

Wheel Matching Technology to Create Conformal Frogs at AirTrain JFK



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Bombardier Transportation

Presentation Outline

- 1 Wheel Match Technology (WMT) – What is it ?**
- 2 Defining Conformal Frogs**
- 3 Comparison Test Program and Results**
- 4 Profiling Device and Process**
- 5 Inspections**
- 6 Discussion**



Wheel Matching Technology (WMT)

Problem Description and State of the Art

- Rapid surface wear over turnout frog profiles cause ‘pot-hole’ effect resulting in extreme wheel hammering and significant rail and vehicle damage (JFK example)
- Preventative solutions:
 - Weld repair every 2-3 years
 - Moveable Point Frogs
 - *New Conformal Frogs*
- Crossover frogs are an important cost driver for the operator affecting railway safety > speed restrictions



Technology Description

WMT frog profiling process transforms any AREA steel frog into Conformal frog without need for replacement



Benefits:

- 90% savings vs new replacement Conformal frog
- > 5x increase of maintenance intervals after retrofit
- 70% reduction in bogie structural strain
- 20 dBa wayside noise reduction @ 80 km/h
- Repeatable and consistent accuracy: +/-0.2⁰ profile
- Retrofit time similar to replacement time (3-4-hours)

Achieving Conform Frog Performance



New Conformal Frog Installation
Cost > 30K \$USD



WMT Repair Process
Cost < 3K \$USD

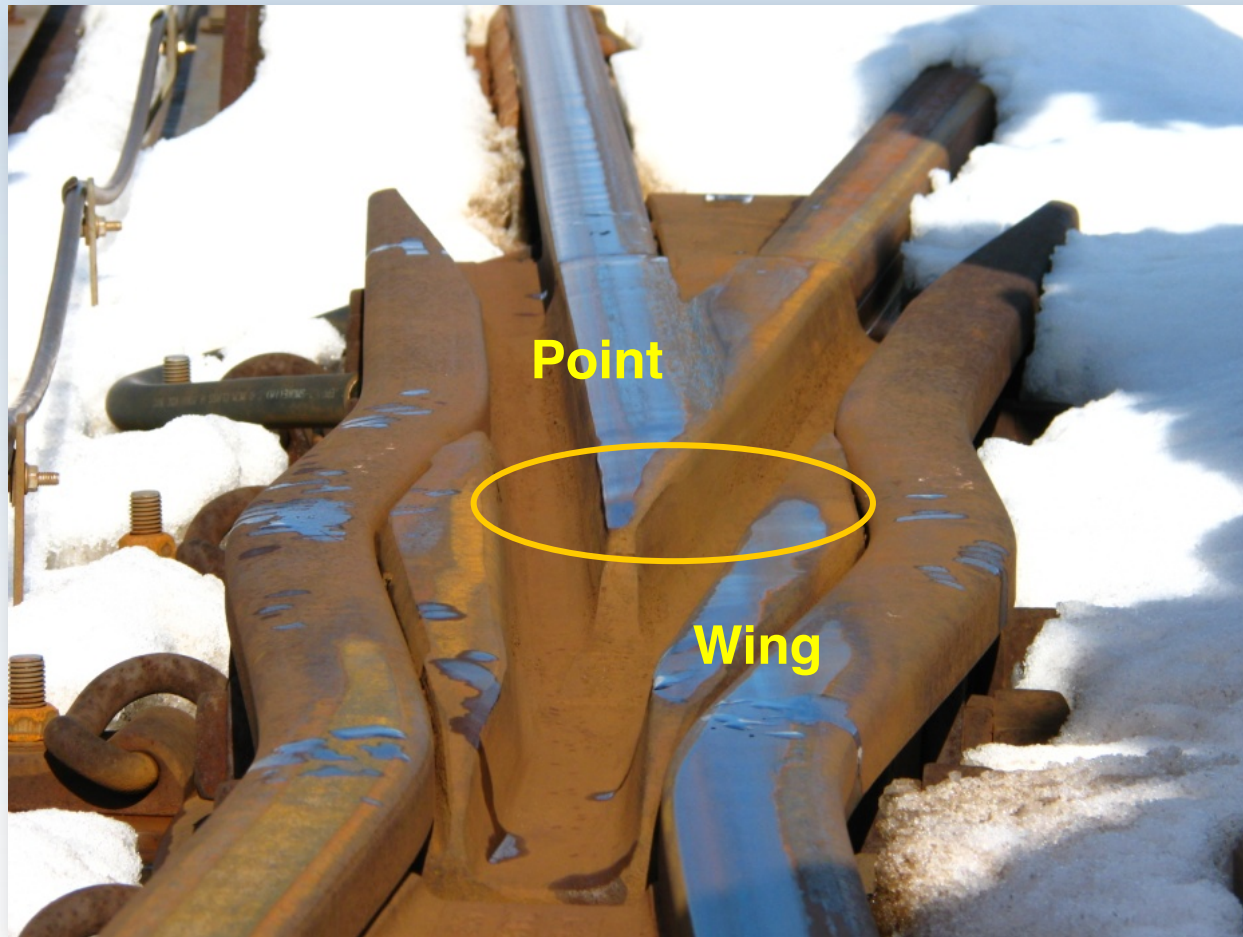


*Transit typically specify **Moveable Point Frogs** for low N&V applications ... substitute **Moveable Point with Conformal Fixed Frog** for > 5x savings*

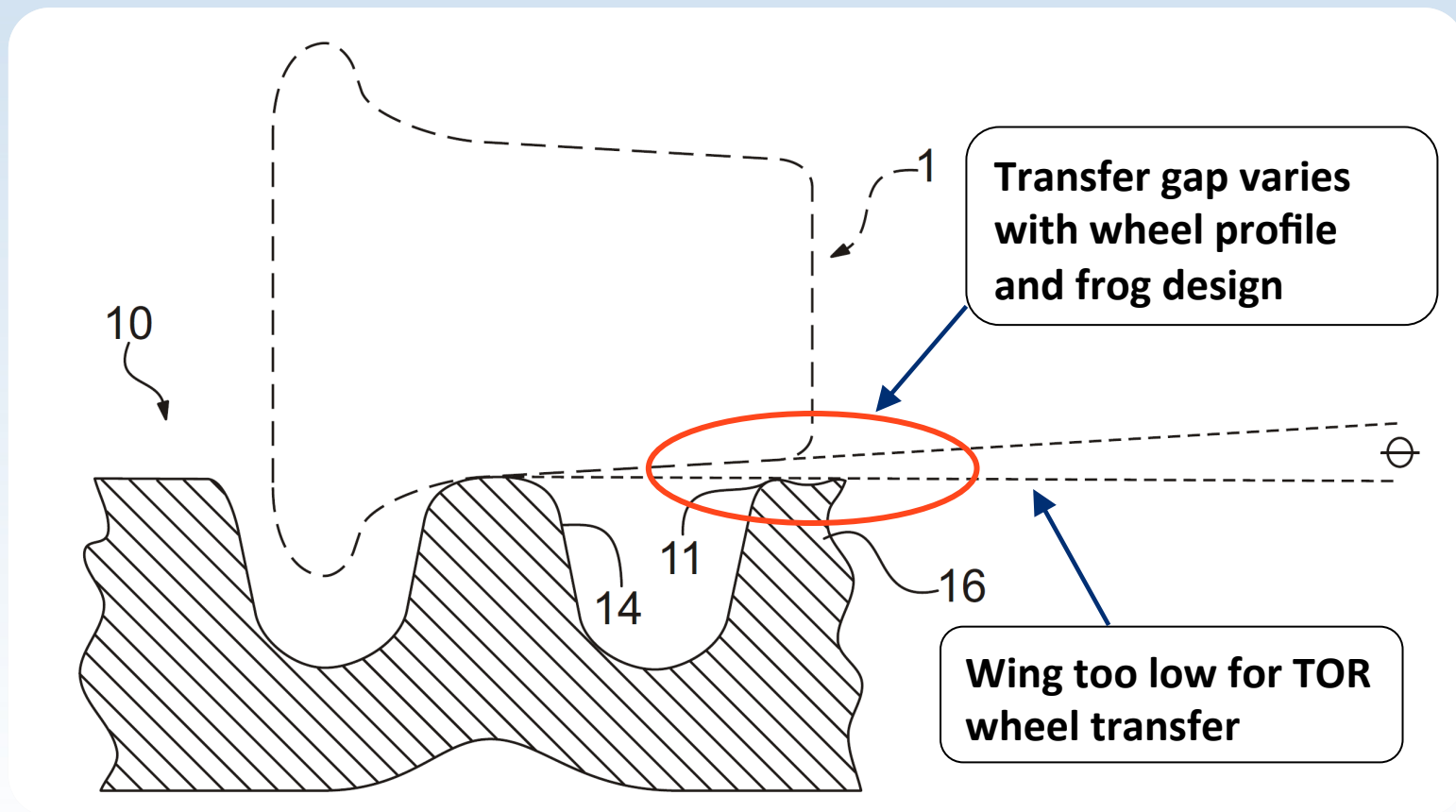
Cost > 150K \$USD

Defining Conformal Frogs

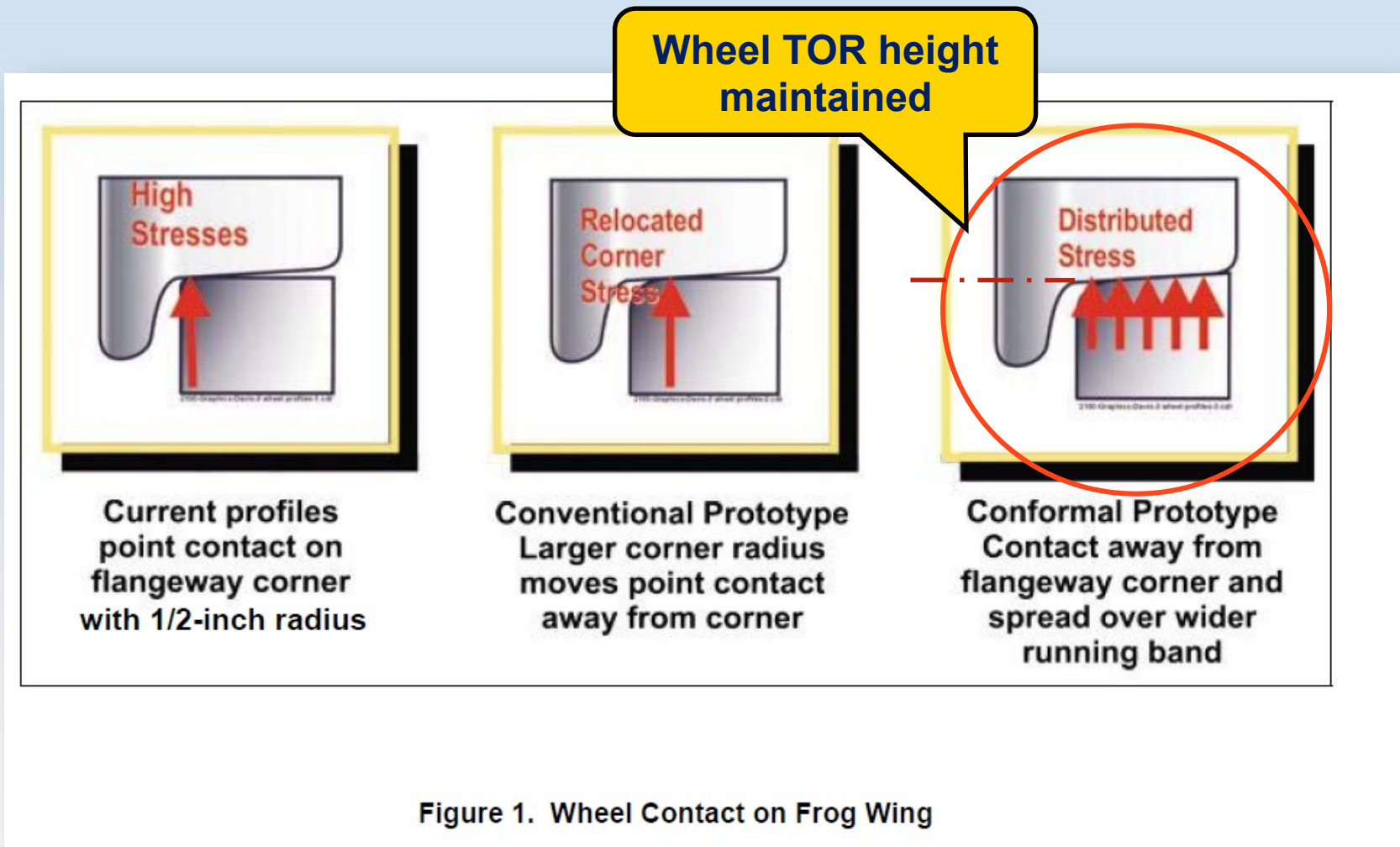
Worn Frog – Point /Wing (10mm below TOR)



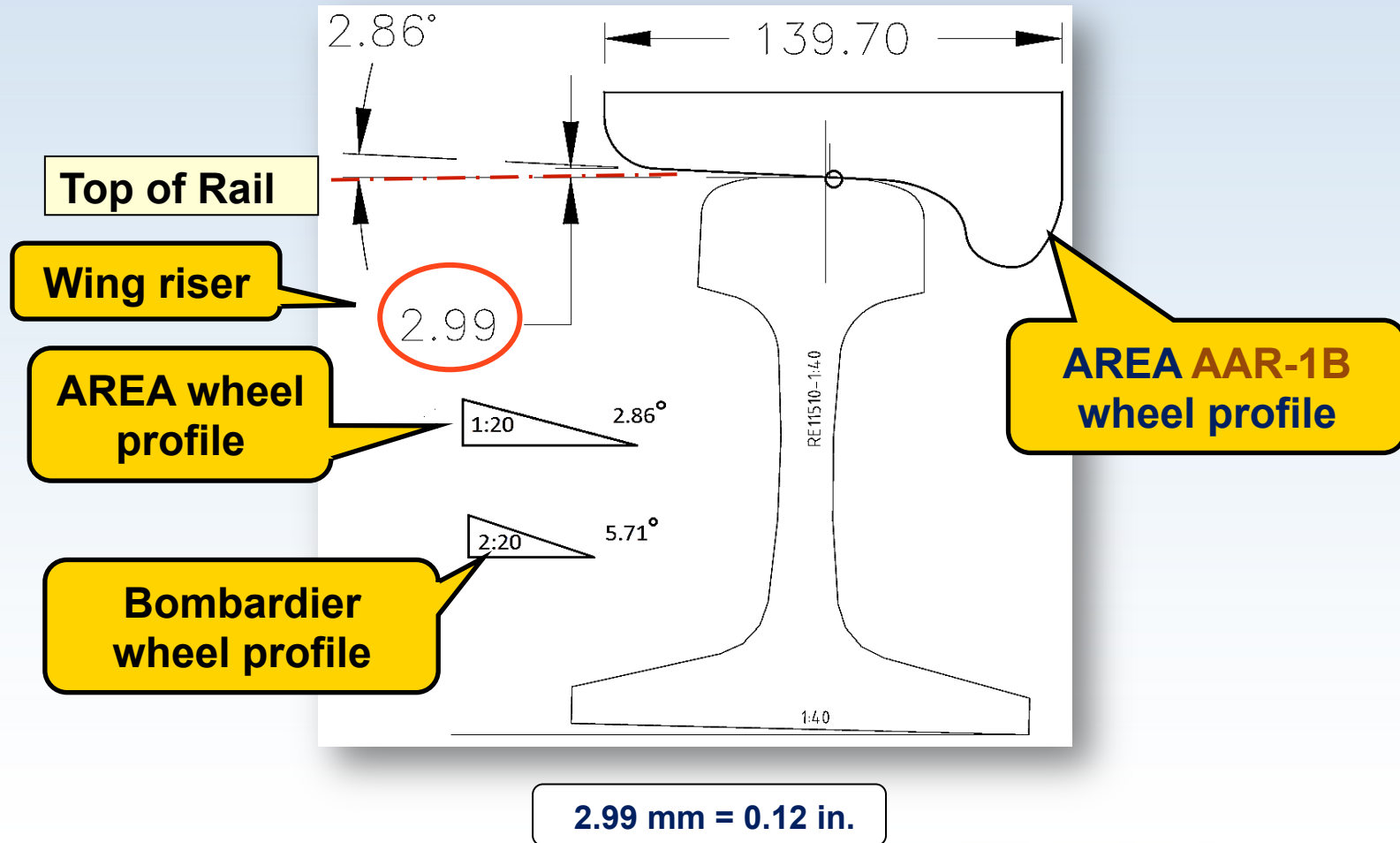
Typical Wheel Transfer thru Frog



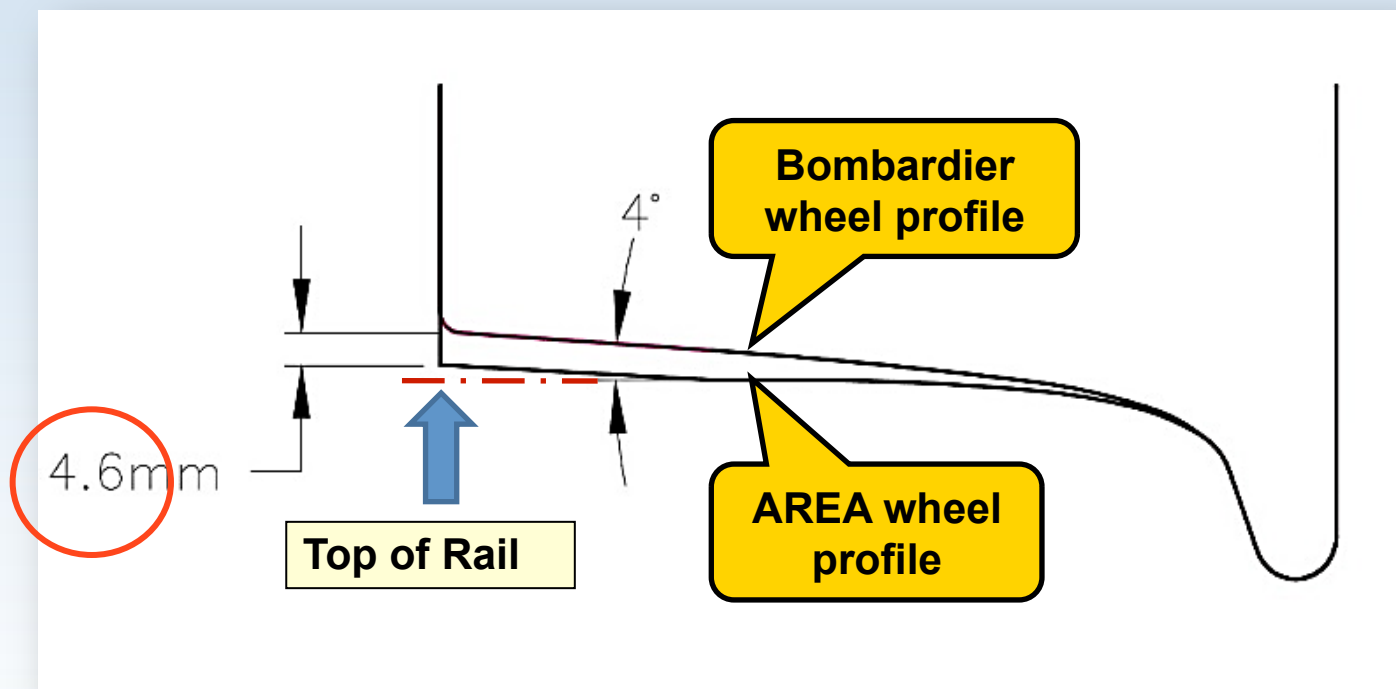
What is “Conformal Frog”



AREA vs BT Wheel Profile



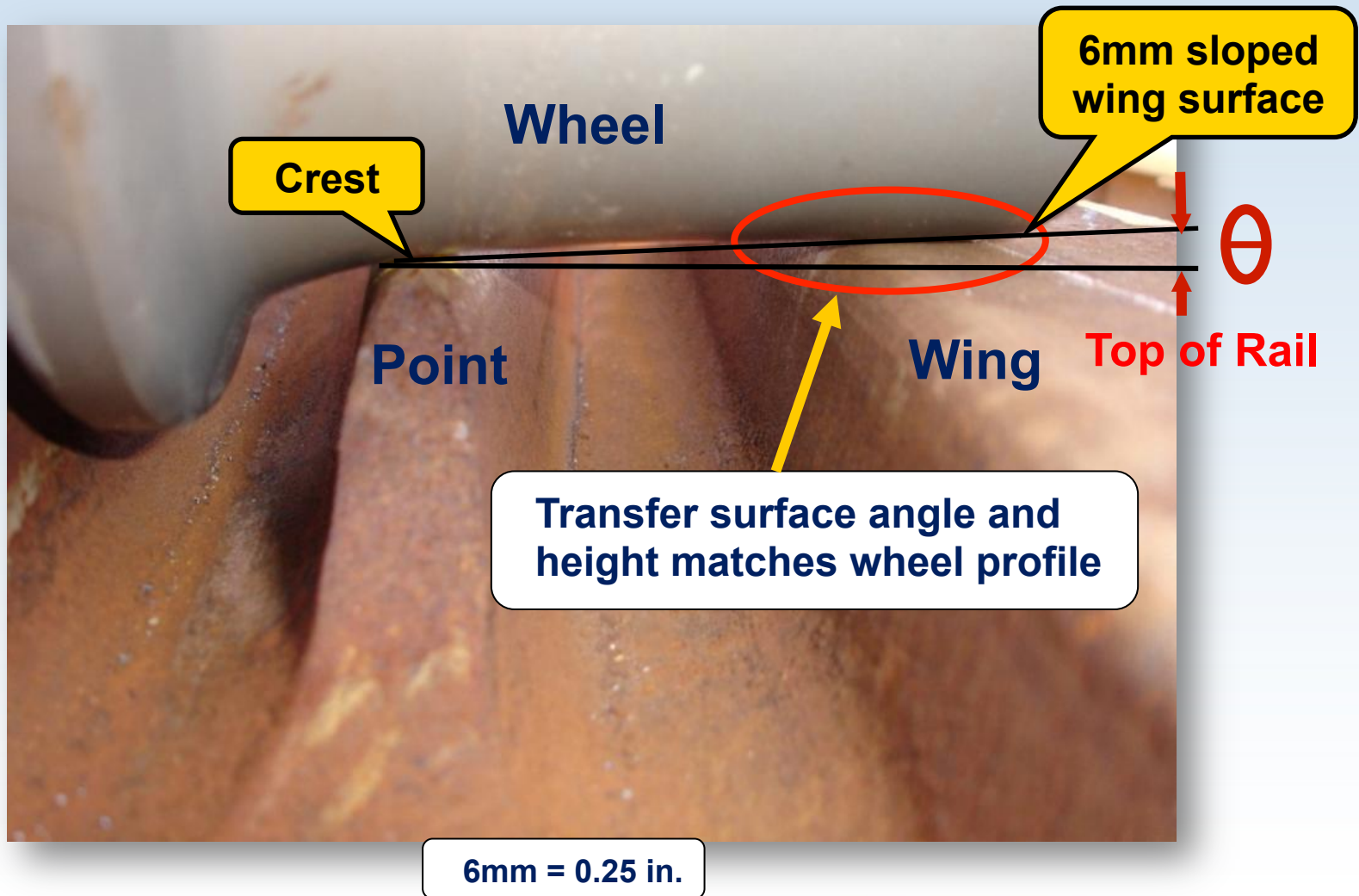
AREA vs BT wheel profile



4.6 mm = 0.19 in.



