

# SEISMIC RETROFIT AND REHABILITATION OF GEORGIA STREET BRIDGE & WALLS



Nathan Johnson, PhD, PE

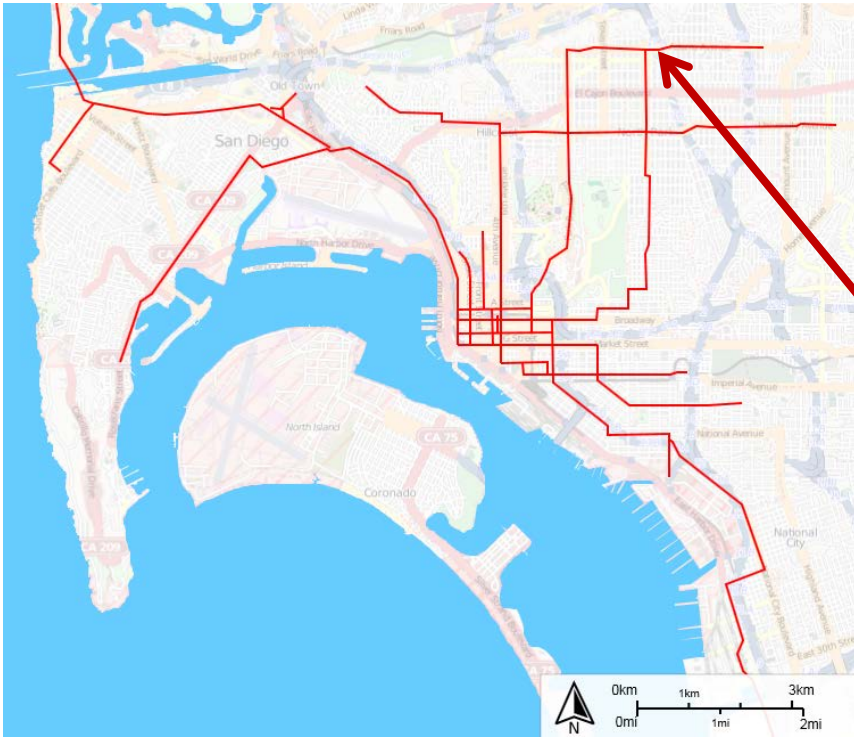
Ebrahim Amirihormozaki, PhD, PE



Western  
Bridge  
Engineers'  
Seminar

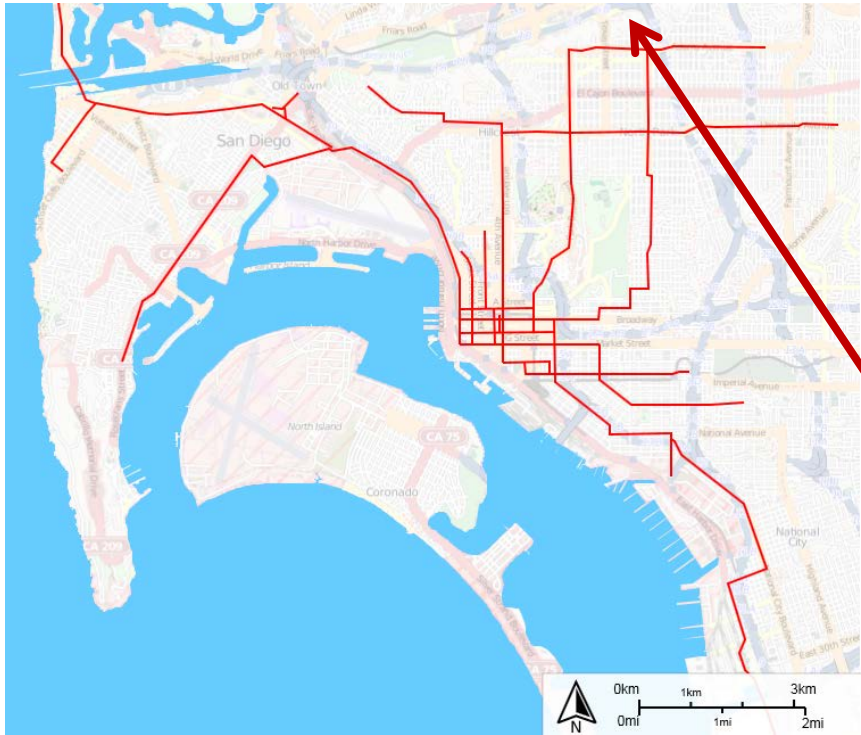
# Outline

- History of Georgia Street Grade Separation
- Rehabilitation and Retrofit of Bridges
- Recent Timeline and Designation
- Existing Condition (Seismic/Service/Condition)
- Seismic Analysis
- Retrofit vs. Replace
- Preservation of Historic Resource
- Retrofit/Rehabilitation/Reconstruction

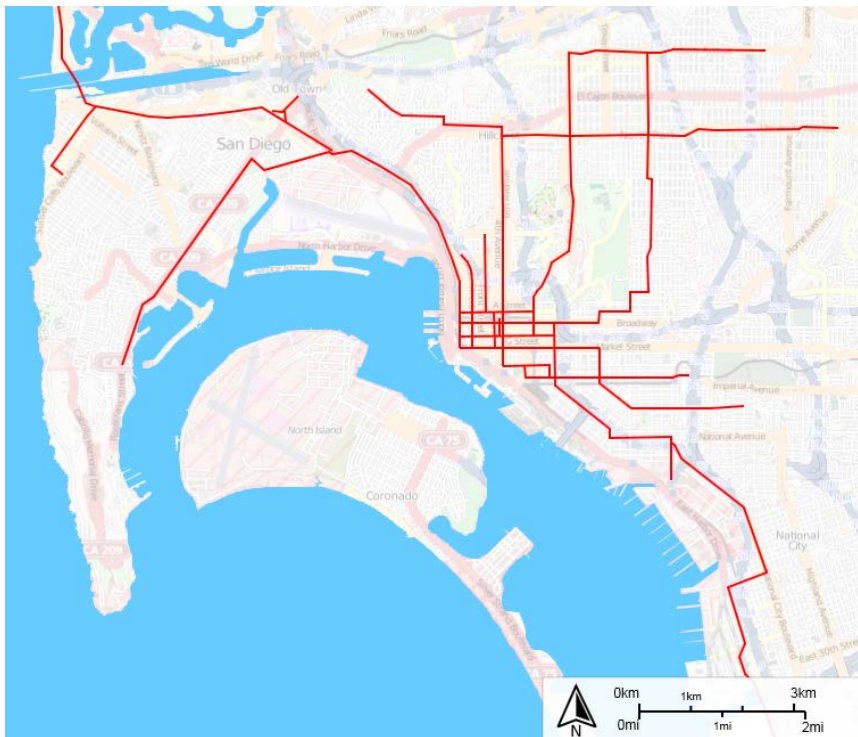


- 1892 – SDER Established by Spreckels
- 1905 – **Adams Avenue in Normal Heights**





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- 1914 – **Georgia Street Bridge Built**
- 1915 – Begin Panama-California Expo



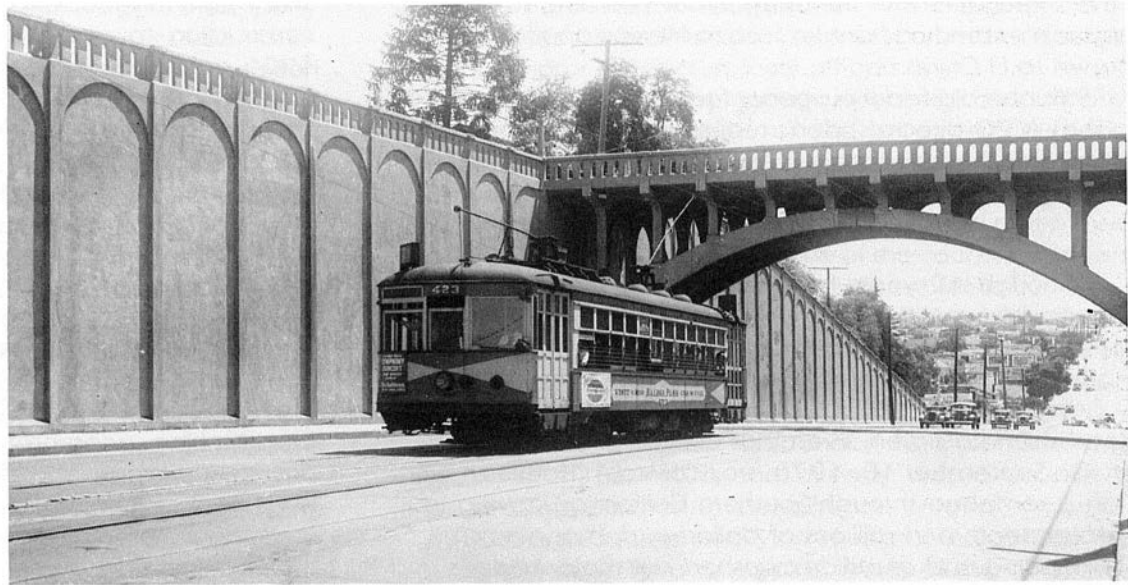


1910 looking east



1911 looking east

# 1923 looking east







2014 looking east

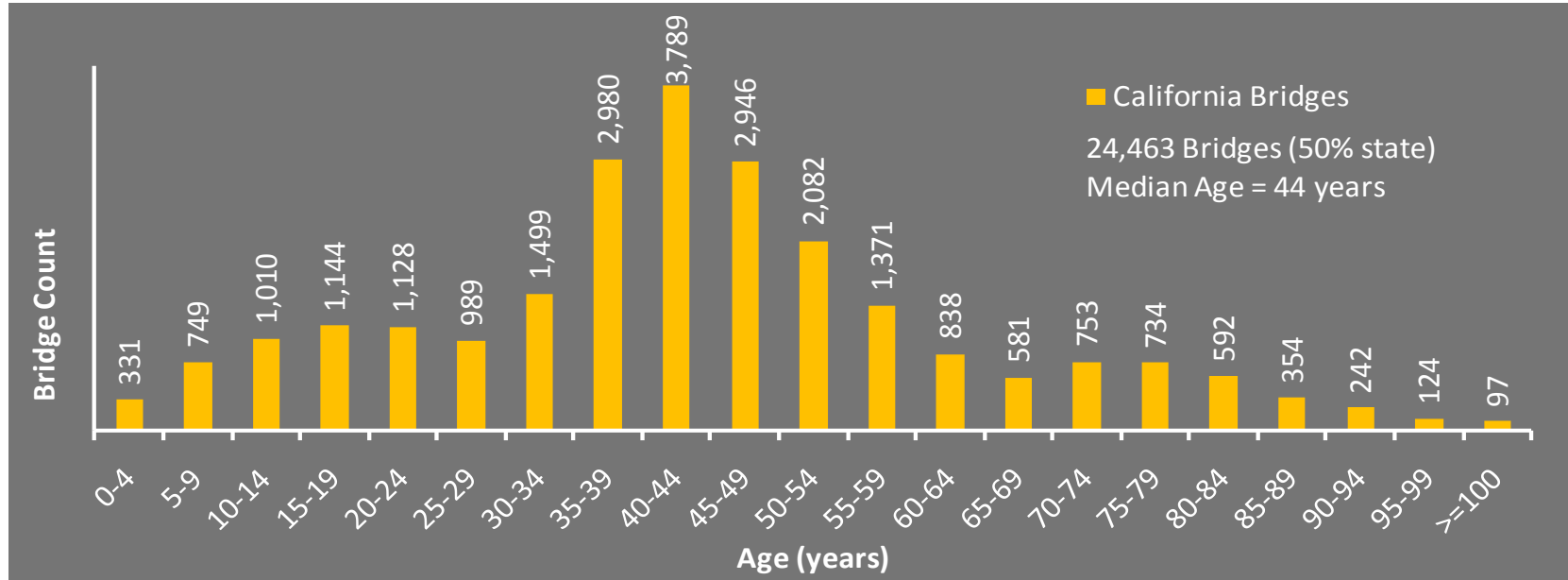


# Life of a Bridge



- Typical Bridge life expectancy is similar to a person
- Design life of 50-100 years
- Without proper care could require major rehab at 50

# Bridge Rehabilitation



- Approximately 75 new bridges/year
- Rehabilitation per year (assuming age 50)
  - Inventory 45y-55y = 6700
  - Approximately 670 / year

