2008**
- **2008 CMAA Construction Management Project Achievement Award**
- **2008 ASCE Region 9 History and Heritage Project of the Year**

QUESTIONS?