

Rehabilitation of Tacoma Avenue S. Bridge, WA

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September 9-11, 2015
Engineering

Peppermill Hotel, Reno, Nevada



Outline

- Introduction
- Objectives
- Assessment of bridge deficiencies
- Seismic retrofit considerations
- Repair of major elements
- Concluding remarks



Introduction

- Bridge was built in 1930
- Bridge is 5-span, 333' long and 52' wide.
- It serves as a critical link within the City of Tacoma.
- Bridge now shows deficiency in load carry capacity, and is posted.

Introduction (Cont'd)

- Two of the 4 traffic lanes are closed and both sidewalks are closed.
- The roadway does not meet the current City roadway standard and needs to be widened.
- The steel superstructure and substructure is rusted and damaged. The bridge is vulnerable to earthquake loading.



Introduction (Cont'd)

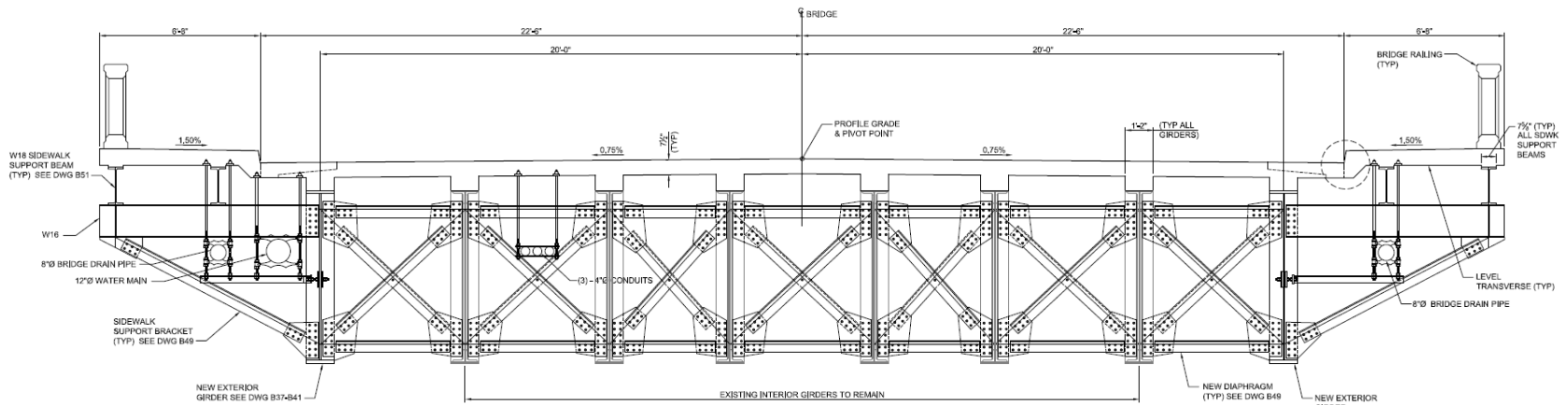
- Steel rust damages are in girders and crossbeams.
- Sidewalk cantilever system is failing.
- Abutment 1 has moved due to Nisqually earthquake in 2001.
(Abutment 1 settled by 8" and moved toward north by 4")



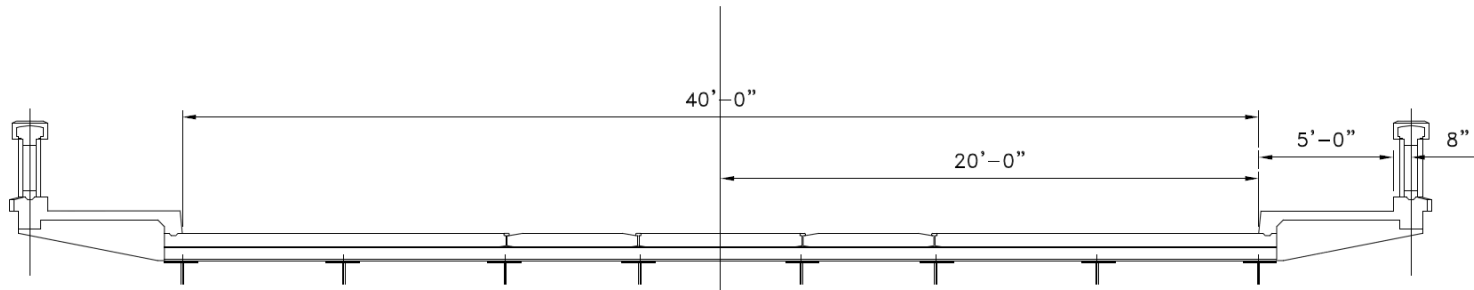
Objectives

- The objectives are;
 - To rehabilitate the bridge to its original design capacity (i.e. AASHO Class AA Loading; 8-axles 96 kips Streetcar)
 - Widen the bridge from 56'-4" to 59'-2" wide (geometry improvement)
 - Improve seismic capacity to the extent feasible without major expense.

Objectives



Widened Cross Section



Original Cross Section



Bridge Description



Assessment of bridge deficiencies

- Based on in-depth inspection report:
 - Girders have pack rust and section losses due to rusting
 - Crossbeam at bent 5 has substantial reduction in section
 - Roadway is not adequate (deck geometry coded 2)
 - Substructure is damaged (rusted, bent bracing etc.)
 - Seismic settlement Pier/ Abutment 1



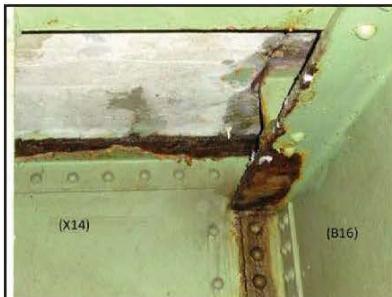
Bridge Deficiencies



PIER 3 CROSS GIRDER (X14) TOP FLANGE



PIER 3 CROSS GIRDER (X15) TOP FLANGE



PIER 3 (B18) TOP FLANGE



PIER 3 (B18) TOP FLANGE



NO.	REVISED
DATE	BY

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DATE	BY



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CITY OF TACOMA	
DEPARTMENT OF PUBLIC WORKS	
TACOMA AVE. S. BRIDGE REHABILITATION	B28
TACOMA, WASHINGTON	
PIER 3 STEEL DAMAGE PHOTOS	

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DATE	BY



Bridge Deficiencies



PIER 5 (B10) CROSS GIRDER (X10) TOP FLANGE



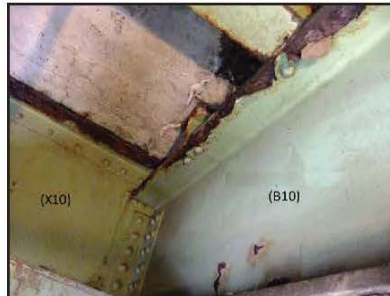
PIER 5 CROSS GIRDER (X10) BOTTOM FLANGE



PIER 5 CROSS GIRDER (X11) TOP FLANGE



PIER 5 CROSS GIRDER (X11A) TOP FLANGE



PIER 5 (B10) TOP FLANGE



PIER 5 (B5) TOP FLANGE

PHOTOGRAPHS BY: TRANTECH ENGINEERING LLC, 10000 15TH AVENUE S.W., TACOMA, WA 98406, TEL: 253-405-1234, FAX: 253-405-1235

		DATE: 02/20/14 BY: JTB CHECKED: JTB APPROVED: JTB PROJECT: PIER 5 STEEL DAMAGE PHOTOS		CITY OF TACOMA DEPARTMENT OF PUBLIC WORKS	B31
				TACOMA AVE. S. BRIDGE REHABILITATION TACOMA, WASHINGTON PIER 5 STEEL DAMAGE PHOTOS	02/27/14



Bridge Deficiencies



FOUNDATION P2a (6W)



FOUNDATION P2b (6C)



FOUNDATION P2c (6E)



FOUNDATION P3a (6W)



FOUNDATION P3b (6C)



FOUNDATION P3c (6E)

12/15/2016 11:30 AM - 12/15/2016 12:00 PM - 12/15/2016 12:30 PM - 12/15/2016 1:00 PM - 12/15/2016 1:30 PM - 12/15/2016 2:00 PM - 12/15/2016 2:30 PM - 12/15/2016 3:00 PM - 12/15/2016 3:30 PM - 12/15/2016 4:00 PM - 12/15/2016 4:30 PM - 12/15/2016 5:00 PM - 12/15/2016 5:30 PM - 12/15/2016 6:00 PM - 12/15/2016 6:30 PM - 12/15/2016 7:00 PM - 12/15/2016 7:30 PM - 12/15/2016 8:00 PM - 12/15/2016 8:30 PM - 12/15/2016 9:00 PM - 12/15/2016 9:30 PM - 12/15/2016 10:00 PM - 12/15/2016 10:30 PM - 12/15/2016 11:00 PM - 12/15/2016 11:30 PM

		REVISION DATE APPD	DATE APPD	FILE NO. PROJECT NO. DRAWING NO. SCALE DATE	SHEET NO. TOTAL SHEETS		CITY OF TACOMA DEPARTMENT OF PUBLIC WORKS	B19
							TACOMA AVE. S. BRIDGE REHABILITATION TACOMA, WASHINGTON PIER 2 & 3 FOUNDATION REPAIR PHOTOS	



Bridge Deficiencies



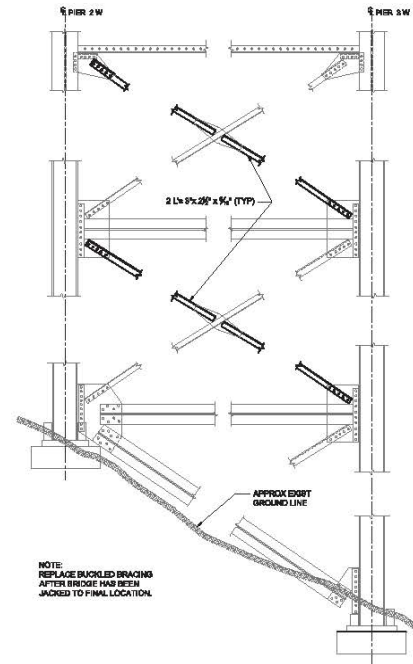
PIER 2 & 3 DIAGONAL BRACING LOOKING EAST



PIER 2 & 3 DIAGONAL BRACING LOOKING WEST



PIER 2 & 3 DIAGONAL BRACING LOOKING WEST



EXISTING BRACING PIER 2 & 3
WEST FRAME ONLY

1/10/2018 10:00 AM - Tacoma, Western State University, 2018 - BRIDGE OF DEFERRED MAINTENANCE TO OWNER BY DATE 10/10/18



