

# Folsom Lake Crossing

Western Bridge  
Conference

Jeff Thomure / MS, CA PE – CH2M HILL

September, 2009



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# Folsom Lake Crossing Outline

## Presentation Outline

- Project Overview
- Design Summary
- Construction Summary
- Lessons Learned / Best Practices

# Folsom Dam



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# Project Team

## Funding Agencies:

- US Army Corps of Engineers, Sacramento
- *City of Folsom*

## Consultants:

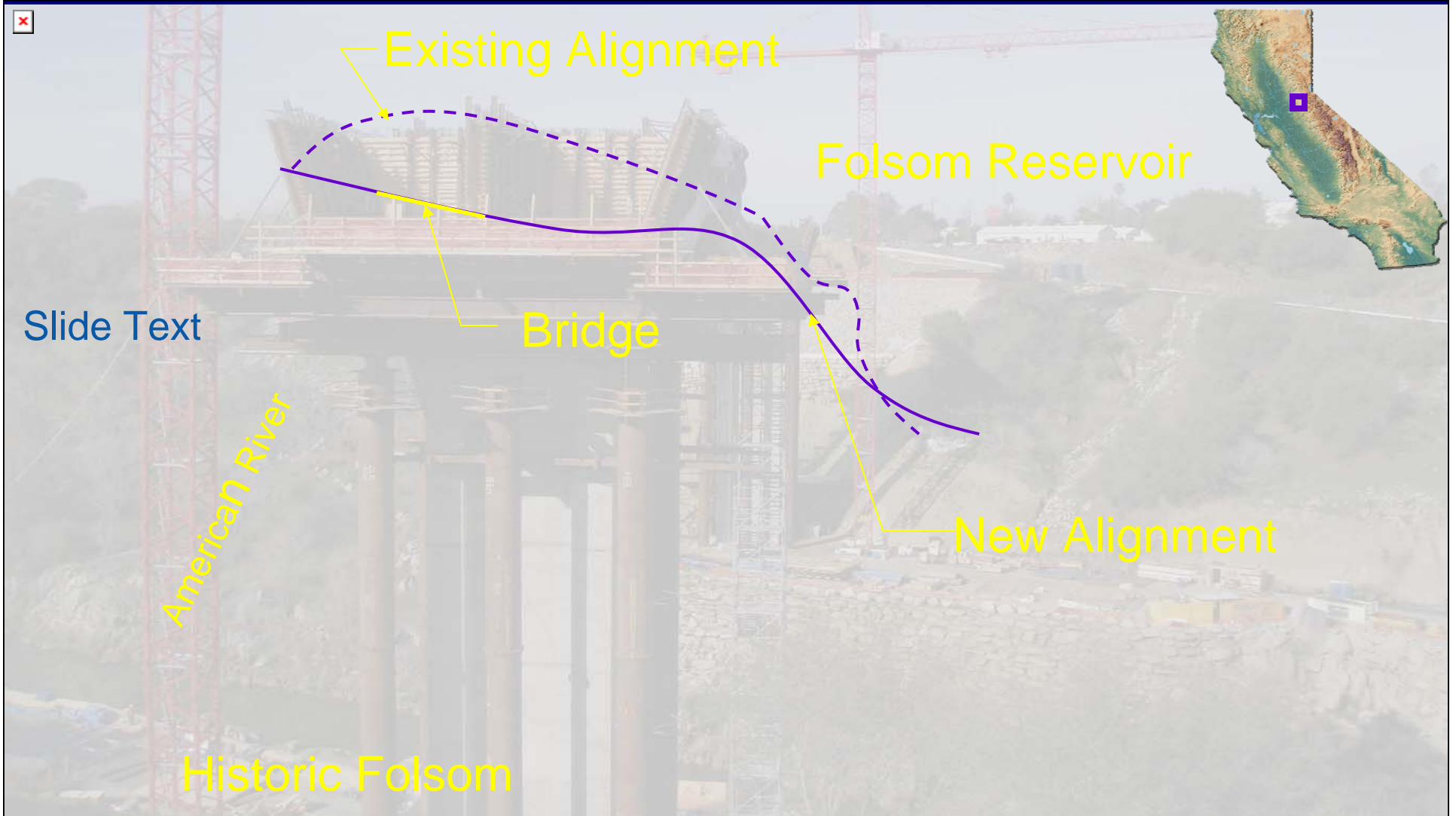
- CH2M HILL (Bridge Design)
- *URS (Road Design, Bridge Check)*