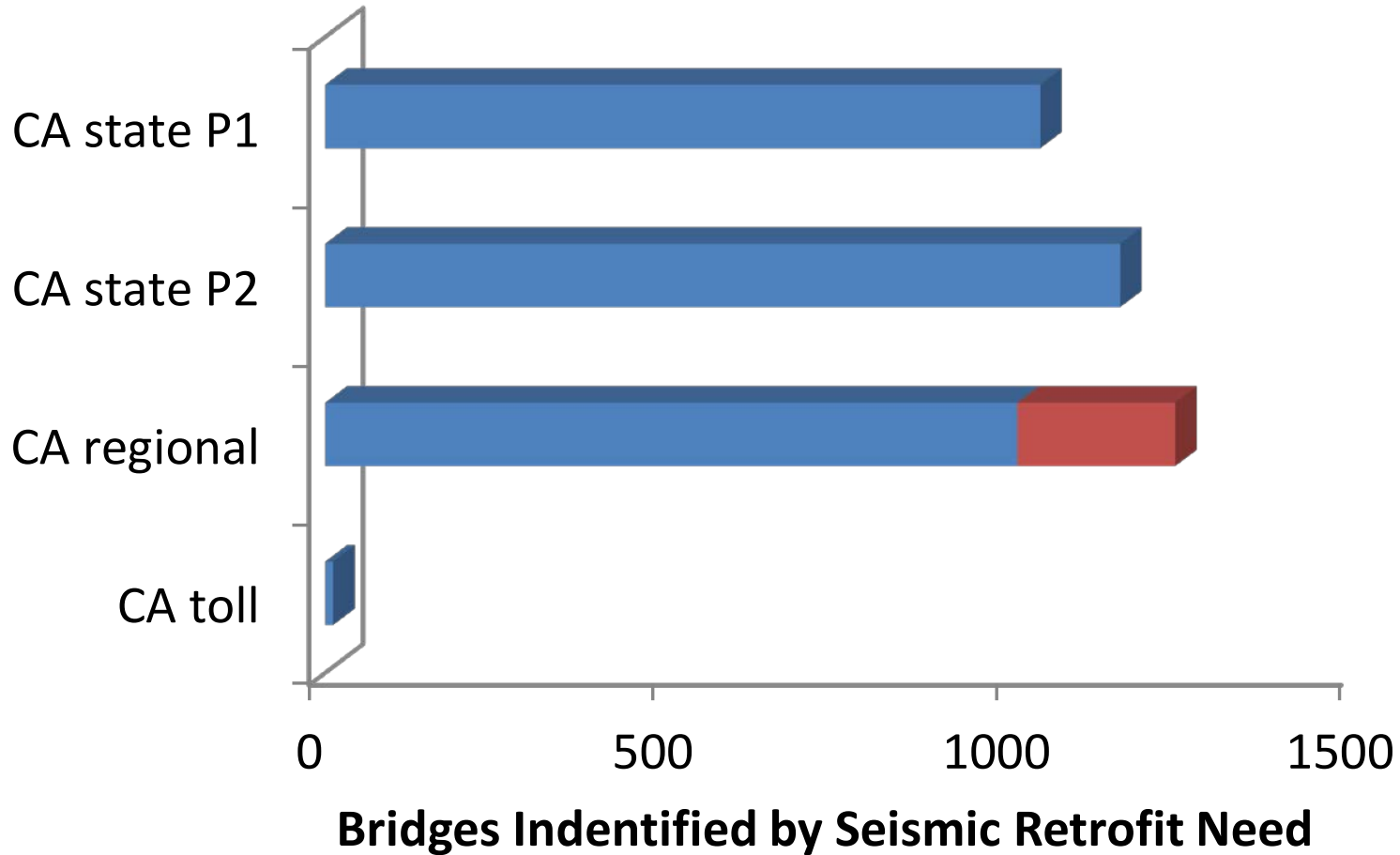


# Retrofit

- State adopted prioritization
  - Importance and vulnerability
  - Life Safety or better
  
- 1971 San Fernando →
  - 1986 Caltrans Phase 1 (completed in 2000)
- 1989 Loma Prieta →
  - Caltrans increased research
- 1994 Northridge
  - Caltrans Phase 2, Caltrans toll, CA Local



# California LBSRP



**This list was created from early 1990's knowledge...**



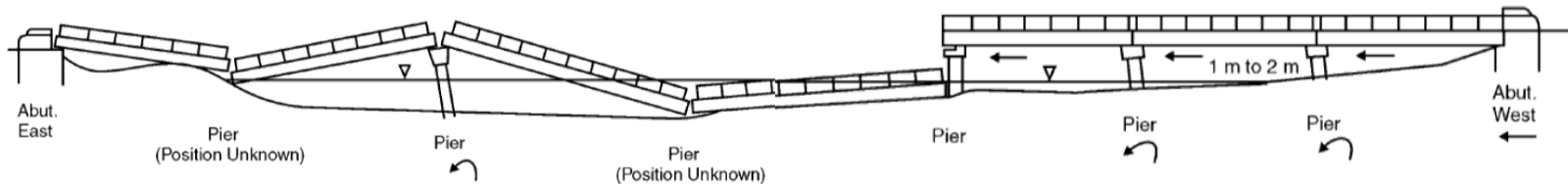
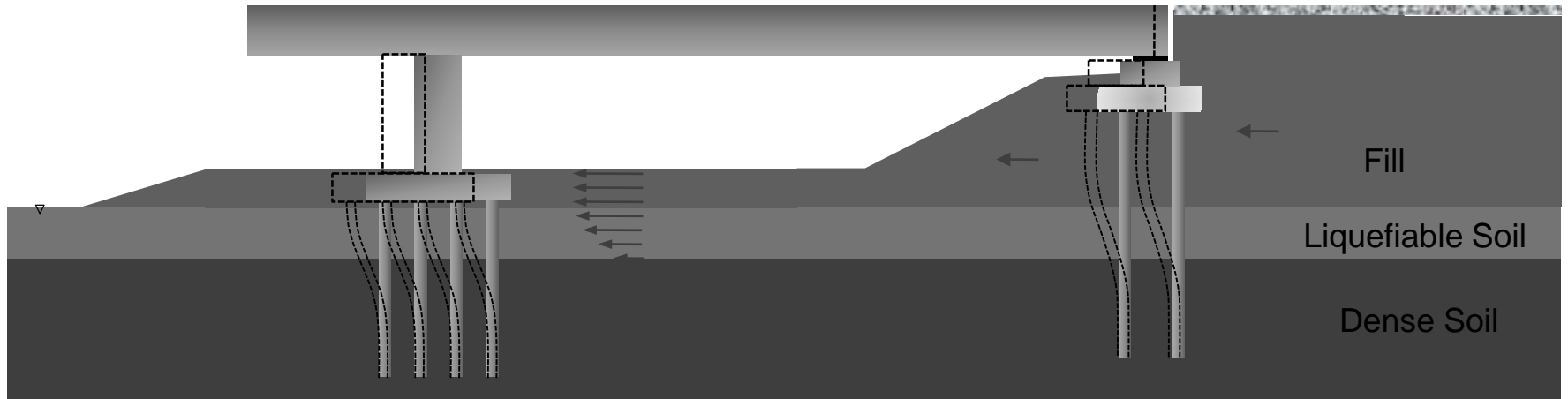
# Future Retrofit Needs in CA


Revised Fault Maps

Liquefaction

Lateral Spreading

Near Fault Ground Accelerations



- 
- Correct Seismic Deficiencies
  - Rehabilitate to Remove from EBL
  - Provide Minimum 50 Years Additional Life
  - Avoid Adverse Effect to Historic Resource



# Georgia Street Timeline

- Built in 1914 in San Diego, CA
- Two 640-Foot Long Anchor Block Retaining Walls
- 3-Hinge Concrete Arch Bridge



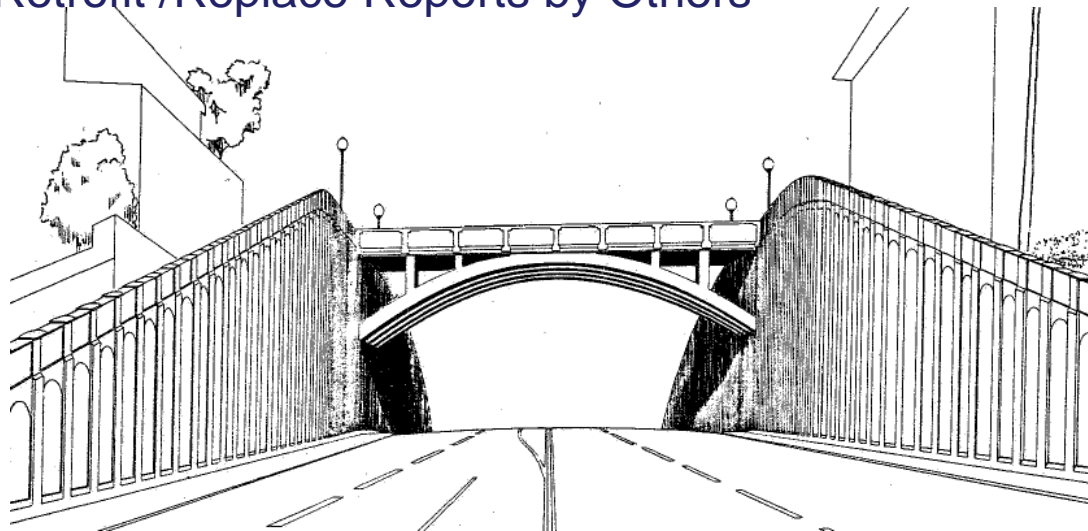
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- Early 1990's Caltrans Identified
- 1995 Repair/Retrofit /Replace Reports by Others





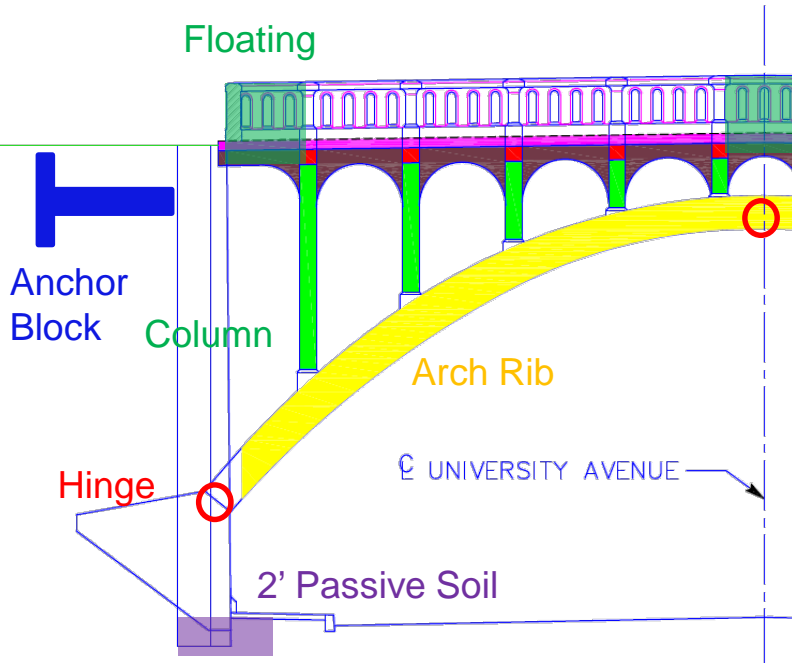
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- Many Past Repairs Since 1947
- Early 1990's Caltrans Identified
- 1995 Repair/Retrofit /Replace Reports by Others
- 1999 Placed on Historic Register
- 2002 Vulnerability Study to Replace by Others
- 2009 Begin New Retrofit/Replace Studies
- 2012 Caltrans Approved Rehabilitation/Retrofit
- 2015 Begin Construction

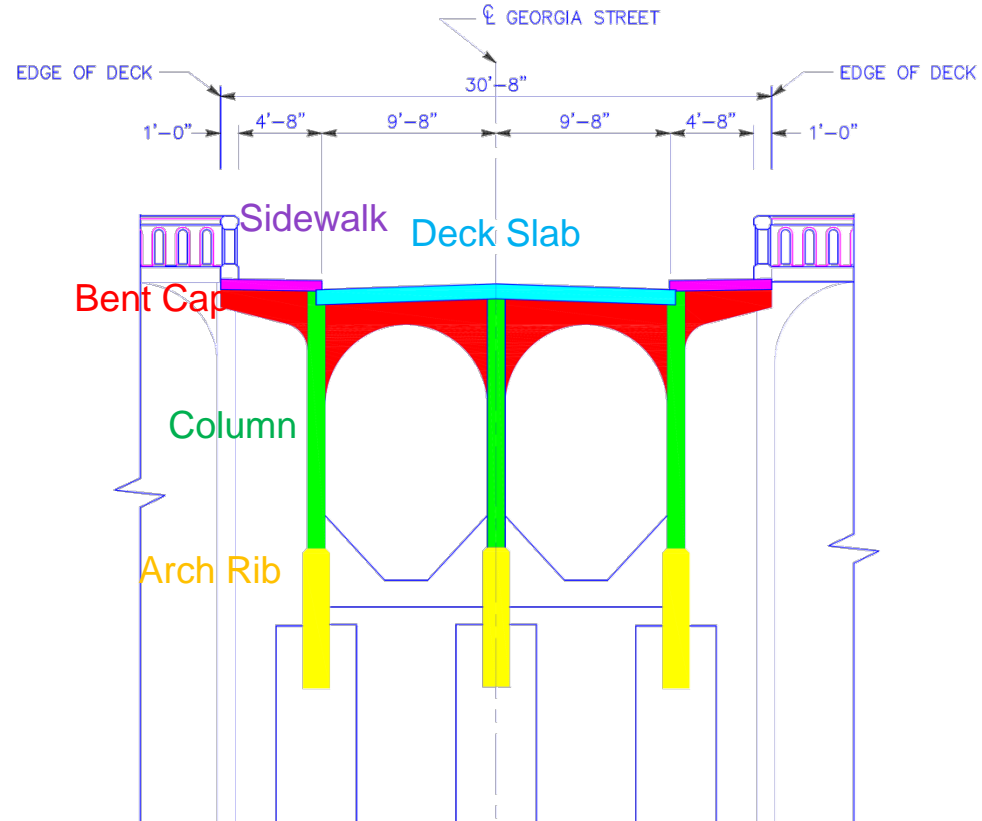


25 years!