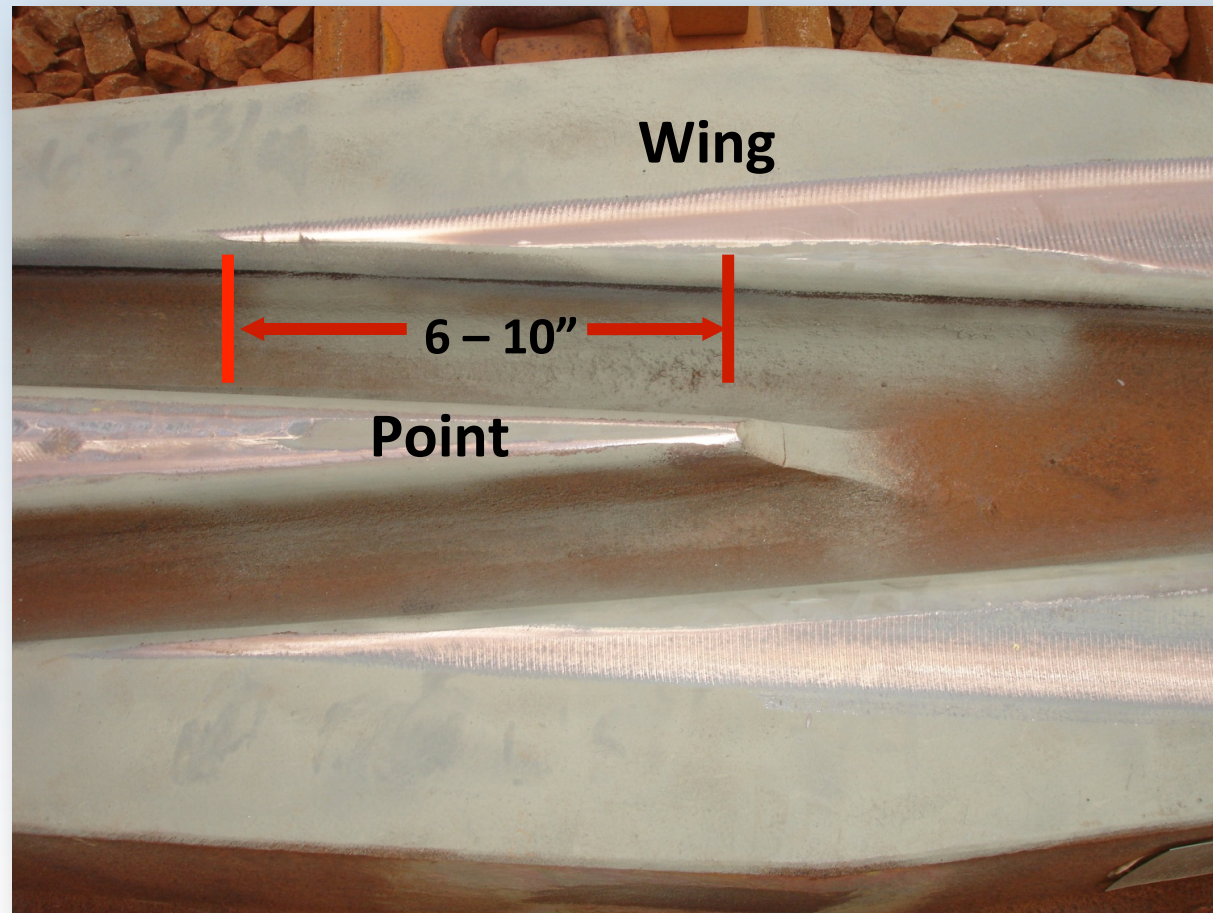
Conformal Frog Interface



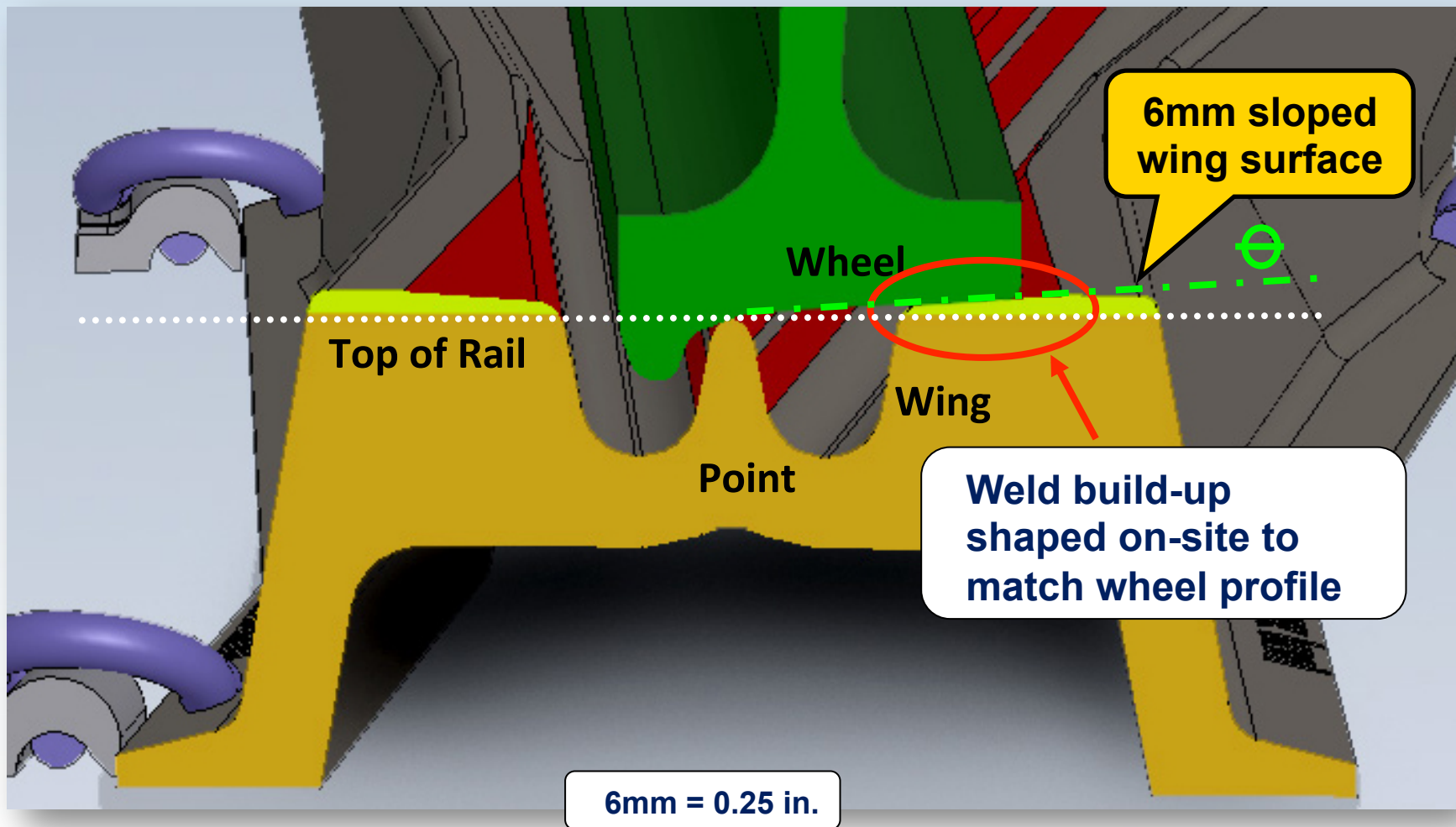
Conformal Frog at JFK Custom machined profile



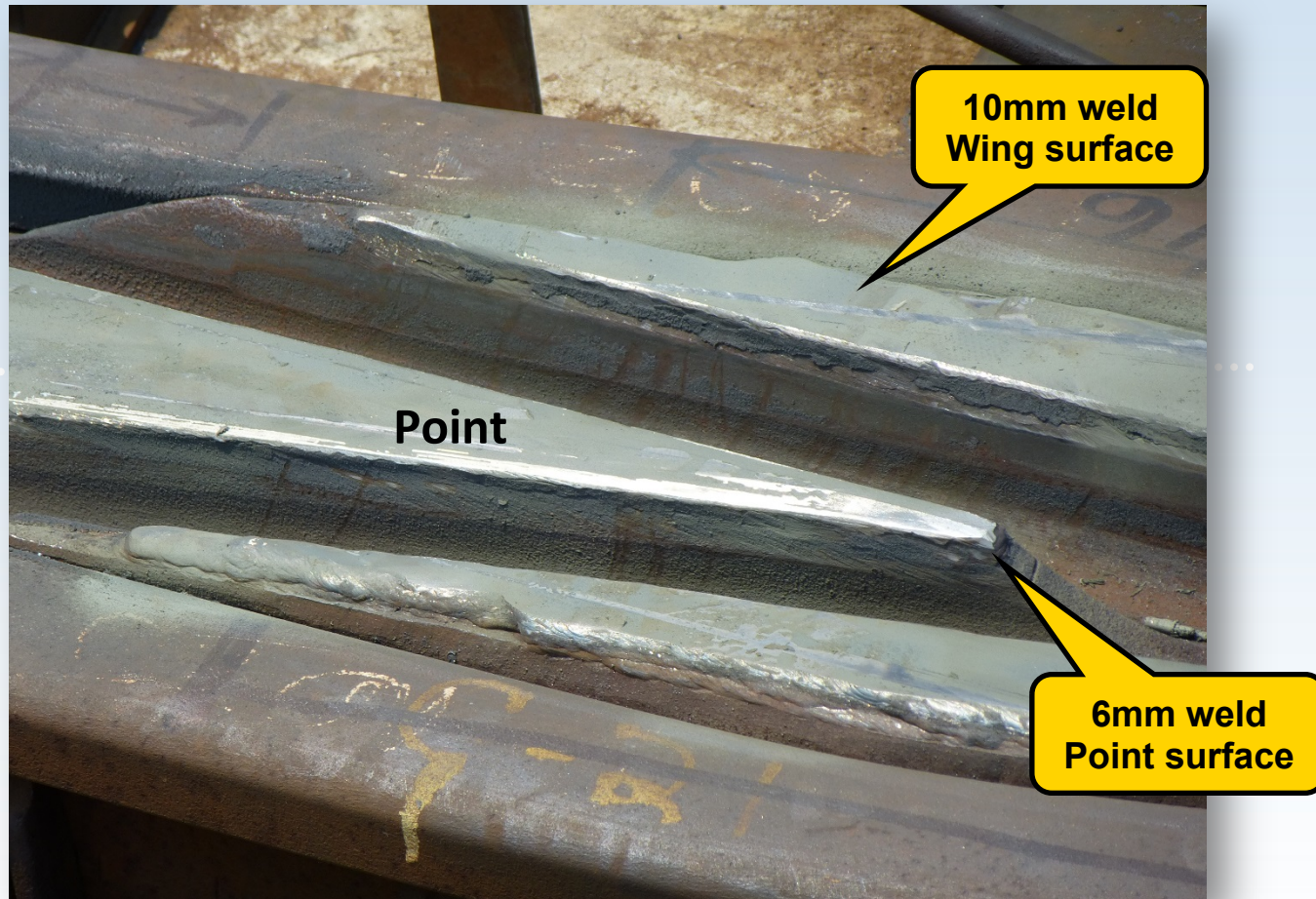
Shared Wheel Support Across Transfer Gap



Conformal Frog WMT Rework Process



WMT Conformal Frog



10mm = 0.40 in.

Frog/Profile Grinders



Wing risers
not repaired



Visual Rework Inspection



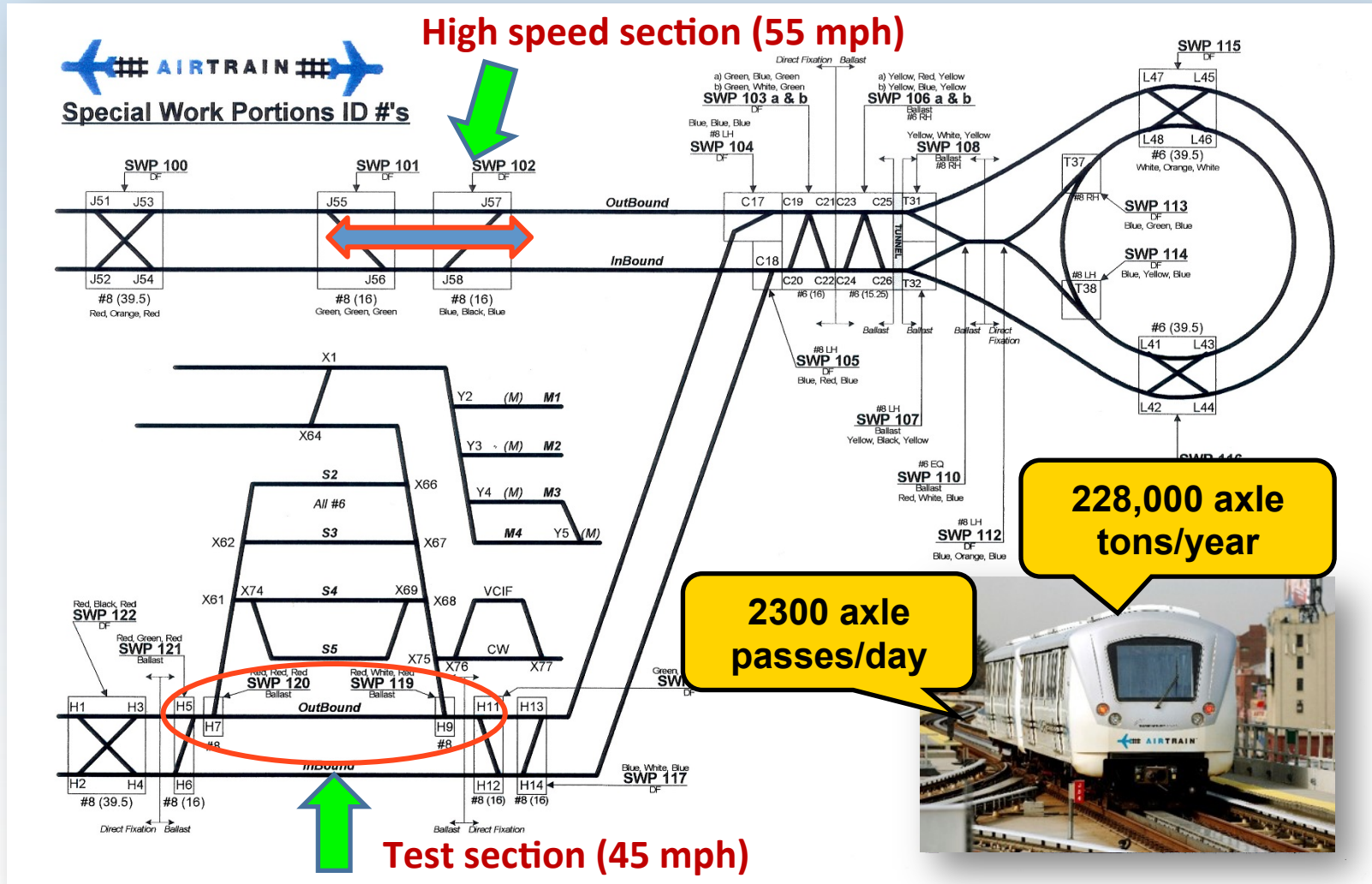
Comparison Test Program and Results

AirTrain JFK



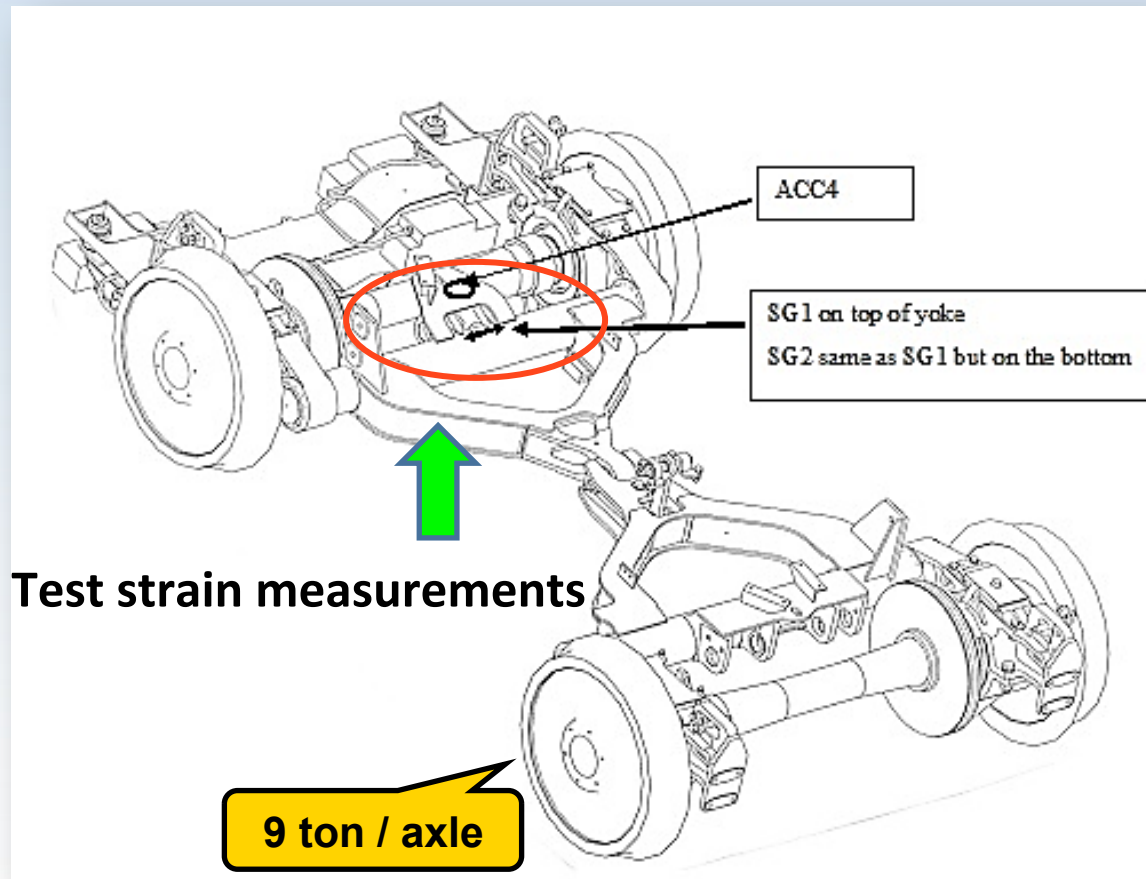
AirTrain JFK Alignment

44 Mainline Frogs over 13-km loop



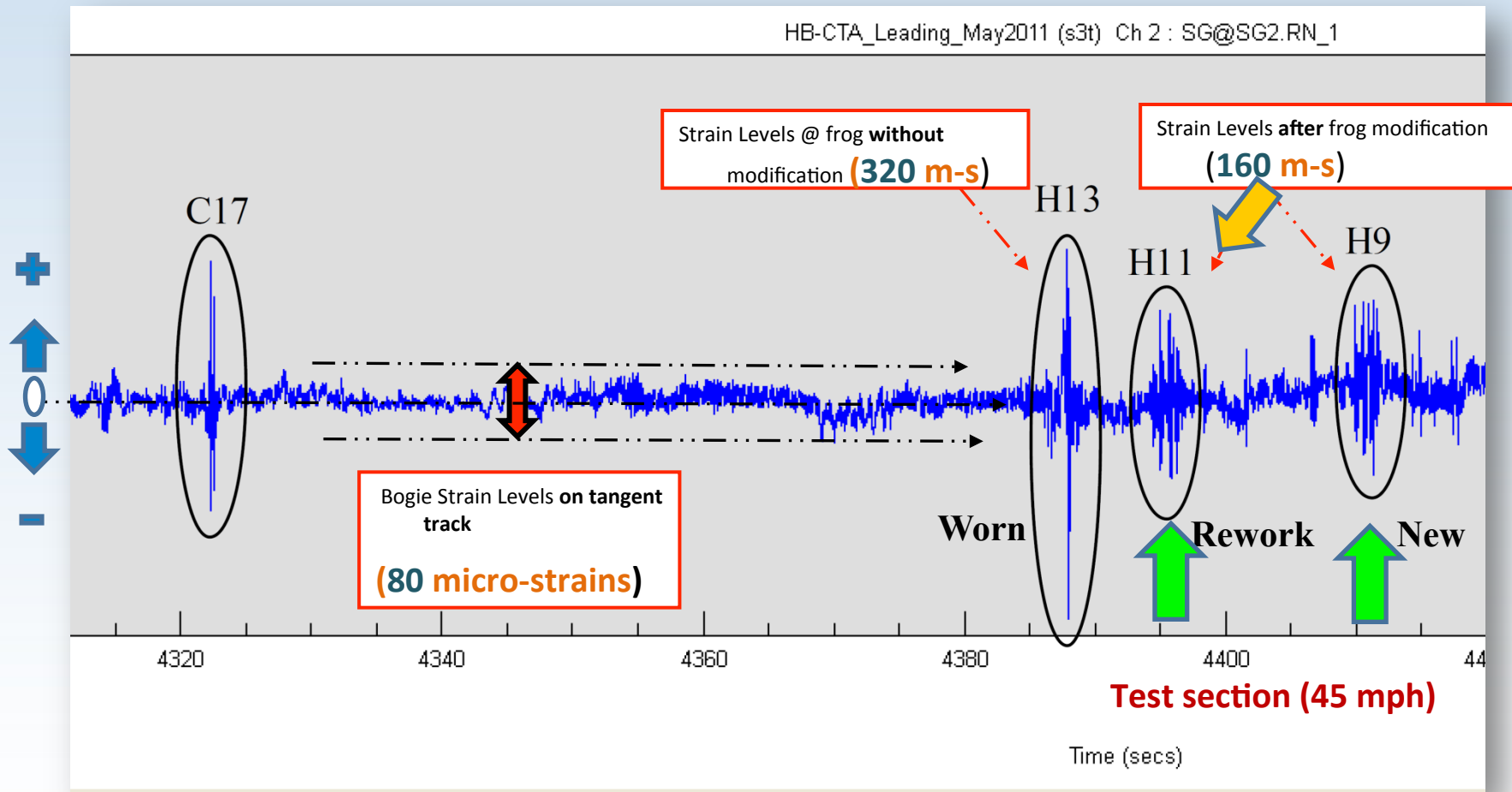
Bogie Strain Gauge Set-up

(Frog impact measurements)