## Constructor:

- Kiewit
- McNary Bergeron
- SDI
- A & A Ready Mix Concrete



# Final Alignment



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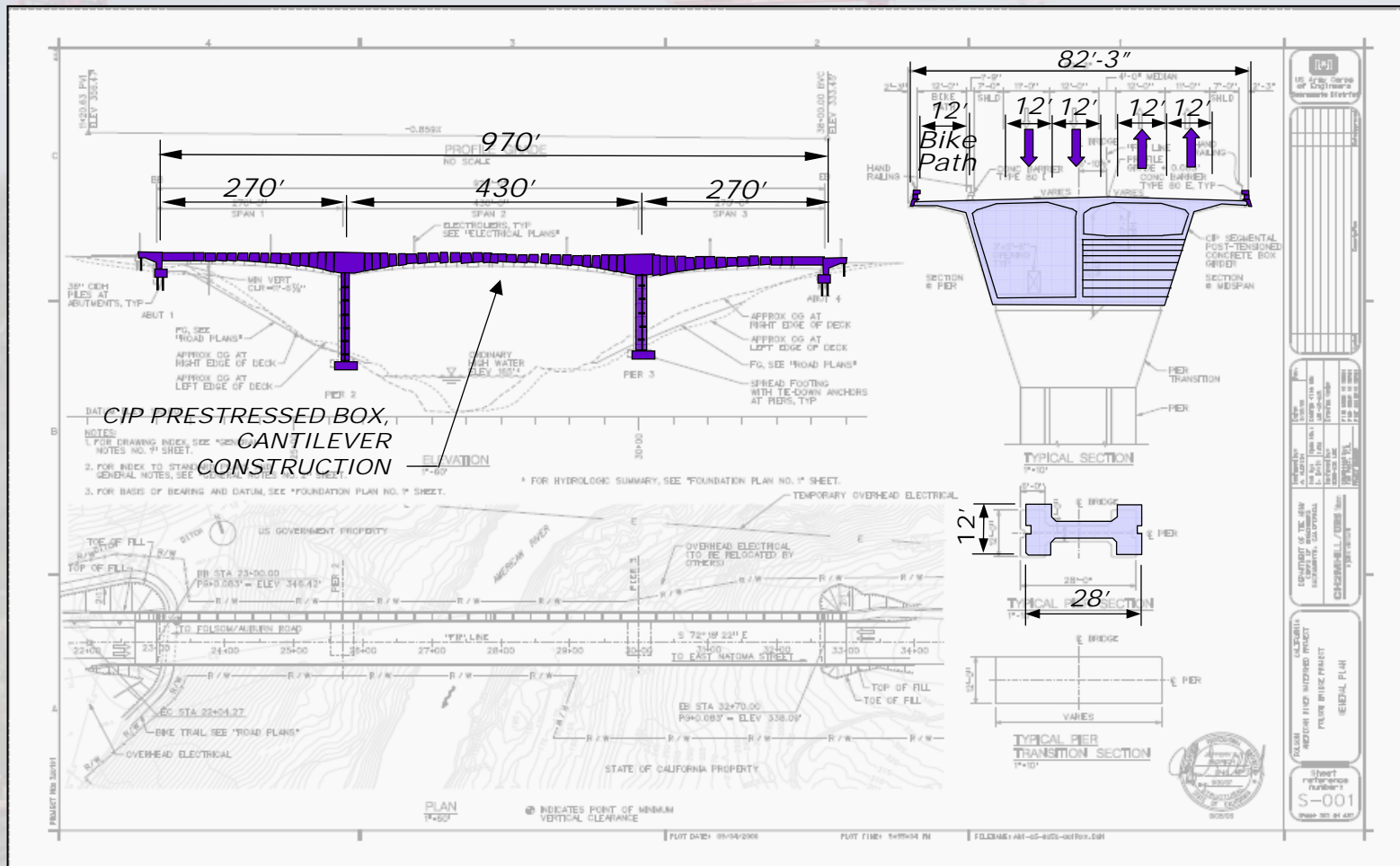
# Alternatives Considered

- CIP Concrete Box Girder
- Steel Plate Girder
- Extradosed Concrete Girder
- CIP Segmental Box Girder

# Design

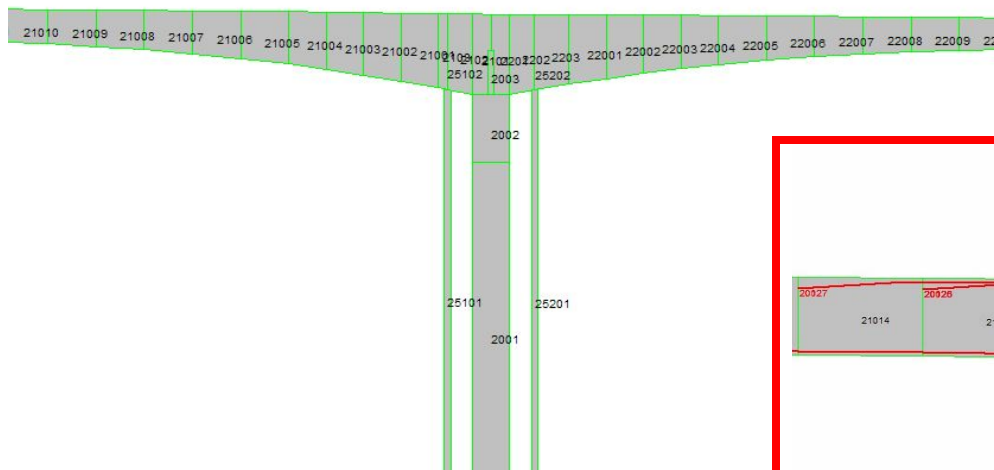


# Bridge General Plan



# Time Dependent Analysis

- Construction and Material Non-linear Time Effects
- CEB-FIP 1990 Code
- Software: Bridge Designer 2 (BD2)
- Model Assumed Sequence and equipment

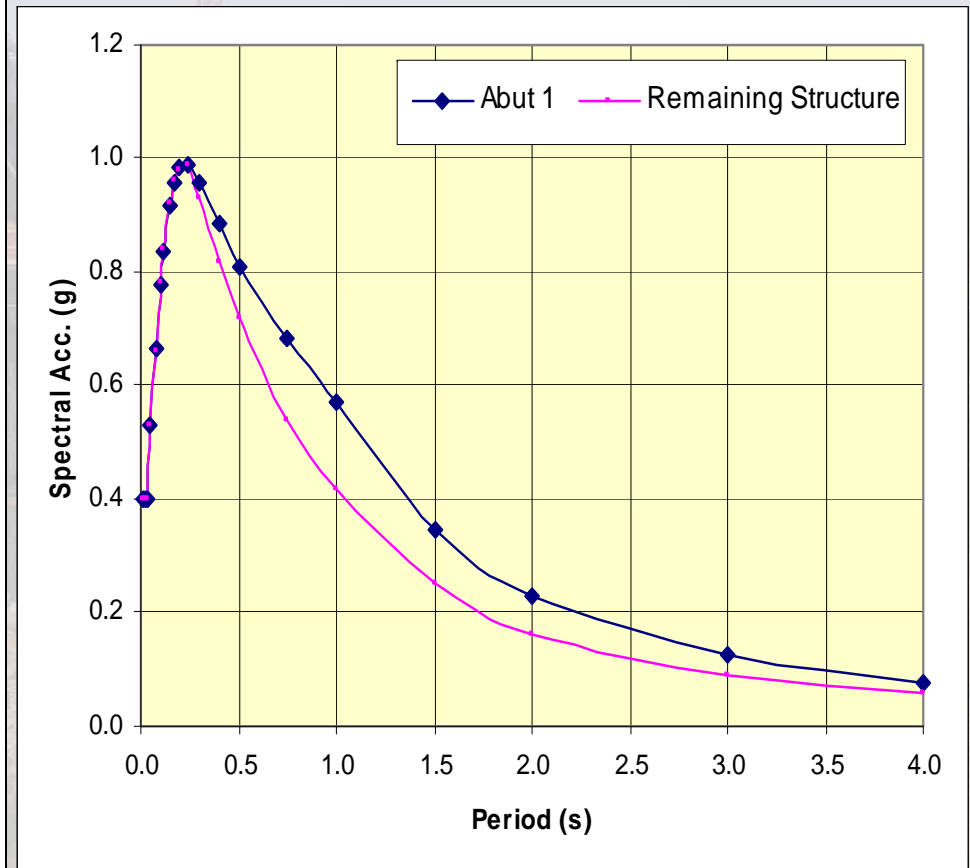


- Construction Sequence Features
  - 2 Week Segment Cycle
  - Pier Struts
  - Cast – in Place Segments at Abutments