NO.	DATE	BY	REVISION



FILE NO. 180004 DATE 4/10/18 BY J. HOFF CHECKED APPROVED	CITY OF TACOMA DEPARTMENT OF PUBLIC WORKS TACOMA AVE. S. BRIDGE REHABILITATION TACOMA, WASHINGTON PIER 2 & 3 BRACING REPAIR	B22 SHEET NO. 80 OF 122
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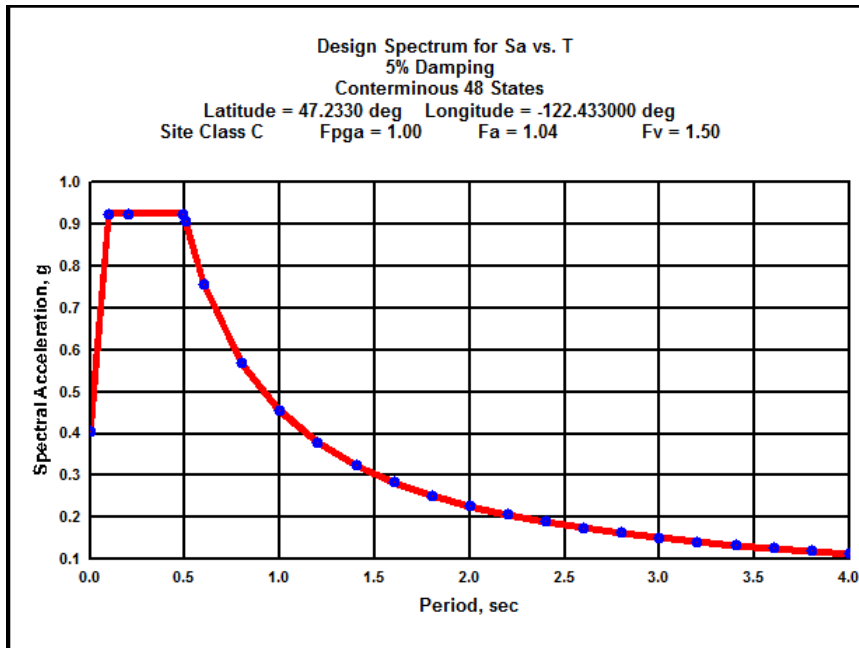
Bridge Deficiencies

- Deck thickness = 6.75"
- Deck rating = 0.45 (shear governing)
- Deck geometry coded = 2
- Deck needs to be replaced and roadway to be widened by 7 feet.

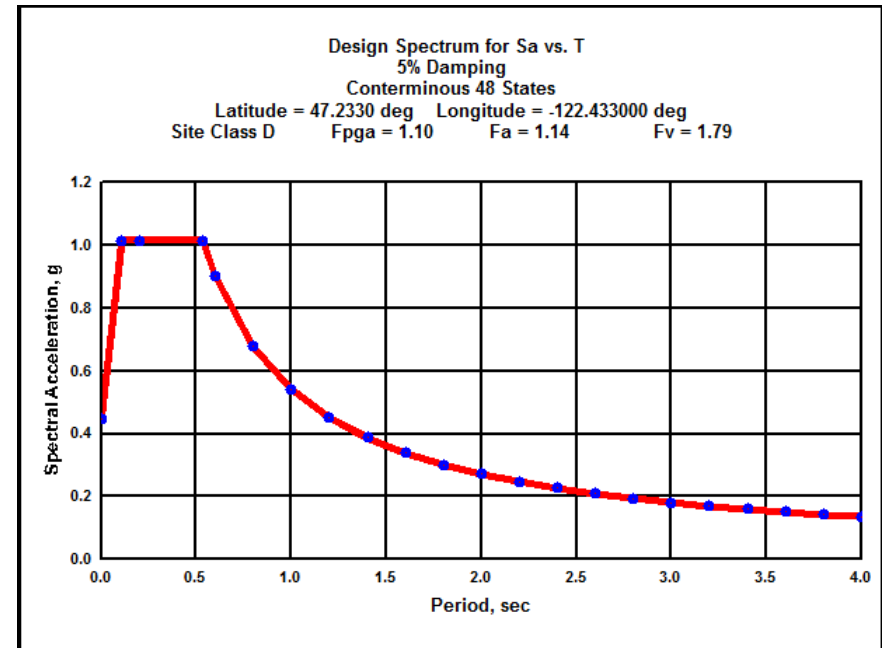
Bridge Deficiencies

- Sidewalk condition = 4 (poor)
- Concrete sidewalk support bracket cracked
- Cantilever reinforcement yielding and sidewalk tipping down

Seismic Retrofit Considerations



1. Earthquake response spectra for C site (N Abutment)



2. Earthquake response spectra for D site (S Abutment)

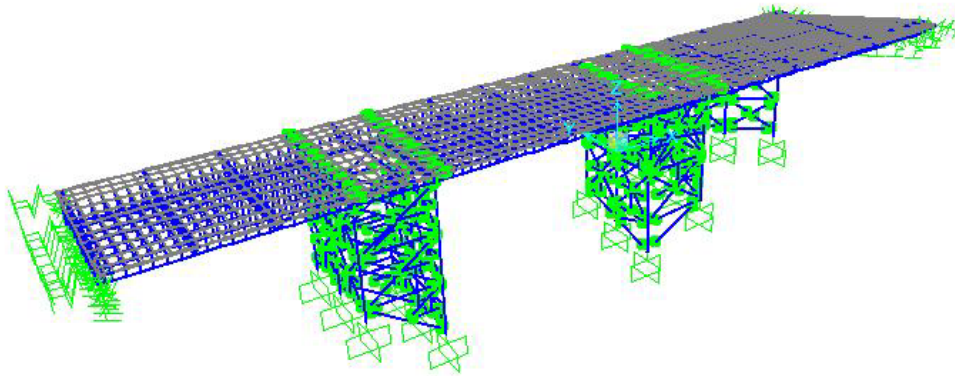


Seismic Retrofit Considerations

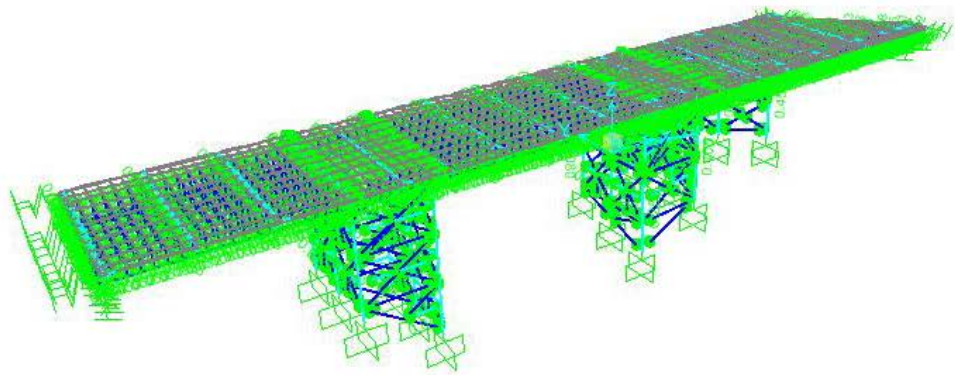
- $S_s = 0.89g$
- Method C: component capacity/demand method.
- Seismic demands are determined from multi-mode response spectrum method.
- Capacity/demand ratios are calculated for individual components.
- The bridge is vulnerable to earthquake loading.



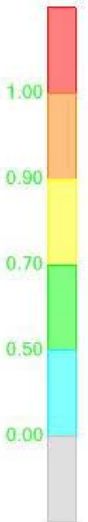
Seismic Retrofit Considerations



1. Bridge model



2. Seismic demand/capacity



Seismic Retrofit Considerations

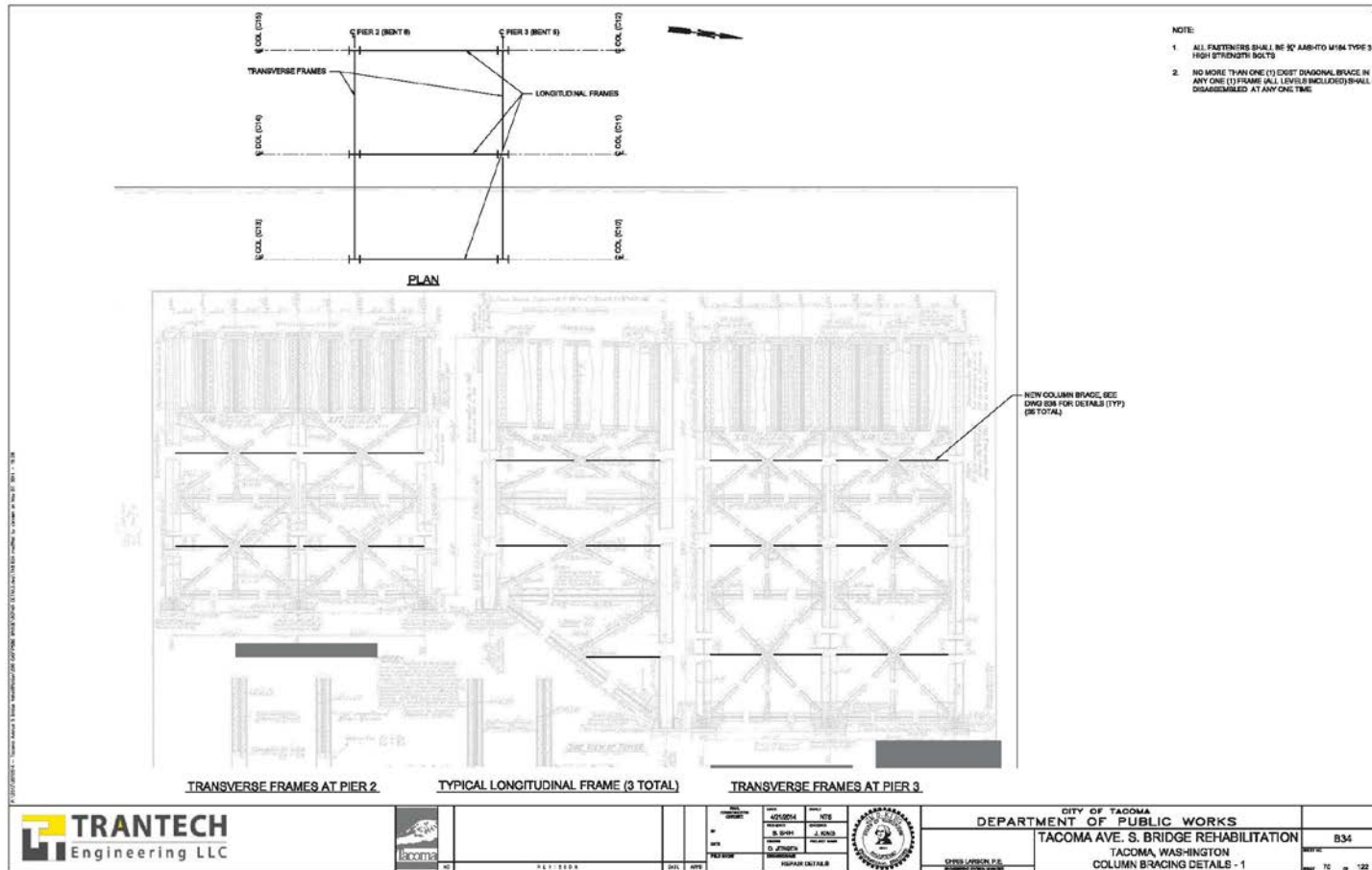
- Catcher blocks and longitudinal restrainers
- New light weight deck (added mass less than 10%)
- Reduction of unsupported length of columns
- Jacking the bridge to its original position
- Replace buckled braces



