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CITY OF LOS ANGELES

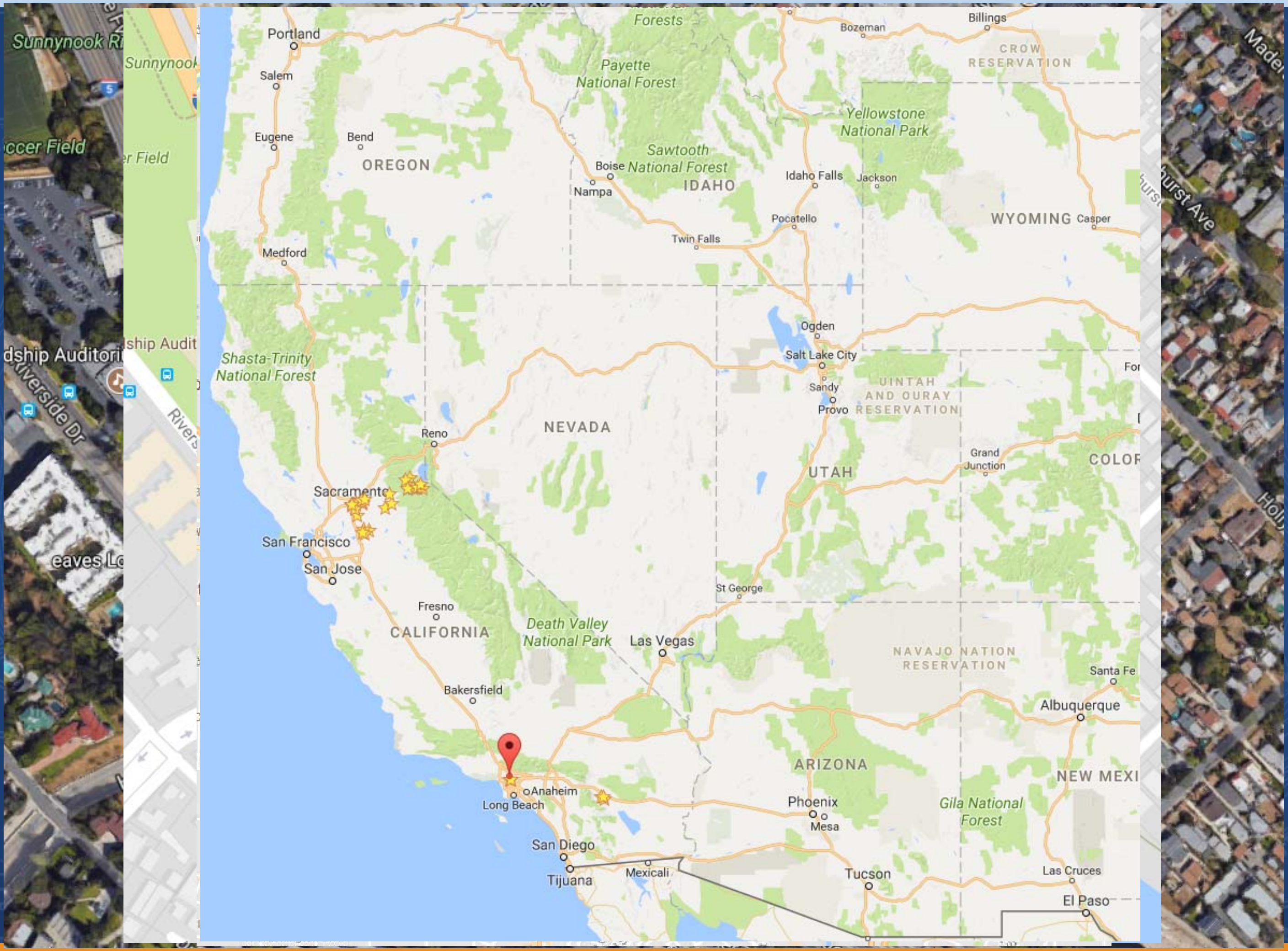
REUSE OF 1920s RED CAR BRIDGE PIERS

Presenters: Lucas Miner, P.E.
Wenn Chyn, P.E.

Introduction

- **Red Car Bridge Piers**
  - This presentation gives an example of how creative solutions can be developed to recycle existing structures to better meet the needs of a client and a community.
  - I hope that this presentation will give you ideas on how you can use similar solutions to meet the needs of your clients

Where?


Portland
Salem
Eugene
Bend
OREGON
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Payette National Forest
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Boise
Nampa
IDAHO
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Billings
CROW RESERVATION
Yellowstone National Park
Idaho Falls
Jackson
Pocatello
Twin Falls
WYOMING
Casper
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Salt Lake City
Sandy
Provo
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Shasta-Trinity National Forest
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Santa Fe
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Long Beach
ARIZONA
NEW MEXI
Phoenix
Mesa
Gila National Forest
San Diego
Tijuana
Mexicali
Tucson
Las Cruces
El Paso
Sunnynook
Riverside Dr

Who?

- **Prime Consultant**
  - Psomas

- **Project Manager**
  - Wenn Chyn, P.E. at City of Los Angeles
  - Wenn is going to spend a few minutes talking about the motivation for the project.
    - LA River Revitalization
    - Community Needs

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Los Angeles River Revitalization Master Plan