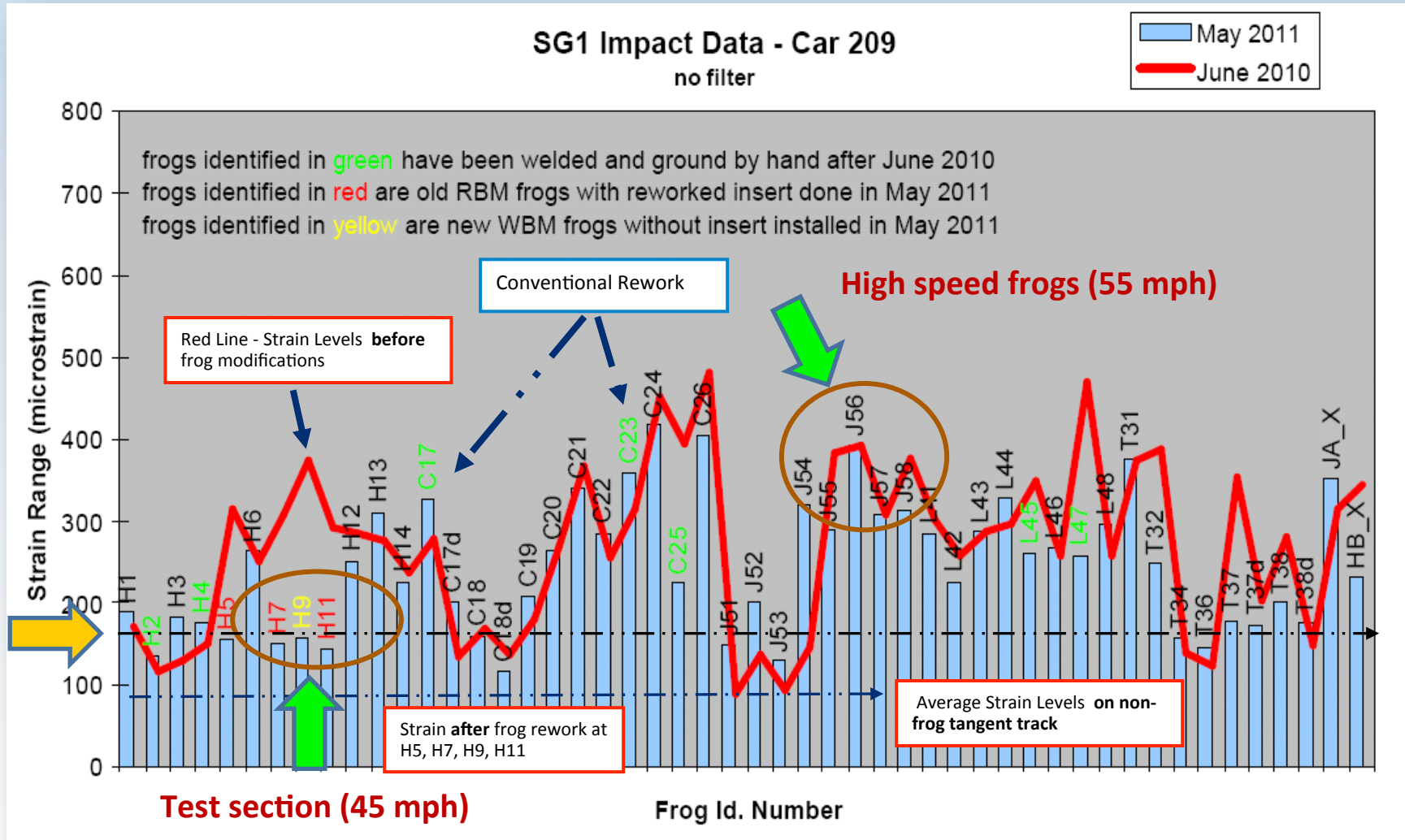


Vehicle Bogie Stress Results

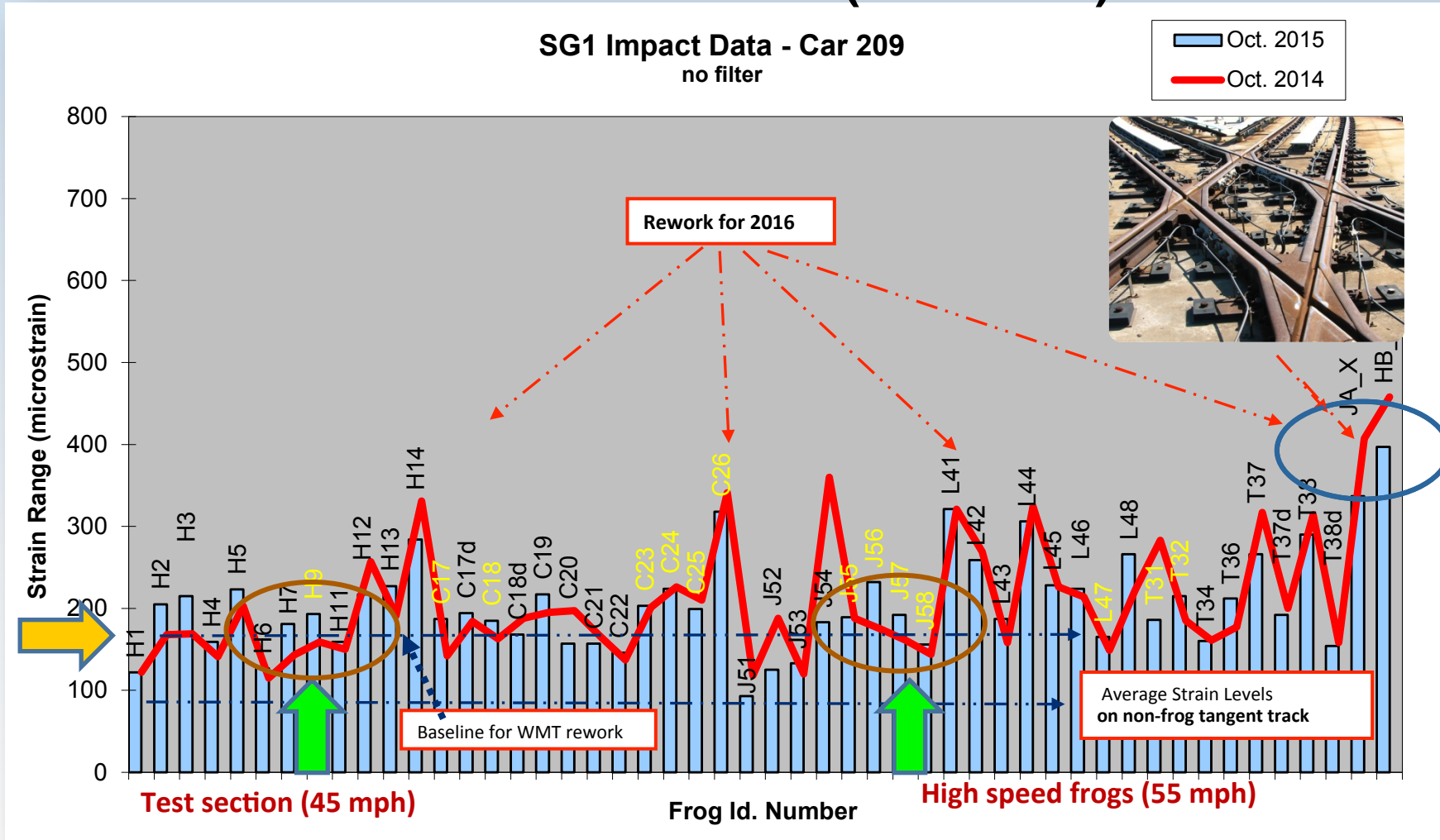
(Test section @ 45 mph)



Frog Impact Test Results After Initial Rework (May 2011)



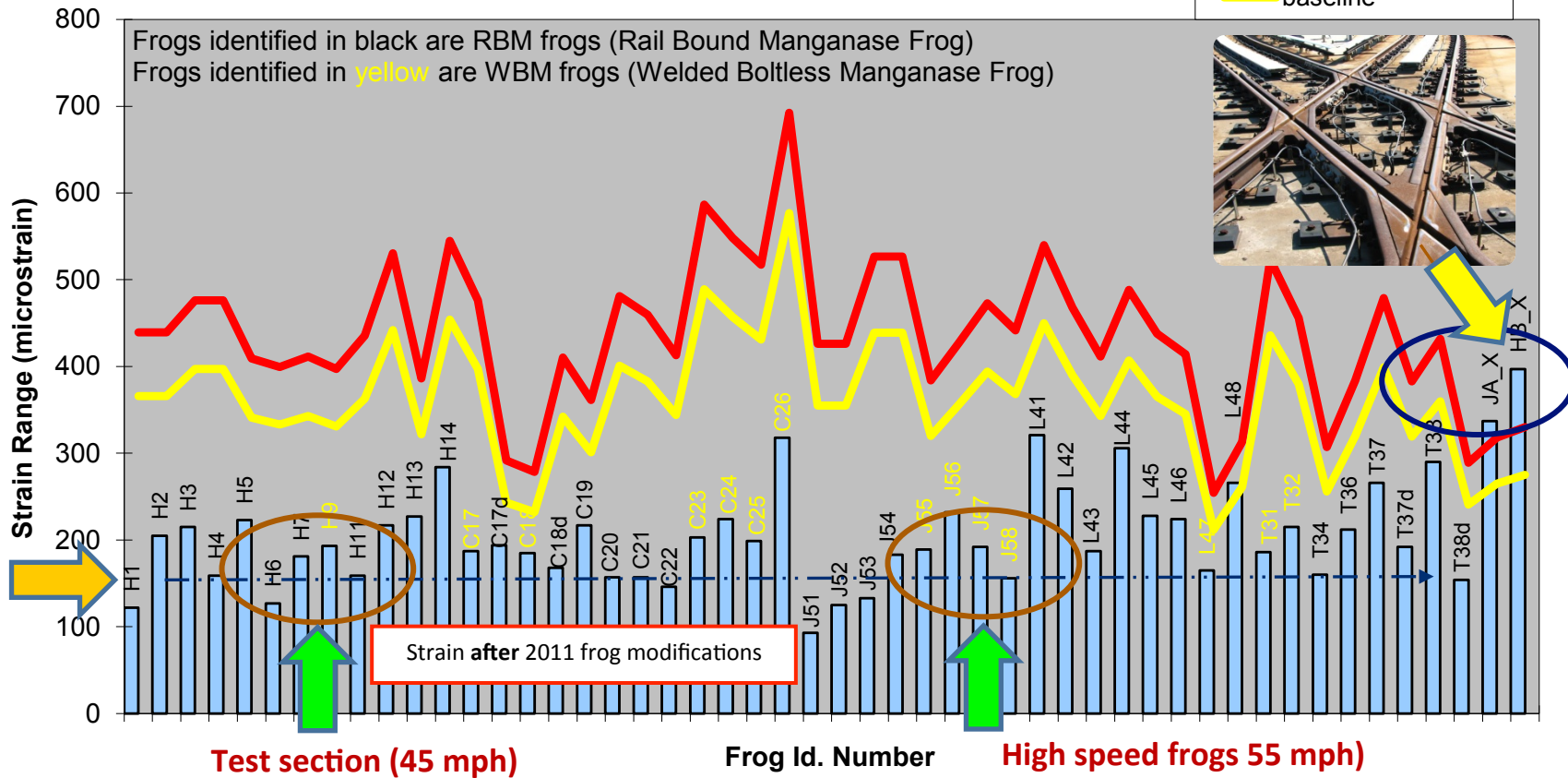
Frog Impact Test Results After 4 Years (Oct. 2015)



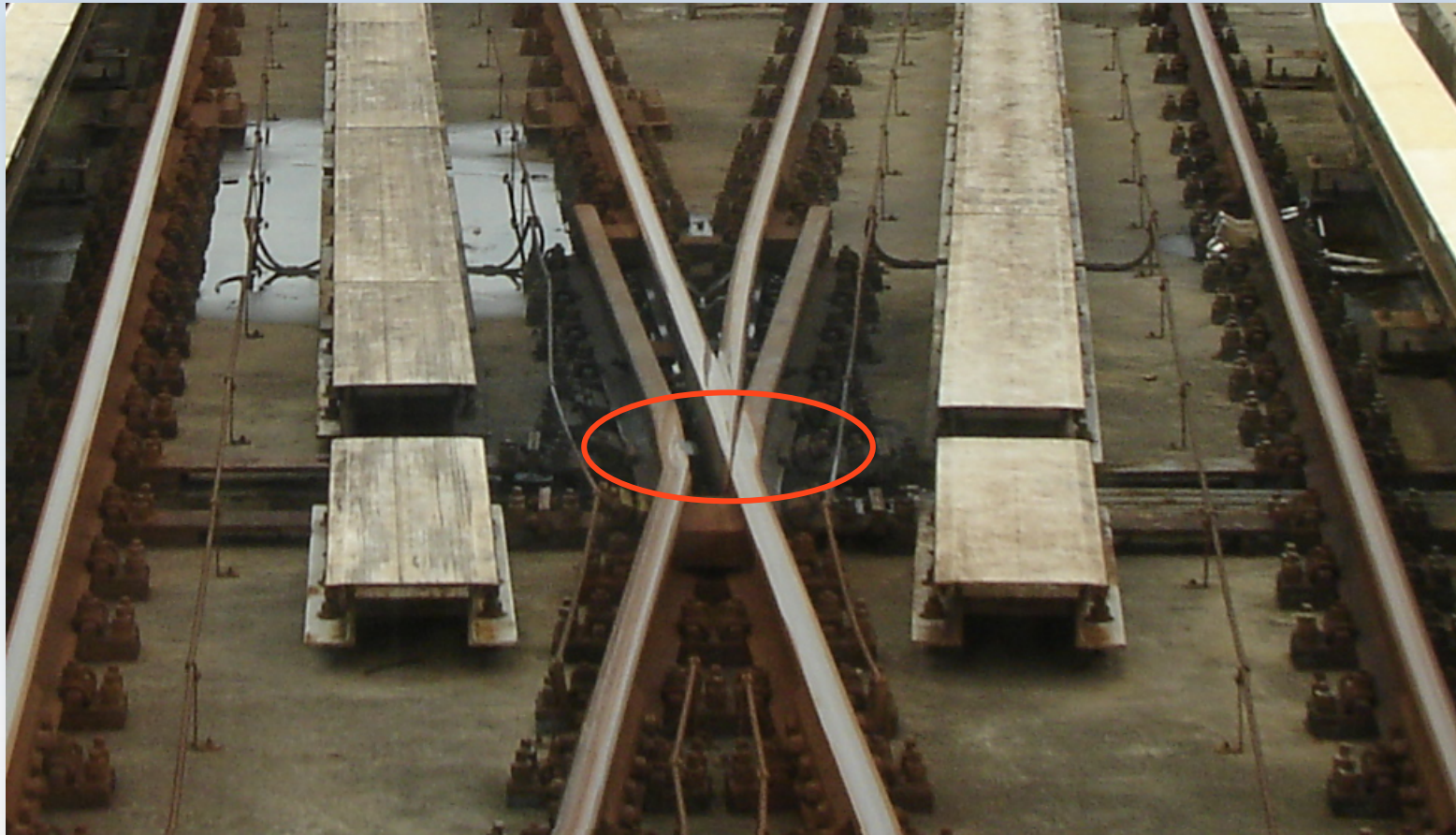
Impact Test Comparison Before/After 4 Years (2011 - 2015)

SG1 Impact Data - September 2015
car 209 - no filter

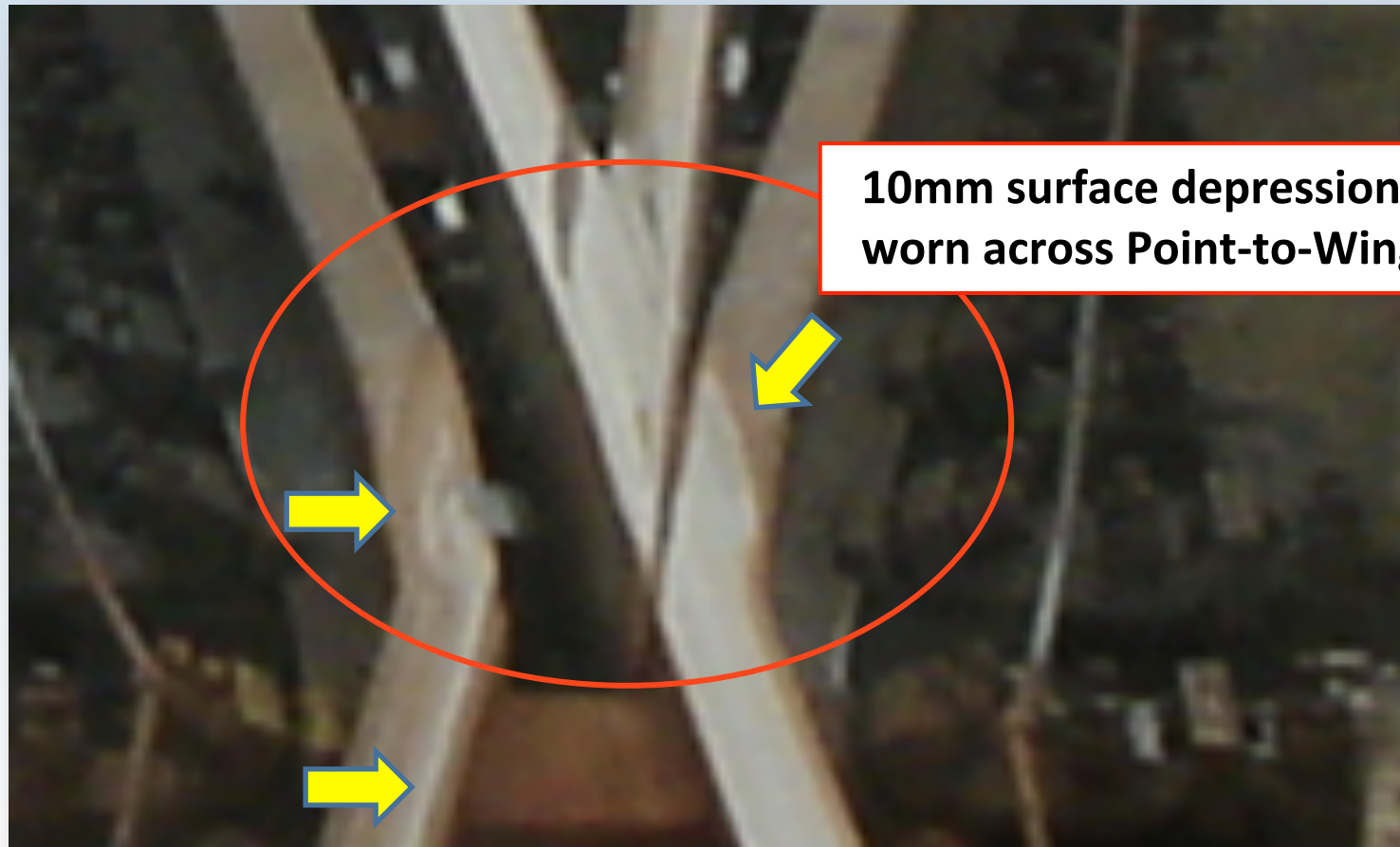
- █ Oct. 2015
- █ Maintenance Limit
- █ baseline



Typical Moveable Point Frog (Vancouver SkyTrain)



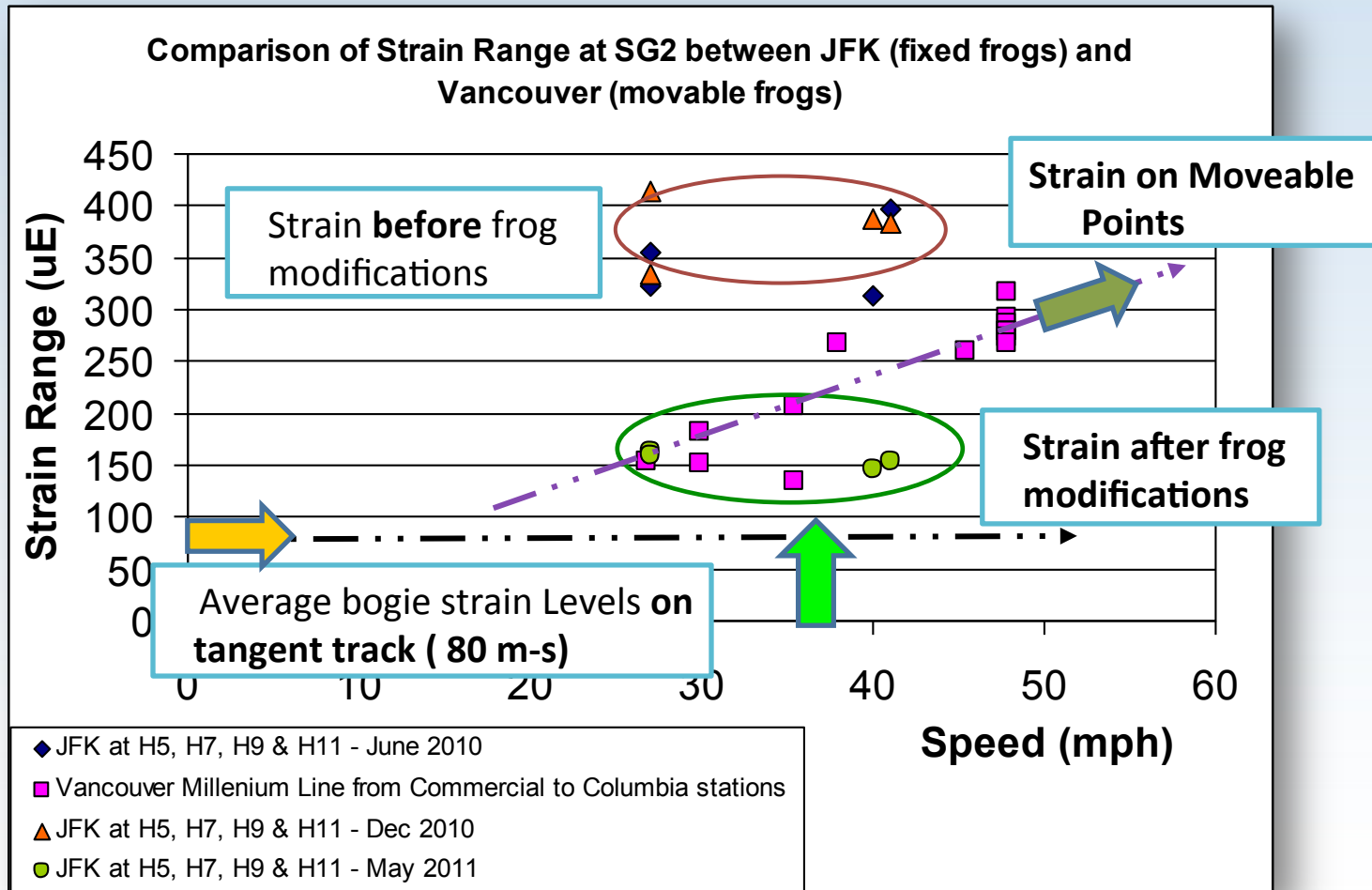
Surface Wear Moveable Point Frog



10mm surface depression –
worn across Point-to-Wing



Bogie Stress Comparisons Fixed vs Moveable Point



Equipment Set-up



Precision Profiling Device



Portable Self-contained Assembly (90kg weight)



