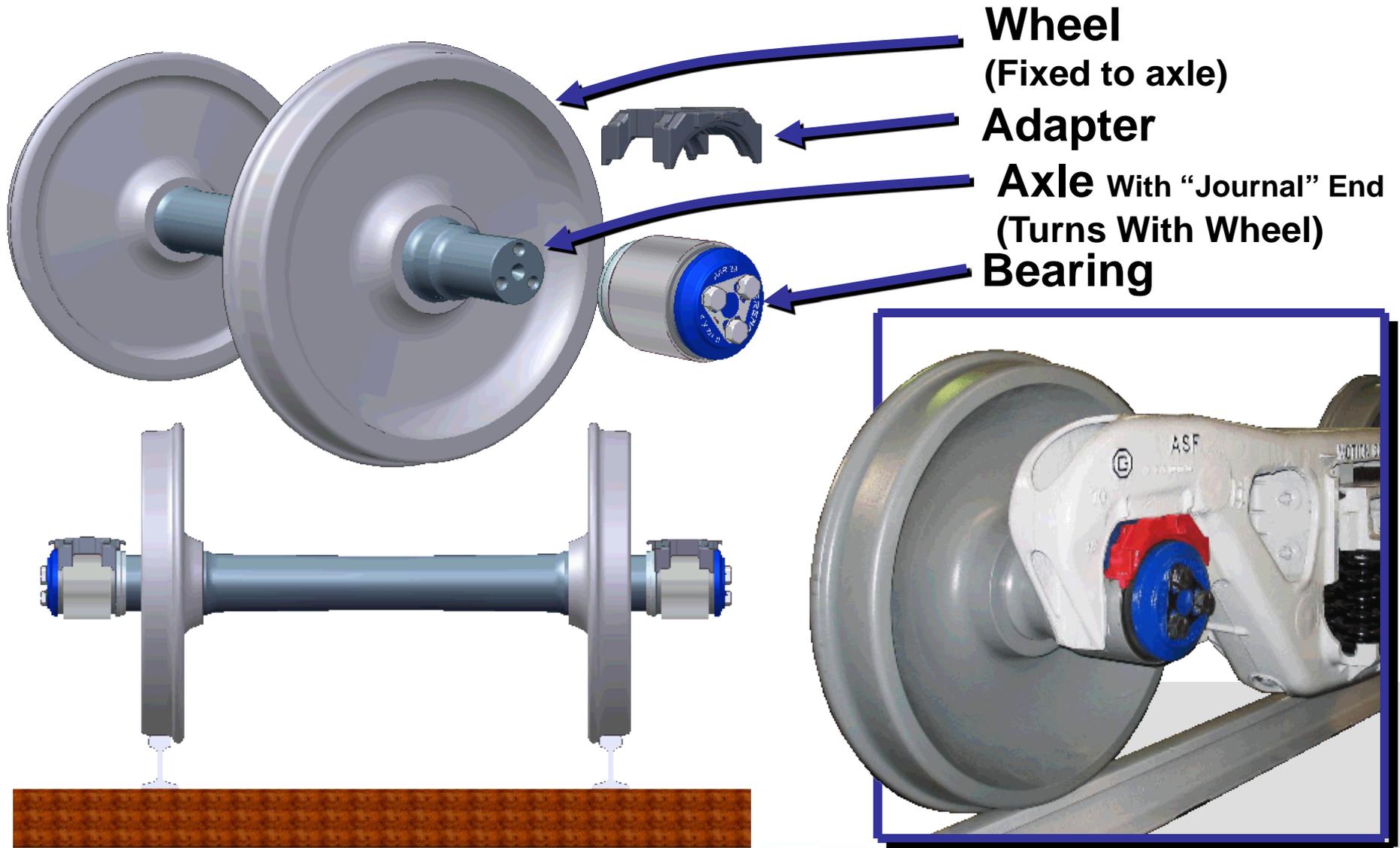


Roller Bearing Basics and Wheel Rail Interface Considerations

Paul A. Hubbard
Director of Engineering, Bearings
Amsted Rail Company, Inc.
Brenco Bearing Division

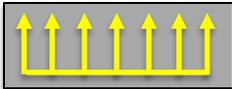


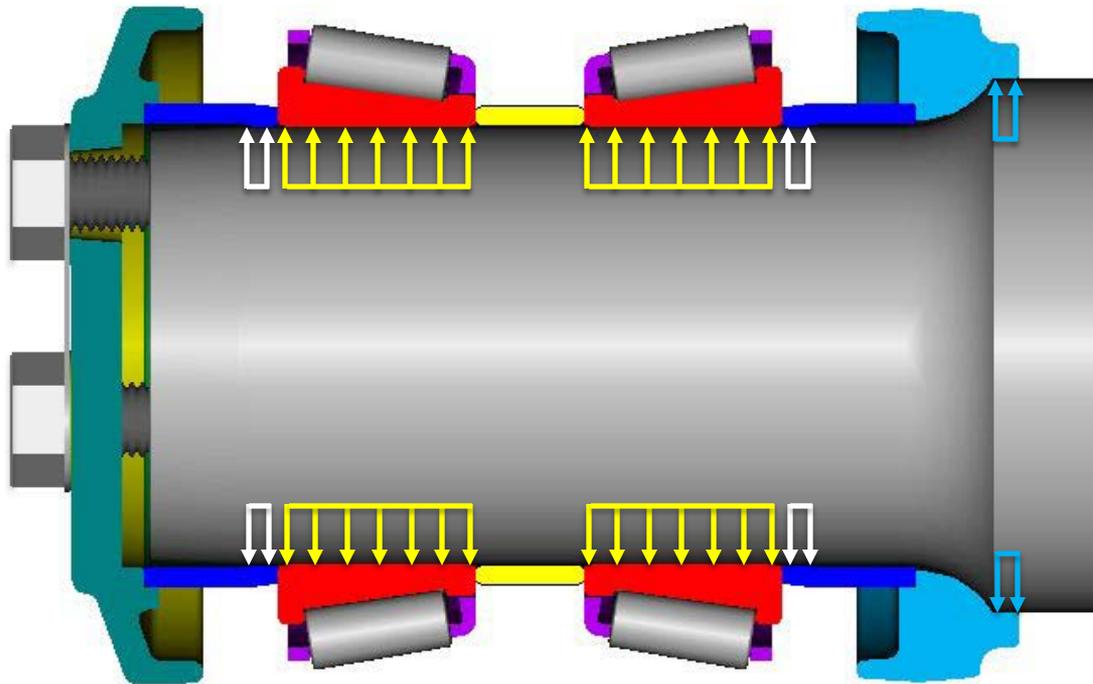
Railroad Wheel Set



Bearing “Stack” Components

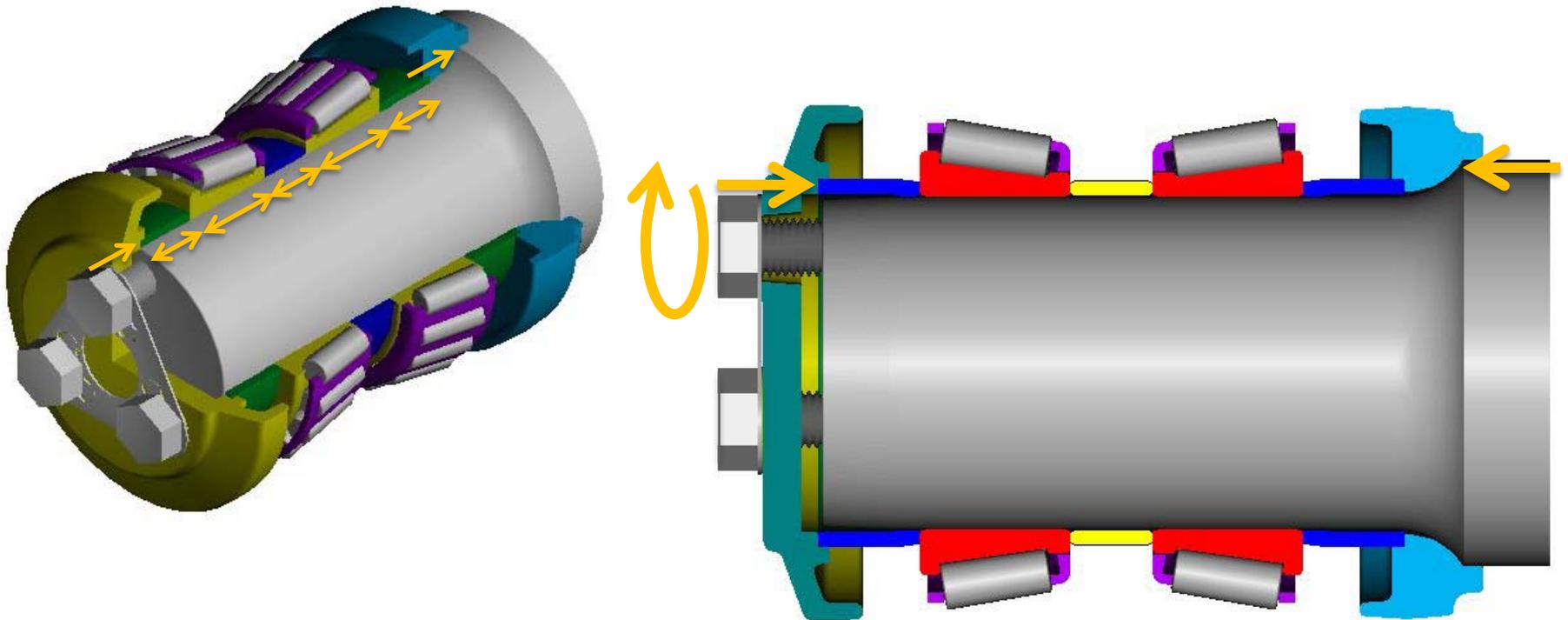
- Rotating Components with interference fit – Radial Clamp

