2017 SEBPP ANNUAL MEETING

Preserving the New River Gorge Bridge

Chad Robinson, PE – WVDOT
Matt Lewellyn, PE – B&N

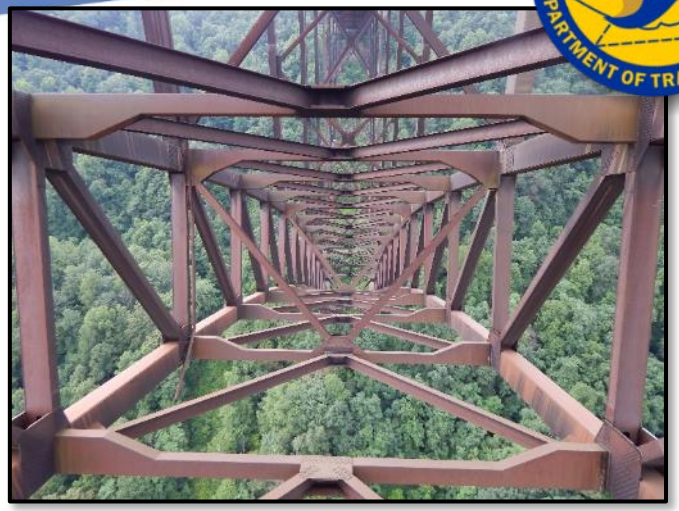
BURGESS & NIPLE
Engineers ■ Architects ■ Planners

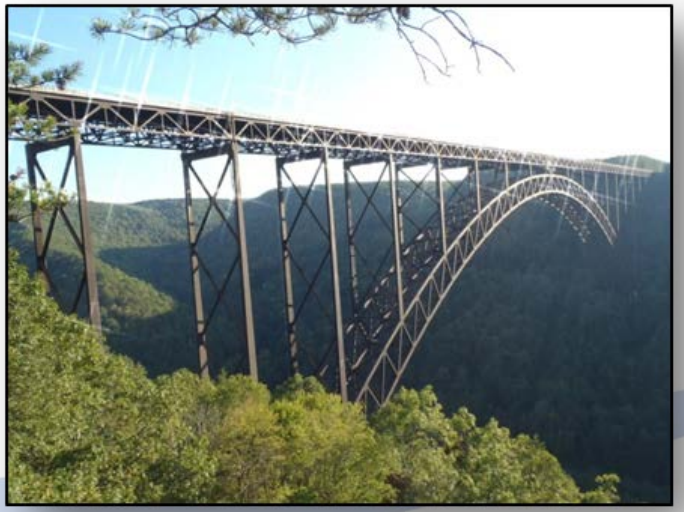
TSP2 TRANSPORTATION SYSTEM PRESERVATION TECHNICAL SERVICES PROGRAM
AASHTO BRIDGE PRESERVATION

Tuesday, April 11, 2017 11:20-12:00 AM

Presentation Overview

- Overview
  - Recent Projects
  - Bridge Configuration
- Project Specifics
  - Inspection Video
  - Load Rating
  - Preservation Techniques
  - Bearing Slide
- Questions and Answers





“The” New River Gorge Bridge

June 1974 – October 1977
$37 Million

- Main Span Length: 1,700 ft Arched Truss
- Overall Length: 3,031 ft
- Height above the New River: 876 ft
- Unique Claim: Longest Steel Arch Bridge in the Western Hemisphere
- Added to the National Register for Historic Structures in 2013
- Today’s Cost:

Today $300-350 Million

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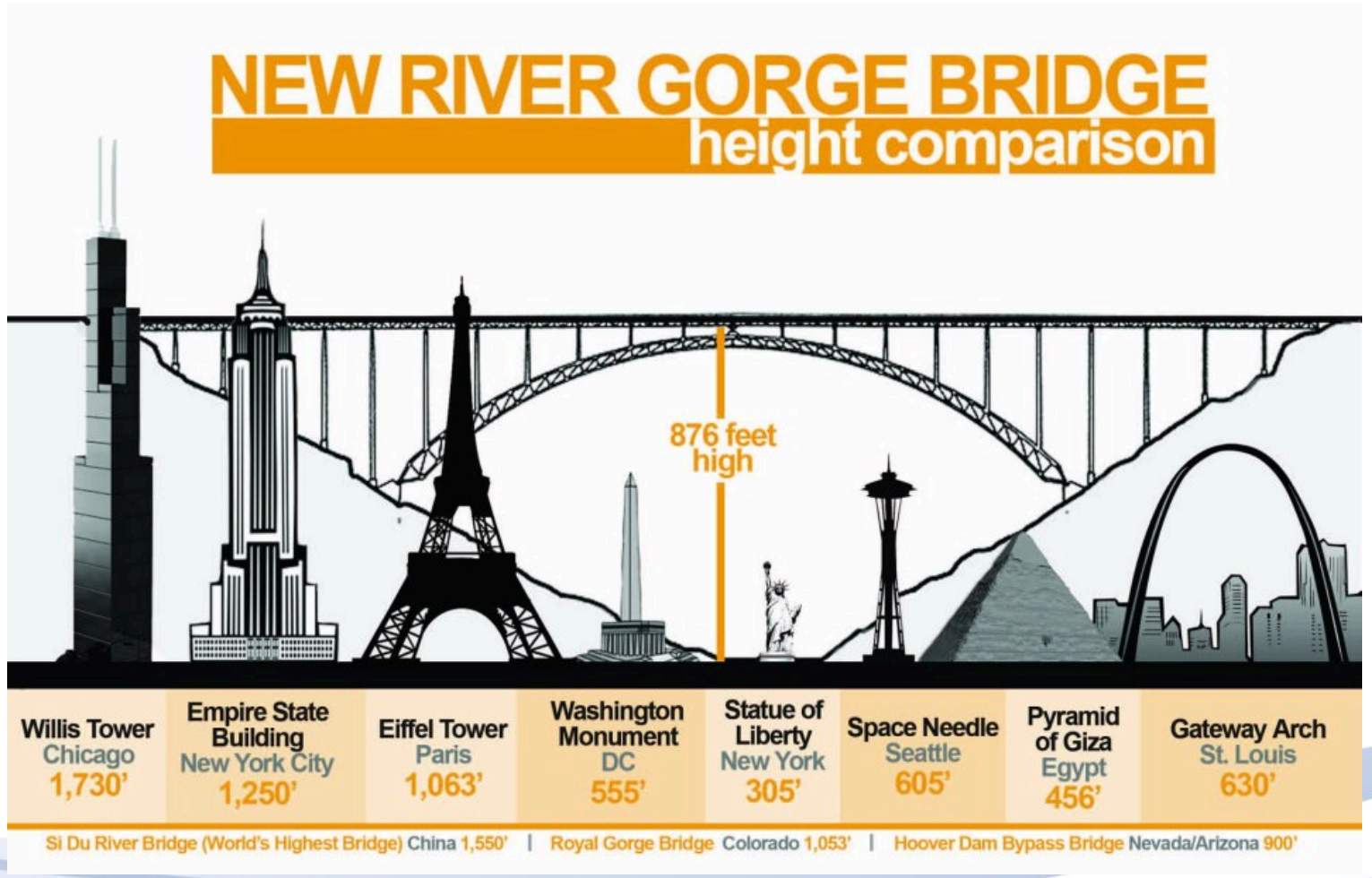
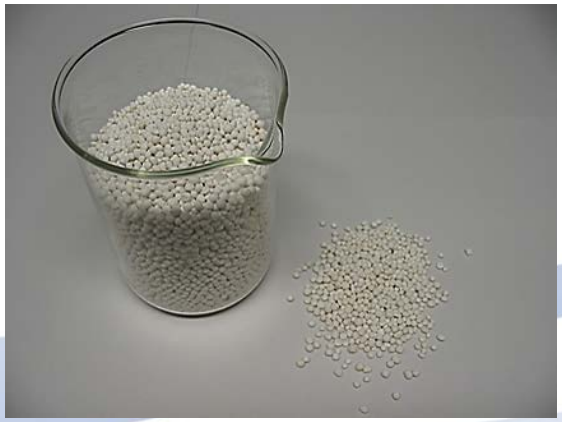
How High is the New River Gorge Bridge?



Weathering Steel and De-icing

- Salt Spray from 1977 to 1998
  - Corrosion Initiated
  - Leaking into Box Members

- 1998 Maintenance
  - Washing to Remove Salt
  - Replaced Deteriorated Bolts
  - Caulked Box Members



- Current De-icing Plan
  - Calcium Magnesium Acetate
  - Salt stops on approaches

Recent Projects on the Gorge

- 2010 – Deck Overlay
- 2012 Rehab ~ $3 Million
- 2008-2014 Inspections
  - Load Rating
  - Rehabilitation Plans
- 2015-2020 Inspections
  - Element Level
- 2016 Rehabilitation
  - 4 Bidders
  - $4.3 Million to $6.3 Million

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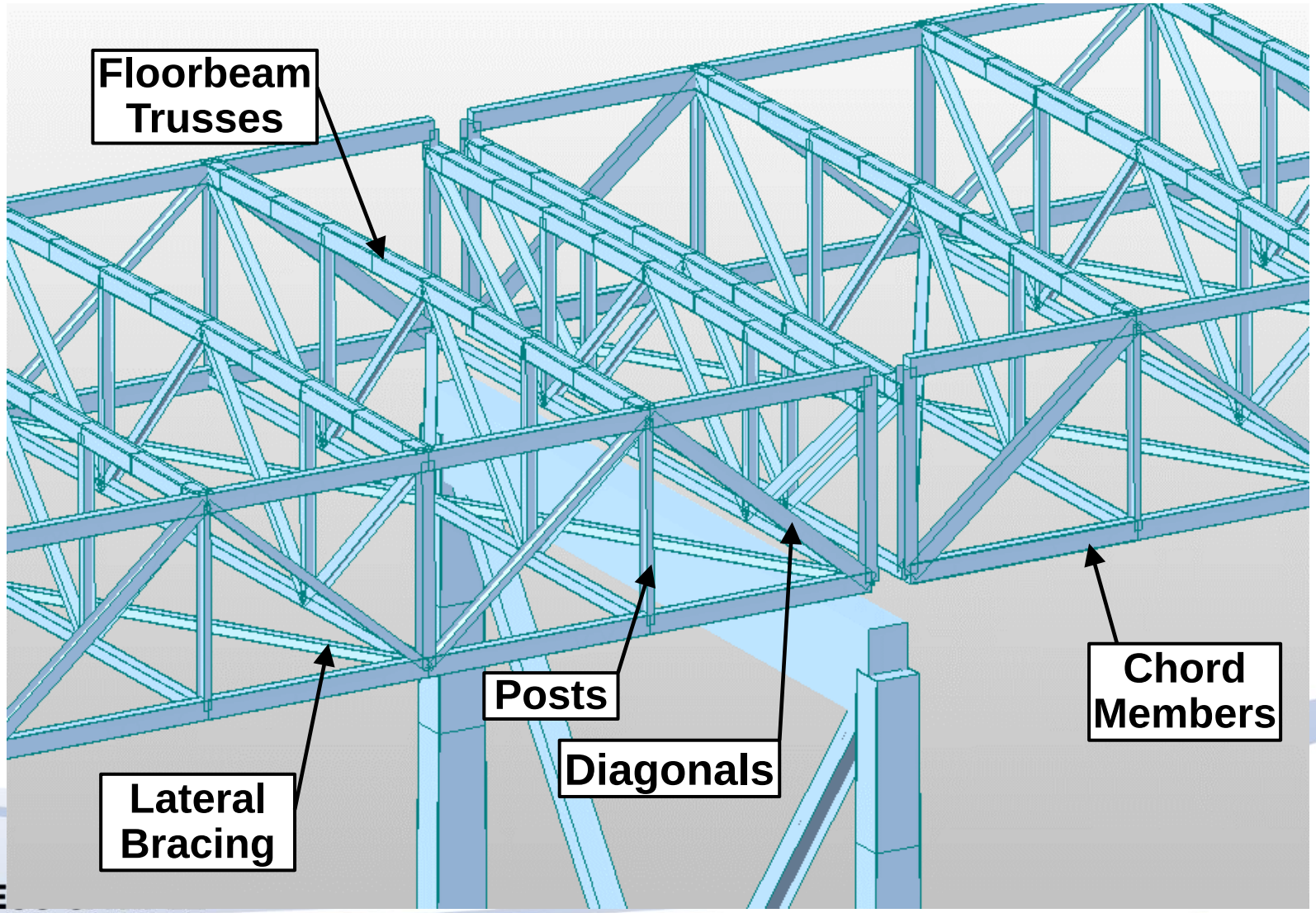
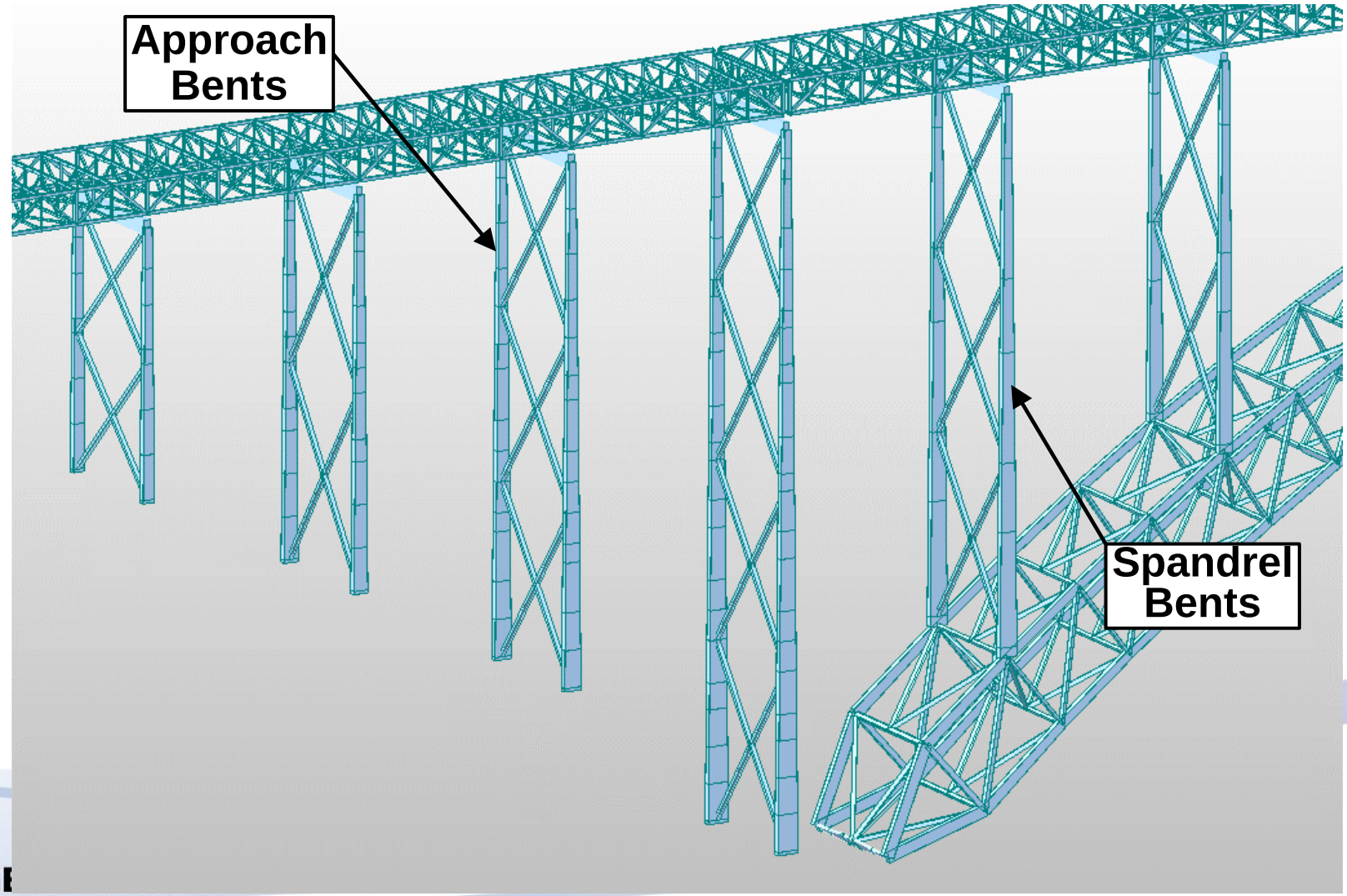
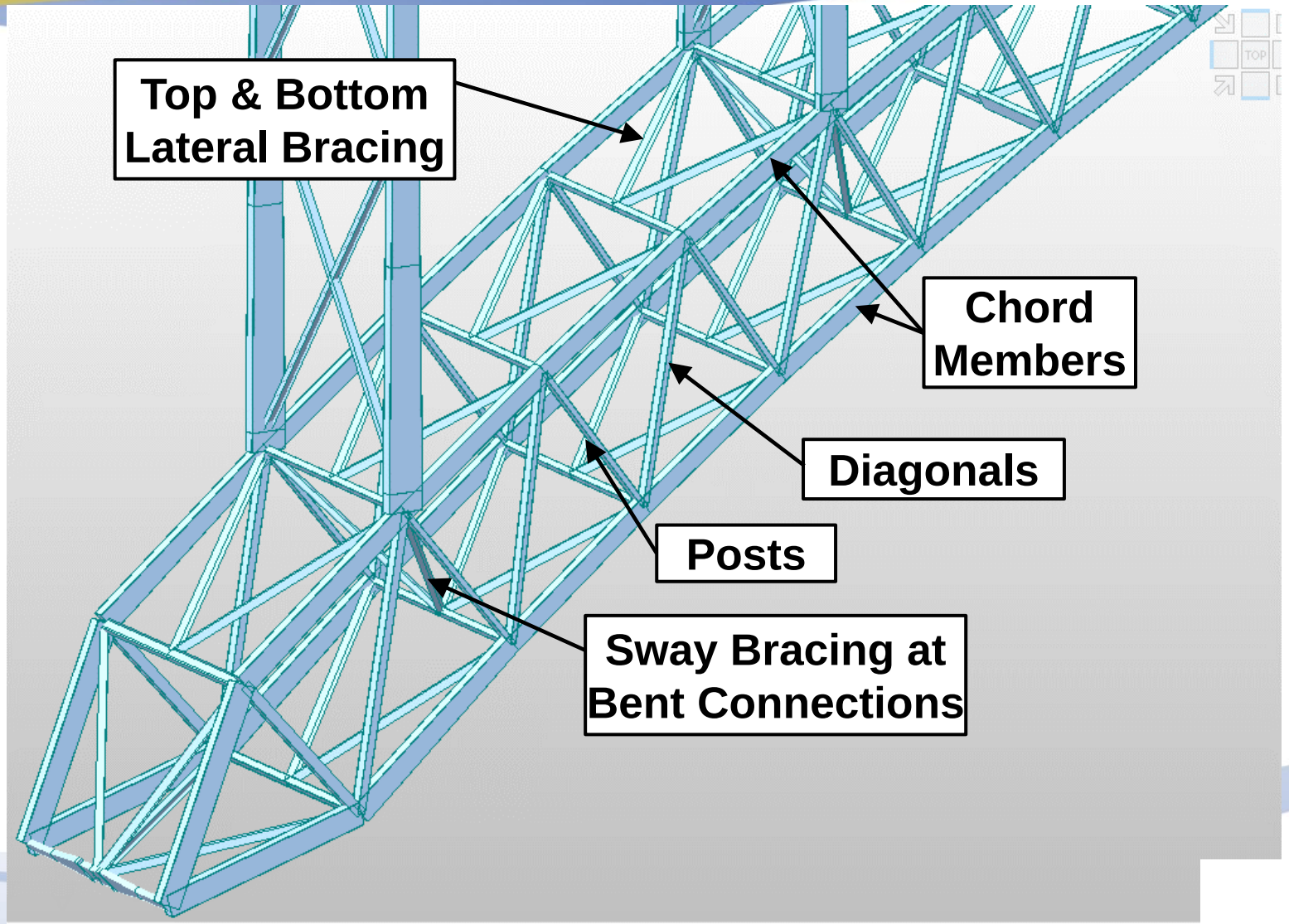
Bridge Configuration - Deck Truss