**240V 3-phase power source >
High-frequency Inverter > 300Hz
5HP drive motor**



Profiling Head

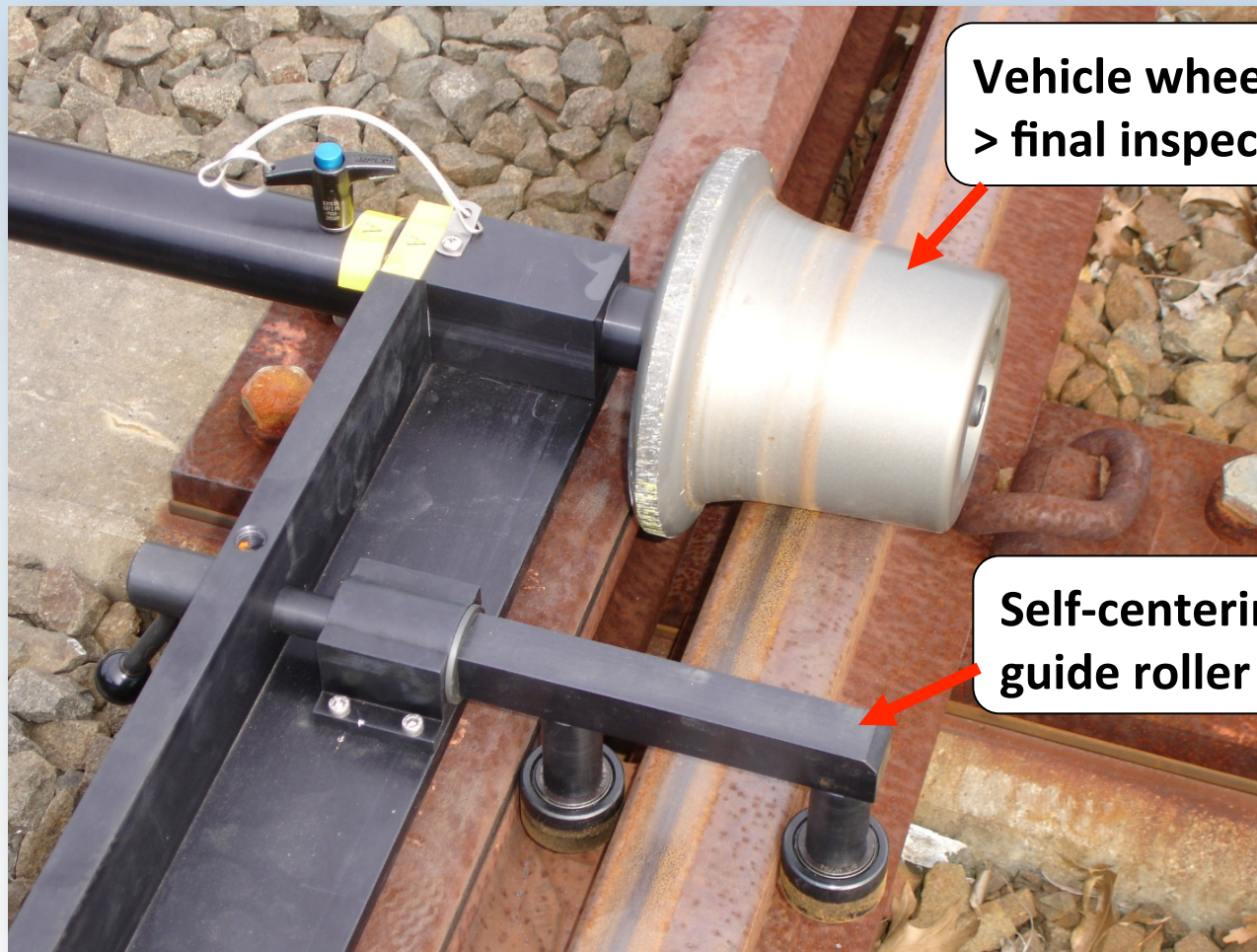


**Multi-axis fine adjustment >
40" Linear slide bearing**

5" Cup Stone



Wheel Support and Guidance

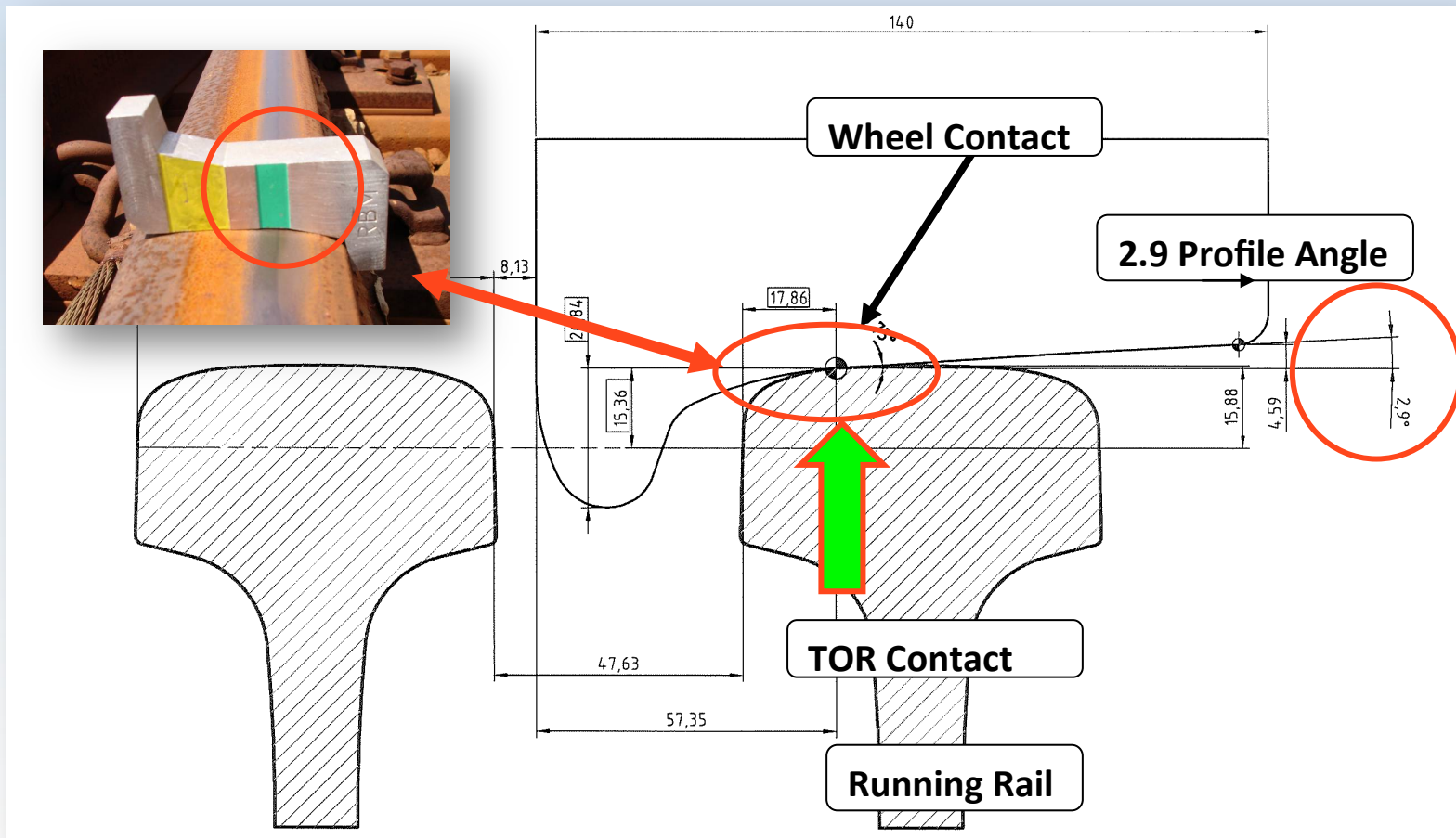


Vehicle wheel profile
> final inspection

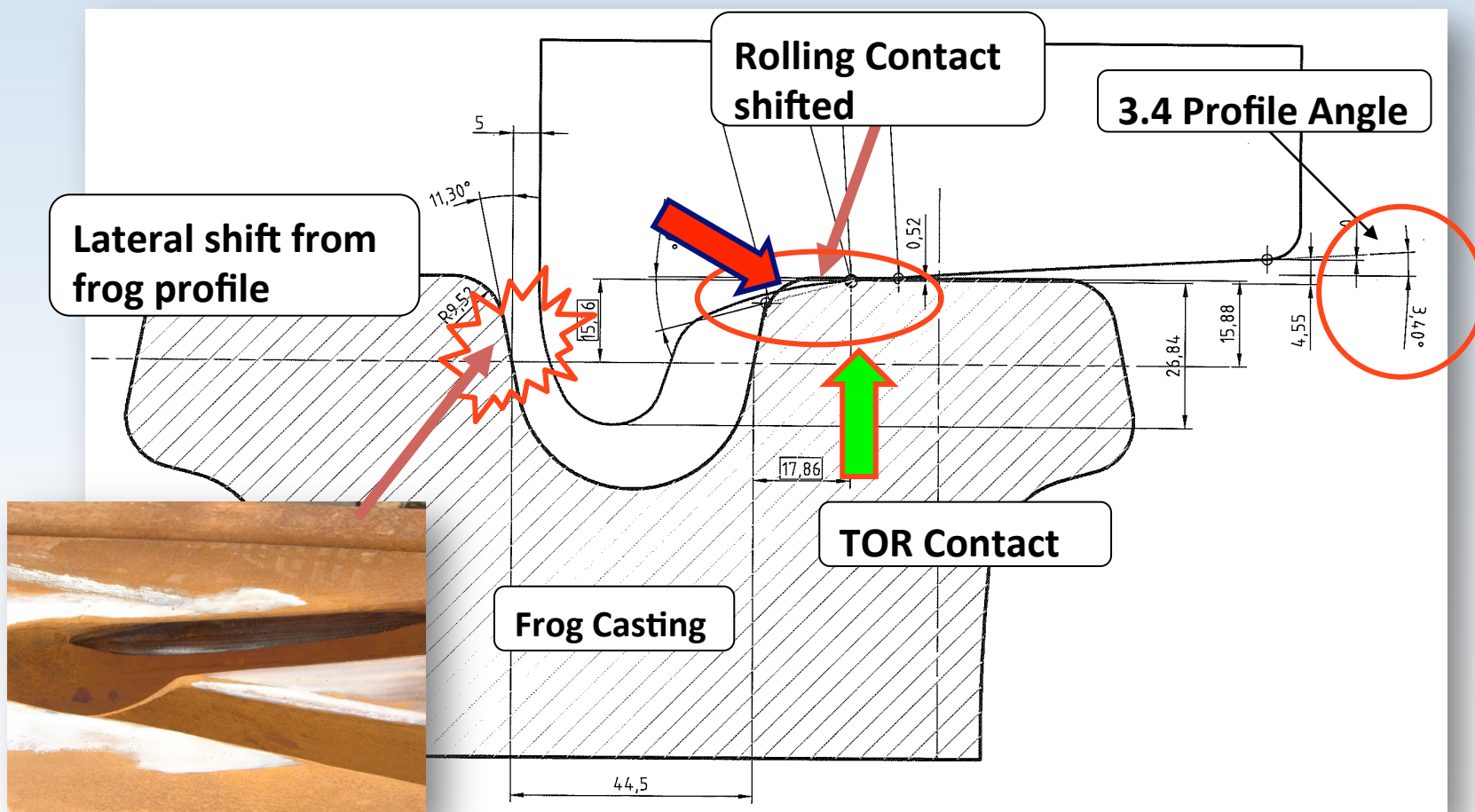
Self-centering
guide roller



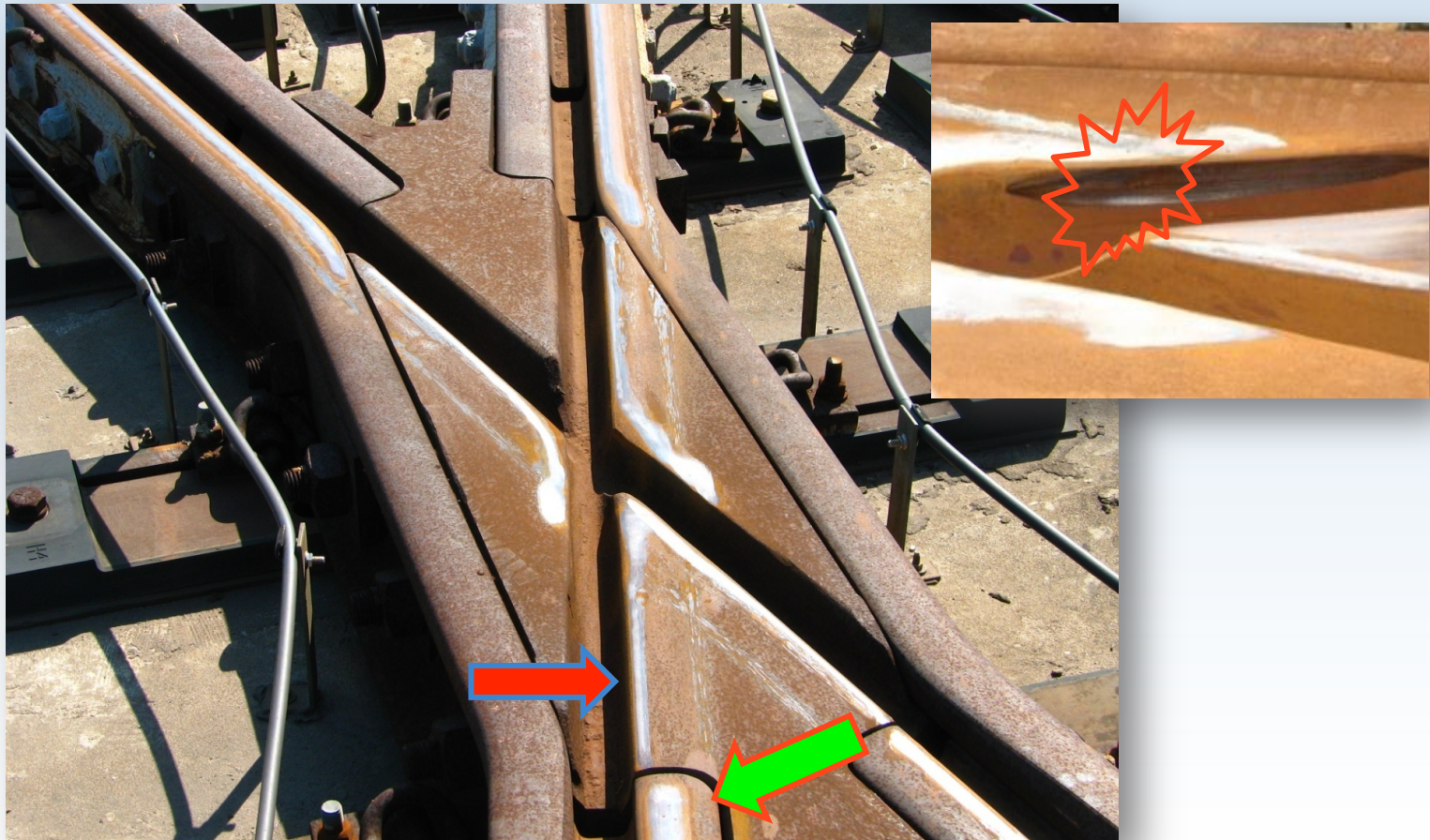
Wheel Contact Profile Angle over Rail



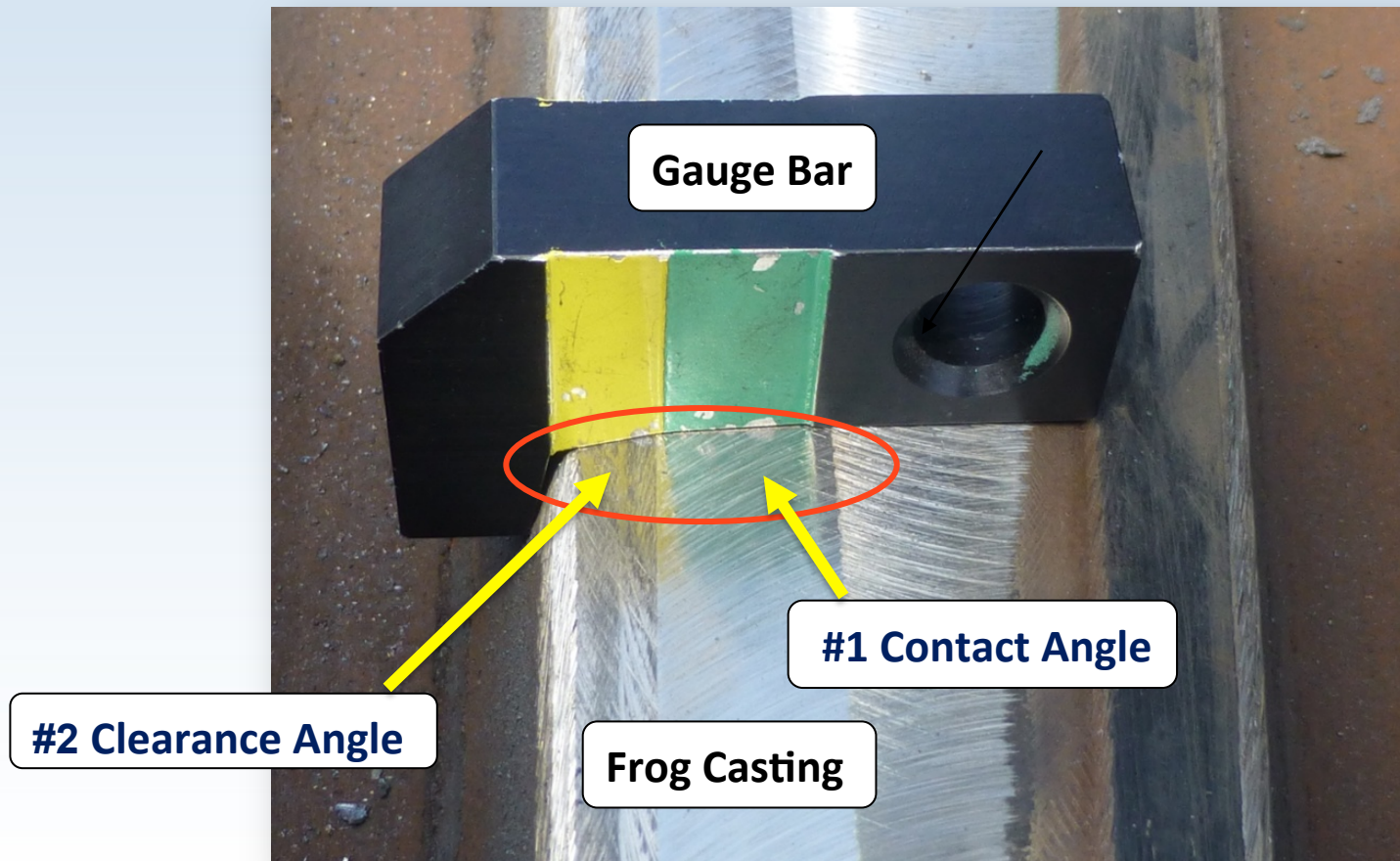
Wheel Contact Profile Angles over Frog

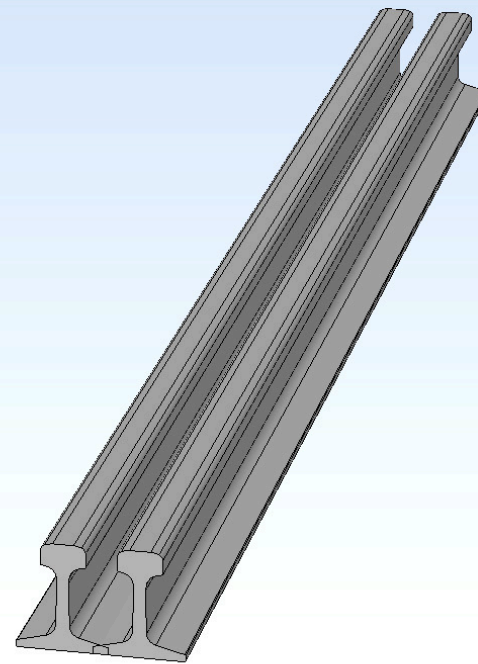
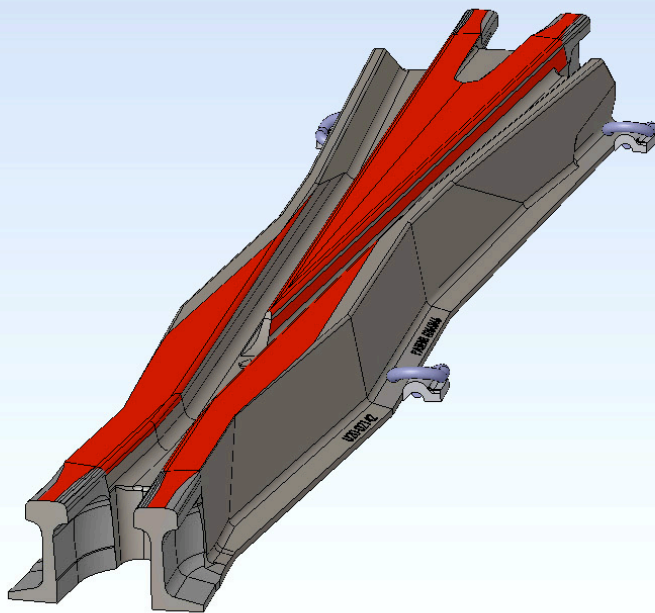