- Cones 
- Wear rings 
- Backing ring collar 



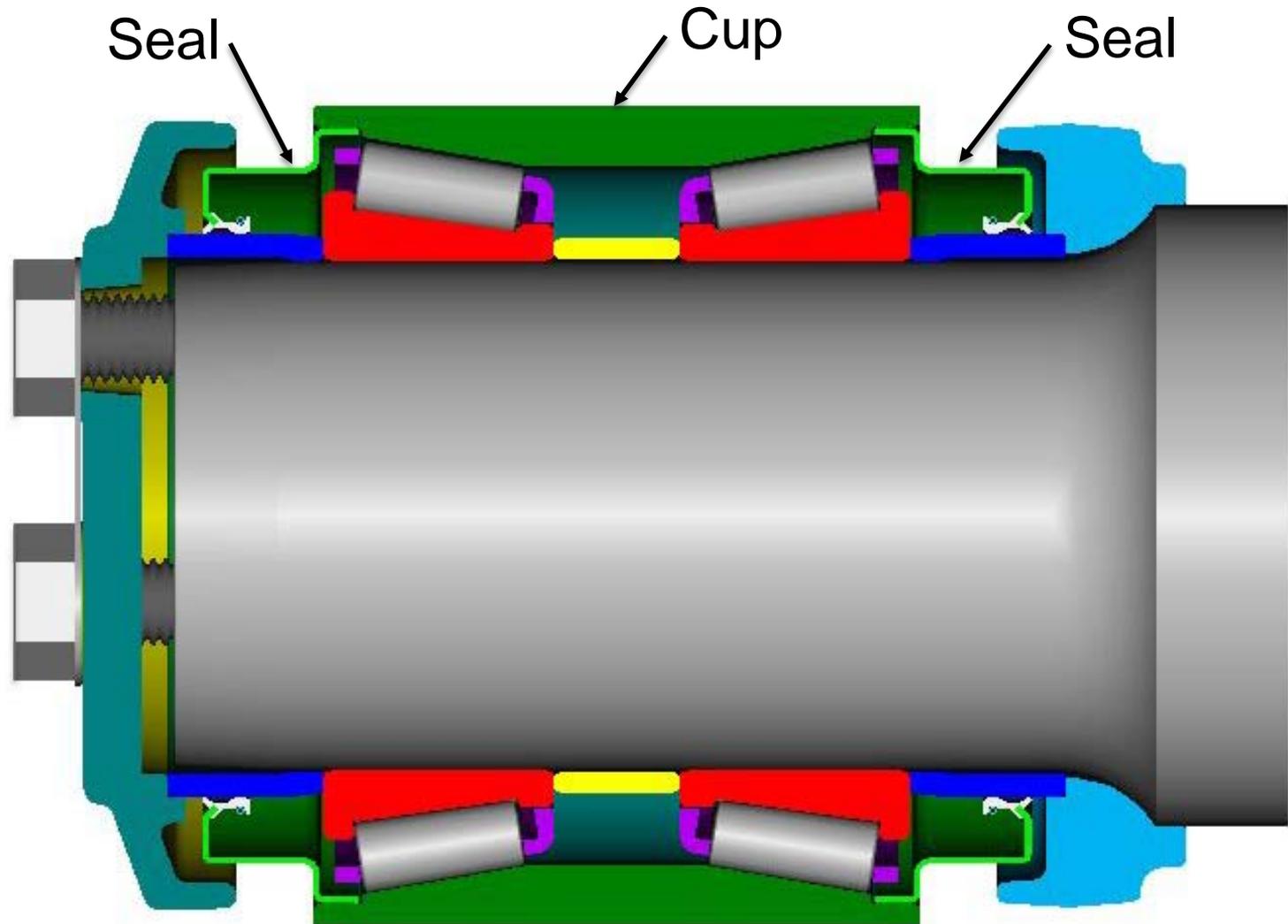
Bearing “Stack” Components

- Lateral Clamp Load
- Rotating Components

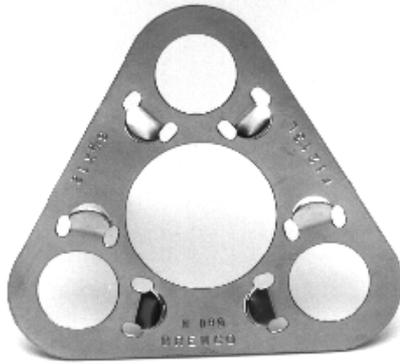


Non - Rotating Components

- These components index within the bearing adapter



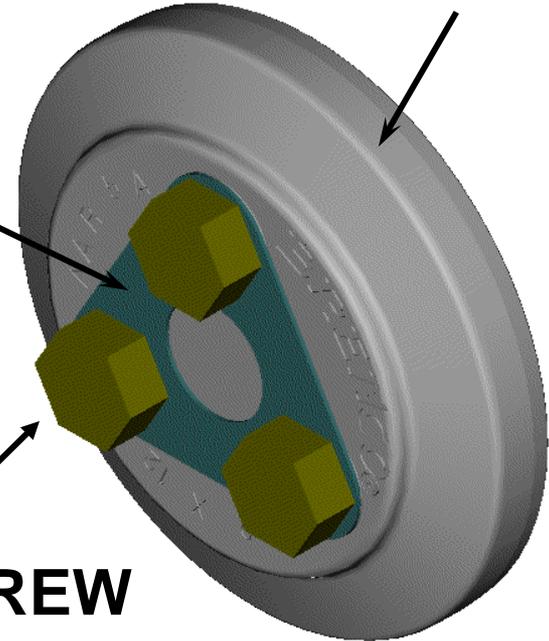
Mounting Components



**LOCKING
PLATE**

ENDCAP

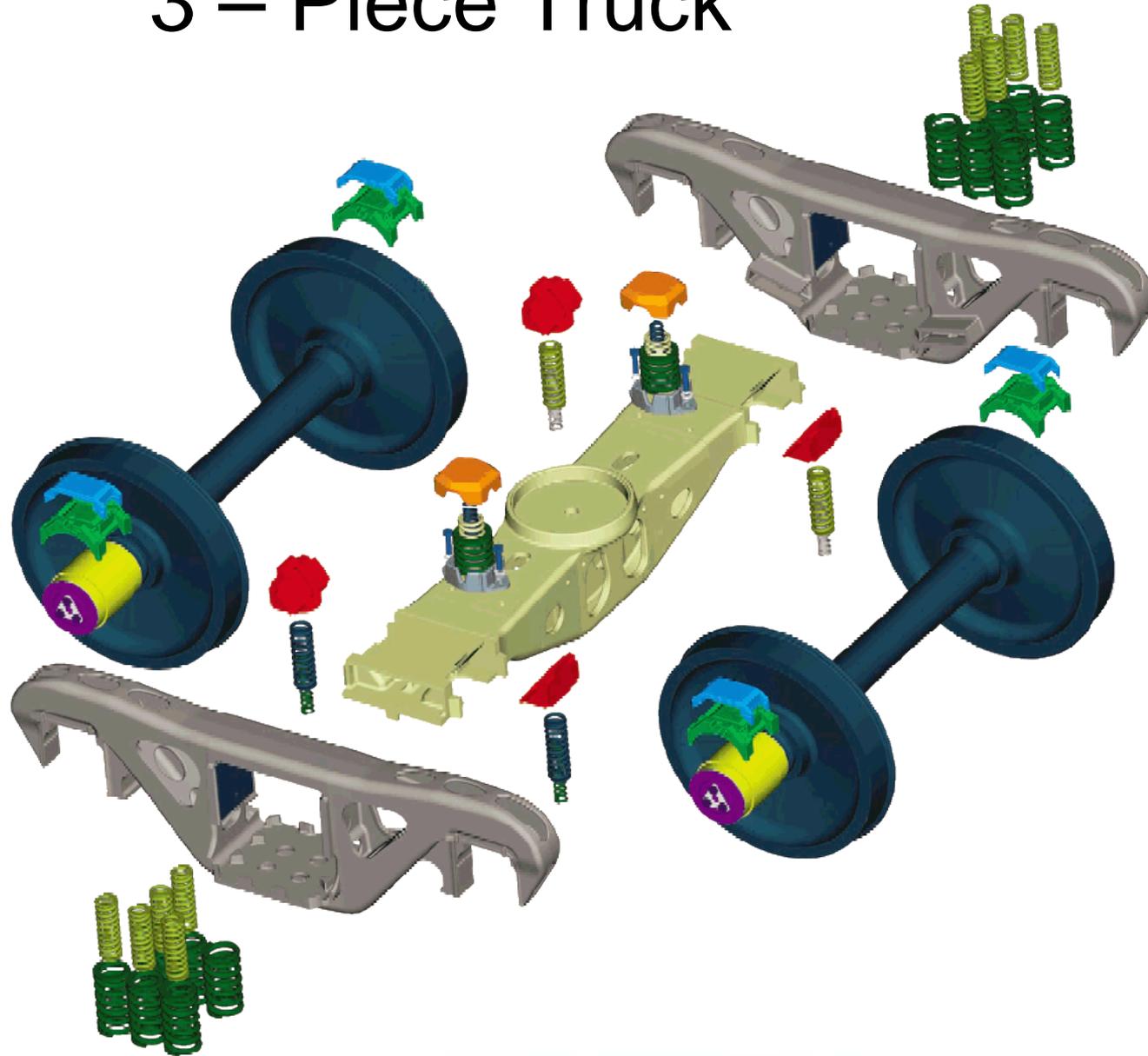
CAP SCREW



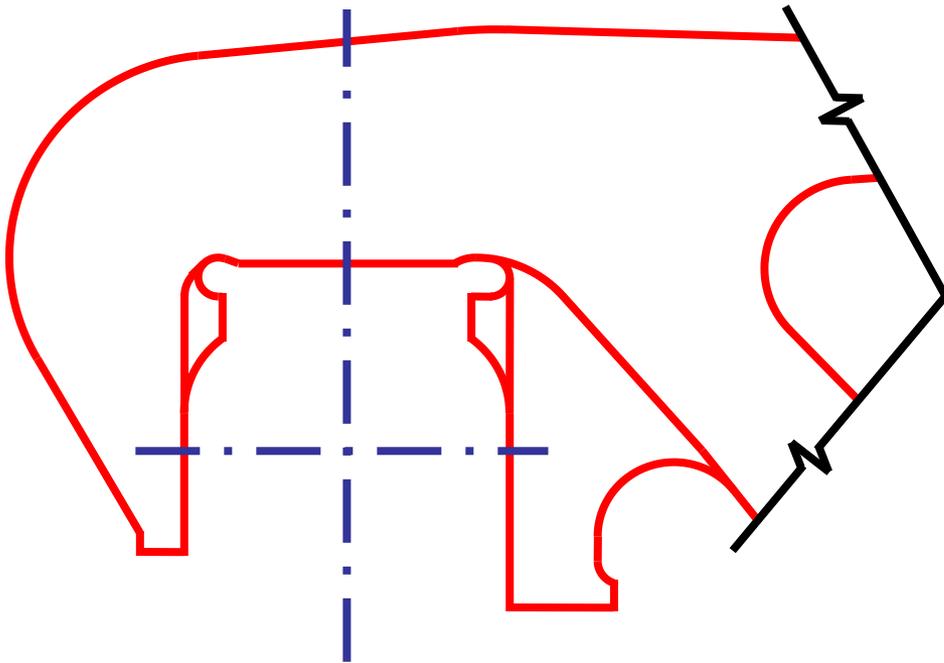
Bearing Failure (Burn Off)



3 – Piece Truck



Side Frame Pedestal Opening



Best Bearing Application Practices

When press seats bearing, count three seconds

- This will ensure that all bearing components have seated

Application of cap screws

- Insert cap screws initially by hand for a few threads
- Then use an impact wrench at Lowest Air Pressure!
- Manual click-type torque wrench
 - Follow 1, 2, 3 pattern - total of 3 times
 - Or until the cap screws stop moving
 - Take care not to bounce on wrench
- Automated torquing devices
 - These also work very well
 - Saves on worker fatigue



How to Improve Bearing Clamp

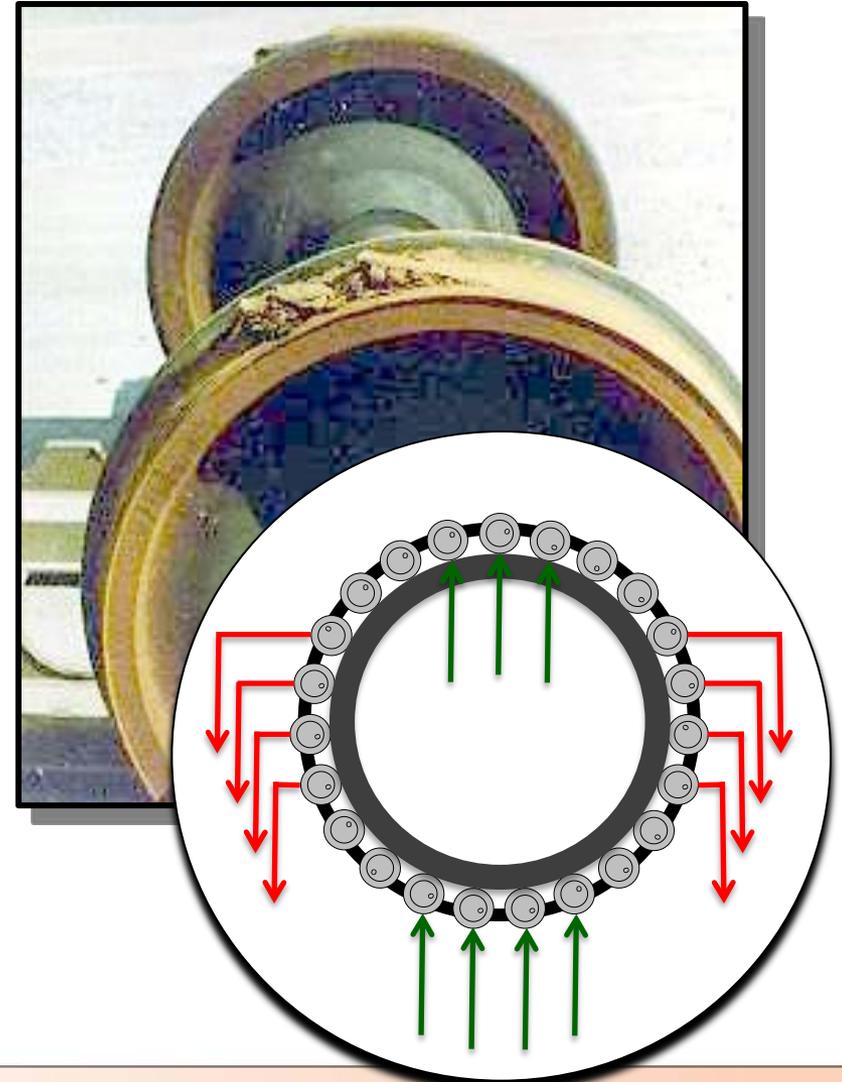
Cleaning of axle bolt holes

- At a minimum blow out holes with air & inspect
- If threads are clean, more torque will become lateral clamp
- Coat cap screws with oil prior to insertion



Bearing Impact Research

Wheel Defects – Impact Loading of Bearing



Steel Cage Defects

Cage Pocket Bar Breakage

- Cracks cause pocket bar to drop
- Jams the roller and starts the cup spinning inside adapter



Cup (Outer Race)



Steel Cage Defects

Worn Cage – Hourglass Effect & Cage Breakage



Steel Cage Defects

Roller Running Over Cage after Steel Cage Breakage

- Less common than the broken cage bar failure



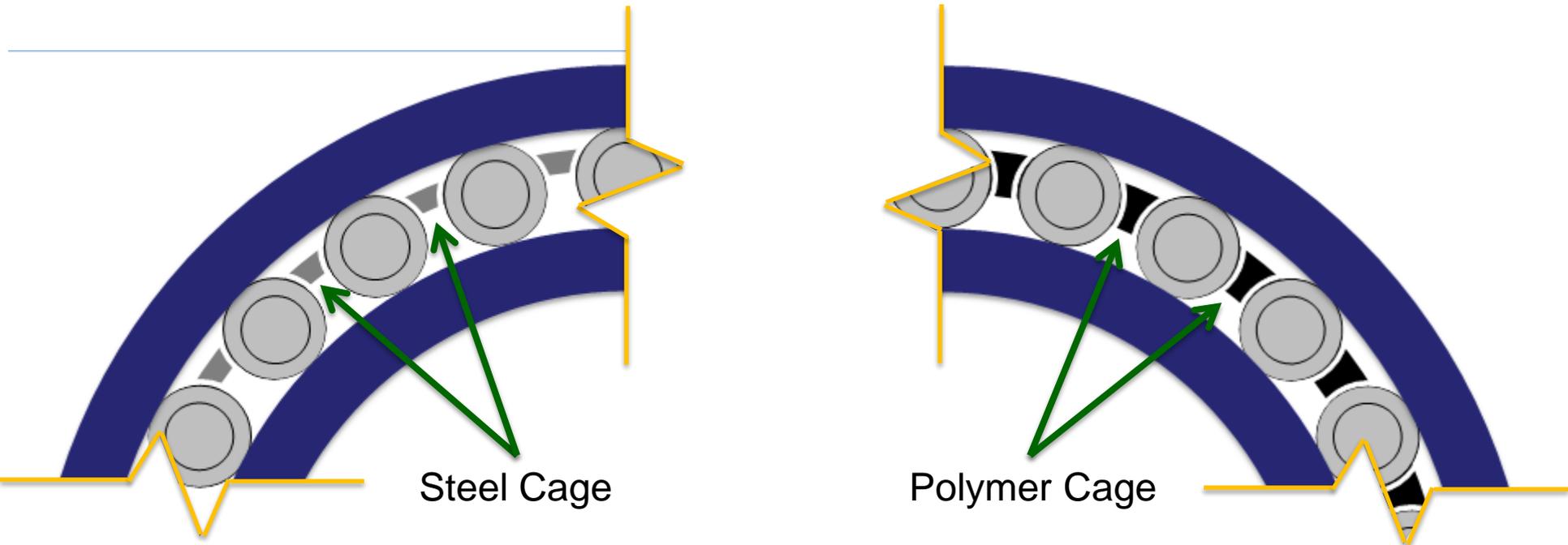
Cage - Polymer

- Tend to resist impacts without being damaged
- In cases where cage is damaged, no tendency to jam rollers
- Extends bearing running time if lubricant fails
- Greatly reduced tendency for Bearing Failure (Burn off)
- Vibration dampening ability



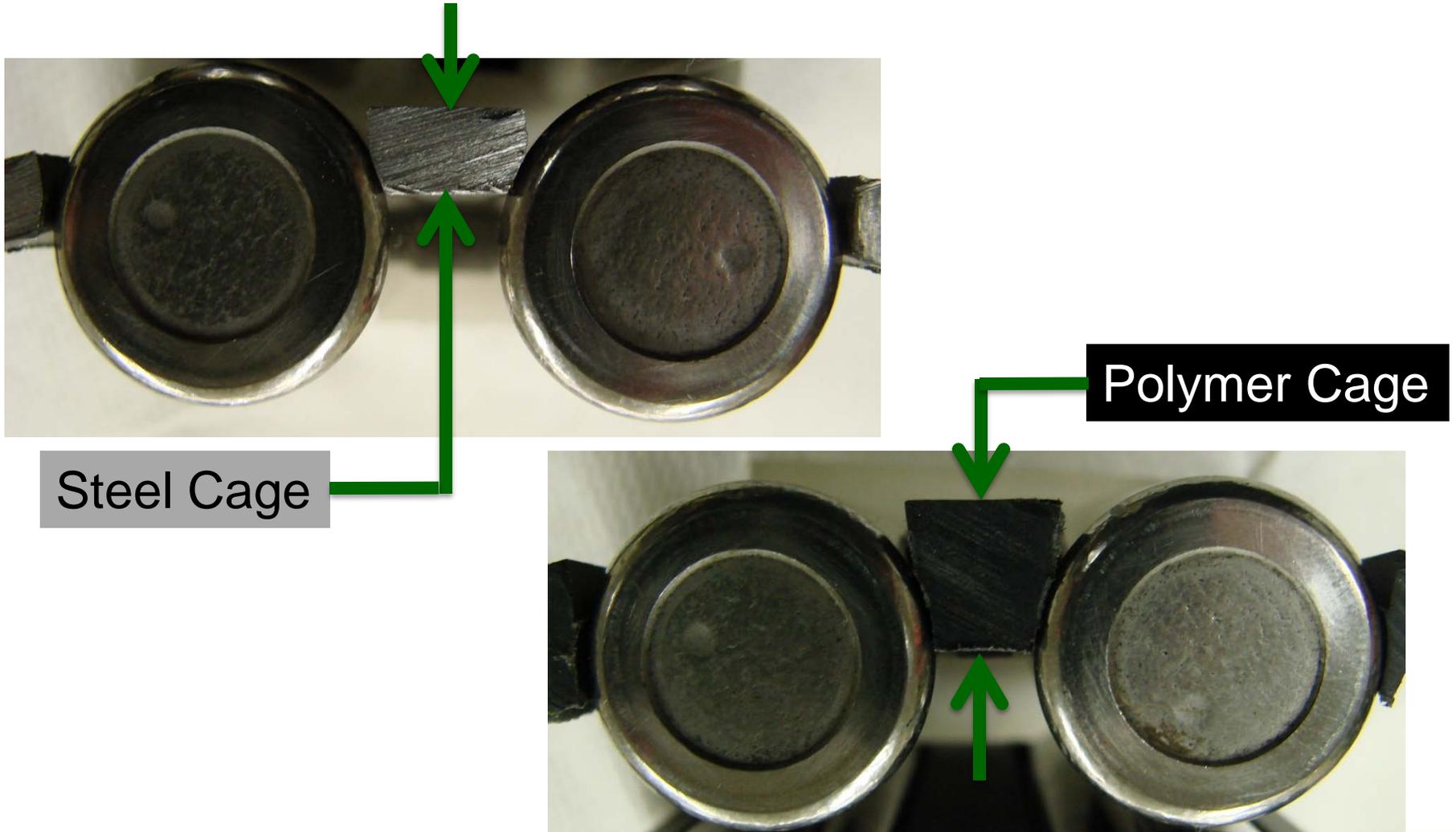
Cage Design – Polymer vs. Steel

- Polymer cages benefit from the geometries that can be produced by injection molding
 - Pocket bars do a much better job supporting the roller