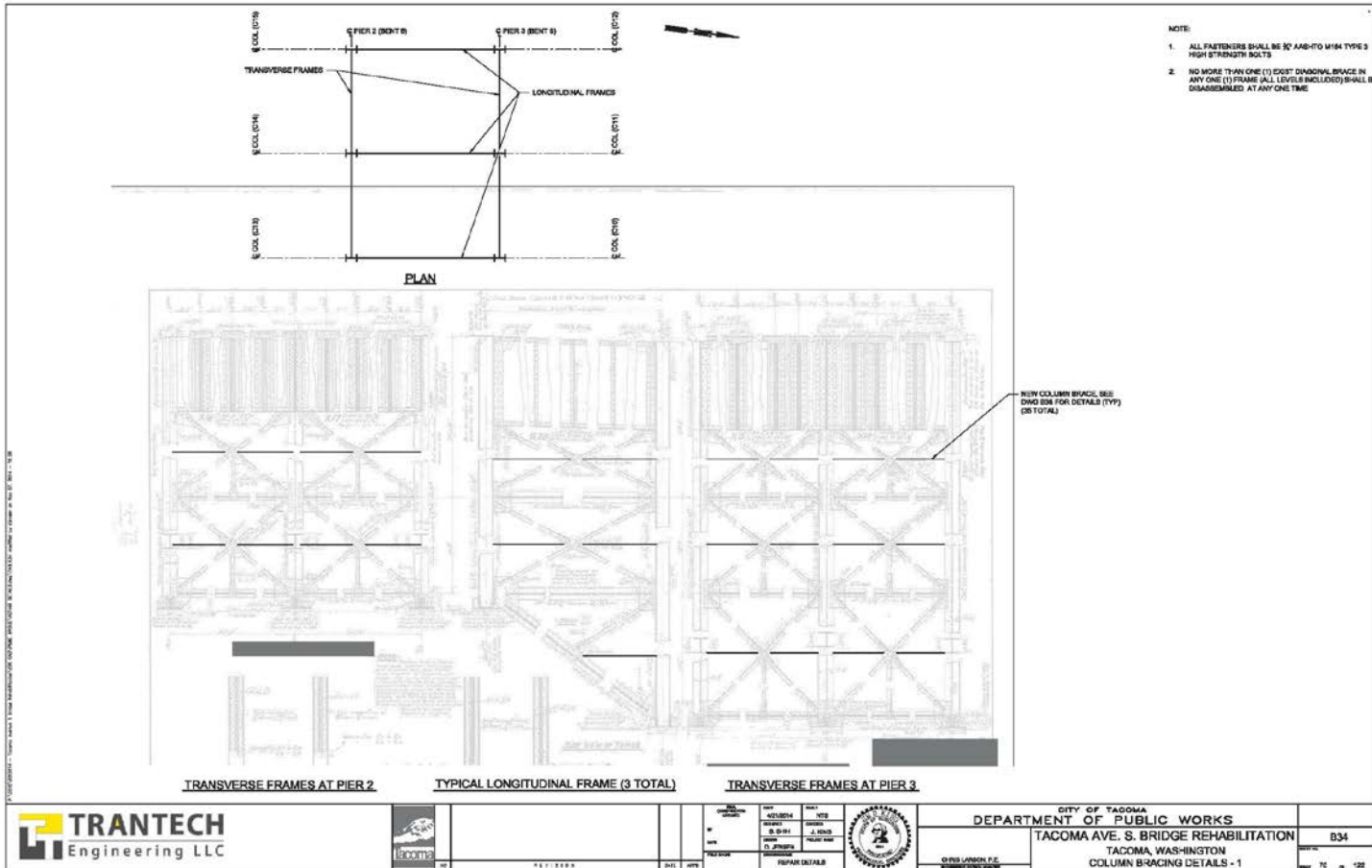
Seismic Retrofit Considerations

- Addition of new cross frames for a better diaphragm and load distribution.
- Making the existing girder composite
- Replacement of rocker bearings with neoprene pads at abutments.
- Connection of abutments to approach slab