# Bridge Components

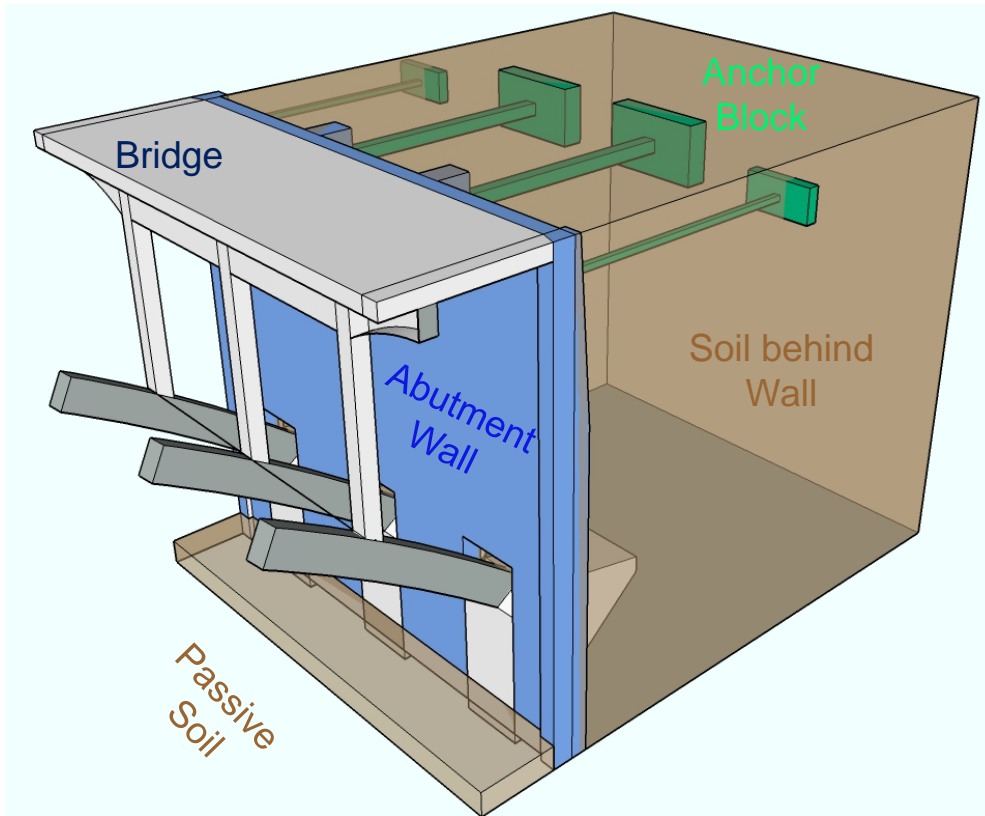


Half Elevation

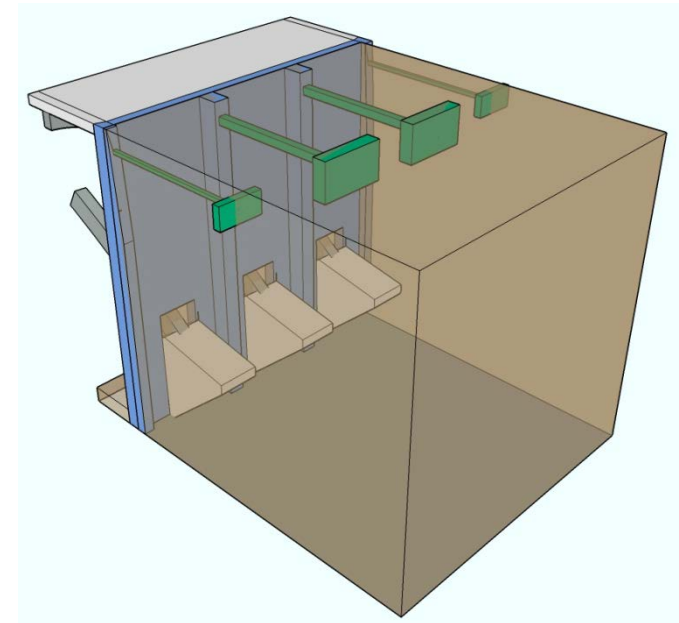


Typical Section

# Bridge Components

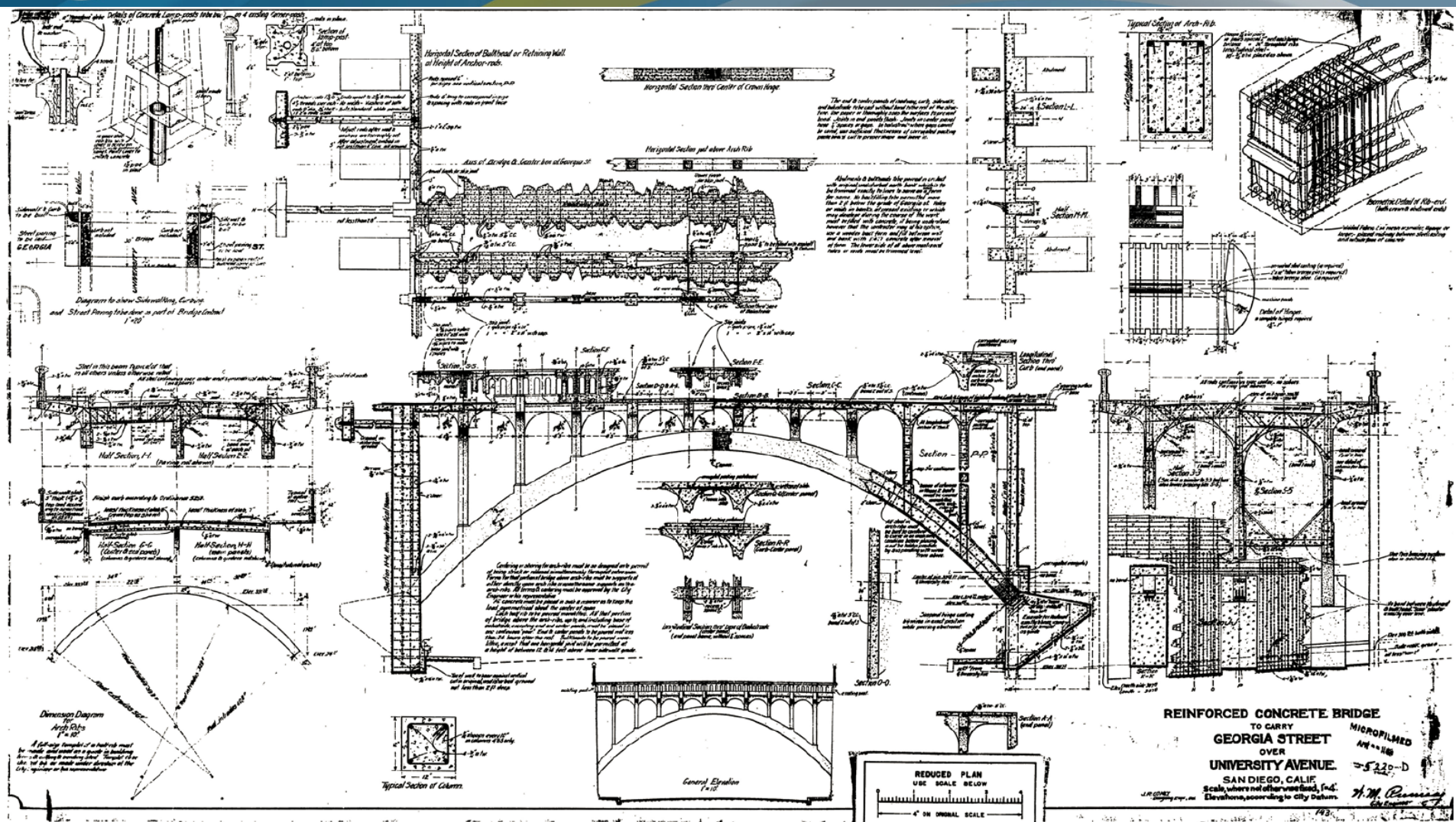


Abutment Front Perspective



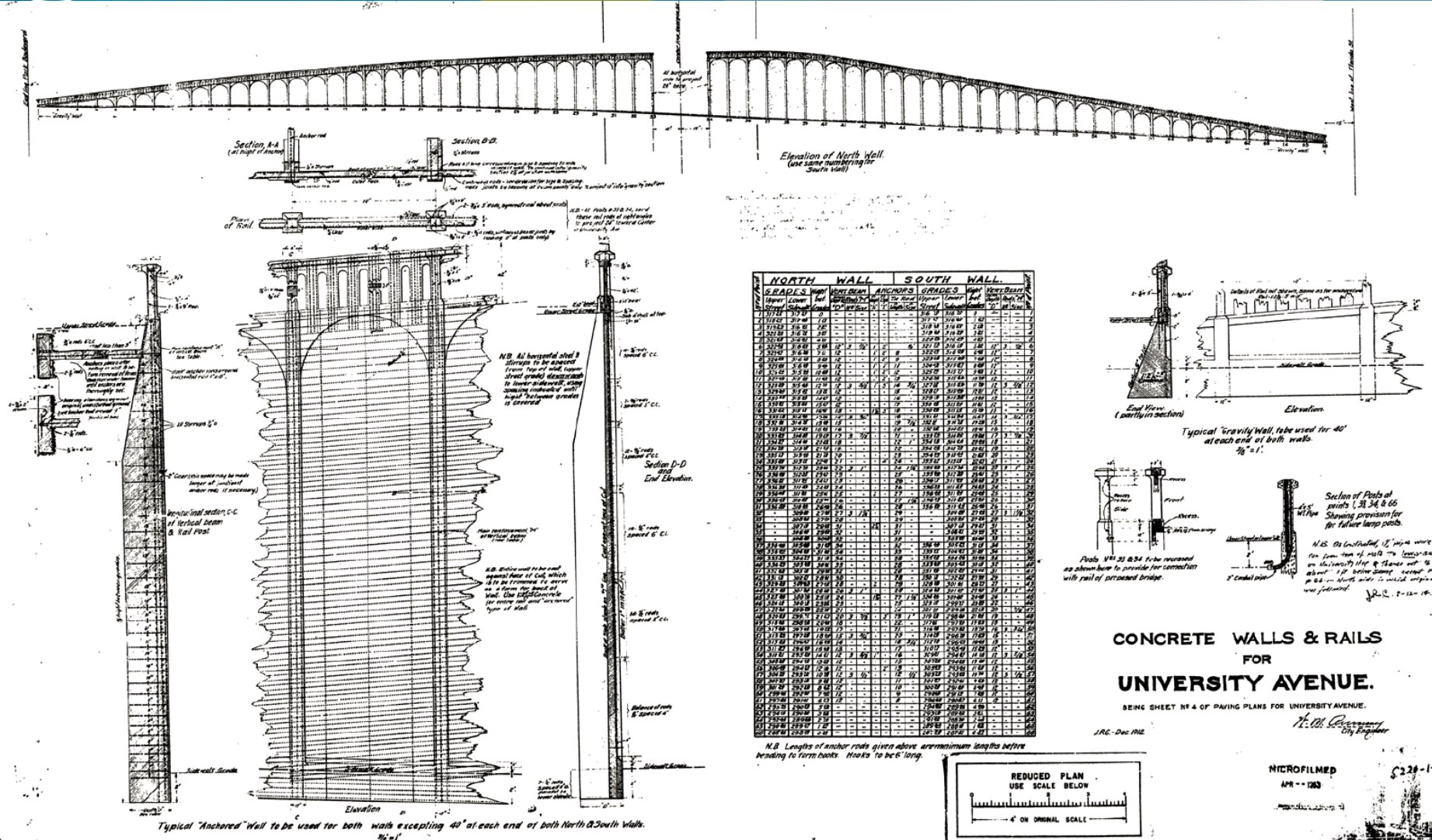
Abutment Back Perspective





# Bridge As-Built Plans





# Functional Deficiencies

- **Barrier rails not sufficient**
- **No sidewalk ADA ramps**
- **Asphalt paving at sidewalk elevation**
- **Substandard vertical and horizontal clearance**
- *Bridge width is substandard*
- **Bridge does not support modern live loads**



