

2018 National Bridge Preservation Partnership Conference

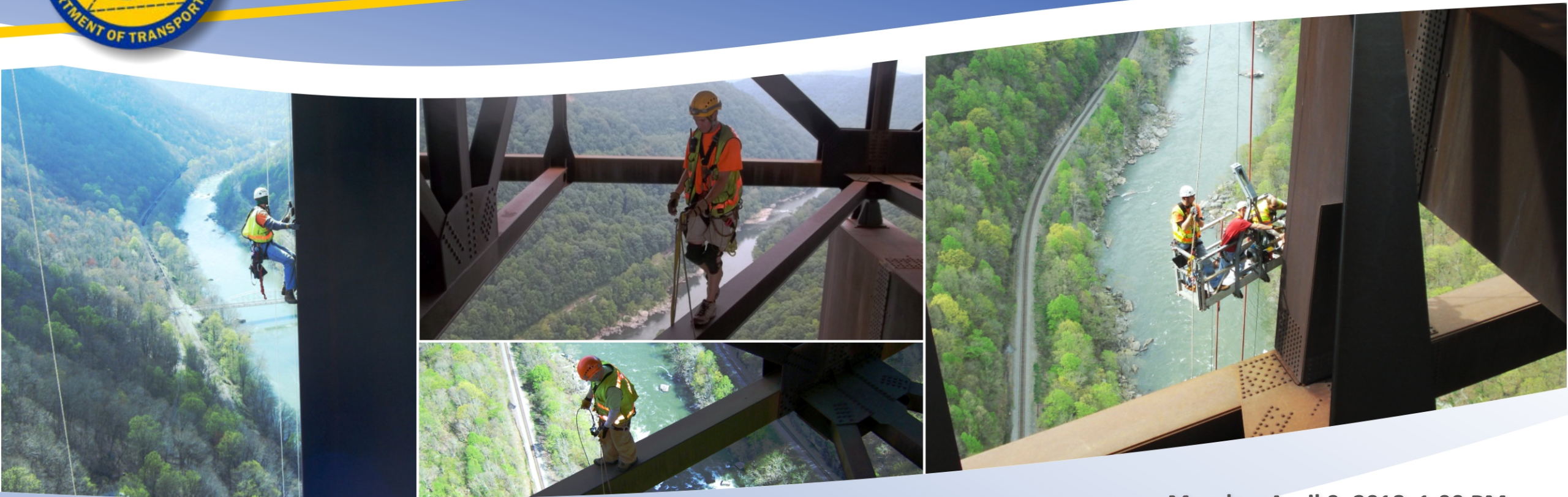
New River Gorge Bridge Rehabilitation

Billy Varney, PE, West Virginia DOT

Matt Lewellyn, PE, Burgess & Niple



BURGESS & NIPLE
Engineers ■ Architects ■ Planners



TSP 2 TRANSPORTATION SYSTEM PRESERVATION
TECHNICAL SERVICES PROGRAM
AASH|O BRIDGE PRESERVATION

Monday, April 9, 2018 1:00 PM

2nd Presentation ~25 minutes

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





NEW RIVER GORGE BRIDGE

height comparison



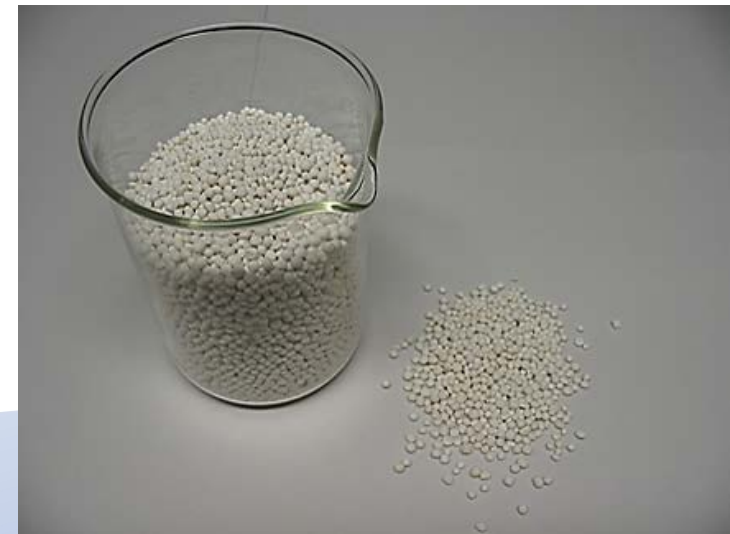
Willis Tower Chicago 1,730'	Empire State Building New York City 1,250'	Eiffel Tower Paris 1,063'	Washington Monument DC 555'	Statue of Liberty New York 305'	Space Needle Seattle 605'	Pyramid of Giza Egypt 456'	Gateway Arch St. Louis 630'
--	---	--	--	--	--	---	--

Si Du River Bridge (World's Highest Bridge) China 1,550' | Royal Gorge Bridge Colorado 1,053' | Hoover Dam Bypass Bridge Nevada/Arizona 900'

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

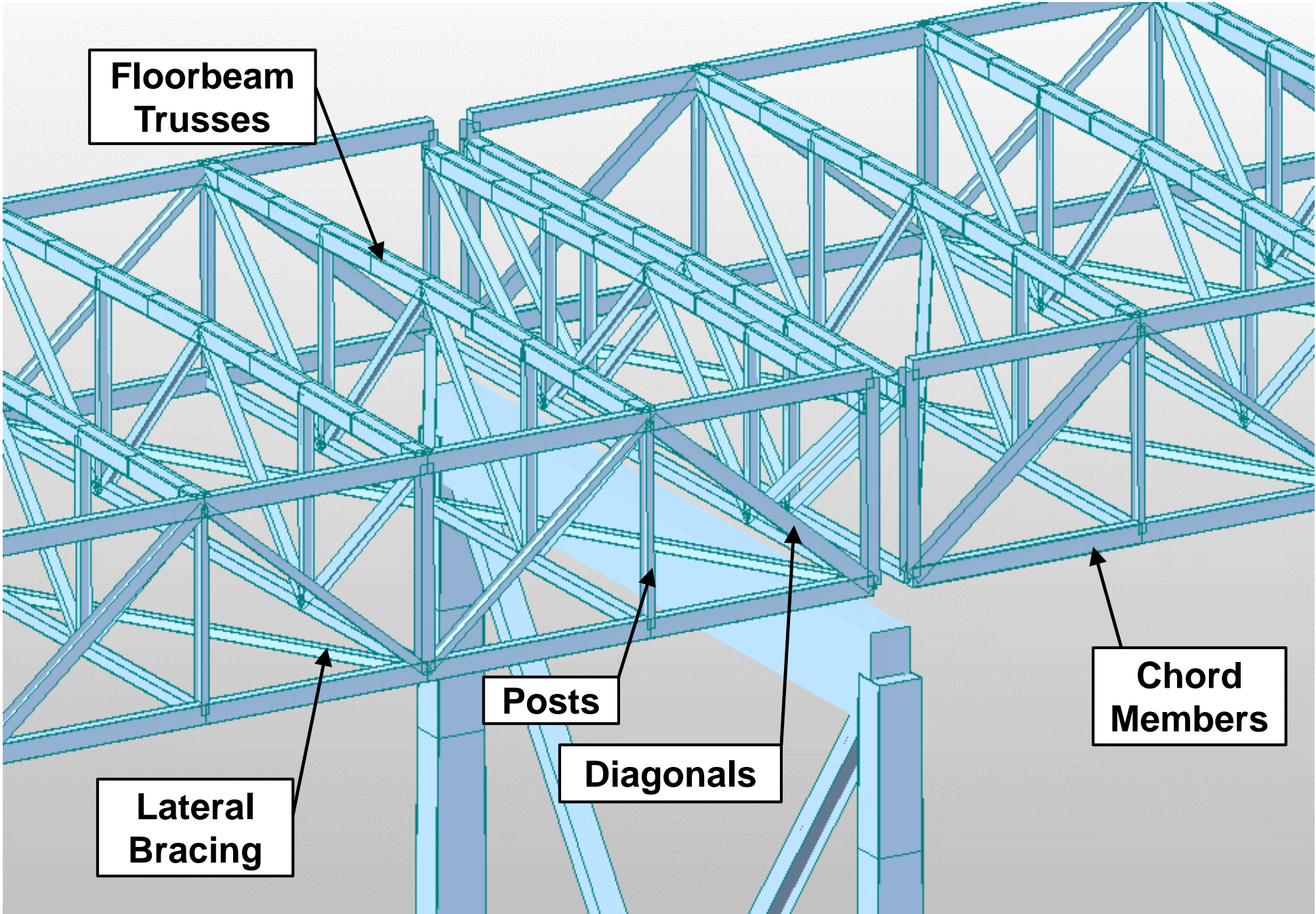


BURGESS & NIPLÉ
Engineers ■ Architects ■ Planners

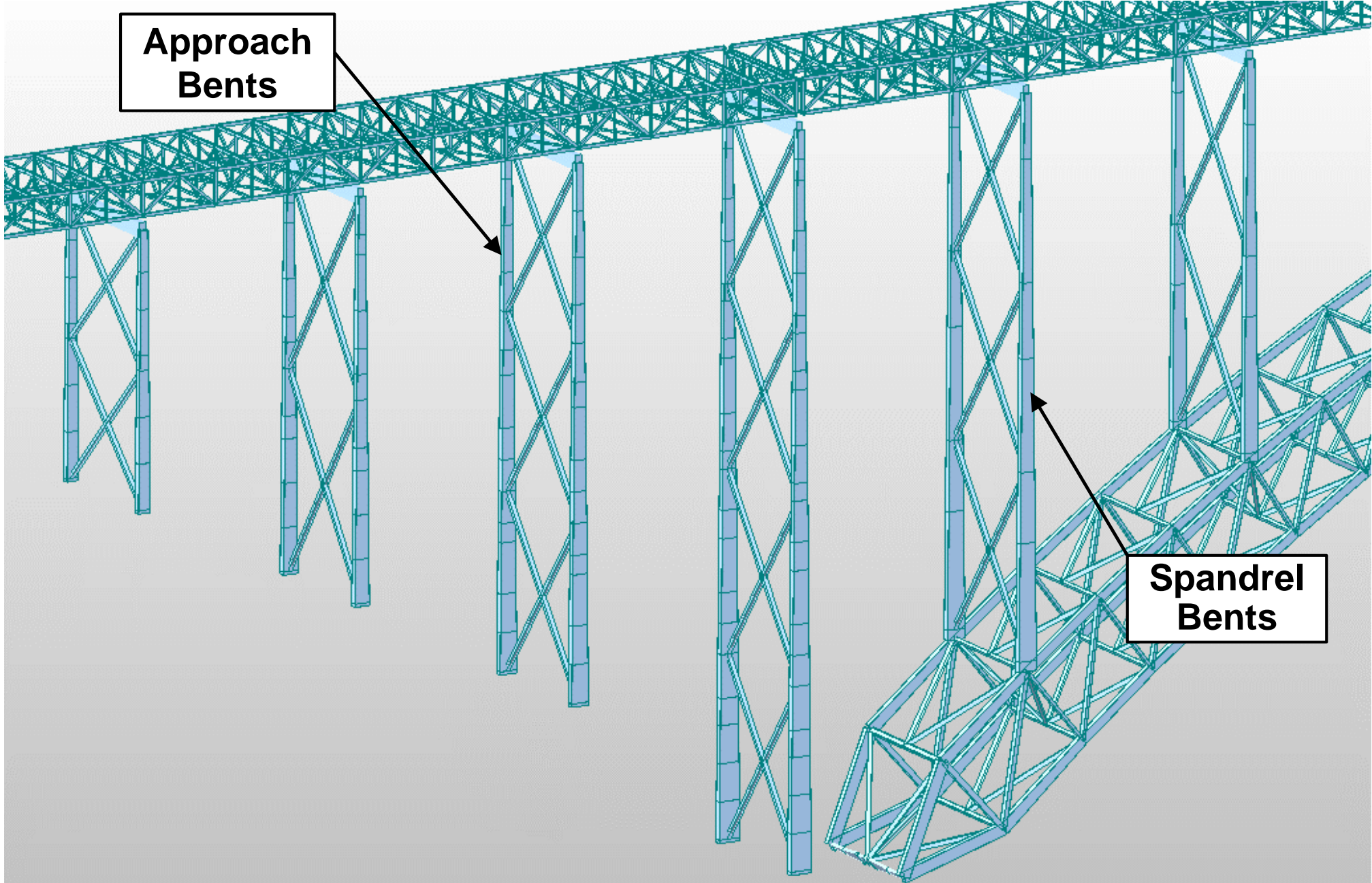


SGI
Specialty Groups Inc.