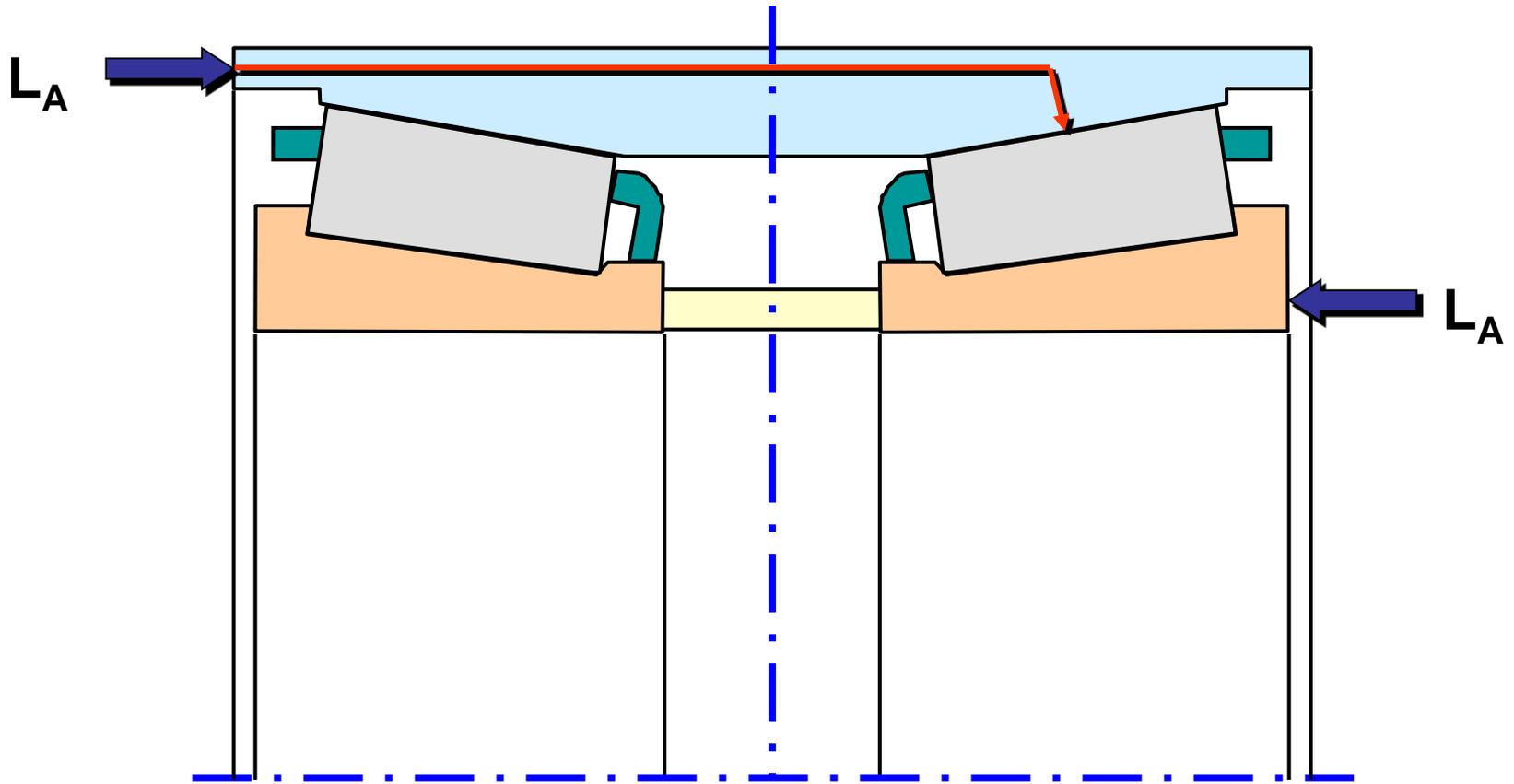


Cage Design – Polymer vs. Steel

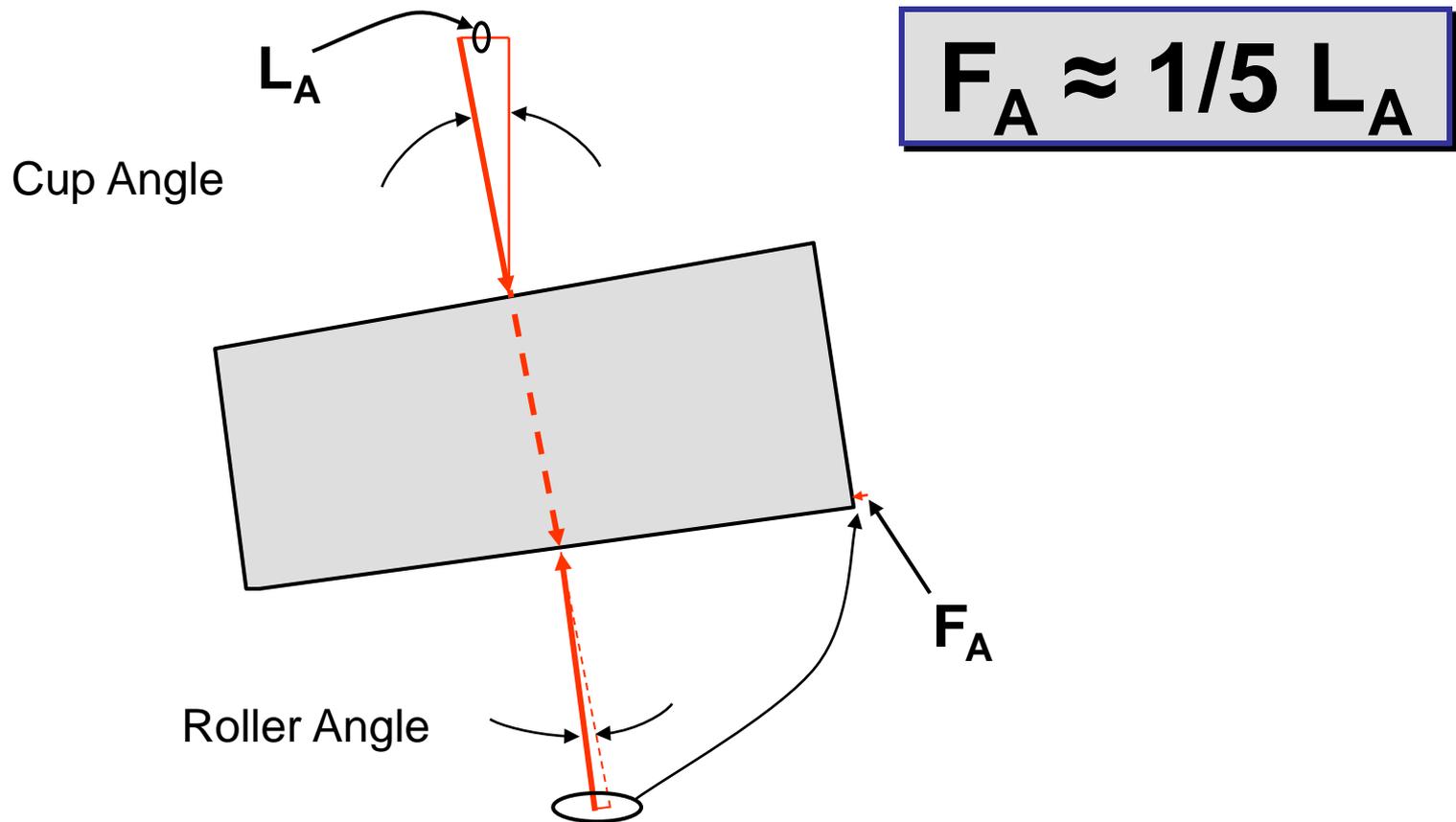
- Polymer cages – Improved section thickness



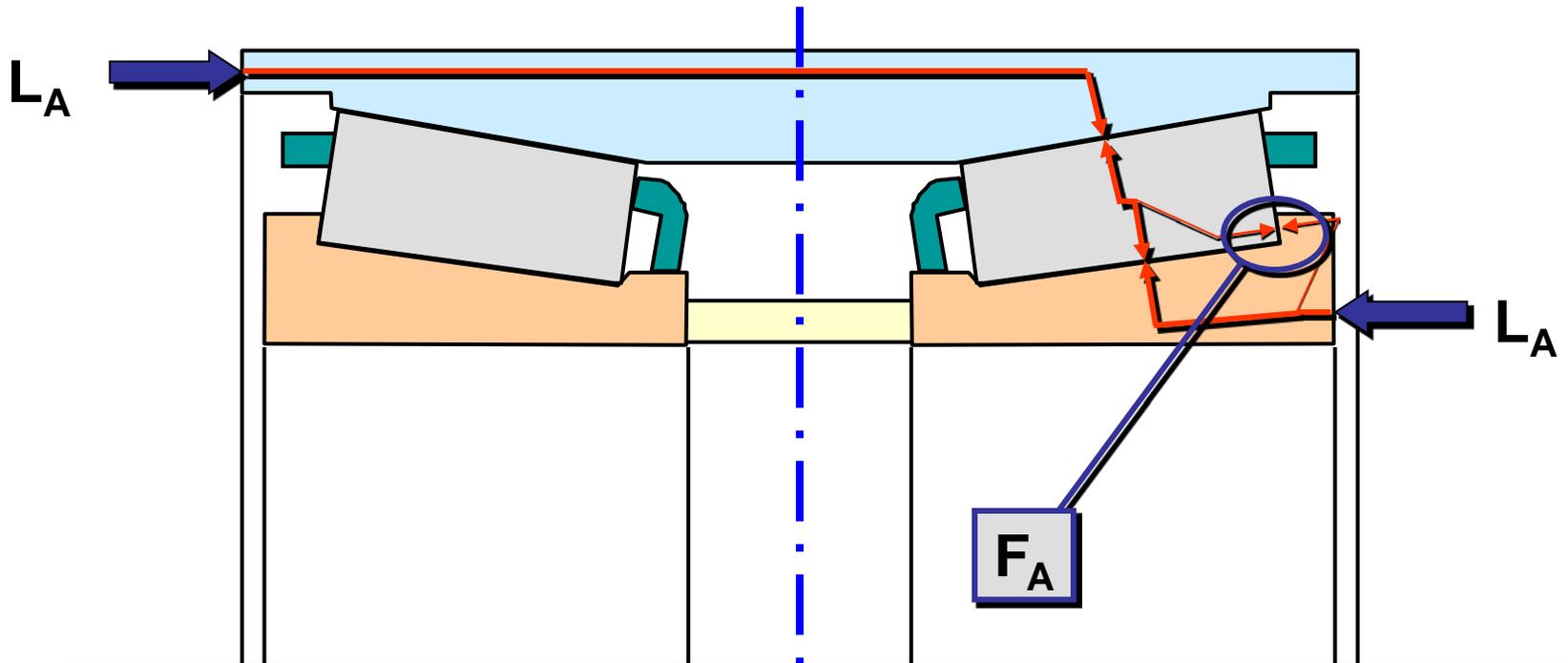
Axial / Lateral (Horizontal) Load Tapered Bearing



Axial / Lateral (Horizontal) Load Tapered Bearing



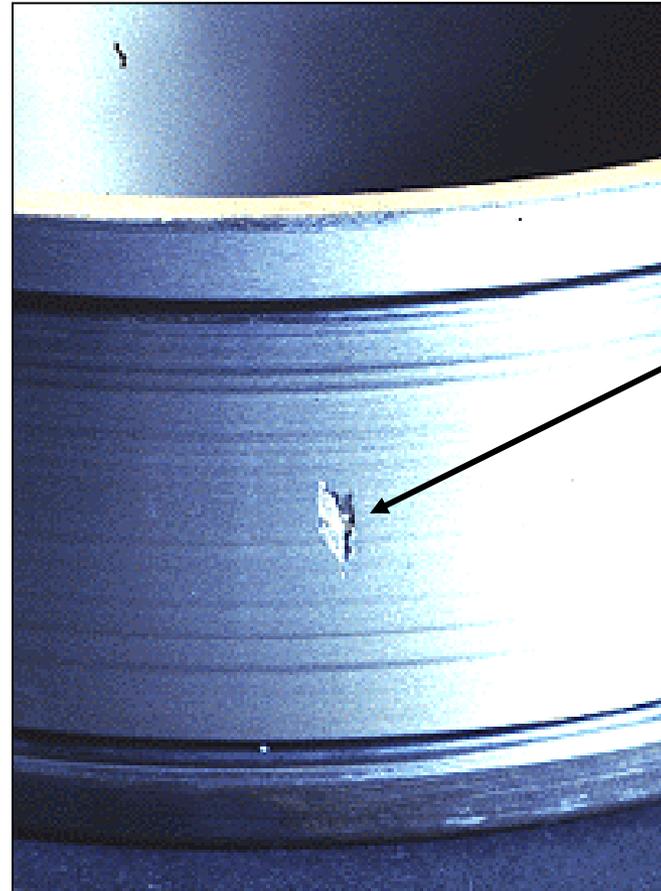
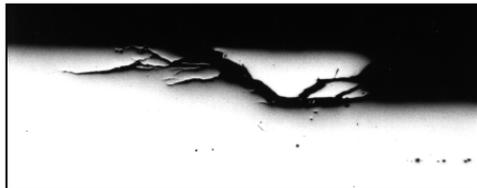
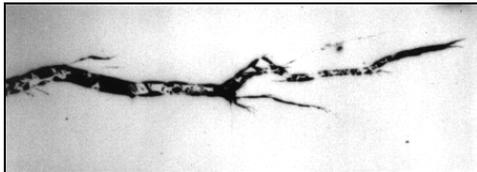
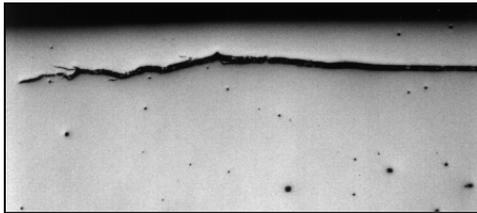
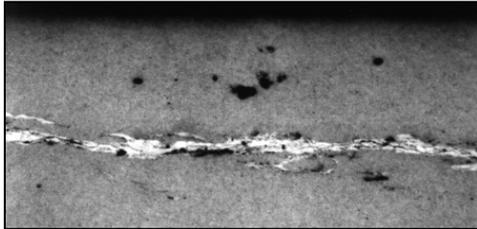
Axial / Lateral (Horizontal) Load Tapered Bearing



$F_A \approx 1/5 L_A = \text{Less Friction, Heat}$



Fatigue Spalling



**FATIGUE
SPALL**



Fatigue Spalling

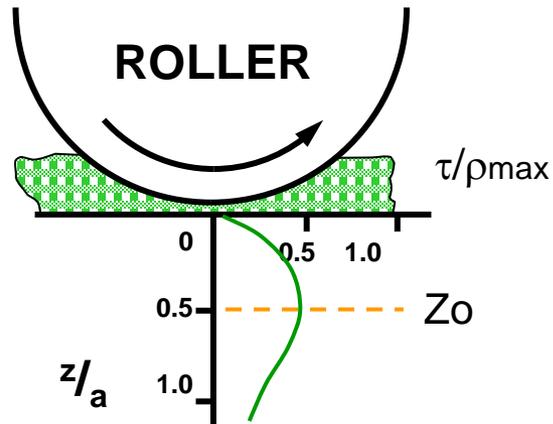
- The raceway component has reached the end of its life
- Failure due purely to fatigue