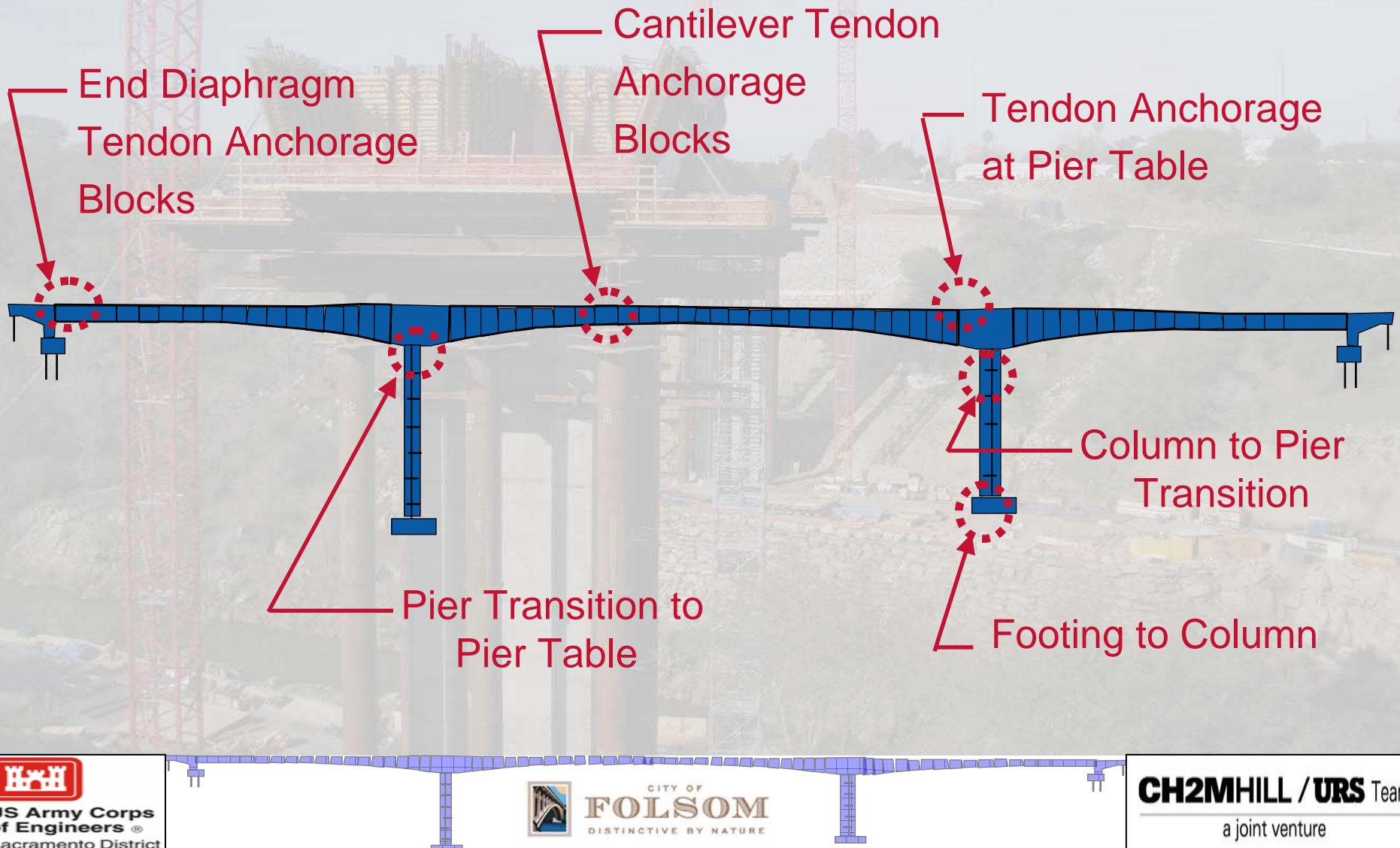


# Seismic Design

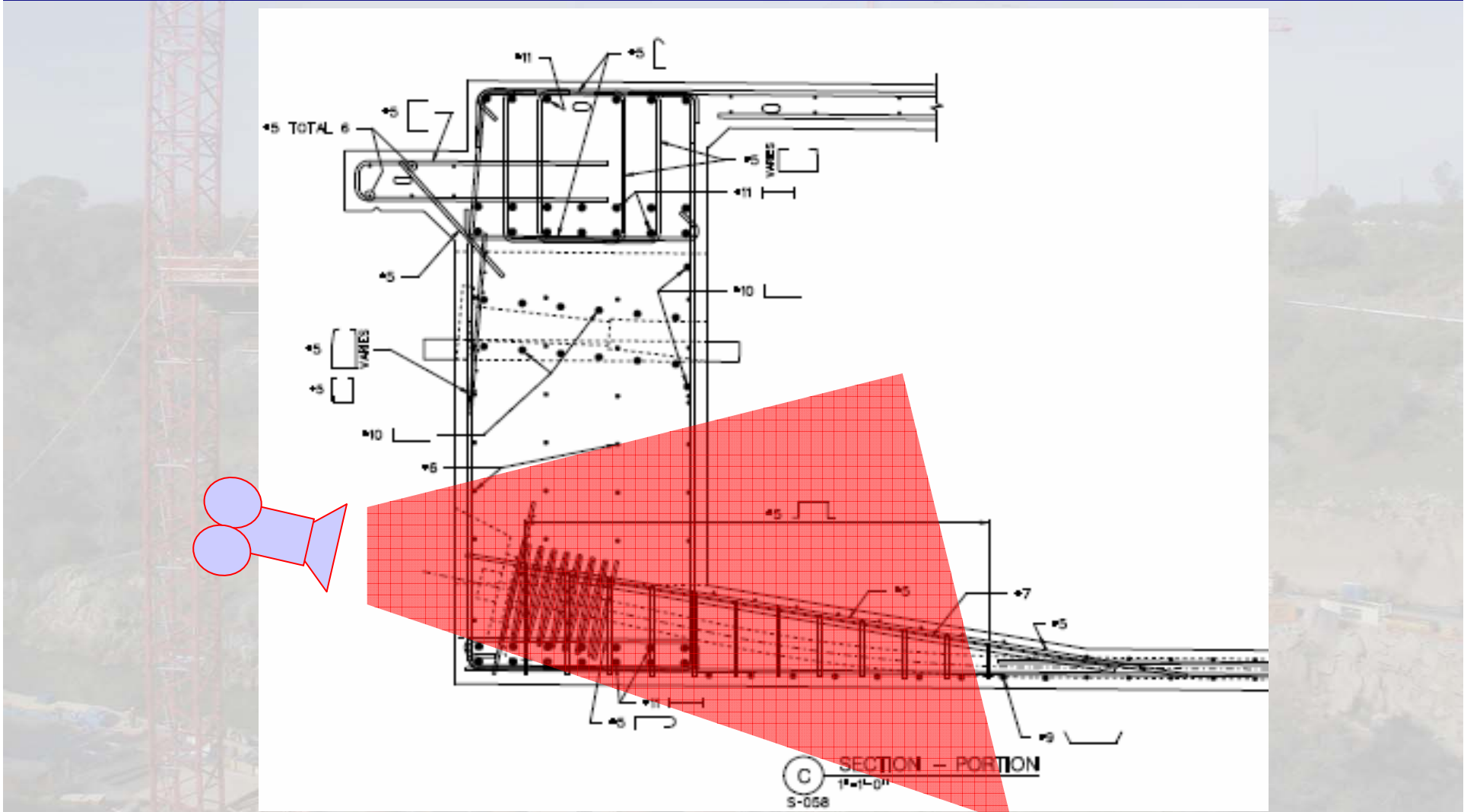
- Caltrans Design Philosophy
  - Column Plastic Hinging
    - Joint Shear
    - Footing Hold Downs
- ARS Analysis (SAP 2000)
  - Bear Mountain fault approximately 8 km (5 miles) from the bridge site
  - maximum Credible Earthquake (MCE) magnitude of 6.5.
  - Near-field effects Implemented
  - Vertical Acceleration
    - $1.0V + 0.3T + 0.3L$
- 10% G Construction case.