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April 2007

LOS ANGELES RIVER REVITALIZATION MASTER PLAN

River Loop

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Red Car Bridge

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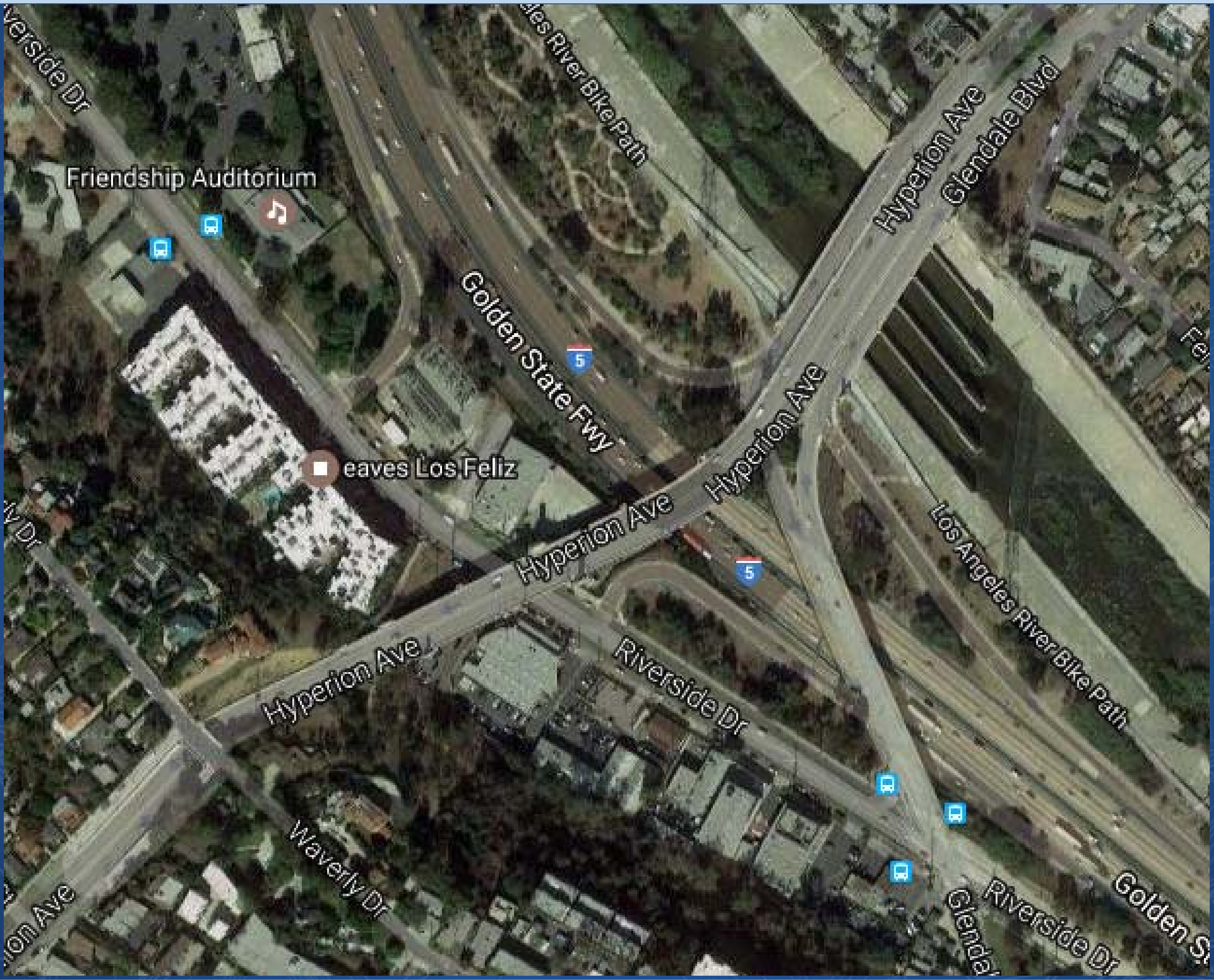
Overview – Unused Railroad Piers Adjacent to Glendale-Hyperion Bridge



Pedestrian Access

- Need Pedestrian Access During Construction
  - Temporary Ped Bridge or Red Car Pedestrian Bridge?

Red Car Bridge

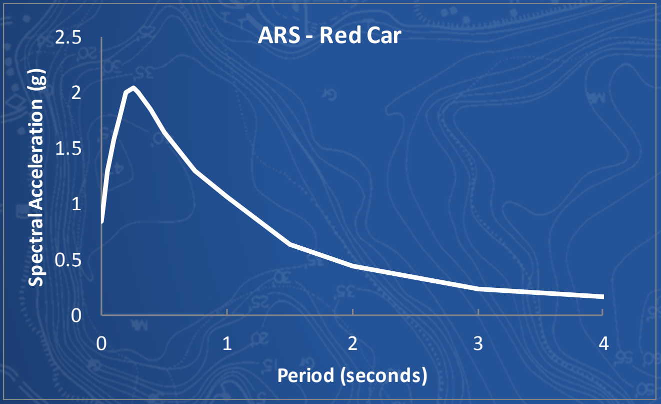
- Original bridge was constructed in 1929
    - Different design code
    - No seismic design criteria
- Superstructure was removed in 1960
- City of LA desires to build a pedestrian bridge at this location

Project Goals

- Provide Pedestrian Access during Glendale-Hyperion Rehab
- Construct Permanent Pedestrian Crossing
  - Reap lasting benefits from funds allocated for temporary pedestrian access.
- Reuse Existing Railroad Piers
  - If piers could hold RR cars, can’t they hold pedestrians?
  - Dropping a steel truss on existing piers costs less than constructing an entirely new bridge with deep foundations.
  - Also sidesteps many environmental and hydraulic issues
  - Recycling of structures contributes to sustainability and efficiency.

