

# LAUREL STREET OVERCROSSING

## RETROFIT AND REHABILITATION



Western  
Bridge  
Engineers'  
Seminar

**TYLIN**INTERNATIONAL

# AGENDA

- History and Layout
- Seismic Demand and Retrofitting
- Rehabilitation and Bridge Inspection
- Project Award

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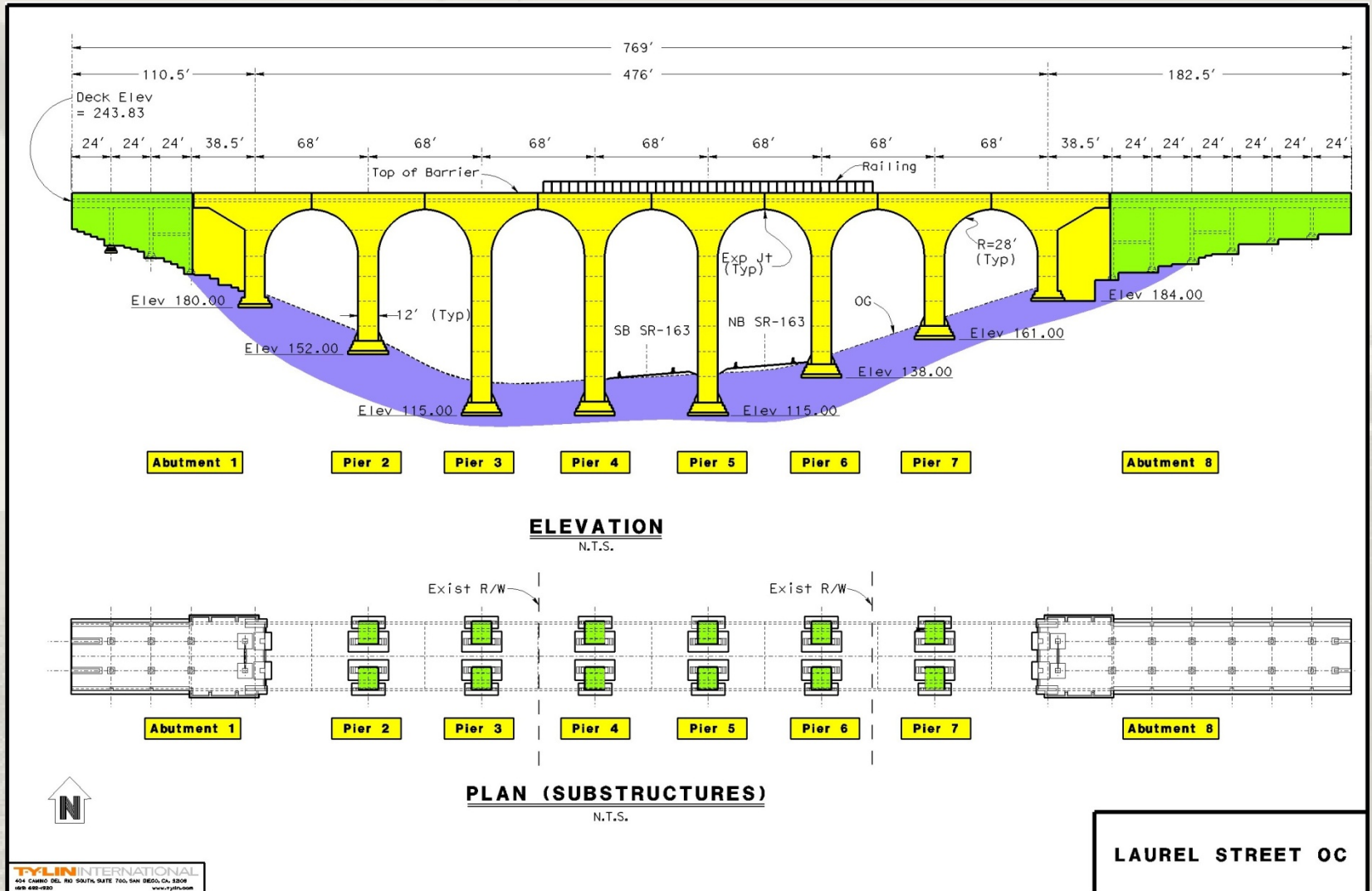
# LOCATION MAP



# 1915 PANAMA-CALIFORNIA EXPOSITION



# BRIDGE LAYOUT





# SOUTH ELEVATION





# VIEW FROM SR-163





# BRIDGE DECK

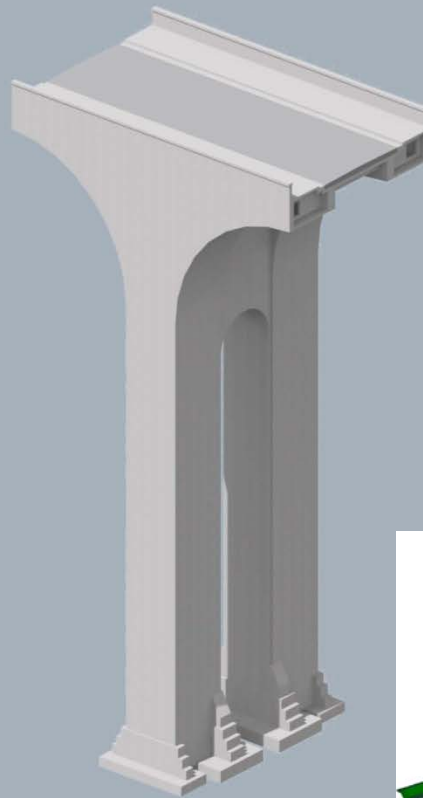
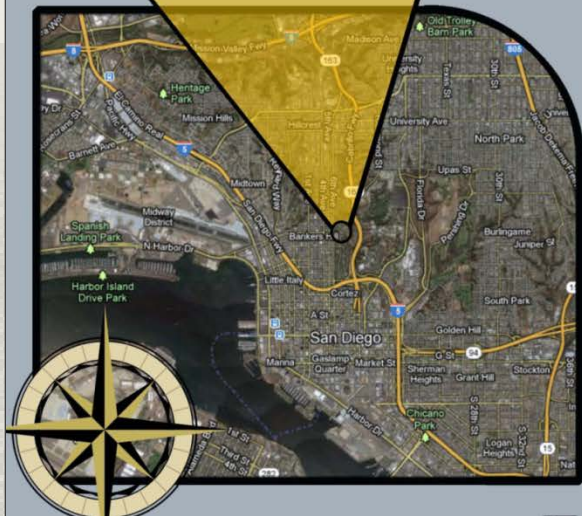