# Existing Condition



Structurally Deficient  
Sufficiency Rating = 44.9





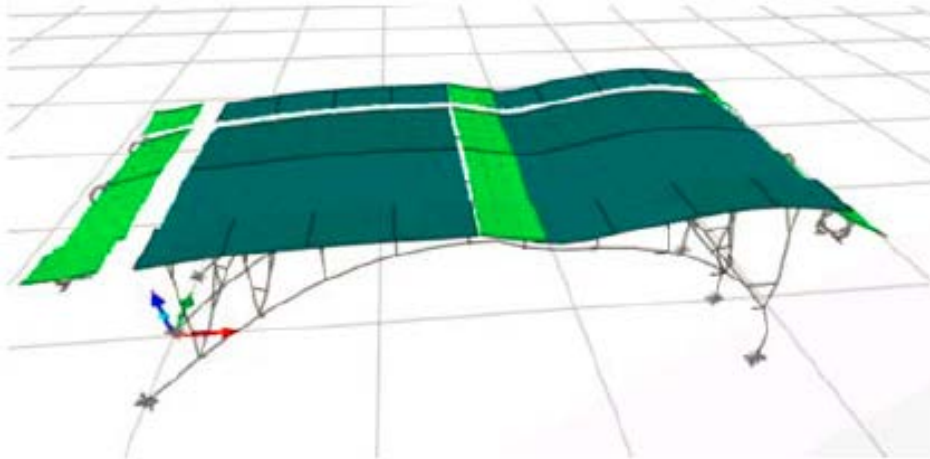




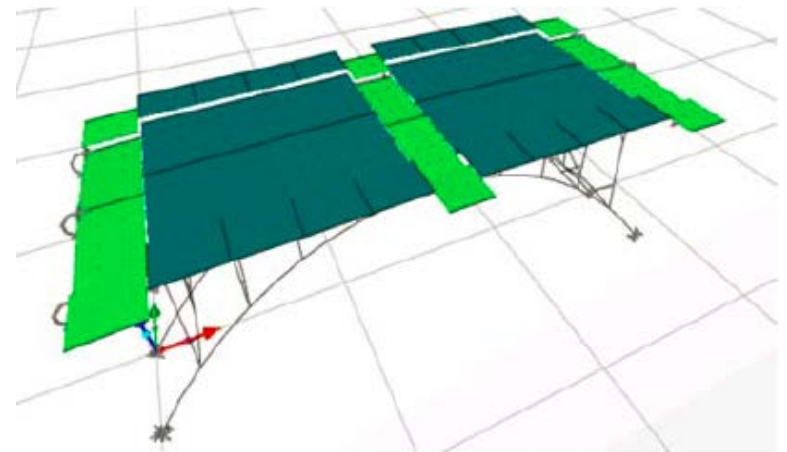


# Seismic Analysis

- CQC frequency with secant stiffness
  - Arch, spandrel, superstructure displacement demands
  - Elastic element demands
  - Influence of foundation stiffness



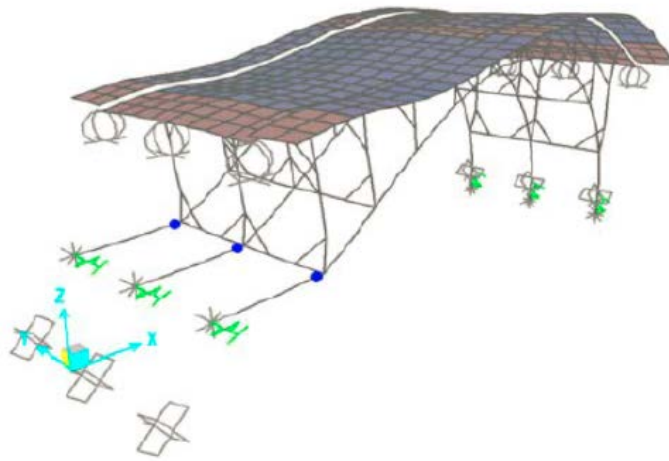
Longitudinal



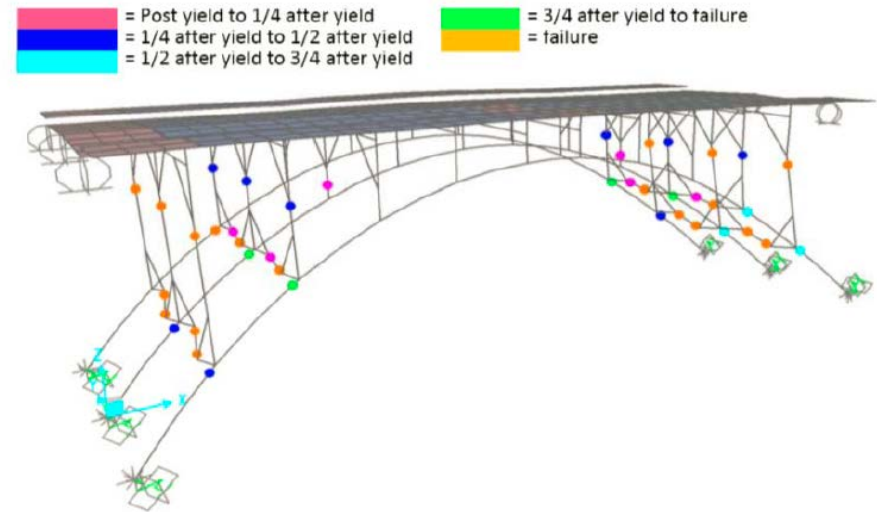
Transverse



- System pushover analysis
  - Arch displacement capacity and force demands
  - Bent displacement capacities and force demands



Longitudinal



Transverse

- Local bent pushover analysis
  - Bent displacement capacities
  - Cap beam and joint shear checks

# Seismic Vulnerabilities

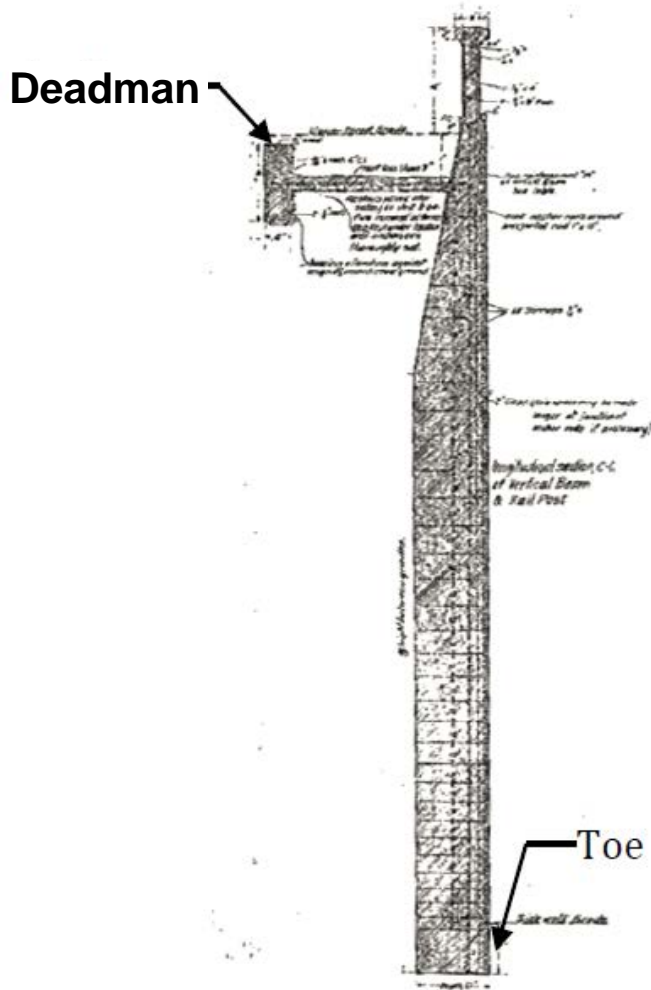
## ○ Global Analysis

- Floating slabs need to be continuous
- Abutment restraint will lower superstructure demand
- Ensure stability of hinges (axial and bending)

## ○ Component Analysis

- Spandrel columns have insufficient shear capacity
- Center spandrels have very high shear
- Arch-ribs insufficient shear/torsion steel
- Abutment and retaining walls need strengthening

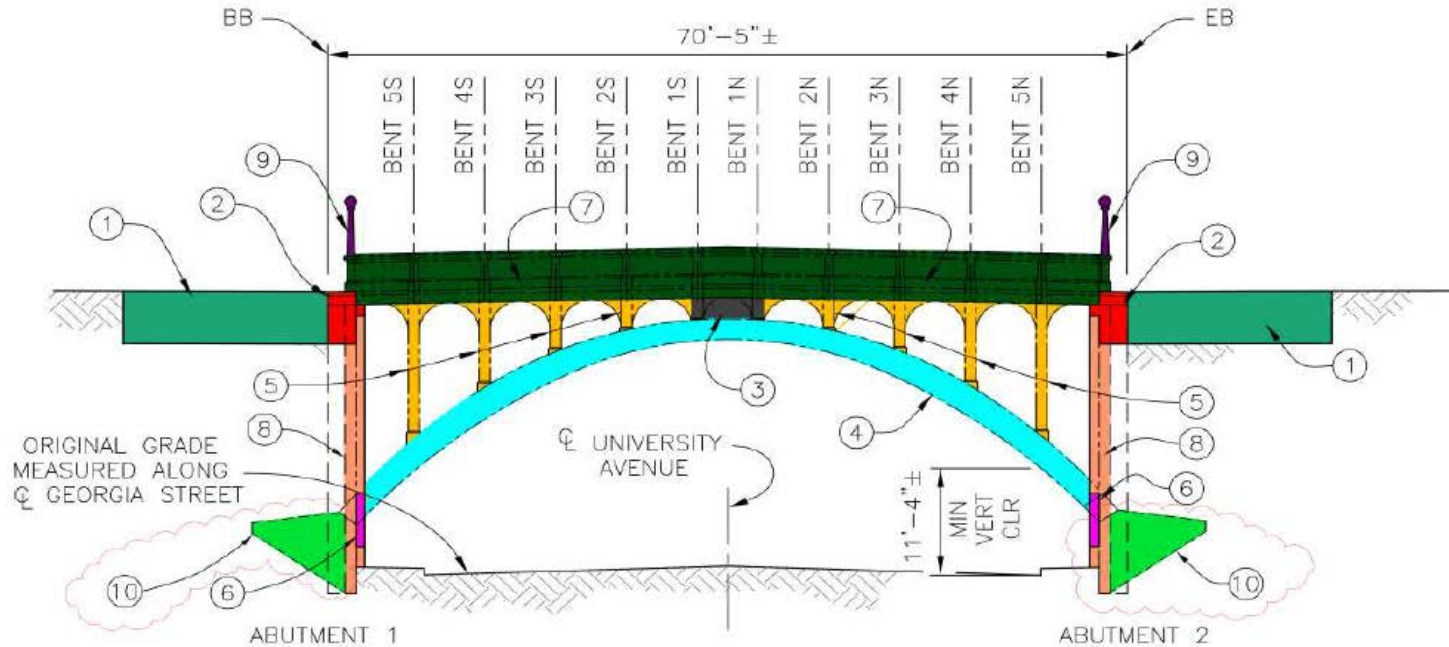
# Wall D/C Analysis



Element of Abutment or Attached Wall Beam	Unit	D/C Ratio		
		Case 1	Case 2	Case 2
		Static (added cohesion)	Static design	Seismic design
Abutment Toe Passive + Friction	(kip)	0.36	1.17	2.14
Abutment Deadman Passive	(kip)	0.26	1.17	1.55
Abutment Deadman Rod	(kip)	0.07	0.33	0.44
Abutment Deadman Shear	(kip)	0.05	0.23	0.30
Abutment Vertical Beam Moment	(kip-ft)	0.09	0.33	0.56
Abutment Vertical Beam Shear	(kip)	0.08	0.28	0.47
Lagging Bending Moment (3/8 in bar)	(kip-ft)	0.02	0.10	0.10
Lagging Bending Moment (1/2 in bar)	(kip-ft)	0.02	0.08	0.11
Lagging Bending Moment (5/8 in bar)	(kip-ft)	0.02	0.07	0.13
Wall Beam Toe Passive + Friction	(kip)	0.67	2.14	4.05
Wall Beam Deadman Passive	(kip)	1.33	5.22	7.99
Wall Beam Deadman Rod	(kip)	0.16	0.64	0.97
Wall Beam Deadman Shear	(kip)	0.69	2.68	4.11
Wall Vertical Beam Moment	(kip-ft)	0.22	0.77	1.35
Wall Vertical Beam Shear @ Top	(kip)	0.34	1.31	2.06
Wall Vertical Beam Shear @ Base	(kip)	0.19	0.61	1.14