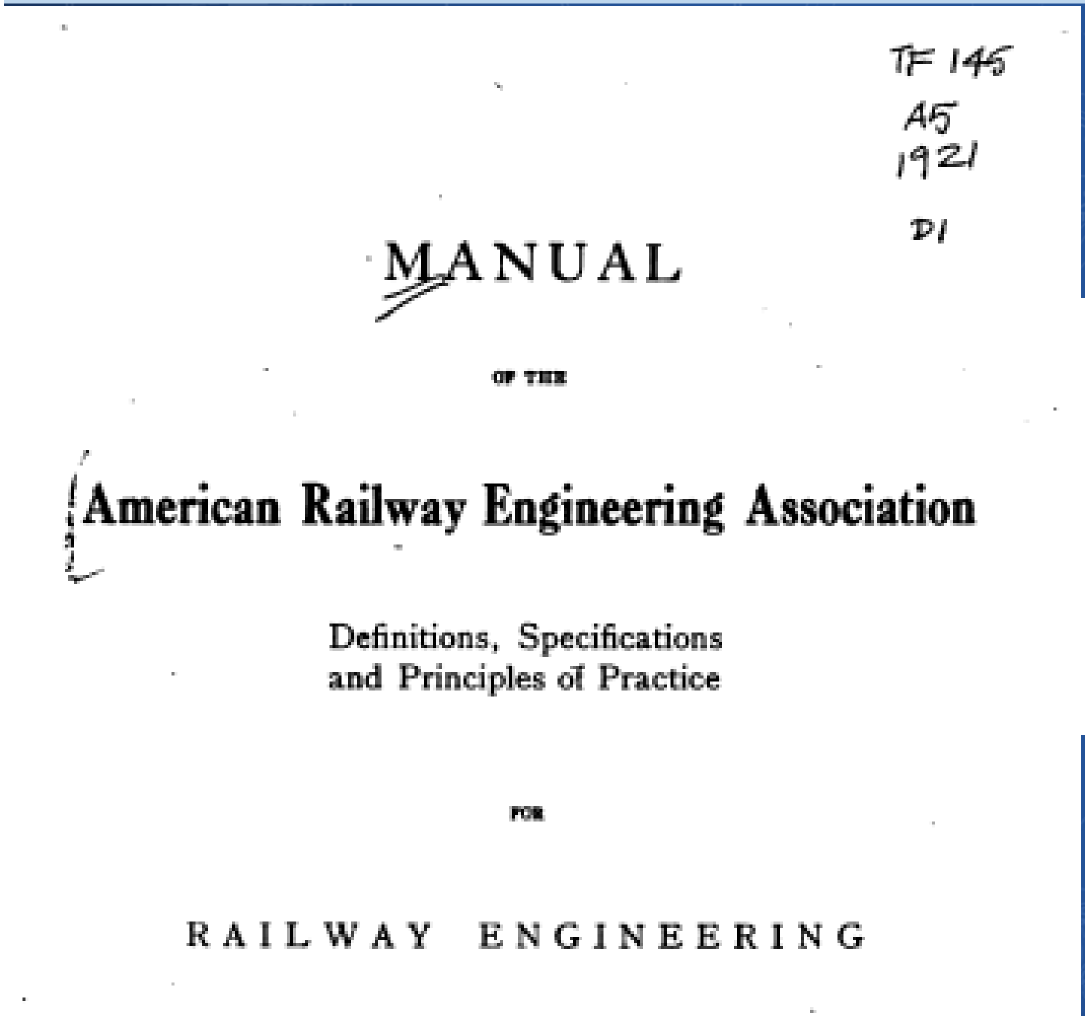
Is it Feasible?

- The Challenge
  - No As-builts
  - High Seismic Demands



  - 1920s Railroad Bridge Design Practice
  - Heavy Piers (1300 kips each)