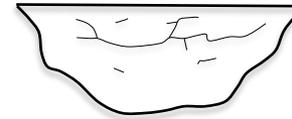
Raceway Fatigue Spalling

SHEAR STRESS DISTRIBUTION ON SURFACE AND BELOW SURFACE

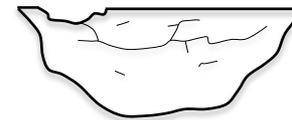
With Full Oil Film Between Rollers and Raceway



T : Shear Stress
 p : Contact Pressure
 Z_0 : Depth of Maximum Shearing Stress
 a : Roller Contact Half Width



Subsurface Crack Propagation



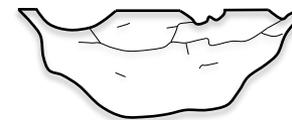
Initial Surface Flaking



Spall Area Repaired by Grinding



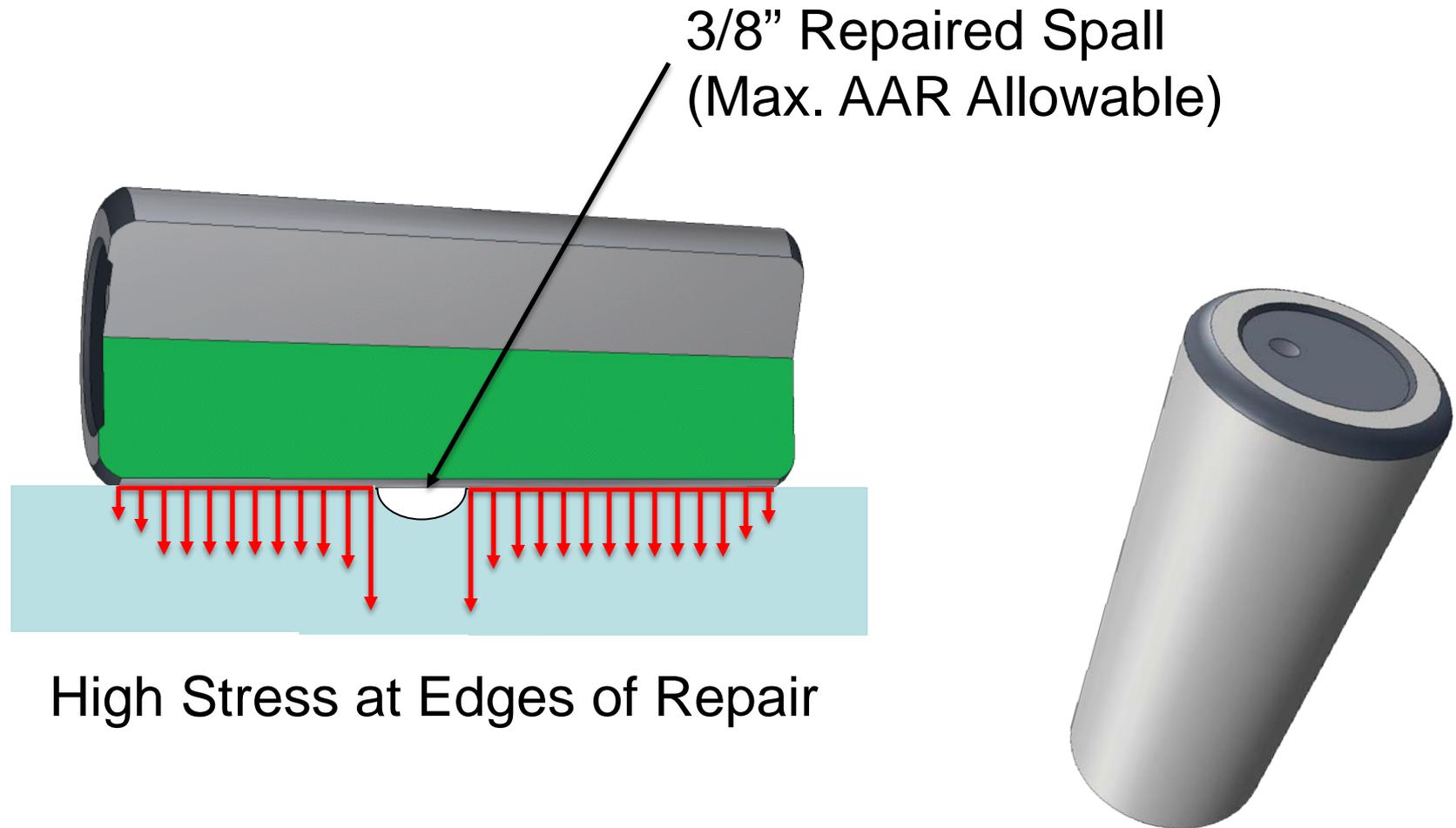
Subsurface Cracking Continues



Continued Subsurface to Surface Flaking Occurs



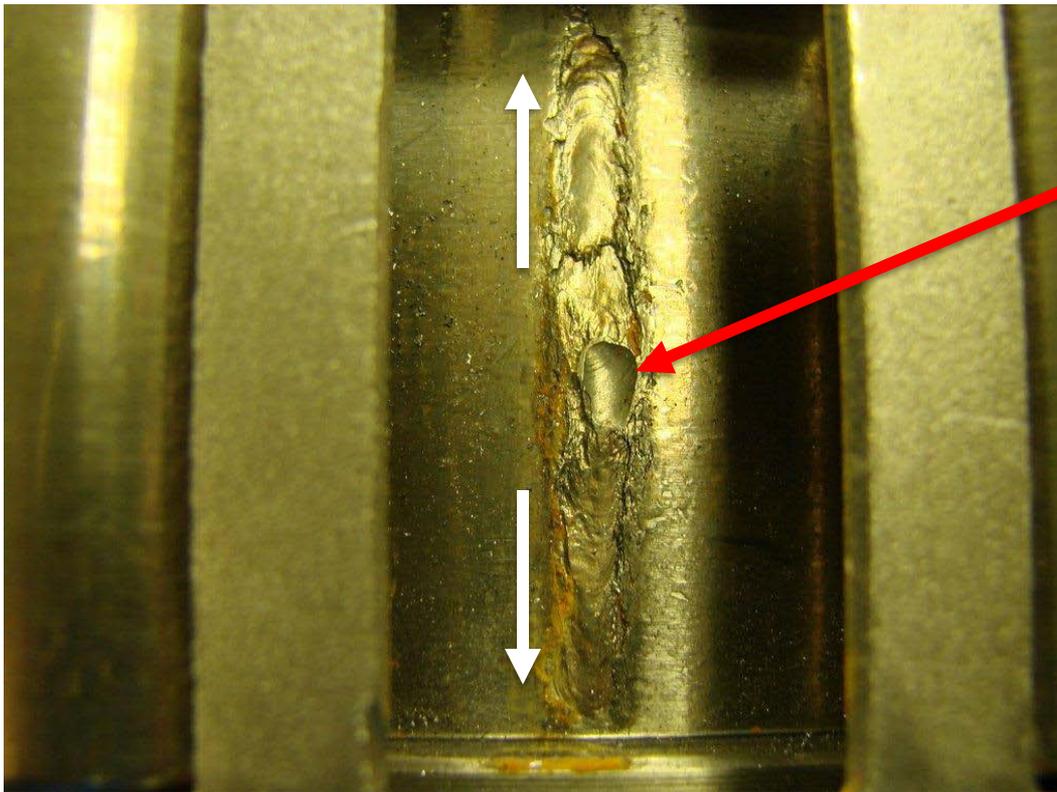
Repaired Spall on Raceway



Raceway Fatigue Spalling

Repaired cone spall that went back into service

- After running in service, the spall propagated in both directions and became a barline spall

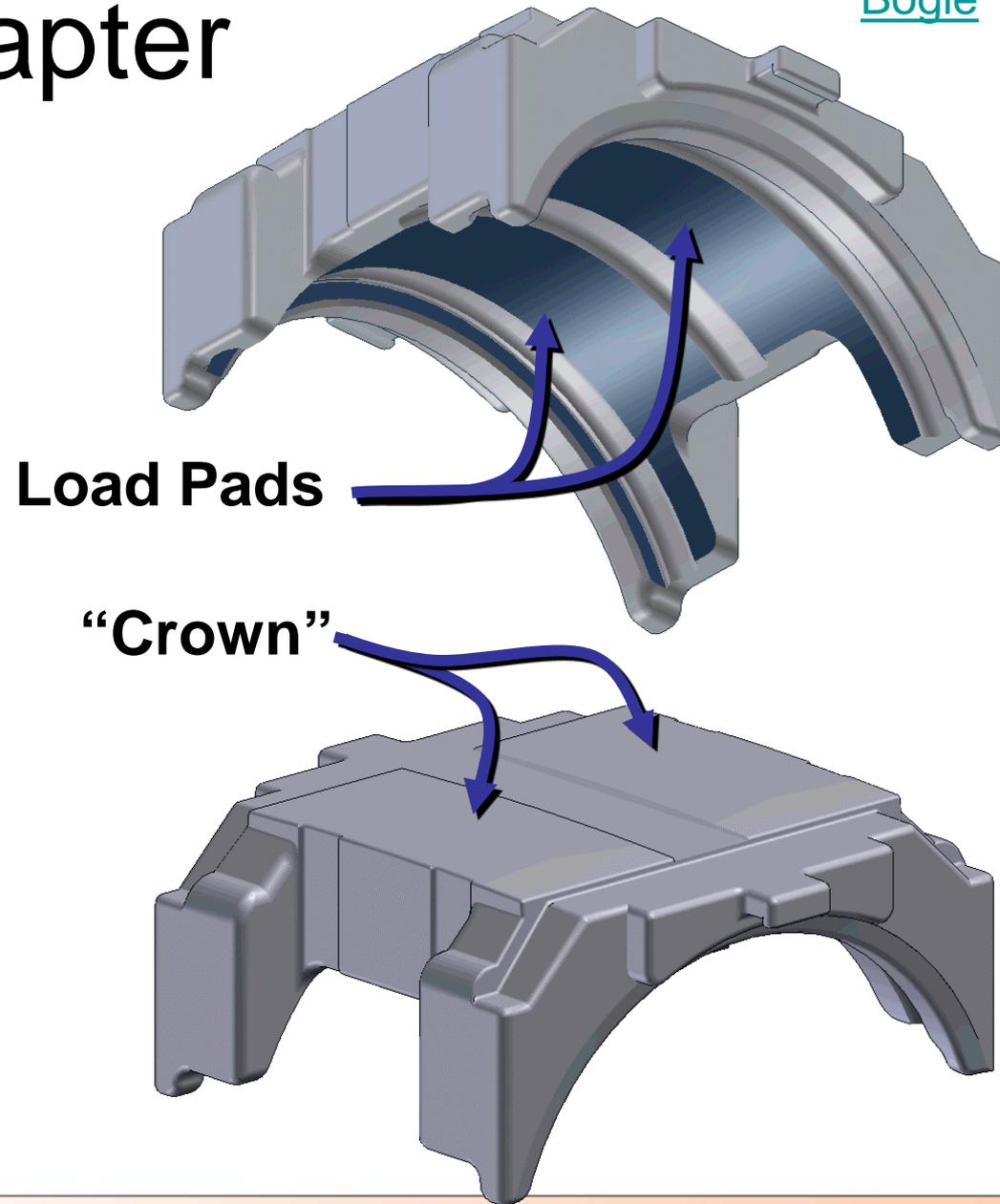
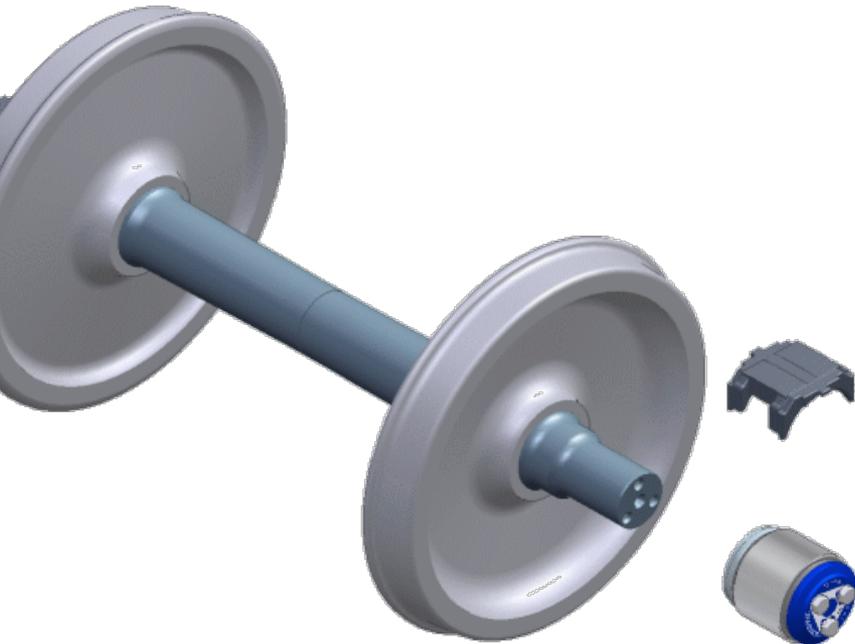