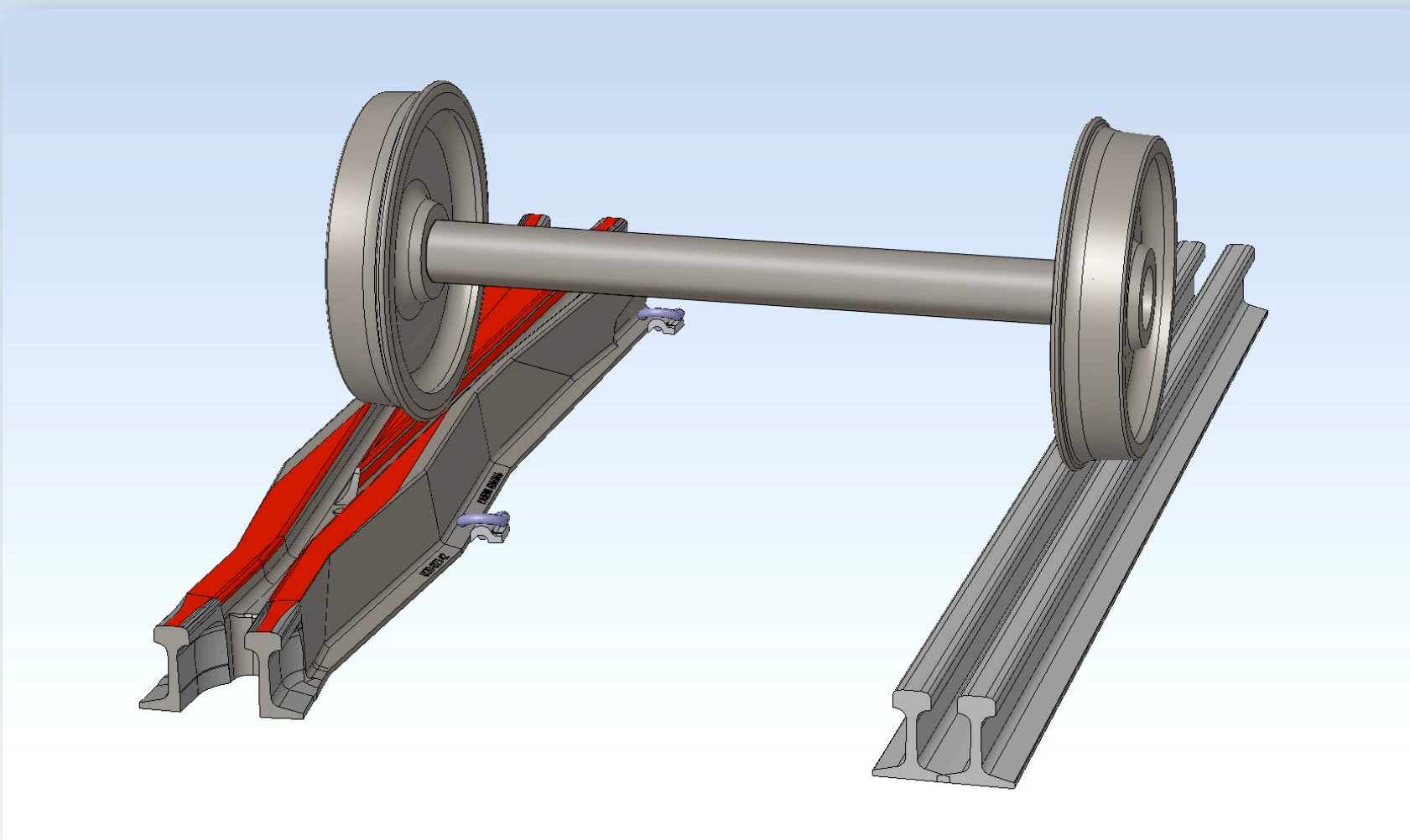
Wheel Contact Path Shift Over Crossover

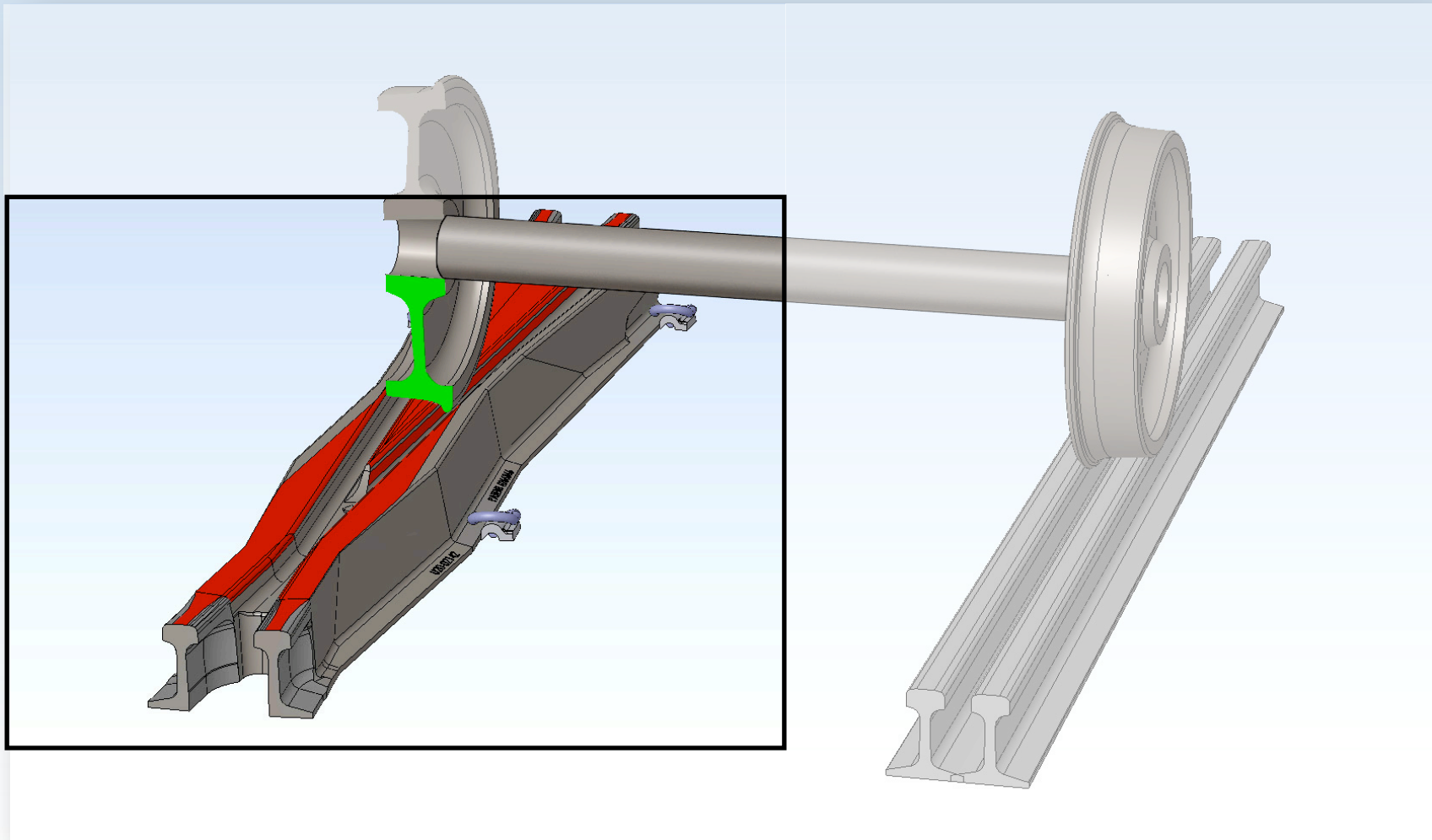


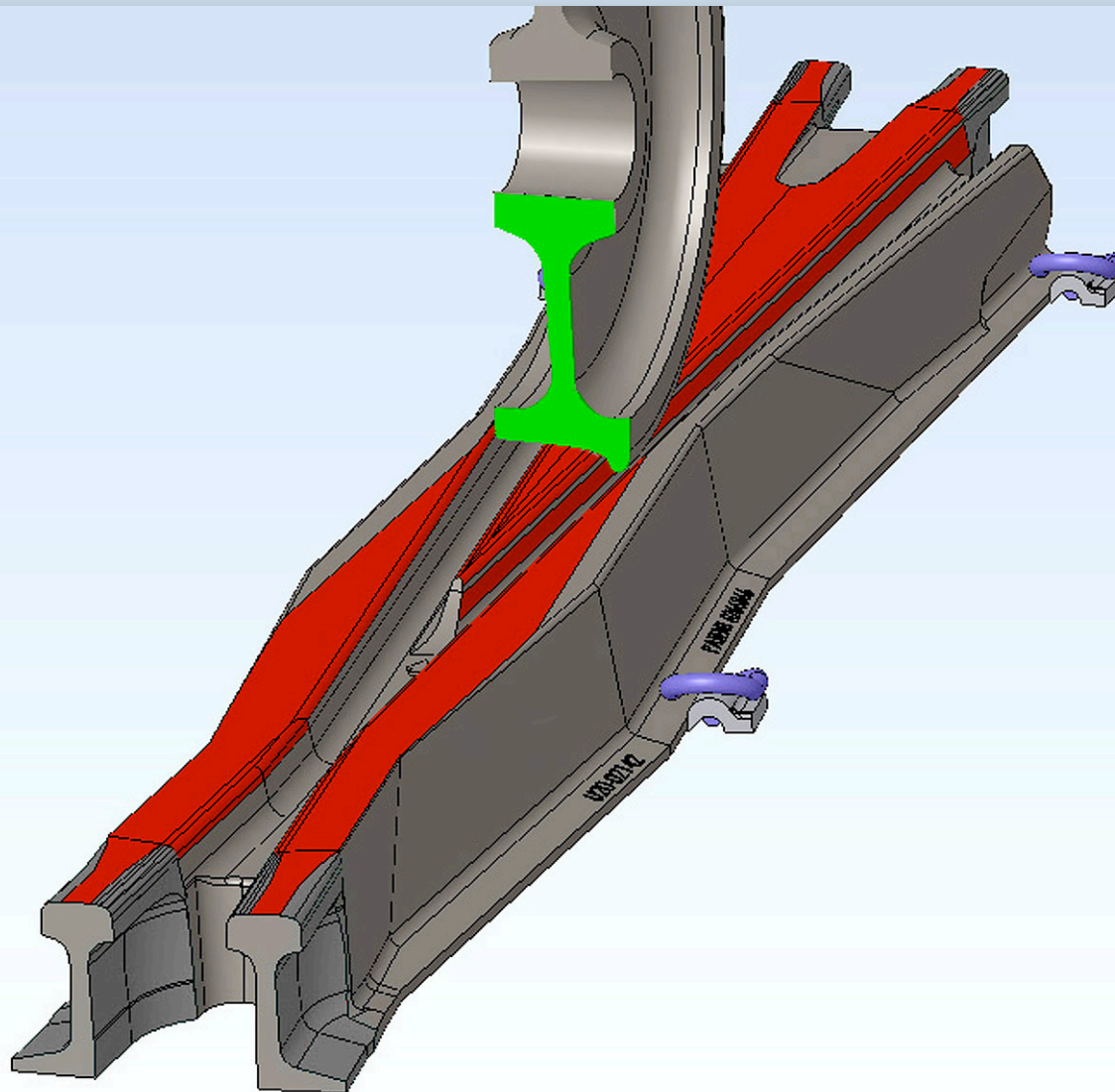
Modification to Straighten Contact Path

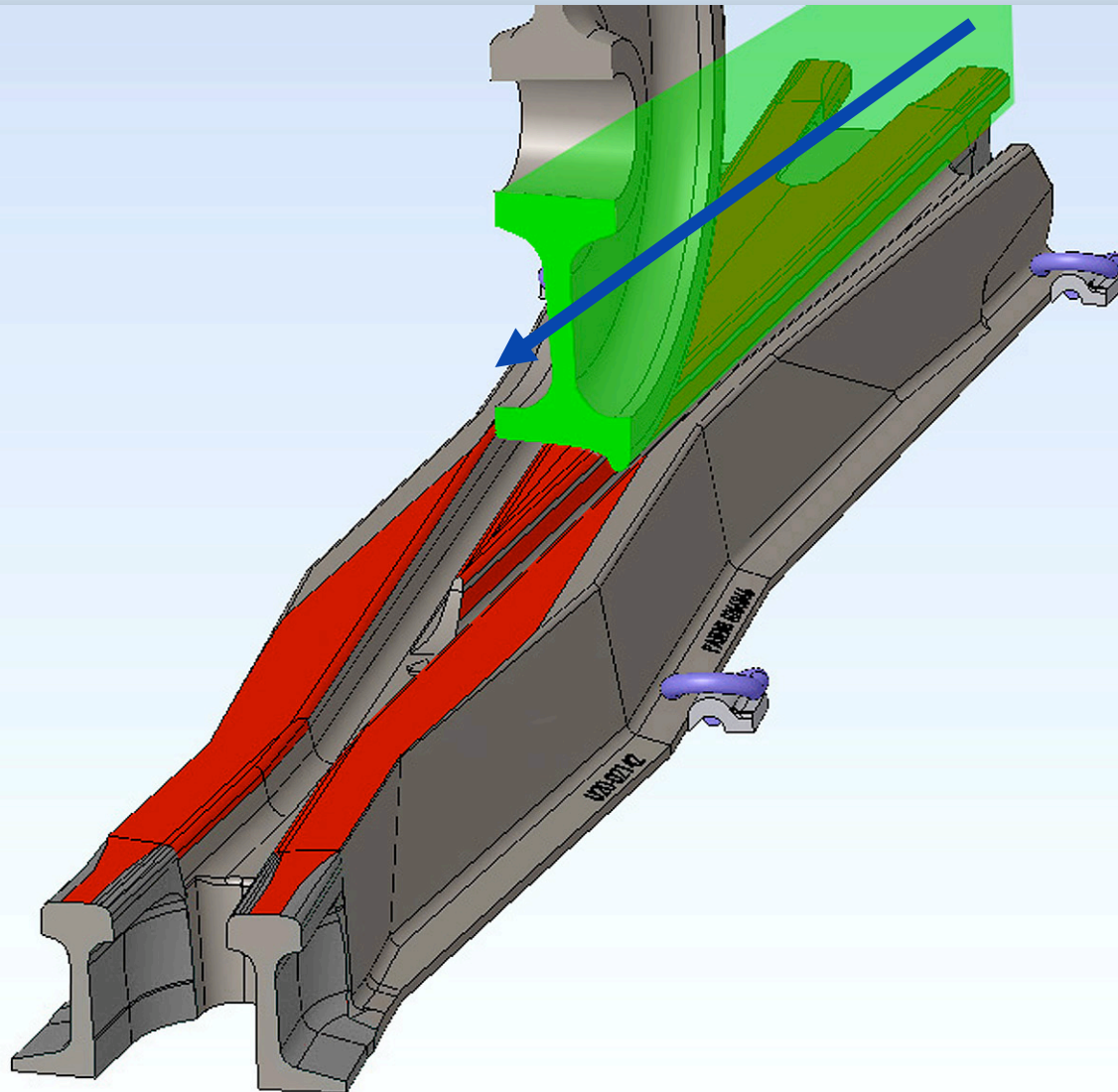


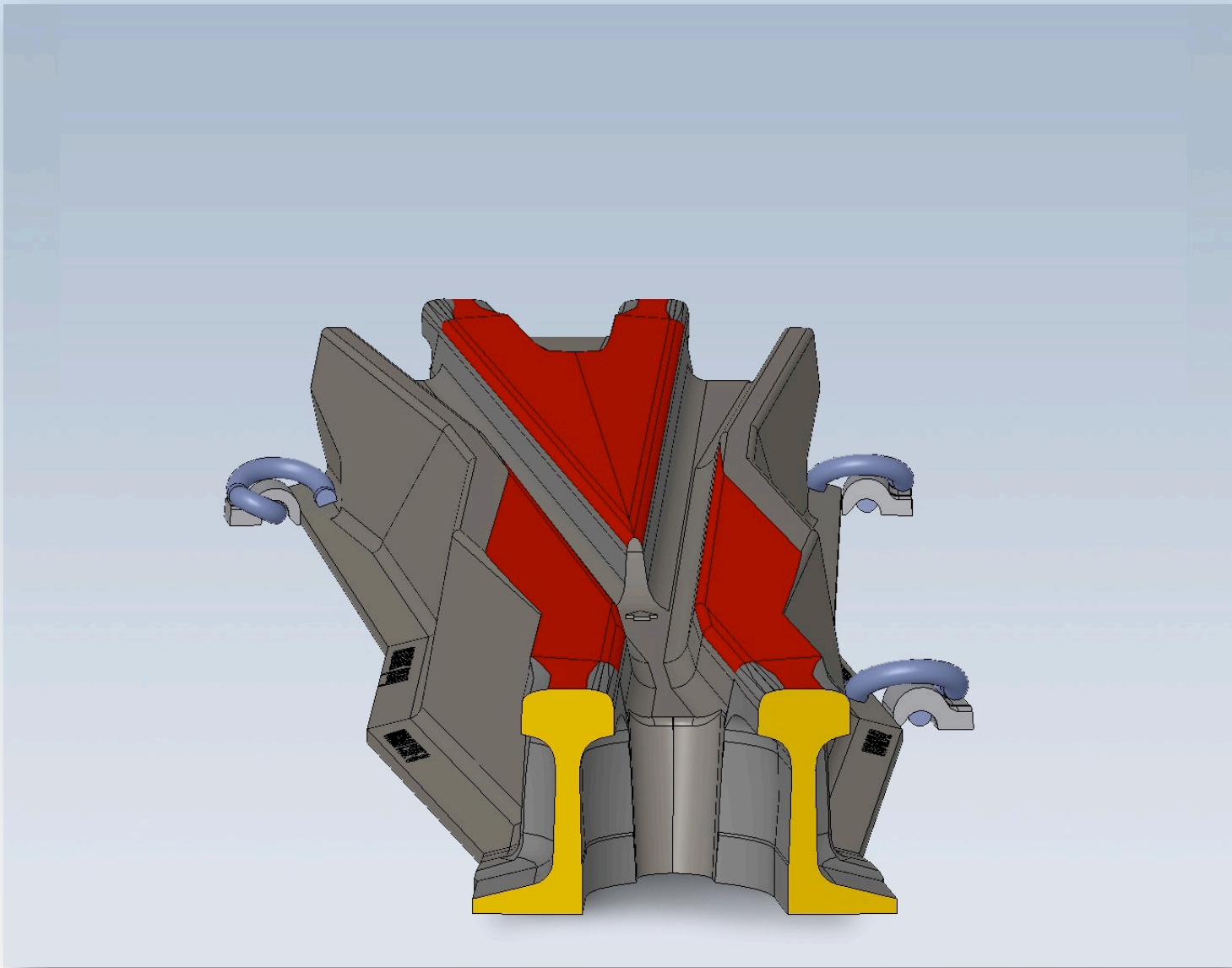