Procedure: Design Practice Investigation


TF 145
A5
1921
D1

MANUAL

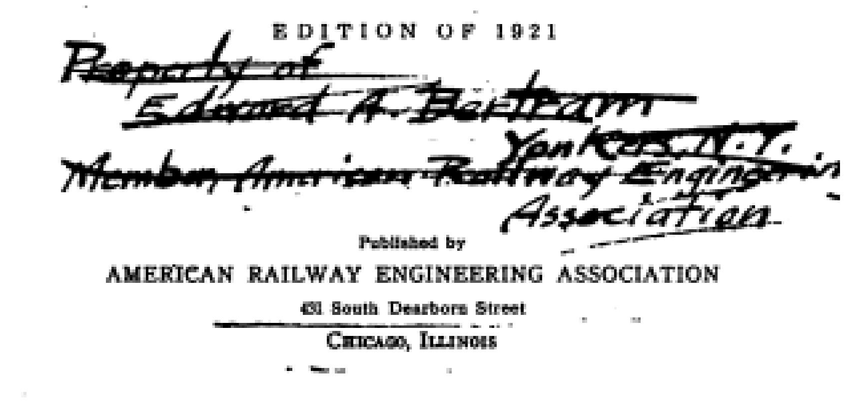
OF THE

American Railway Engineering Association

Definitions, Specifications
and Principles of Practice

FOR

RAILWAY ENGINEERING


EDITION OF 1921

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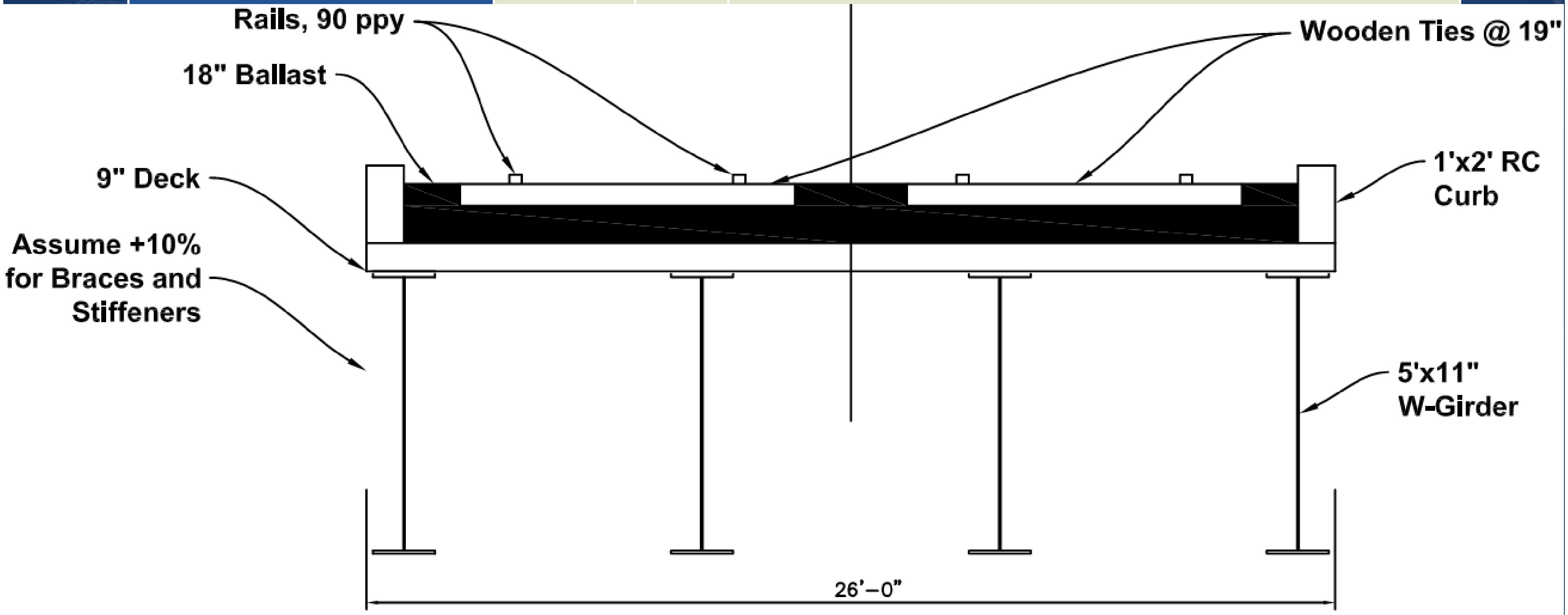
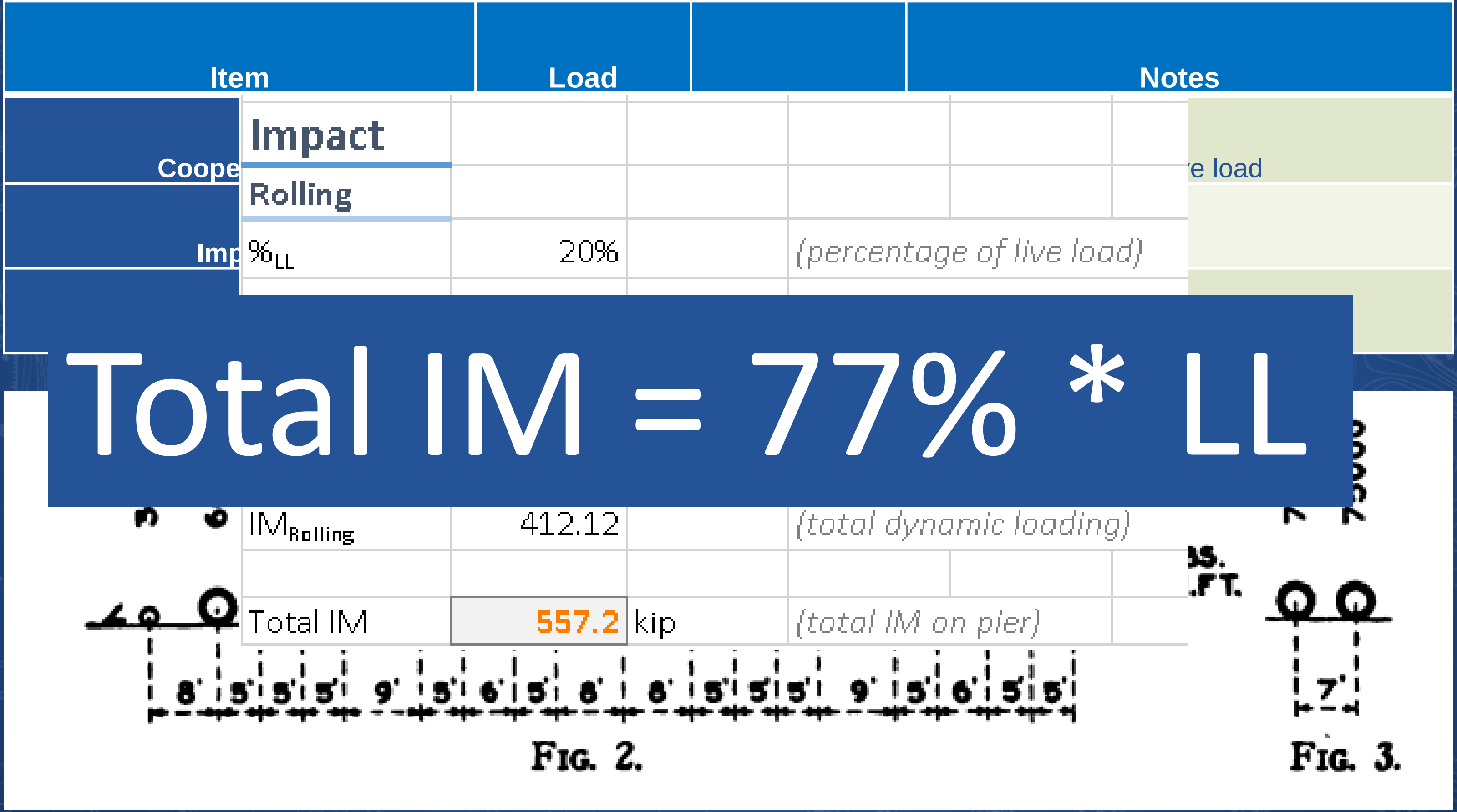
Procedure: Dead Loads