Initial
Spall
Repair

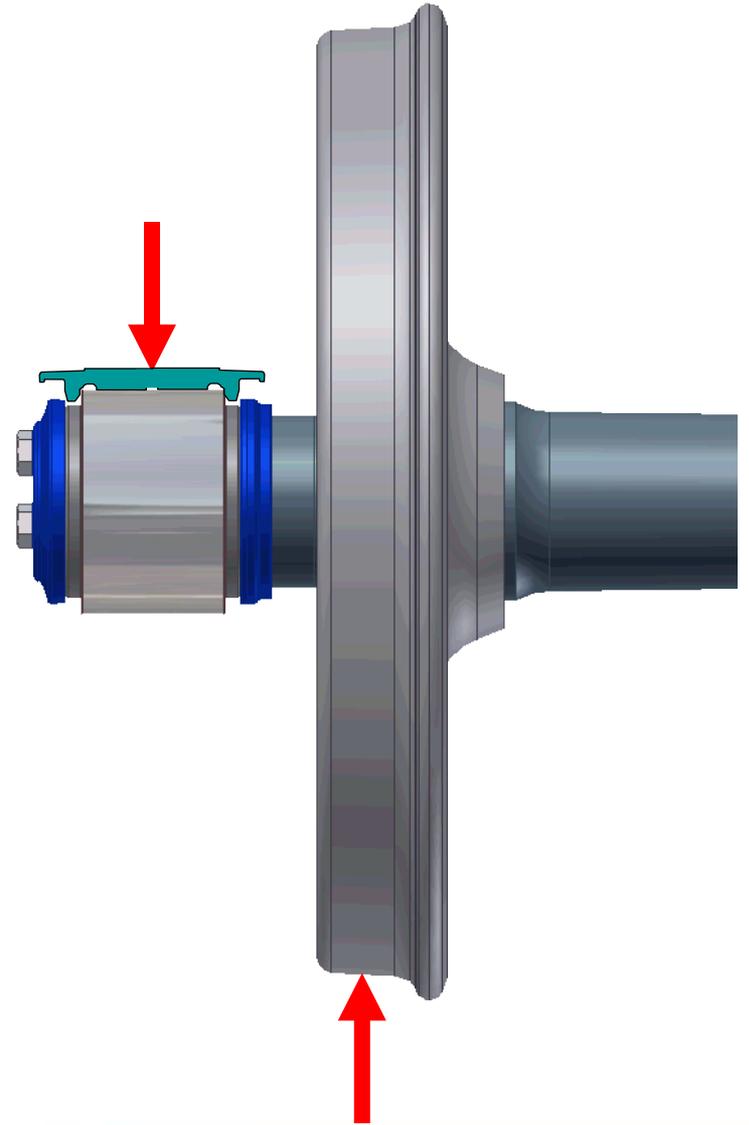
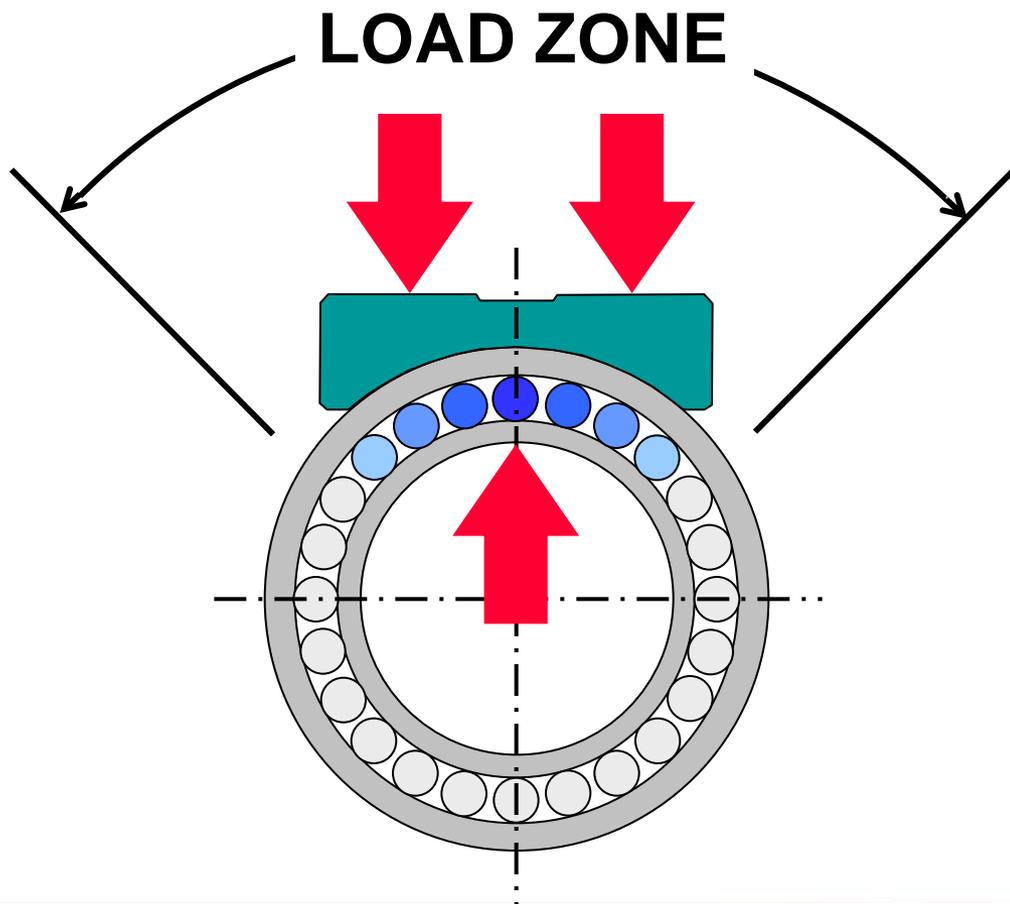


Adapter

- Narrow Style

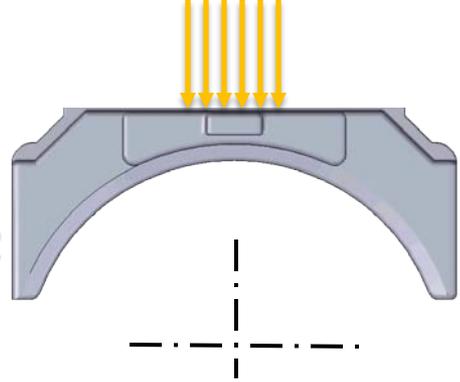
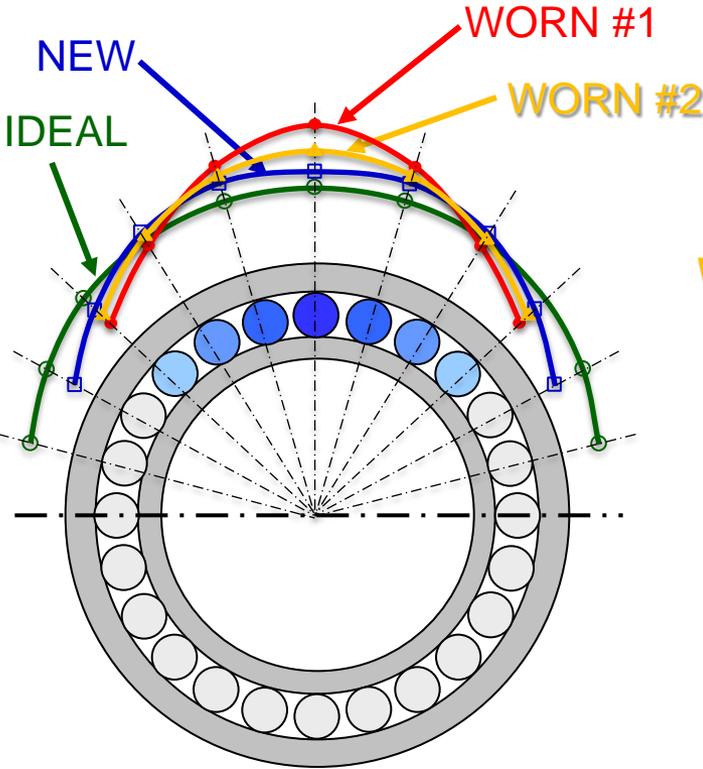
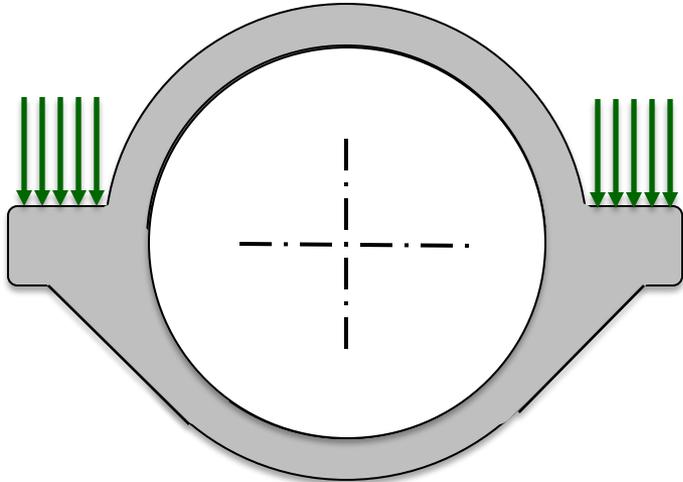


Load Zone of Bearing

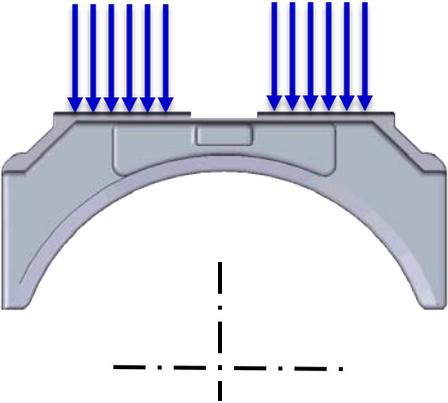


Roller Load Optimizing

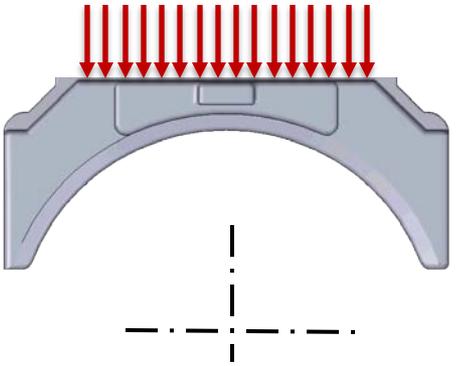
IDEAL



WORN 2 - AAR STYLE



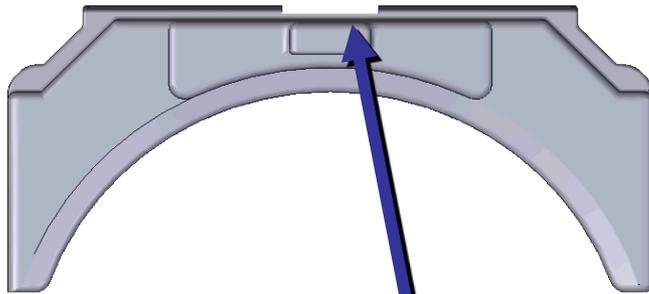
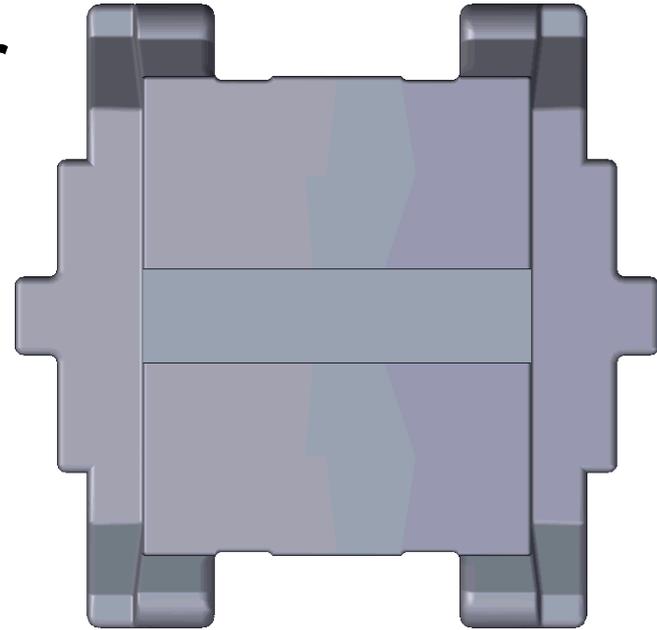
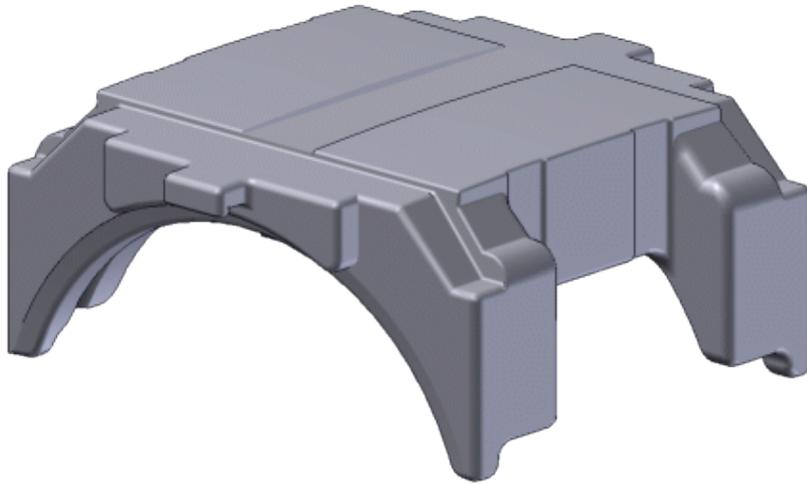
NEW - AAR STYLE



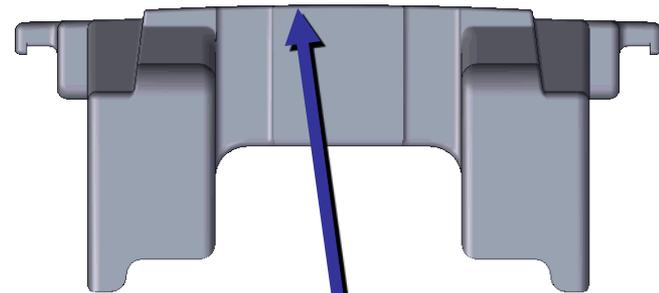
WORN 1 - AAR STYLE



Adapter



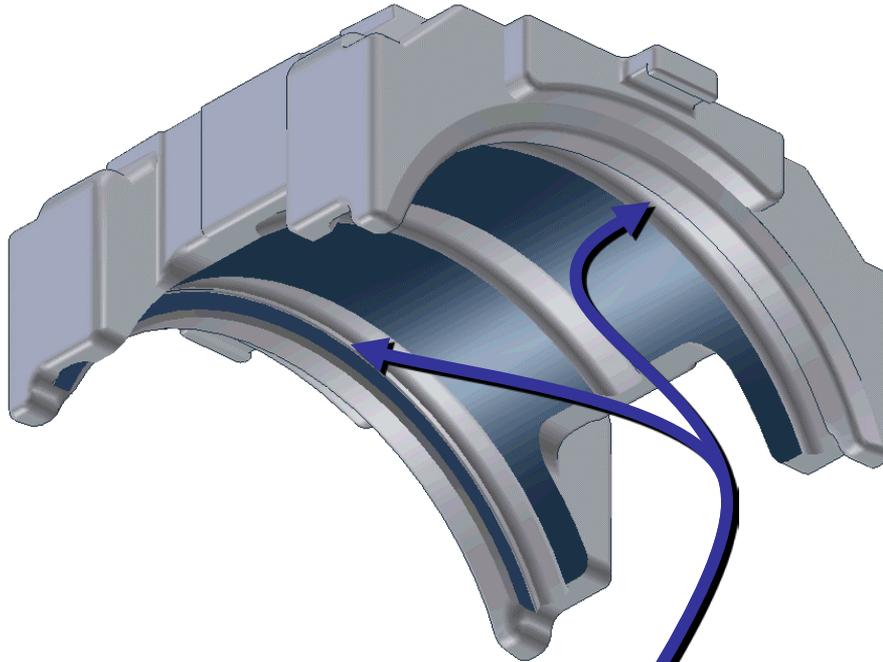
The center Groove distributes the load away from “12:00”



The Crown radius helps center the load inboard-to-outboard



Adapter

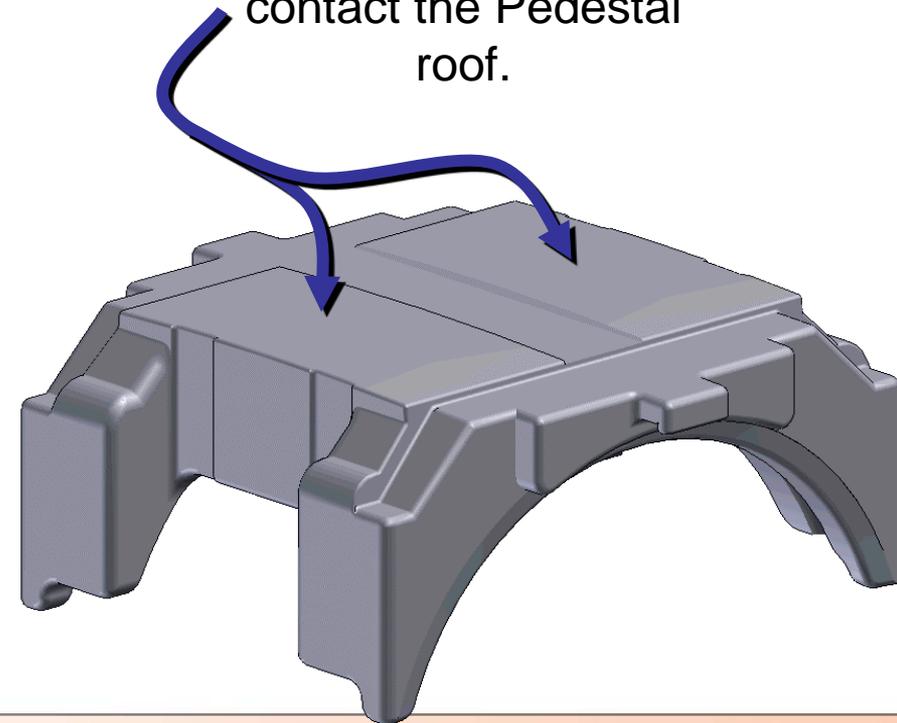


Hardened Shoulders

Inside of the flange
“Lips” that contact the
ends of the cup.