# ABUTMENT INTERIOR

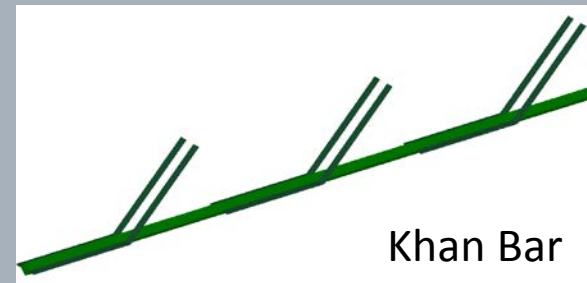




# TYPICAL PIER



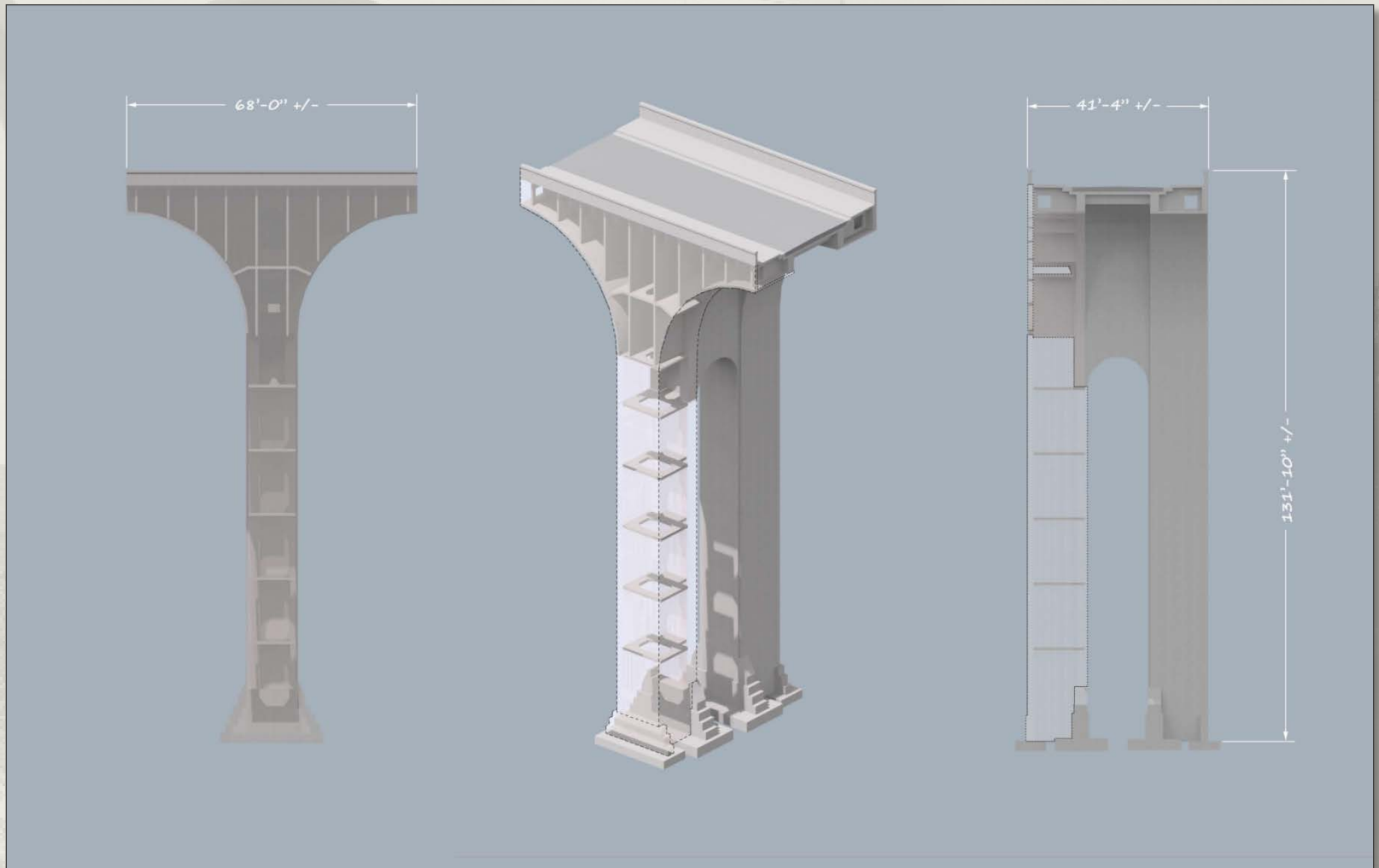
- Cast-in-Place Reinforced Concrete
- Twin Cell Superstructure
- Transverse T-Beams and Deck Between Cells
- Numerous Internal Diaphragms
- Twisted Square Reinforcing Bars
- Khan Reinforcing Bars



Khan Bar



# INTERIOR PIER DETAILS



# EMERGENCY REHABILITATION AND FIRE



**THE FIRE**

- 1) At 4:32 a.m., a caller reports a fire at the bridge. The fire appears to have started at the base of a column.
- 2) Fire spreads to the interior wooden structure.

**THE FIRE FIGHT**

- 3) Firefighters remove access-hole covers on the bridge sidewalks and pump in water and foam to douse the flames.
- 4) As the flames spread, crews drill holes in the sidewalk to pump in more water and foam.

**Burning inside**

The historic Cabrillo Bridge in Balboa Park caught fire early yesterday, burning inside its hollow structure. State Route 163 below the bridge and bridge access were closed while fire crews investigated and tackled the bridge's smoldering infrastructure. The fire was extinguished at 4 p.m.