Bridge Configuration - Deck Truss



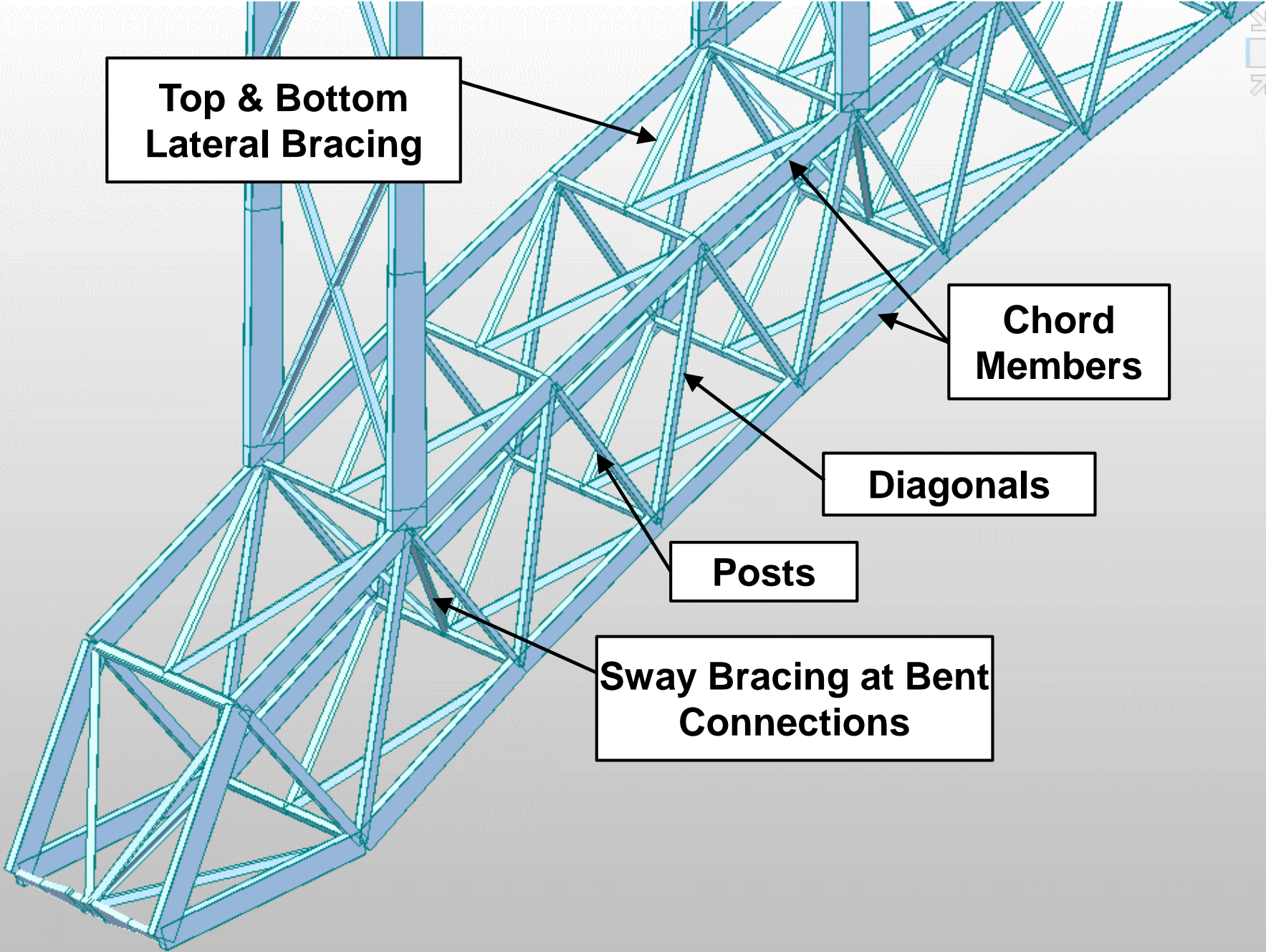
Bridge Configuration - Bents



**Approach
Bents**

**Spandrel
Bents**

Bridge Configuration - Arch Truss

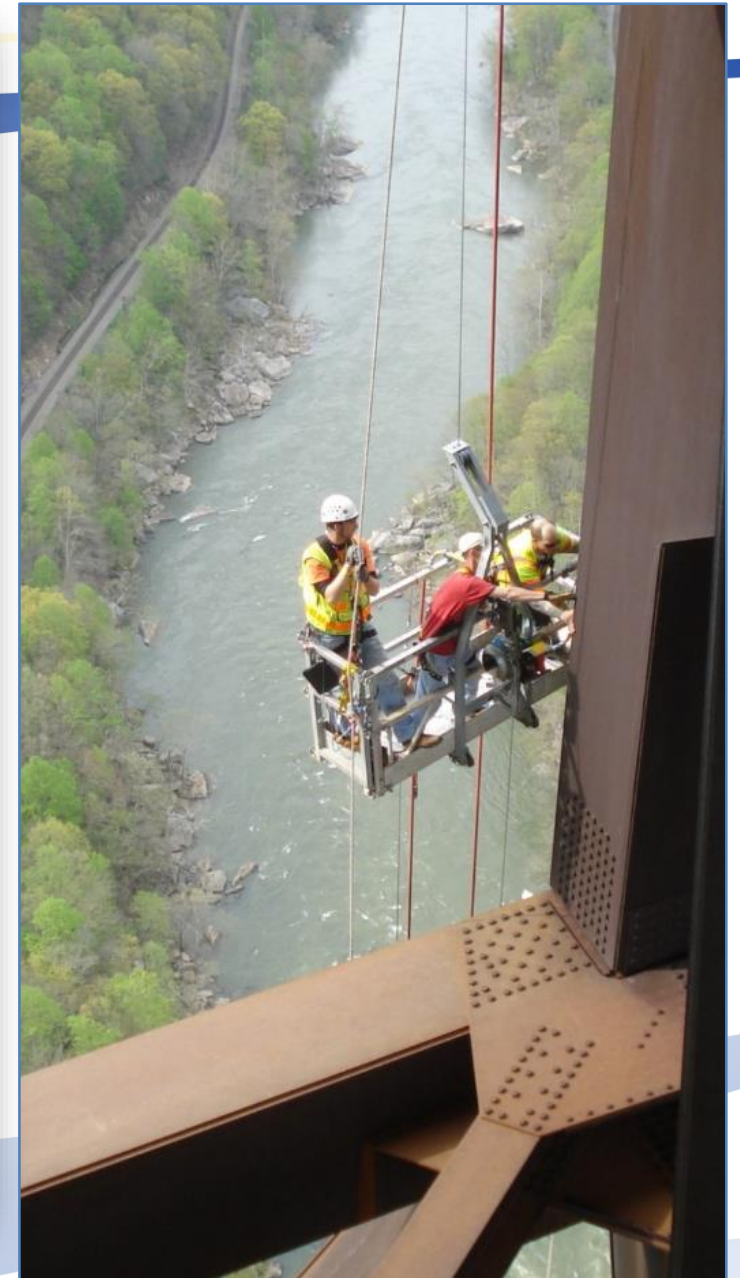
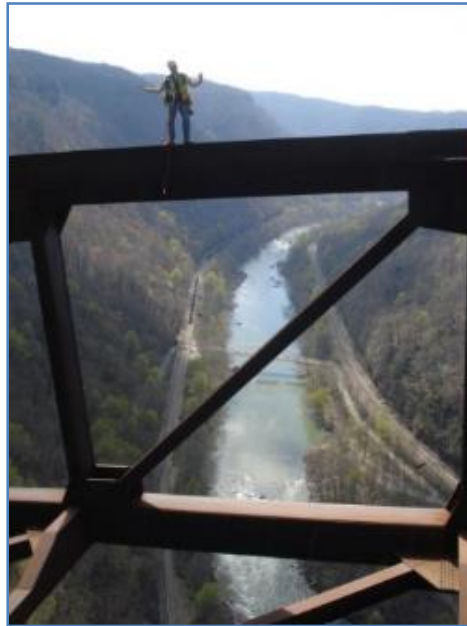


Bridge Inspection Access – Interview with B&N Inspectors



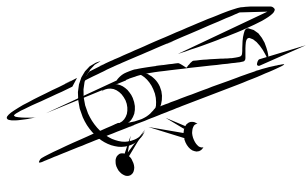
Arch Access

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

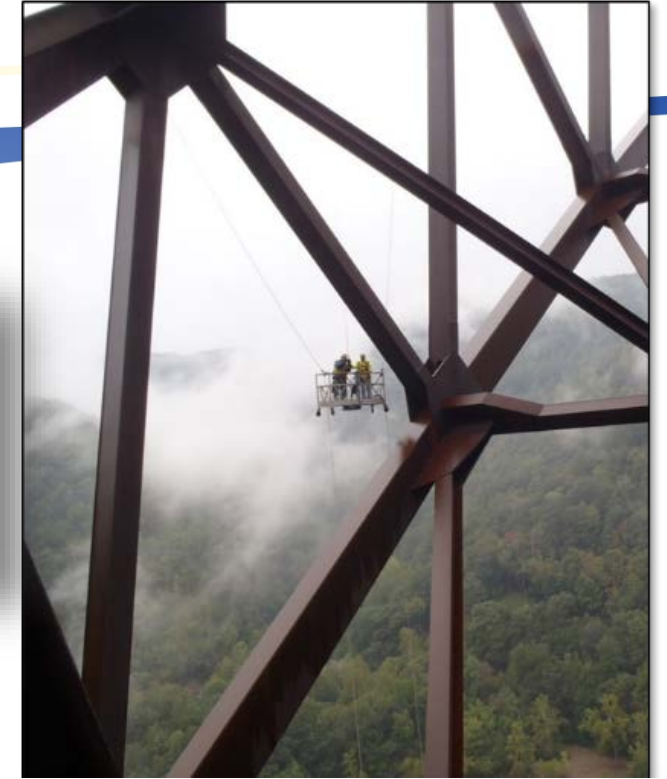


Unique Tidbits of Information

- Falcons
 - Nesting at Bent 13 lower lateral bracing



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



Understanding Long Term Issues – Deck Truss

- Weathering Steel
- Prolonged Wetting
- Poor Bolt Sealing



Pigeon Nesting

Nut Loss



Pack Rust



Section Loss



Deck Truss Preservation in 2012



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

How do we keep them out!?!

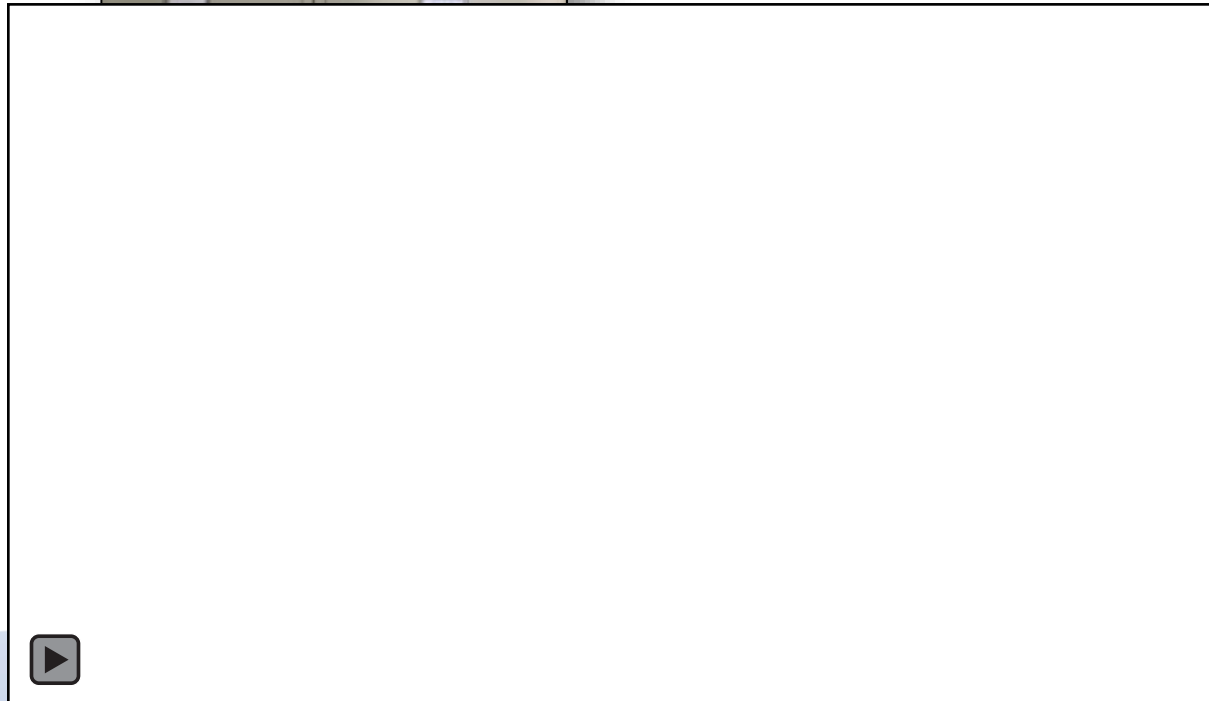
- WVDOT Needed a Reasonable Solution
- **Patented Magnetic Bird Screens**
 - Over 1200 Installed
 - Good Performance since 2008
 - Cost less than Metal Screens
 - Saves \$32,000 in cleaning costs
- Applying to More Bridges
- Additional Service to Owners