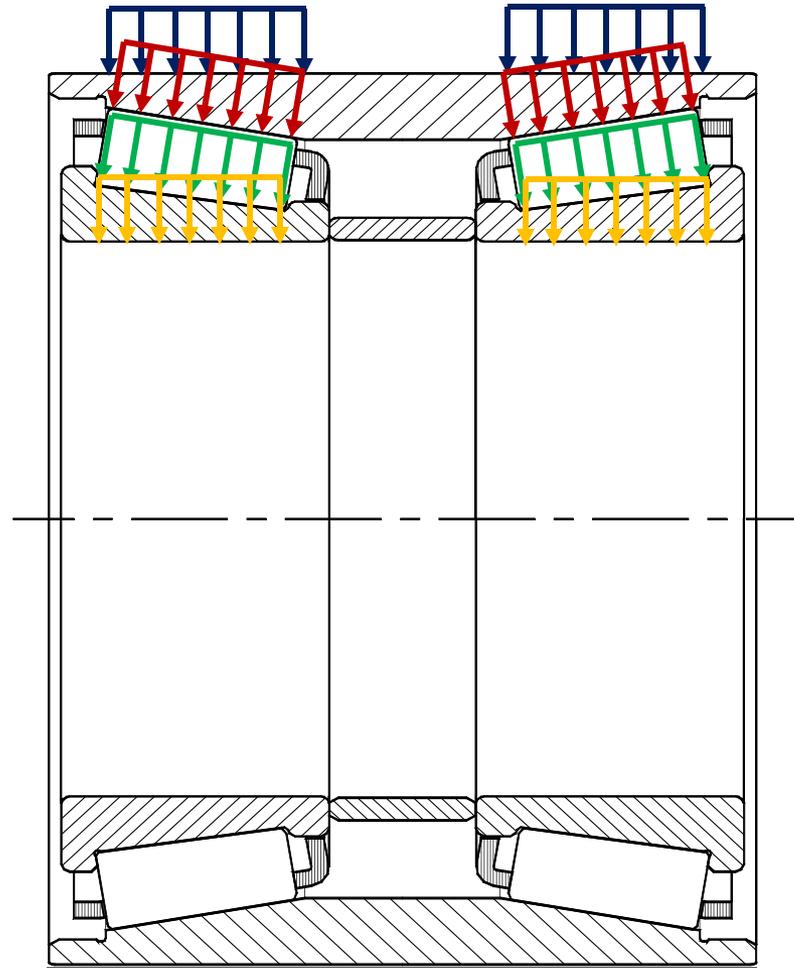
Hardened Crown

The two curved top
pads of the adapter that
contact the Pedestal
roof.



Bearing Loading - Optimal

~50% LOAD ~50% LOAD



Normal Adapter Pattern Marks

- Initial contact pattern (left)
- Pattern after normal creep, or “indexing” (rotation) takes place (right)
- Even distributed loading on the cup

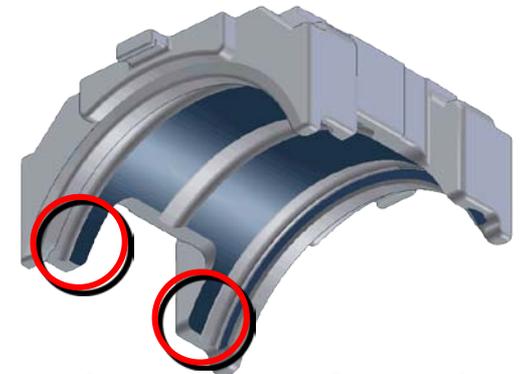


Abnormal Adapter Contact Pattern

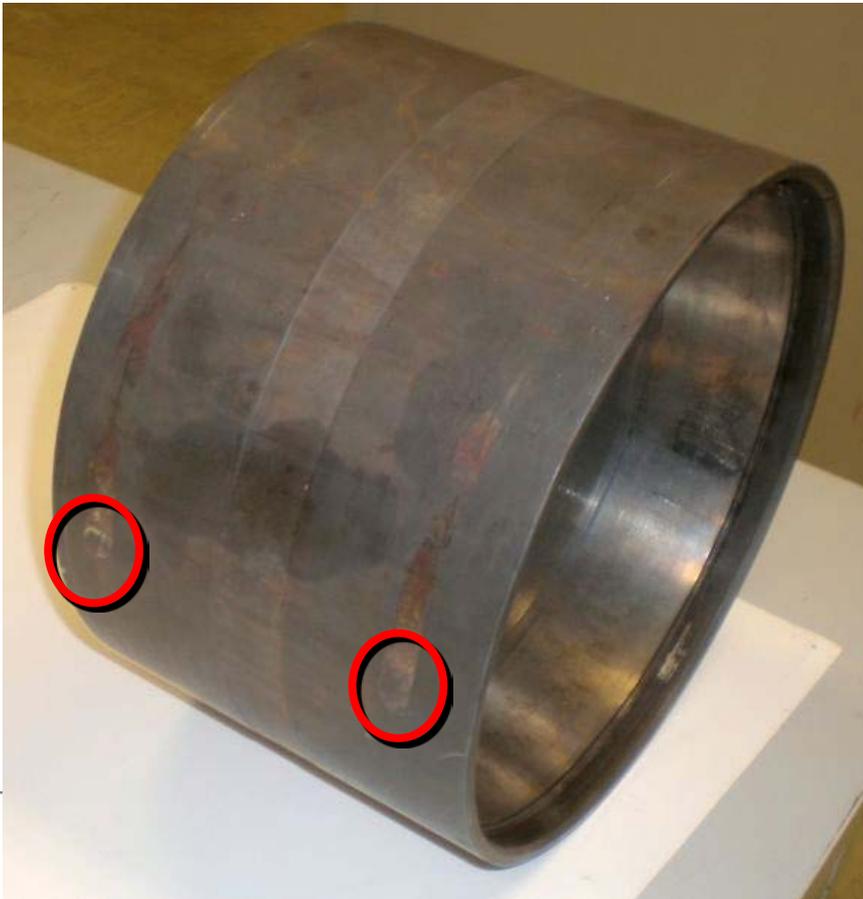
- Radius of adapter pads incorrectly machined (small) and cup is pinched



Abnormal Adapter Contact Pattern



- The tips of the adapter “legs” are carrying the load.



Point Load from Adapter Legs

- Blow-out spall results in thin section
- This and concentrated point loading caused crack

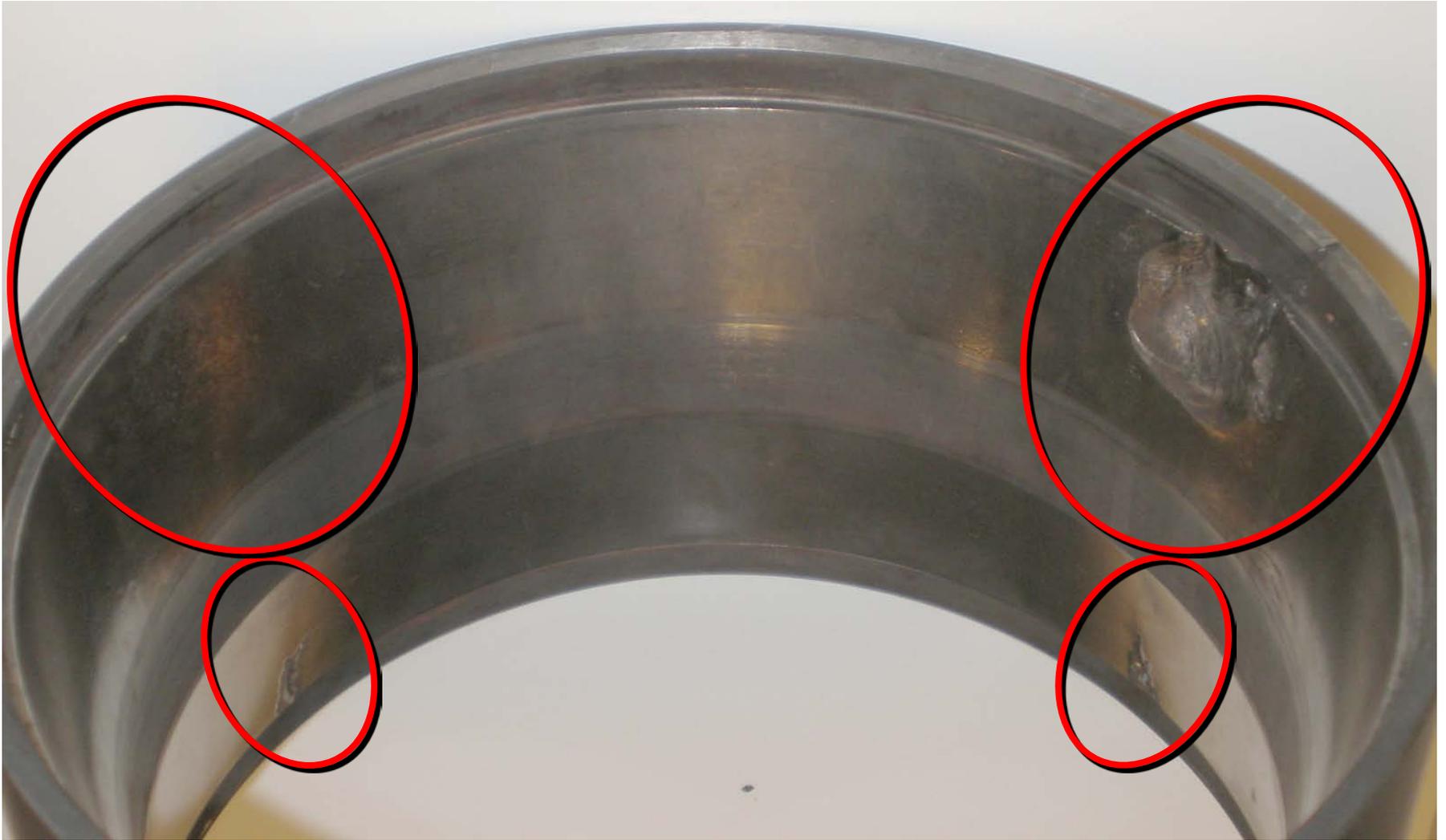


Point Load from Adapter Legs

- As viewed from the outside of the cup
- Blow-out spall results in thin section and crack

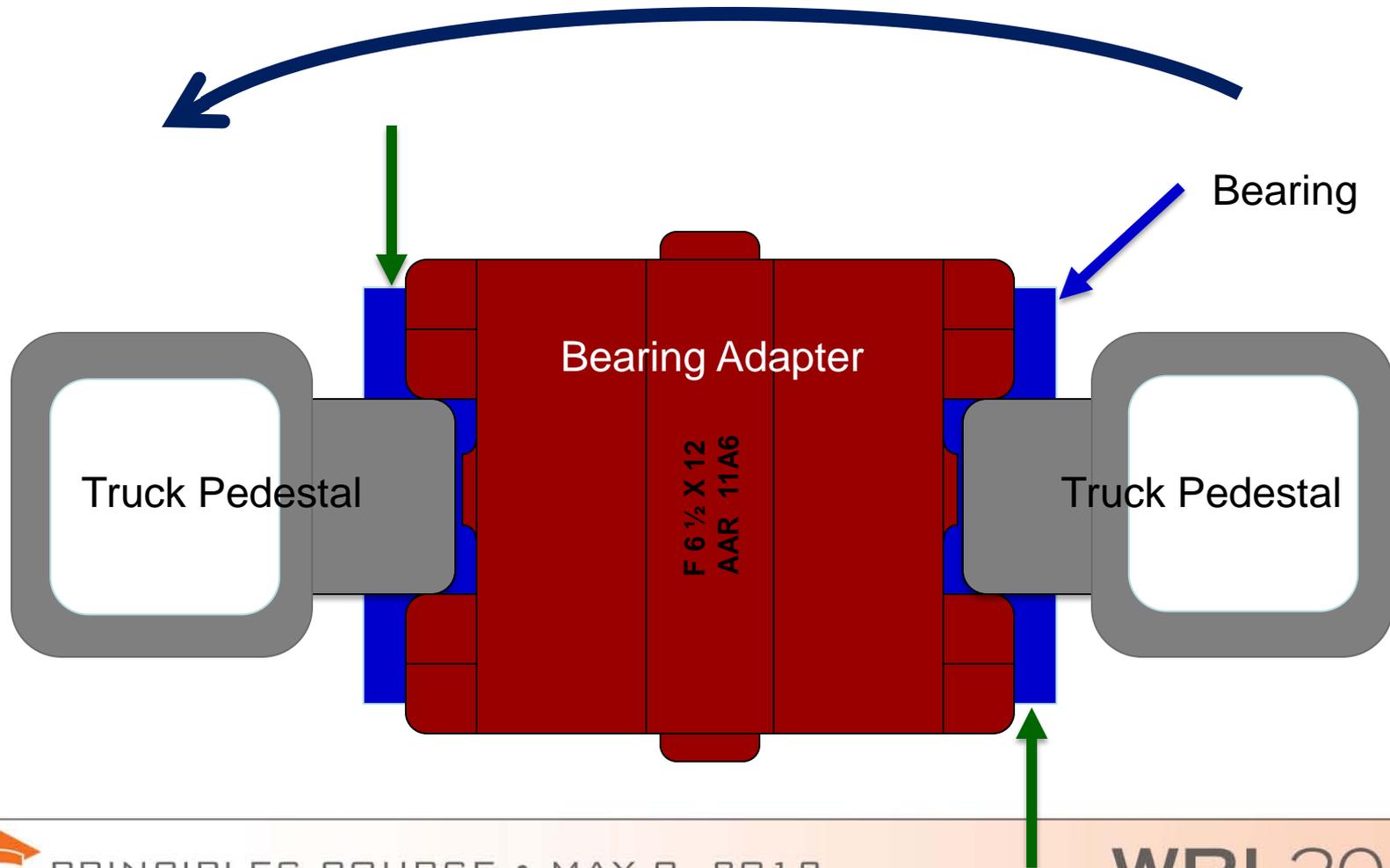


Point Load from Adapter Legs

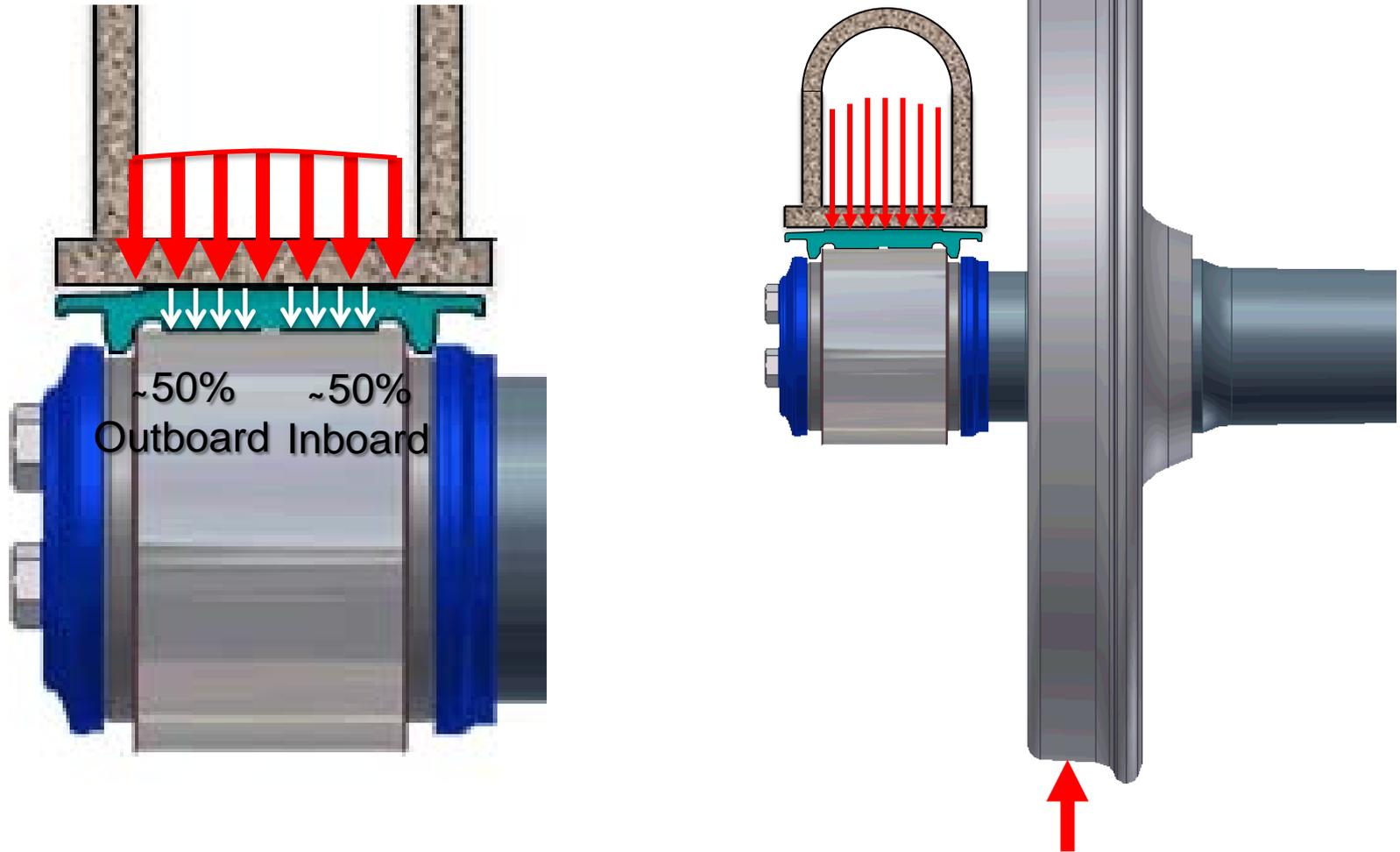


Adapter Legs Too Tight Against Sideframe

- Prevents wheelsets from steering while in curves
- Causes application of offset forces to the bearing