# Integrated Drawings



# End Diaphragm Anchorage



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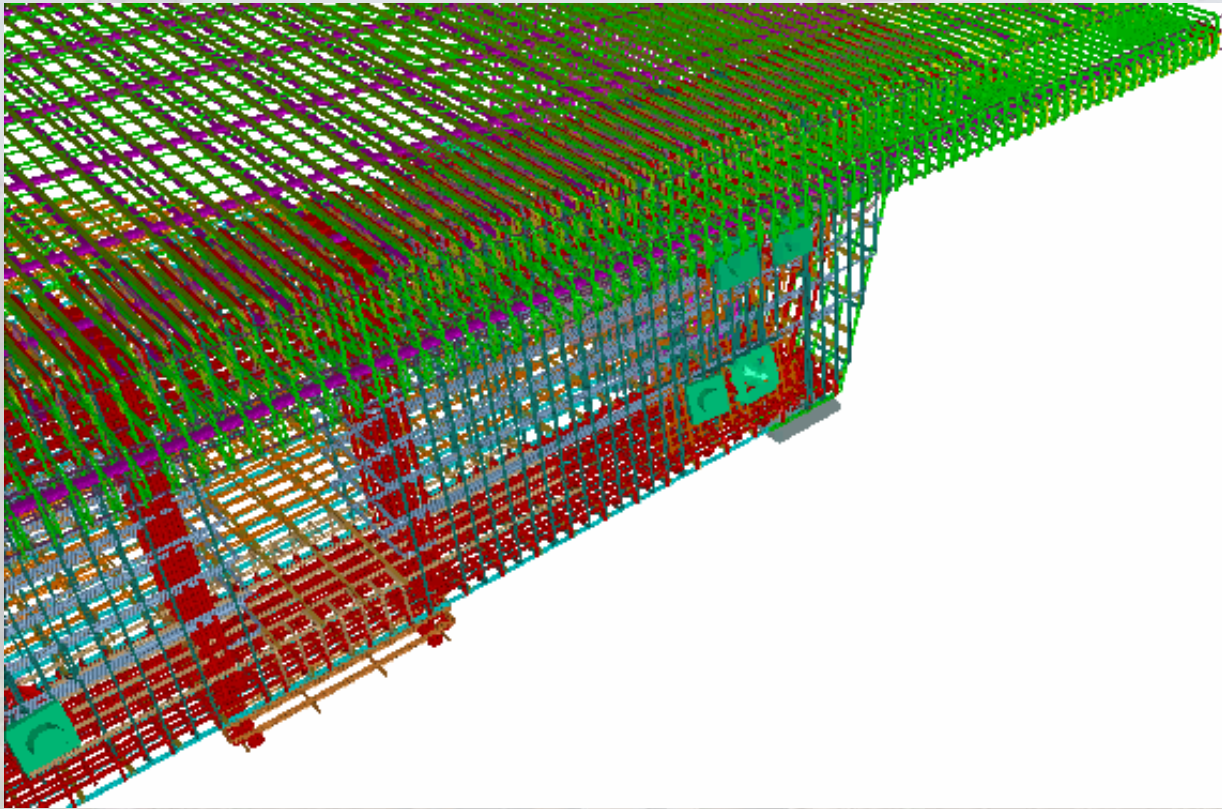


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# End Diaphragm Anchorage



3D Video from a New Perspective



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# Safety During Construction

# Construction



MAKE  
TIME  
FOR  
  
SAFETY

 **Kiewit**  
NORTHERN CALIFORNIA DISTRICT



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# West Slope Replacement



Backfilling Operations



Excavation (90,000 CY)