Seismic Retrofit Considerations



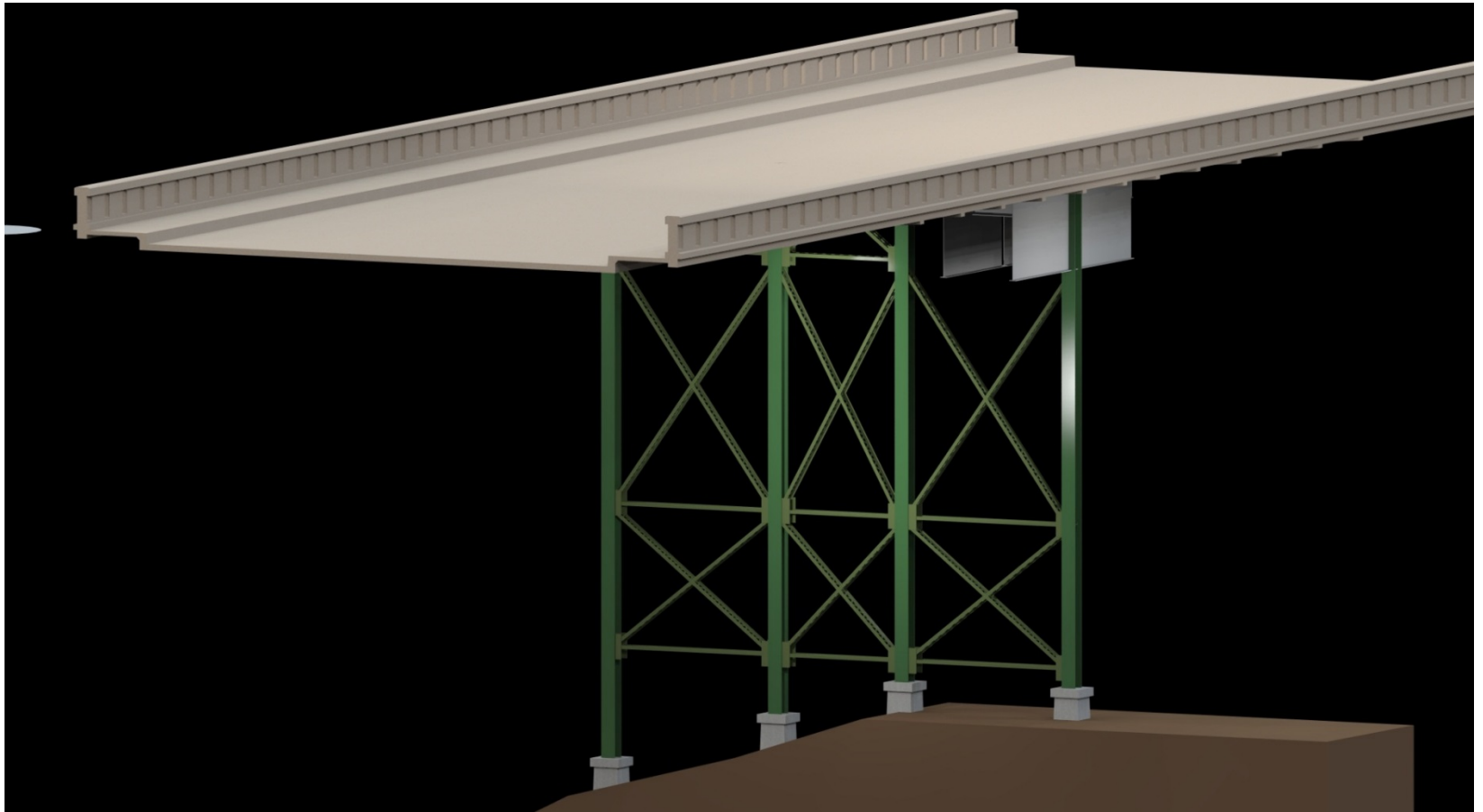
Seismic Retrofit Considerations



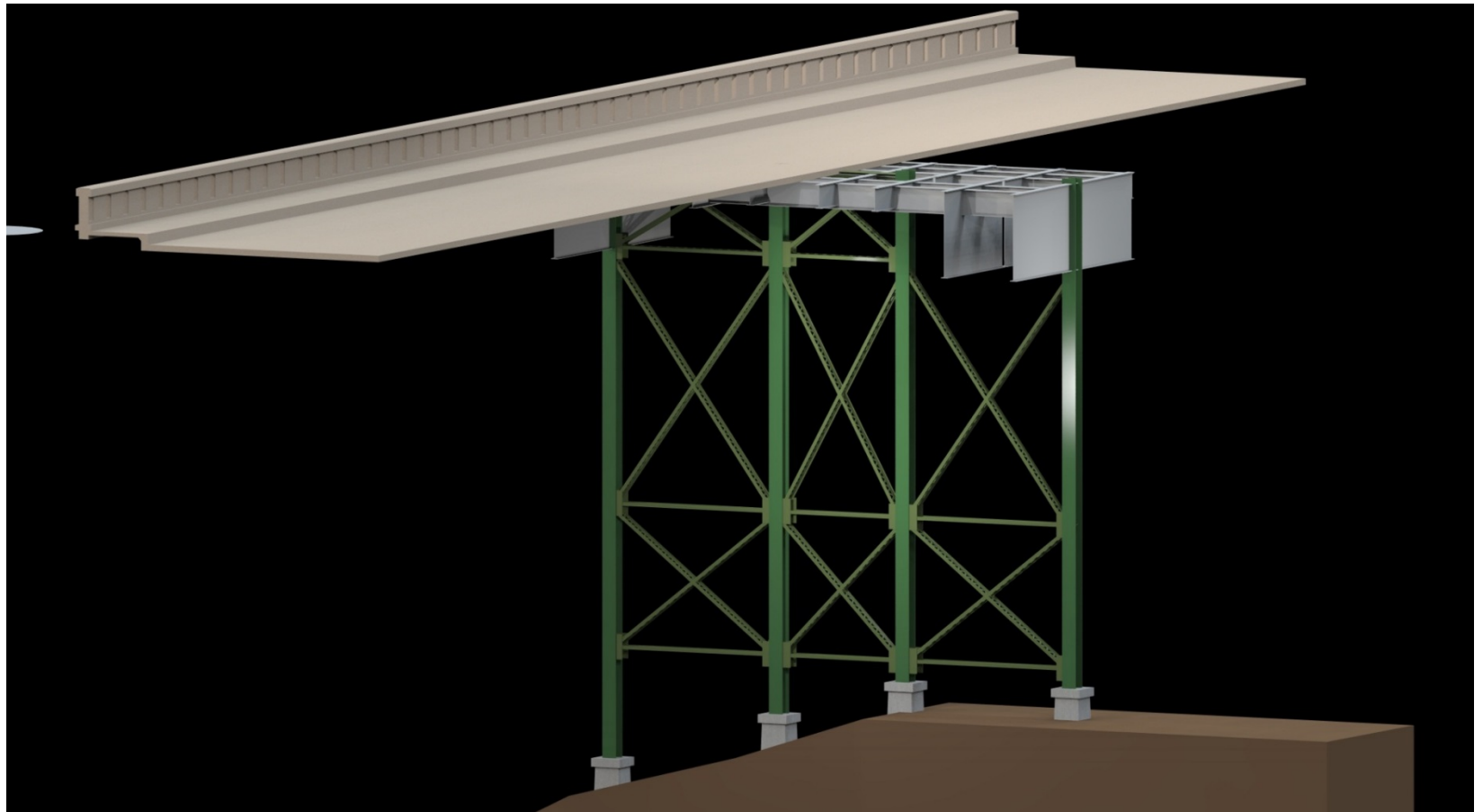
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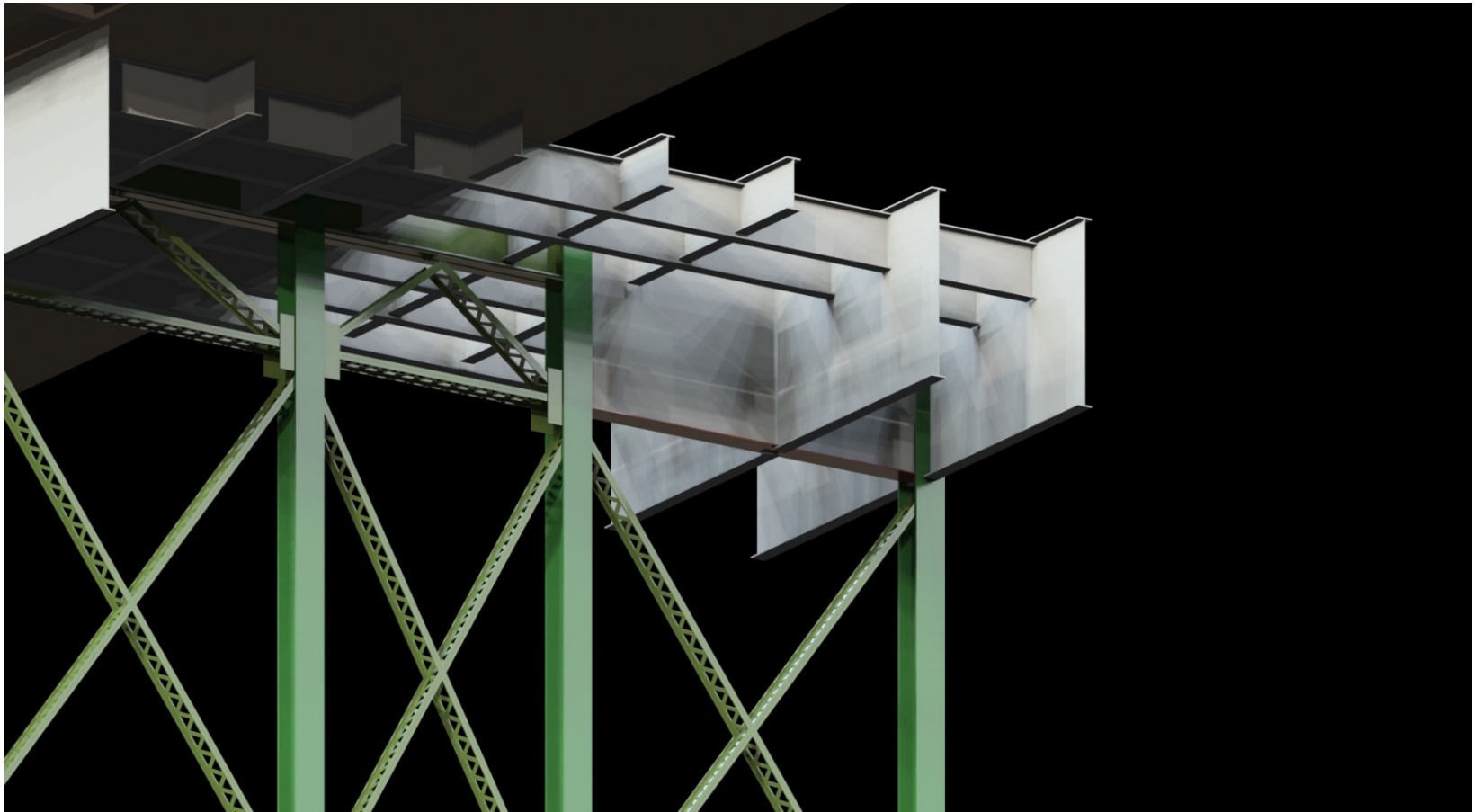
Crossbeam and Girder Repairs