Bridge Configuration - Bents



Bridge Configuration - Arch Truss

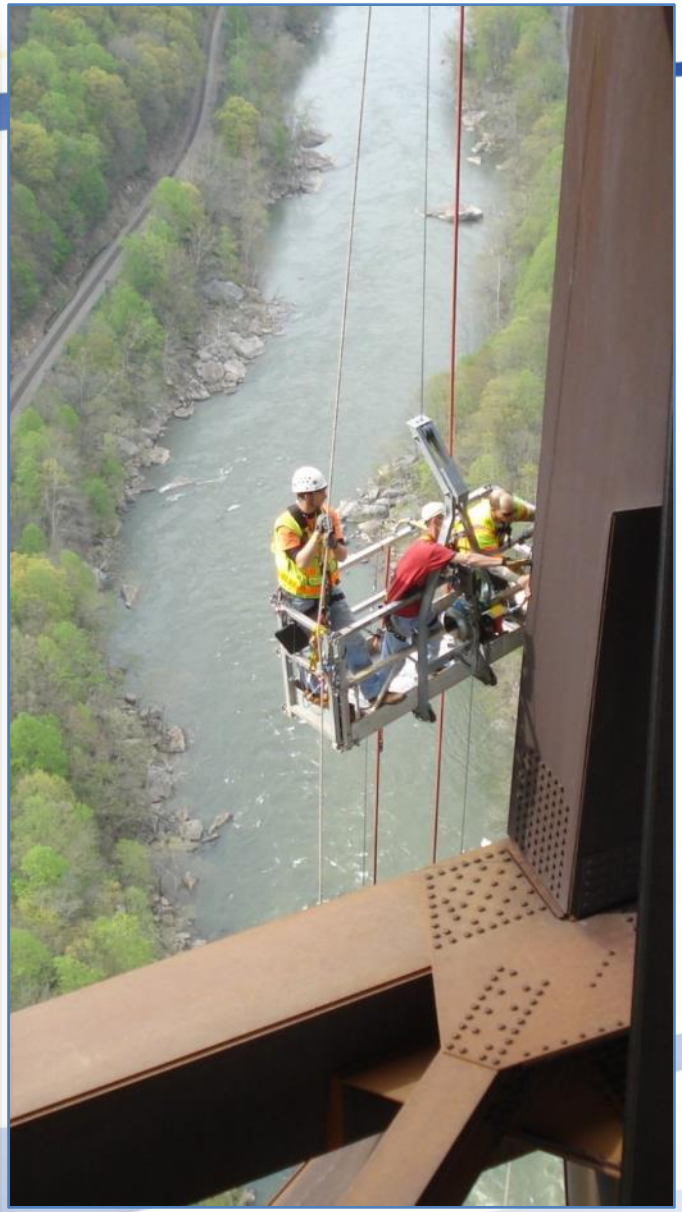


Bridge Inspection Access – Interview with B&N Inspectors

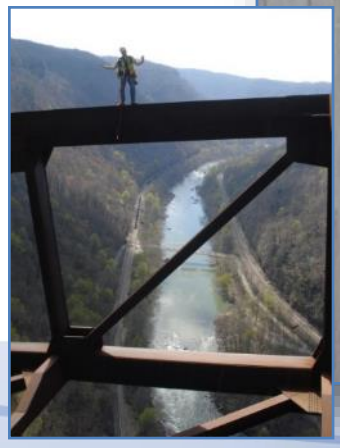
Prepared by Maximus Films Production for the German Documentary on the Worlds Most Extreme Bridges

Arch Access

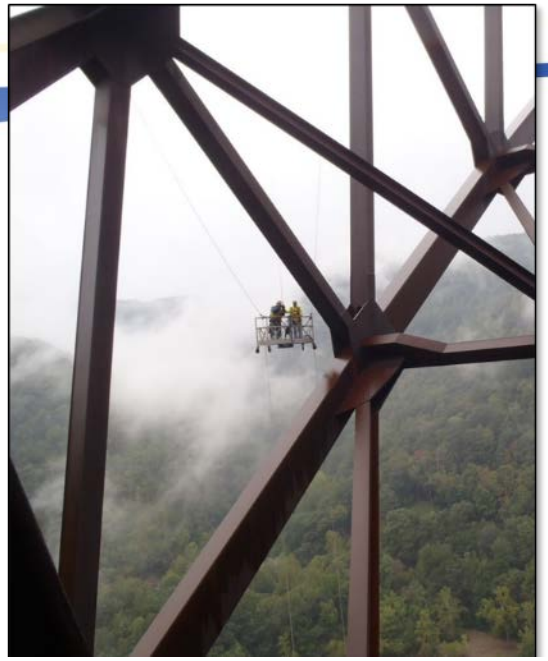
- Spider Access
  - Truck Crane
  - Cable
  - Skyclimber
  - Spider Basket
  - Safety Ropes



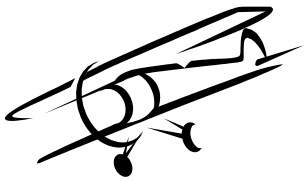
- Rope Access



Unique Tidbits of Information



- Falcons
  - Nesting at Bent 13 lower lateral bracing



- Bi-planes and FAA
  - Keep your ropes short
- ***BridgeWalk*** Tours

BridgeWalk Tours

Understanding Long Term Issues – Deck Truss

- Weathering Steel
- Prolonged Wetting
- Poor Bolt Sealing

Pigeon Nesting

Nut Loss

Pack Rust

Section Loss

Understanding the 2012 Rehab

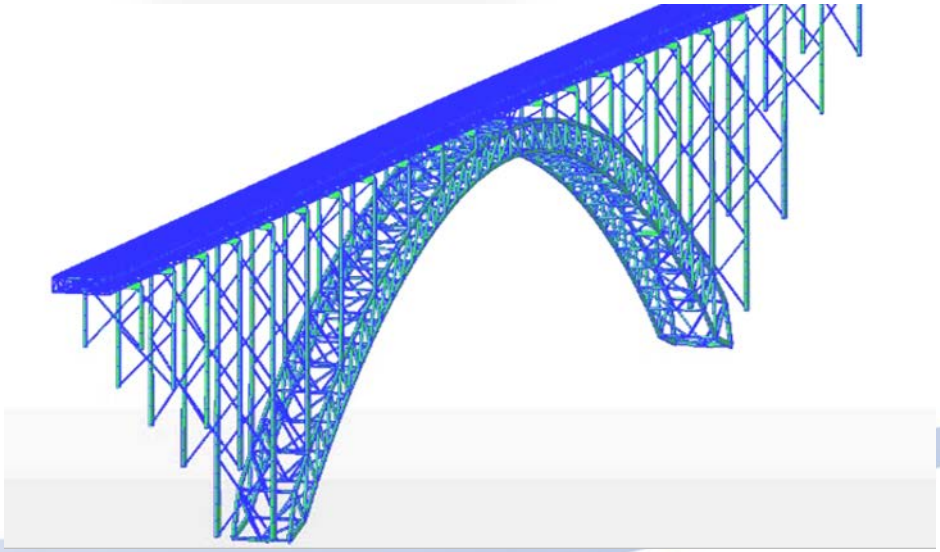
- Vacuum Clean
- Pigeon Waste
- Water Blast
- Caulk Seams
- Apply Penetrant Sealer
  - Inside handholes
  - Areas of corrosion
- Bolt Replacements

How do we keep them out!?!

- WVDOT Needed a Reasonable Solution
- Patented Magnetic Bird Screens
- Installed on New River Gorge Bridge from 2008-2015
- On-going Monitoring of Field Performance
- Continue to Develop

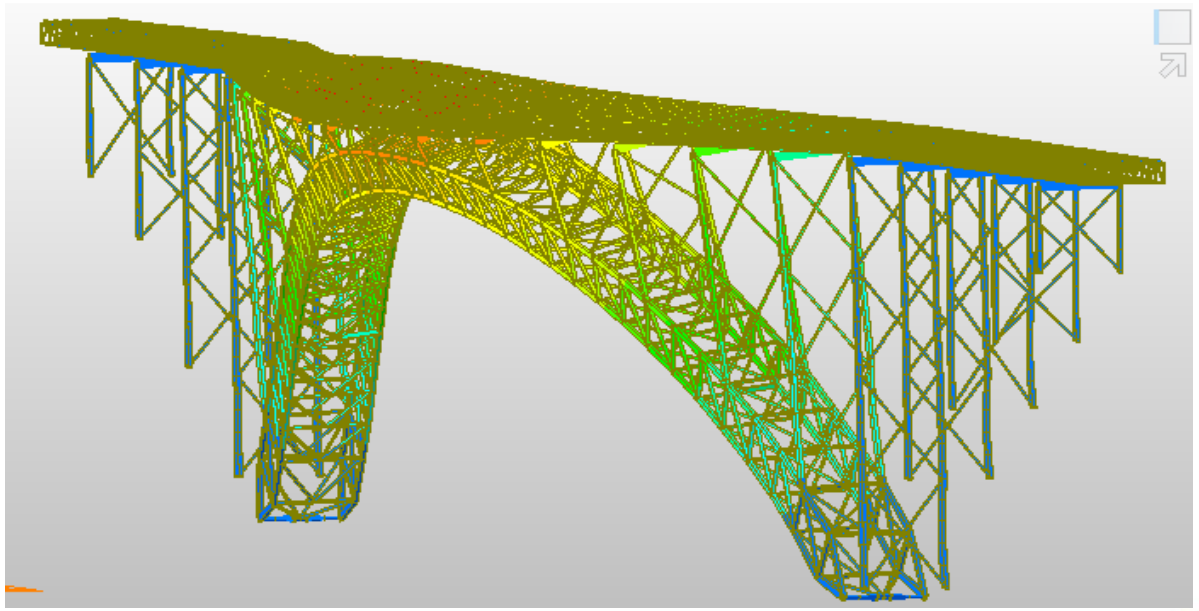
Complexity of Structural Analysis

- ✓3-D Finite Element Model
- ✓15 Rolls of Shop Drawings
- ✓4,840 Rated Members
  - ✓Wind Analysis
  - ✓Thermal Forces
  - ✓CRTS Loads
- ✓ Complex Gusset Plates
- ✓ 1 ½ Man Years of Work



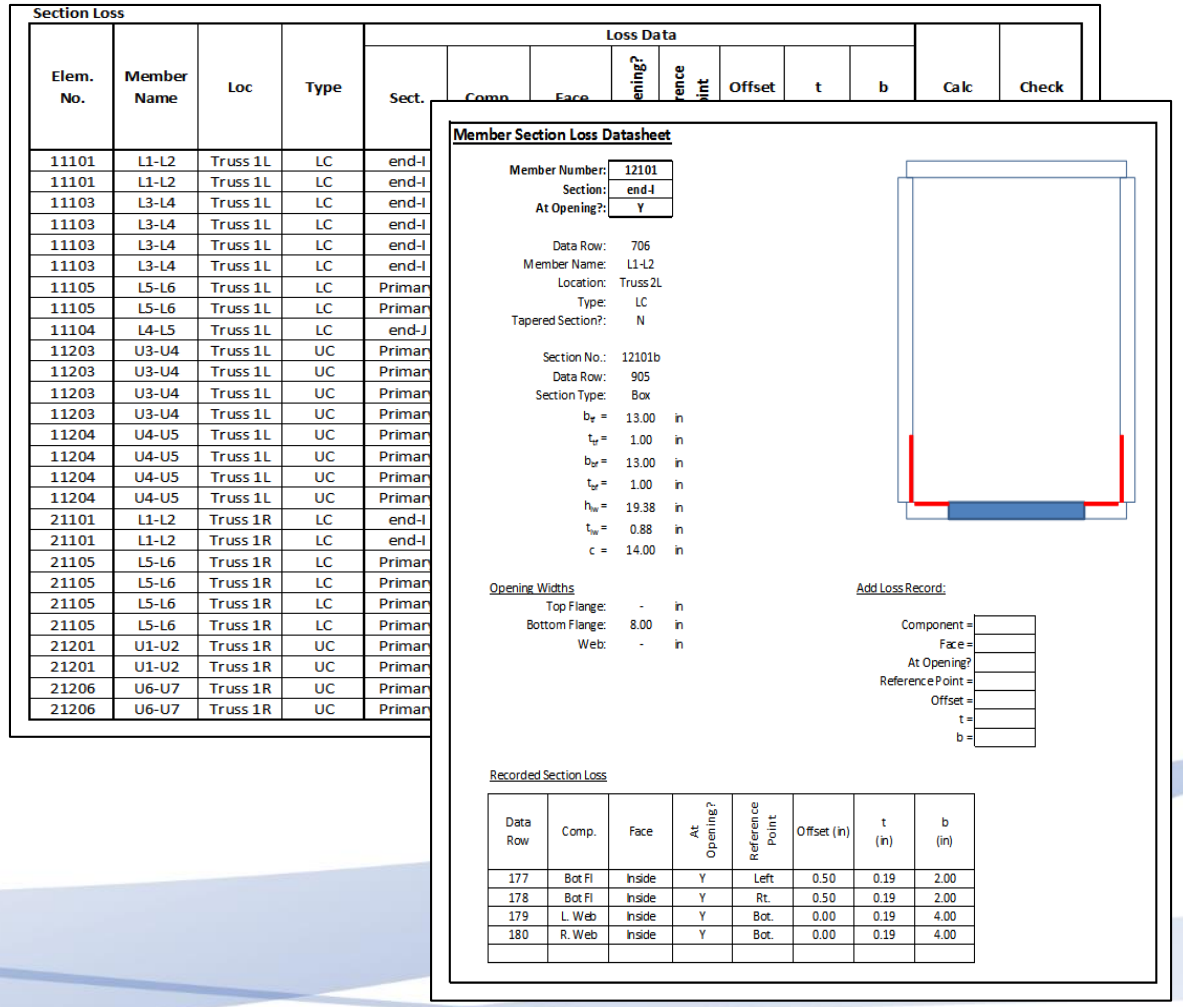
Nonlinear Wind Analysis

- Modeled using Midas Civil Software.
- Geometric nonlinear analysis was conducted for 12 wind combinations + dead load.