Easy to Remove for Inspection

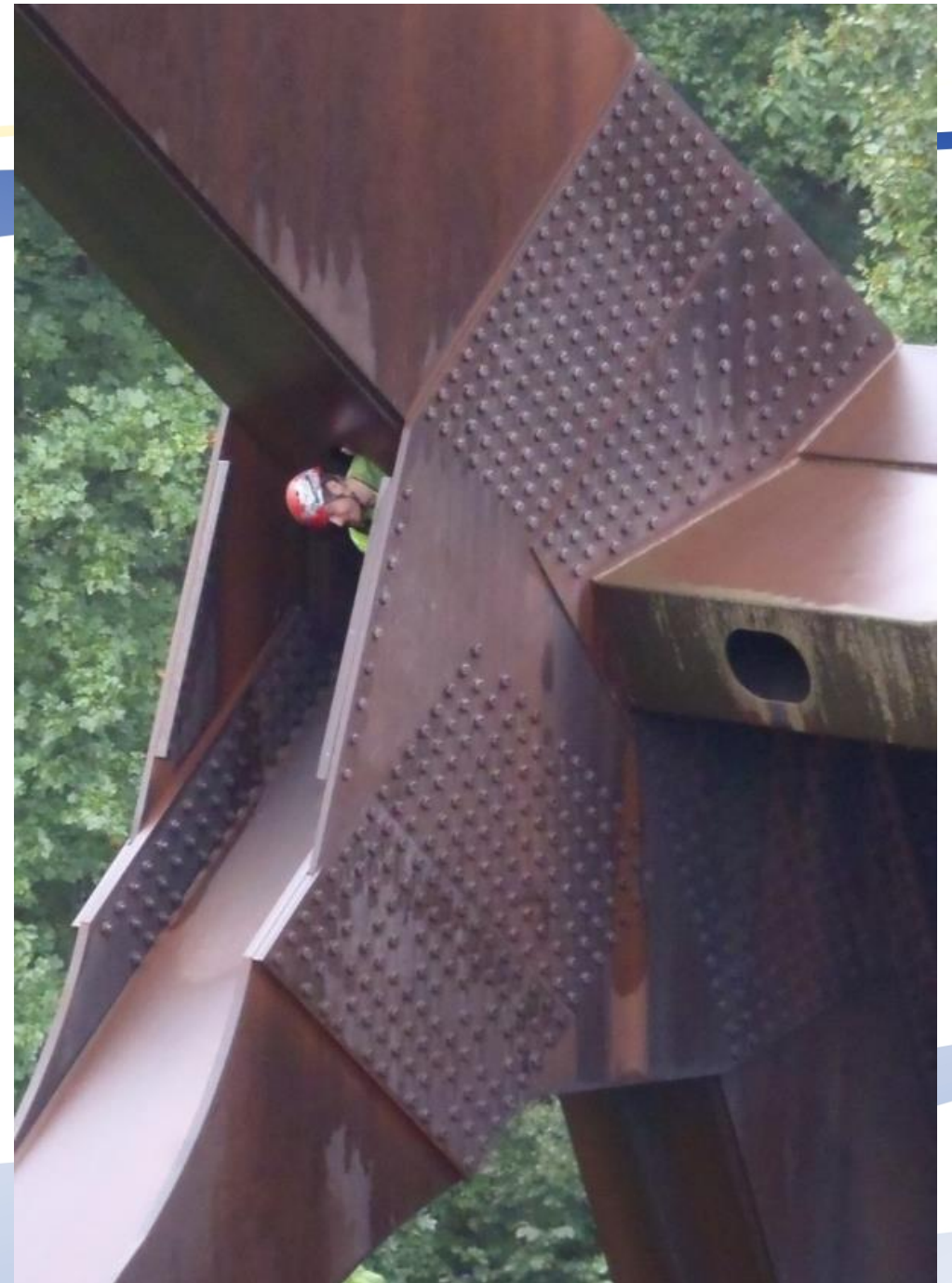
Complexity of Structural Analysis

- 3-D Finite Element MIDAS 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



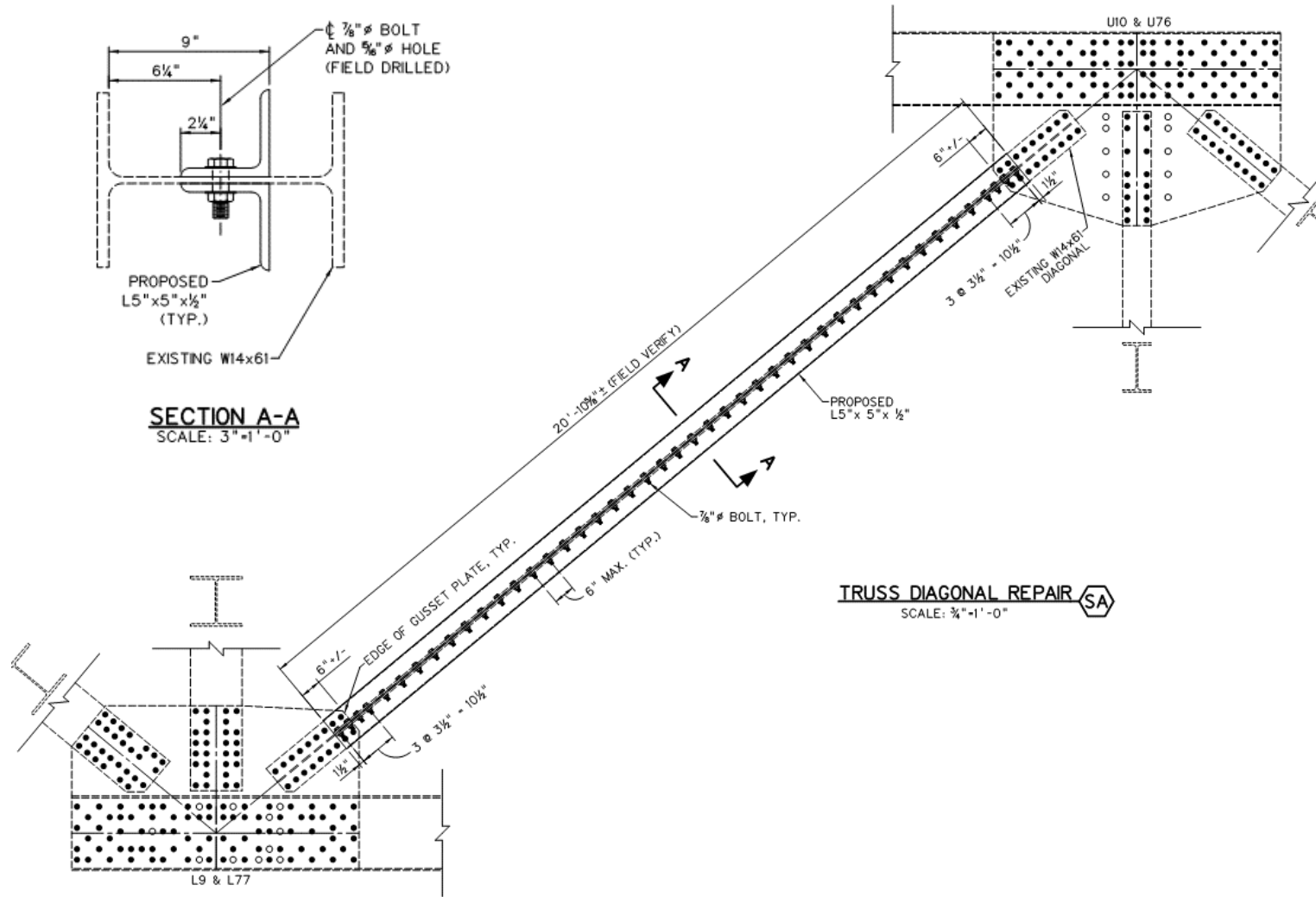
Gusset Plate Rating

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



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.



“Just-in-Time” Substructure Inspection

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

Green = Crack Seal
Orange = Patching



Finished Product

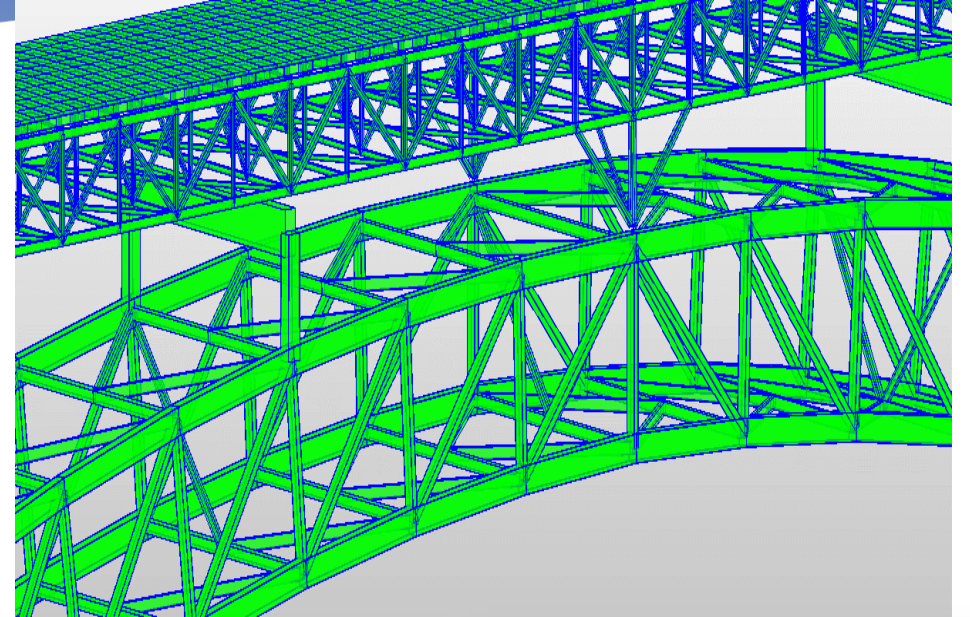


- Cracks – Two-part hybrid urethane mender
- Patches - Non-shrink, High Early Strength
- Protective Epoxy Coating



Primary Issue = Corrosion and Section Loss inside Boxes

- Loss in Bents and Arch
- Cleaning and Sealing
- Follow-up with Magnets
- Not Controlling the Load Rating



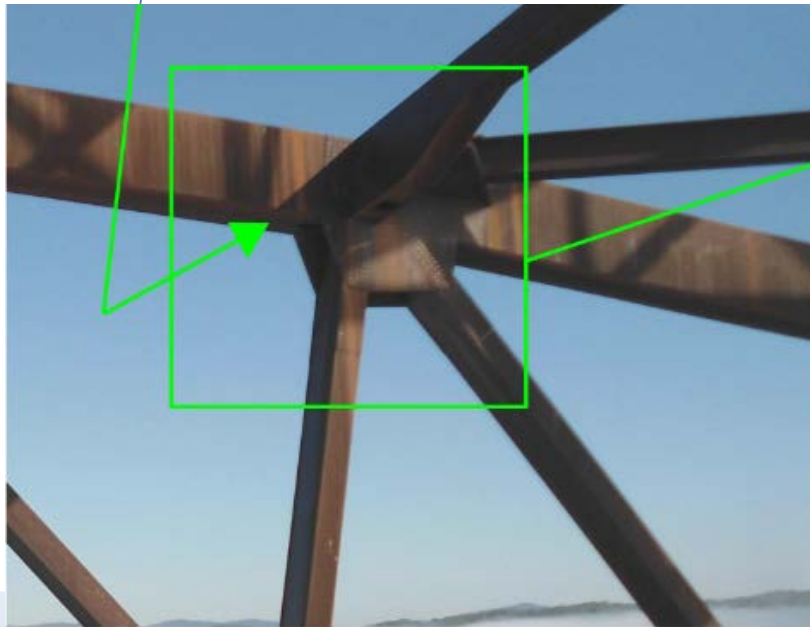
BENT BASE



ARCH DIAGONAL

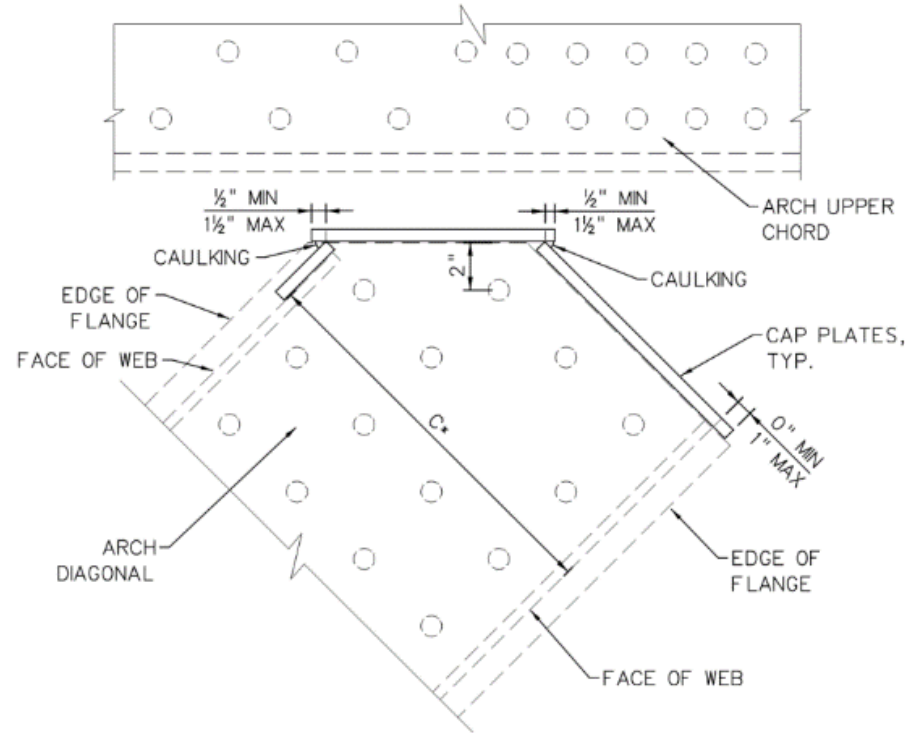
Solving Debris Issues in Arch Members

- **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

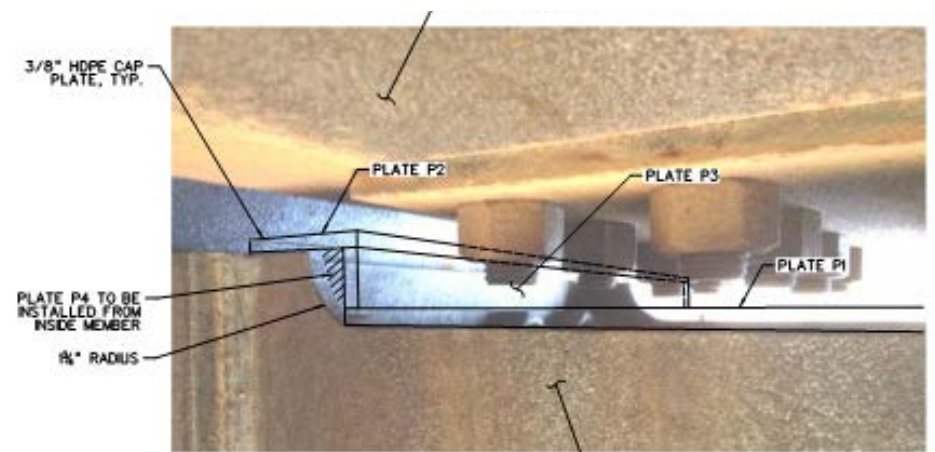


C* = 1'-4⁷/₈" FOR DIAGONALS EXCEPT AT THE FOLLOWING LOCATIONS:
 2'-1¹/₈" @ U2 & U38
 1'-9⁵/₈" @ U5, U8, U35, & U32
 1'-5⁵/₈" @ U11, U29, & U20
 1'-5" @ U14, U17, U26, & U23