Item	Load		Notes
Total	1983.8	kip	Sum of dead loads



Procedure: Live Loads



Item	Load		Notes
Coope			e load
Imp			

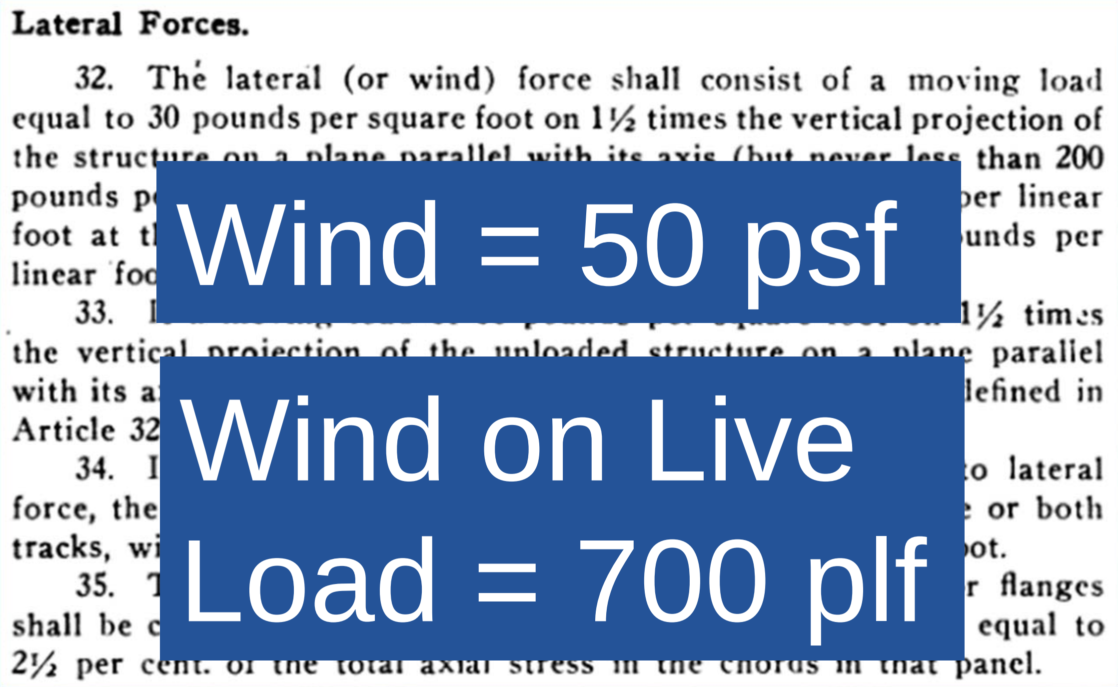
Impact			
Rolling			
$\%_{LL}$	20%		(percentage of live load)
$IM_{Rolling}$	412.12		(total dynamic loading)
Total IM	557.2	kip	(total IM on pier)

FIG. 2.

FIG. 3.

Total IM = 77% * LL

Procedure: Lateral Loads



Lateral Forces.

32. The lateral (or wind) force shall consist of a moving load equal to 30 pounds per square foot on 1½ times the vertical projection of the structure on a plane parallel with its axis (but never less than 200 pounds p per linear foot at t unds per linear foo

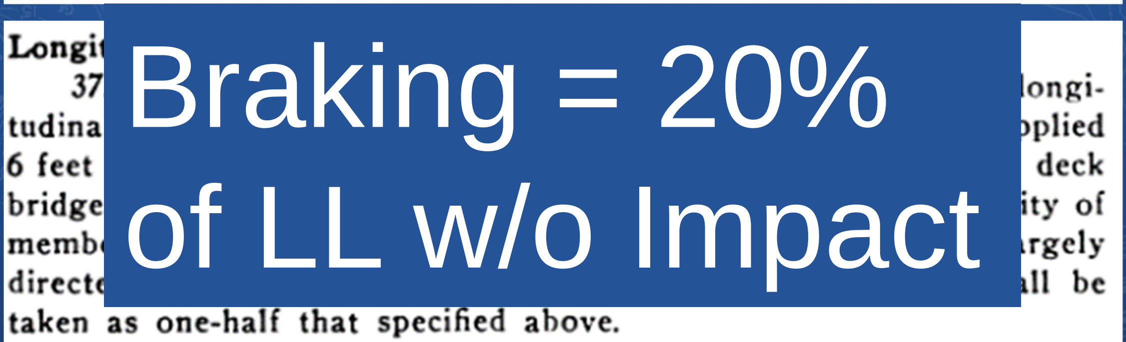
33. I 1½ times the vertical projection of the unloaded structure on a plane parallel with its a defined in Article 32