Data Collection

- Member section loss data from bridge inspection reports.
- Location and depth of loss area.
- Automated real-time graphic display of the loss.



Section Loss

Elem. No.	Member Name	Loc	Type	Loss Data								Calc	Check
				Sect.	Comp	Face	ening?	rence oint	Offset	t	b		
11101	L1-L2	Truss 1L	LC	end-I									
11101	L1-L2	Truss 1L	LC	end-I									
11103	L3-L4	Truss 1L	LC	end-I									
11103	L3-L4	Truss 1L	LC	end-I									
11103	L3-L4	Truss 1L	LC	end-I									
11103	L3-L4	Truss 1L	LC	end-I									
11105	L5-L6	Truss 1L	LC	Primar									
11105	L5-L6	Truss 1L	LC	Primar									
11104	L4-L5	Truss 1L	LC	end-J									
11203	U3-U4	Truss 1L	UC	Primar									
11203	U3-U4	Truss 1L	UC	Primar									
11203	U3-U4	Truss 1L	UC	Primar									
11203	U3-U4	Truss 1L	UC	Primar									
11204	U4-U5	Truss 1L	UC	Primar									
11204	U4-U5	Truss 1L	UC	Primar									
11204	U4-U5	Truss 1L	UC	Primar									
11204	U4-U5	Truss 1L	UC	Primar									
21101	L1-L2	Truss 1R	LC	end-I									
21101	L1-L2	Truss 1R	LC	end-I									
21105	L5-L6	Truss 1R	LC	Primar									
21105	L5-L6	Truss 1R	LC	Primar									
21105	L5-L6	Truss 1R	LC	Primar									
21105	L5-L6	Truss 1R	LC	Primar									
21201	U1-U2	Truss 1R	UC	Primar									
21201	U1-U2	Truss 1R	UC	Primar									
21206	U6-U7	Truss 1R	UC	Primar									
21206	U6-U7	Truss 1R	UC	Primar									

Member Section Loss Datasheet

Member Number: 12101
Section: end-I
At Opening?: Y

Data Row: 706
Member Name: L1-L2
Location: Truss 2L
Type: LC
Tapered Section?: N

Section No.: 12101b
Data Row: 905
Section Type: Box

b_f = 13.00 in
t_f = 1.00 in
b_{bf} = 13.00 in
t_{bf} = 1.00 in
h_w = 19.38 in
t_w = 0.88 in
c = 14.00 in

Opening Widths
Top Flange: - in
Bottom Flange: 8.00 in
Web: - in

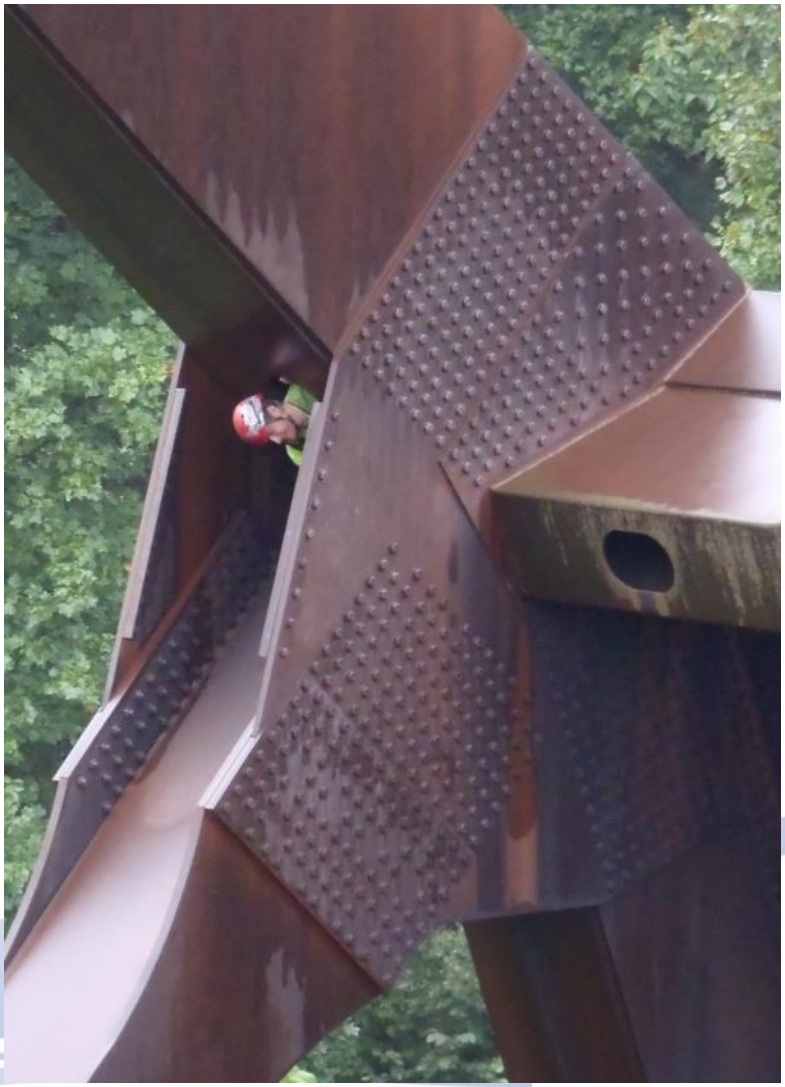
Add Loss Record:
Component =
Face =
At Opening?
Reference Point =
Offset =
t =
b =

Recorded Section Loss

Data Row	Comp.	Face	At Opening?	Reference Point	Offset (in)	t (in)	b (in)
177	Bot Fl	Inside	Y	Left	0.50	0.19	2.00
178	Bot Fl	Inside	Y	Rt.	0.50	0.19	2.00
179	L. Web	Inside	Y	Bot.	0.00	0.19	4.00
180	R. Web	Inside	Y	Bot.	0.00	0.19	4.00

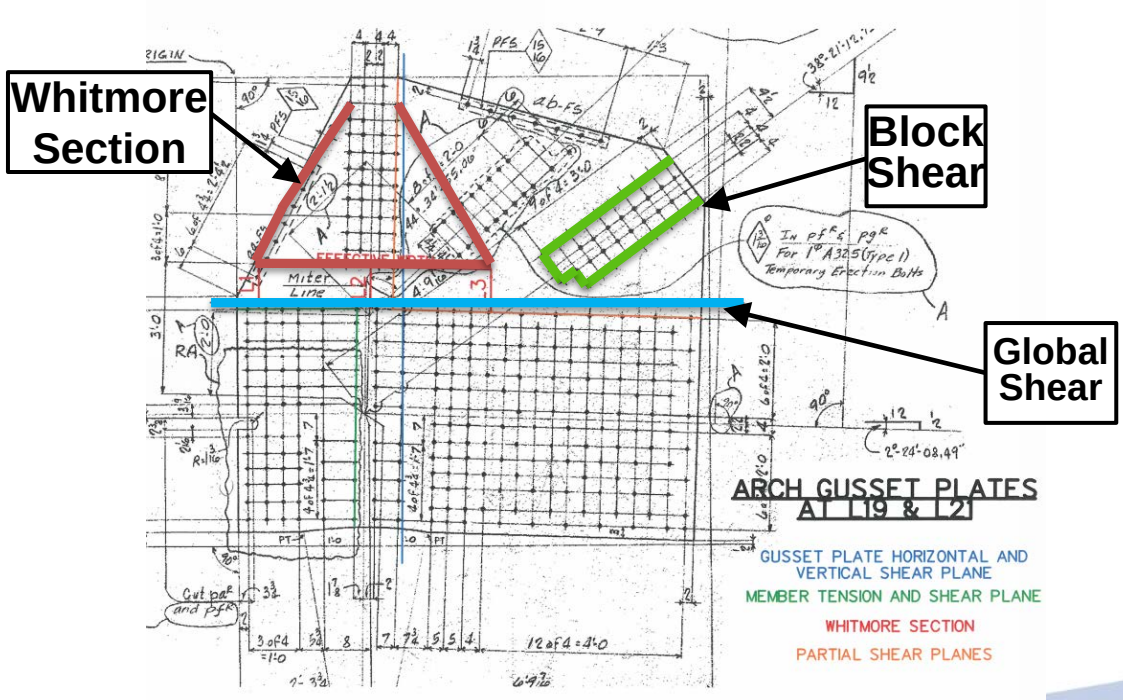
Gusset Plate Rating

- A total of 871 gusset plates were rated.
- Many of the connections are very large and very complex.
- A standardized data collection and rating system was used for efficiency and consistency.



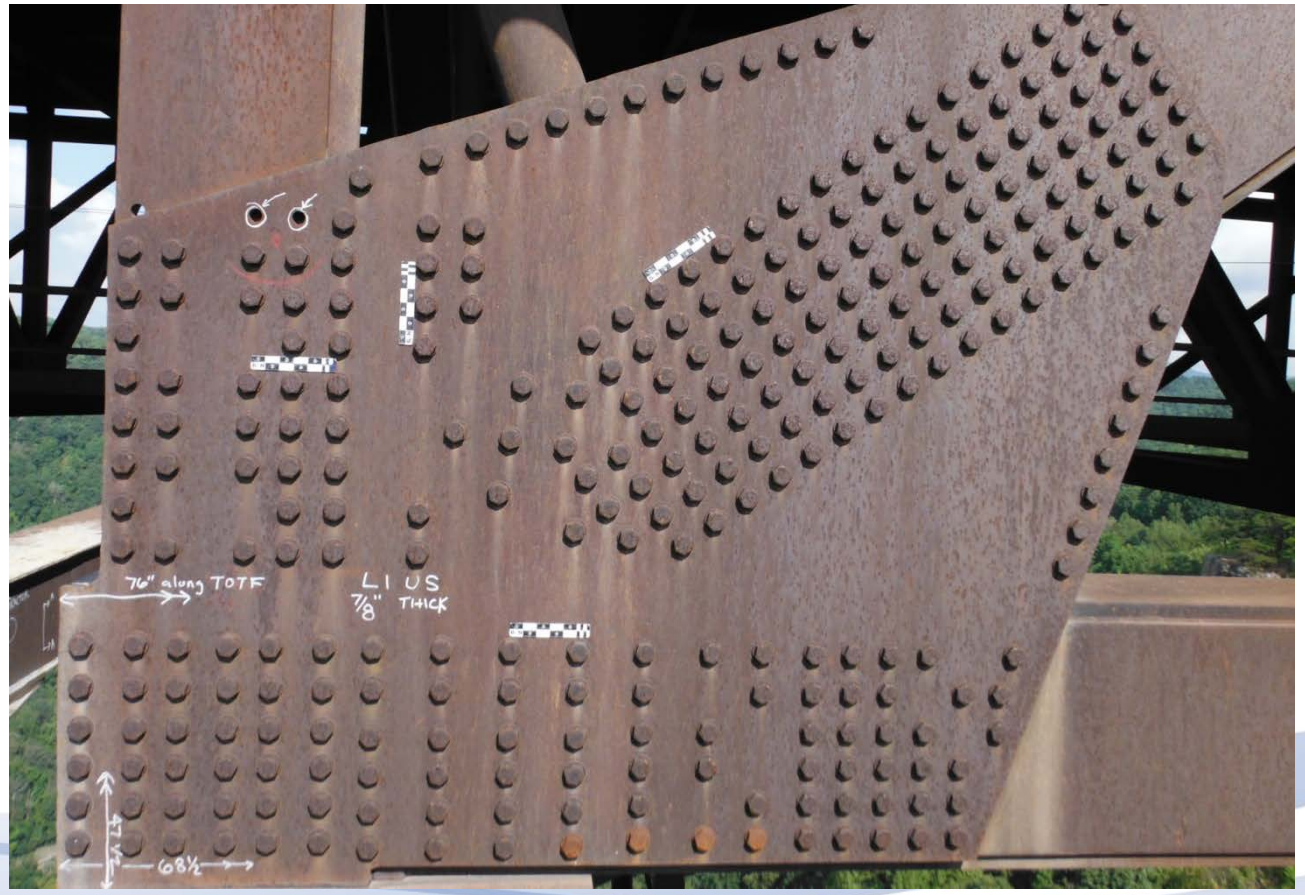
Efficient and Conistent Data Collection

- Shop drawings were imported into Cadd and scaled.
- Critical dimensions (Whitmore section, block shear, global shear planes) were added and measured within the drawing.



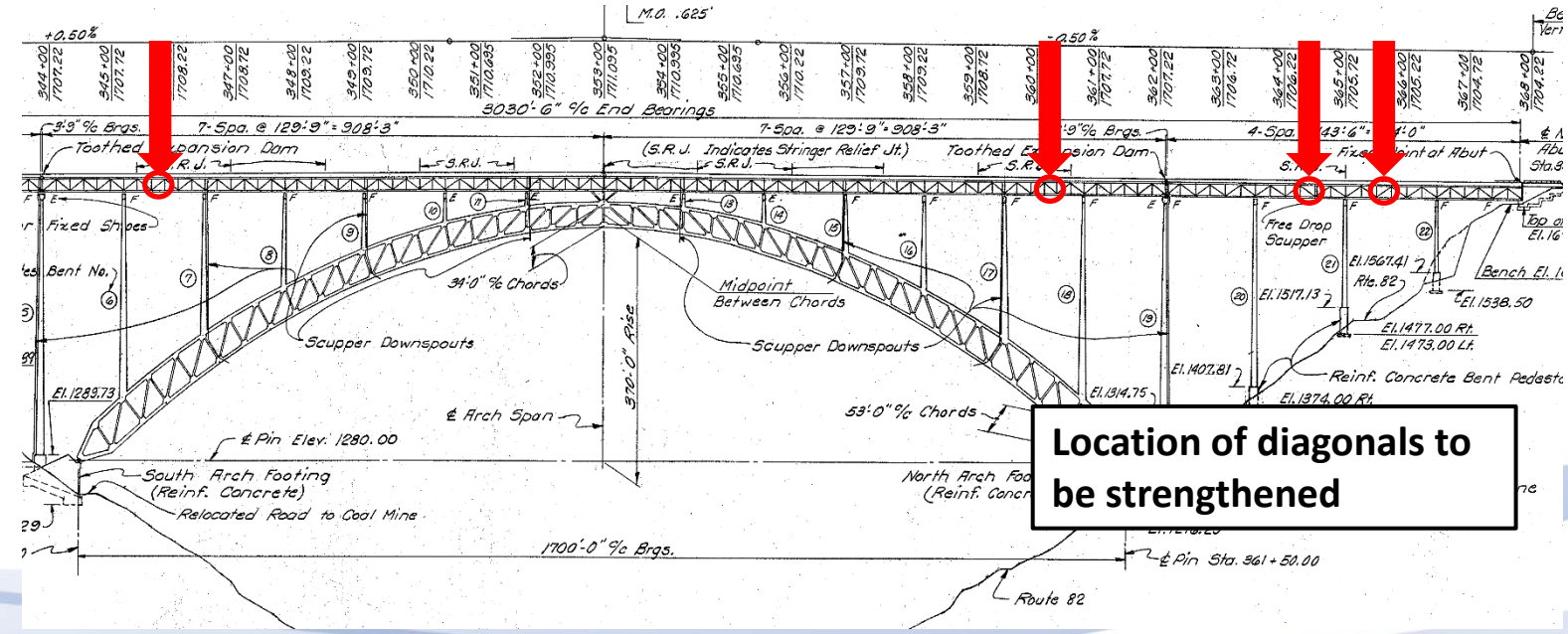
Gusset Plate Rating

Field data collection was used where plan data was incomplete.