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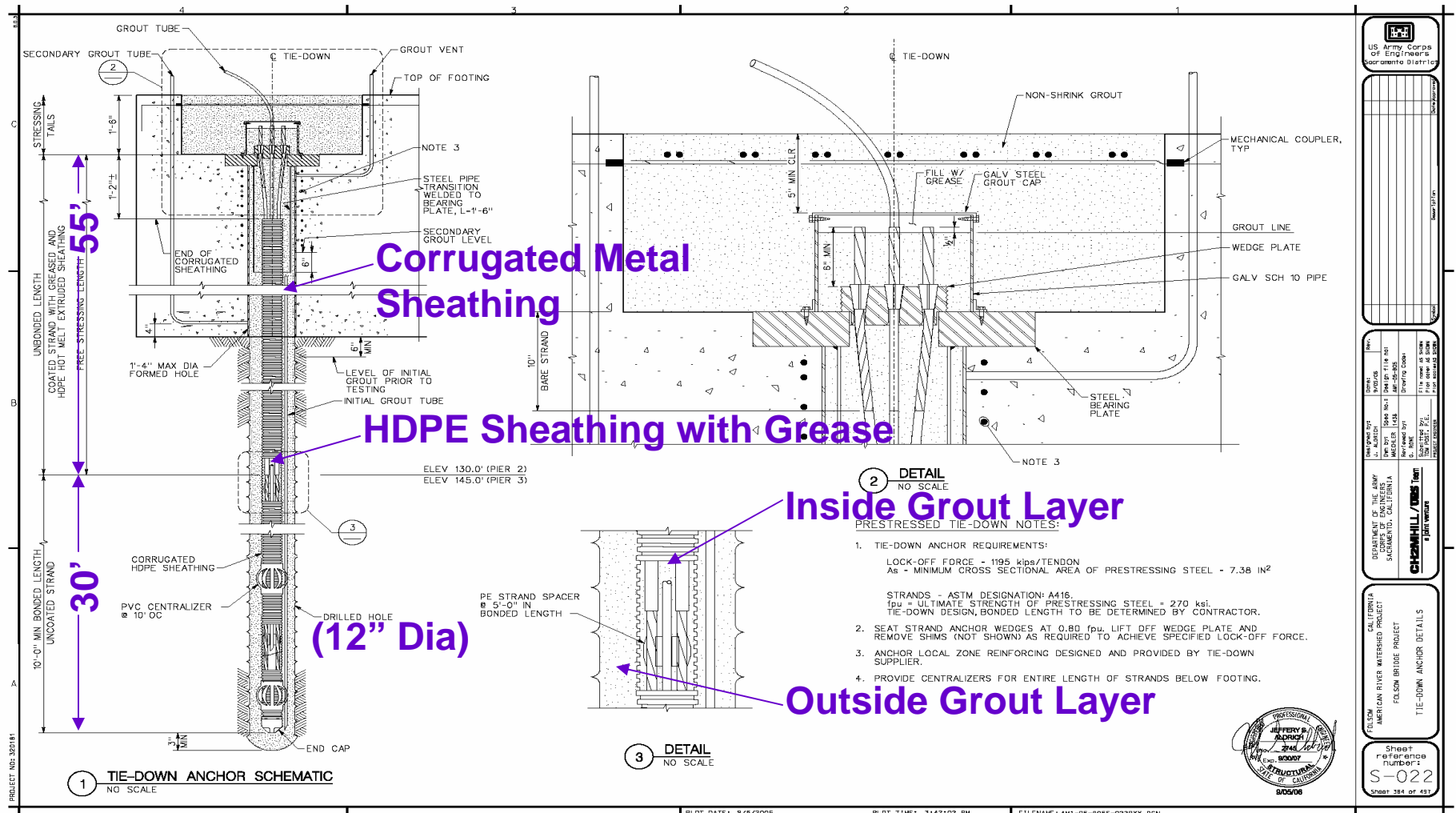


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# Rock Anchors



DRAWN BY: JAV/RS CHECKED BY: JAV/RS DESIGNED BY: JAV/RS DATE: 9/9/2006	PROJECT NO: 022RXX SHEET NO: 022 DATE: 9/9/2006
DEPARTMENT OF THE ARMY WATERSHED DISTRICT OF CALIFORNIA SACRAMENTO, CALIFORNIA <b>CH2MHILL / URS Team</b> a joint venture	
CALIFORNIA AMERICAN RIVER WATERSHED PROJECT FOLSOM BRIDGE PROJECT TIE-DOWN ANCHOR DETAILS	
SHEET REFERENCE NUMBER: <b>S-022</b> SHEET 284 OF 407	



# Rock Anchors

- Drill Rock Anchor Holes (Rotary and Percussion Drilling)
- Water Pressure Test and Infiltration Rate



Drilling



Water Pressure Test



# Rock Anchors

- Install Rock Anchor Prestressing Assembly
- Performance and Proof Tests



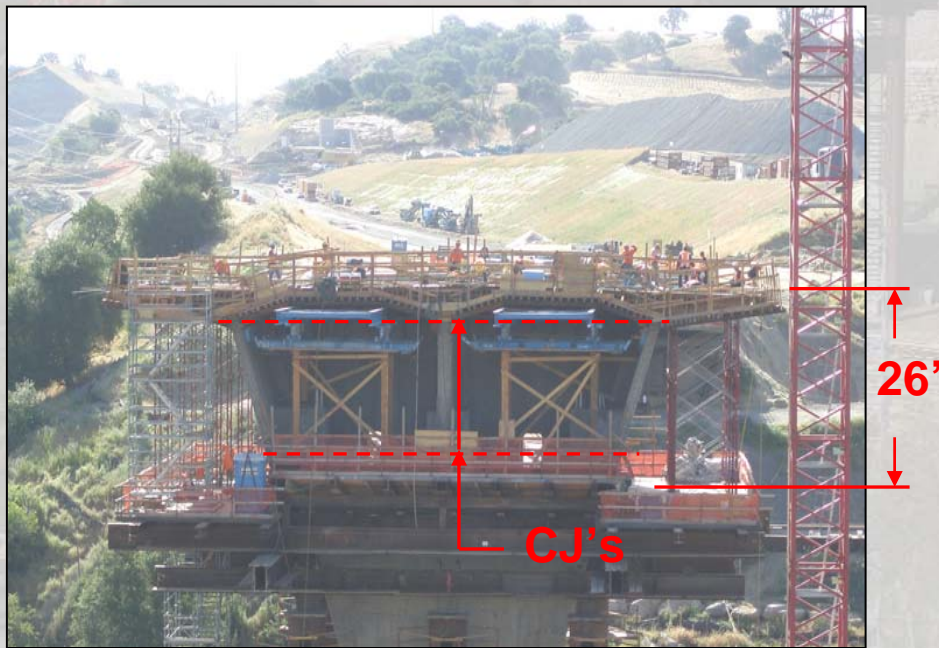
PS Tiedown Assembly



Post-Tensioning

# Pier Tables

- Pier Table Height = 26' (2 CJ's)
- Pier Table Length = 42' + 12' = 54'
- Struts Utilized for Pier Table Falsework