**INSIDE THE SUPPORT COLUMN**

- Wooden frame burned
- Original wood infrastructure
- Hollow interior
- Steel-reinforced concrete
- Access door

SOURCES: San Diego Police Department; Caltrans; city of San Diego; Union-Tribune research

PAUL HORN / Union-Tribune



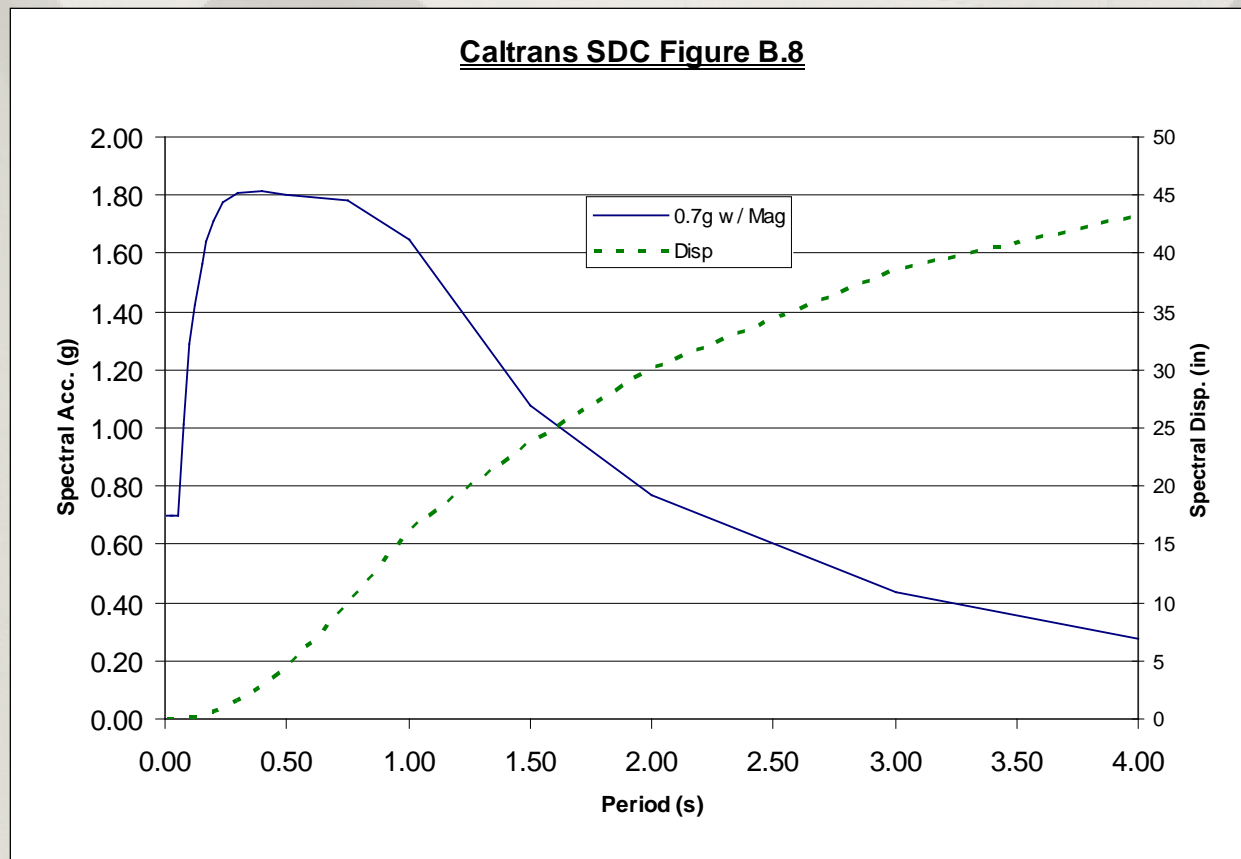
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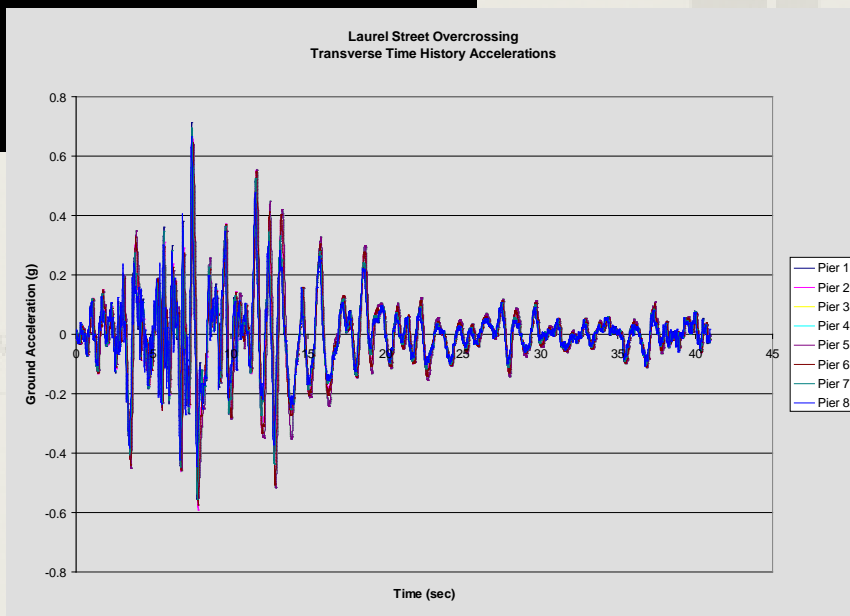
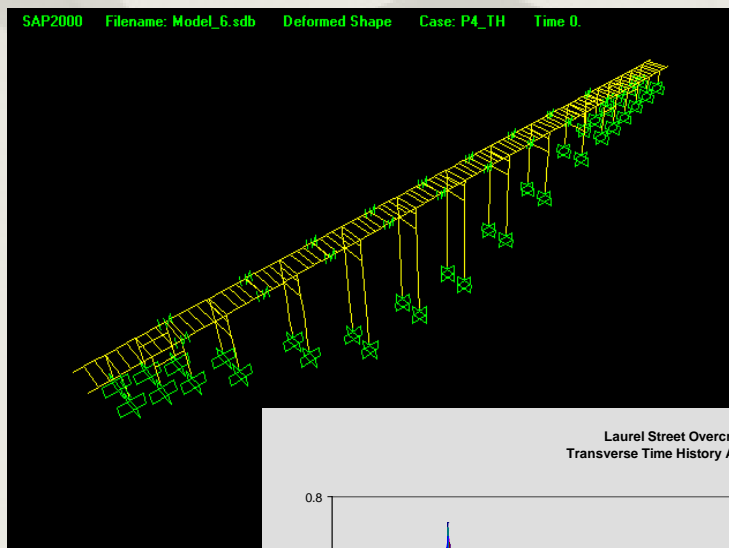