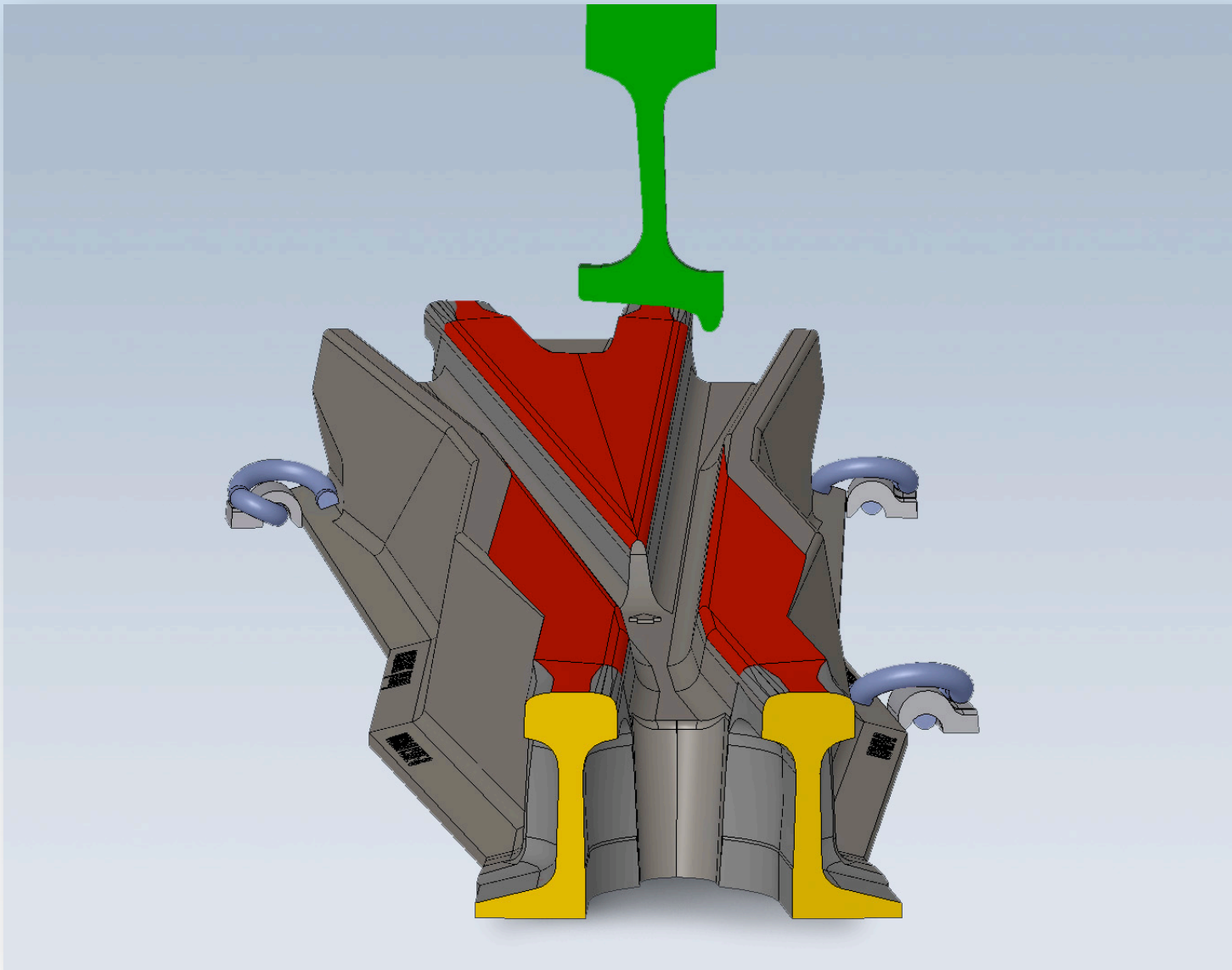


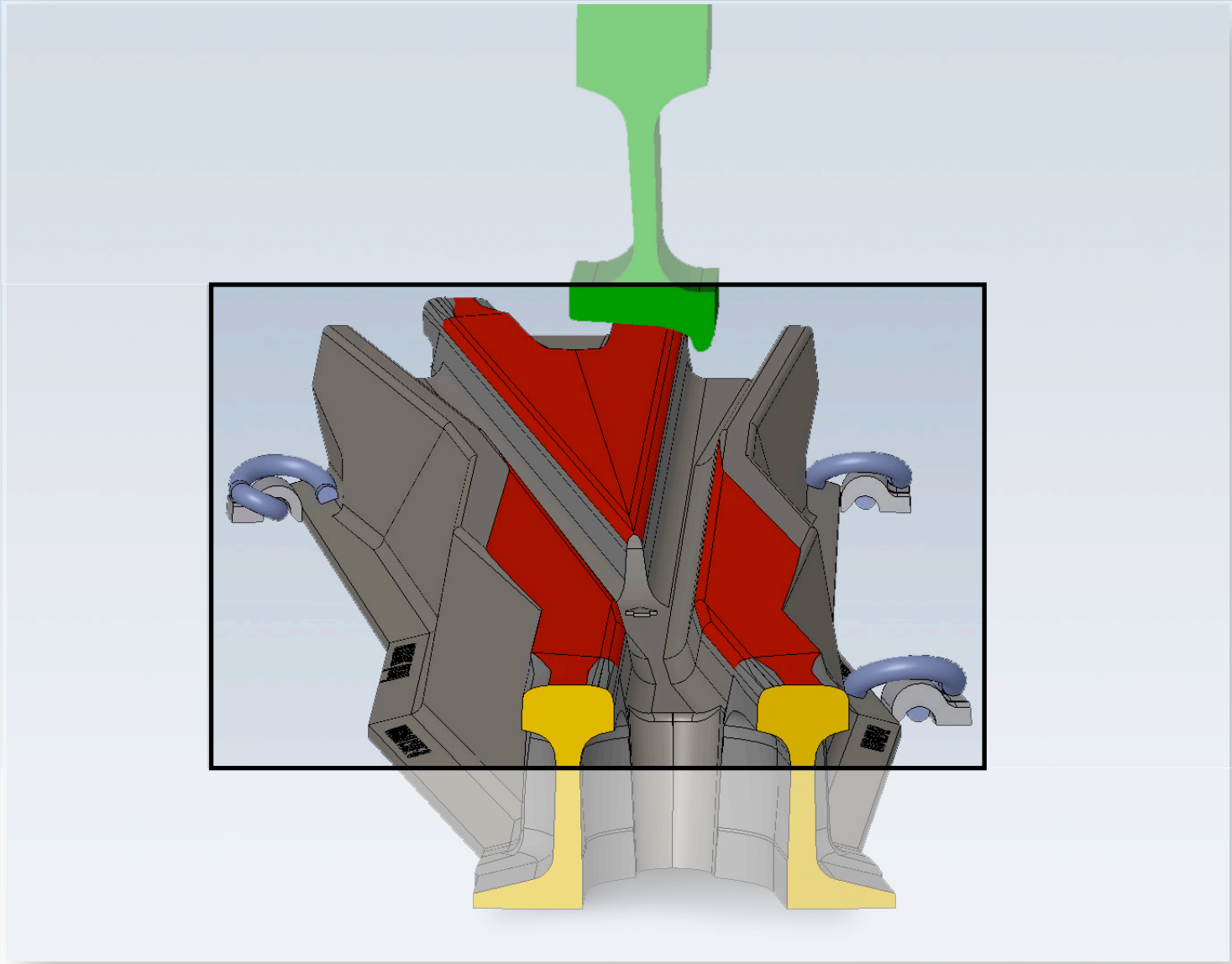


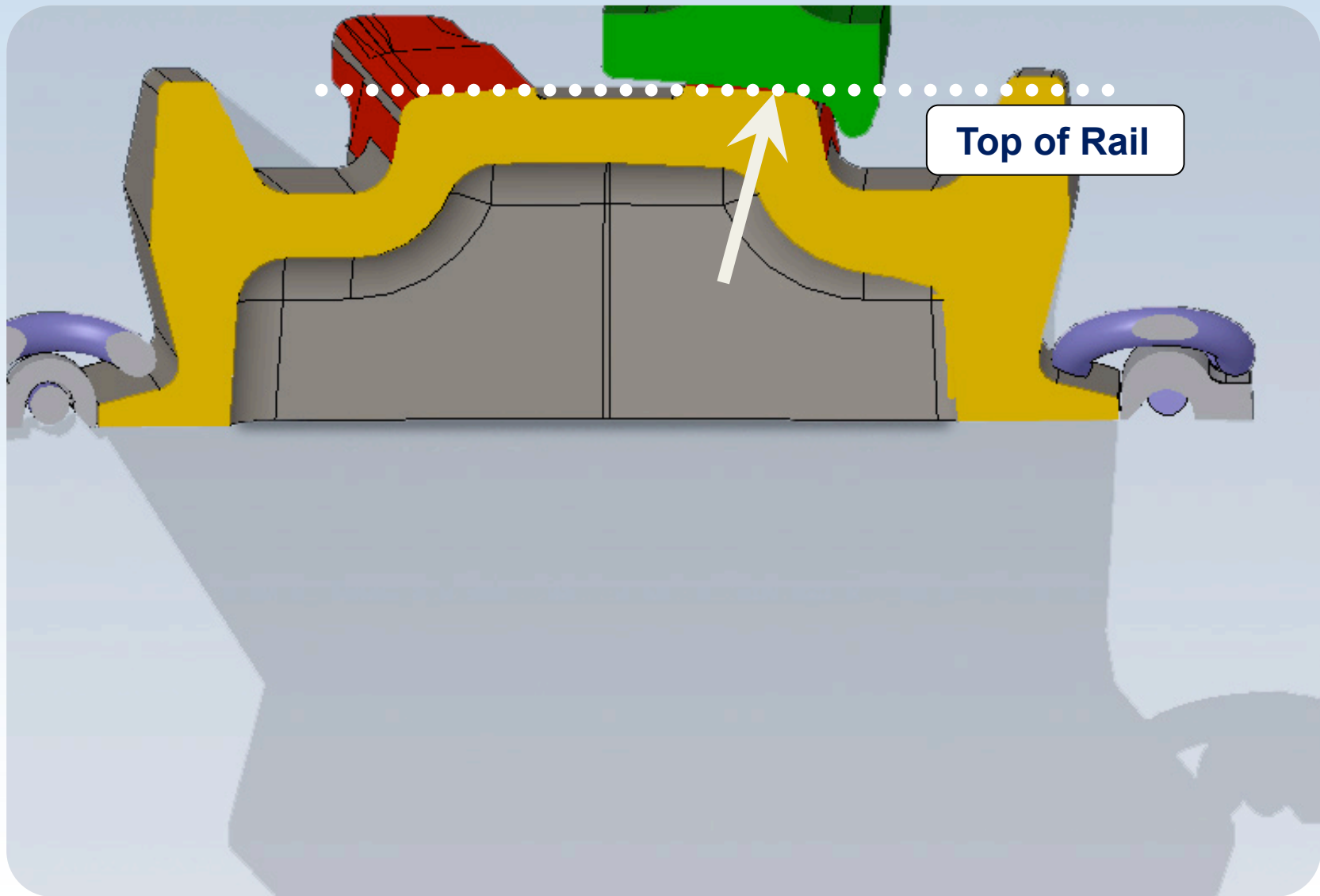


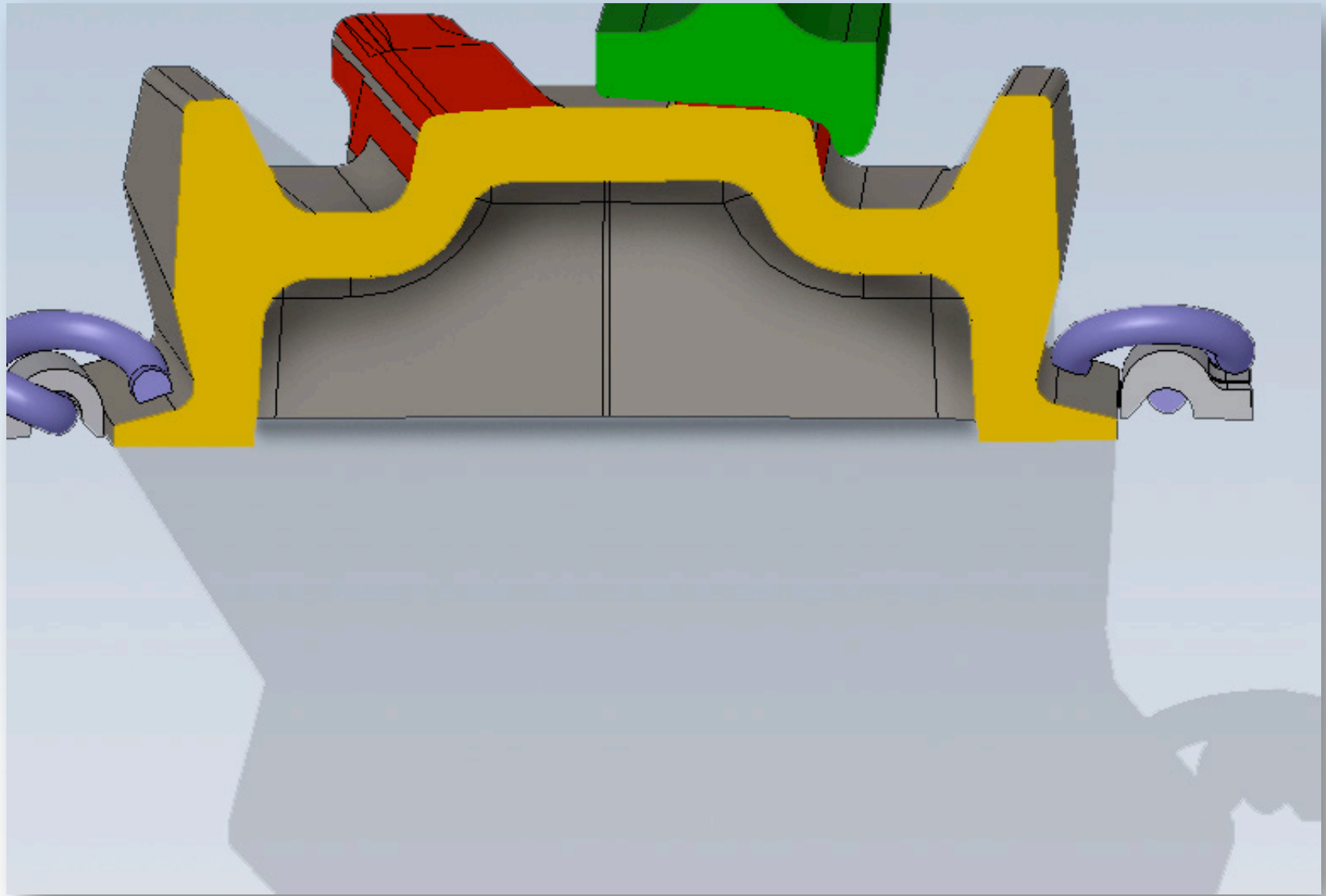


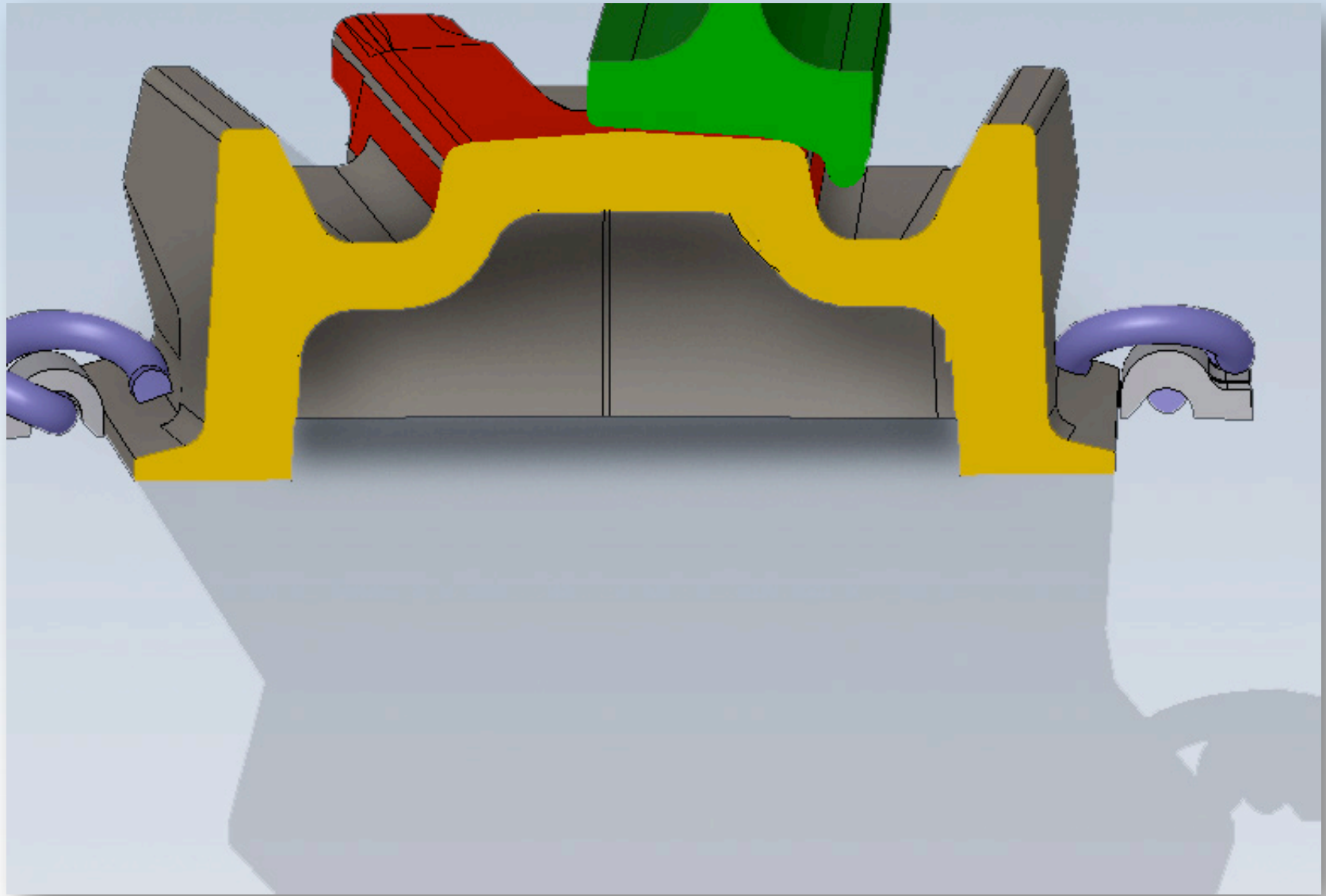


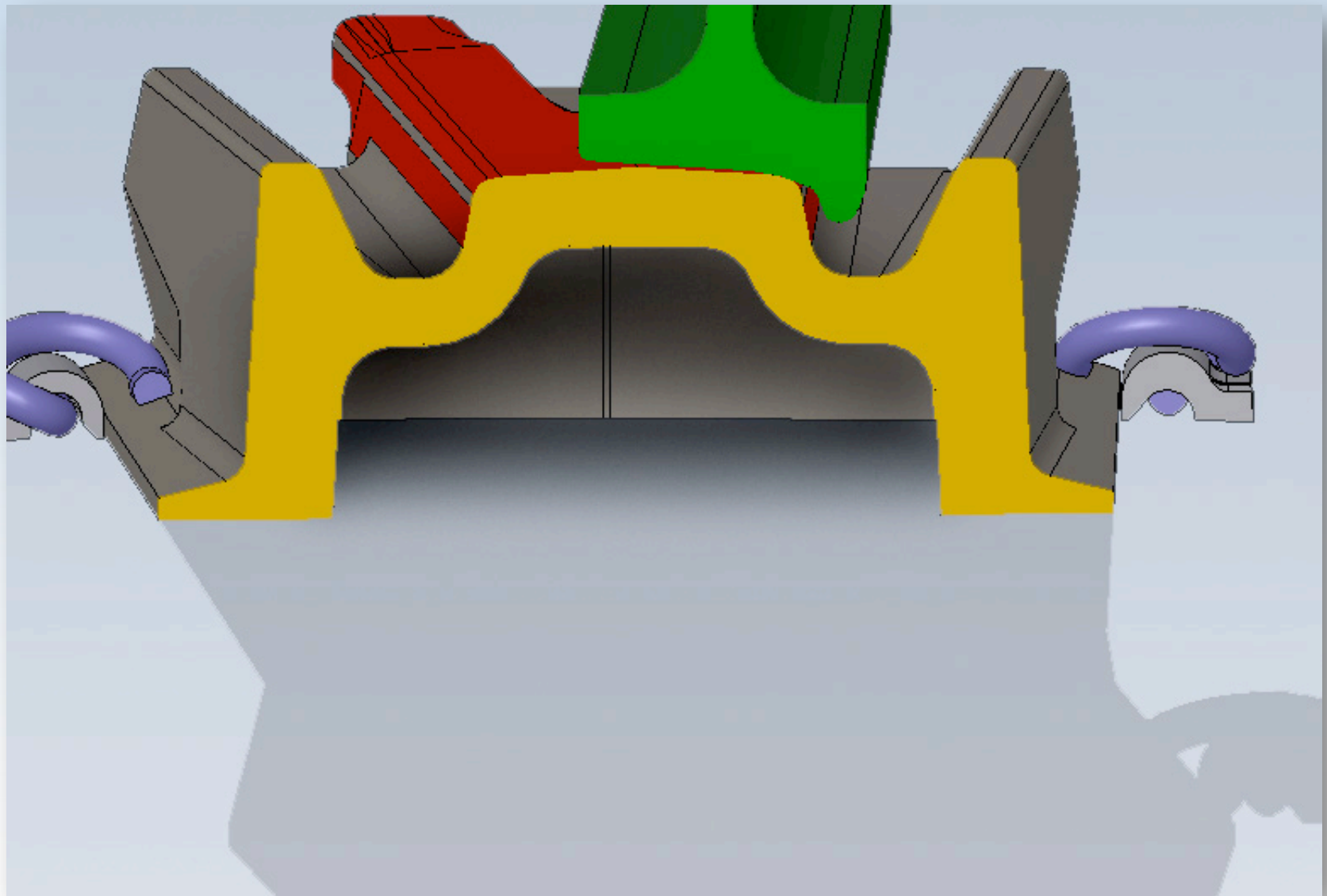


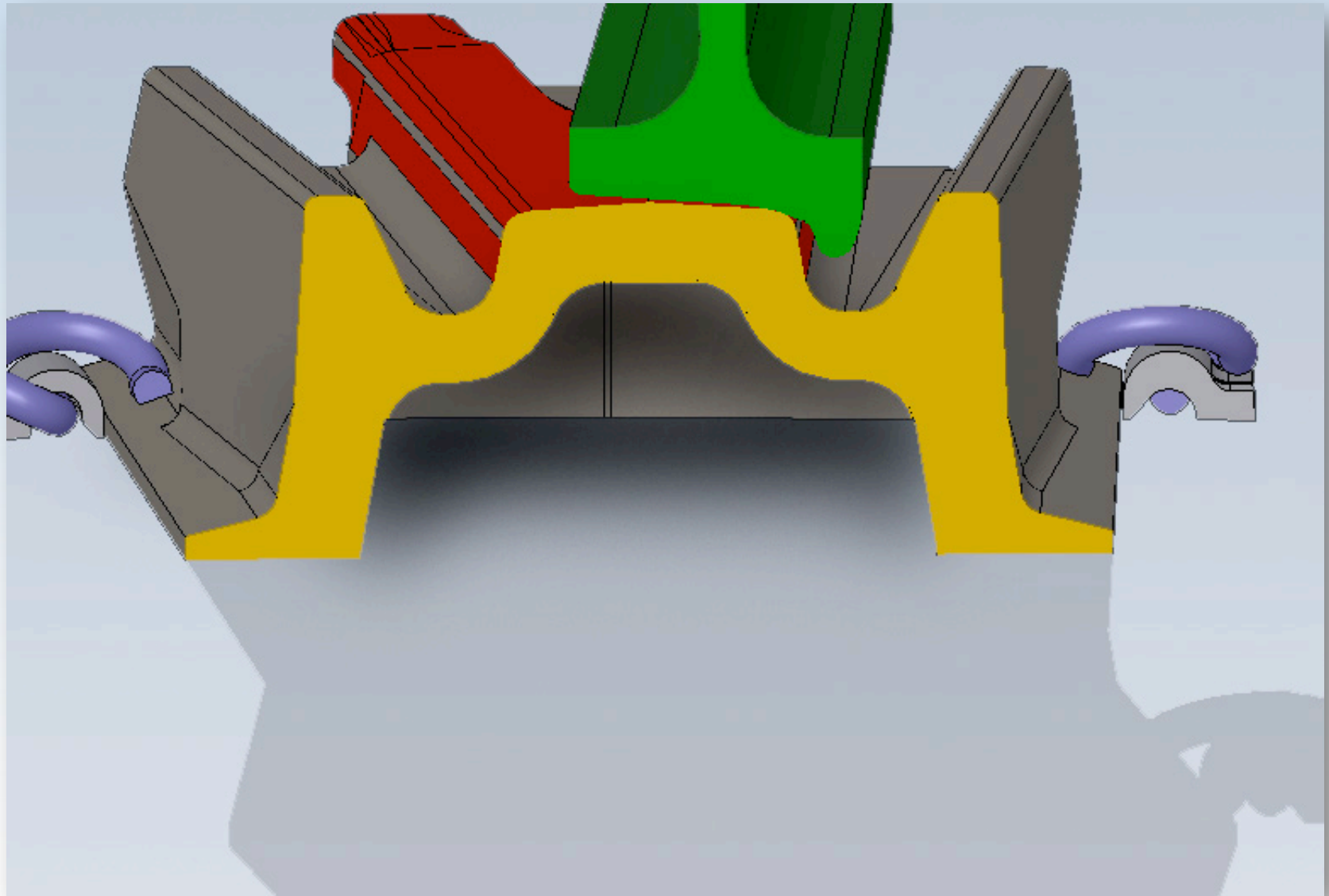