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



ARCH POST
TYPICAL VIEW
 LOOKING DOWN AND NORTH



VIEW F-F
 ARCH POST

Solving Debris Issues in Arch Members

- Installed HDPE Cap Plates



Solving Debris Issues in Arch Members

- **Problem:** Members Not Draining, Weep Holes too High

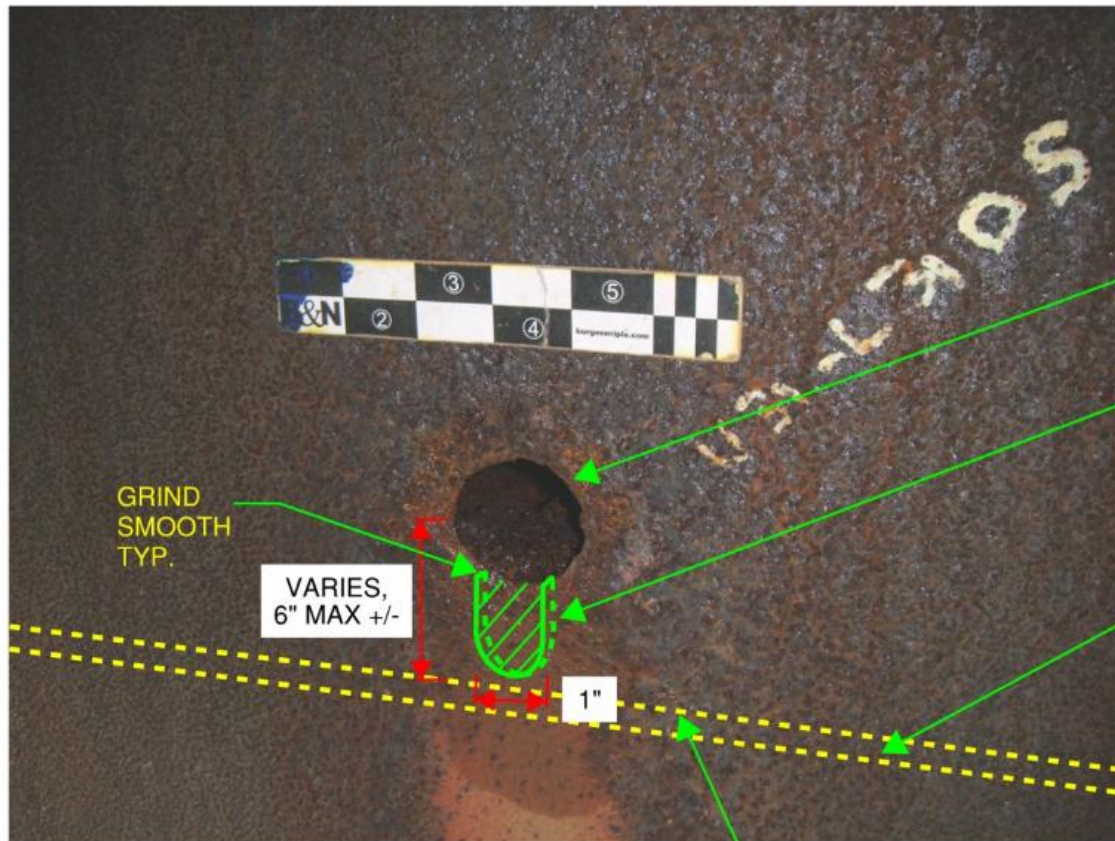


TYPICAL UPPER ARCH WEEPHOLE



Solving Debris Issues in Arch Members

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



DETAIL A

1 1/2" DIA. WEEP HOLE, TYP.

(WH)

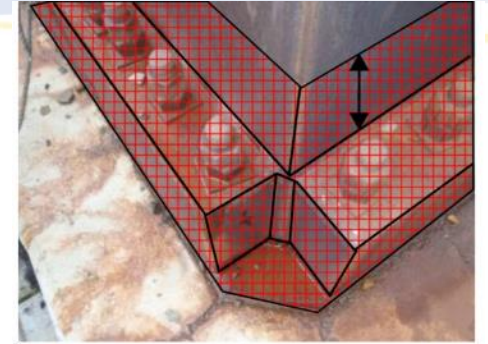
1/2" END DIAPHRAGM PLATE, TYP.

DO NOT CUT INTO TOE OF
END DIAPHRAGM WELD



“Daniel-san! Show me Wax On... Wax Off...”

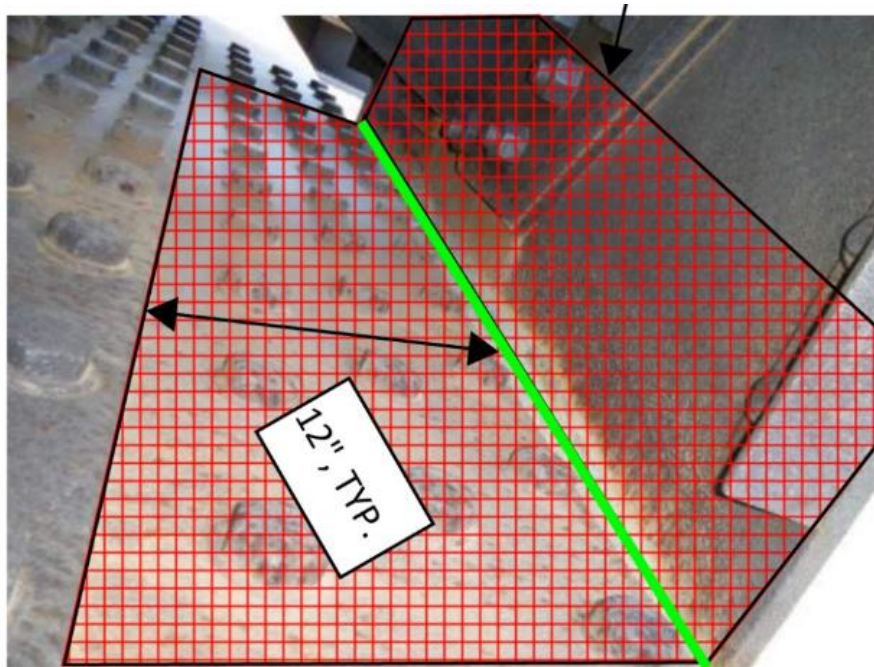
- Pressure Wash or Power Tool
- Penetrant Sealer – let it penetrate 15 mins.
- Wax Coating – sets up like a candle wax
 - Two on WVD0H Approved Products list



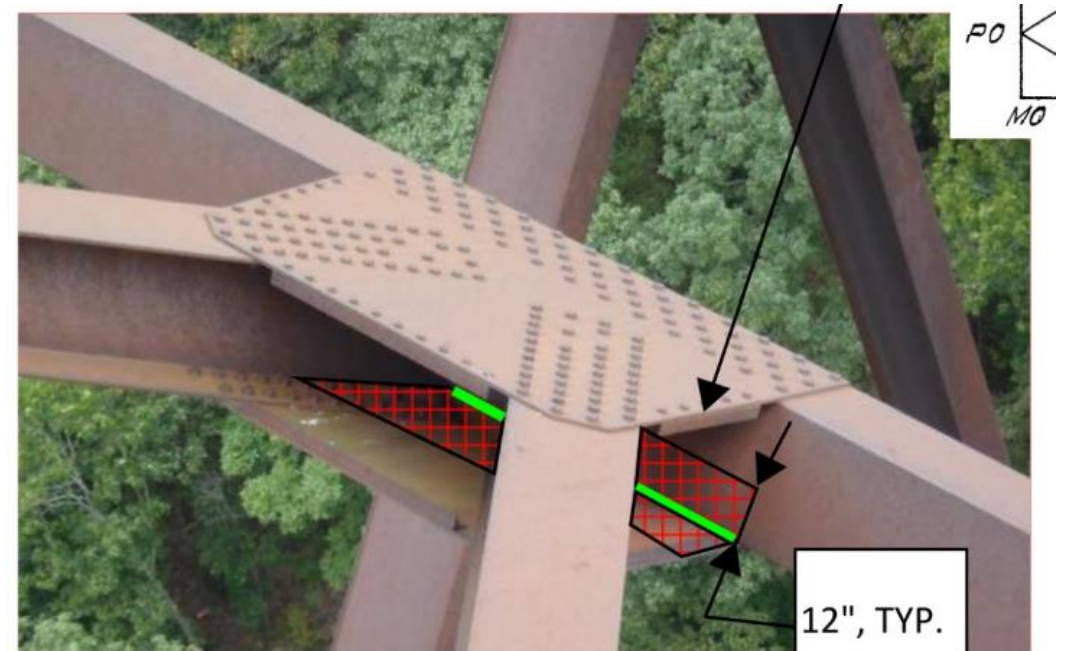
EXTERIOR VIEW

MAX-WAX

CHEMICAR^{USA} TEKTON 34

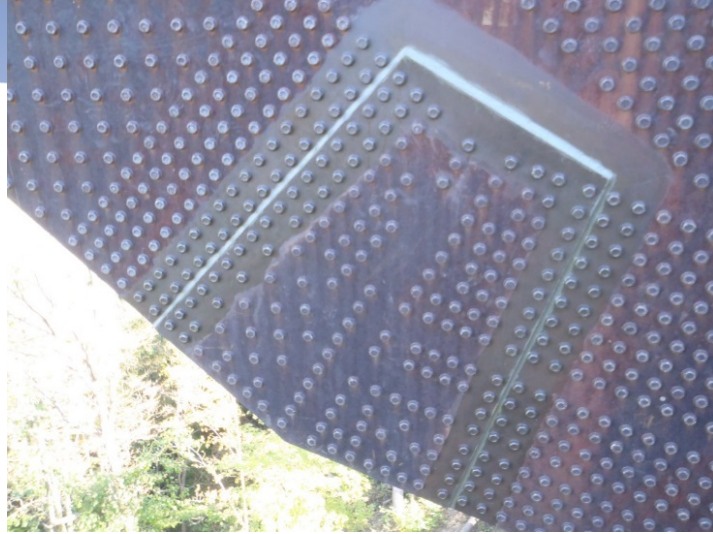


TYPICAL W & P CONNECTION WITH VERTICAL GUSSET



TYPICAL W CONNECTION

Looking GOOD!



Looking GOOD!



Contractor's Access – Not What We Expected



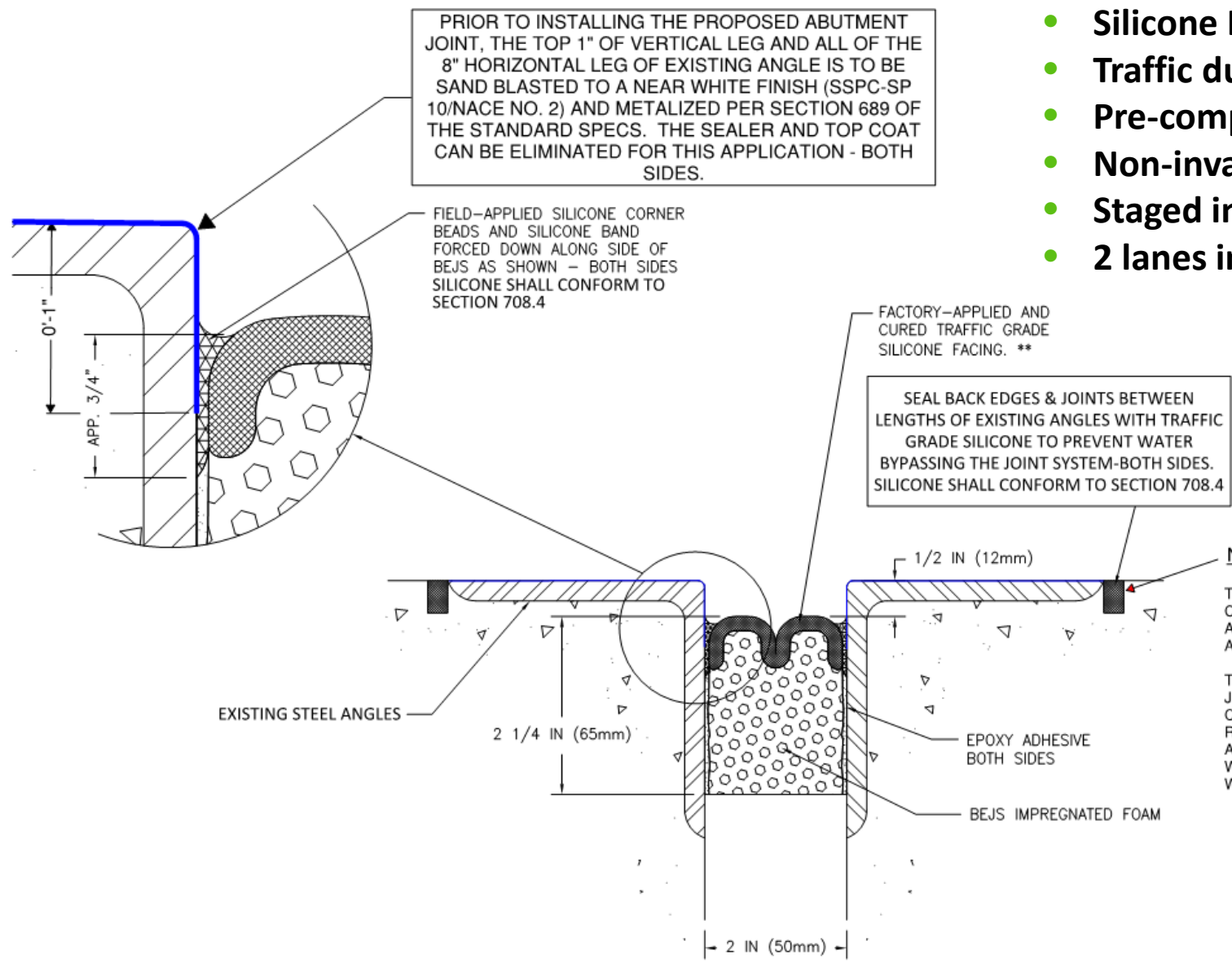
- Spiders
- Anchored to:
 - Catwalk or
 - Rolling Frames on Deck
- Challenging for Inspectors
- B&N Onsite



No More Leaky Joints! --- Expanding Polyurethane Foam Joints

Features

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



Deck Repairs....As Simple as 1, 2, 3.....