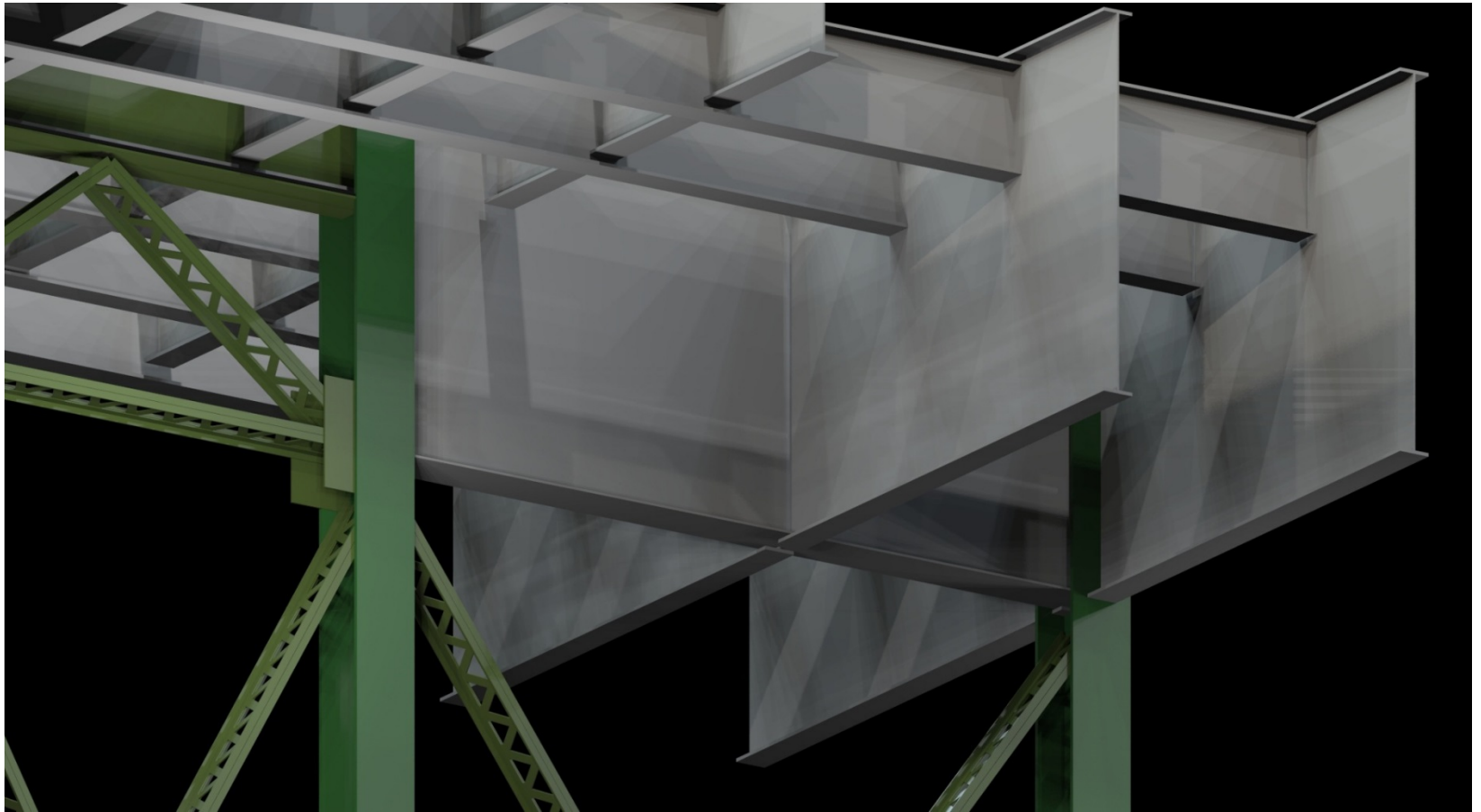
Crossbeam and Girder Repairs



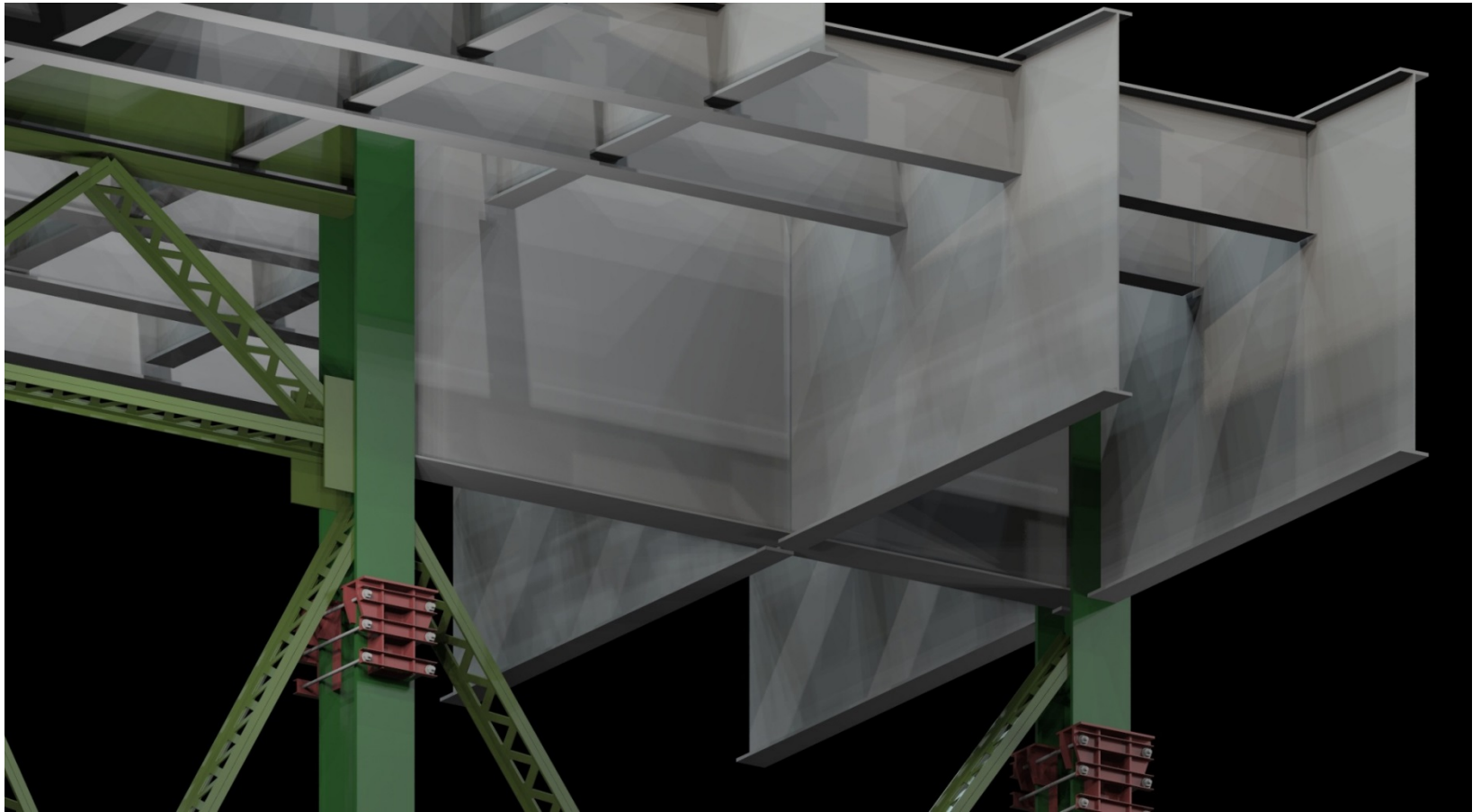
Crossbeam and Girder Repairs



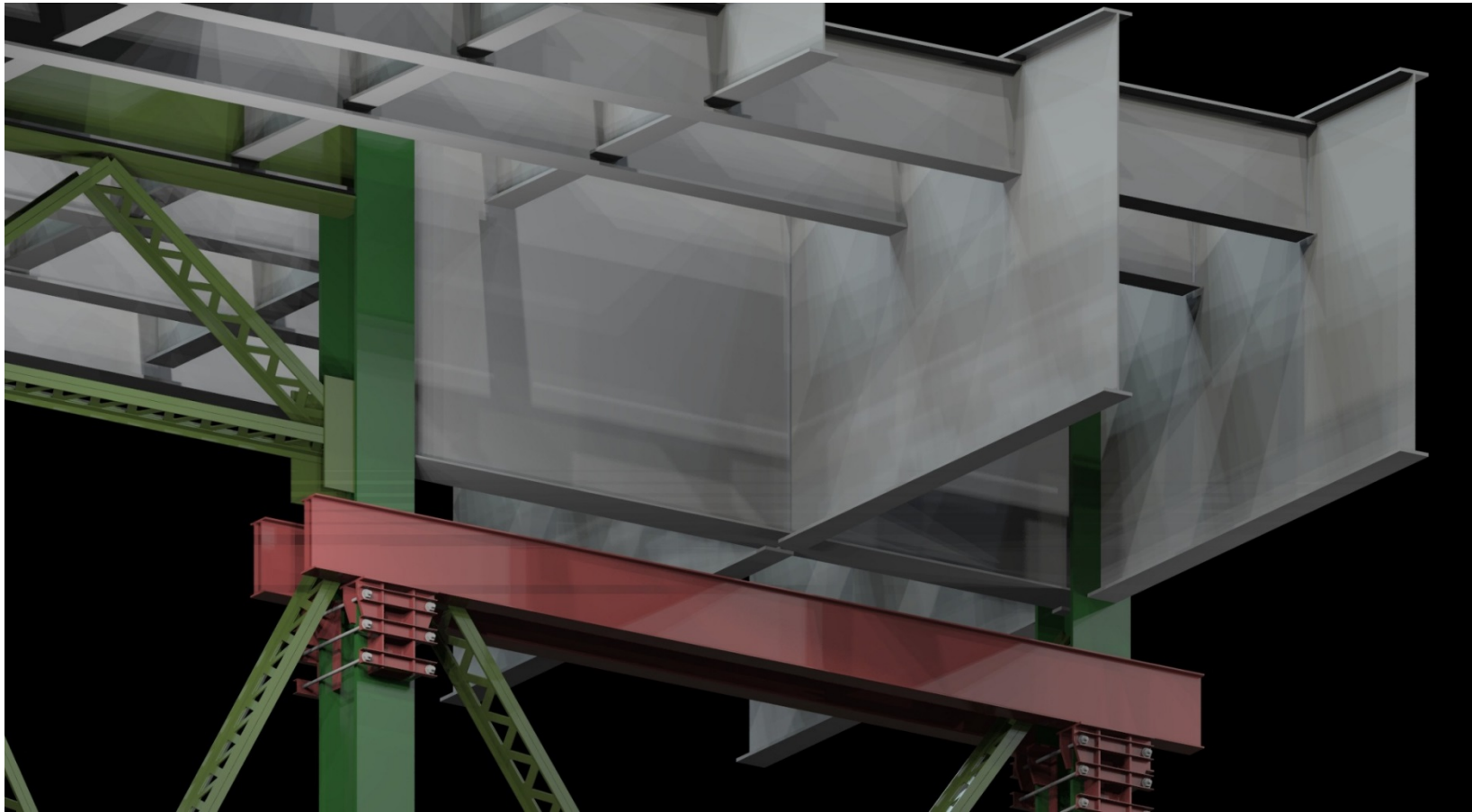
Crossbeam and Girder Repairs



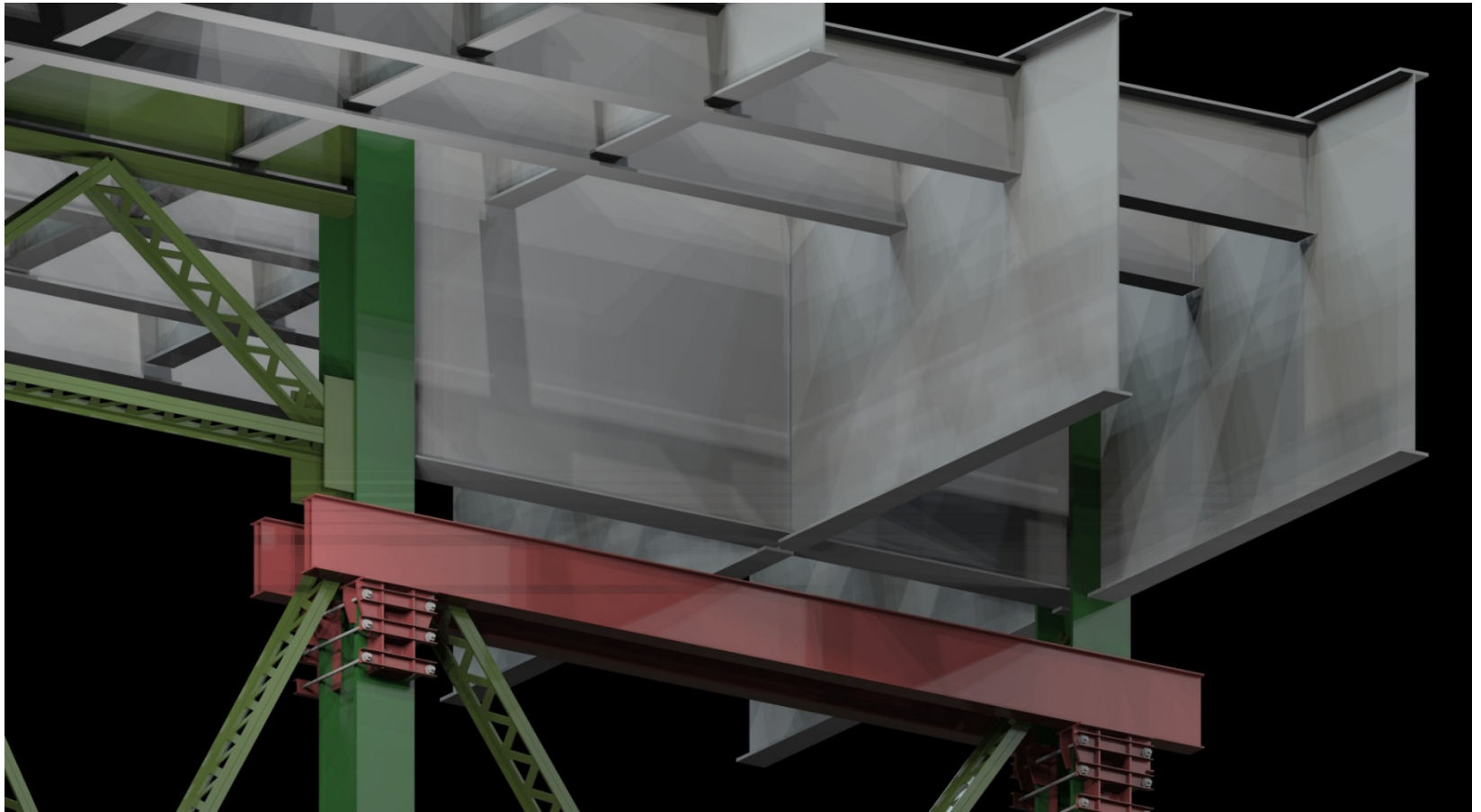
Crossbeam and Girder Repairs



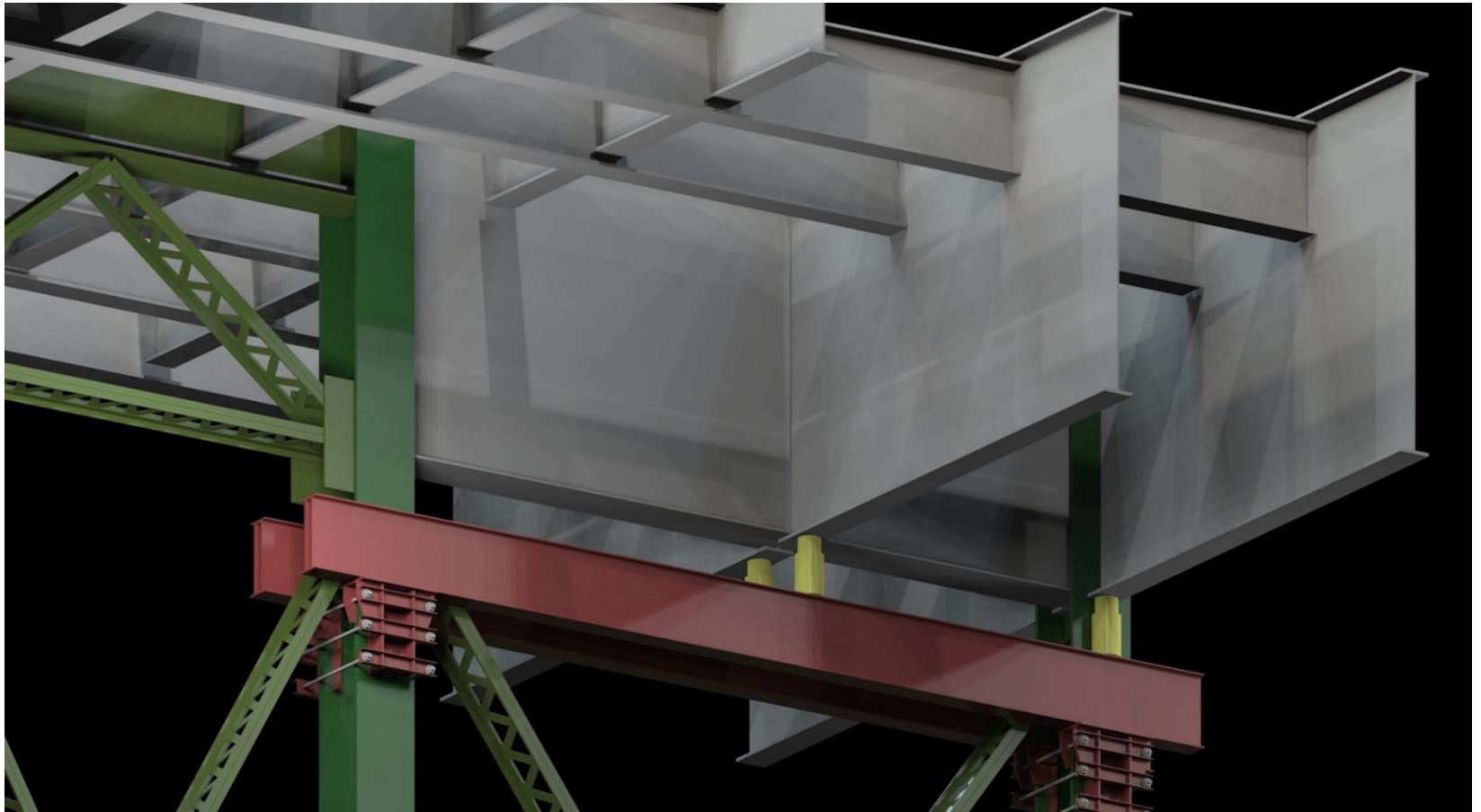