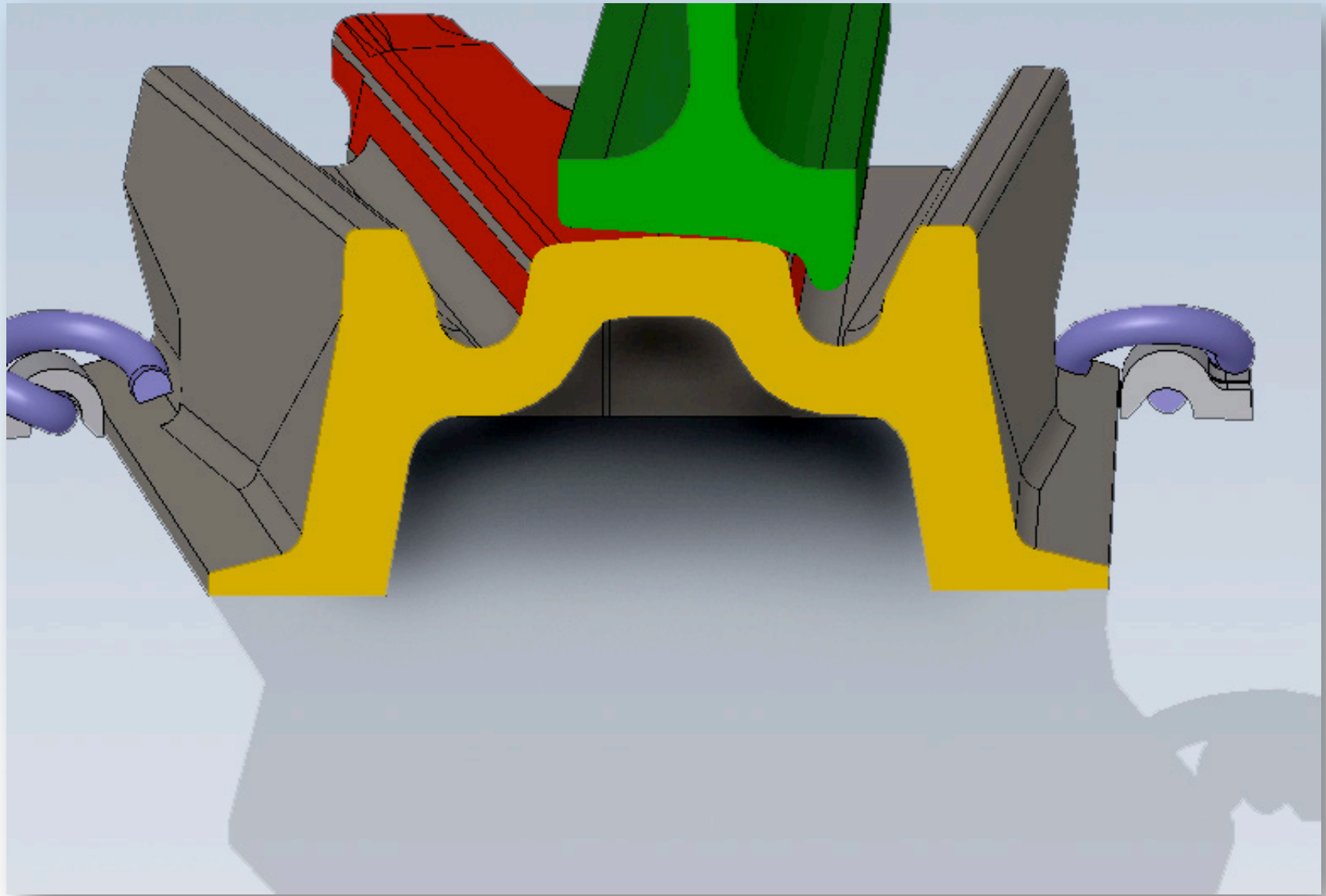


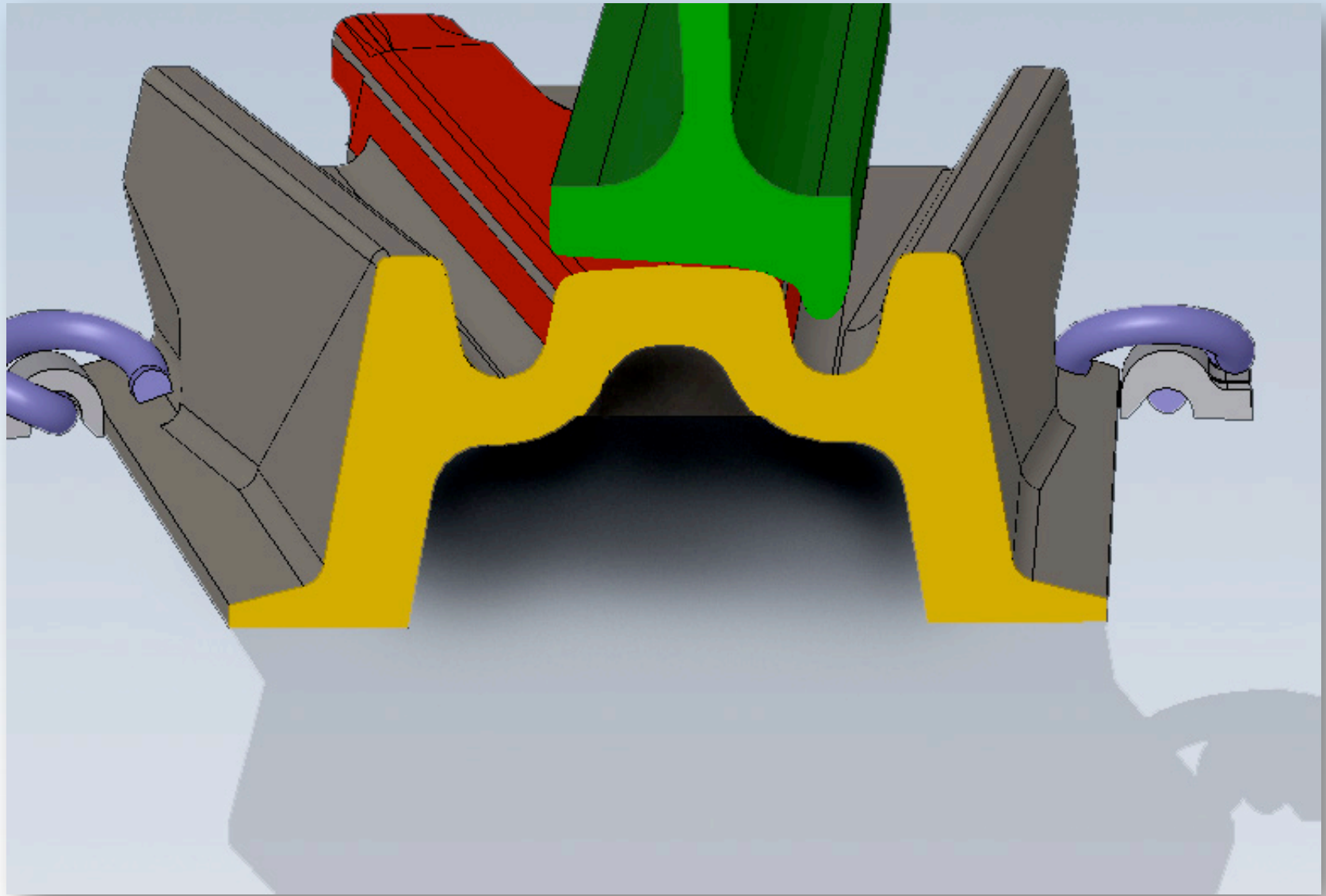


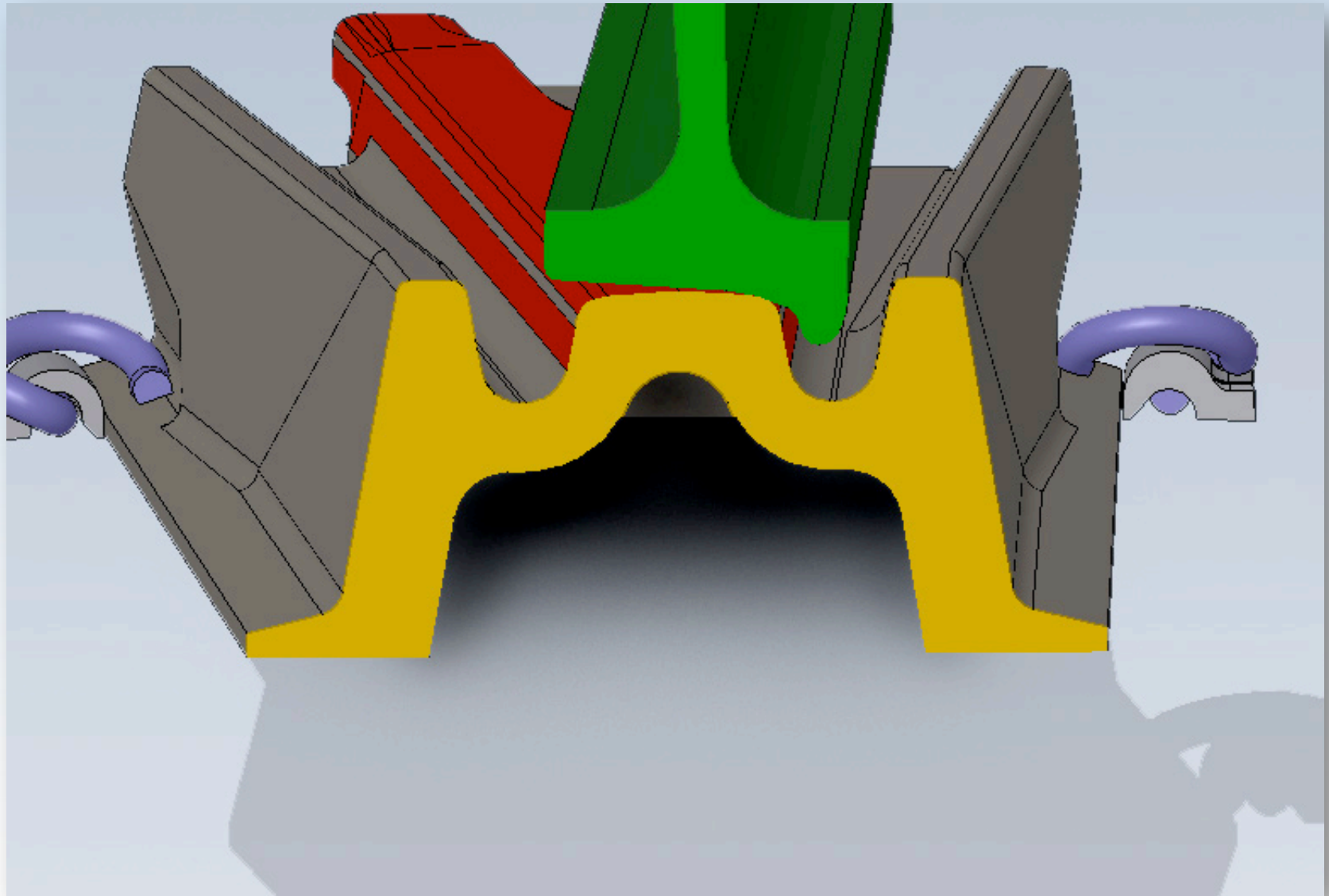


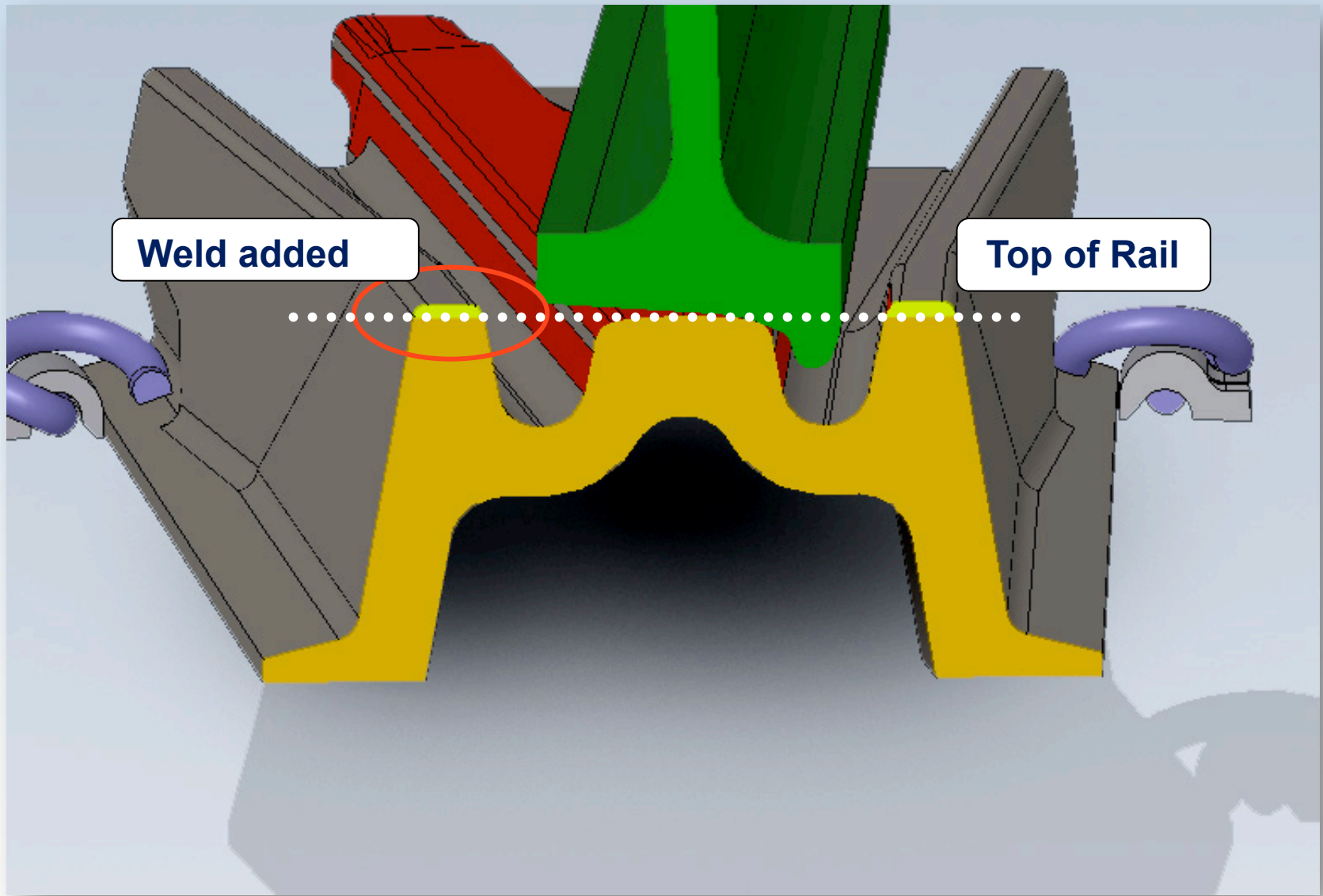


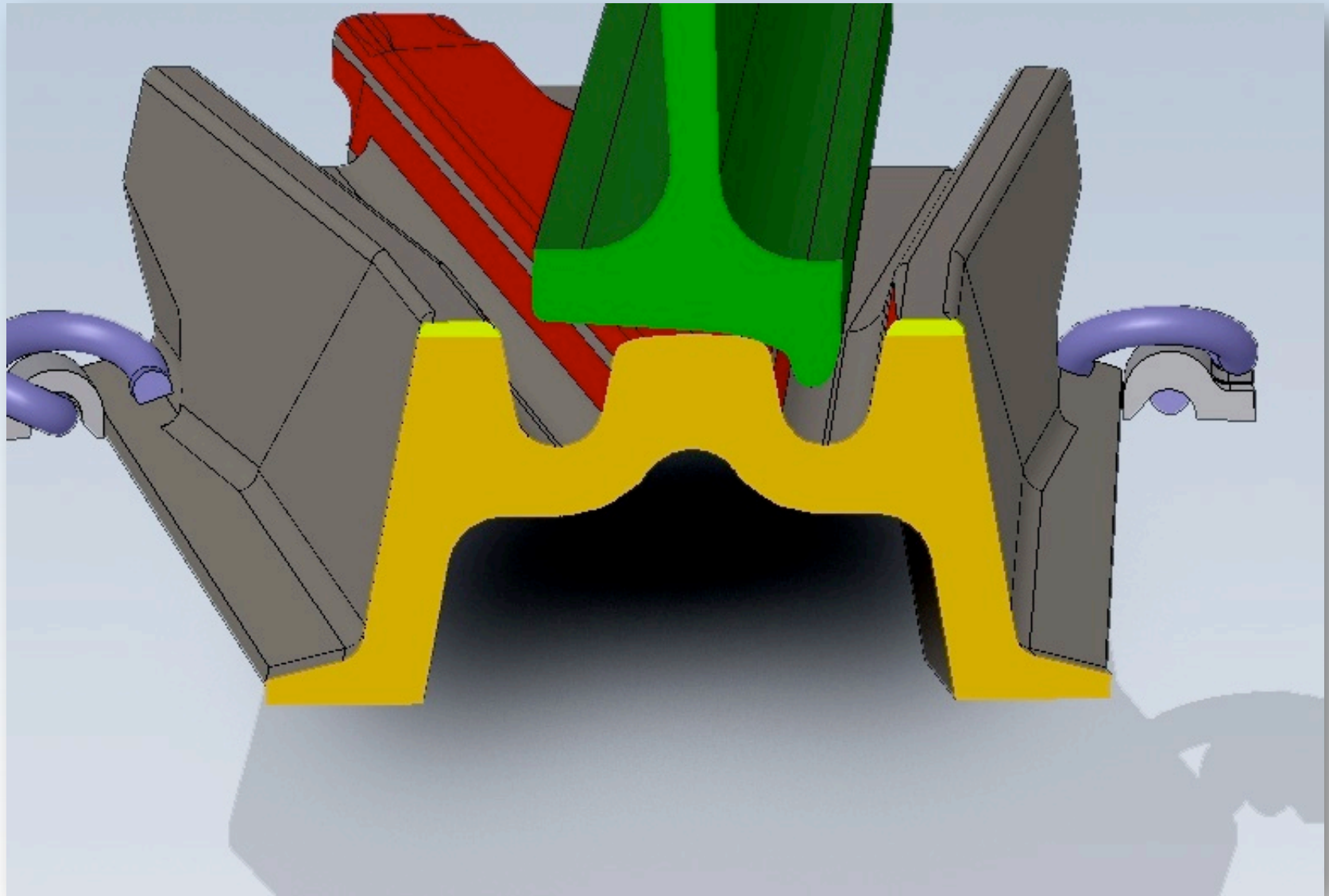


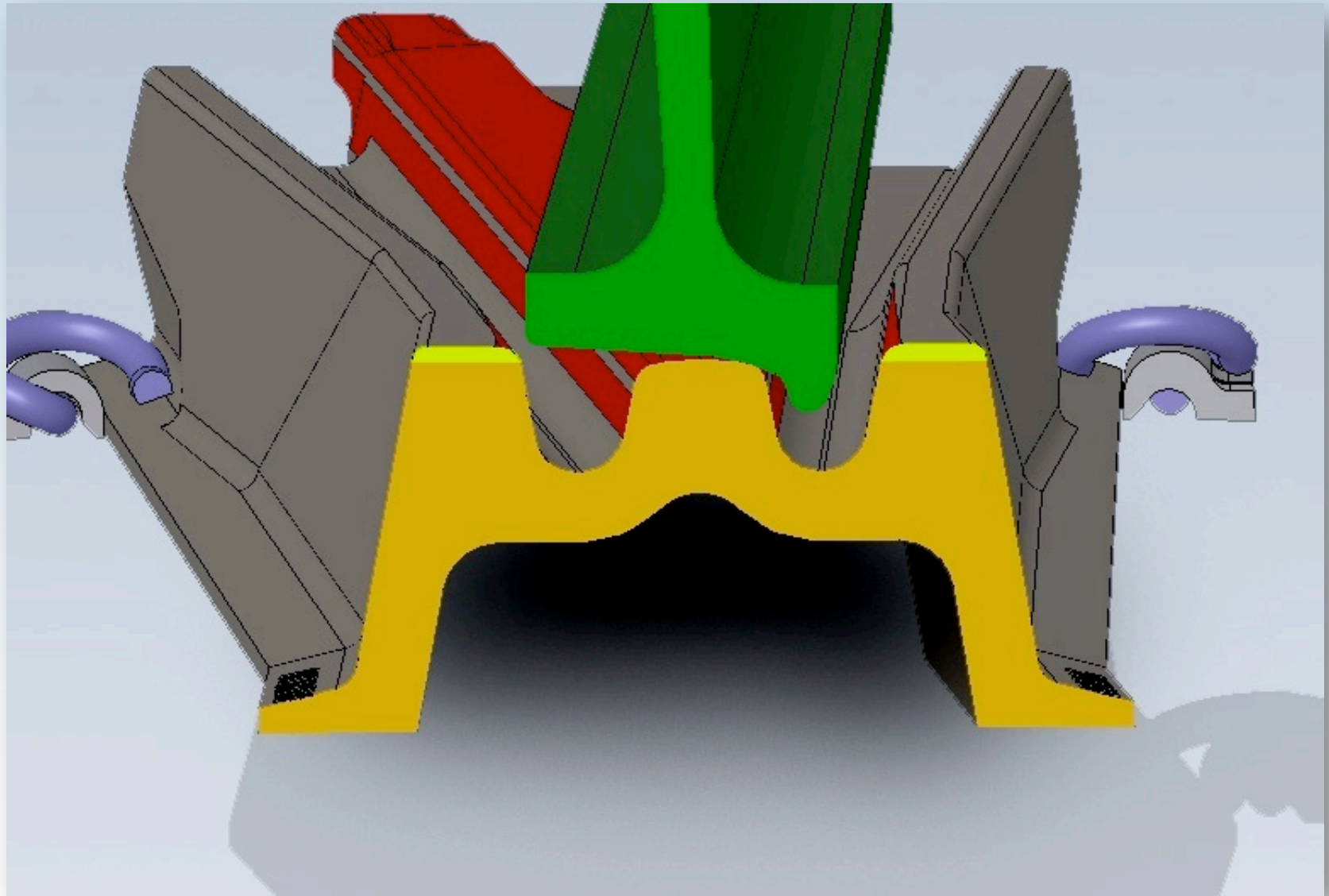


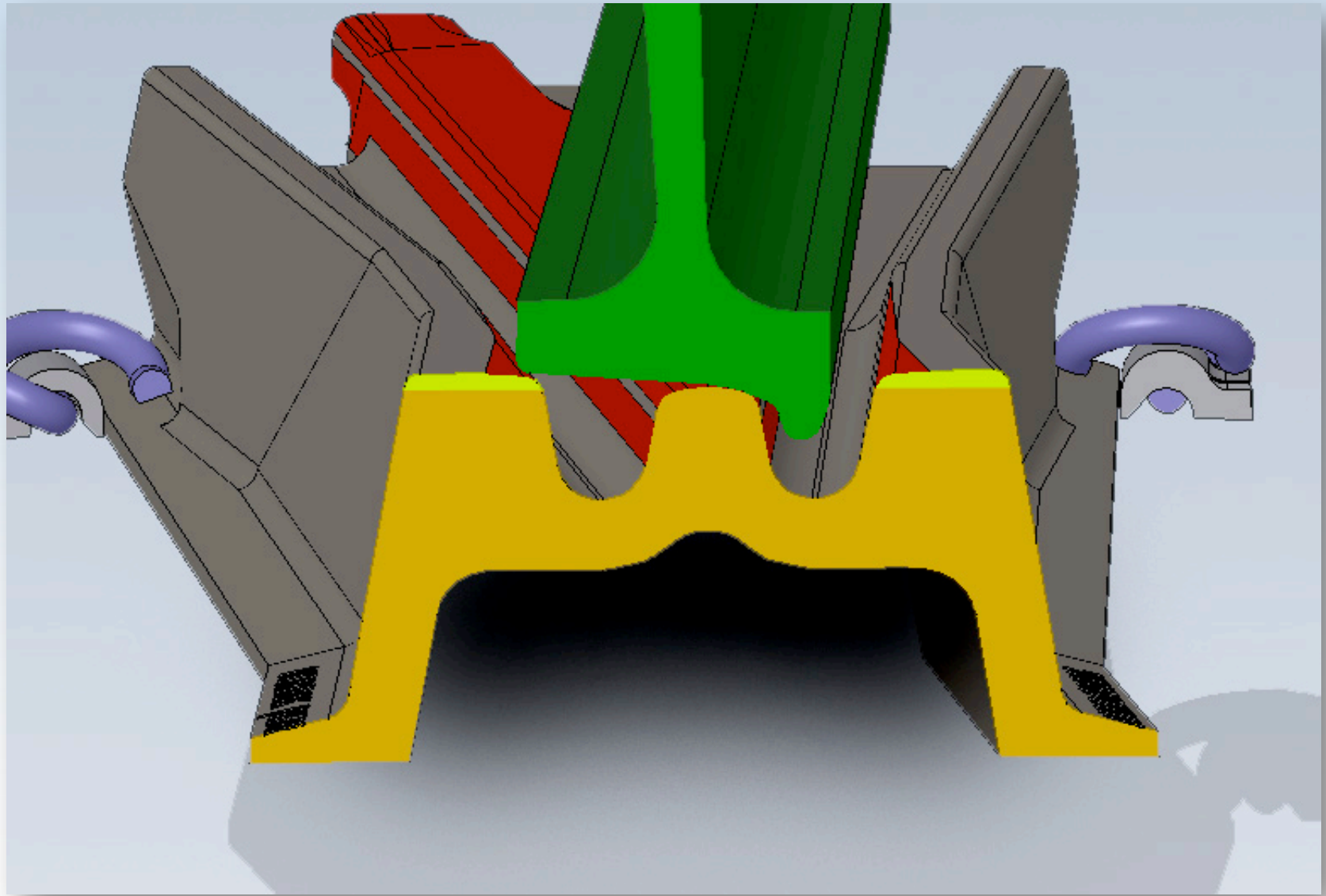