# Pier Tables



Overview



Diaphragm Wall



Diaphragm Rebar



Top Deck



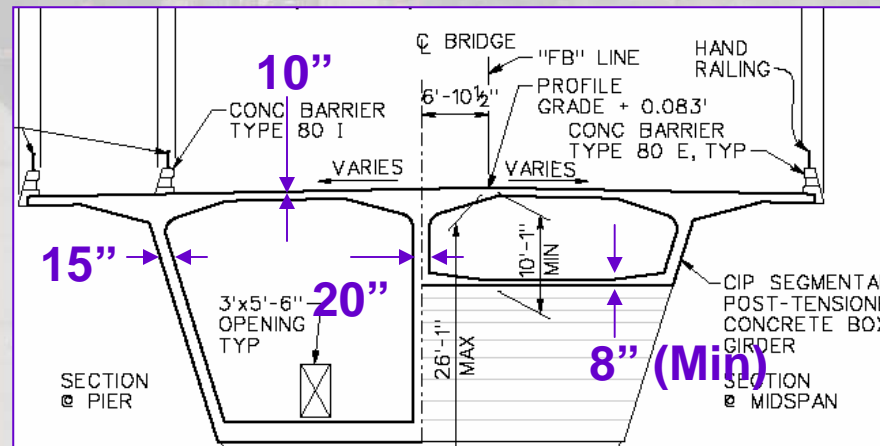
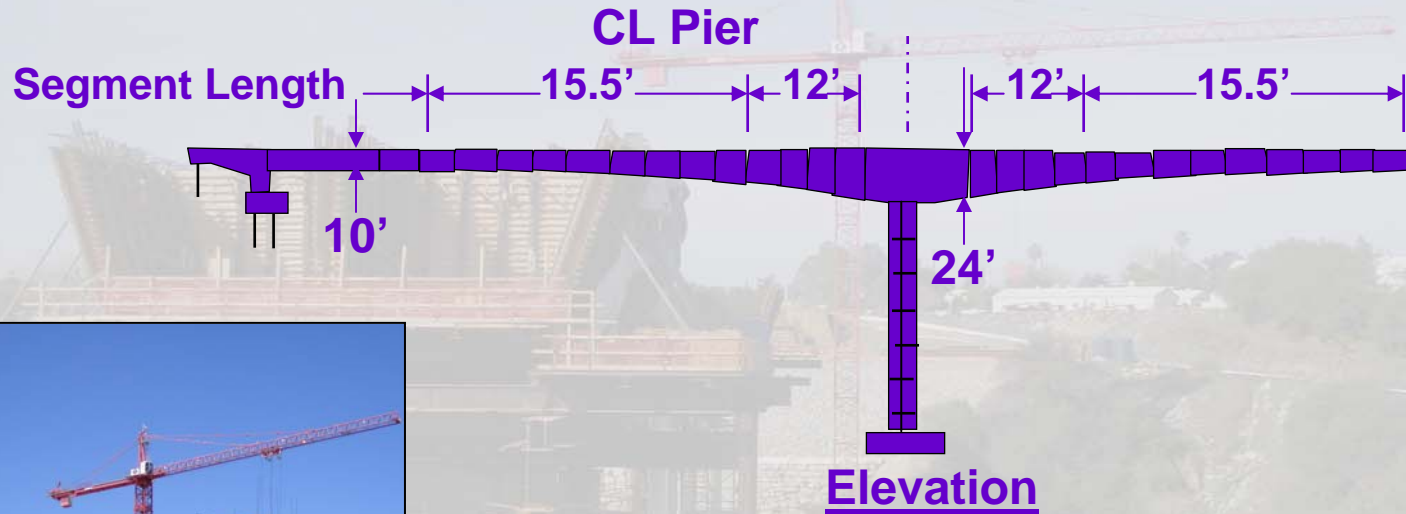
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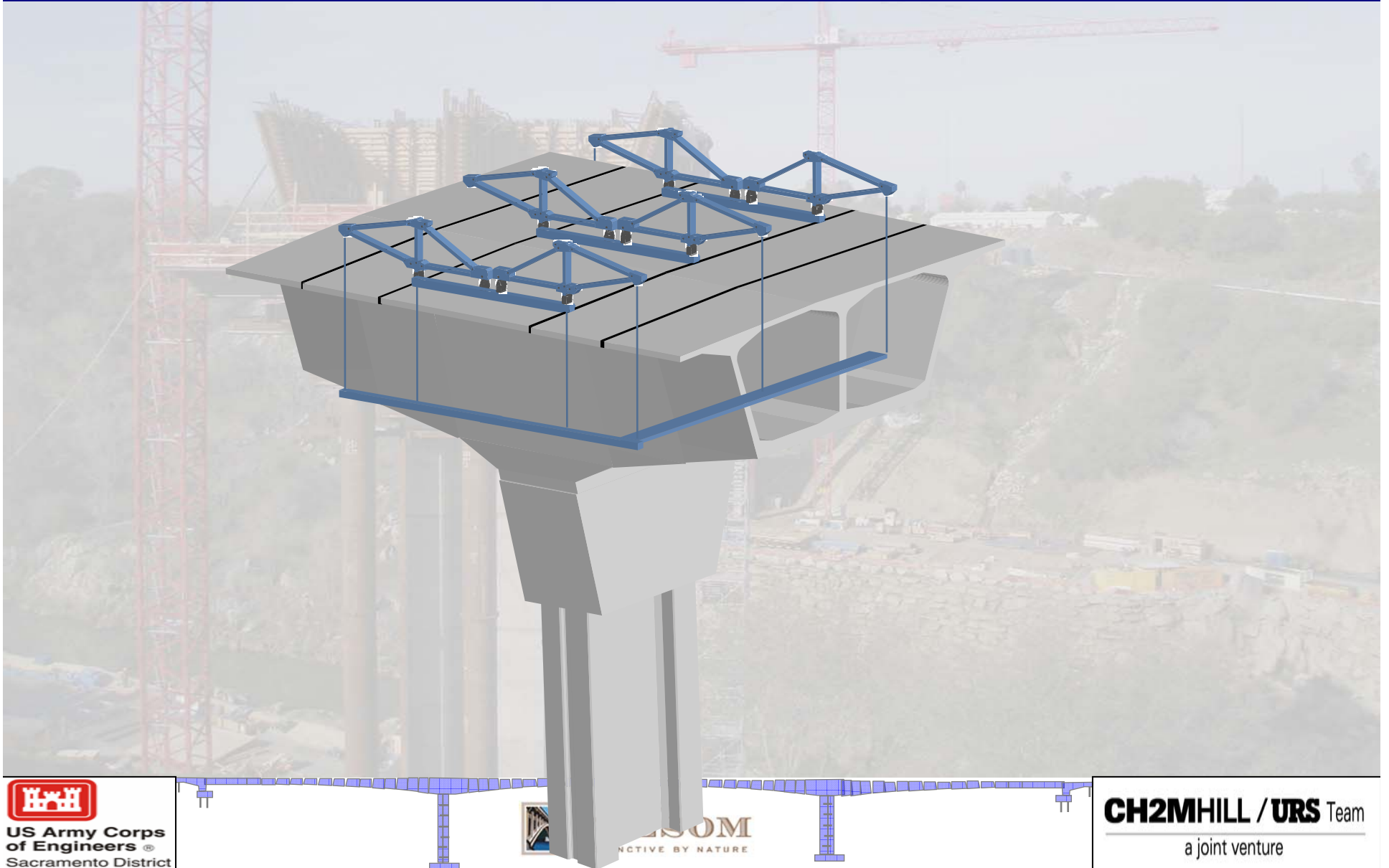
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# Segments