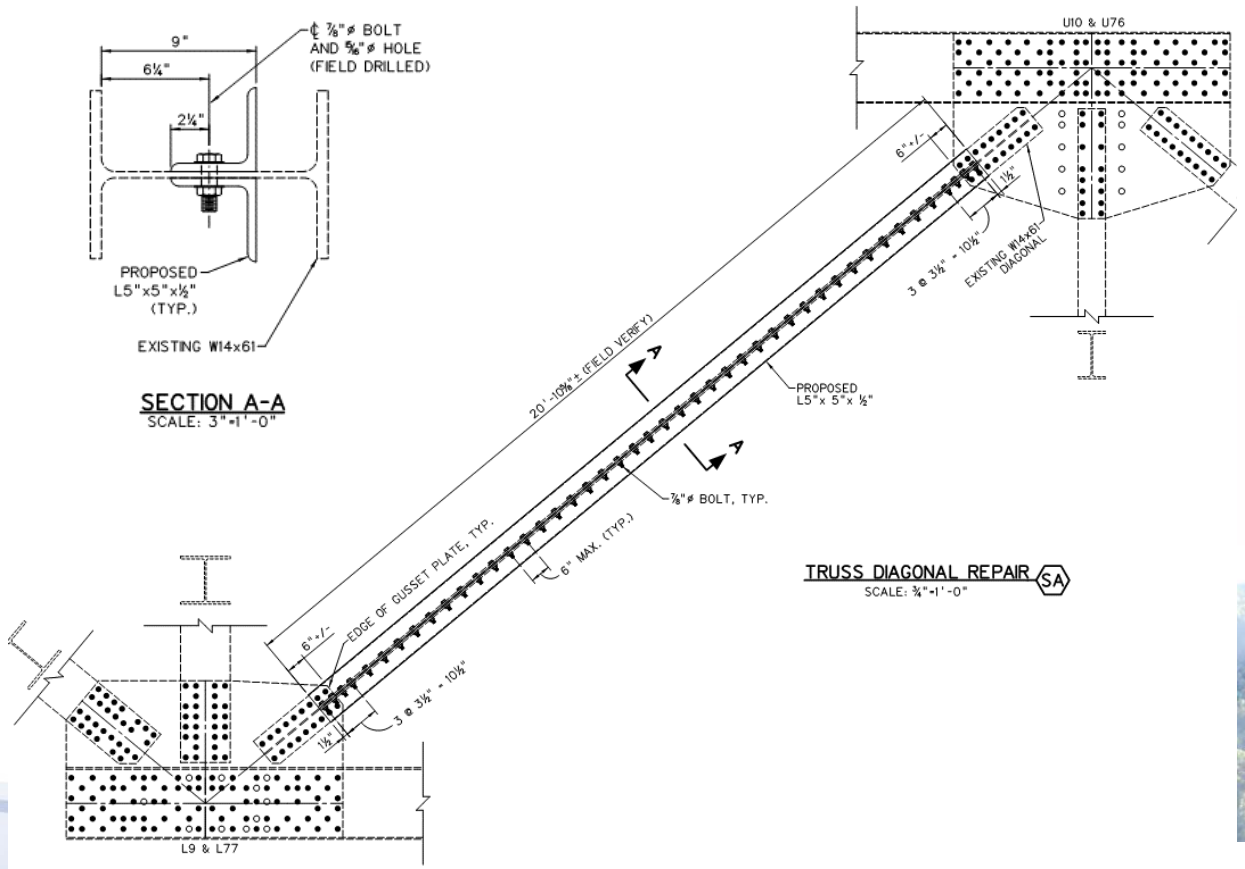
Rating Results For Existing Bridge

- 8 deck truss diagonals need strengthened
- All rated members have HS20 operating ratings > 1.0
- All gusset plates and connections have HS20 inventory and operating ratings > 1.0



Member Strengthening

- Weak axis bending strength will be increased by addition of bolted angles.



2015 Bridge Rehabilitation

Scope of Work

- Clearing and Grubbing
- Concrete Sealing and Patching
- Clean and Paint Selected Areas
- Replace Deteriorated Bolts
- Solve Debris Issue in the Arch Members
- Replace Abutment and Stringer Relief Joints

→ Strengthen Deck Truss Diagonals

➢ Retrofit and Reset Bearings at Bents 19 and 5

- Miscellaneous Repairs and Maintenance, etc.

Clearing Trees and Vines Below the Bridge

- Trees > 5” Dia. Within 50’ of bridge
- Trees growing into Bridge
- Trees falling onto Bridge
- Trees preventing safe inspection
- Vines on Bridge
- Leave it lay, out of the way
- Leave paths with room to work/inspect

North Abutment

“Just-in-Time” Substructure Inspection

- 100% Sounding
- Baskets/Rappelling
- Mark w/Paint
- Photograph/Document/Quantify

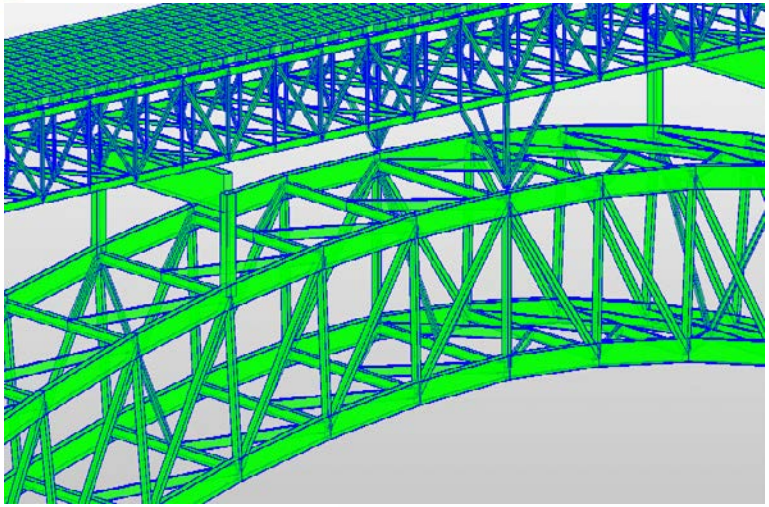
Green = Crack Seal
Orange = Patching

Finished Product

- Cracks – Two-part hybrid urethane mender
- Patches - Non-shrink, High Early Strength
- Protective Epoxy Coating

Primary Issue = Section and Nut Loss

- Deck Truss
  - Sealed in 2012
  - Punch list locations
- Bents and Arch
- Cleaning and Sealing
- Follow-up with Magnets
- Not Controlling the Load Rating



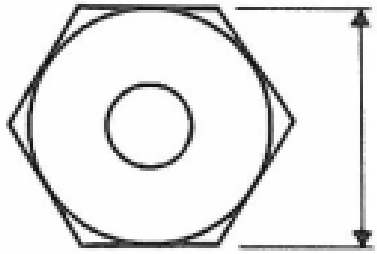
ARCH DIAGONAL

BENT BASE

“Lesson Learned” from Previous Rehabs

BOLT REPLACEMENT GUIDE

1. THE FOLLOWING GUIDES SHALL BE USED TO DETERMINE THE NEED FOR BOLT REPLACEMENT AT LOCATIONS NOT MARKED IN THE FIELD AND/OR NOT SHOWN IN THE PLANS:



"N" = FLAT TO FLAT DIMENSION OF NUT

DECK TRUSS/BENT BOLTS: ORIGINAL BOLT DIAMETER = 7/8"

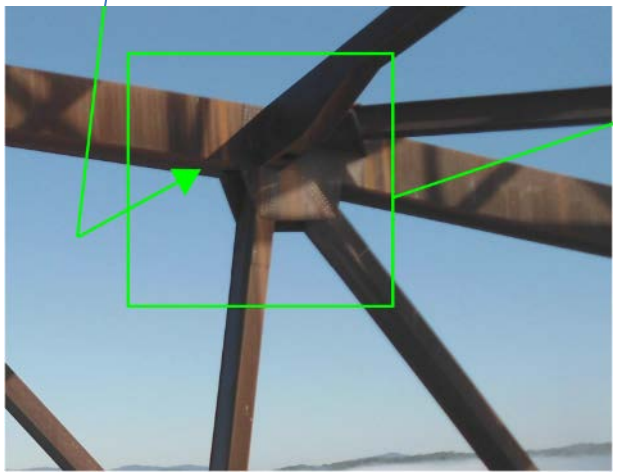
"N"
1 3/8" = 0% LOSS (AS MEASURED IN THE FIELD)
1 1/8" = 50% LOSS = REPLACE

ARCH BOLTS: ORIGINAL BOLT DIAMETER = 1 1/8"

"N"
1 13/16" = 0% LOSS
1 1/2" = 50% LOSS = REPLACE

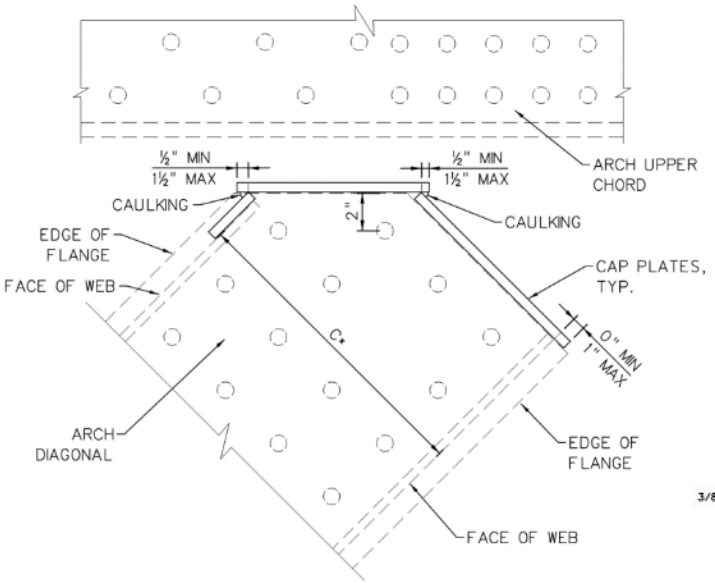
Solving Debris Issues in Arch Members

- Problem: Water Flowing Under Arch Rib
- Solution: Divert Water with Magnetic Drip Bar



Solving Debris Issues in Arch Members

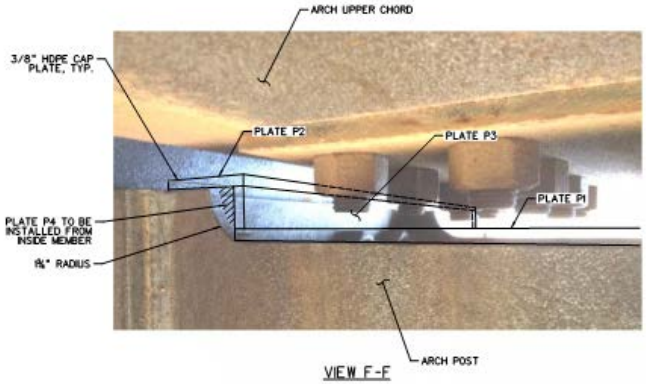
- Problem: Water/Birds Entering Top of Arch Members
- Solution: Install HDPE Cap Plates



C* = 1'-4⅞" FOR DIAGONALS EXCEPT AT THE FOLLOWING LOCATIONS:
2'-1⅛" @ U2 & U38
1'-9⅛" @ U5, U8, U35, & U32
1'-5⅛" @ U11, U29, & U20
1'-5" @ U14, U17, U26, & U23

DETAIL C
SCALE: 3"=1'-0"

TYPICAL VIEW
LOOKING DOWN AND NORTH



VIEW F-F

Solving Debris Issues in Arch Members

- Installed HDPE Cap Plates

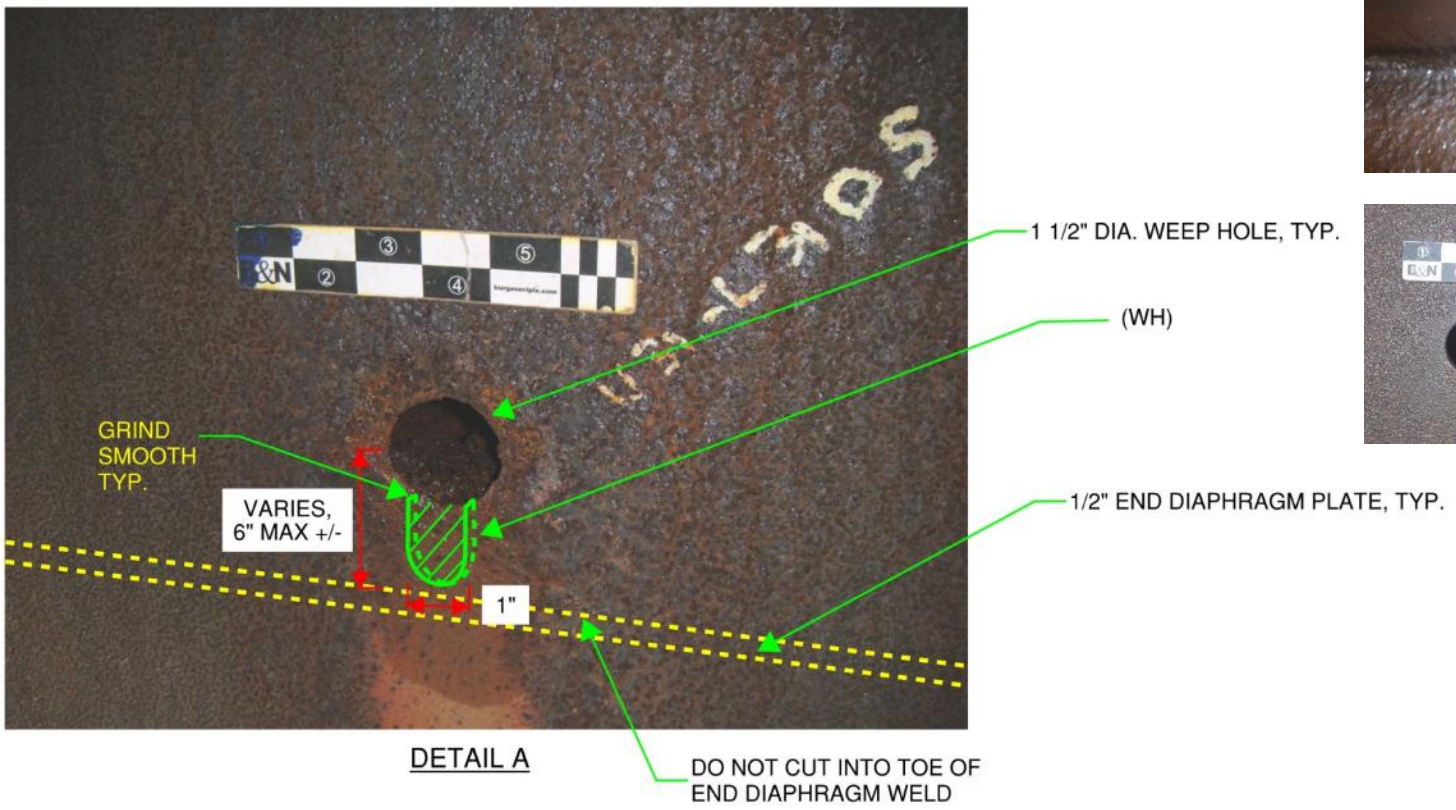
Solving Debris Issues in Arch Members

- Problem: Members Not Draining, Weep Holes too High

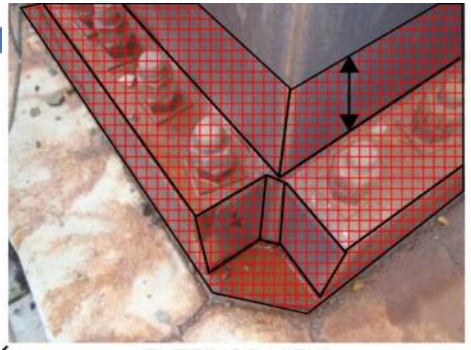
TYPICAL UPPER ARCH WEEPHOLE

Solving Debris Issues in Arch Members

- Problem: Members Not Draining, Weep Holes too High
- Solution: Extend Weep Holes