# SEISMIC DEMAND

- Modified SDC ARS Curve for soil profile D
- $M = 7.25 \pm 0.25$
- Peak Rock Acceleration =  $\pm 0.7g$
- Modified for Near Source Effects
- Period = 1.0 sec



# STRUCTURAL ANALYSIS



Courtesy of David Evans & Associates

## SEISMIC VULNERABILITIES

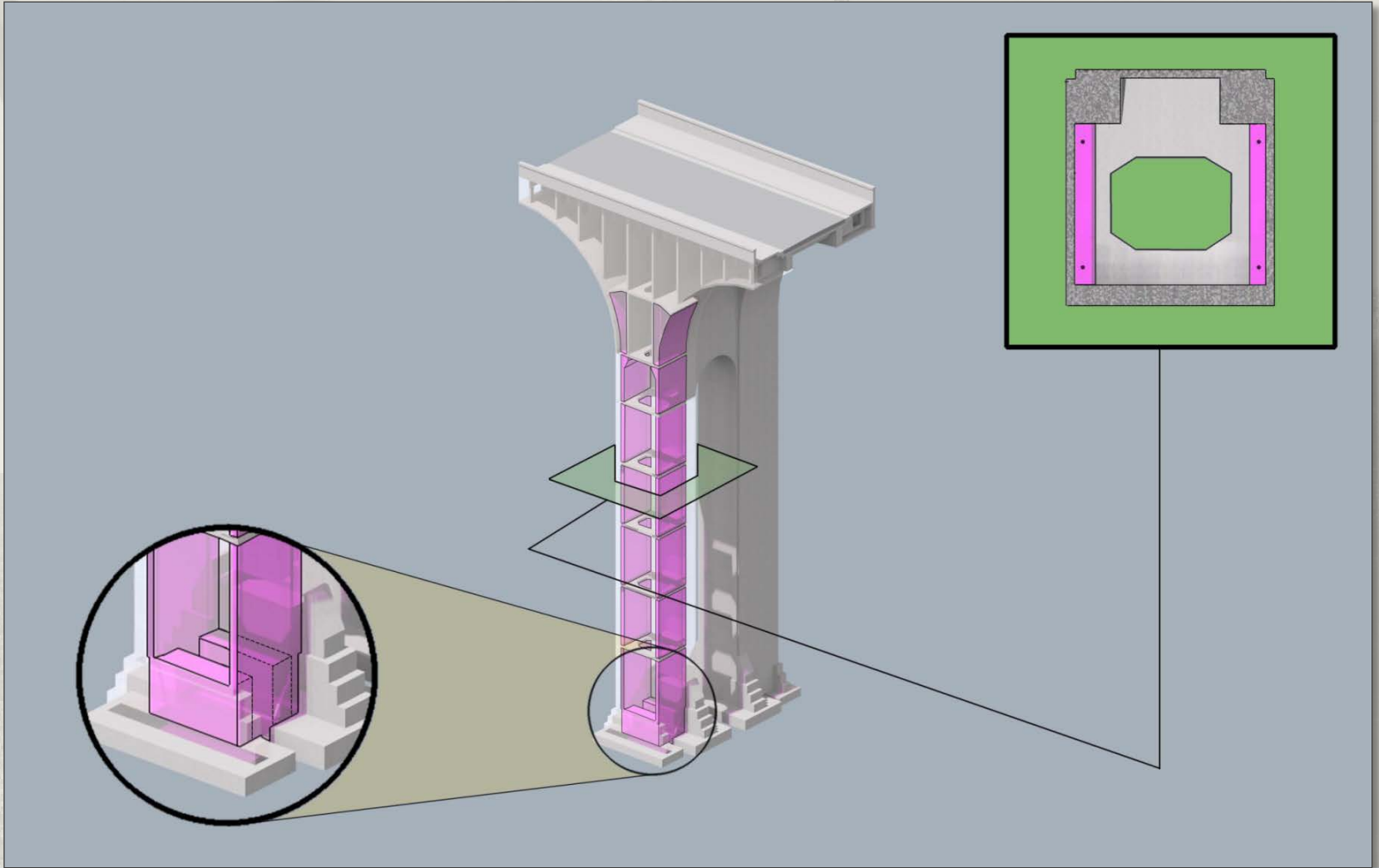
- Tall piers lack displacement capacity
- All the piers fail in shear