Crossbeam and Girder Repairs



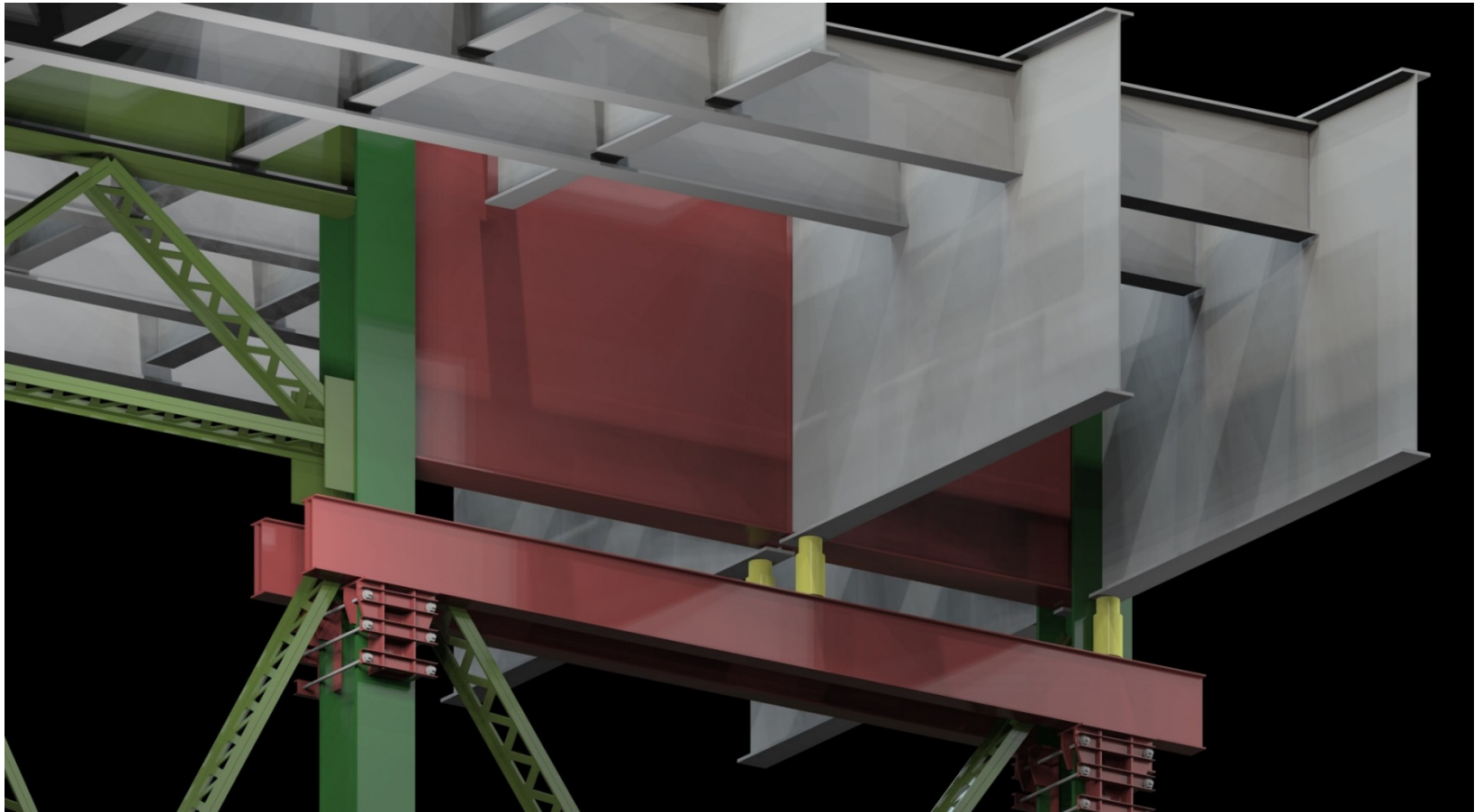
Crossbeam and Girder Repairs



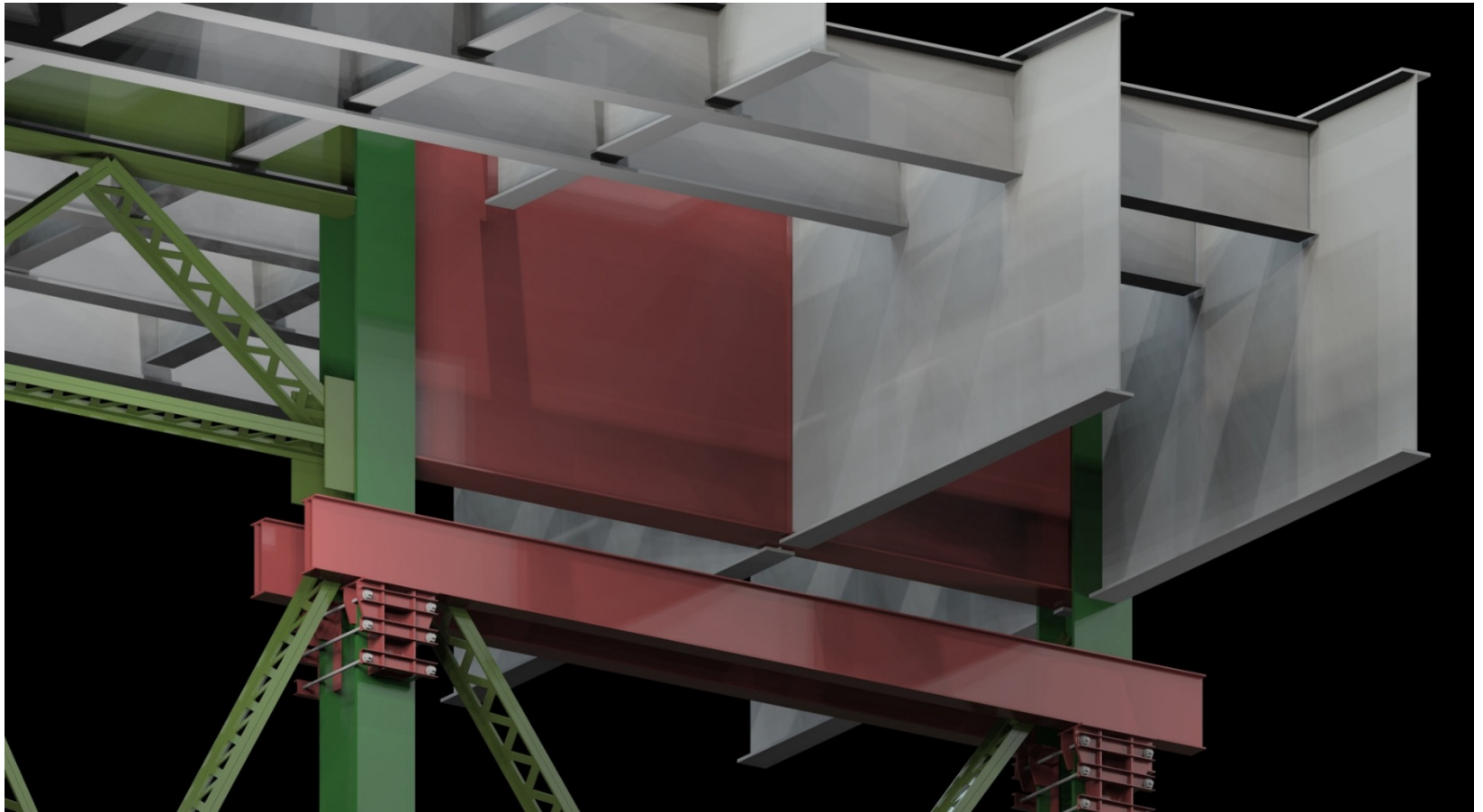
Crossbeam and Girder Repairs



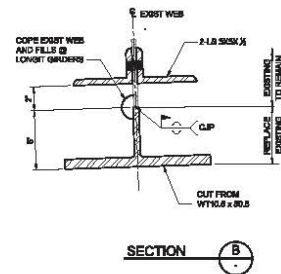
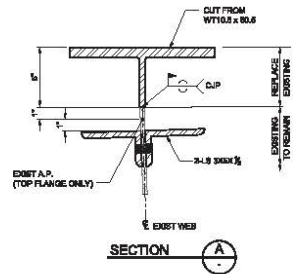
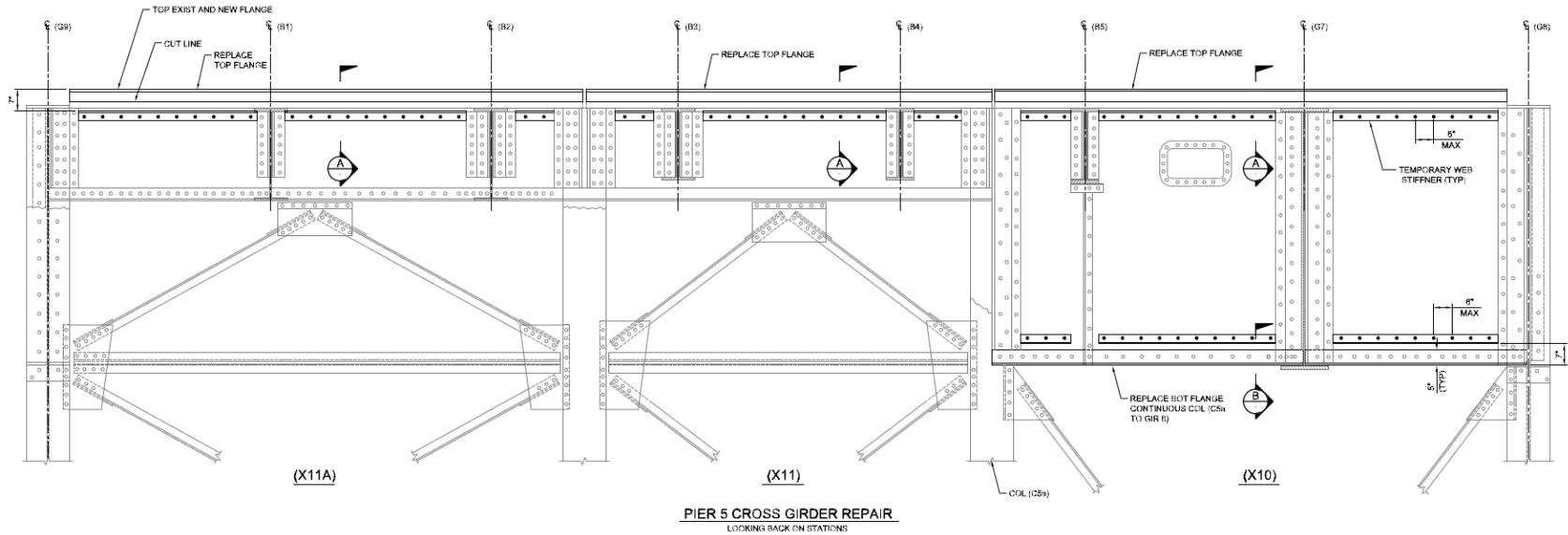
Crossbeam and Girder Repairs



Crossbeam and Girder Repairs