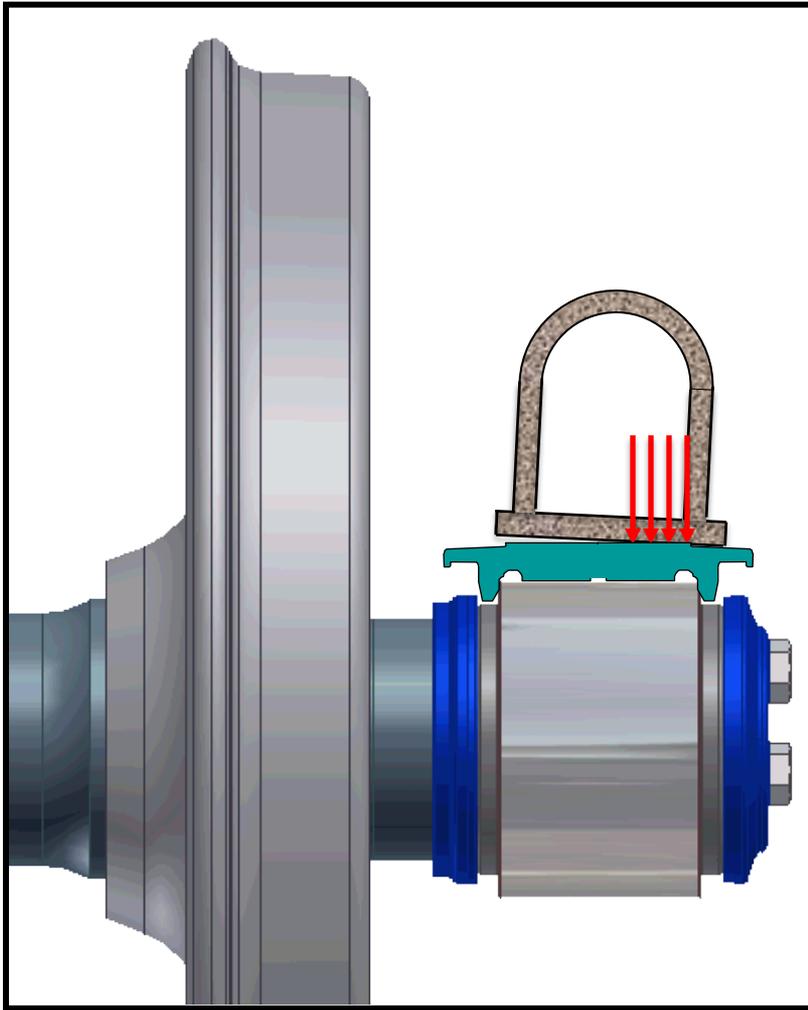


Normal Bearing Loading



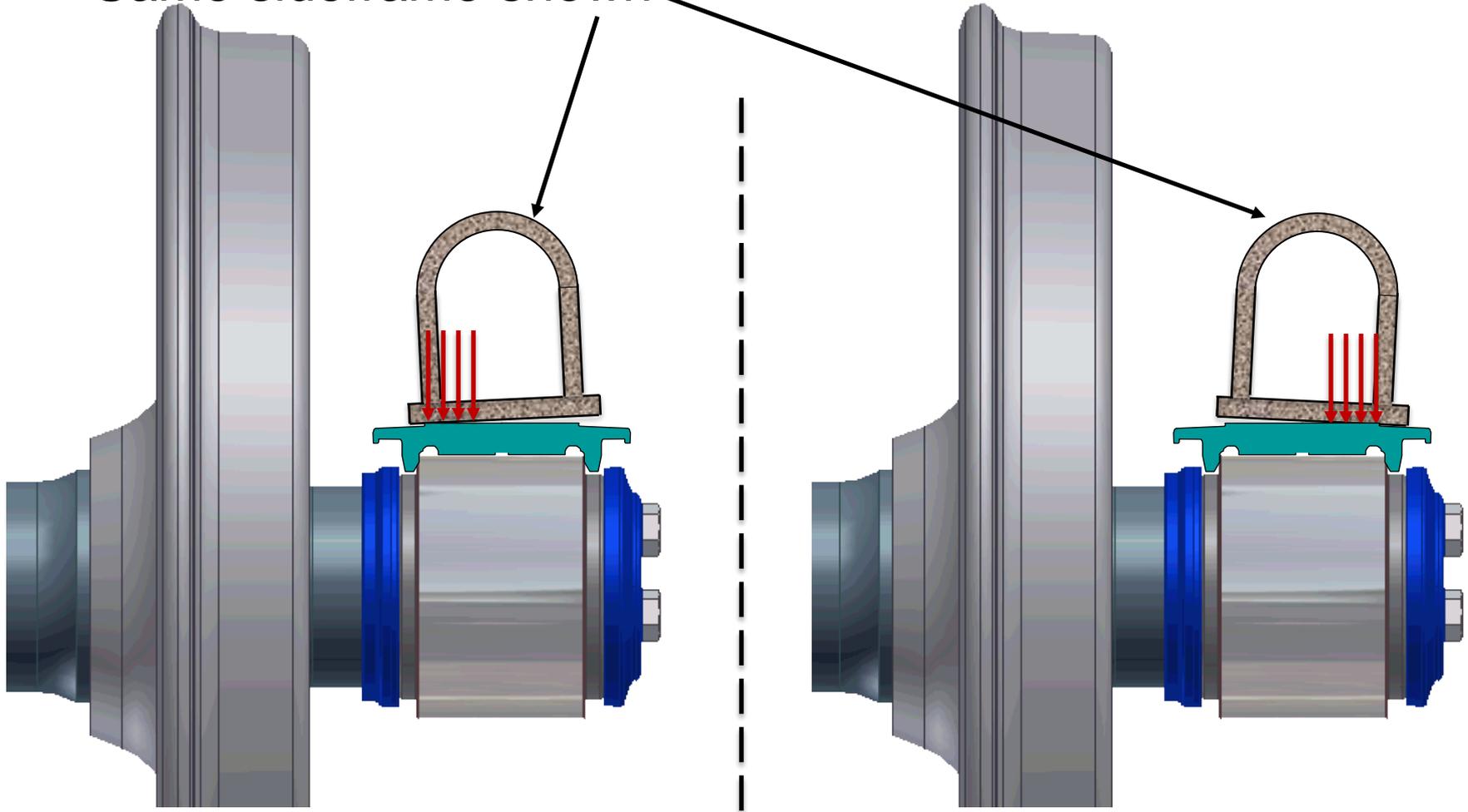
Sideframe Affect on Bearing

- Note wear on only one end of adapter pads

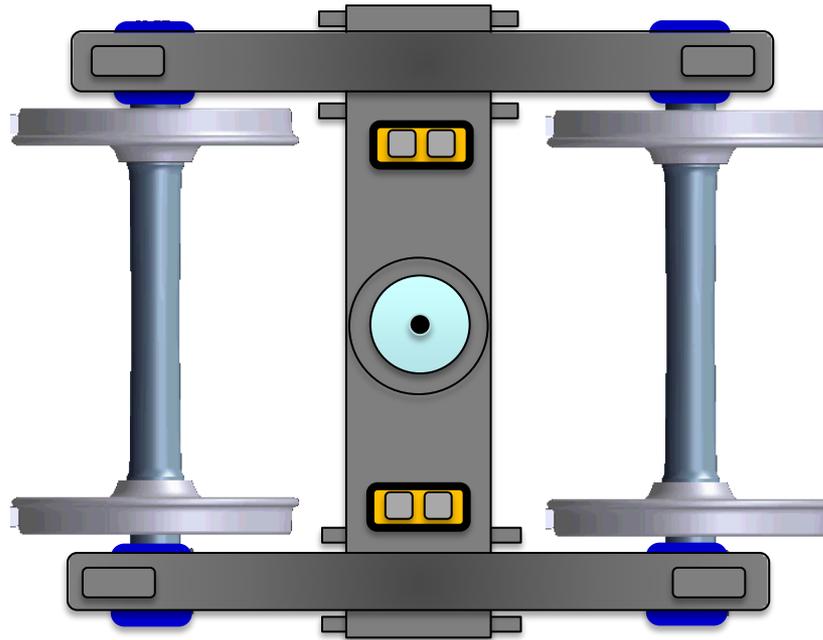


Sideframe Affect on Bearing

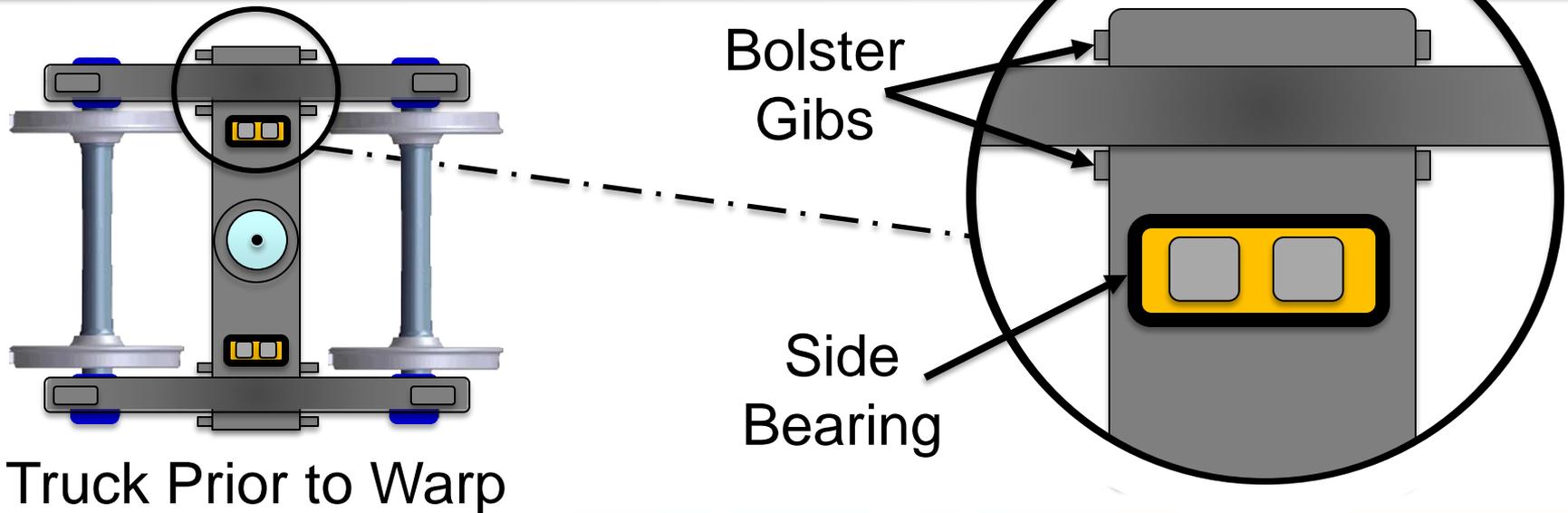
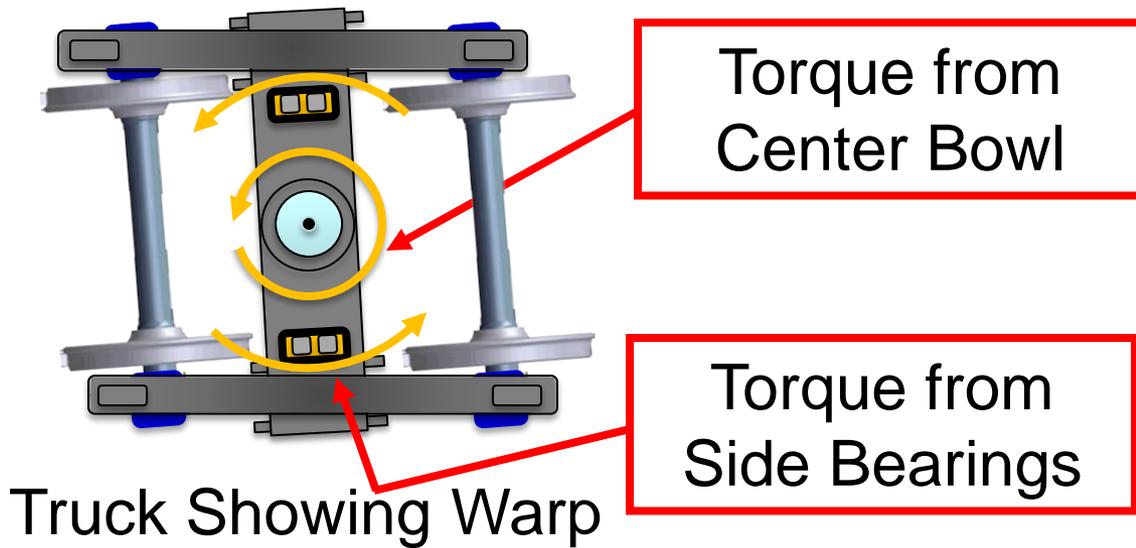
- Incorrectly cast sideframe shown (exaggerated)
- Same sideframe shown