## RETROFIT STRATEGY

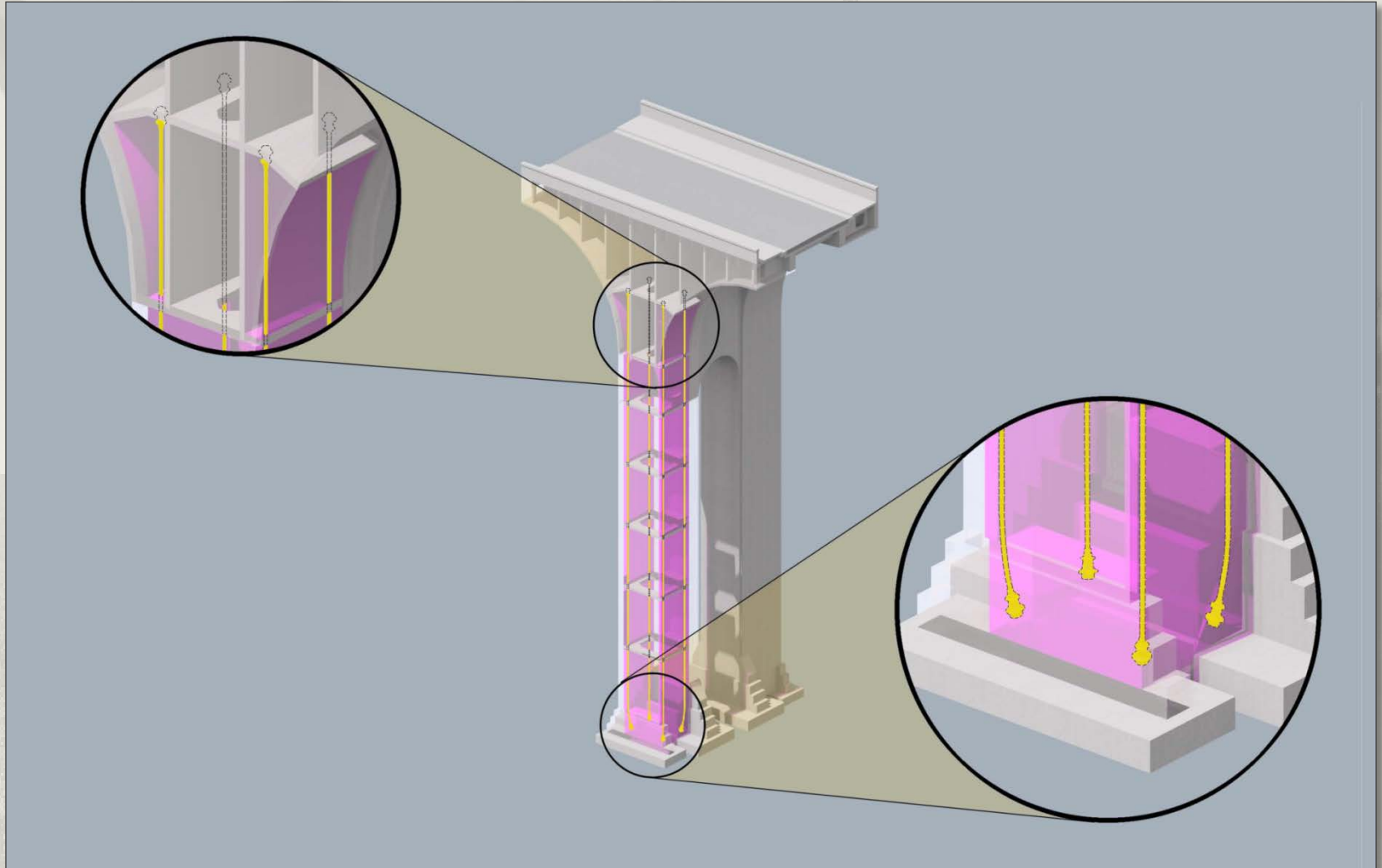
- Internal retrofitting
- Shear walls with vertical post-tensioning
- Close joints between piers
- Post-tension superstructure