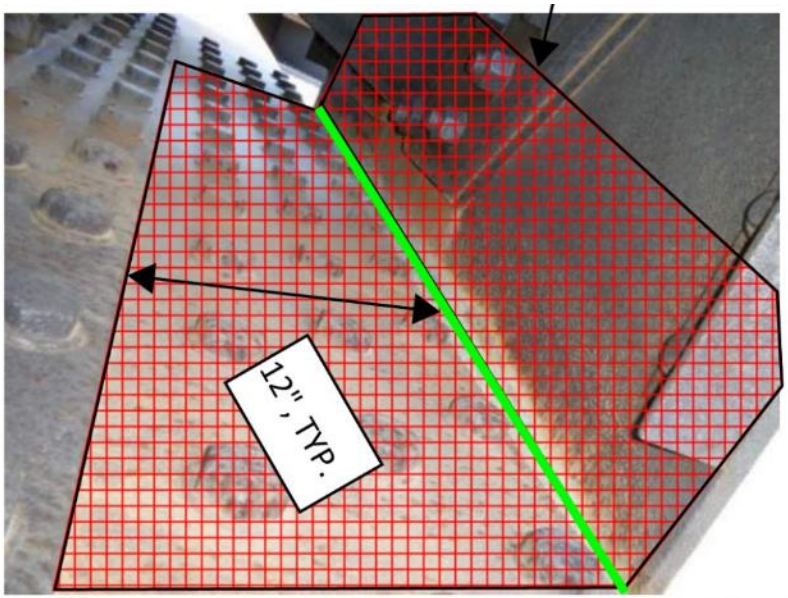
“Danielson! Show me Wax On… Wax Off…”


EXTERIOR VIEW

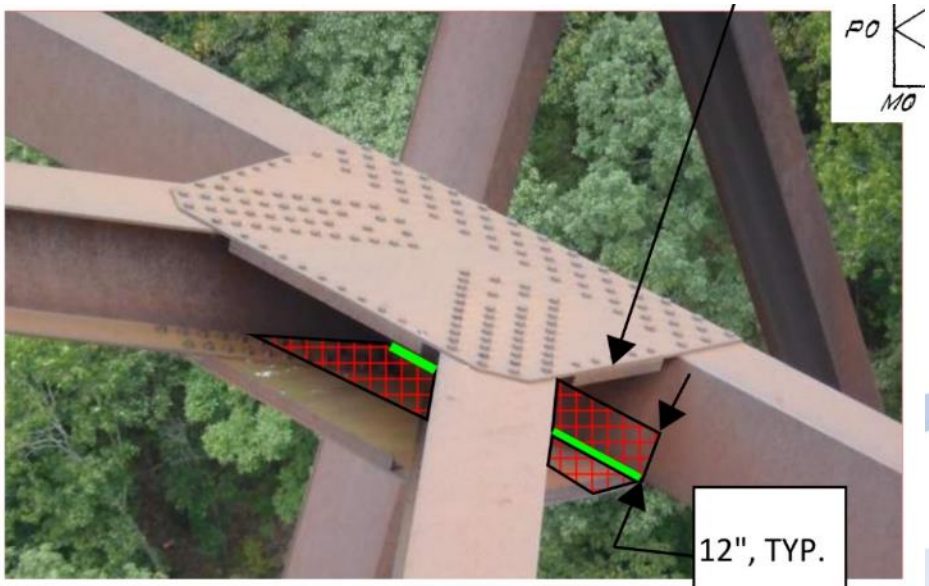
- Pressure Wash or Power Tool
- Penetrant Sealer – let it penetrate 15 mins.
- Wax Coating – sets up like a candle wax
  - Two on WVDOH Approved Products list

MAX-WAX

CHEMICAR usa TEKTON 34

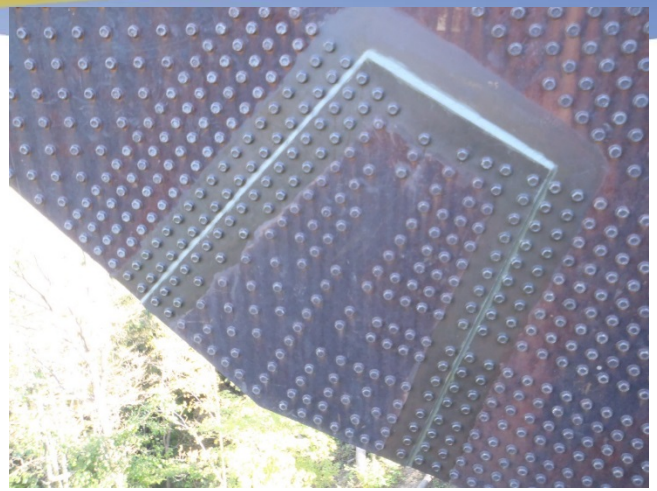


TYPICAL W & P CONNECTION WITH VERTICAL GUSSET



TYPICAL W CONNECTION

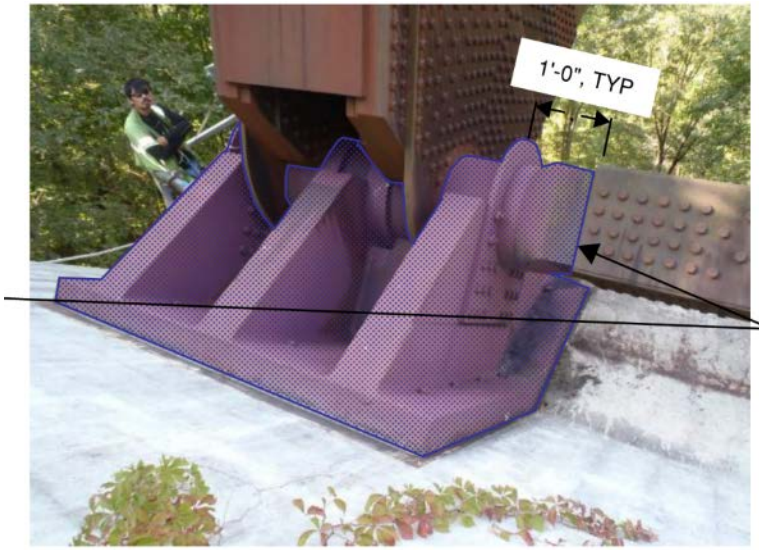
Looking GOOD!



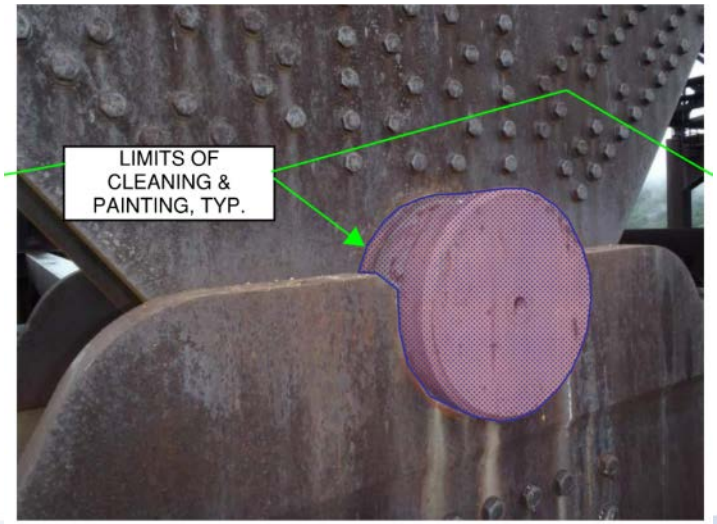
Looking GOOD!

A few places are not weathering steel

- Power Tool Clean
- Epoxy Mastic Prime
- Urethane Top



TYPICAL ARCH GRILLAGE AND PIN AT M0 & M40 US/DS (INBOARD VIEW)



TYPICAL ARCH PIN AT U20 OF ARCH (OUTBOARD VIEW)

G IN KEY

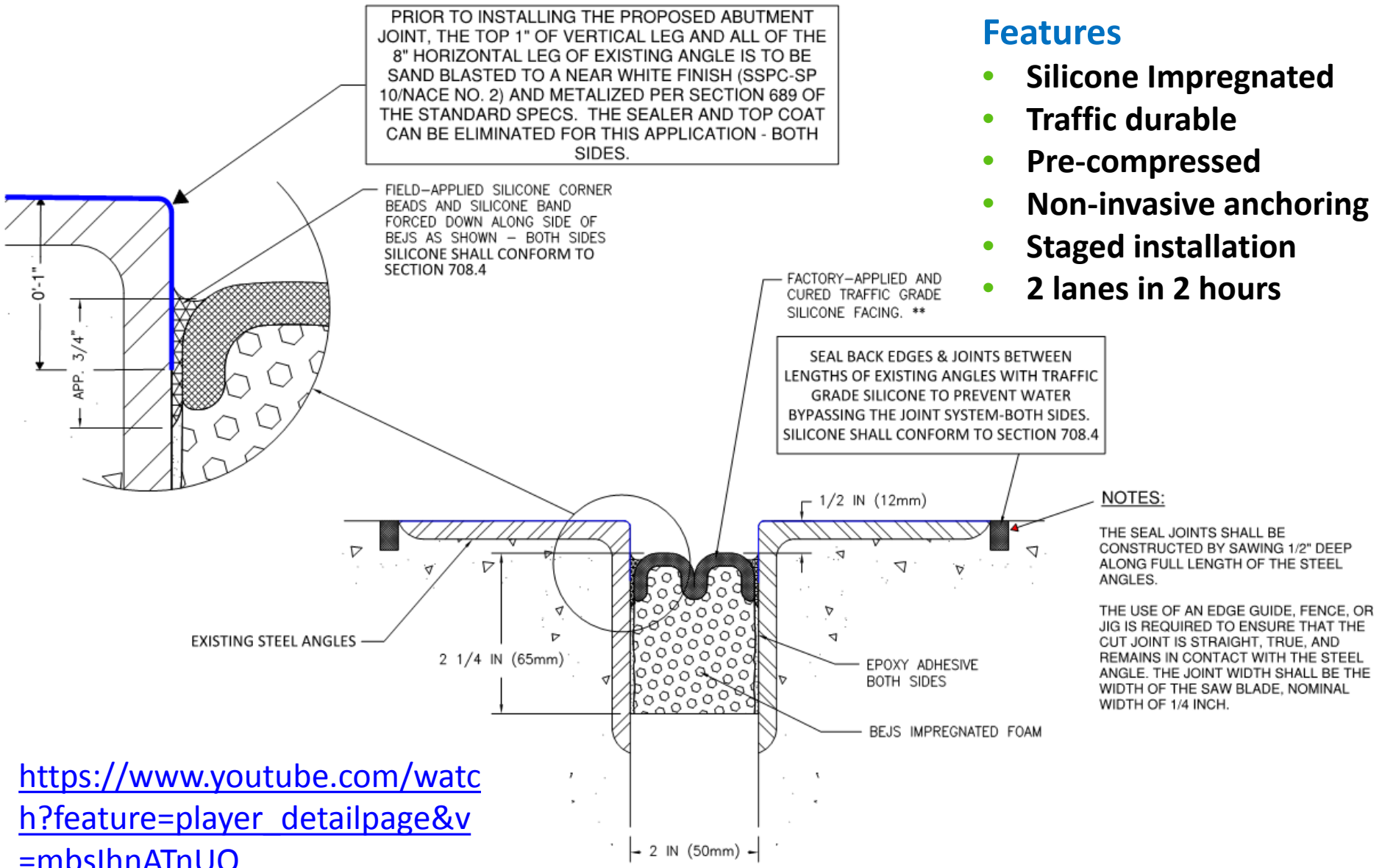
CLEANING SHALL BE PER SSPC-SP 15. EPOXY MASTIC PRIME COAT SHALL BE 5 MILS MINIMUM DRY FILM THICKNESS. URETHANE TOP CHOAT SHALL BE 3 MILS MINIMUM DRY FILM THICKNESS.

Contractor's Access – Not What We Expected

- Spiders
- Anchored to:
  - Catwalk or
  - Rolling Frames on Deck
- Challenging for Inspectors
- B&N Onsite

Leaking Joints causing Pack Rust at Bearings

Expanding Polyurethane Foam Joints



PROPOSED ABUTMENT JONT DETAIL (EJ1)

Features

- Silicone Impregnated
- Traffic durable
- Pre-compressed
- Non-invasive anchoring
- Staged installation
- 2 lanes in 2 hours

https://www.youtube.com/watch?feature=player_detailpage&v=mbsIhnATnUQ

Deck Repairs….As Simple as 1, 2, 3…..

1

2

3

4

Bearing Slide Video

Prepared by Maximus Films Production for the German Documentary on the Worlds Most Extreme Bridges

Bearing Repositioning

- Excessive tilt.
- Plates were misaligned at mean temperatures.
- Roller had slipped.
- Retainer plates should prevent slippage, but they were not functioning properly.

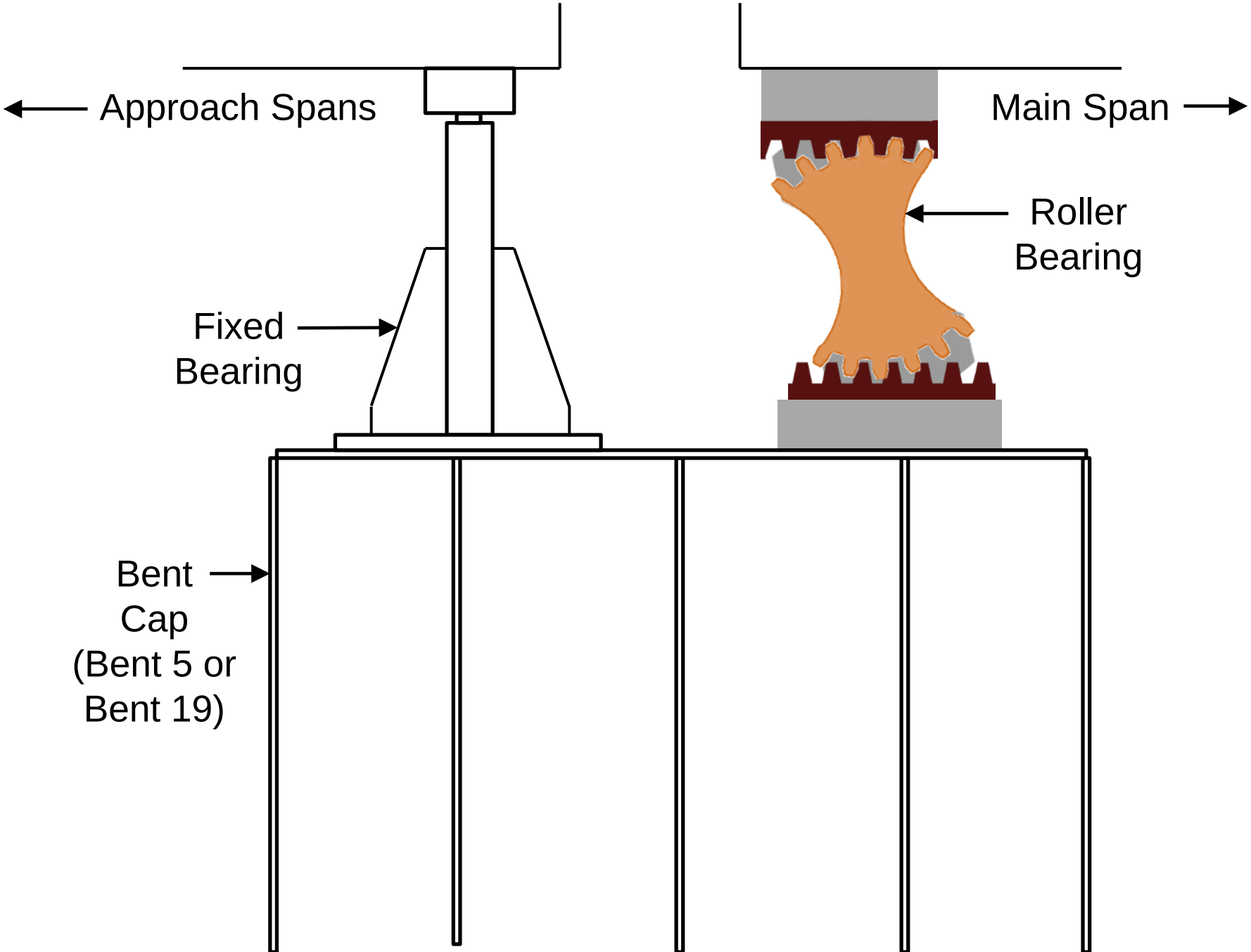
Bearing Repositioning

- Geared retainer plates are intended to keep bearing from slipping relative to the baseplate and sole plate.
- Retainer plates are connected to the roller only at the center of the roller.
- This connection allows the plates to rotate relative to the roller, making the retainer plates ineffective.