34. I o lateral force, the or both tracks, wi oot.

35. T r flanges shall be c equal to 2½ per cent. of the total axial stress in the chords in that panel.

Wind = 50 psf

Wind on Live Load = 700 plf



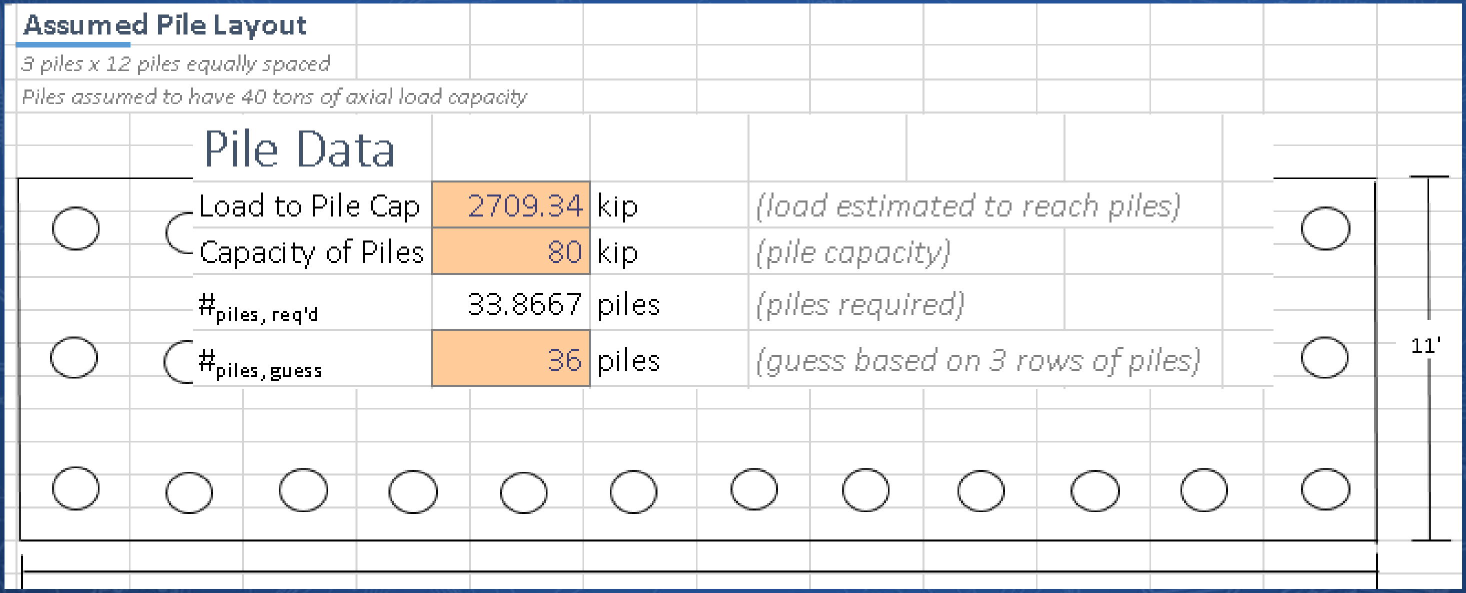
Longit

37 longitudina pplied 6 feet deck bridge ity of memb rgely directe all be taken as one-half that specified above.

Braking = 20% of LL w/o Impact

Procedure: Pile Estimation

- Guessed a pile layout
- Assumed 80 kip piles (used on adjacent structure), calculated # of piles req’d given the assumed dead loads.
- Required # of piles matched guess pretty well.



Assumed Pile Layout

3 piles x 12 piles equally spaced

Piles assumed to have 40 tons of axial load capacity

Pile Data

Load to Pile Cap	2709.34	kip	*(load estimated to reach piles)*
Capacity of Piles	80	kip	*(pile capacity)*
$\#_{piles,\ req'd}$	33.8667	piles	*(piles required)*
$\#_{piles,\ guess}$	36	piles	*(guess based on 3 rows of piles)*

Snag: Unreinforced Piers

Figure 3 – Coring During the Pier Invasive Investigation

OK for Vertical Loads: C/D for Proposed Structure

Load Comparison, Non-Seismic

	Original Bridge Demand	New Bridge Demand			
$P_{vertical}$	3074.1	1837.5	**< OK >**	kip	(force due to axial loading)
V_y	82.8	23.1	**< OK >**	kip	(shear due to transverse loading)
V_x	72.6	23.1	**< OK >**	kip	(shear due to longitudinal loading)
M_{xx}	3850.2	879.3	**< OK >**	k-ft	(pier base moment due to transverse loading)
M_{yy}	2793.4	0.0	**< OK >**	k-ft	(pier base moment due to longitudinal loading)

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Procedure: Seismic Analysis

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- No seismic design details
- Non-ductile structure
  - If structure fails, it will be catastrophic brittle-failure, not slow and controlled failure.
- Footing connection to pier is a “cold joint”
  - Only resistance to shear and moment at pier-footing interface is concrete “adhesion”.
- Connection between footing and piles is unknown

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Research

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Seismic Performance of Stone Masonry and Unreinforced Concrete Railroad Bridge Substructures

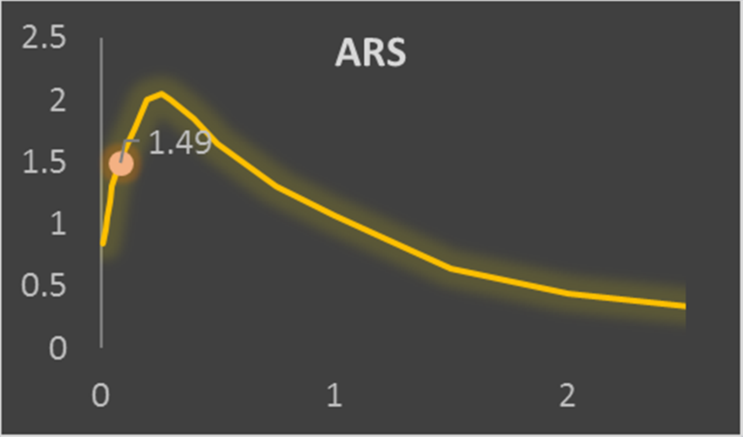
Masonry railroad bridge piers were widely used in early 1900. The use of concrete for bridge piers commenced in the 1920's. These piers have inherent weaknesses when subject to seismic loading which can be exacerbated by the quality of the concrete, its placement and the presence of construction joints. Although these piers are generally adequate for normal loading of the bridge, seismic loads are likely to cause significant damage, particularly if piers go into tension. The objective of this study is to evaluate the seismic resistance, damping, and energy absorption capabilities of old stone masonry and unreinforced concrete railroad bridge piers. Feasible and cost-effective strengthening methods will be identified to ensure that the retrofitted masonry and unreinforced concrete railroad bridge piers could accommodate a higher speed and satisfy seismic criteria without constructing new substructures. Results of this research will be very helpful in determining if new superstructures can be placed on existing masonry piers and abutments and satisfy seismic criteria. This could significantly impact cost savings compared to constructing new foundations and substructures for bridge replacement projects.