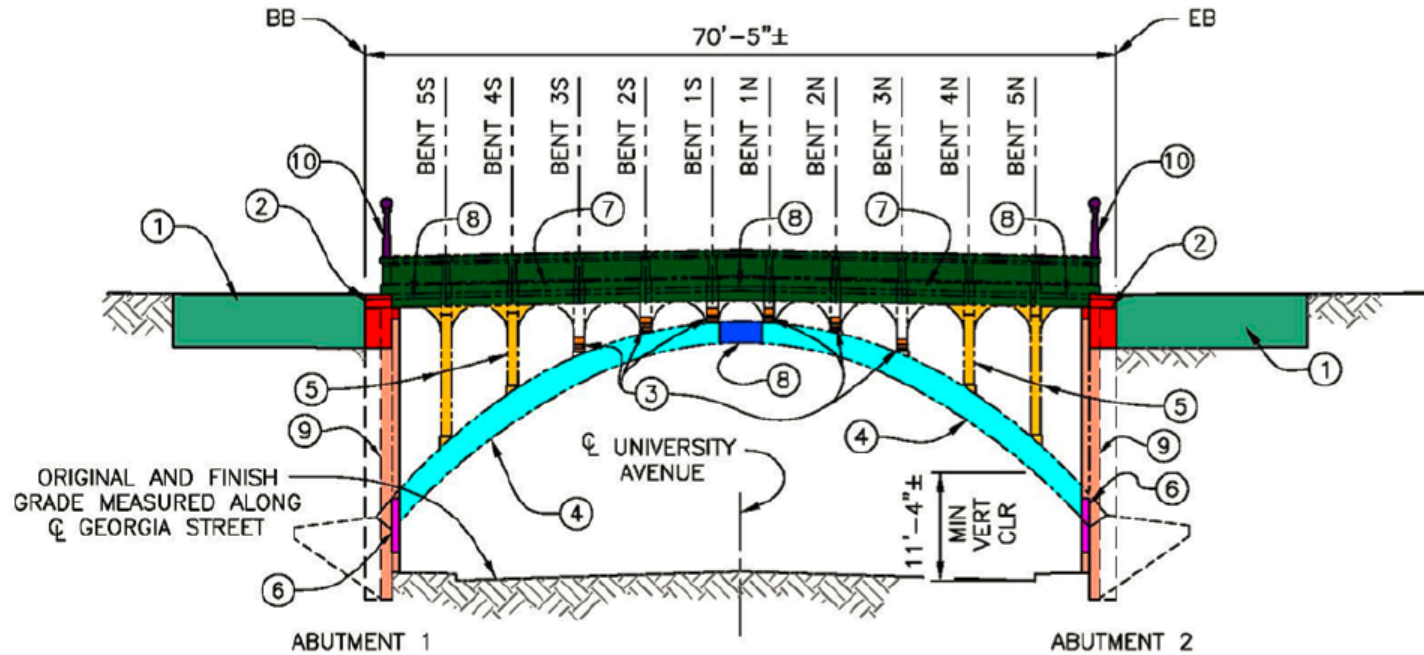
# Retrofit Alternative 1



RETROFIT LEGEND:

- |  |   |
|--|---|
| <span style="background-color: #008000; border: 1px solid black; border-radius: 50%; padding: 2px 5px;">1</span> — SOIL IMPROVEMENT          | <span style="background-color: #FF00FF; border: 1px solid black; border-radius: 50%; padding: 2px 5px;">6</span> — ARCH END GUIDES INTEGRAL WITH NEW FACING     |
| <span style="background-color: #FF0000; border: 1px solid black; border-radius: 50%; padding: 2px 5px;">2</span> — ABUTMENT PASSIVE RETROFIT | <span style="background-color: #008000; border: 1px solid black; border-radius: 50%; padding: 2px 5px;">7</span> — DECK/SIDEWALK/BARRIER REPLACEMENT, REMOVE AC |
| <span style="background-color: #333333; border: 1px solid black; border-radius: 50%; padding: 2px 5px;">3</span> — SHEAR WALL                | <span style="background-color: #FF8C00; border: 1px solid black; border-radius: 50%; padding: 2px 5px;">8</span> — ABUTMENT AND WALL RETROFIT                   |
| <span style="background-color: #00FFFF; border: 1px solid black; border-radius: 50%; padding: 2px 5px;">4</span> — ARCH SHEAR RETROFIT       | <span style="background-color: #4B0082; border: 1px solid black; border-radius: 50%; padding: 2px 5px;">9</span> — REPLACEMENT OF DECORATIVE LIGHTING           |
| <span style="background-color: #FFD700; border: 1px solid black; border-radius: 50%; padding: 2px 5px;">5</span> — SPANDREL REPLACEMENT      | <span style="background-color: #00FF00; border: 1px solid black; border-radius: 50%; padding: 2px 5px;">10</span> — THRUST BLOCK STABILIZATION                  |

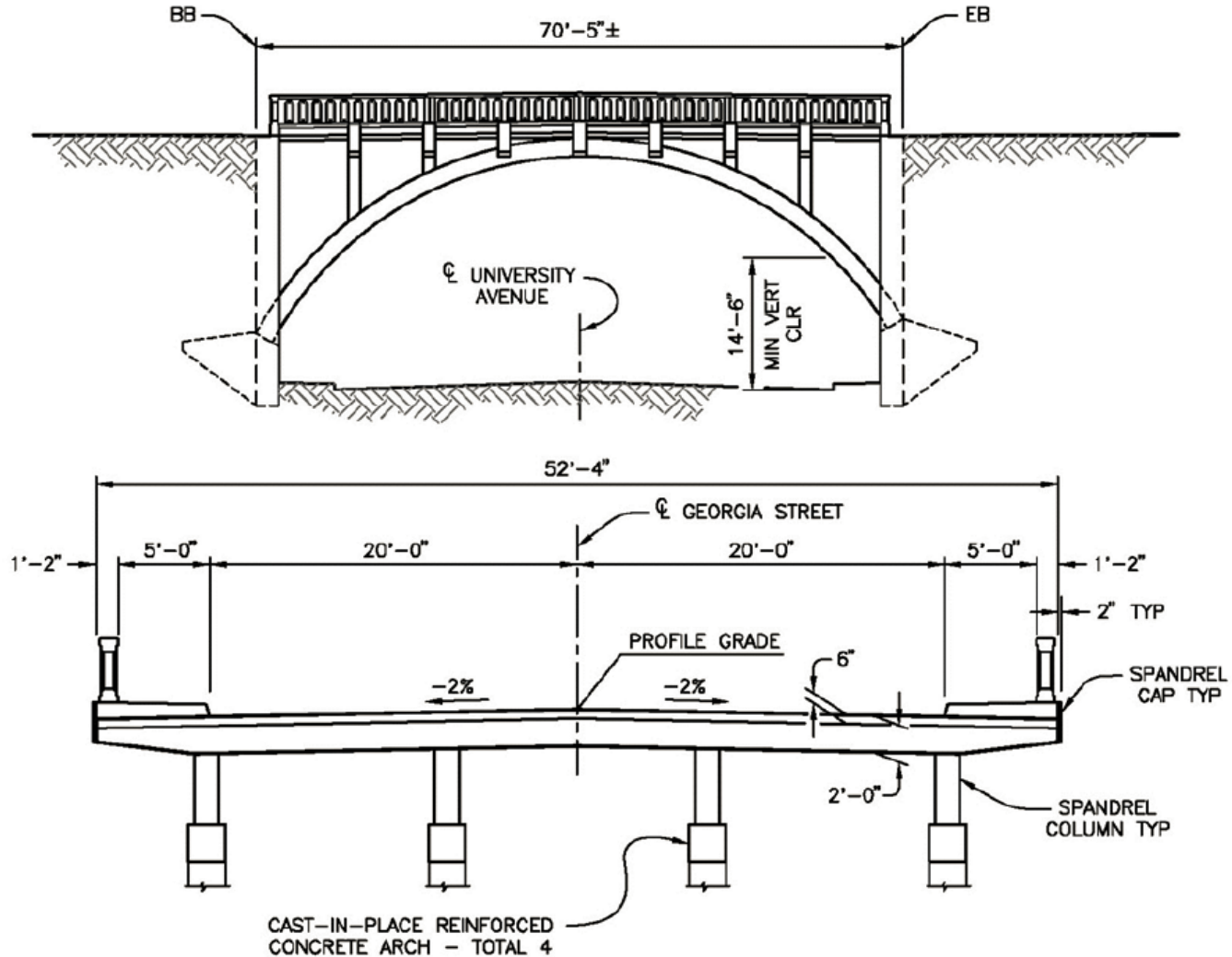
# Retrofit Alternative 2



RETROFIT LEGEND:

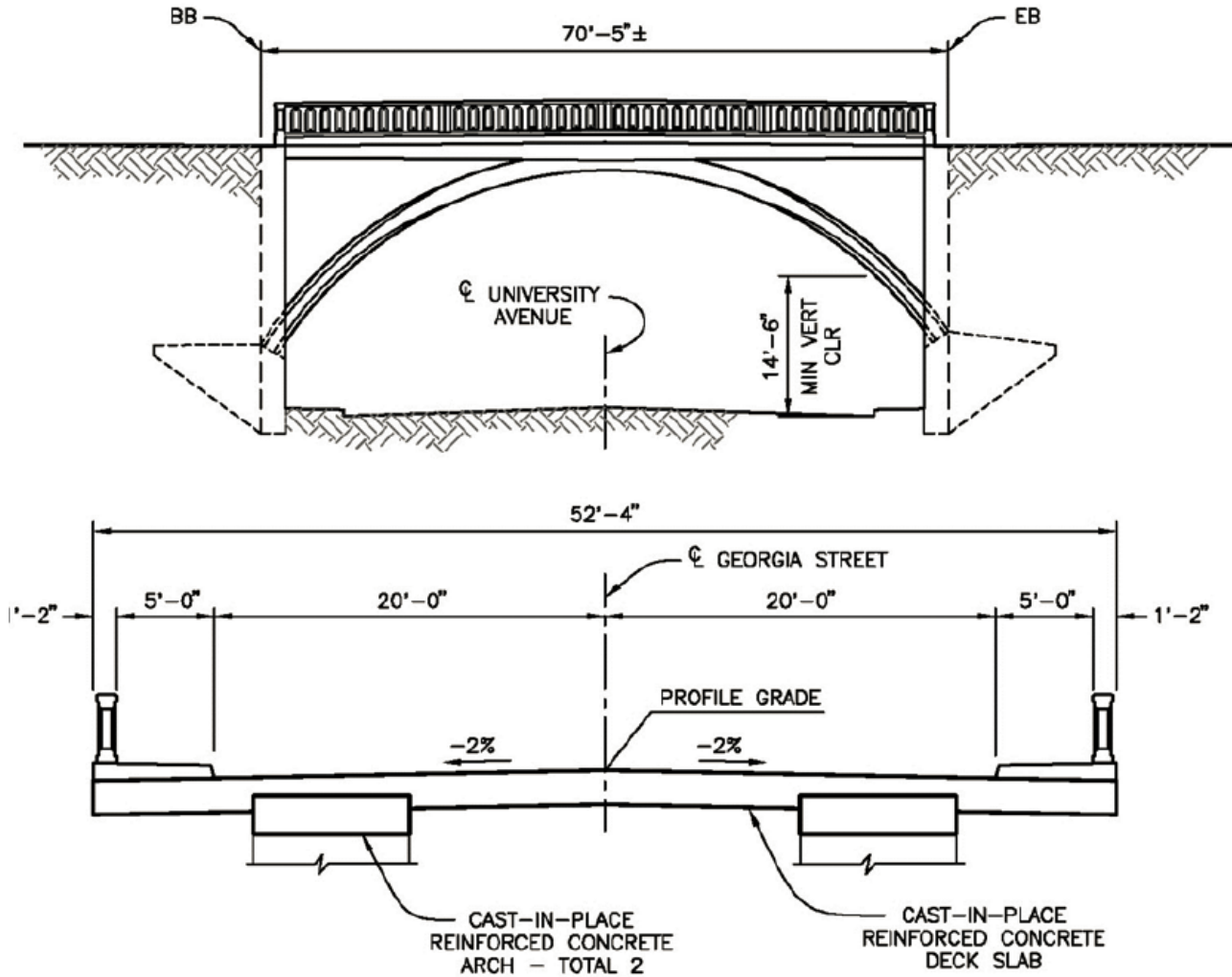
- |   |   |
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| <span style="border: 1px solid black; border-radius: 50%; padding: 2px;">3</span> – SHEAR WALL                | <span style="border: 1px solid black; border-radius: 50%; padding: 2px;">8</span> – ARCH HINGE SHEAR GUIDE              |
| <span style="border: 1px solid black; border-radius: 50%; padding: 2px;">4</span> – ARCH SHEAR RETROFIT       | <span style="border: 1px solid black; border-radius: 50%; padding: 2px;">9</span> – ABUTMENT WALL RETROFIT              |
| <span style="border: 1px solid black; border-radius: 50%; padding: 2px;">5</span> – SPANDREL REPLACEMENT      | <span style="border: 1px solid black; border-radius: 50%; padding: 2px;">10</span> – REPLACEMENT OF DECORATIVE LIGHTING |