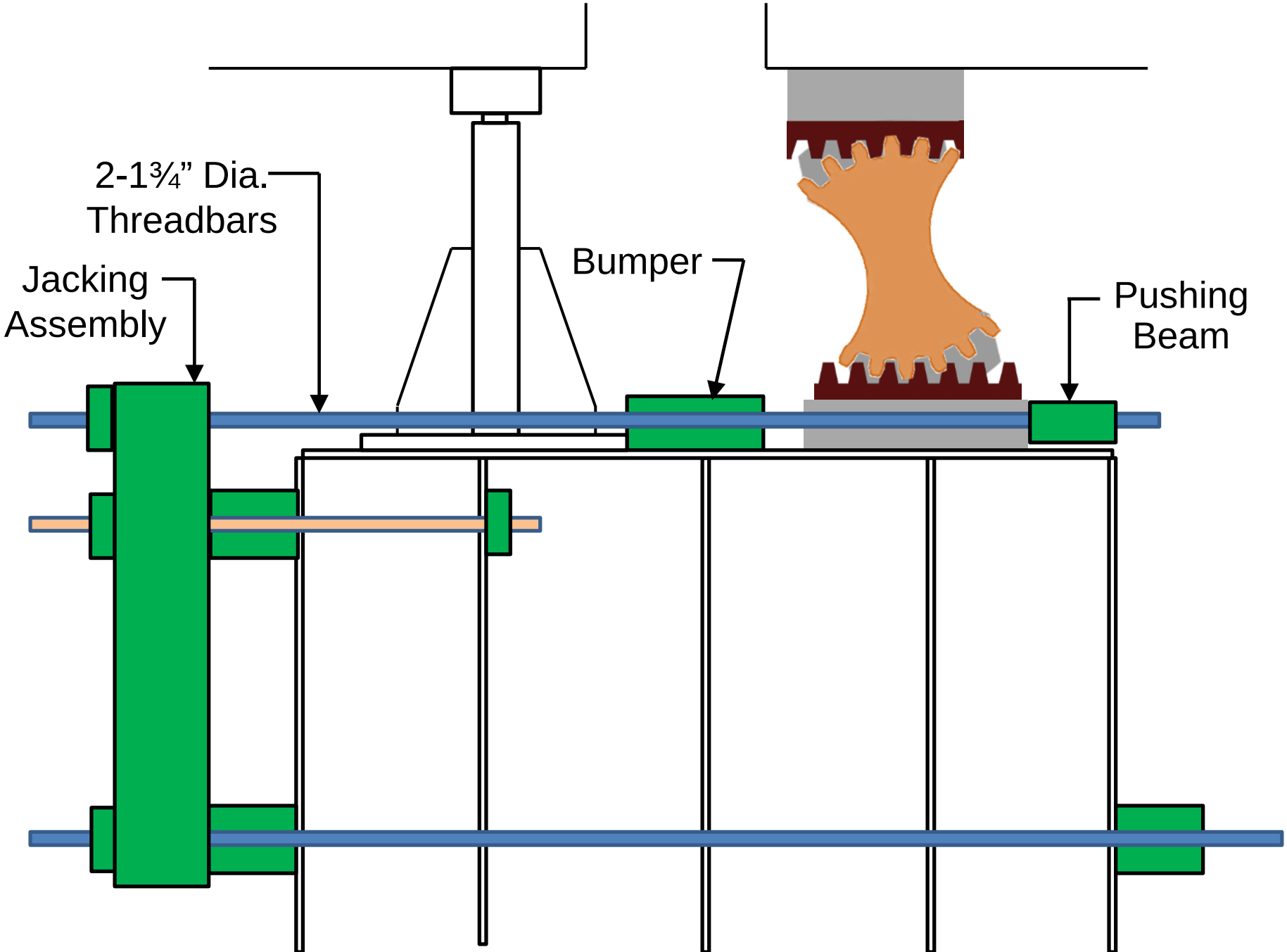
Vertical Jacking vs. Sliding

- Vertical jacking would be very difficult due to height of the bent and the steel pier cap.

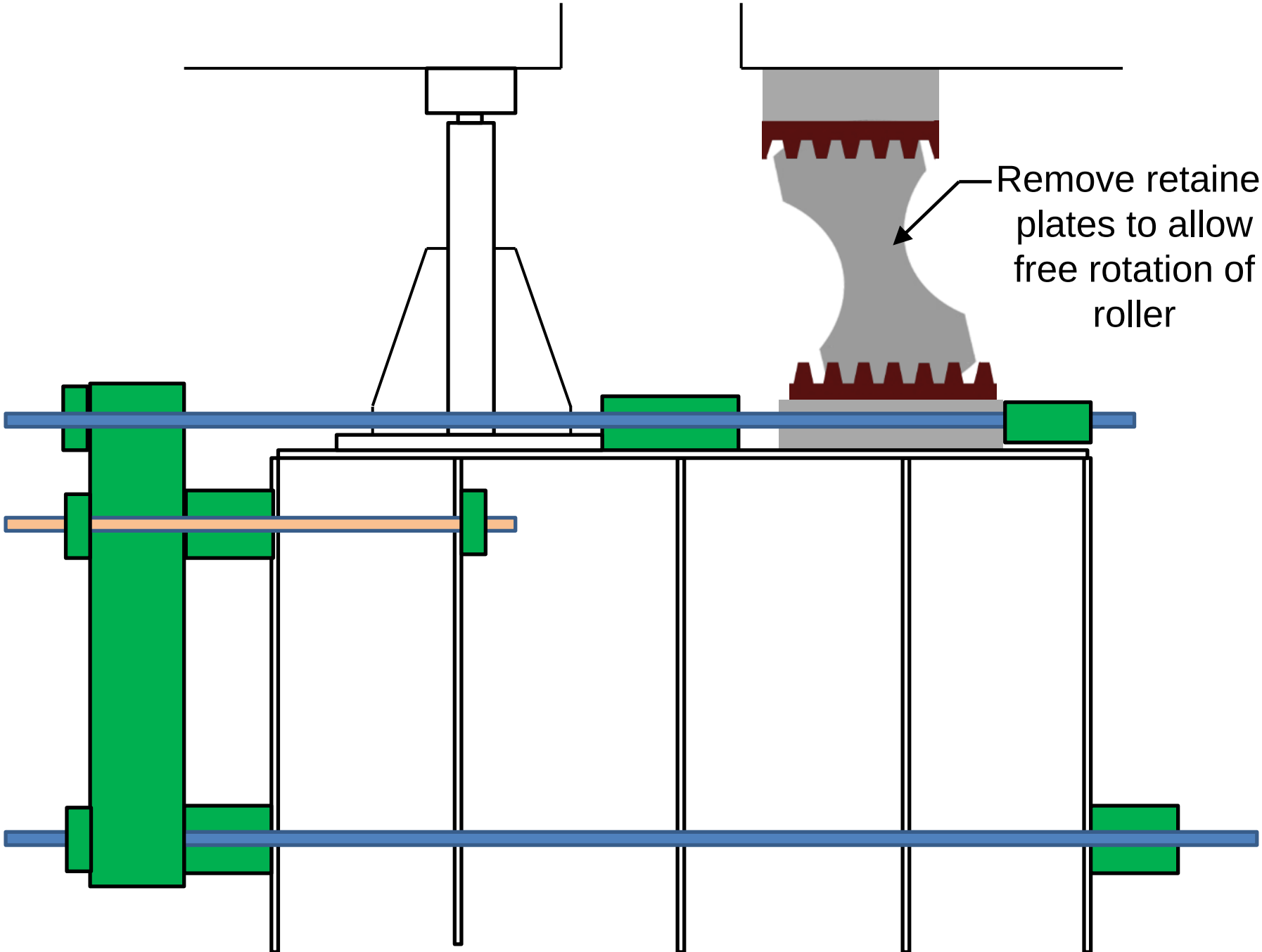
Schematic layout of Bent 5 / Bent 19 bearings:



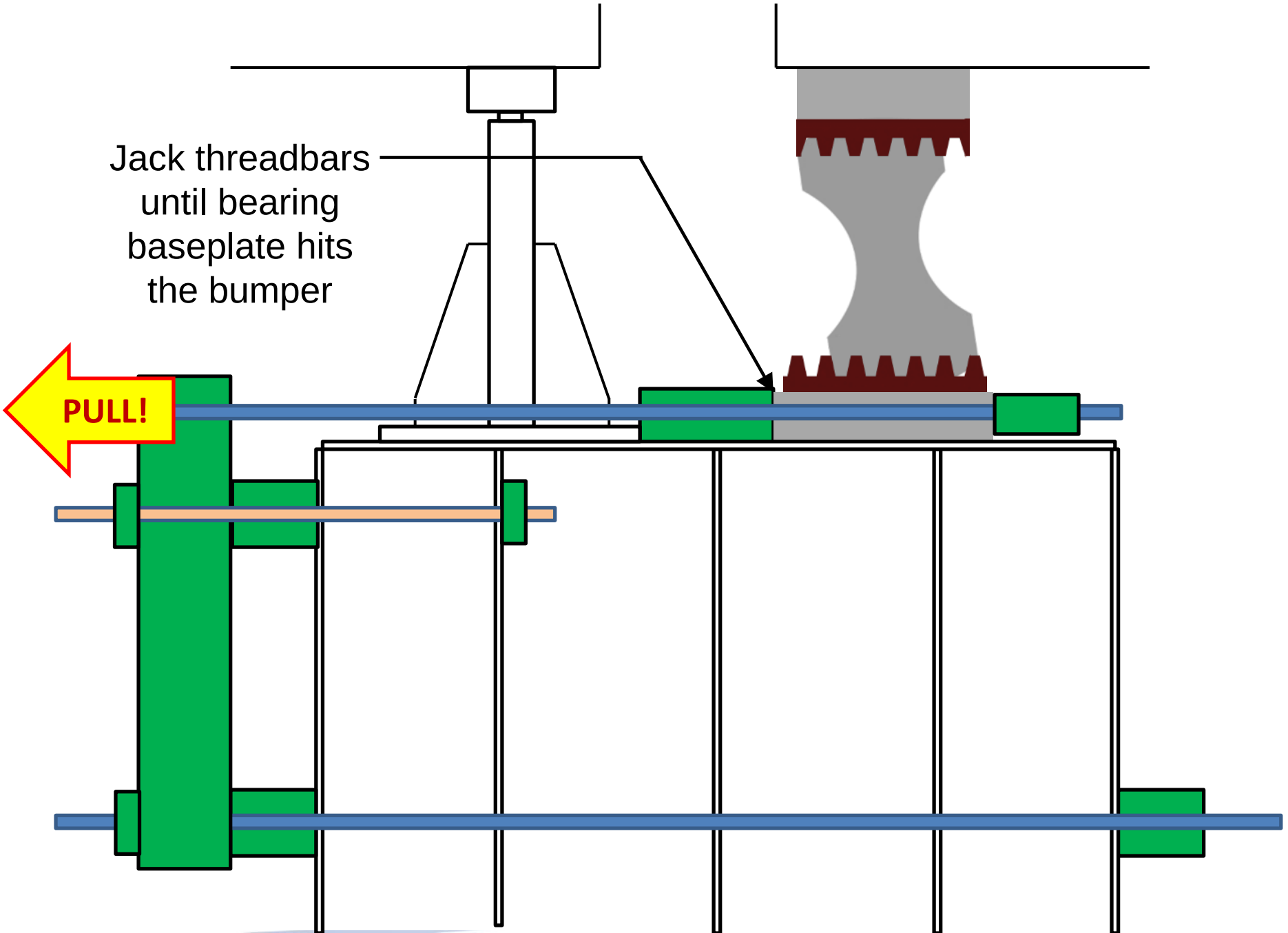
Step 1: Install Jacking Assembly & Threadbars



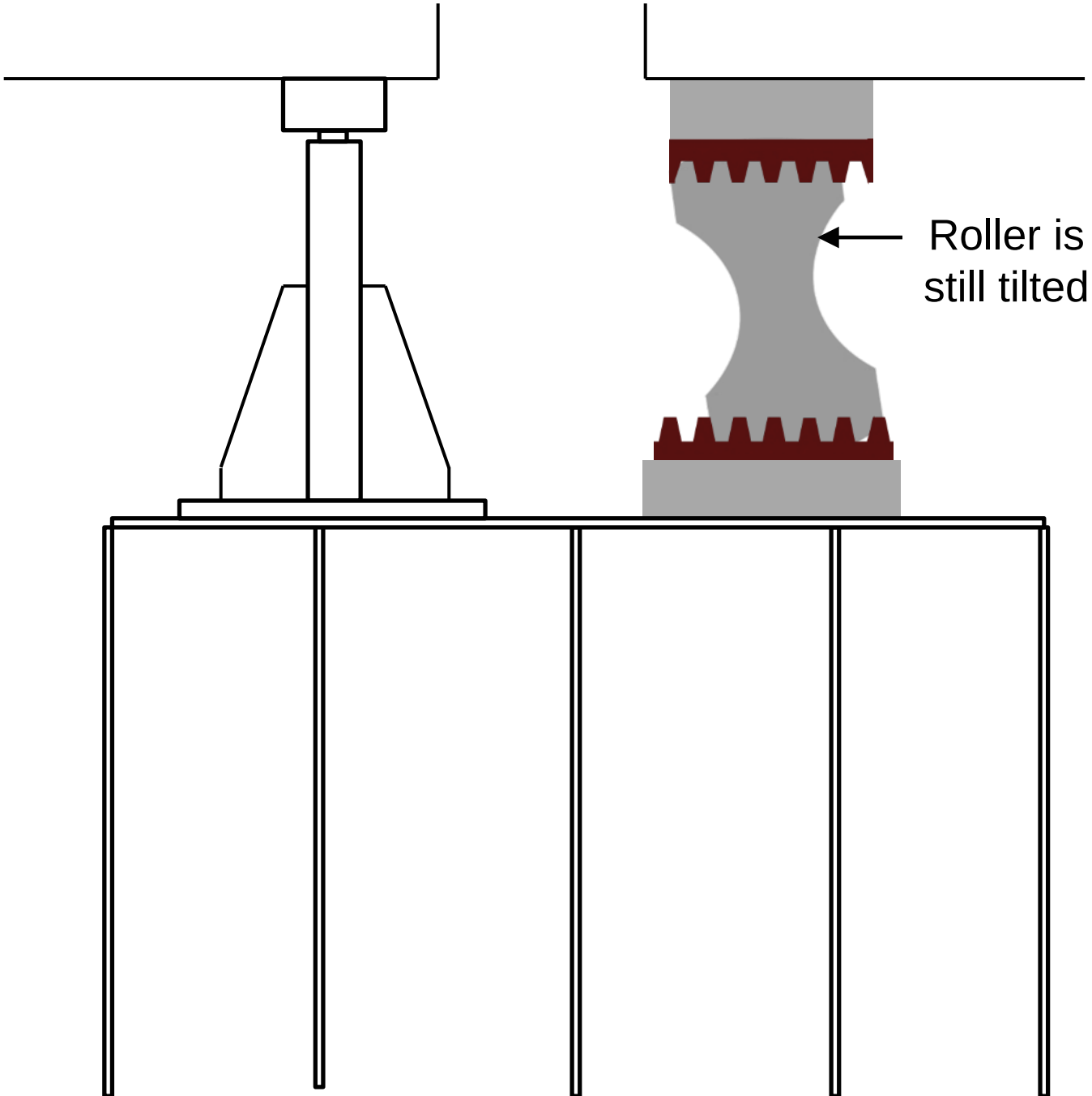
Step 2: Temporarily remove retainer plates from roller bearing