TRB
TRANSPORTATION RESEARCH BOARD

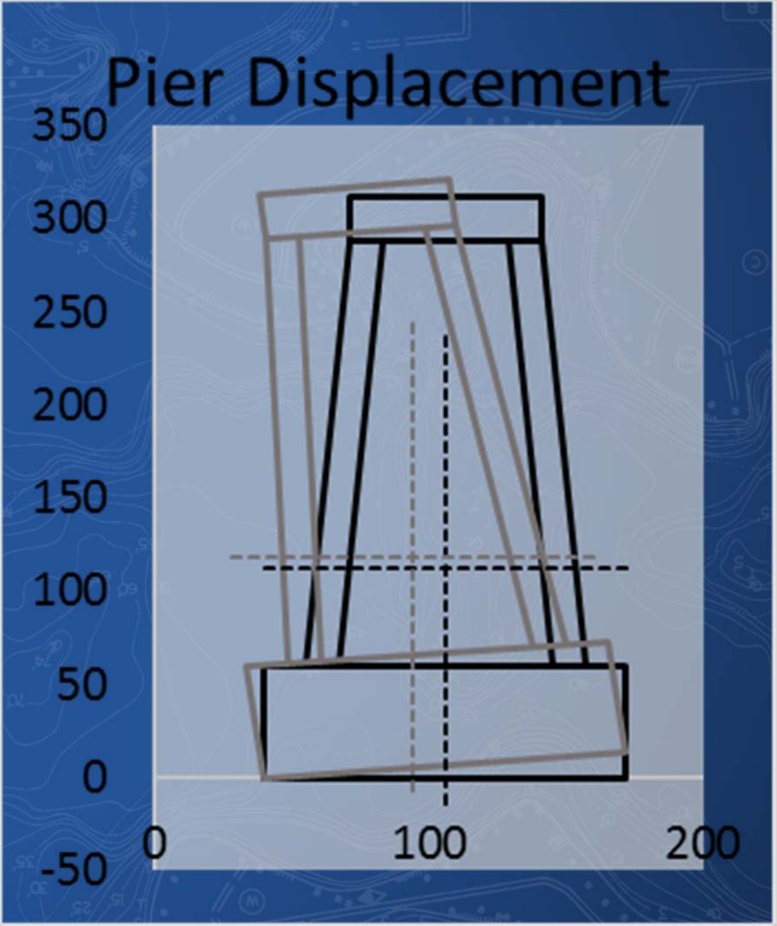
Dr. John Ma, PE
University of Tennessee,
Knoxville

Procedure: Seismic Analysis

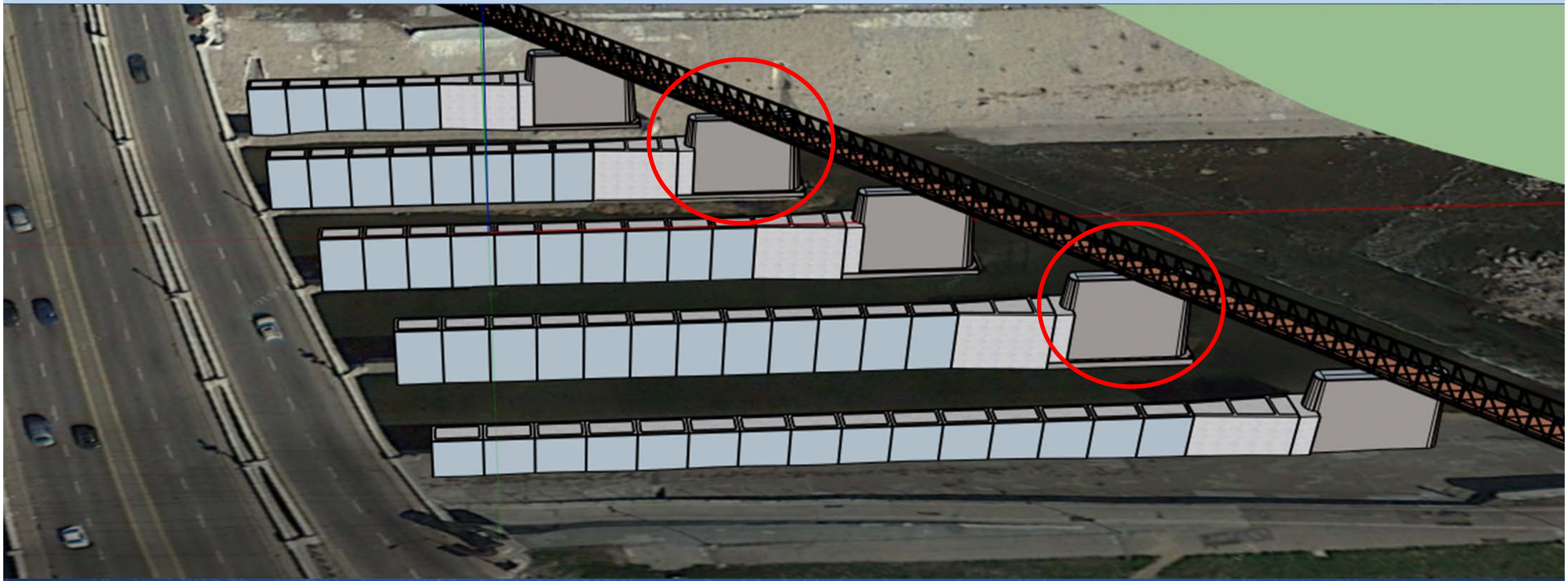
- Acceleration Response Spectrum Analysis



-30” Displacement at top of pier.
-Displaces so much b/c of massive pier
-Pier Remains Intact
-Piles Fail: EMI provides nonlinear spring for pile behavior
-Structure Rocks on top of Piles
-No Sliding Due to Concrete Channel