# Replacement Alternative 1





# Replacement Alternative 2



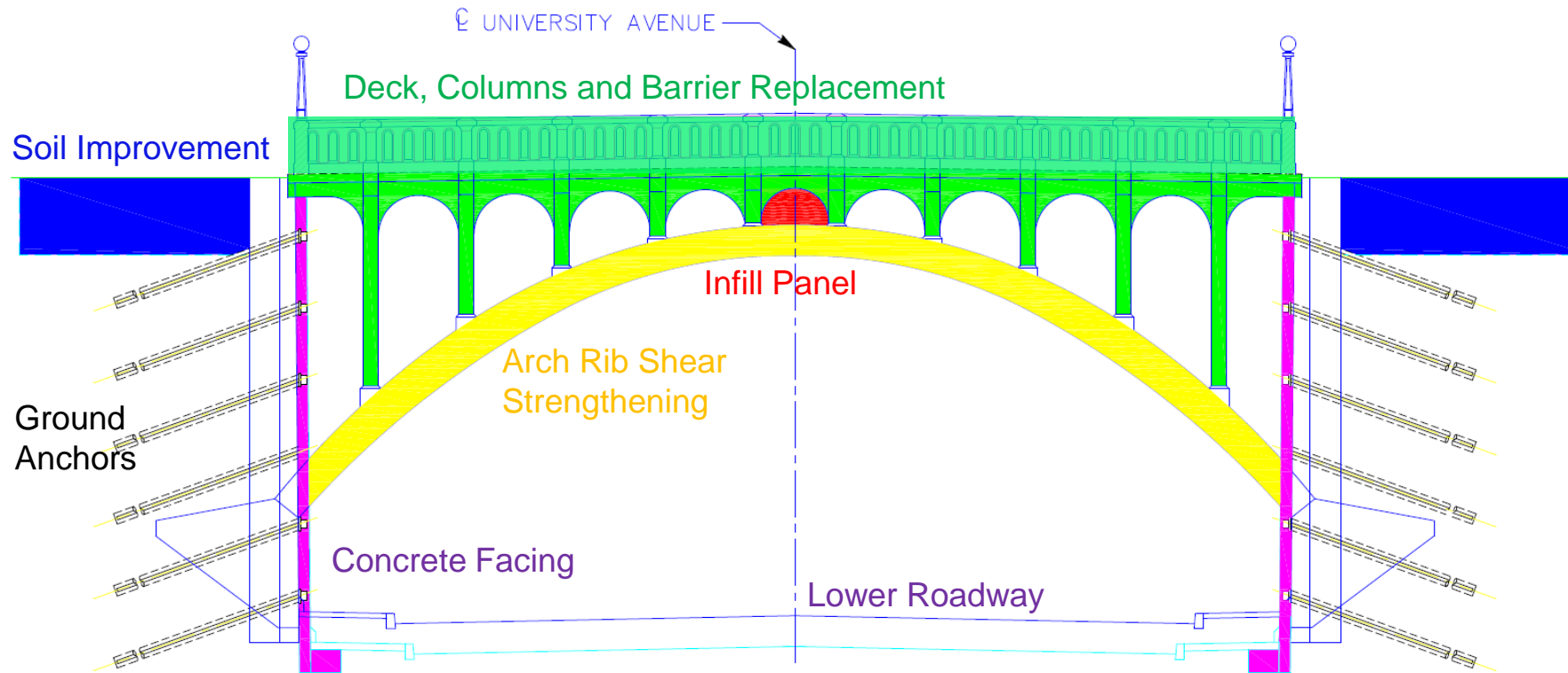
# Historic Preservation

- Community Meetings
  - SOHO, North Park Planning Committee, Uptown Planners



- NEPA CE – CEQA IS/MND Finding of no Adverse Effect with Standard Conditions – Rehabilitation
  - Arch ribs to remain
  - Historic corner lighting
  - Wall facing
  - Barrier rails
  - Shear panel design
  - Geometry, texture, color to match as-built
  - Replace sidewalks (historic scoring)
  - Remove street lighting

# Retrofit Alternative 1 (preferred)

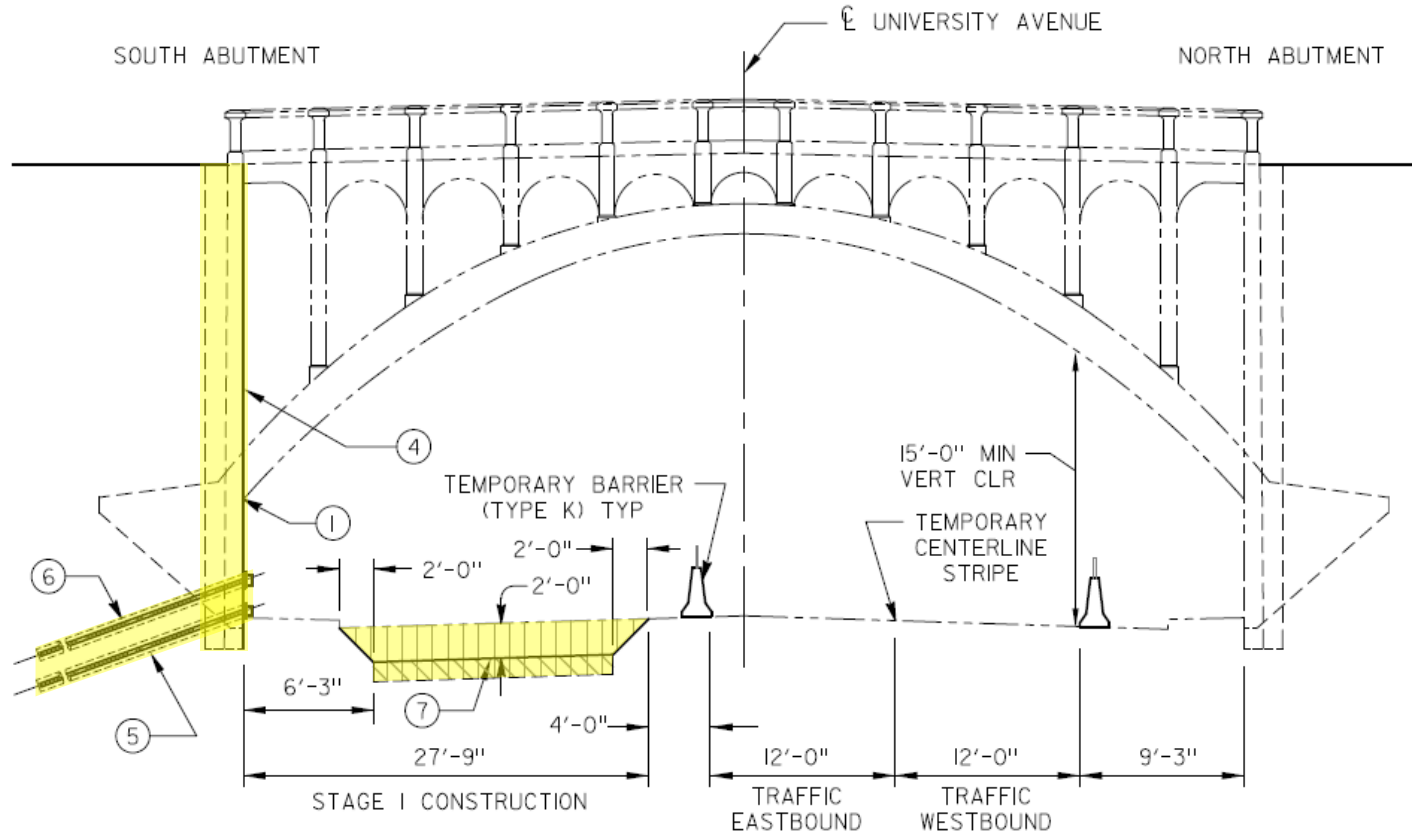


Bridge Elevation



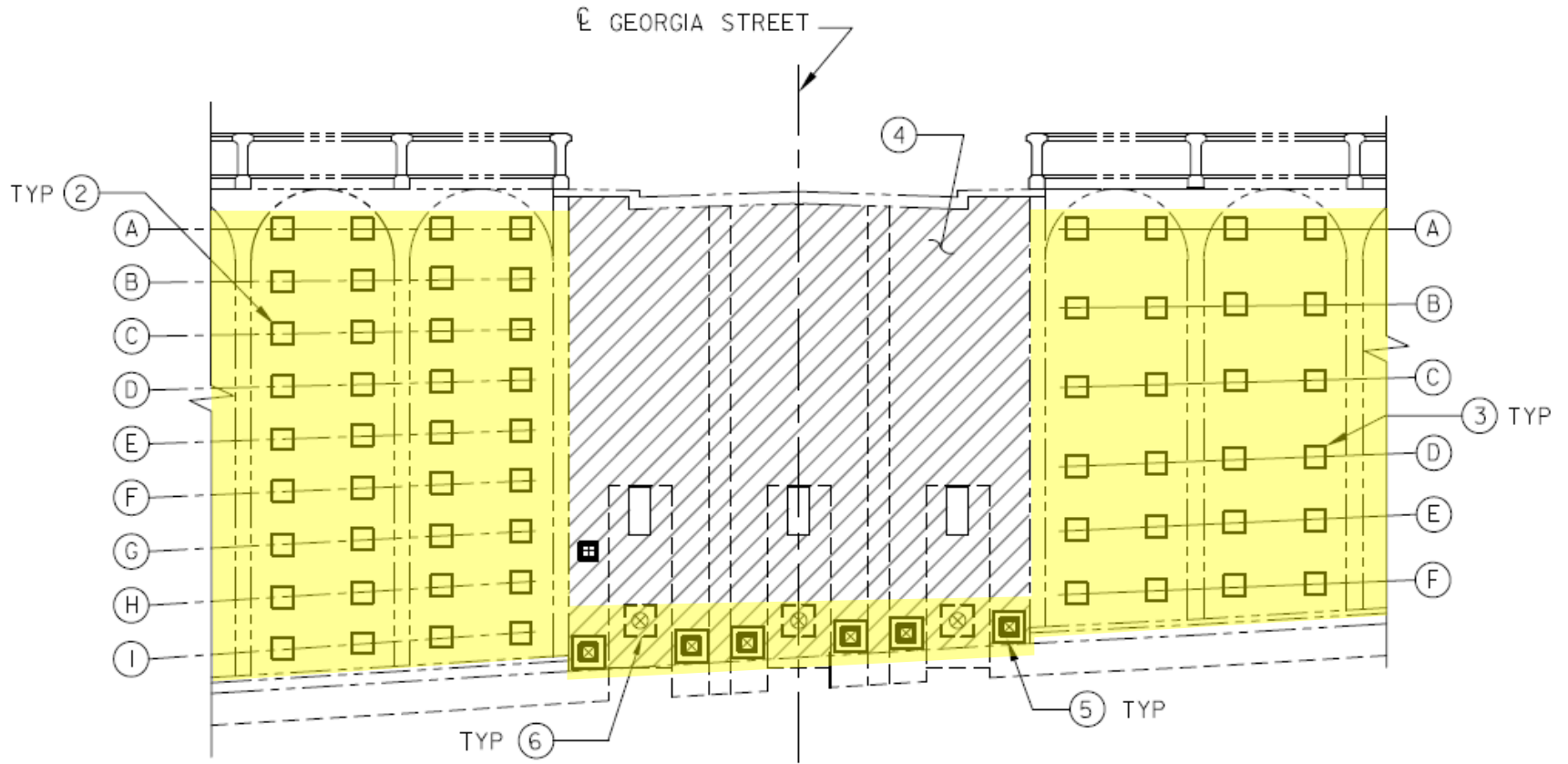
# Construction Phasing

- Major Construction Stages
  - Stage 1 – 3
    - Stabilize Walls
    - Partially Stabilize Abutments
    - Lower University Avenue
  - Stage 4A: Partial Demolition of Bridge
  - Stage 4B: Retrofit Abutment Walls
  - Stage 4C: Retrofit Arch-Ribs
  - Stage 4D: Partial Superstructure Reconstruction