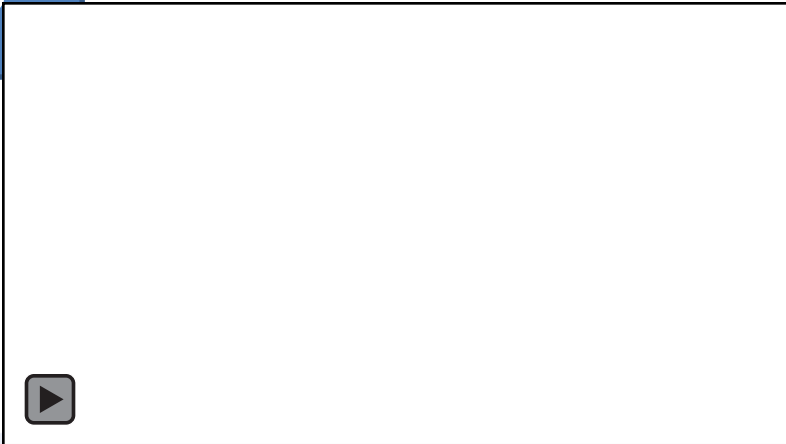
1



2



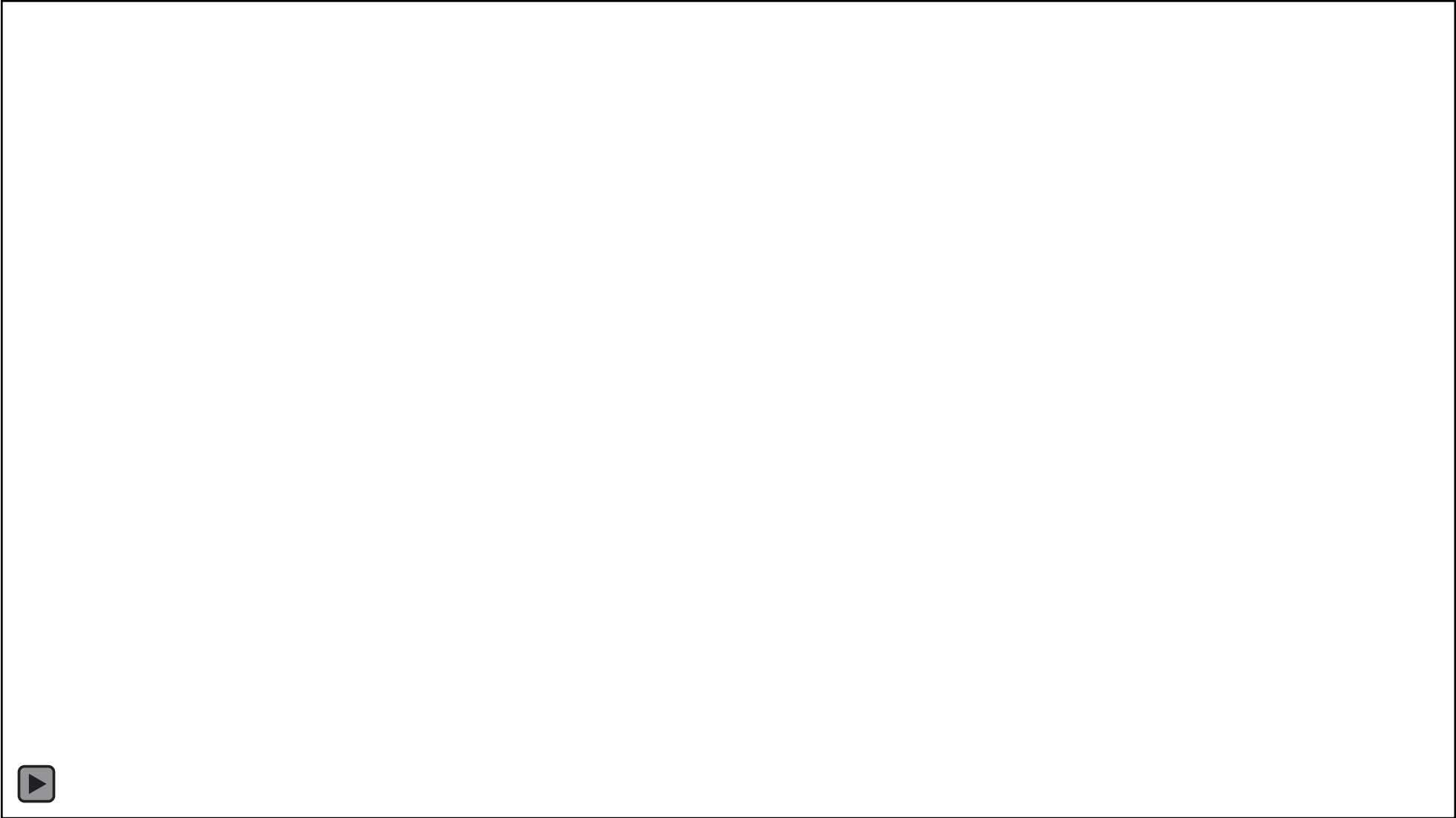
3



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.

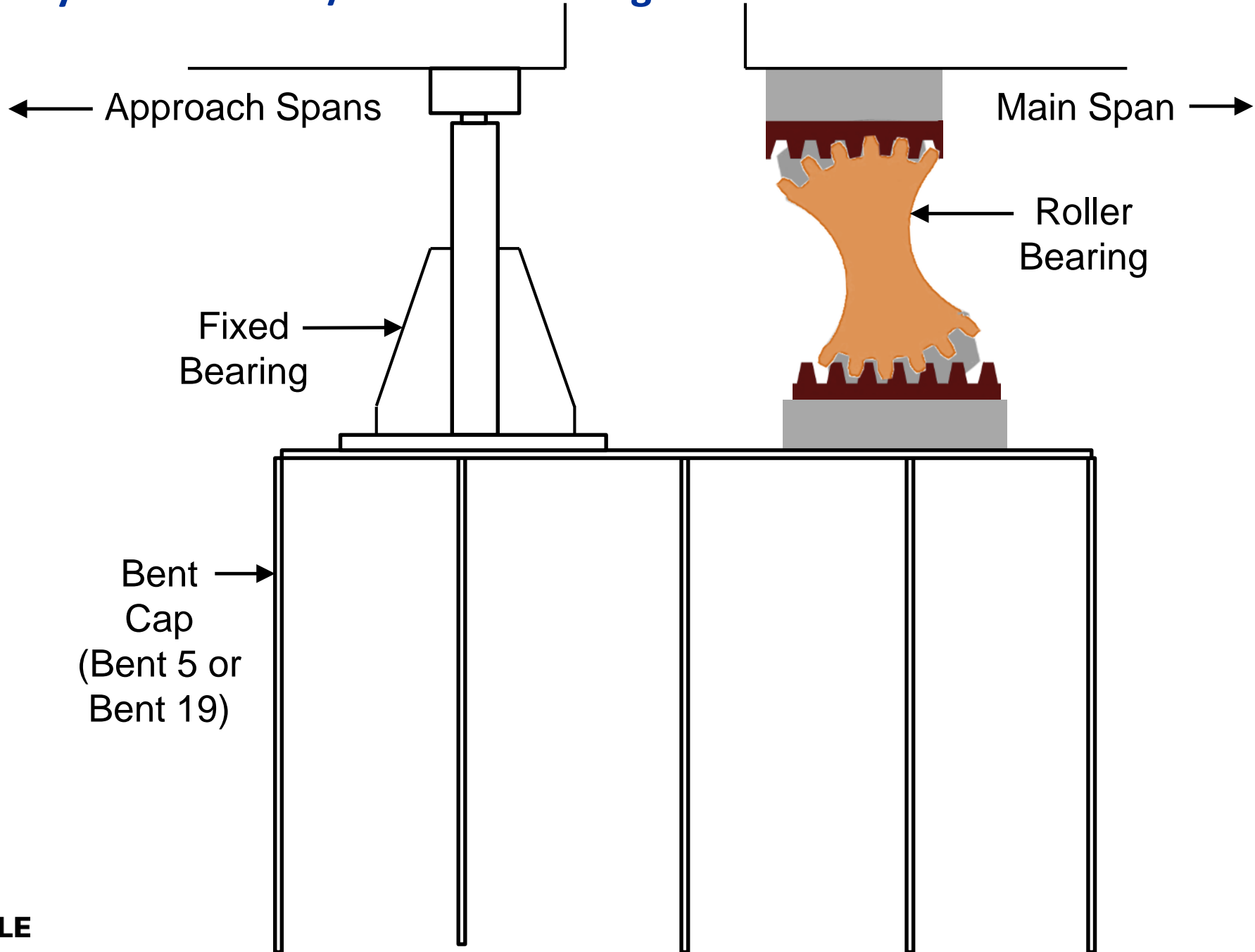


Vertical Jacking vs. Sliding

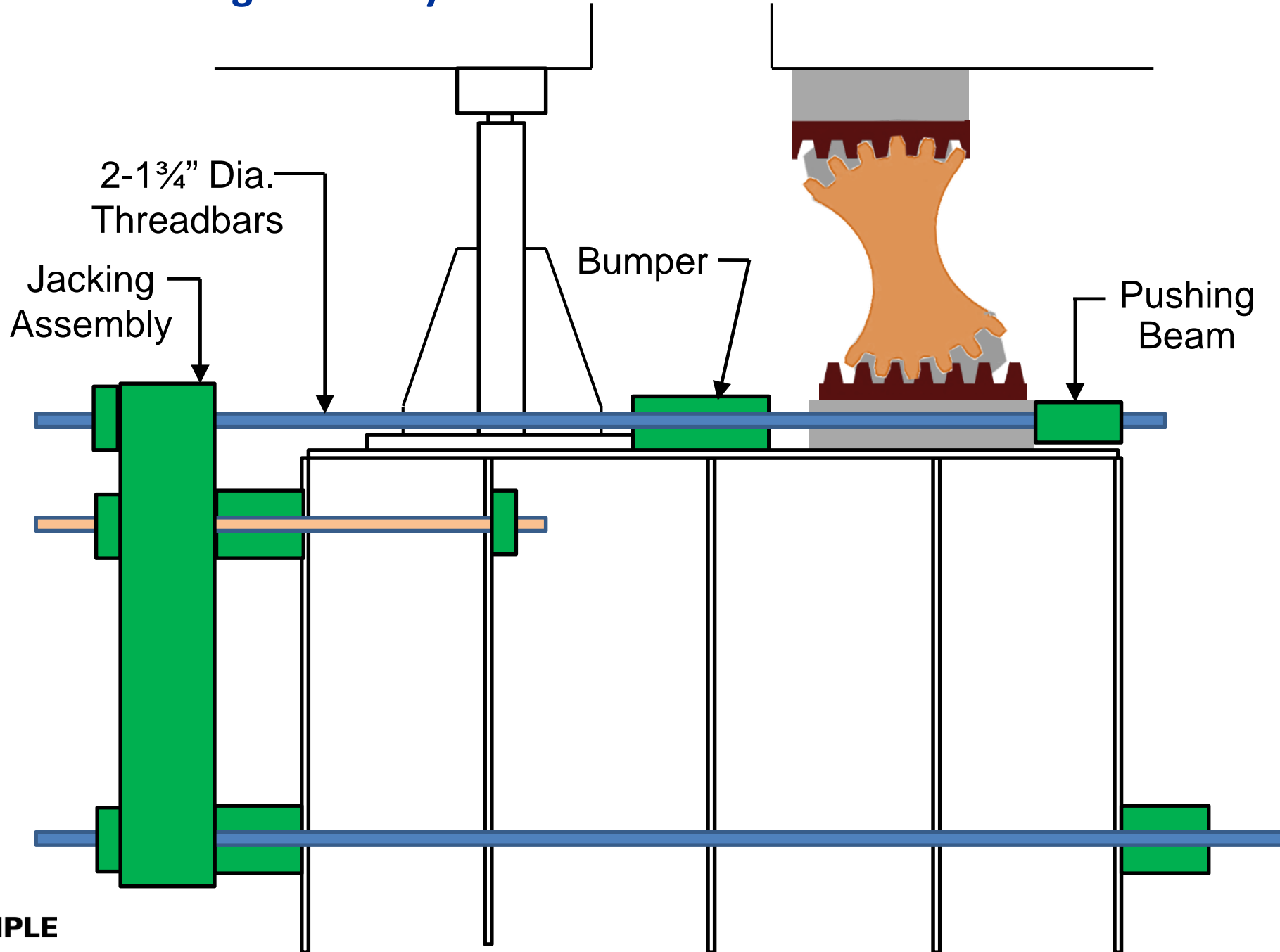
- Vertical jacking would be very difficult due to height of the bent and the steel pier cap.