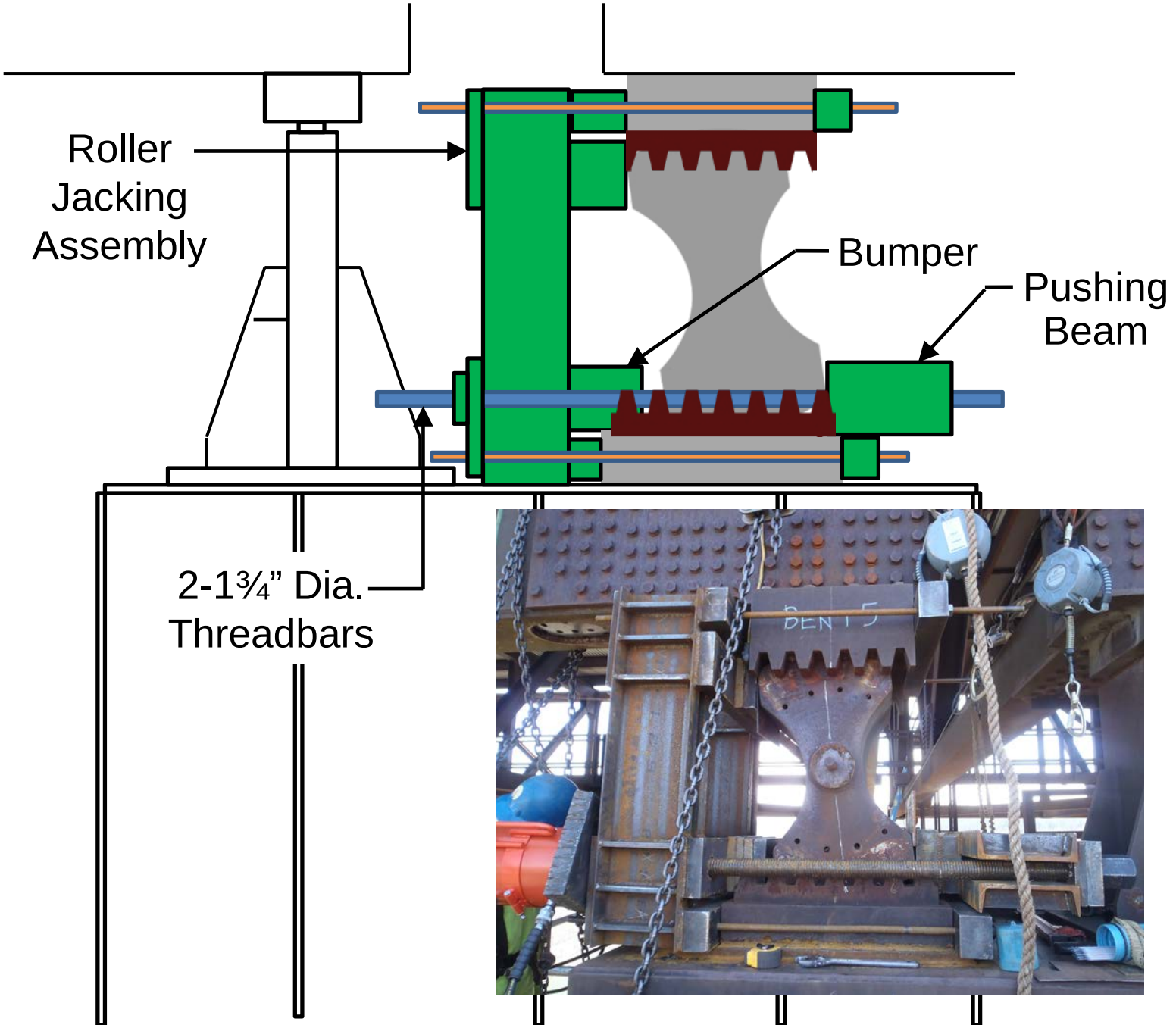
Step 3: Jack threadbars, pull bearing base plate to final position



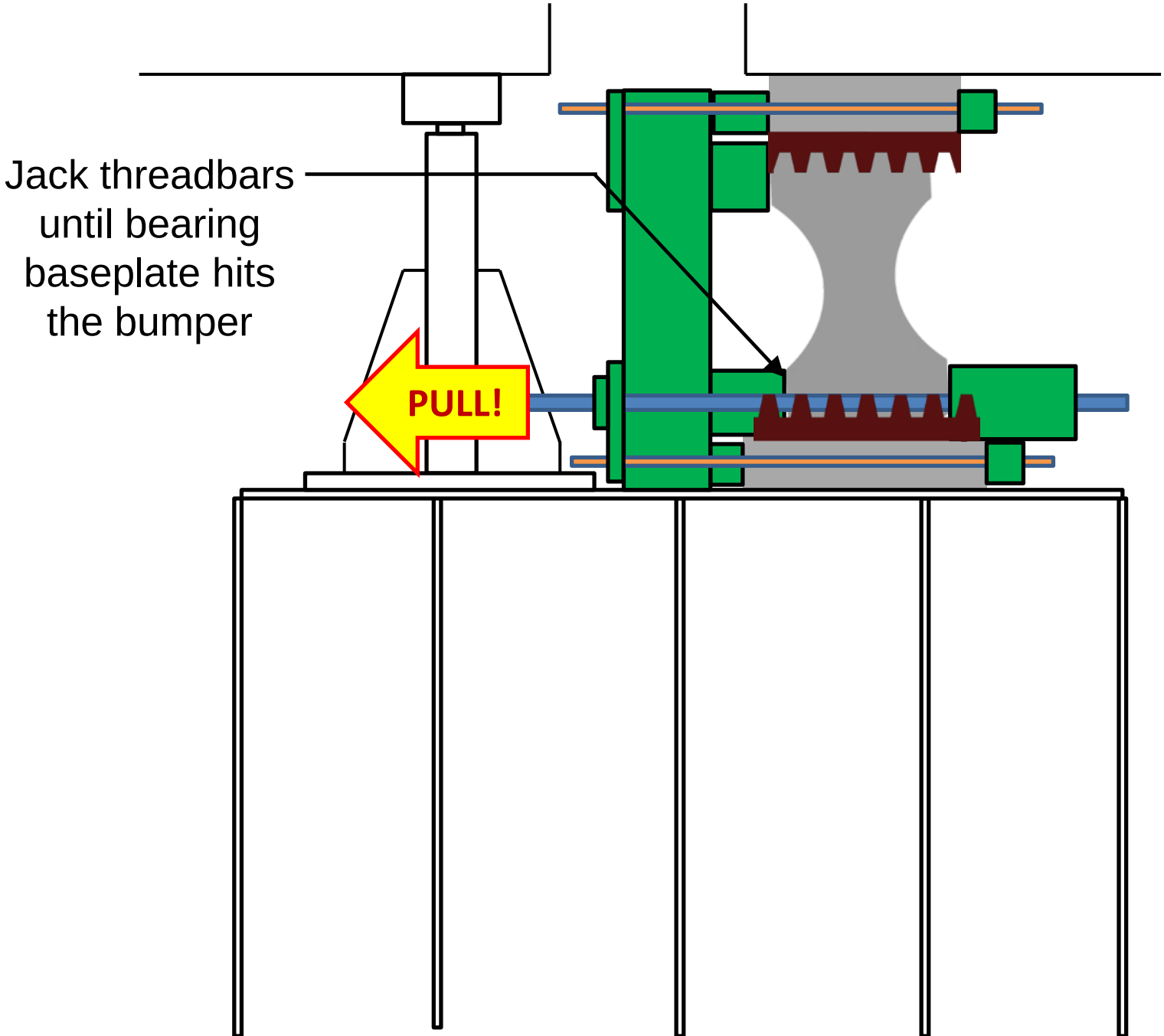
Step 4: Remove jacking assembly



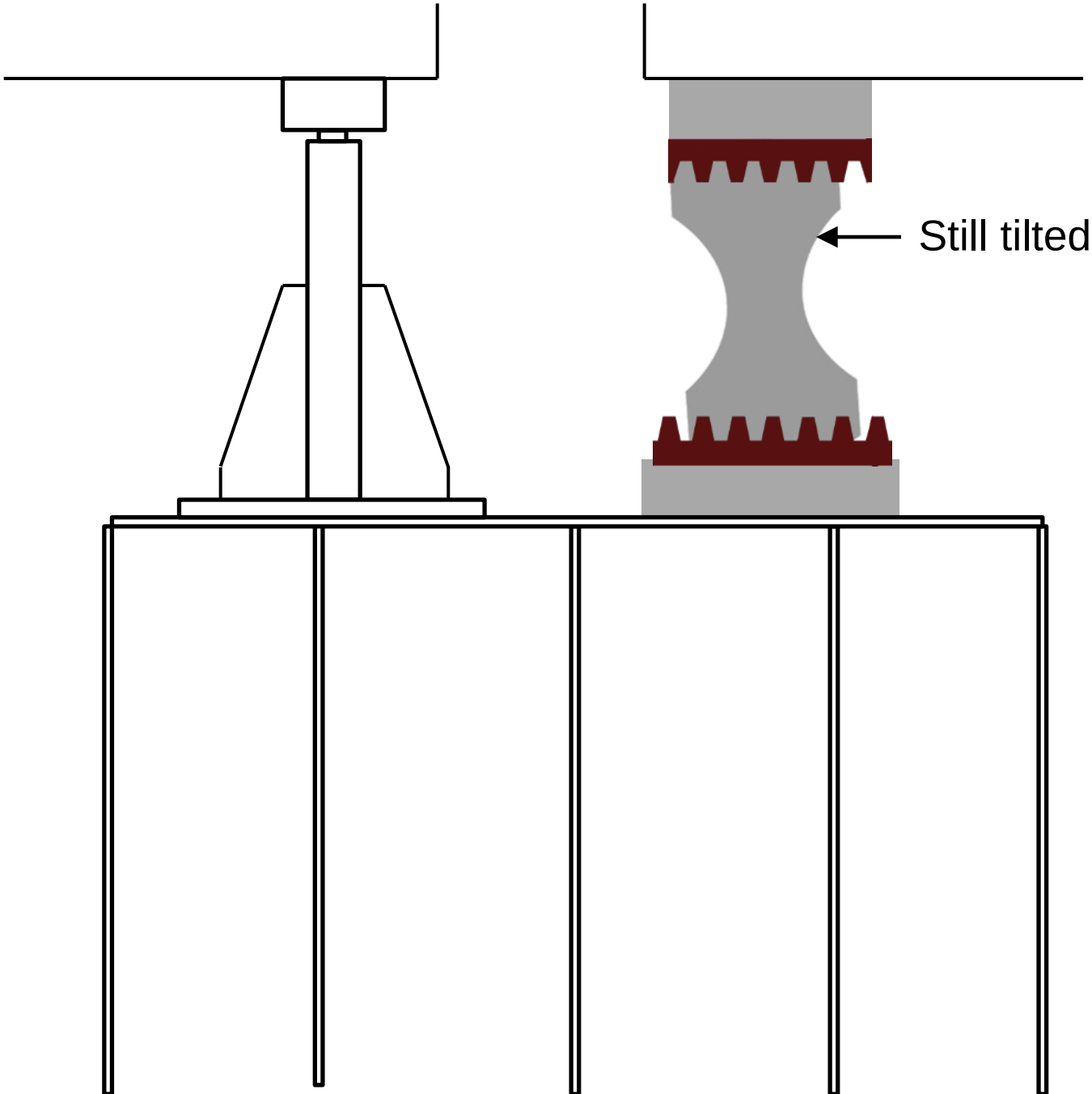
Step 5: Install roller jacking assembly and threadbars



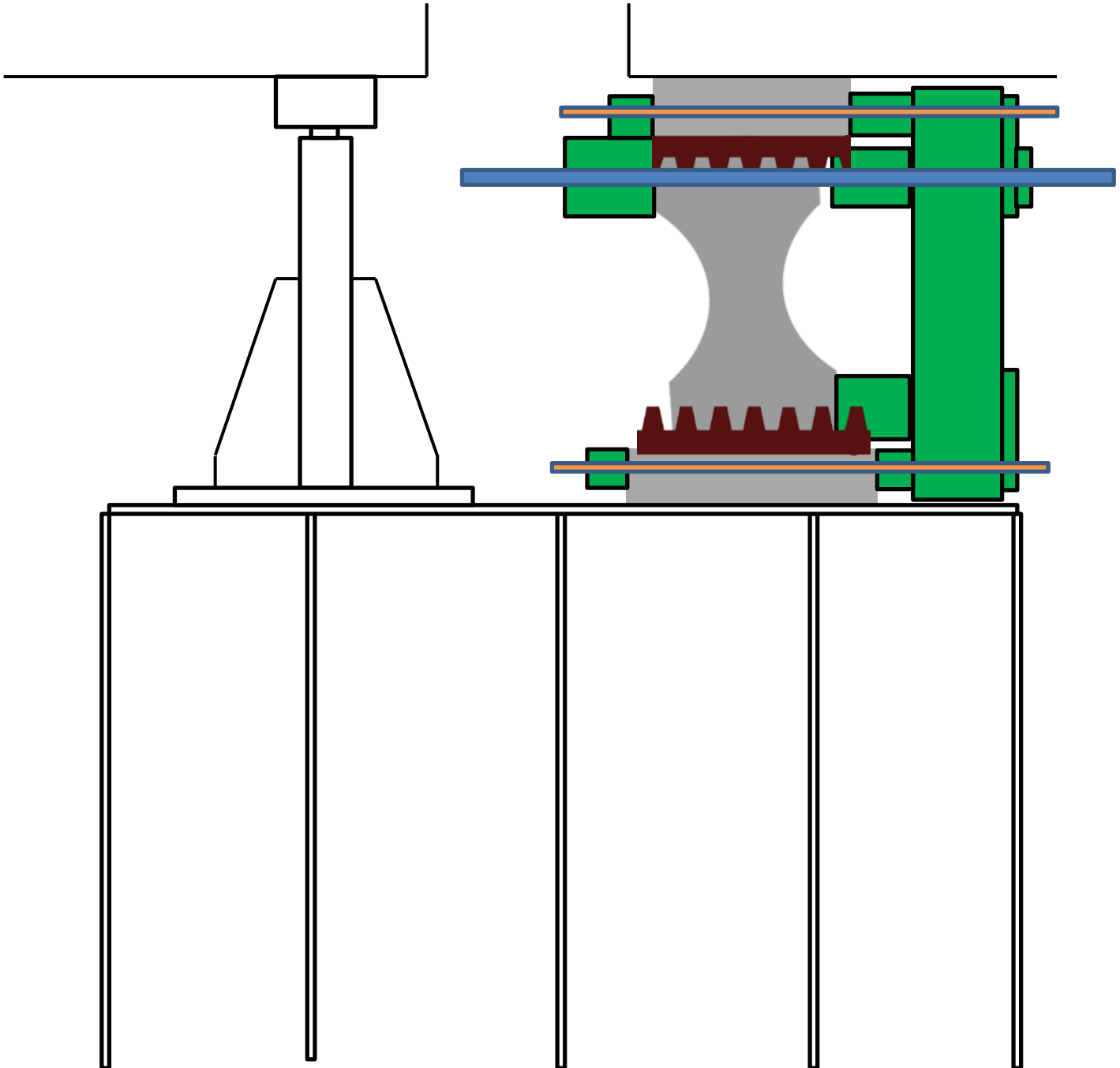
Step 6: Jack threadbars and pull roller base to final position