# Cantilever Construction - Segments



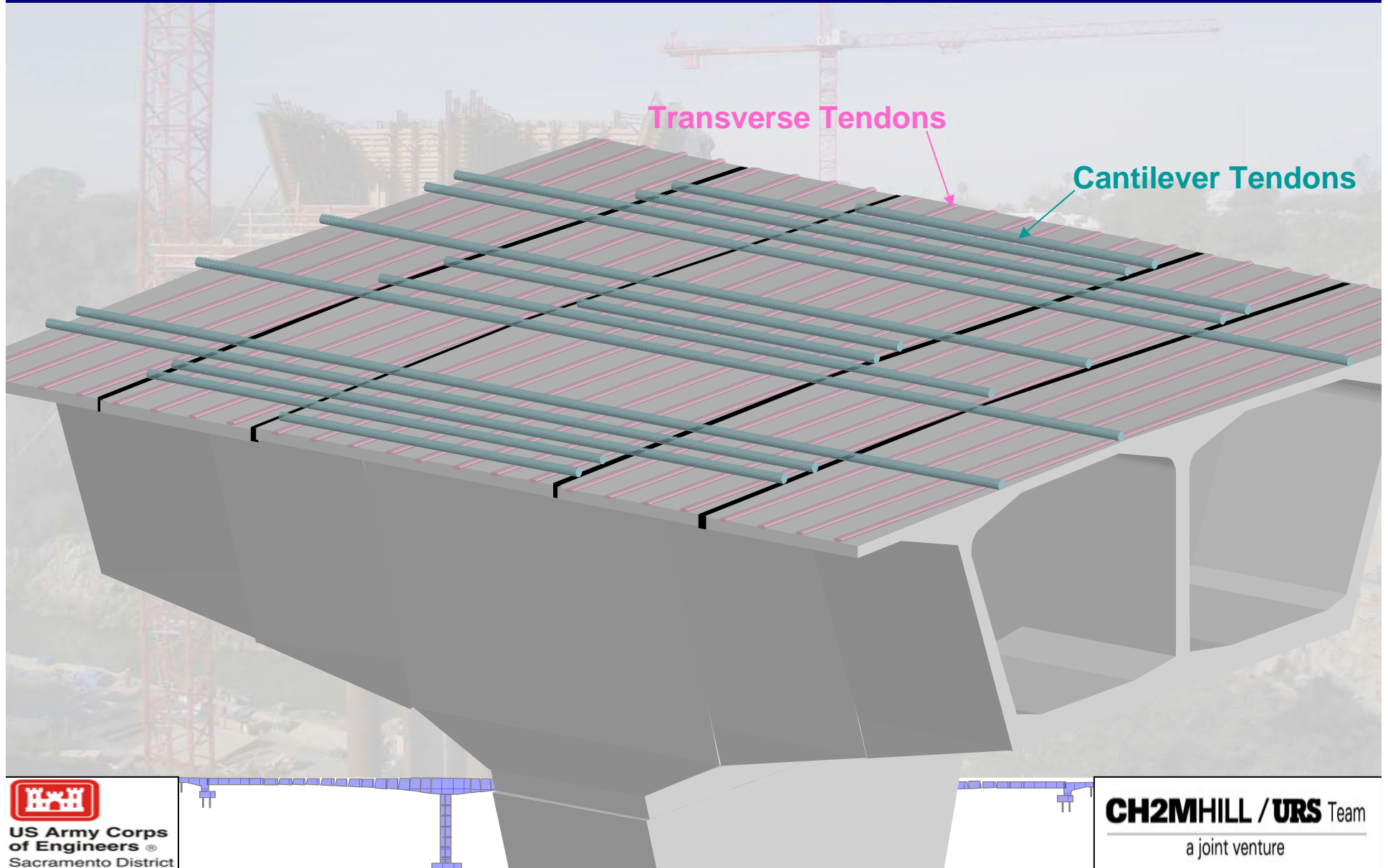
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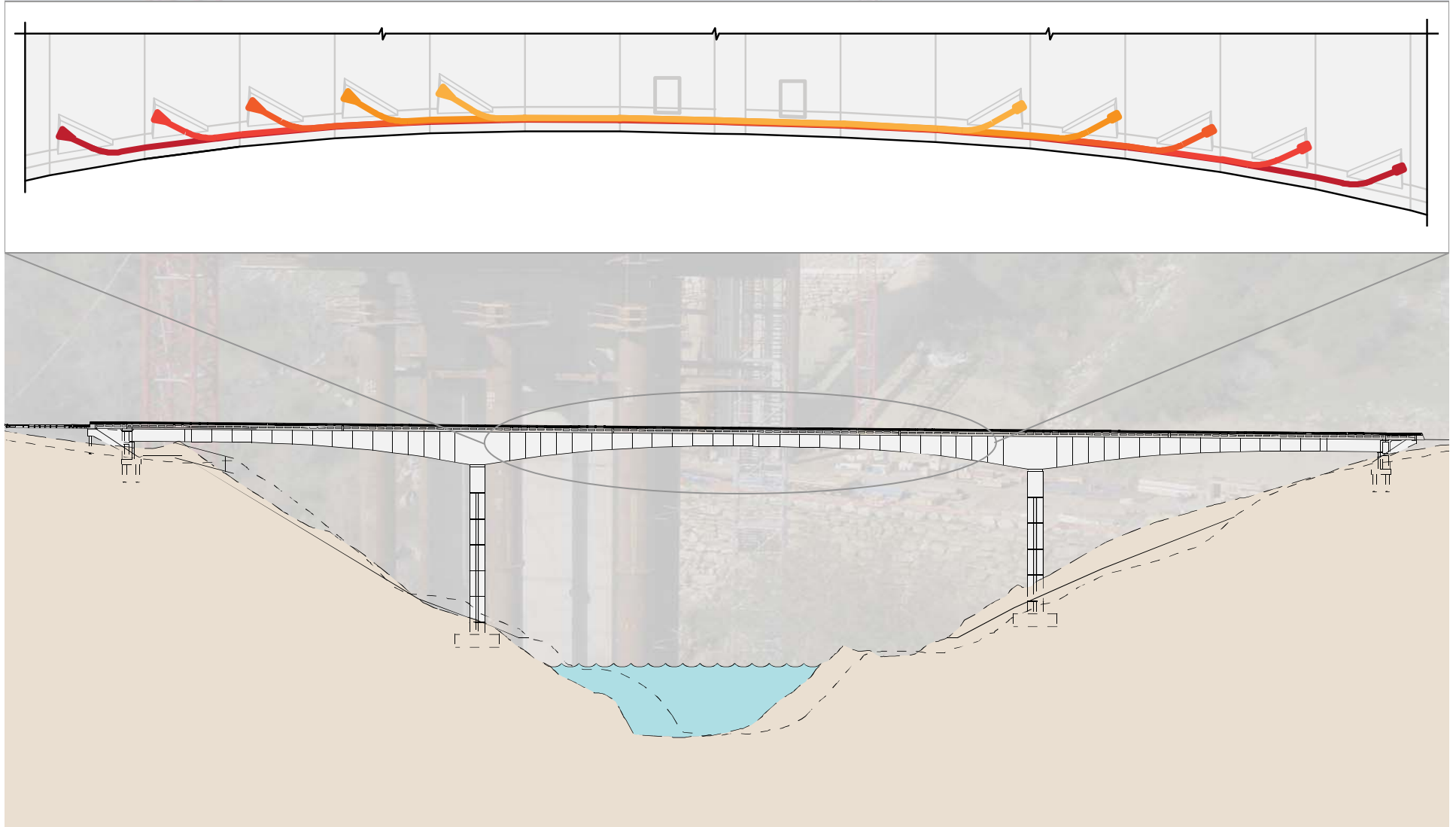
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# Post-tensioning