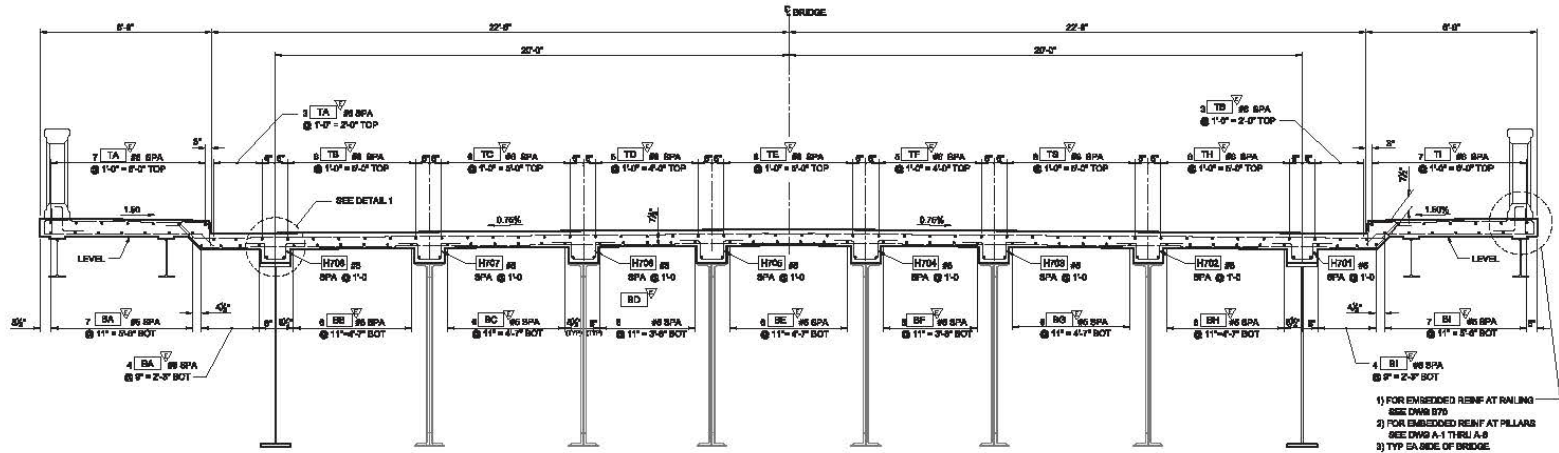
Crossbeam repairs



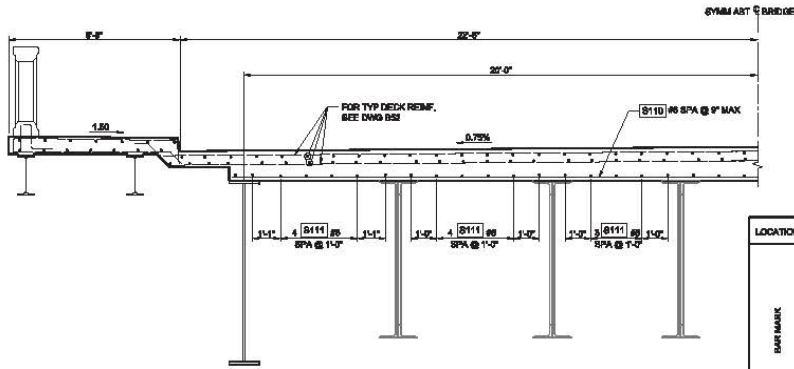
Repair crossbeam X10 at pier 5



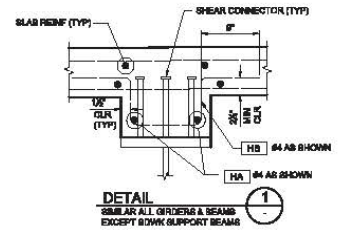
Deck Replacement



TYPICAL DECK SECTION WITH REINFORCING
 UTILITIES SHEAR CONNECTOR AND BRIDGE RAILING REINF NOT SHOWN FOR CLARITY
 SPAN & SECTION SHOWN