Truck Warp

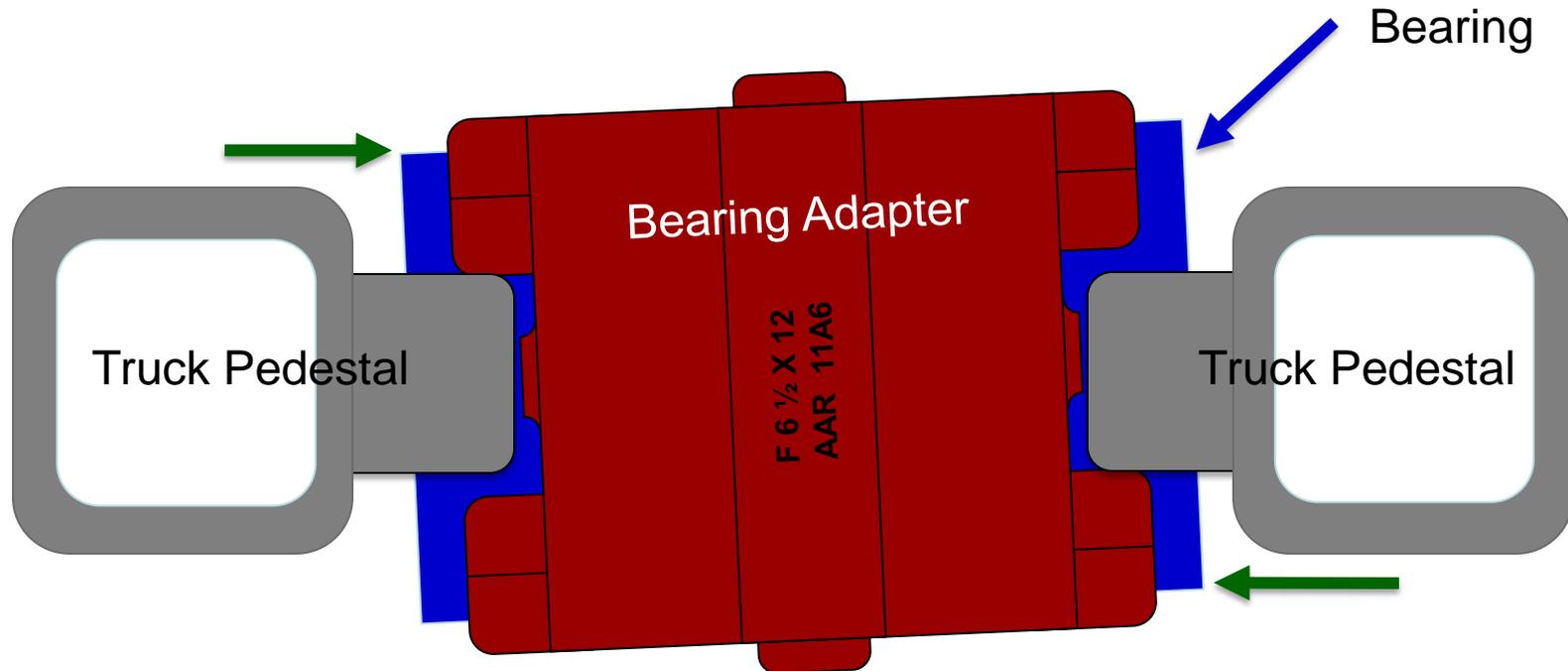


Truck Warp

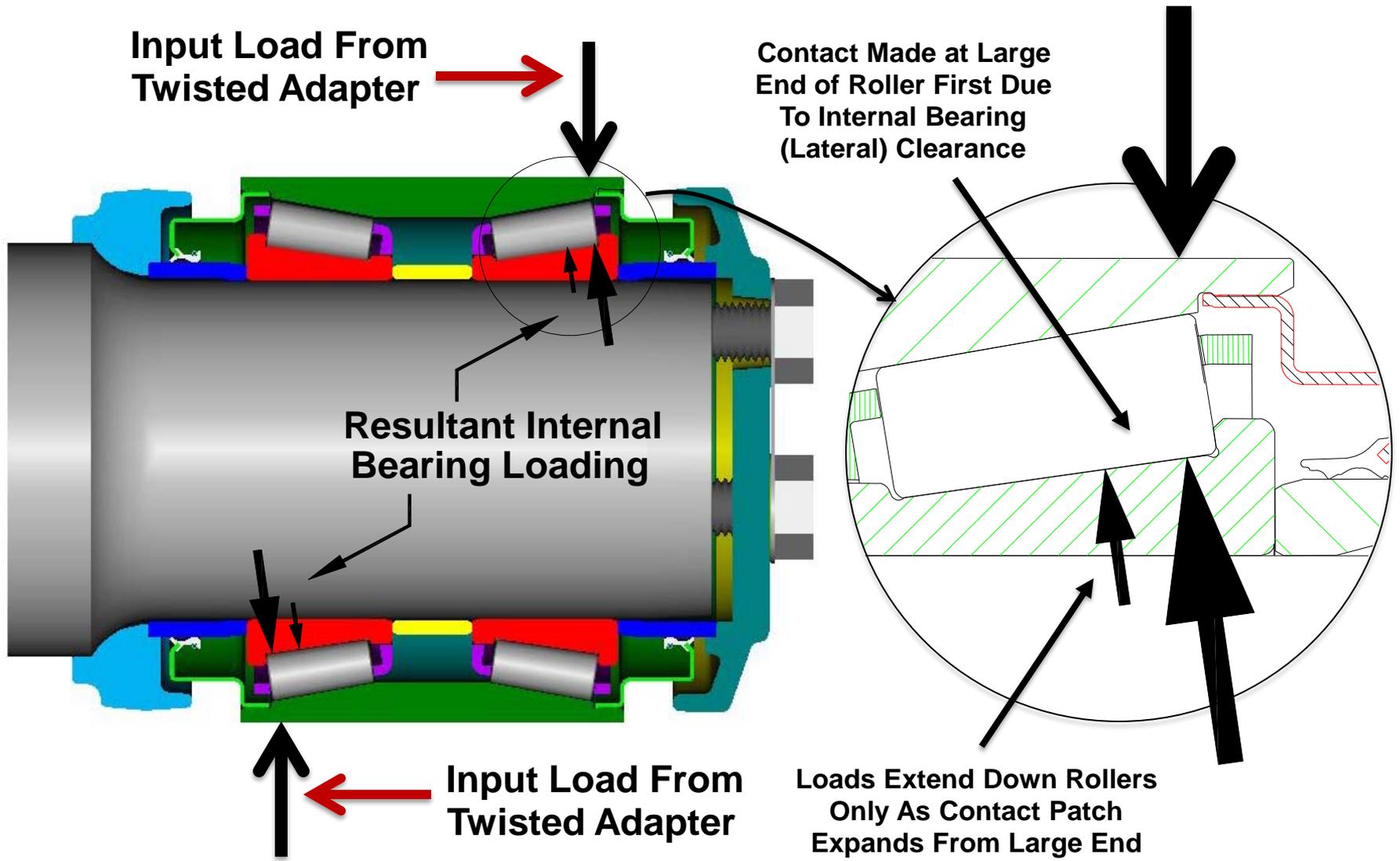


Affect of Truck Warp on Bearing

- Bearing becomes cross-loaded
- Higher loads seen on large end of the roller
- Fatigue life of bearing is reduced



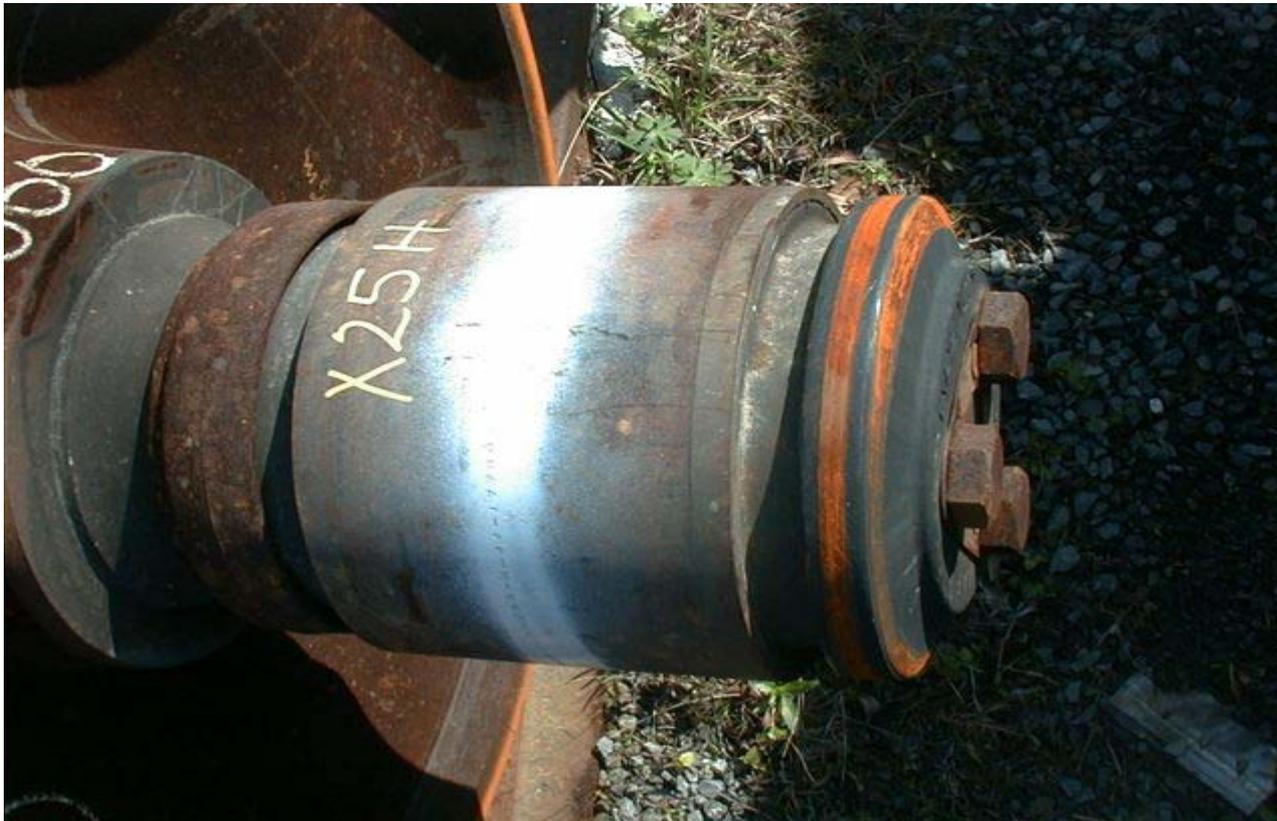
Cross-Loaded Bearing



Affect of Excessive Truck Hunting

Displaced Adapter to the Outboard Side

- Contact with End Cap
- Displaced adapter to inboard side will contact backing ring
- Frame keys recommended

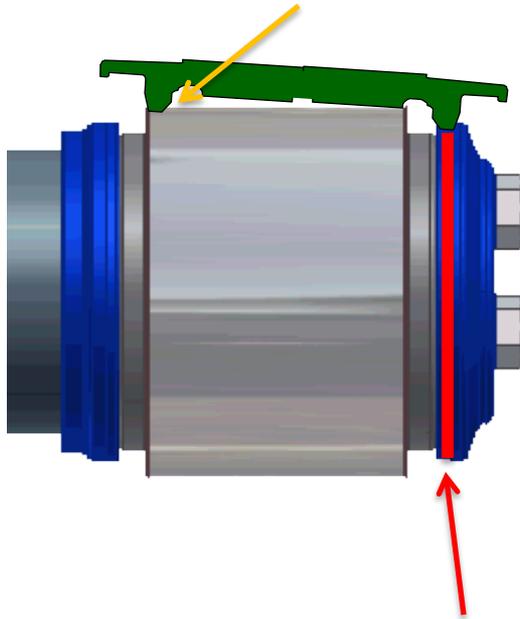


Adapter Displacement

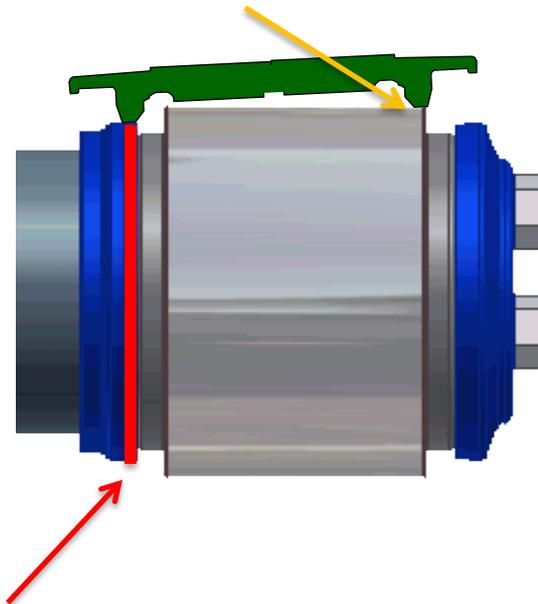
Outboard Displacement

Inboard Displacement

Point Loading of Inner Ring (Cup)



Contact with End Cap

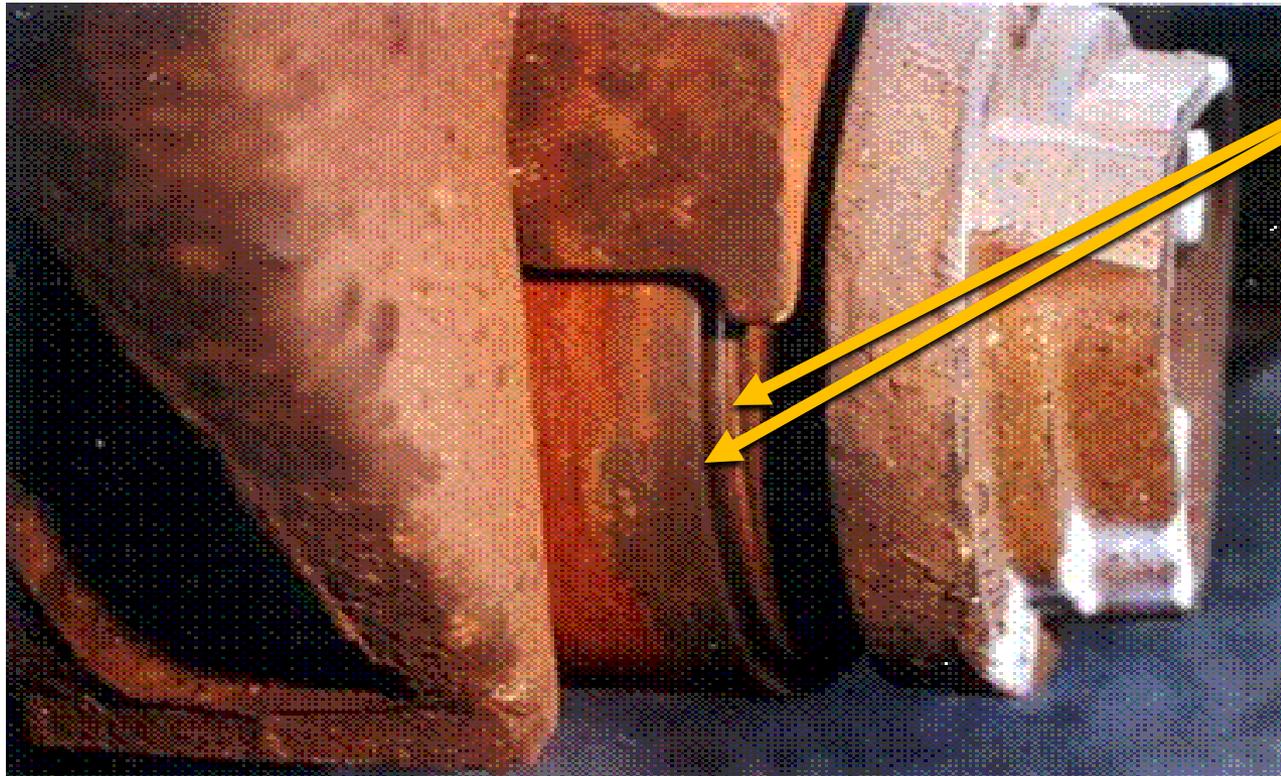


Contact with Backing Ring



Affect of Excessive Truck Hunting

Displaced Seal on the Outboard Side - Potential Grease Loss



Grease
Seal
Displaced



Truck or Adapter Related Spalling

- Spalling shows on either inboard or outboard side
 - Possible adapter manufacturing issue
 - Possible side frame manufacturing issue
- Long spall band coinciding with length of adapter contact



Wheel Defect – Out of Round

- Failures include cage breakage and increased load seen by raceway components leading to premature spalling



Questions?