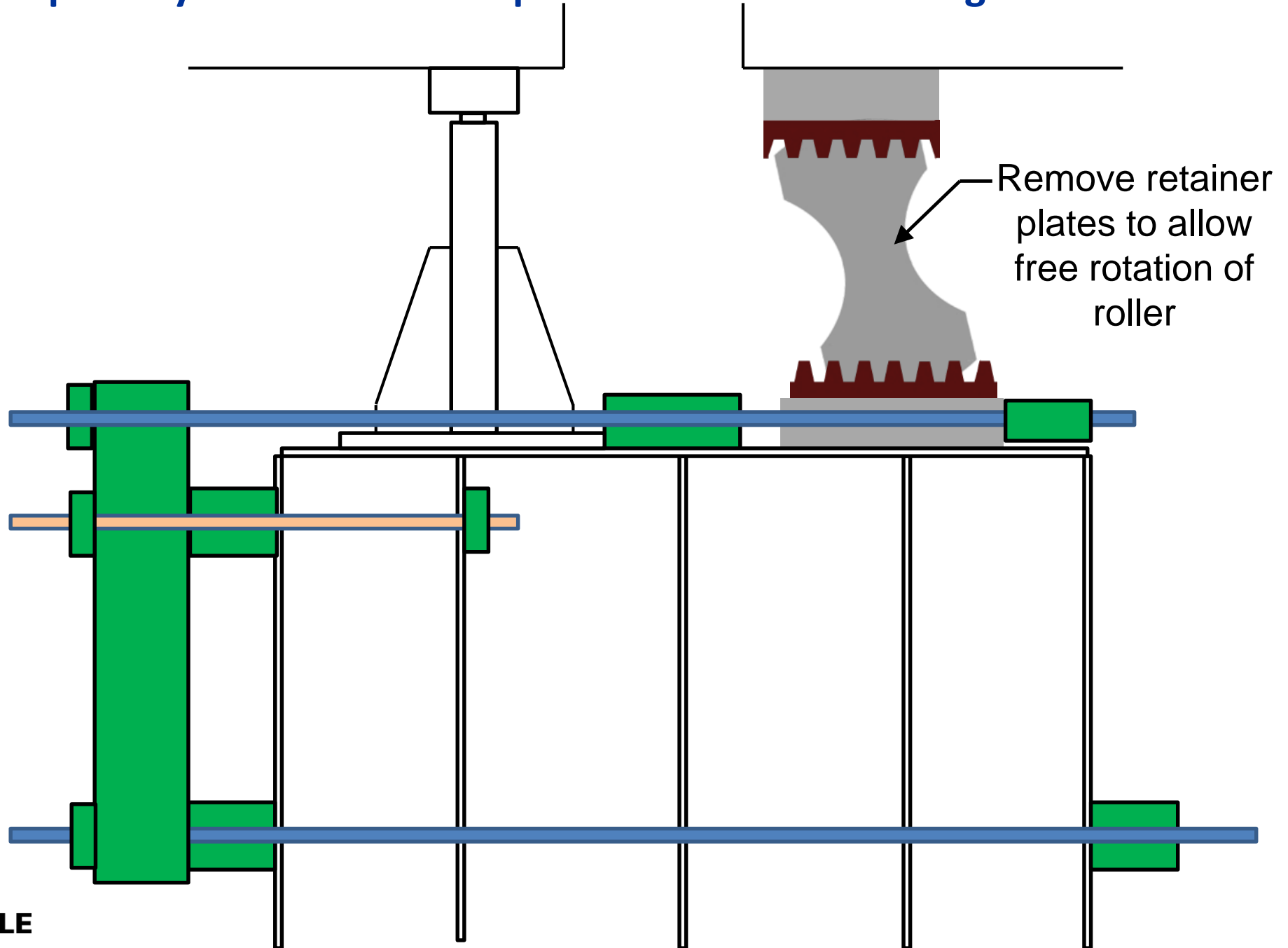
Schematic layout of Bent 5 / Bent 19 bearings:



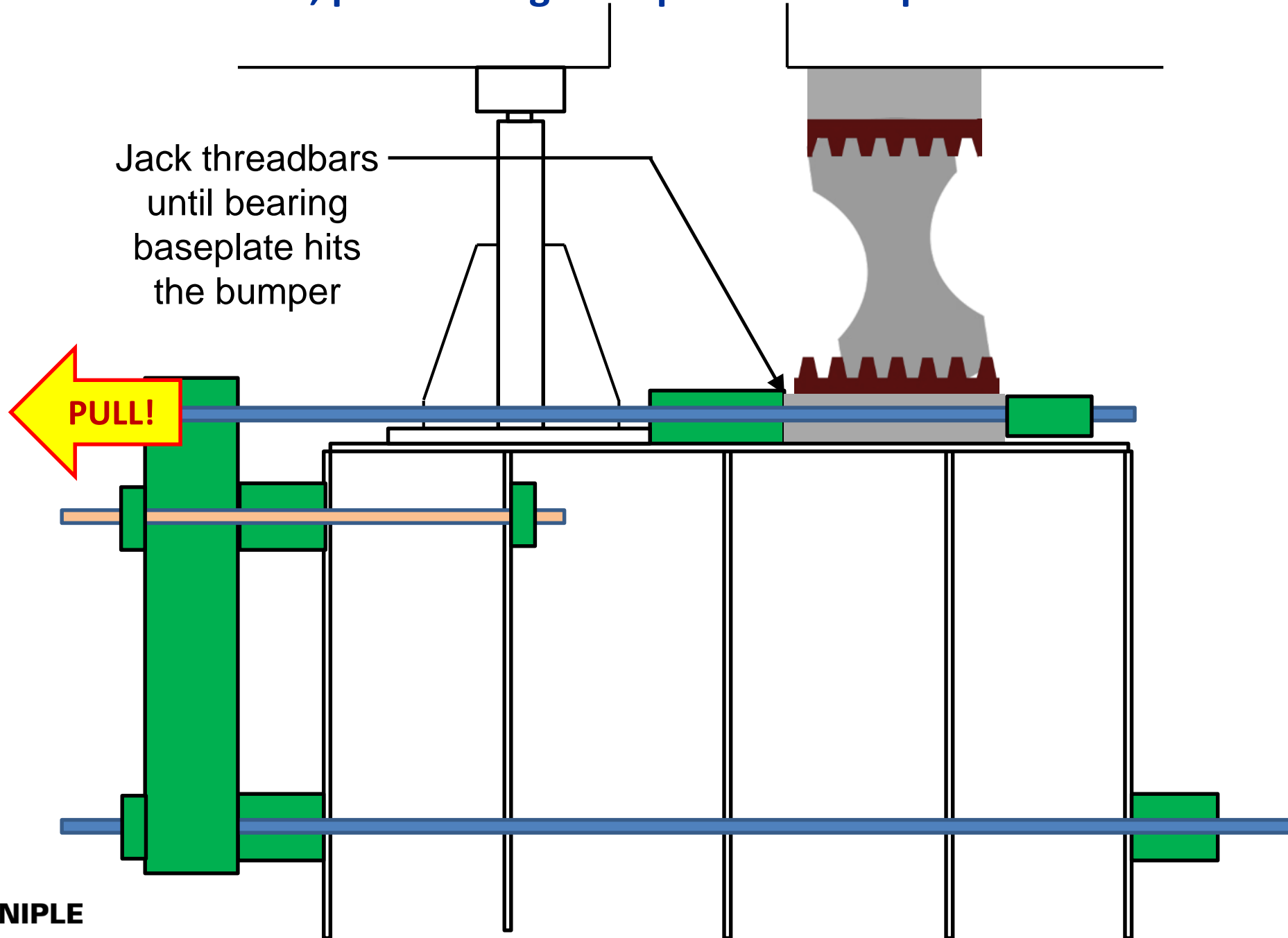
Step 1: Install Jacking Assembly & Threadbars



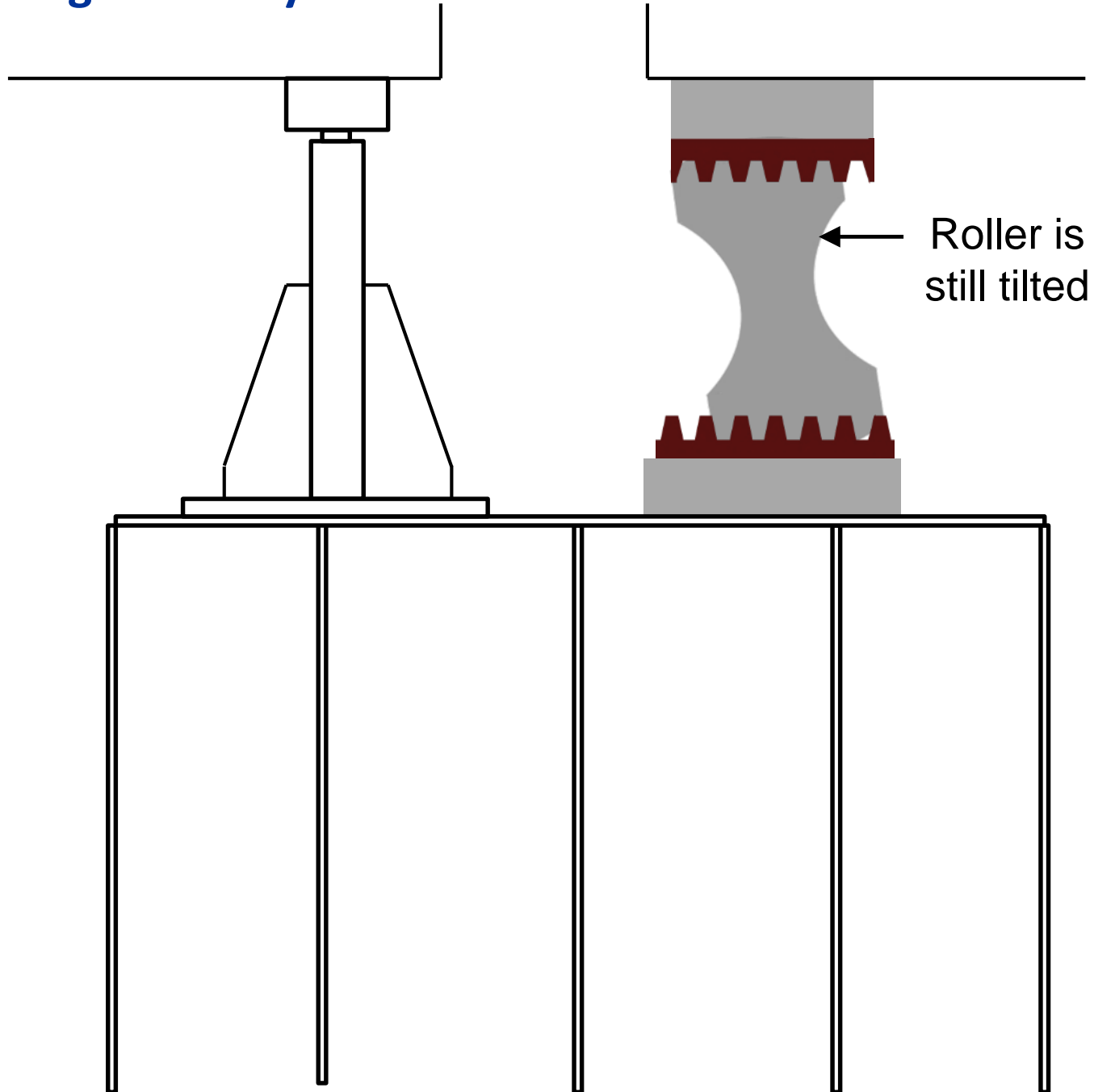
Step 2: Temporarily remove retainer plates from roller bearing



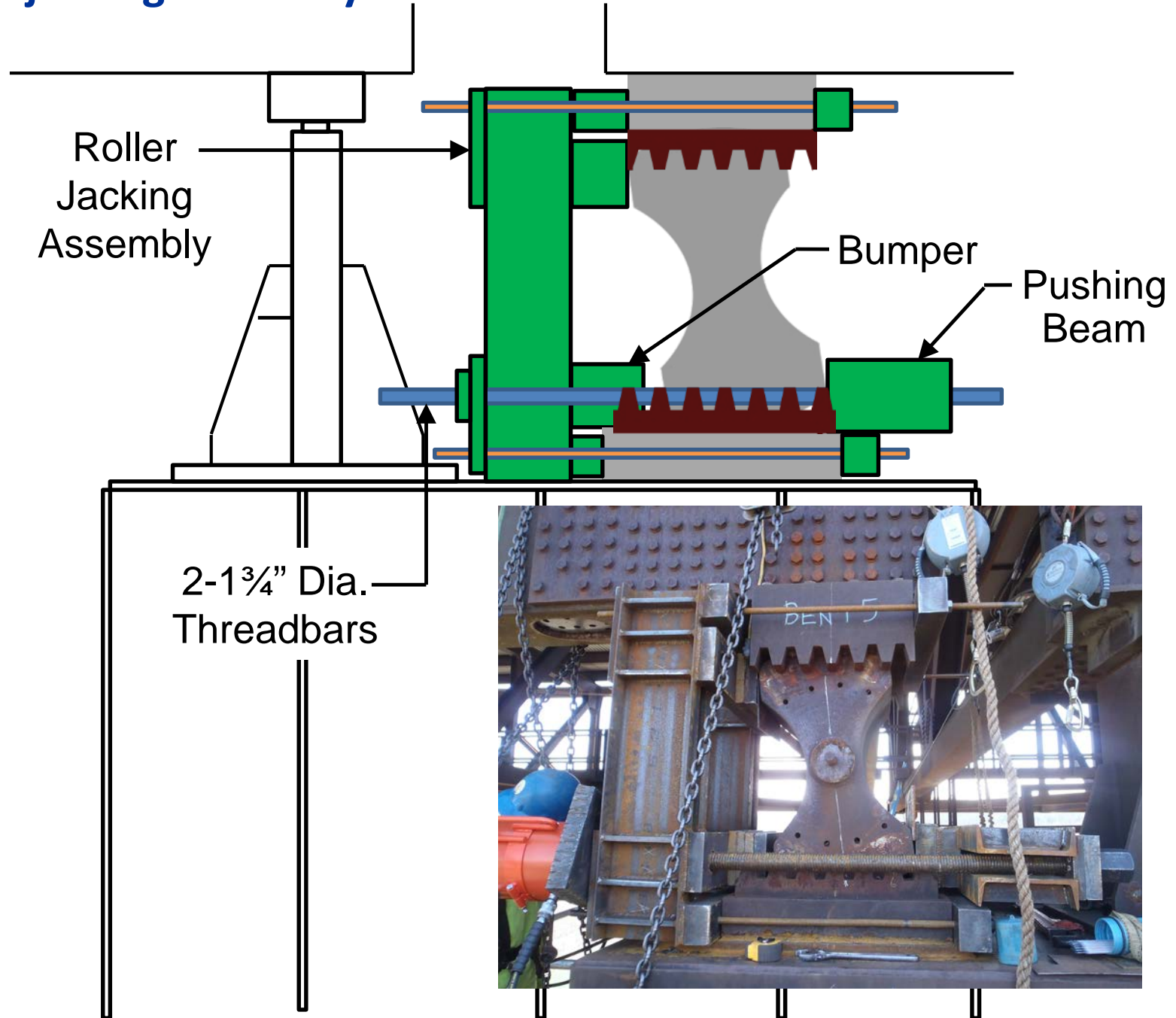
Step 3: Jack threadbars, pull bearing base plate to final position