THICKENED DECK SLAB - SECTION
 UTILITIES NOT SHOWN FOR CLARITY
 SPAN & SECTION SHOWN

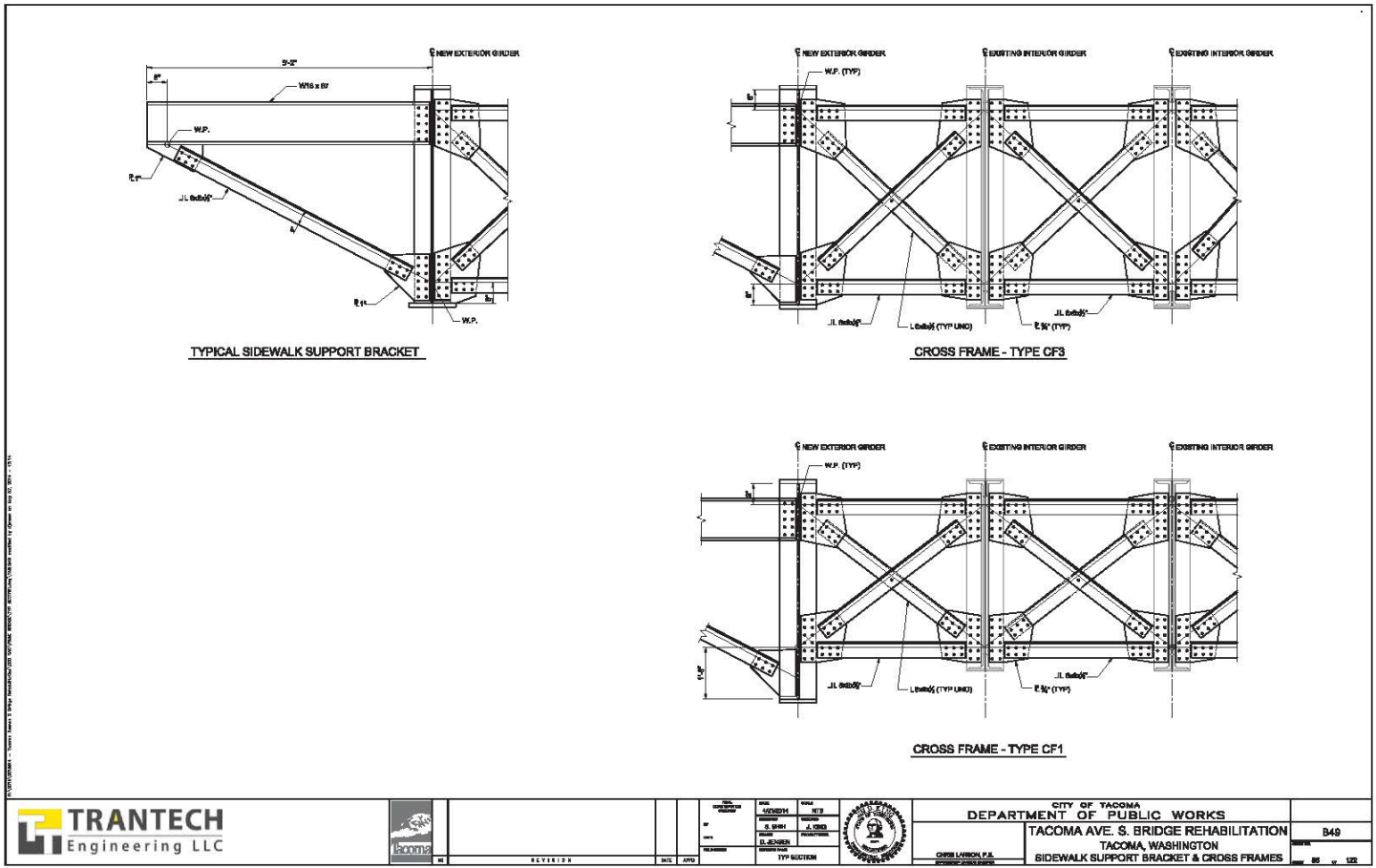


DETAIL 1
 SHOW ALL CORNERS & BEAMS
 EXCEPT DOWN SUPPORT BEAMS

LOCATION	BAR TA	BAR TB	BAR TC	BAR TD	BAR TE	BAR TF	BAR TH	BAR TI	BAR BA	BAR BB	BAR BC	BAR BD	BAR BE	BAR BF	BAR BG	BAR BH	BAR BI	BAR HA	BAR HB
BAR MARK	S101	B101	S101	B101	S101	B101	S101	B101	S101	B101	S101	B101	S101	B101	S101	B101	S101	B101	S101
	S102	B102	S102	B102	S102	B102	S102	B102	S102	B102	S102	B102	S102	B102	S102	B102	S102	B102	S102
	S201	B201	S201	B201	S201	B201	S201	B201	S201	B201	S201	B201	S201	B201	S201	B201	S201	B201	S201
	S301	B301	S301	B301	S301	B301	S301	B301	S301	B301	S301	B301	S301	B301	S301	B301	S301	B301	S301
	S401	B401	S401	B401	S401	B401	S401	B401	S401	B401	S401	B401	S401	B401	S401	B401	S401	B401	S401
	S501	B501	S501	B501	S501	B501	S501	B501	S501	B501	S501	B501	S501	B501	S501	B501	S501	B501	S501
	S601	B601	S601	B601	S601	B601	S601	B601	S601	B601	S601	B601	S601	B601	S601	B601	S601	B601	S601
	S701	B701	S701	B701	S701	B701	S701	B701	S701	B701	S701	B701	S701	B701	S701	B701	S701	B701	S701

NOTE: ALL BARS CALLED OUT ON RBS TO BSR ARE ONLY REFERENCED IN THIS DRAWING.

New Cross Frames



REV	DATE	BY	CHK
01	05/14/14	INT	AVD

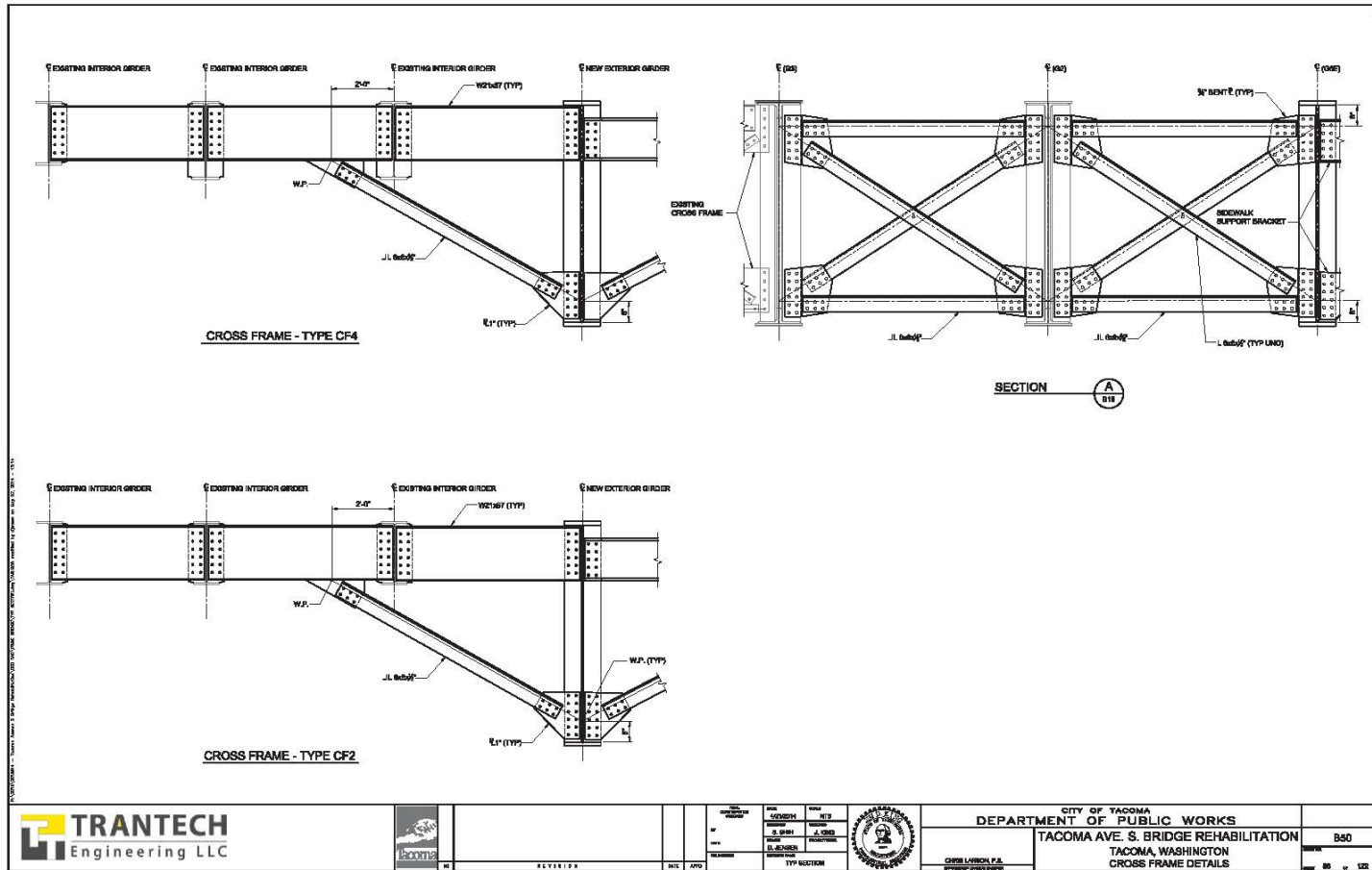
DESIGNED	CHKD
J. BISH	HTP
ELABOR	J. BISH
REVISED	REVISIONS
TYP SECTION	



CITY OF TACOMA DEPARTMENT OF PUBLIC WORKS		
TACOMA AVE. S. BRIDGE REHABILITATION TACOMA, WASHINGTON		B49
CHRIS LARCHAK, P.E. REGISTERED PROFESSIONAL ENGINEER		REV 05 11 12

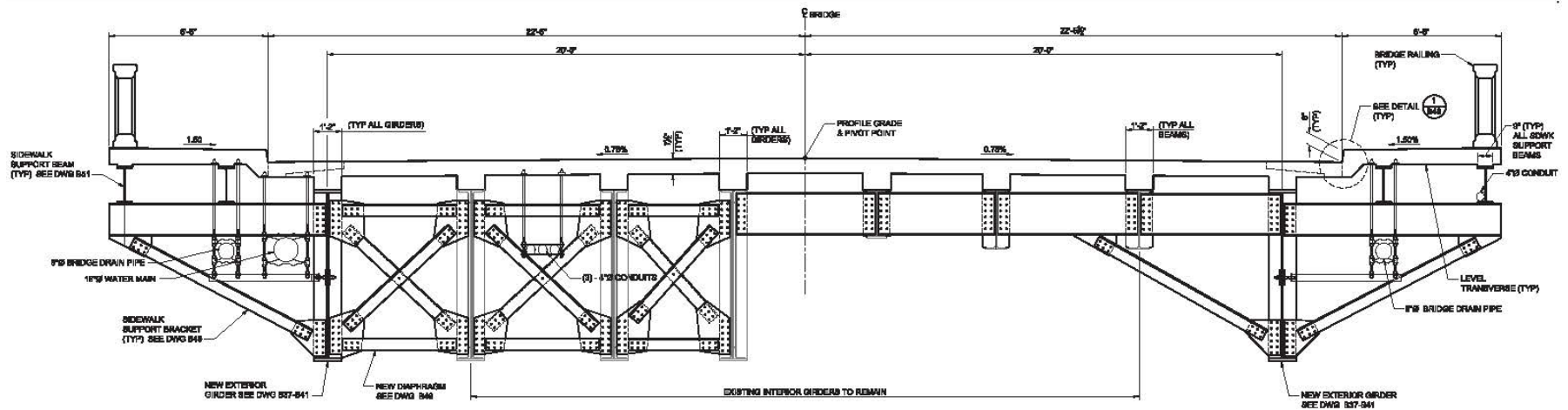


New Cross Frames



New Cross Frames

- Sidewalk width = 6'-8"
- Cantilever length = 9'-4"
- Sidewalk support bracket



TYPICAL SECTION - SPAN 5
 BEAM REINF AND GIRDER/BEAM SHEAR
 CONNECTORS NOT SHOWN FOR CLARITY

NOTES:

1. FOR DECK REINF DETAILS, SEE DWG B62.
2. FOR SIDEWALK SUPPORT DETAILS, SEE DWG B48 AND B61.
3. FOR BRIDGE RAILING DETAILS, SEE DWG B46, B47 & B70.



Completed Structure



Concluding remarks

- Posting of the bridge is removed.
- Seismic capacity of the bridge is enhanced via simple described practical measurements.
- Practical steel repair measurements are described.
- New light weight deck is utilized to reduce the superstructure mass.
- New cross frame system is utilized as a primary structural system for distribution of live loads and lateral loads within the superstructure.
- Bridge aesthetics were incorporated