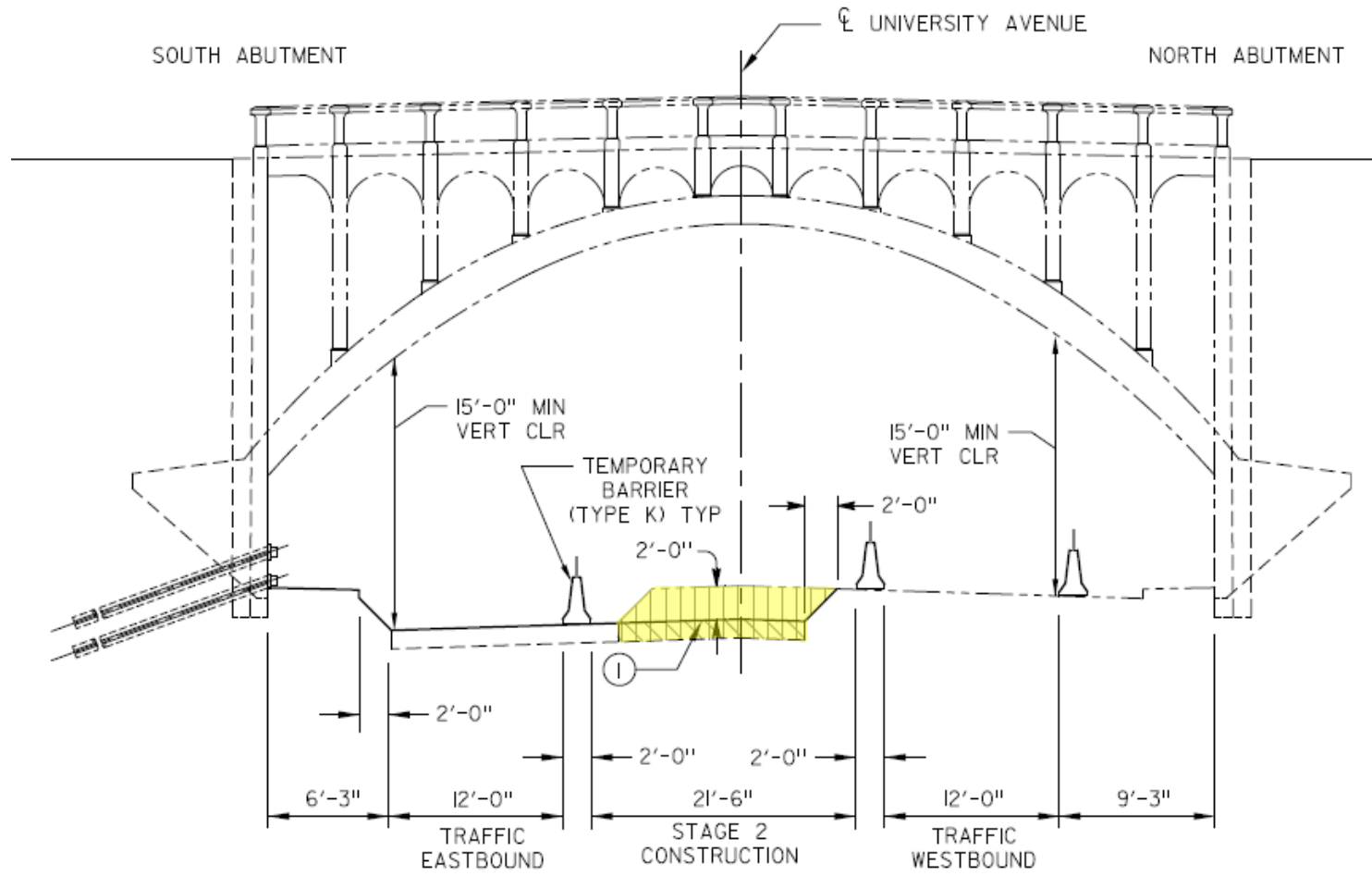
**STAGE 1  
BRIDGE ELEVATION**

NOT TO SCALE



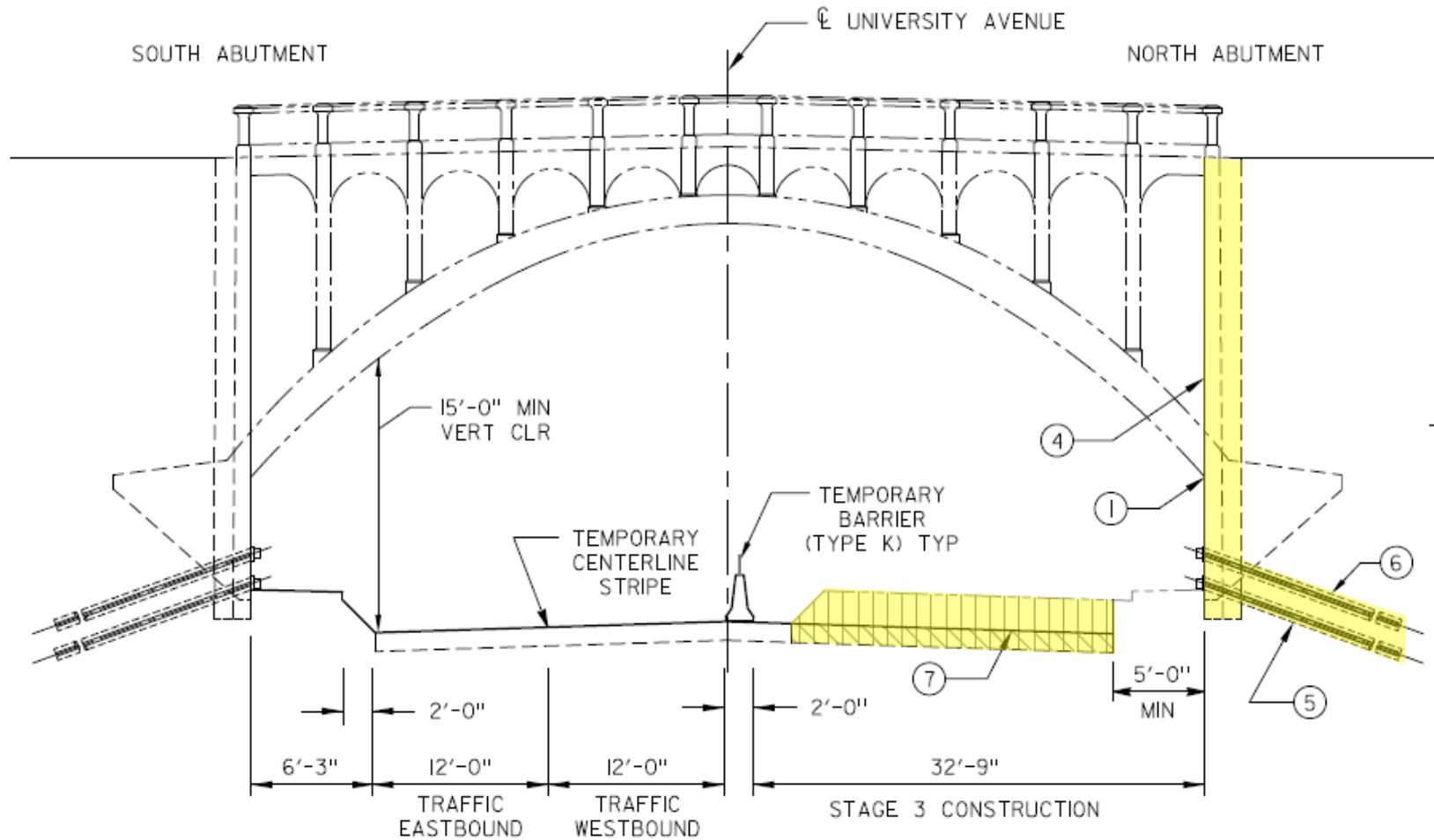
**STAGE 1**  
**SOUTH ABUTMENT ELEVATION**