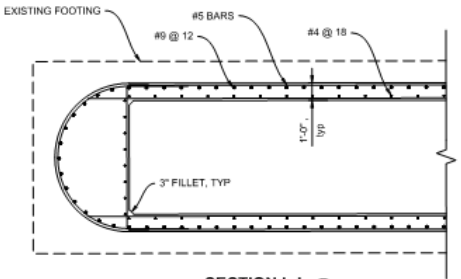


Solution

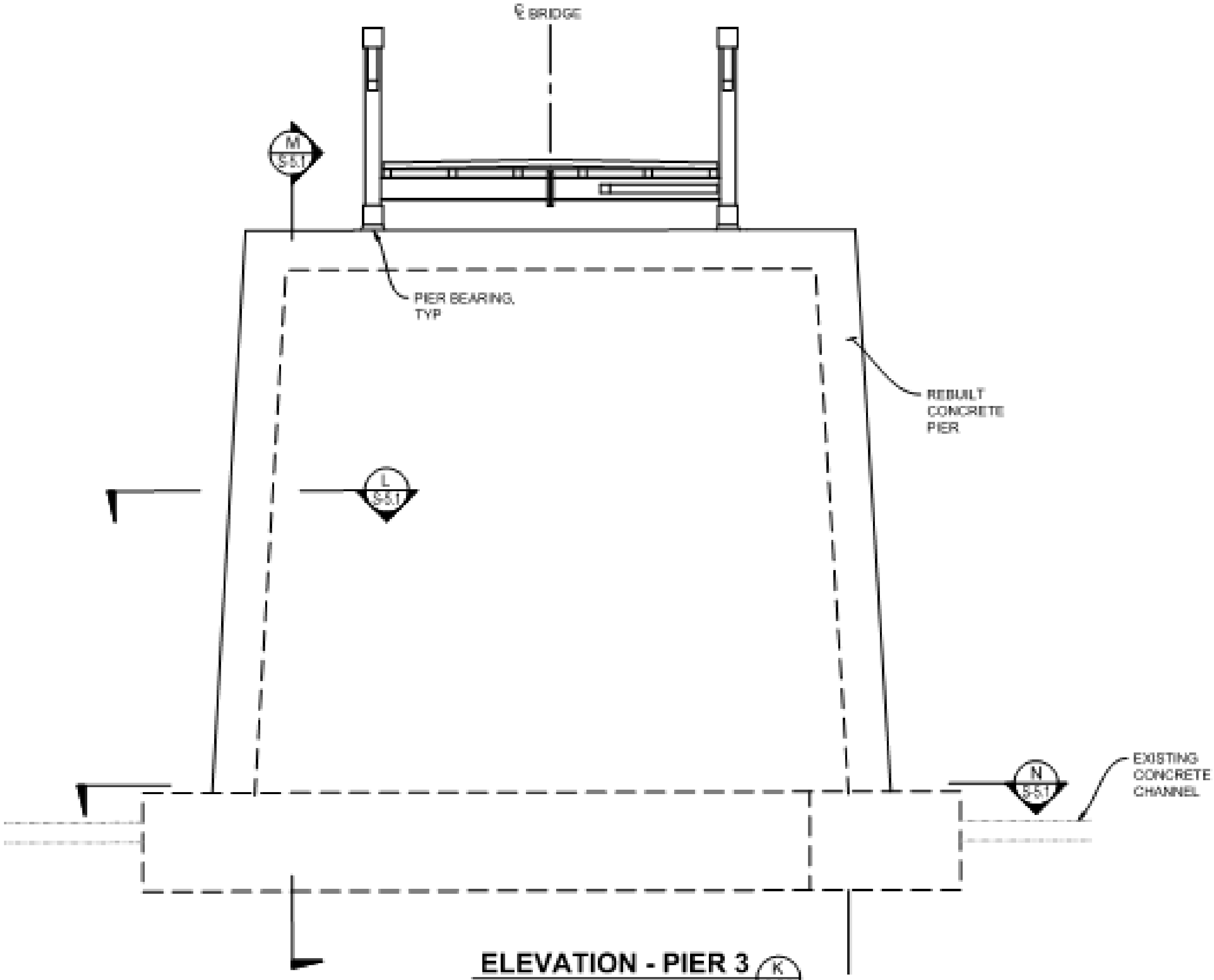


- Allow rocking and pile damage during seismic event.
- Replace Piers 3 and 5, dowel into existing footings.
- Provide detailing to prevent superstructure unseating.

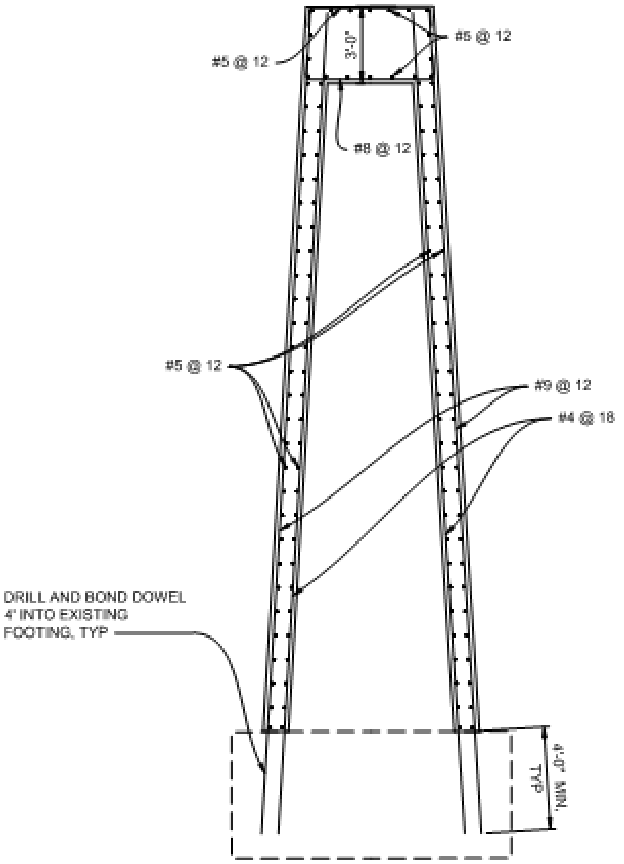
Results



SECTION L-L (L / S-5.0)
SCALE: 3/8" = 1'-0"



ELEVATION - PIER 3 (K / S-5.0)
SCALE: 1/4" = 1'-0"



SECTION M-M (M / S-5.0)
SCALE: 3/8" = 1'-0"

Results

Red Car Bridge

Solution Achievements

- Provides Pedestrian Access during Glendale-Hyperion Rehab
- Creates Permanent Pedestrian Crossing
  - Reap lasting benefits from funds allocated for temporary pedestrian access.
- Reuses Existing Railroad Piers

Questions?