# PIER SHEAR WALLS



# PIER VERTICAL POST-TENSIONING

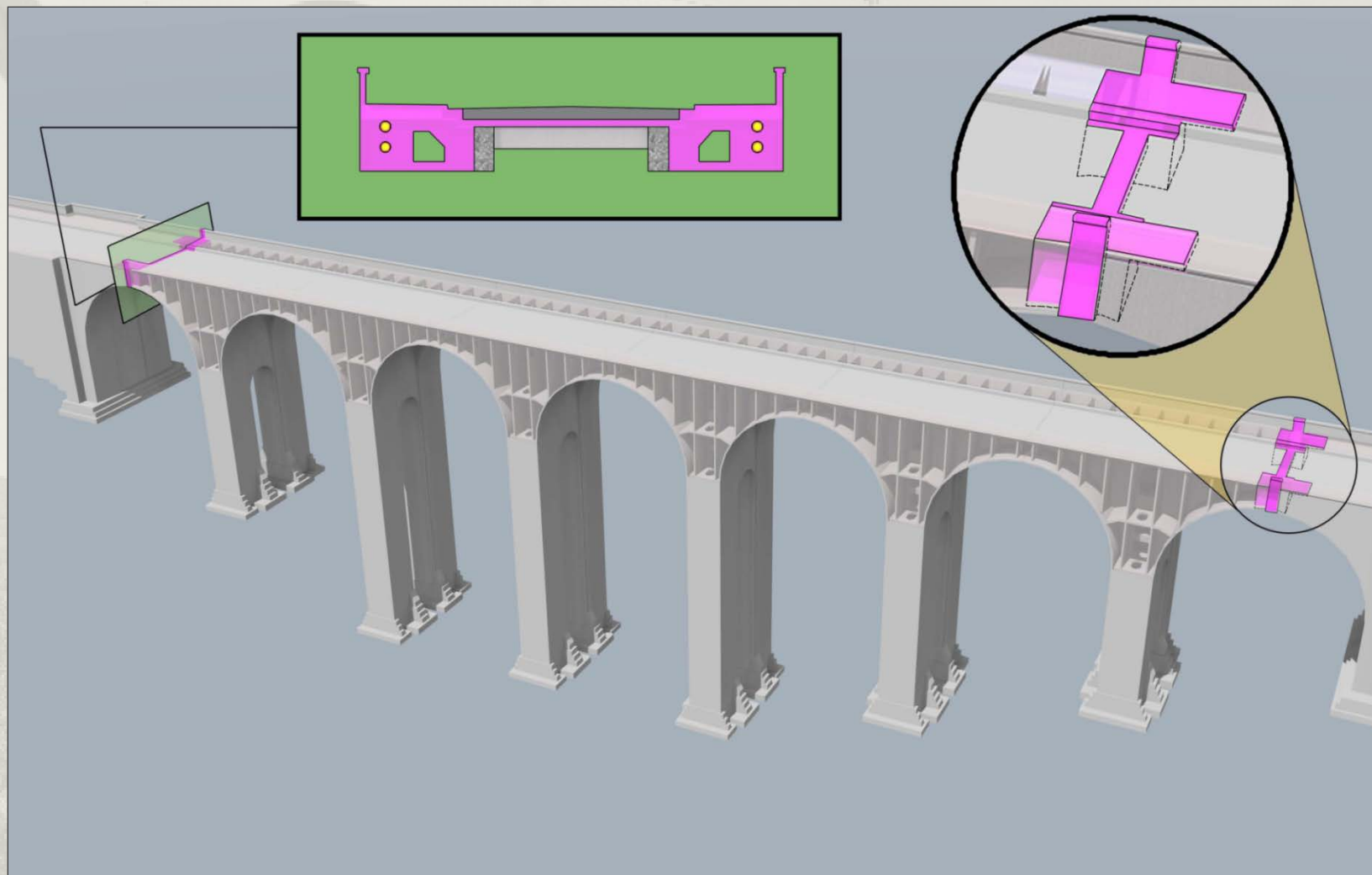


# CLOSE SUPERSTRUCTURE JOINTS

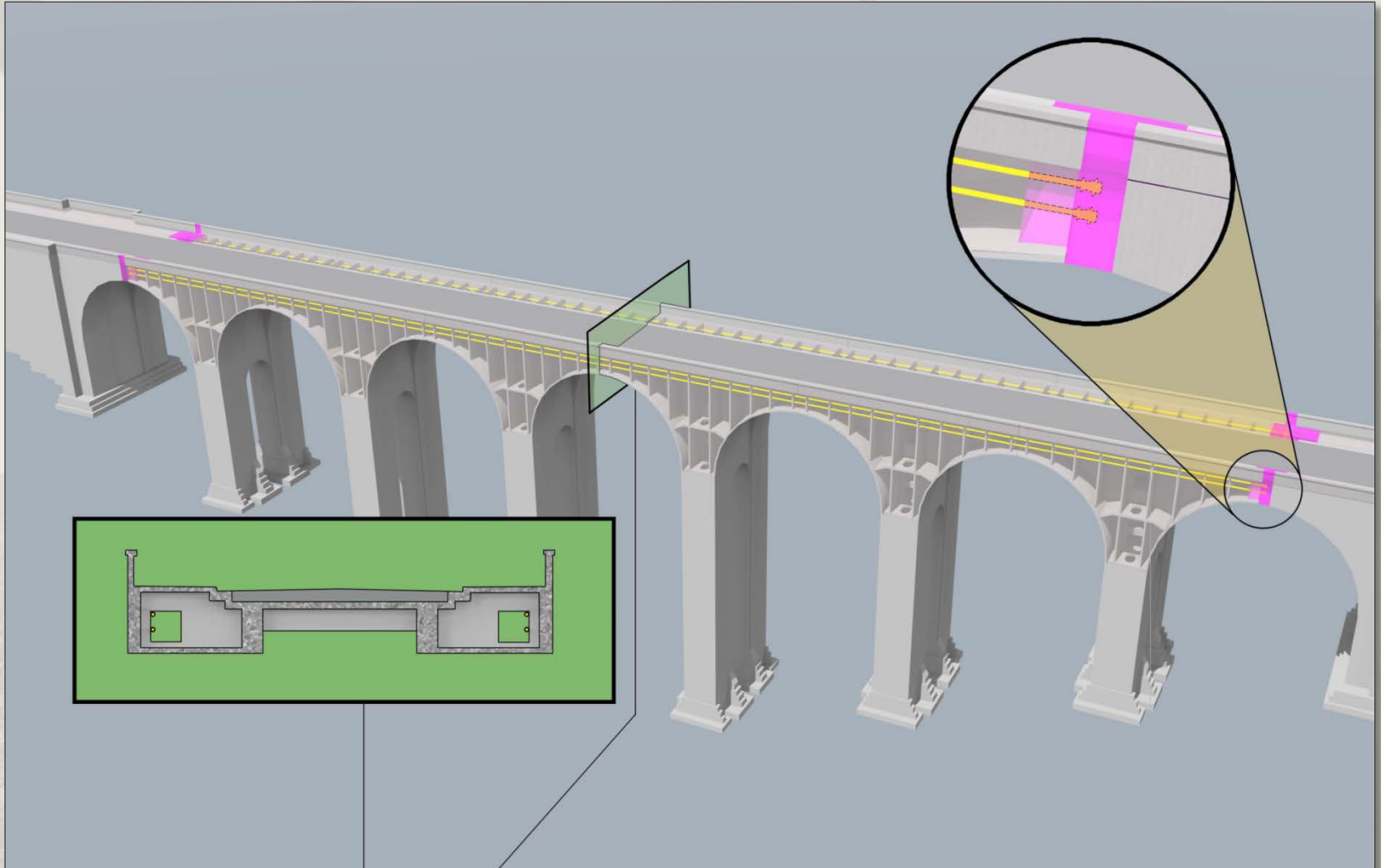




# POST-TENSIONING END DIAPHRAGMS



# LONGITUDINAL POST-TENSIONING



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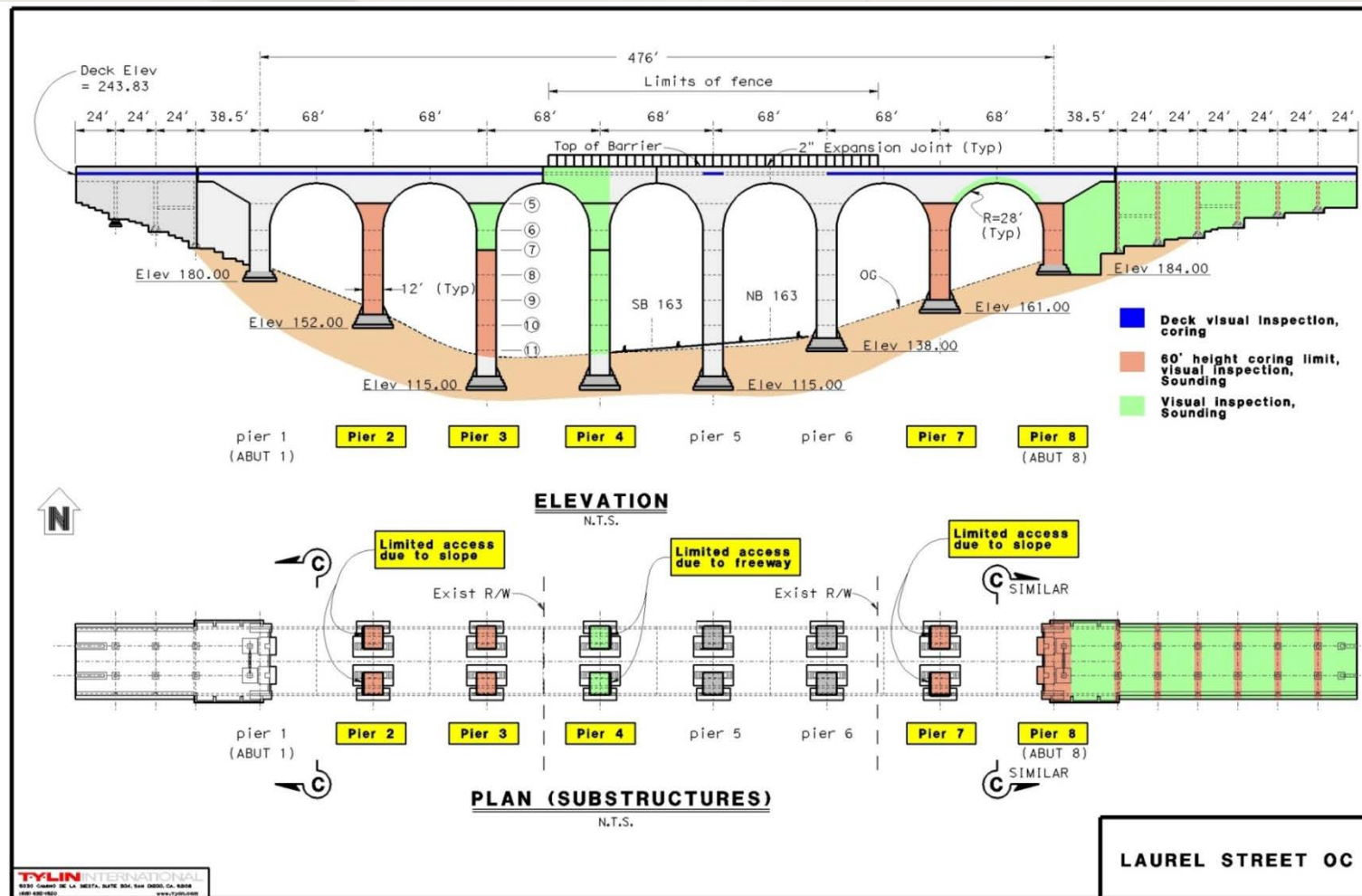
# REHABILITATION

- Retrofit strategy requires intact cross sections
- Remove and repair unsound concrete
- Clean and replace corroded reinforcing bars
- Exterior rehabilitation must be colored and textured to match existing concrete

# STRUCTURAL INSPECTION

- Recommendation from VE analysis
- Determine the types and locations of repair
- Limited inspection access
- Manlift, snooper truck & scaffolding