# Continuity Tendons



# Segment Construction Cycle (5-Day)

- Day 1-3:
  - Set Forms
  - Install Rebar in Bottom Slabs, Webs, and Top Deck
  - Install Post-Tensioning Ducts and Hardware in Top Deck
- Day 4
  - Cast Segment
- Day 5
  - Post-Tension Transverse Tendons
  - Post-Tension Cantilever Tendons
  - Break Forms and Advance Form Traveler



# Segment Mix Design

- Specified Compressive strength: 6500 psi (42 Days)
- 8.5 Sack Mix with 25% Fly Ash
- w/c Ratio – 0.33
- Admixtures
  - Retarder (Added at Batching Plant)
  - NC-534 Accelerator (Added on Site)
- Achieved Compressive Strength
  - 3000 – 6000 psi in 18 Hours
  - Above 8000 psi at 42 Days

# Construction: Mass Concrete

- Mass Concrete Definition:
  - Substructure – 3 feet Thick
  - Superstructure – 1'-6" Thick (High Early Strength)
- Pre-cooling concrete via liquid nitrogen injection



Liquid Nitrogen Injection



Pier Insulating Blankets



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# Mass Concrete Considerations

Location	Date	Air Temp (°F)		Max Temp Dif (°F)	Max Temp (°F)
		High	Low		
Segment 2-1E	6/29/08	107.3	59.2	23.8	171.2
Segment 2-2W	7/7/08	99.3	62.9	31.2	161.7
Segment 2-2E	7/14/08	94.5	69.9	15.9	159.3
Segment 2-3W	7/18/08	98.4	56.3	15.2	157.0
Segment 2-3E	7/21/08	106.4	54.4	15.6	177.9
Segment 2-4W	7/25/08	104.1	53.8	17.2	171.9
Segment 2-5E	8/5/08	111.1	57.7	6.3	164.4
Segment 2-7W	8/15/08	111.1	67.9	23.2	171.8
Segment 2-7E	8/18/08	110.8	57.1	18.4	170.3
Segment 2-8E	8/28/08	106.0	61.8	21.9	<b>178.7</b>
Segment 3-1W	7/16/08	104.1	60.4	<b>34.4</b>	176.9
Segment 3-2E	7/22/08	<b>111.9</b>	55.9	24.2	162.5
Segment 3-8E	09/10/08	96.1	57.8	30.5	168.3
Segment 3-13E	10/22/08	79.4	60.0	16.1	155.9



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# Lessons Learned / Best Practices

1. Friction Testing
2. Grouting
3. Closure Segments
4. Pier Struts
5. Modeling Segment Weight
6. Bike Pathways



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