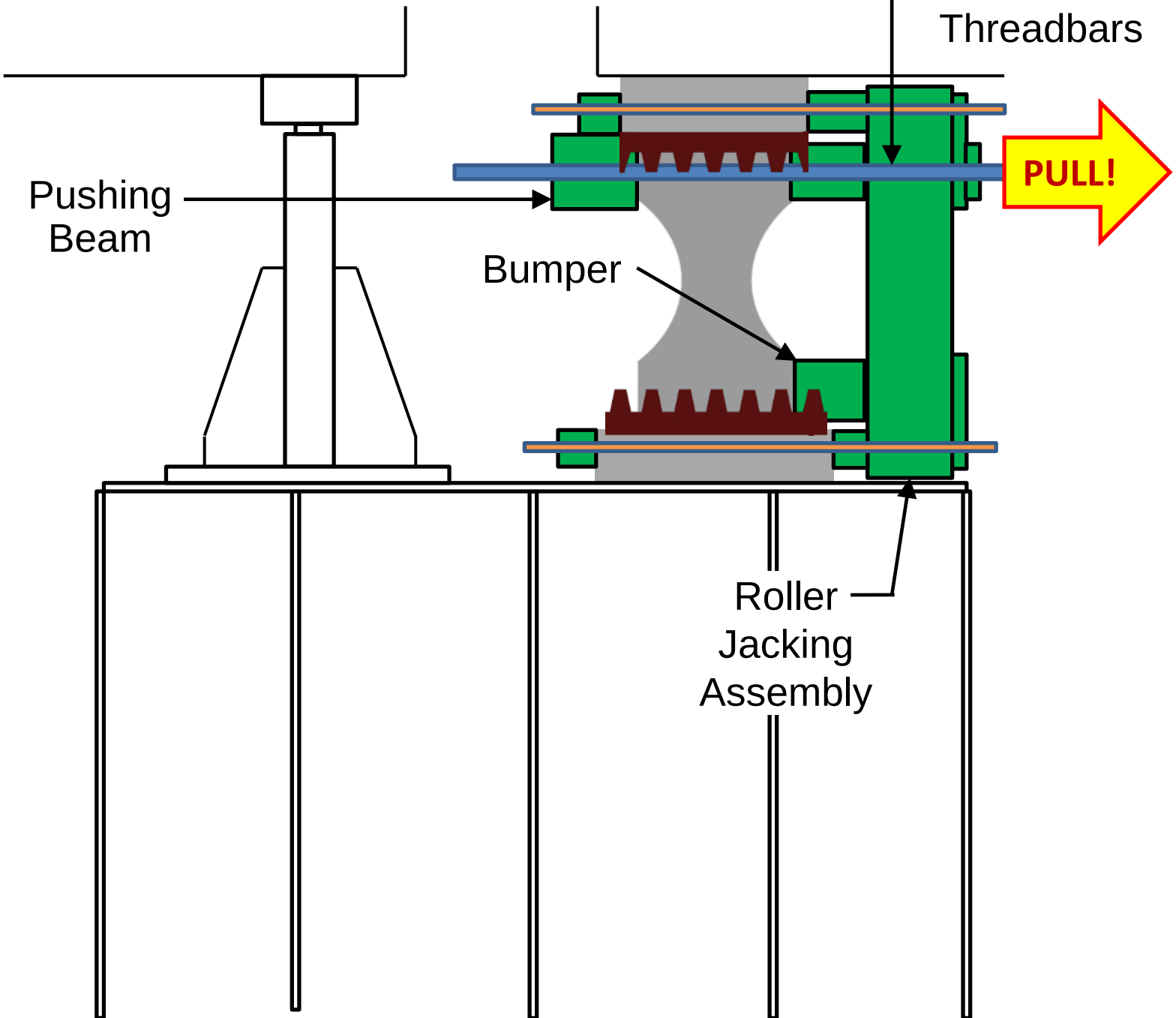
Step 7: Remove roller jacking assembly



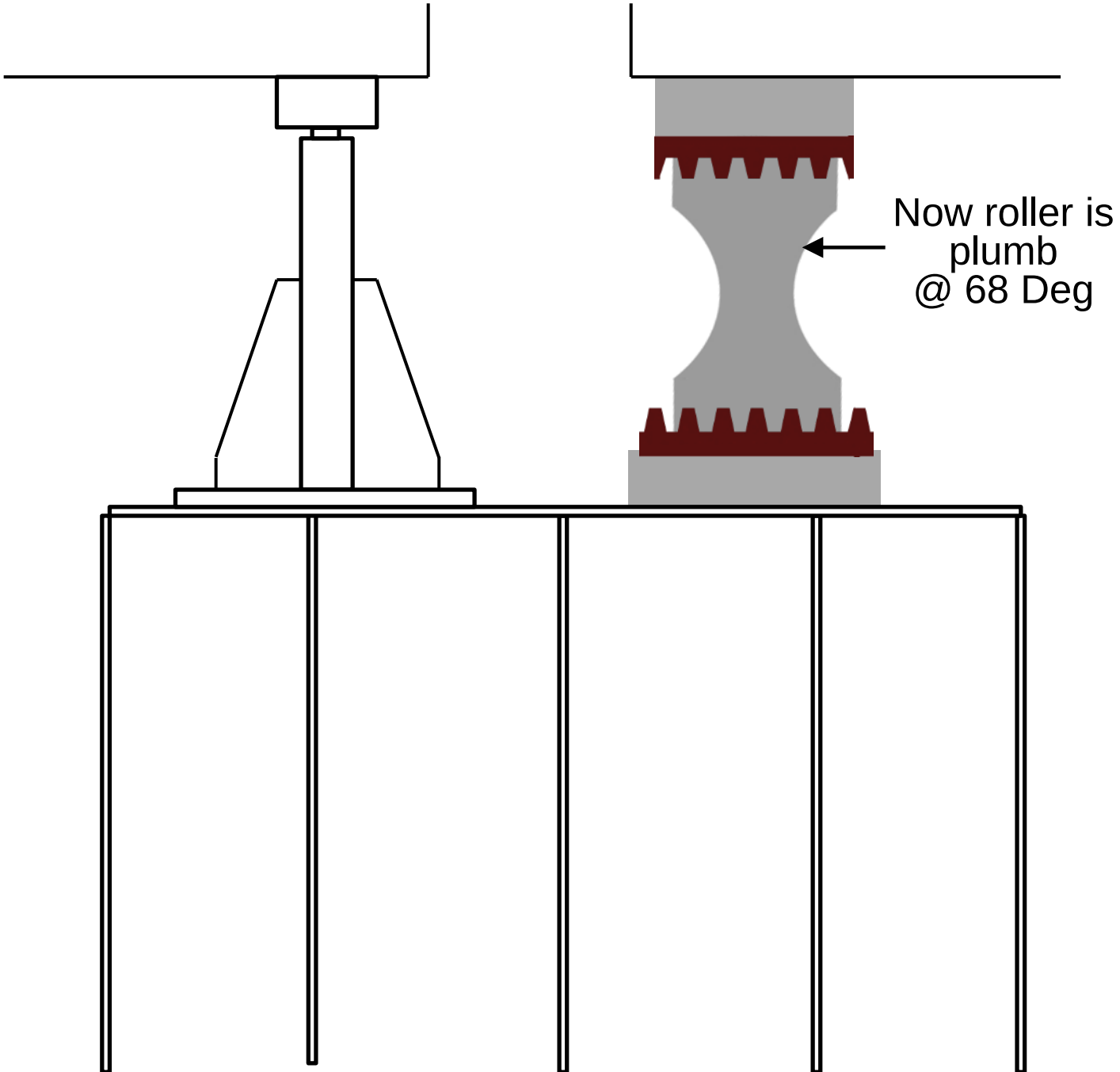
Step 8: Re-install roller jacking assembly



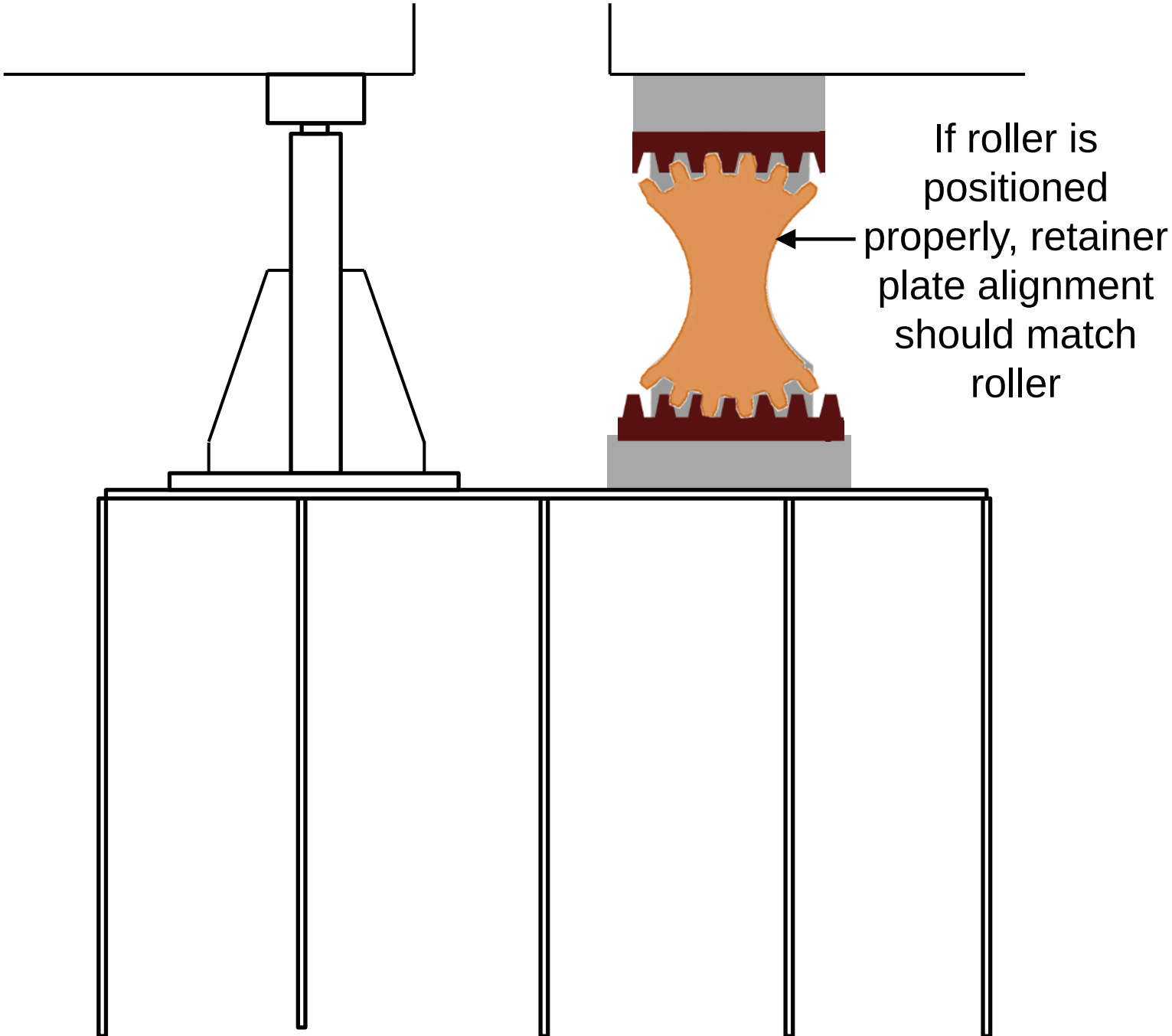
Step 9: Jack threadbars, pull top of rocker to final position



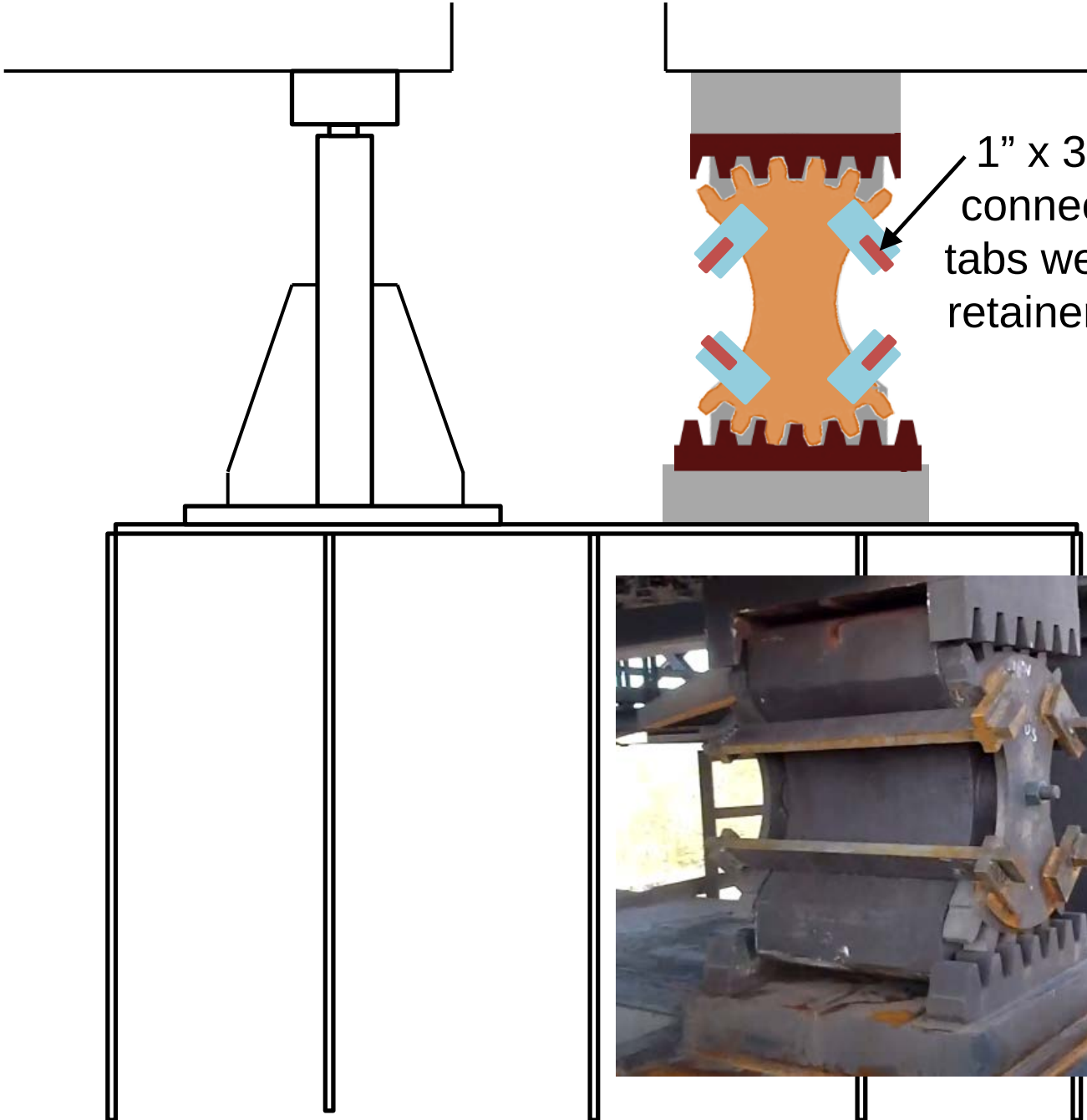
Step 10: Remove roller jacking assembly



Step 11: Reinstall retainer plates



Step 12: Install retaining bars to lock retainer plates and roller together



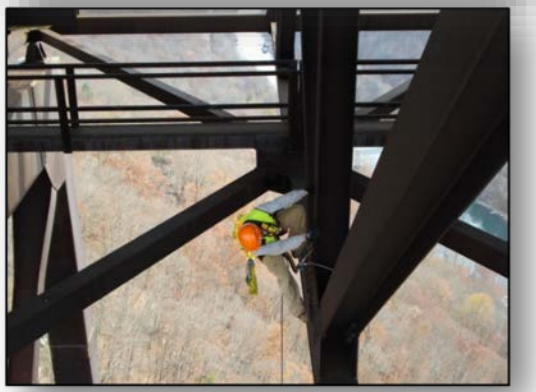
QA/QC Inspection - Punch List Reports

Photo 16
Typical area where sealer needs touched up at outside fillet weld channels and at bottom of vertical gusset plate inside spandrel bent bottom cell.

Photo 22
At bases of land bents, touch up the paint on the concrete surface around the steel bases as needed.

Todays Take Away's

- Significant, Unique Structure
- Technical Challenges
- Successful Partnership
- Practical Solutions
- Innovative Materials
- Protect the Public Investment



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Questions?

Chad Robinson, PE
Bridge Inspection Program Manager

Adrian Lusk, PE
D9 Bridge Engineer

David Whited
DOH Project Manager

Matt Lewellyn, PE
Matt.Lewellyn@burgessniple.com

Travis Butz, PE
Travis.Butz@burgessniple.com

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Engineers ■ Architects ■ Planners