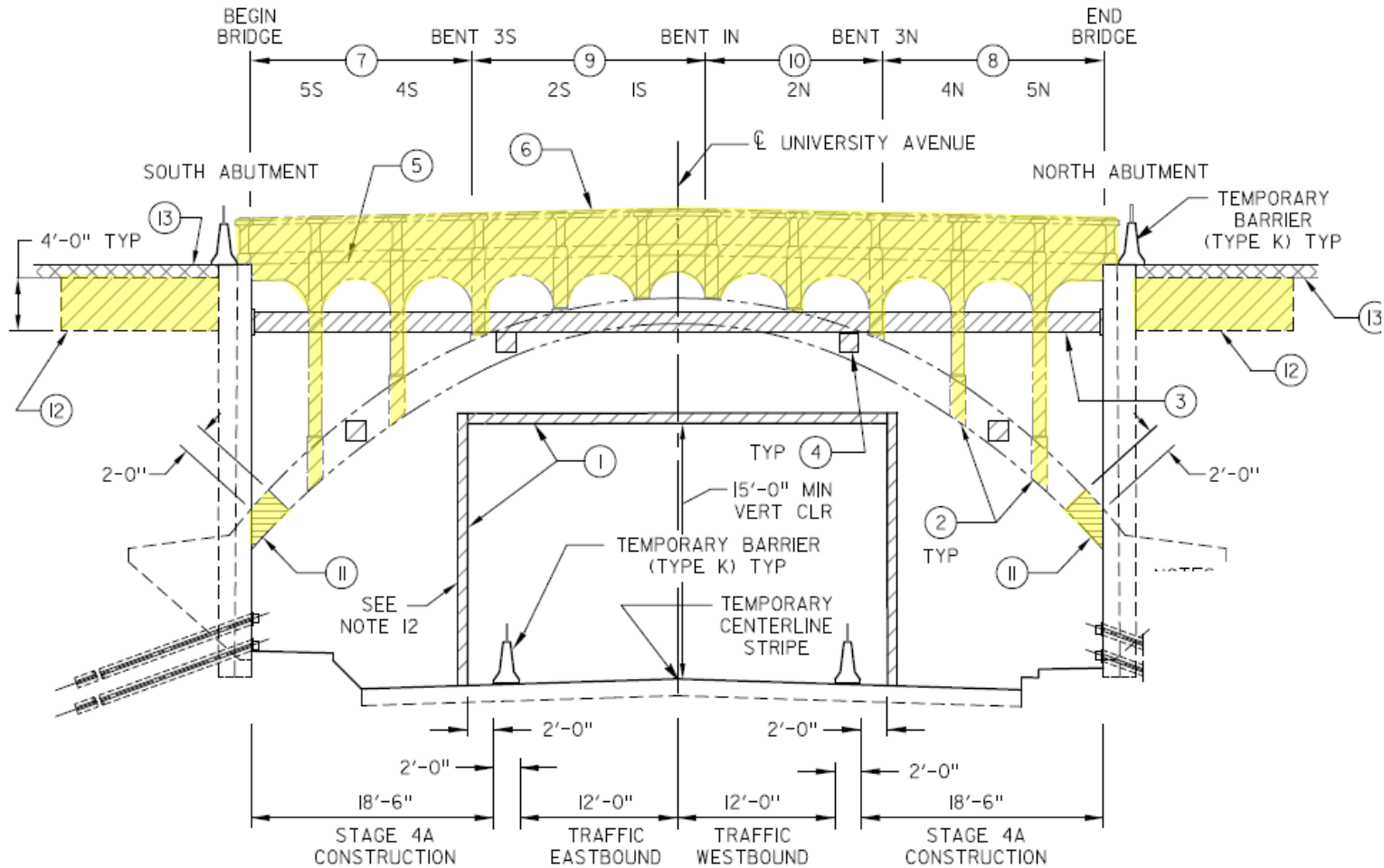
**STAGE 2  
BRIDGE ELEVATION**

NOT TO SCALE



**STAGE 3  
BRIDGE ELEVATION**

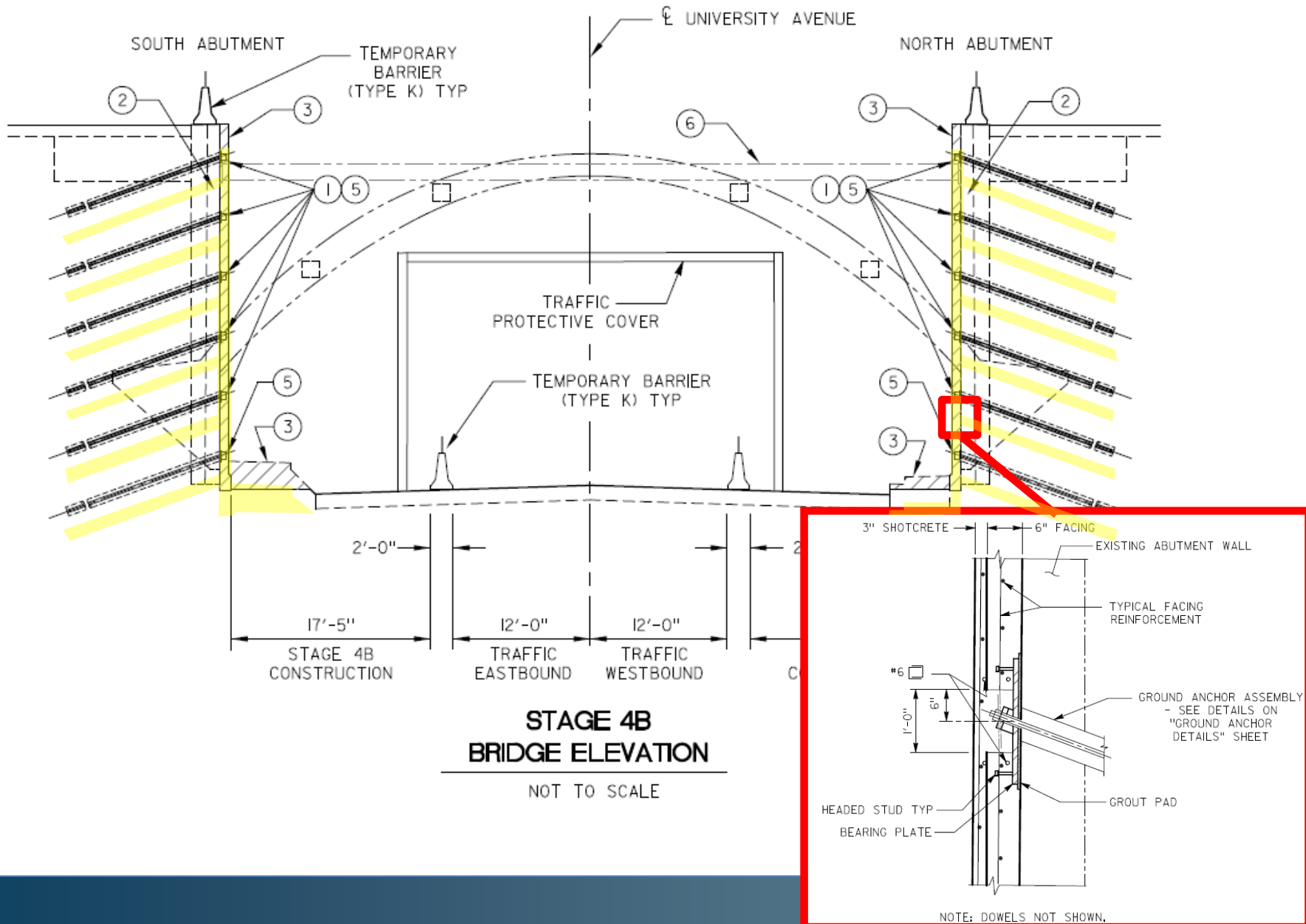
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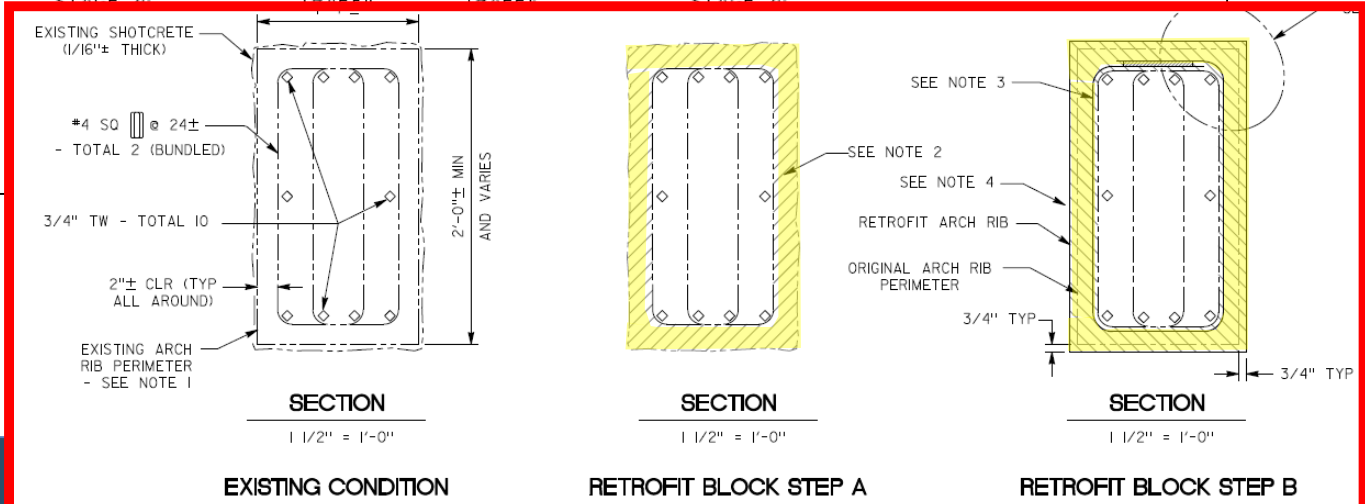
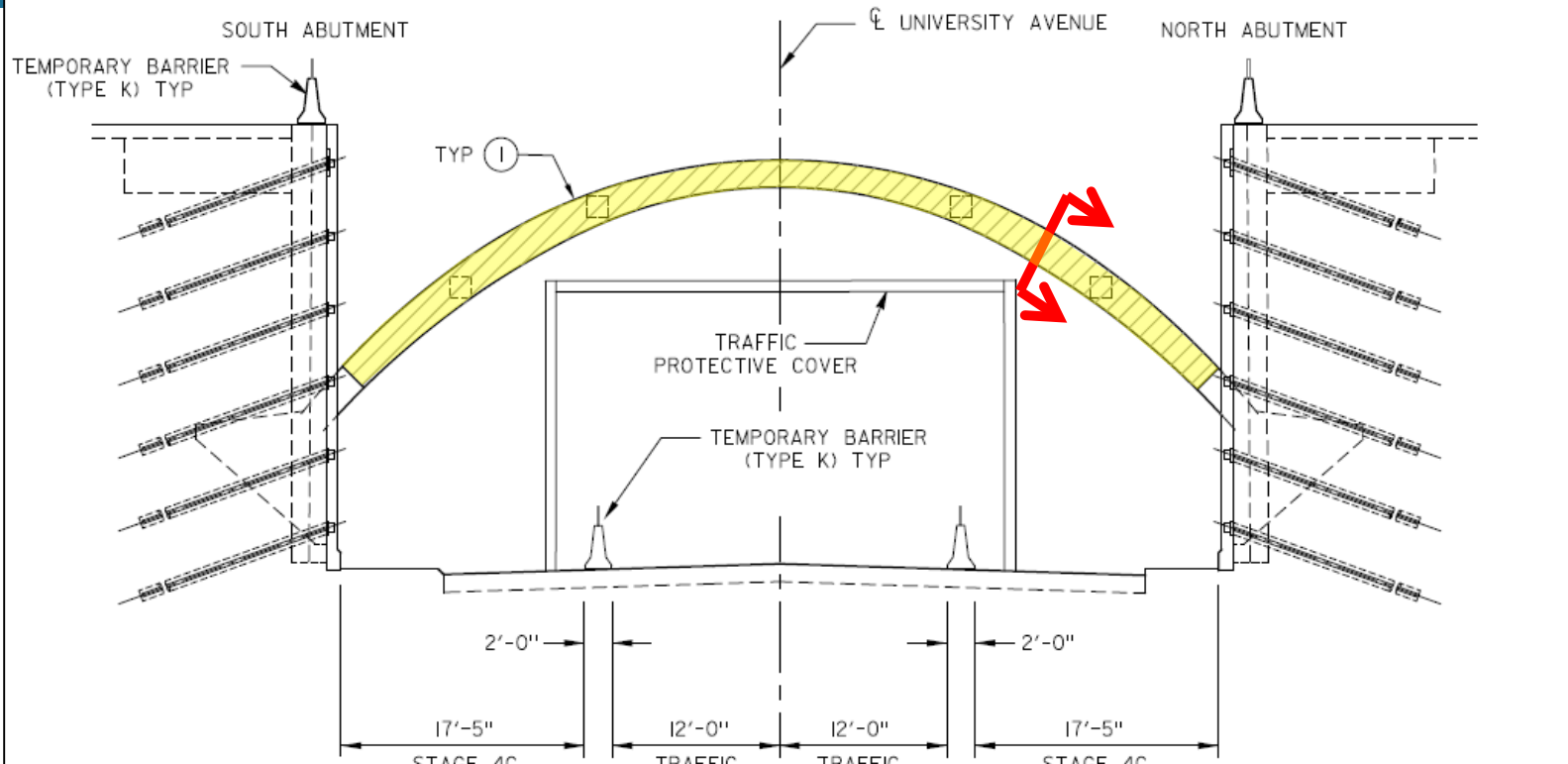


**STAGE 4A  
BRIDGE ELEVATION**

NOT TO SCALE



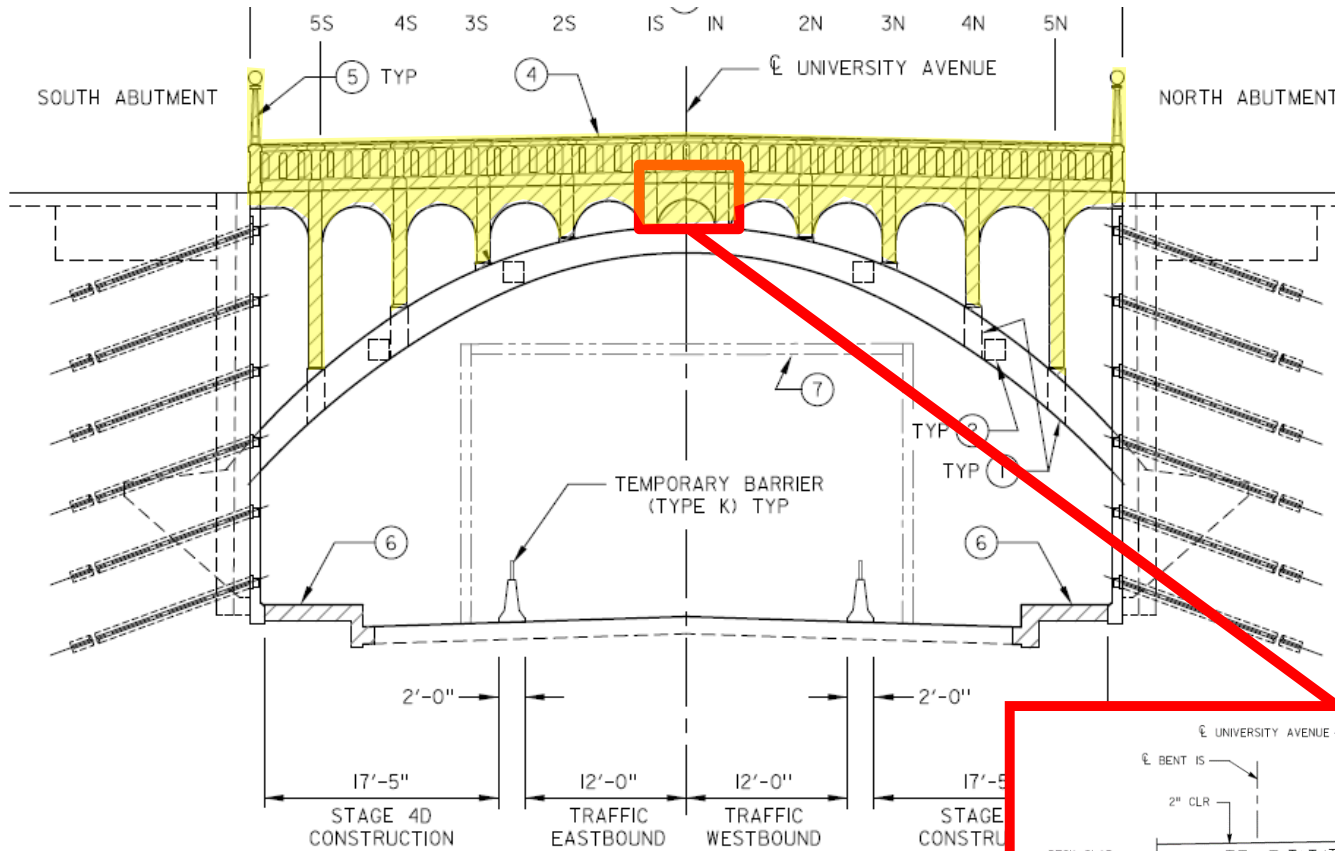




EXISTING CONDITION

RETROFIT BLOCK STEP A

RETROFIT BLOCK STEP B

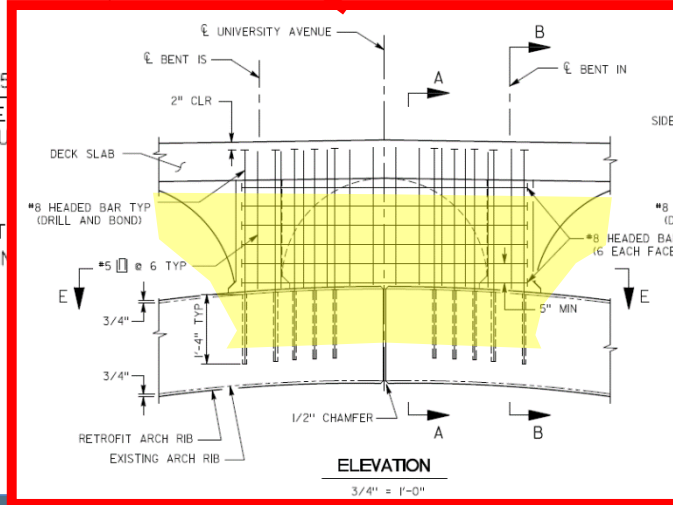


**NOTES:**

- 1. THE CONTRACTOR MUST SUBMIT DETAILS OF THE RECONSTRUCT OF THE BRIDGE DECK, BENT CAPS, AND COLUMNS TO THE ENGINEER FOR APPROVAL.

**STAGE 4D  
BRIDGE ELEVATION**

NOT TO SCALE





# Summary

- Unique Solution to Challenging Project
- Critical Point for Aging Bridges
- Retrofit and Rehabilitation Needs
- Historic Bridges Require Active PDT and Champion
- Listen to Voice of Community
- Bidding Lessons



**Nasland**

LINSCOTT  
LAW &  
GREENSPAN  
engineers

**Ninyo & Moore**

IS ARCHITECTURE  
JONE R. STIEGLER, FAIA

SPARLING

WORK TOGETHER | DESIGN BETTER

**HELIX**  
Environmental Planning

**Thank You**