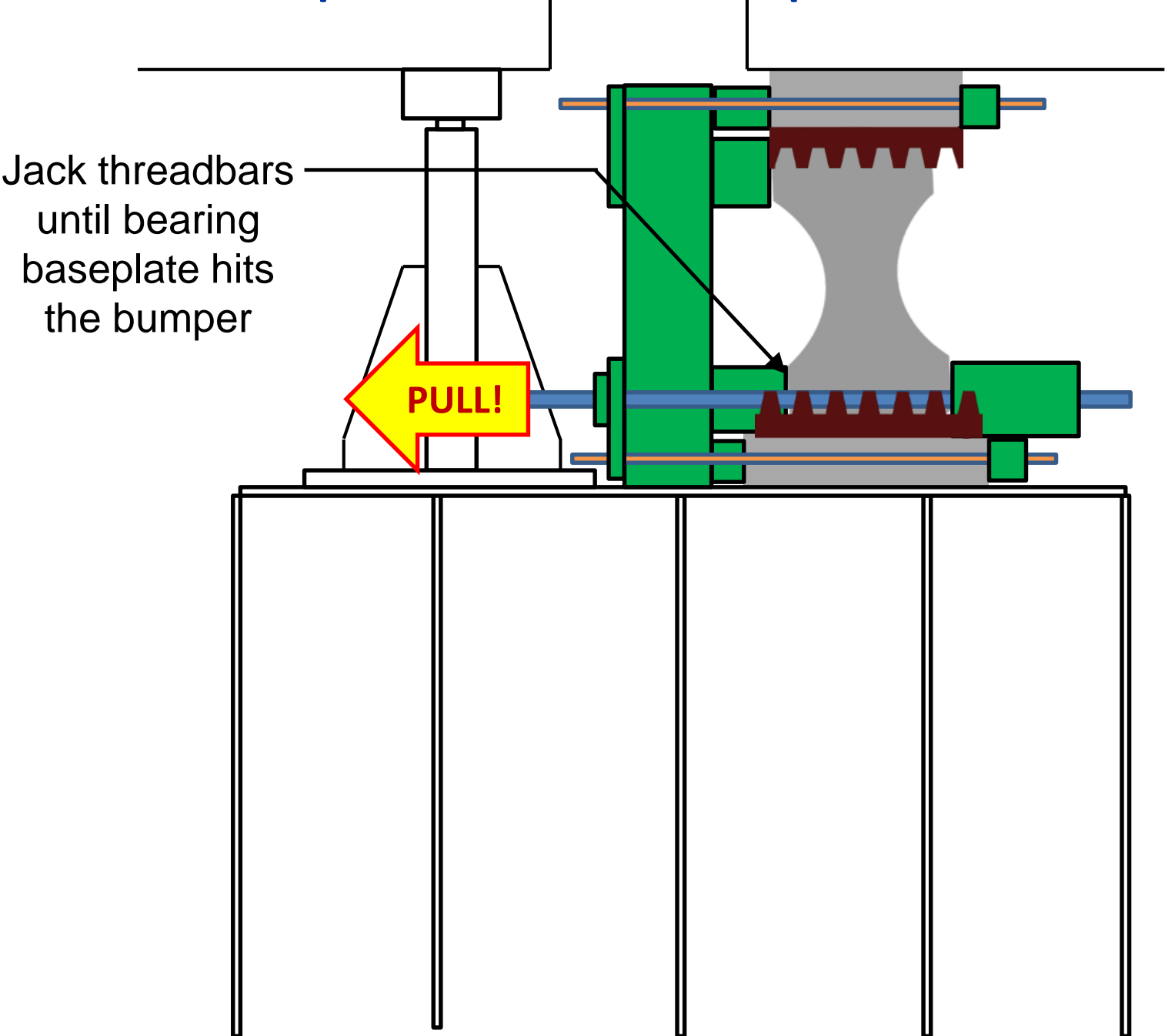
Step 4: Remove jacking assembly



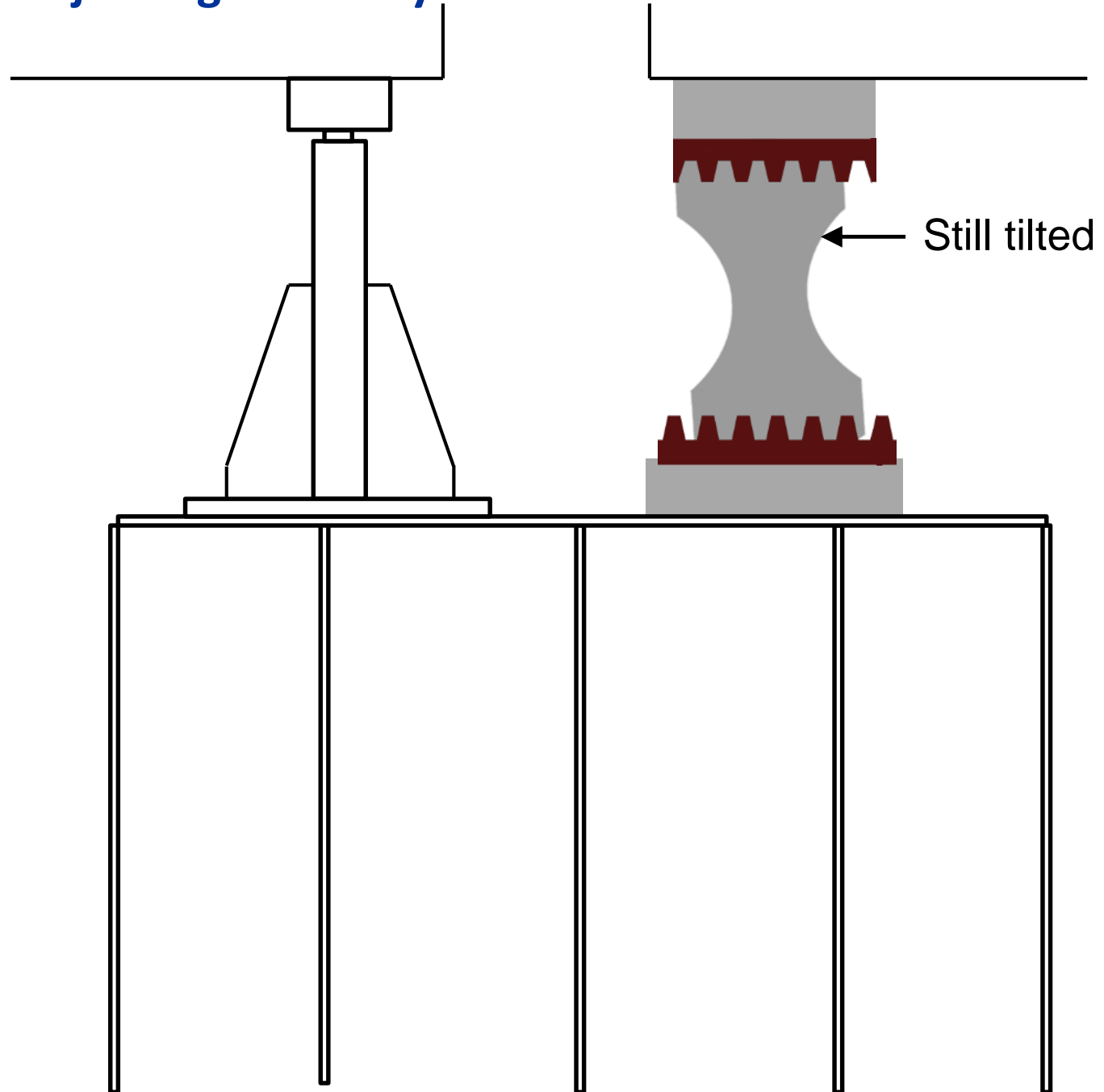
Step 5: Install roller jacking assembly and threadbars



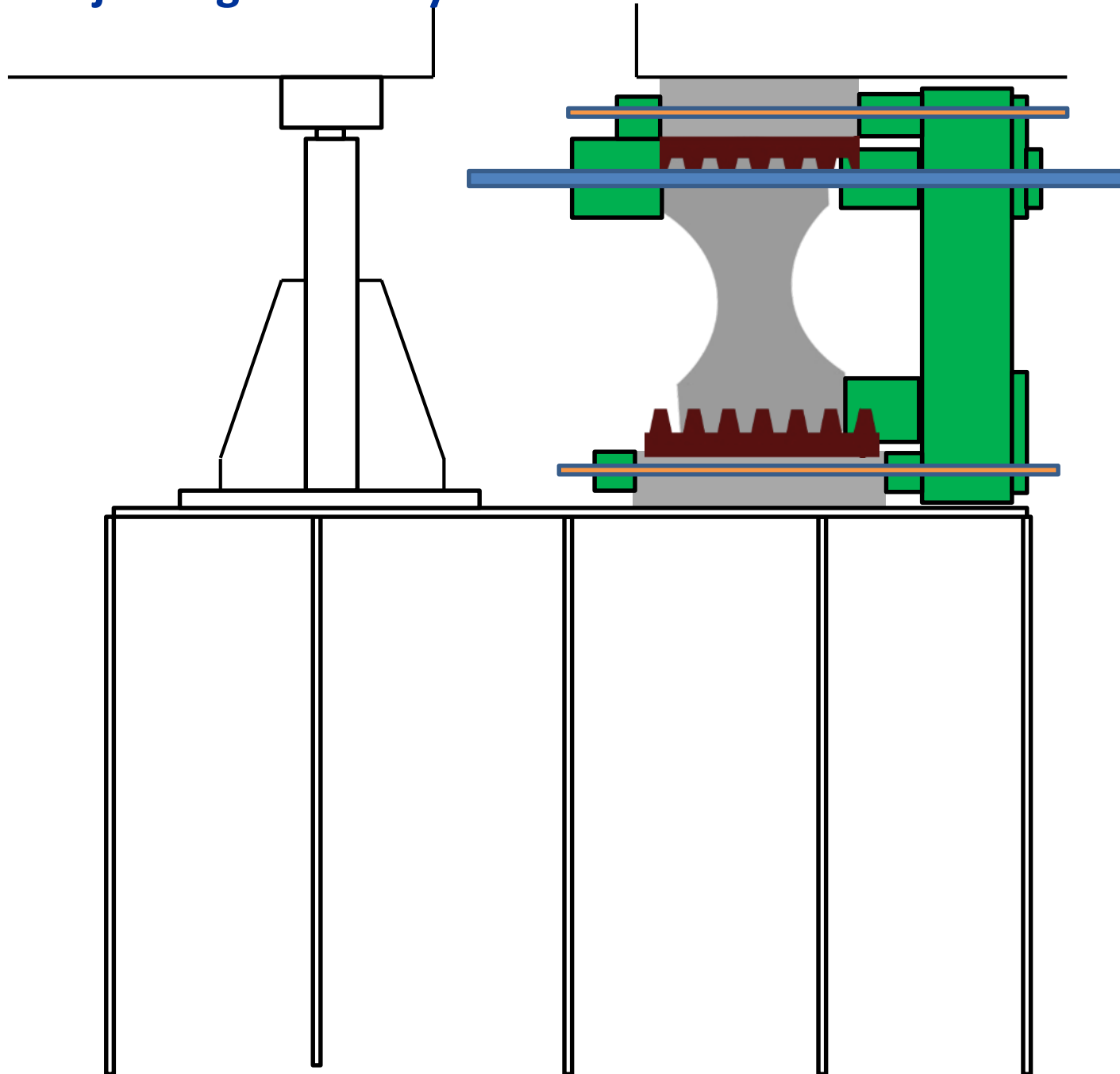
Step 6: Jack threadbars and pull roller base to final position