# INSPECTION ACCESS





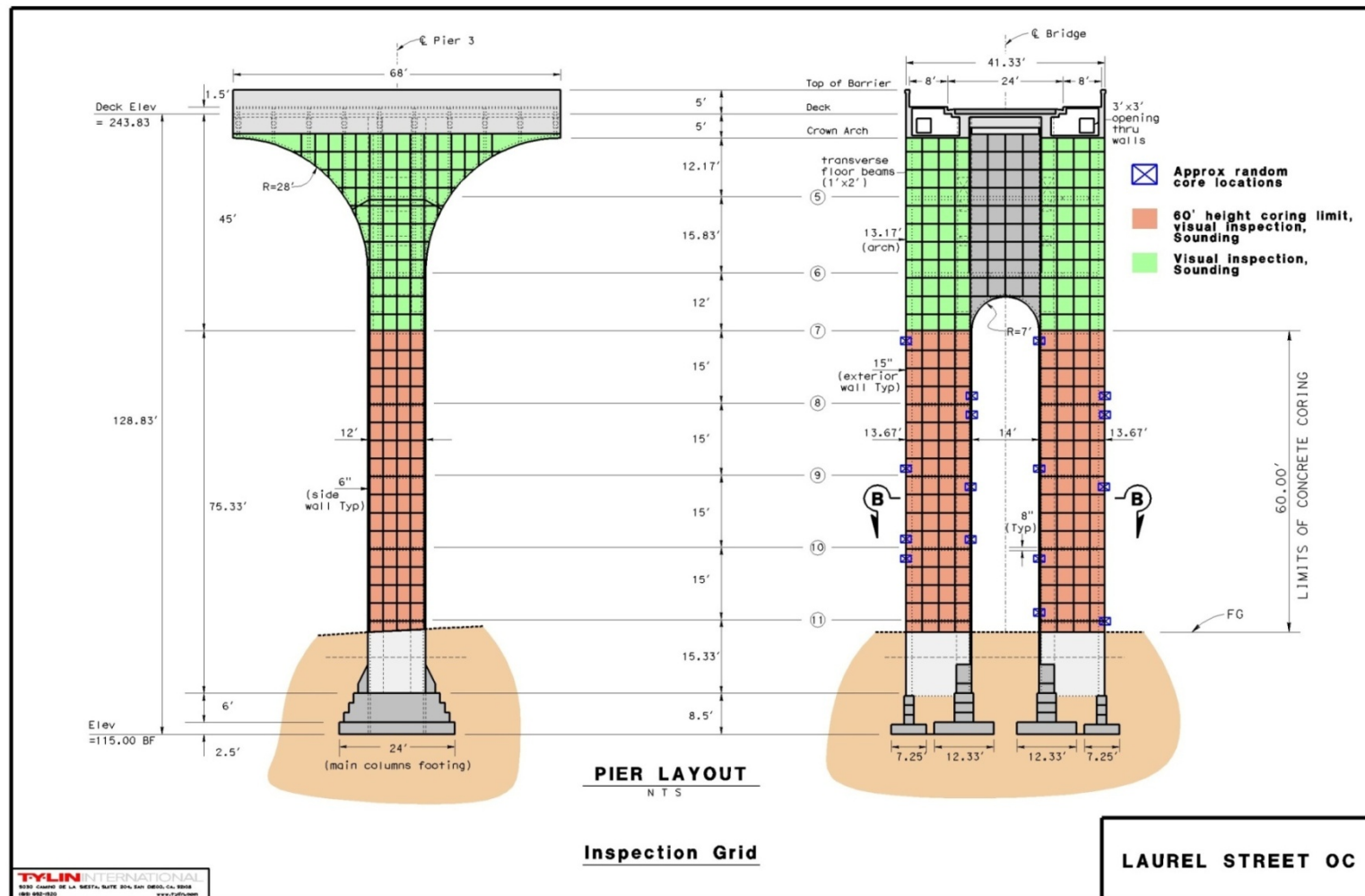
# INSPECTION EQUIPMENT



# STRUCTURAL INSPECTION

- Surface mapping
- Rock pockets
- Spalling
- Settled aggregate
- Efflorescence through joints
- Aided in cost & quantity estimating

# SURFACE MAPPING





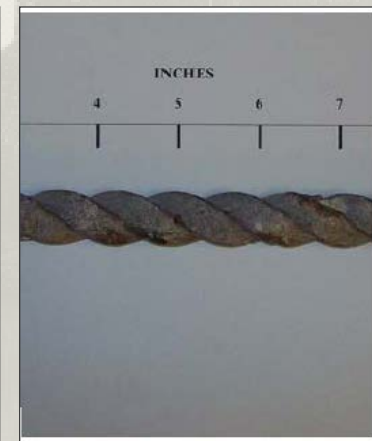
# UNSOUND CONCRETE





# TESTING PERFORMED

- Non Destructive Testing
  - Visual Inspection
  - Rebound Hammer
  - Ground Penetrating Radar
- Destructive Testing
  - 100 Concrete Core Samples
  - Compression Strength
  - Petrographic
  - Concrete Chemical
  - Rebar Tensile Strength



# ELECTRICAL AND ACCESSIBILITY INSPECTION

- High voltage distribution line on catwalk
- Electrical transformers in abutments
- Exposed wiring inside and outside bridge
- No interior lighting



# EXPOSED WIRING





# ELECTRICAL AND ACCESSIBILITY INSPECTION

- Wood catwalk is deteriorated, no railings
- Some piers inaccessible
- Eroded interior abutment slopes
- Broken drain pipes
- Doors need replacement



# DIFFICULT INSPECTION ACCESS



# ELECTRICAL AND ACCESSIBILITY IMPROVEMENTS

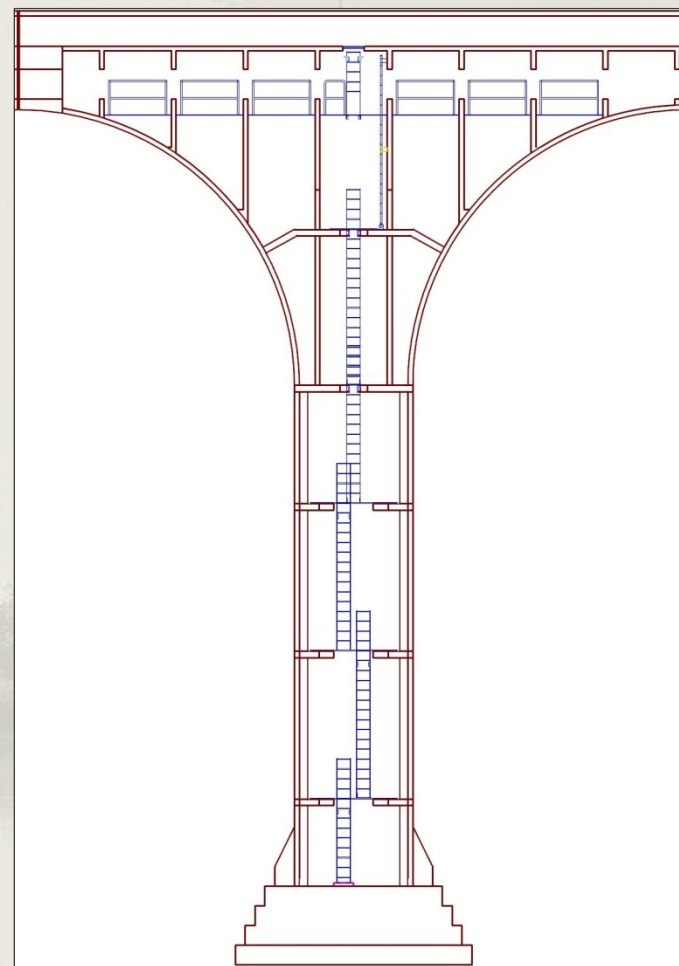
- Remove catwalk and wood debris
- Remove transformers and high voltage lines
- New electrical system and interior lighting





# ELECTRICAL AND ACCESSIBILITY IMPROVEMENTS

- Install Cal/OSHA compliant ladders and catwalks
- Doors in all piers
- Grade abutment slopes



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# PROJECT AWARD

- Bridge remain open during construction
- A+B contract construction and time
- Top 3 bids within 2% of each other
- Low bid \$16,550,000
- Duration 200 working days
- Completed before 2015 Centennial Celebration

# ACKNOWLEDGMENTS

- City of San Diego
- Caltrans District 11 (San Diego)
- Caltrans Structures Design South (Diamond Bar)
- Caltrans Structures Office Engineer (Sacramento)
- UCSD (Peer Review)
- David Evans & Associates (Finite Element Modeling)
- Atkins (Preliminary Design)
- Ninyo & Moore (Inspection & Testing)
- McLean & Schultz (Independent Check)



# Questions ?