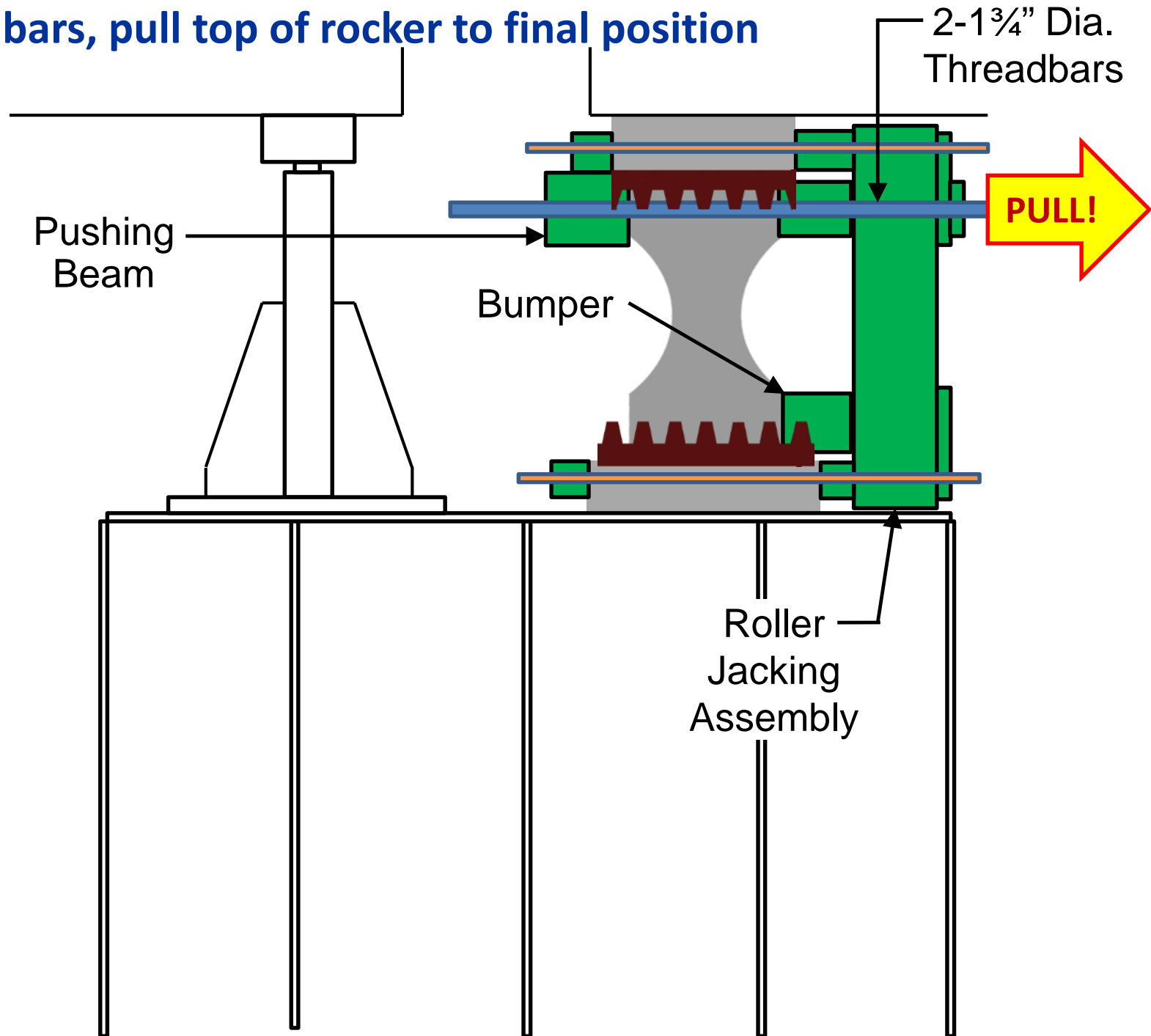
Step 7: Remove roller jacking assembly



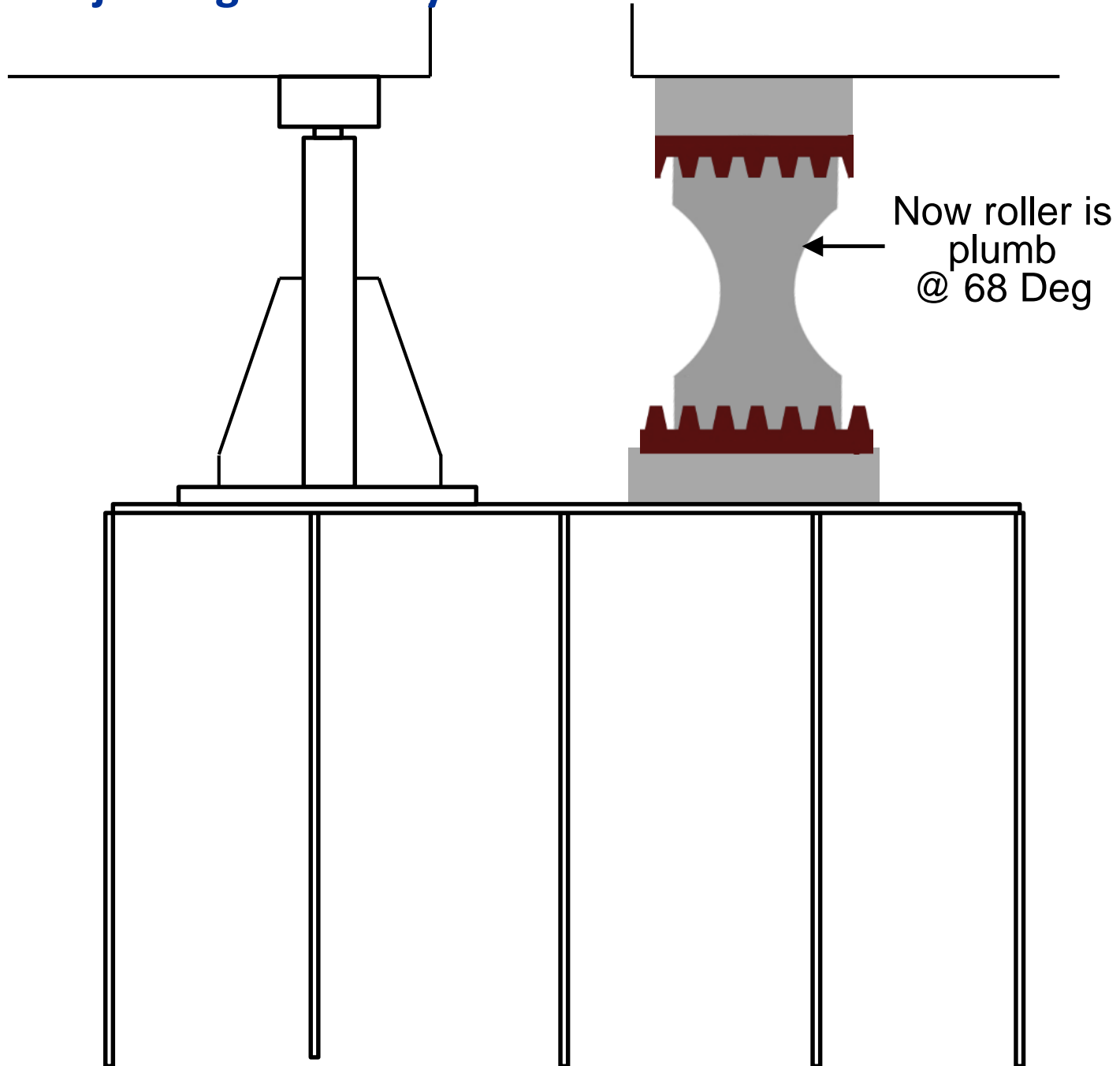
Step 8: Re-install roller jacking assembly



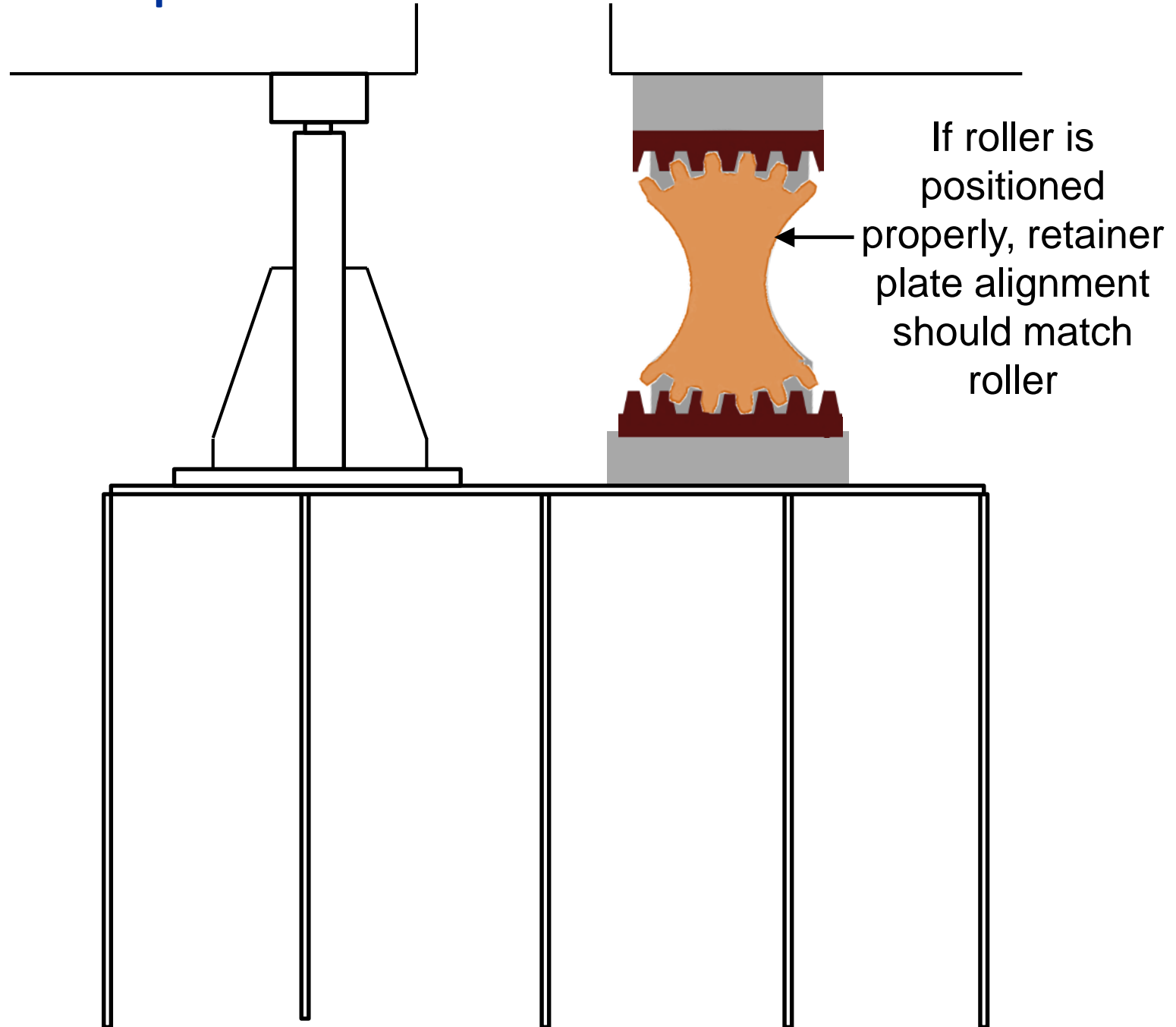
Step 9: Jack threadbars, pull top of rocker to final position



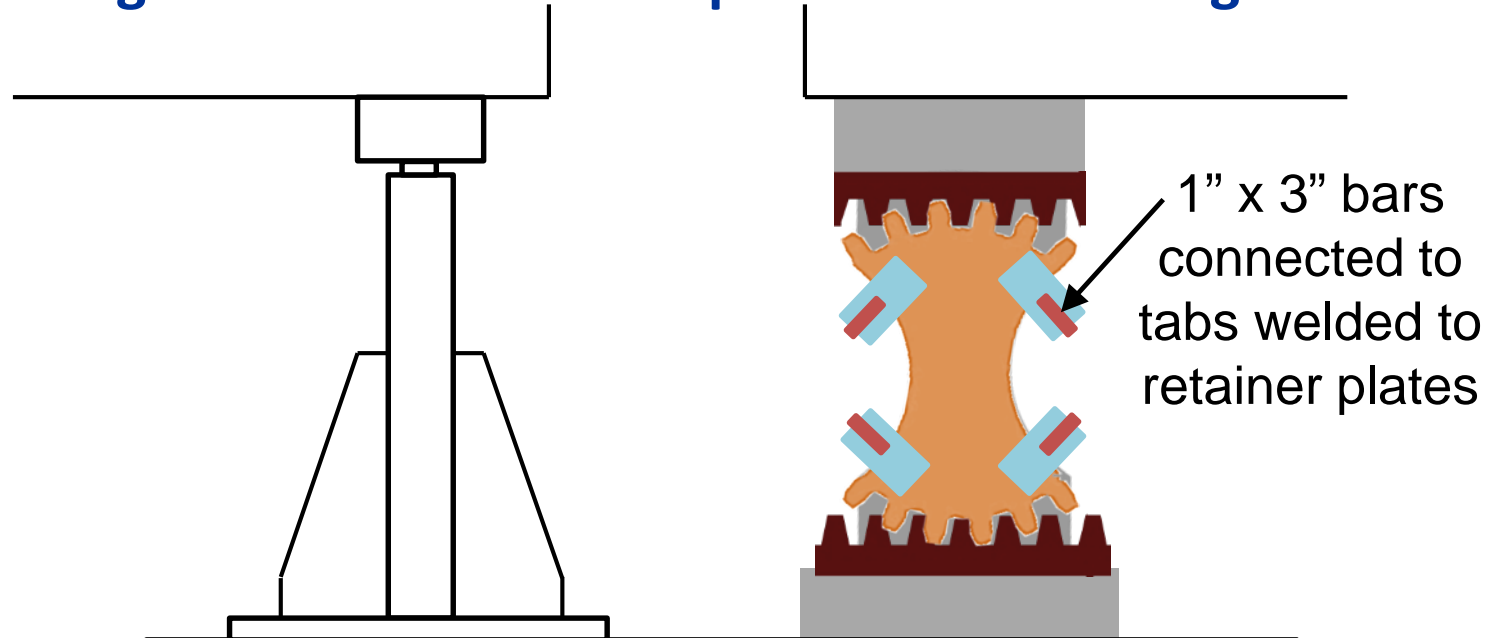
Step 10: Remove roller jacking assembly



Step 11: Reinstall retainer plates



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



QA/QC Inspection - Punch List Reports

- Good Value to the Owner



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.

Today's Take Away's

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



Questions?

Billy Varney, PE

West Virginia DOT

William.H.Varney@wv.gov



Matt Lewellyn, PE

Burgess & Niple, Inc.

Matt.Lewellyn@burgessniple.com



BURGESS & NIPLE
Engineers ■ Architects ■ Planners