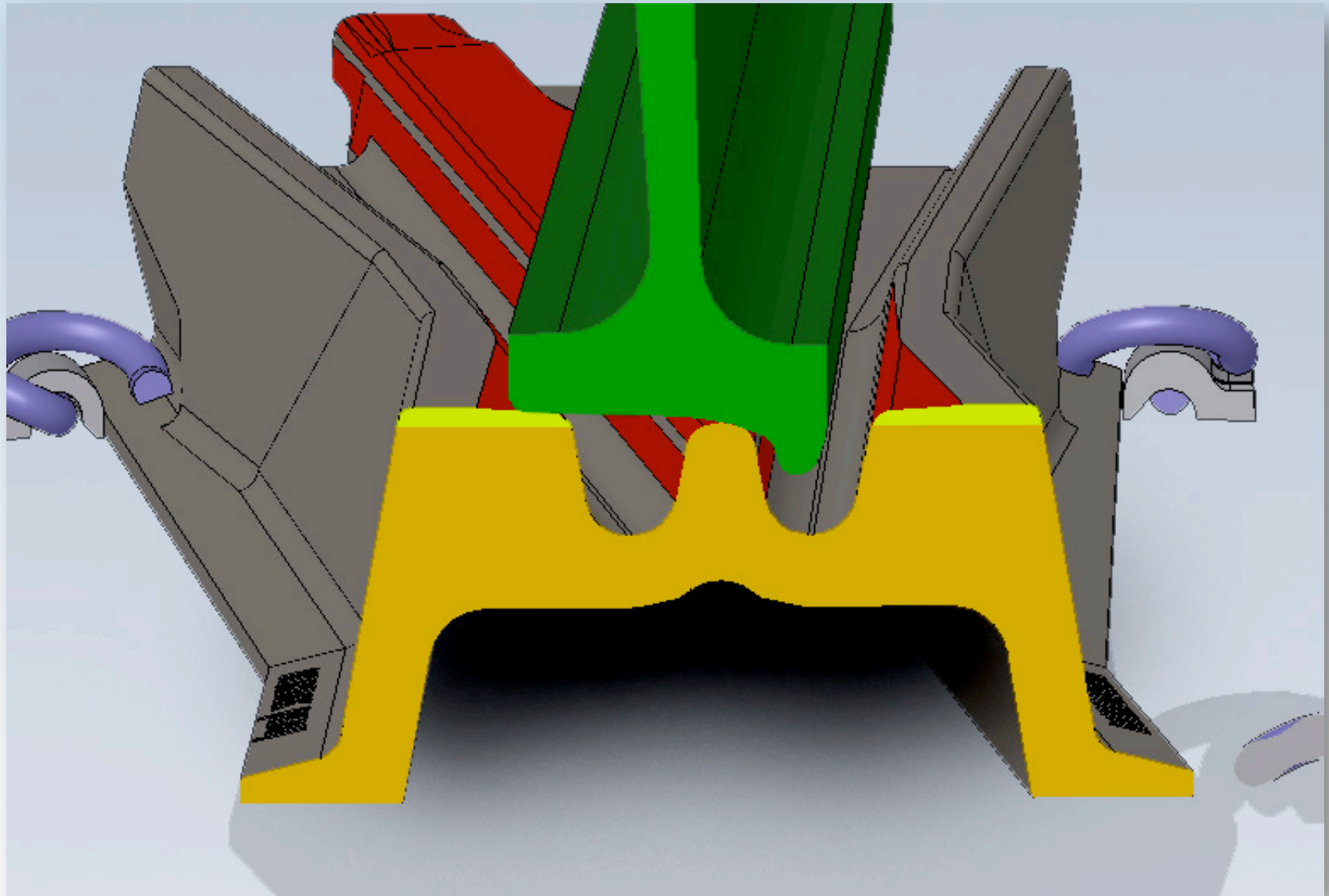


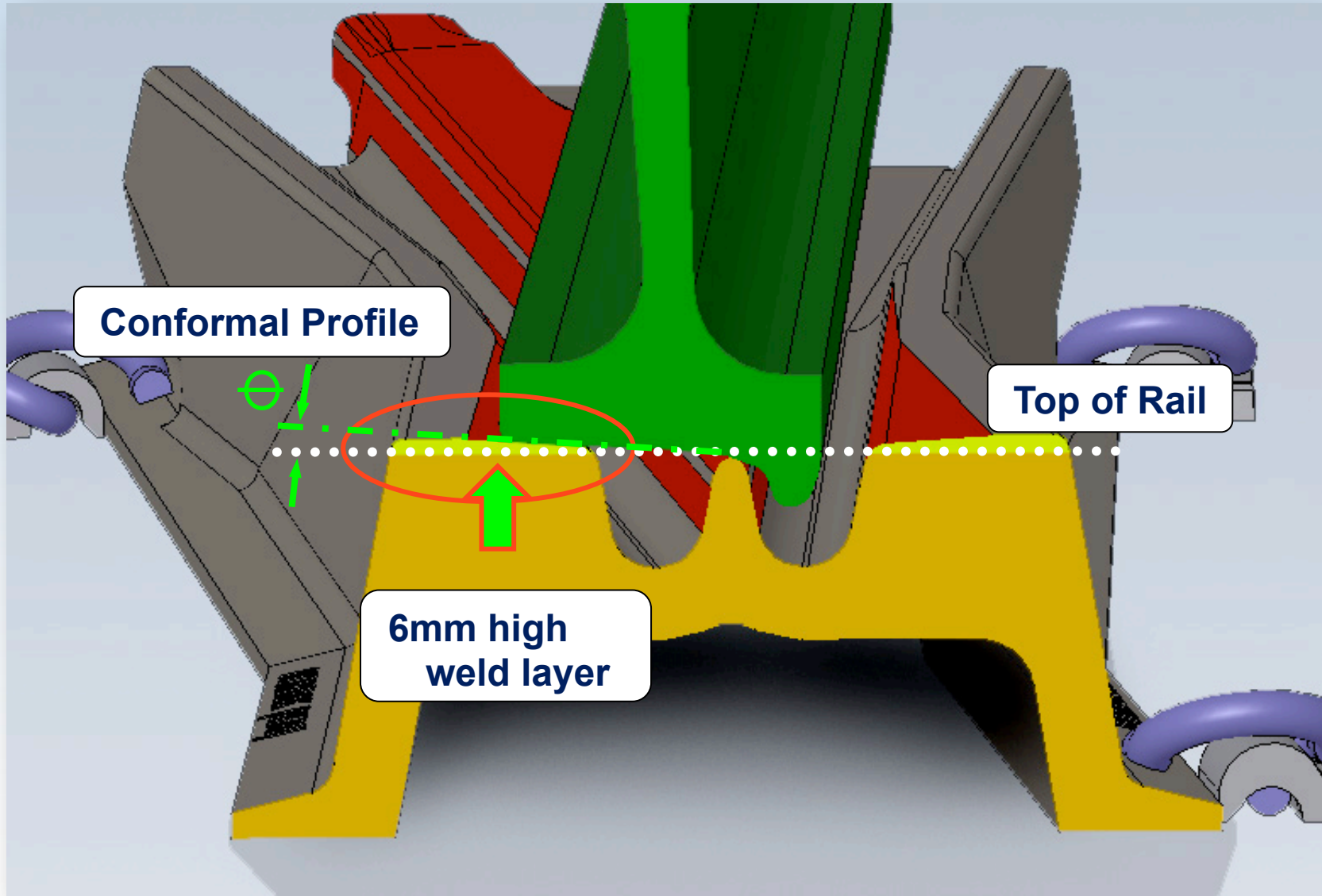










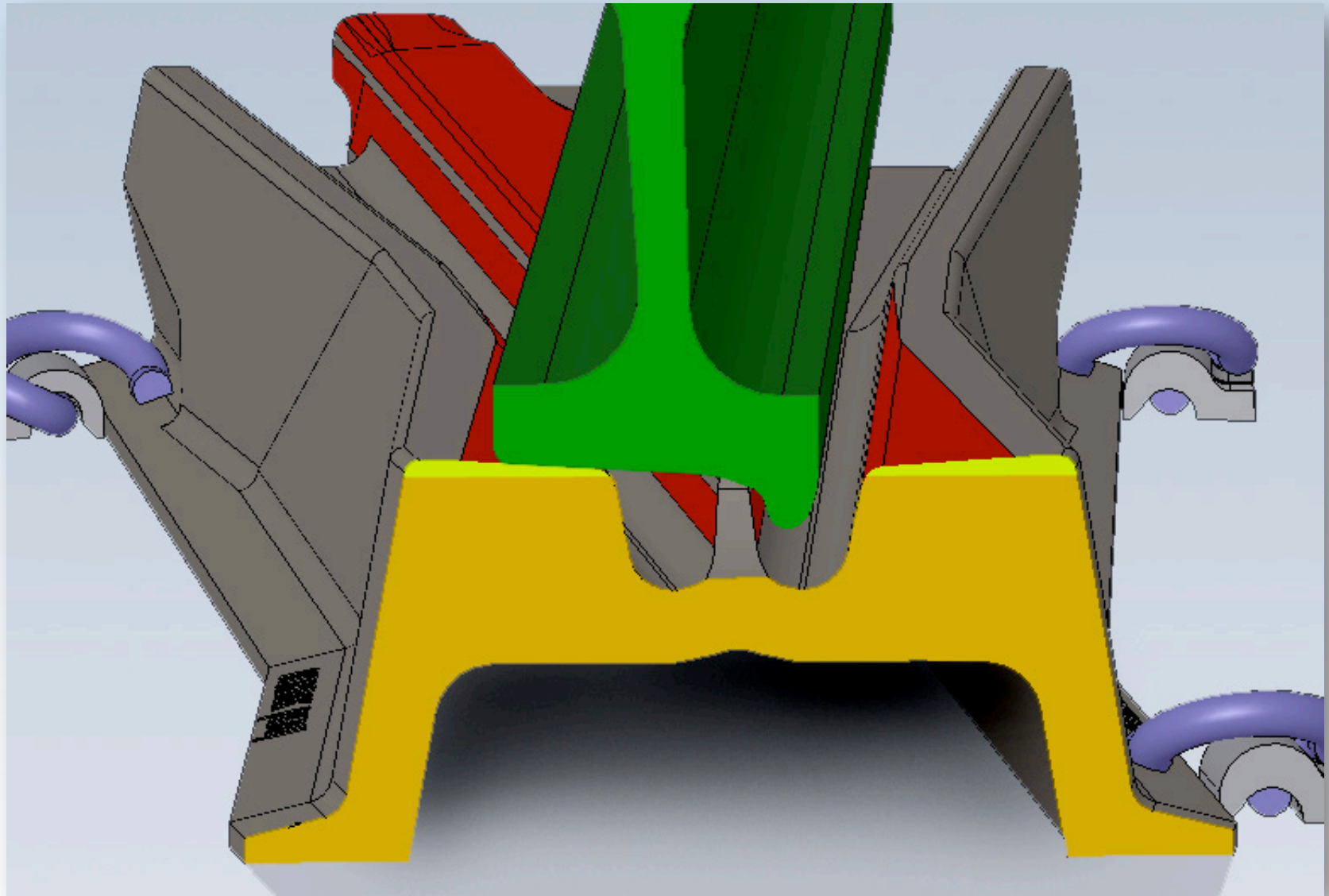


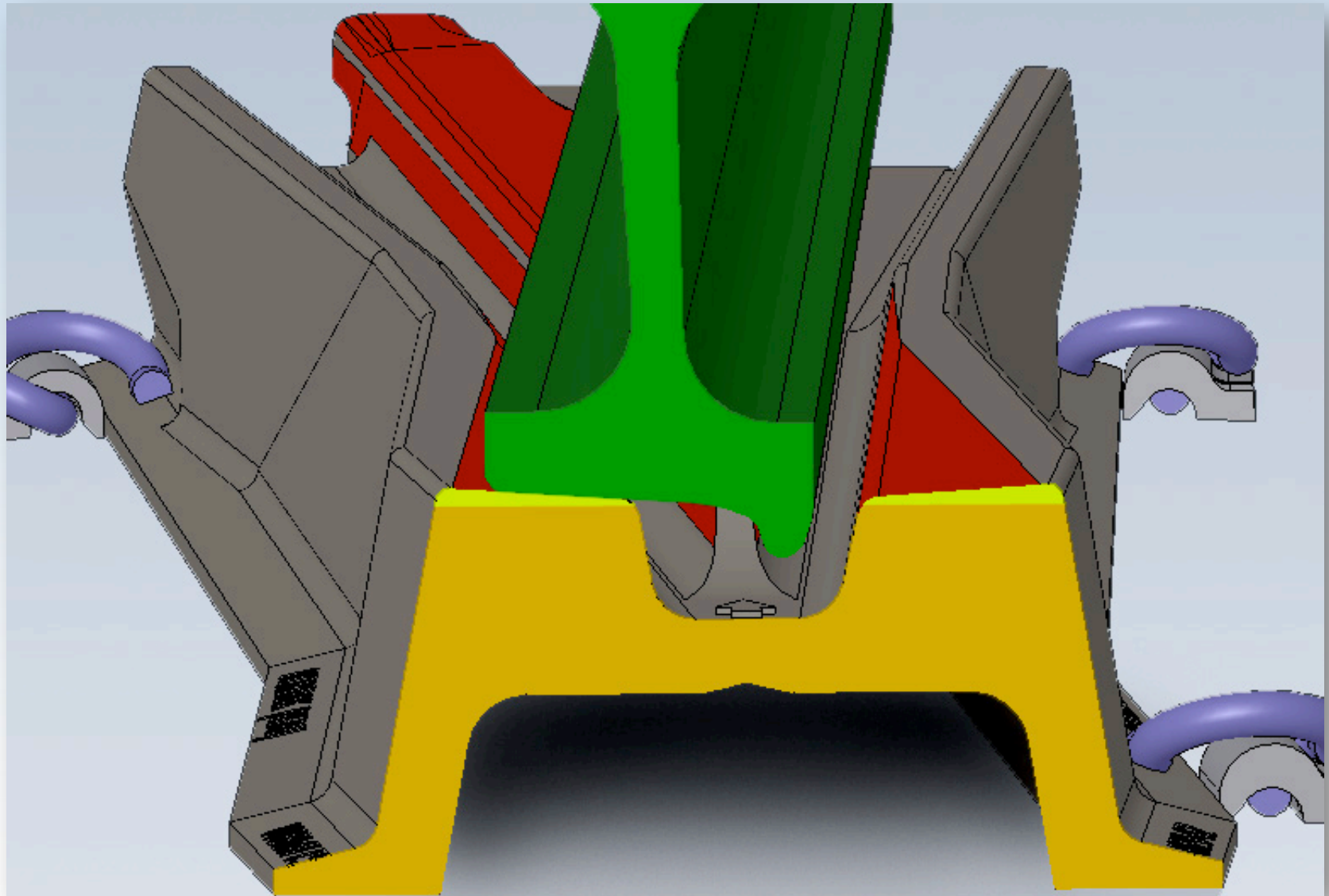
Conformal Profile

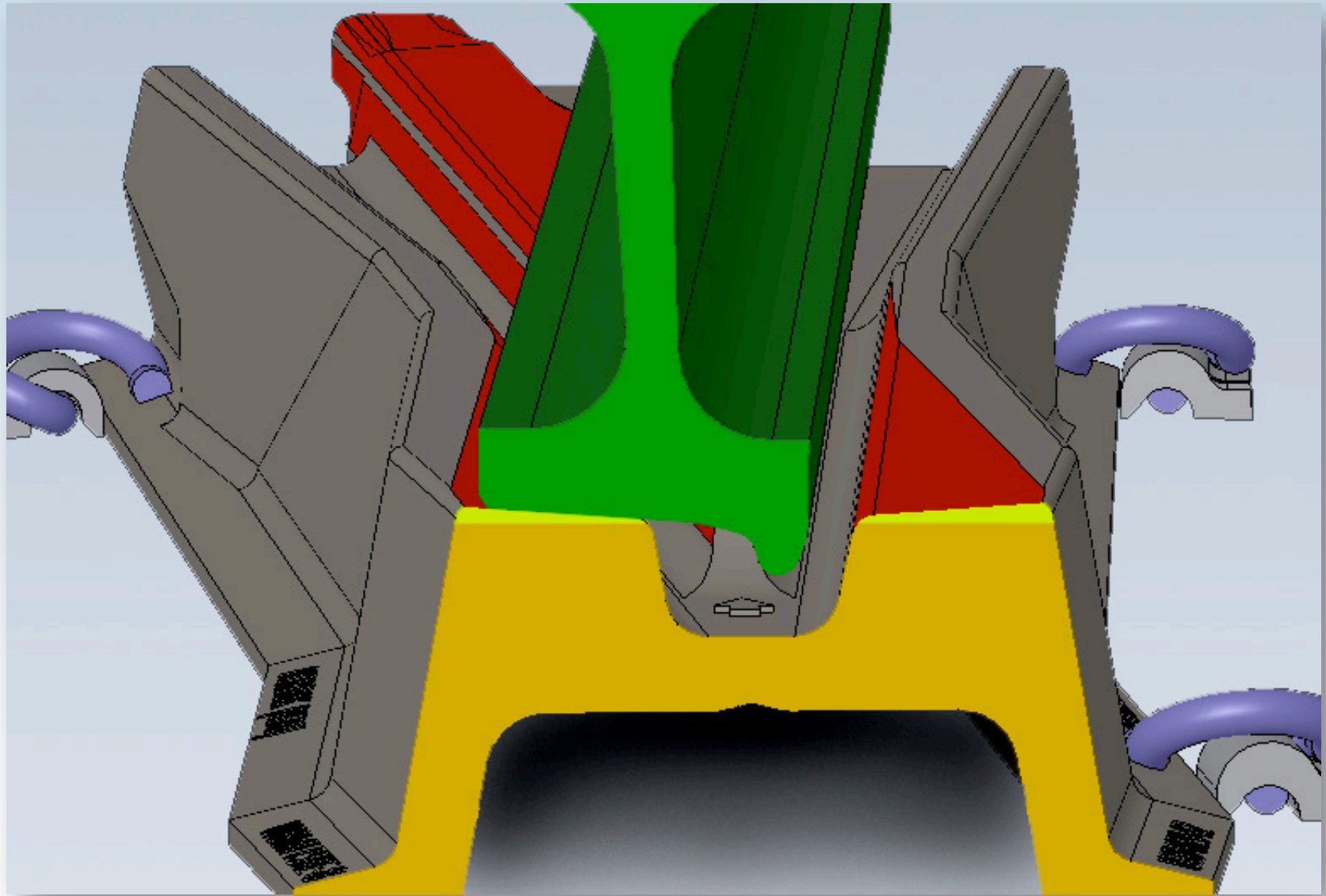
Top of Rail

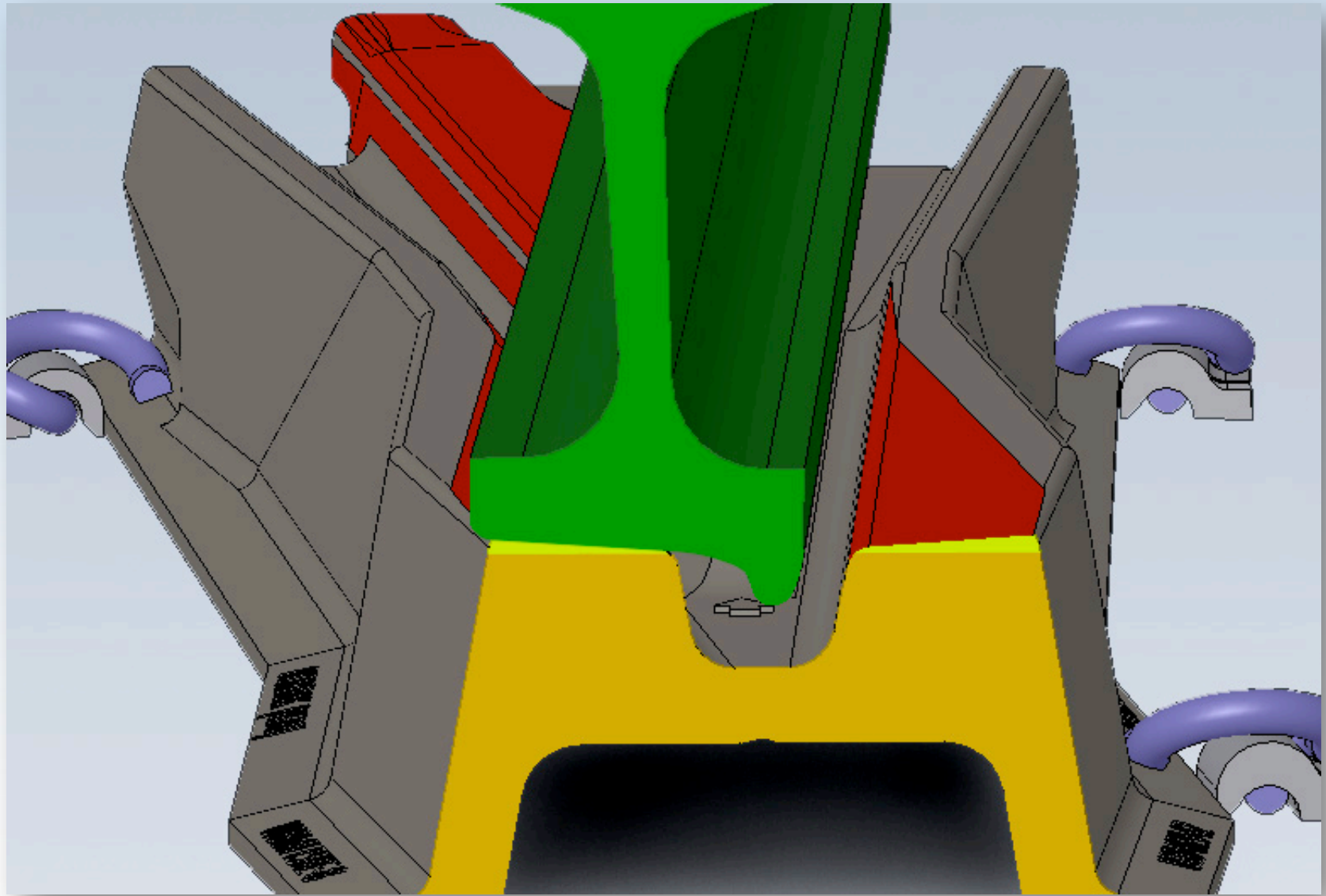
6mm high
weld layer







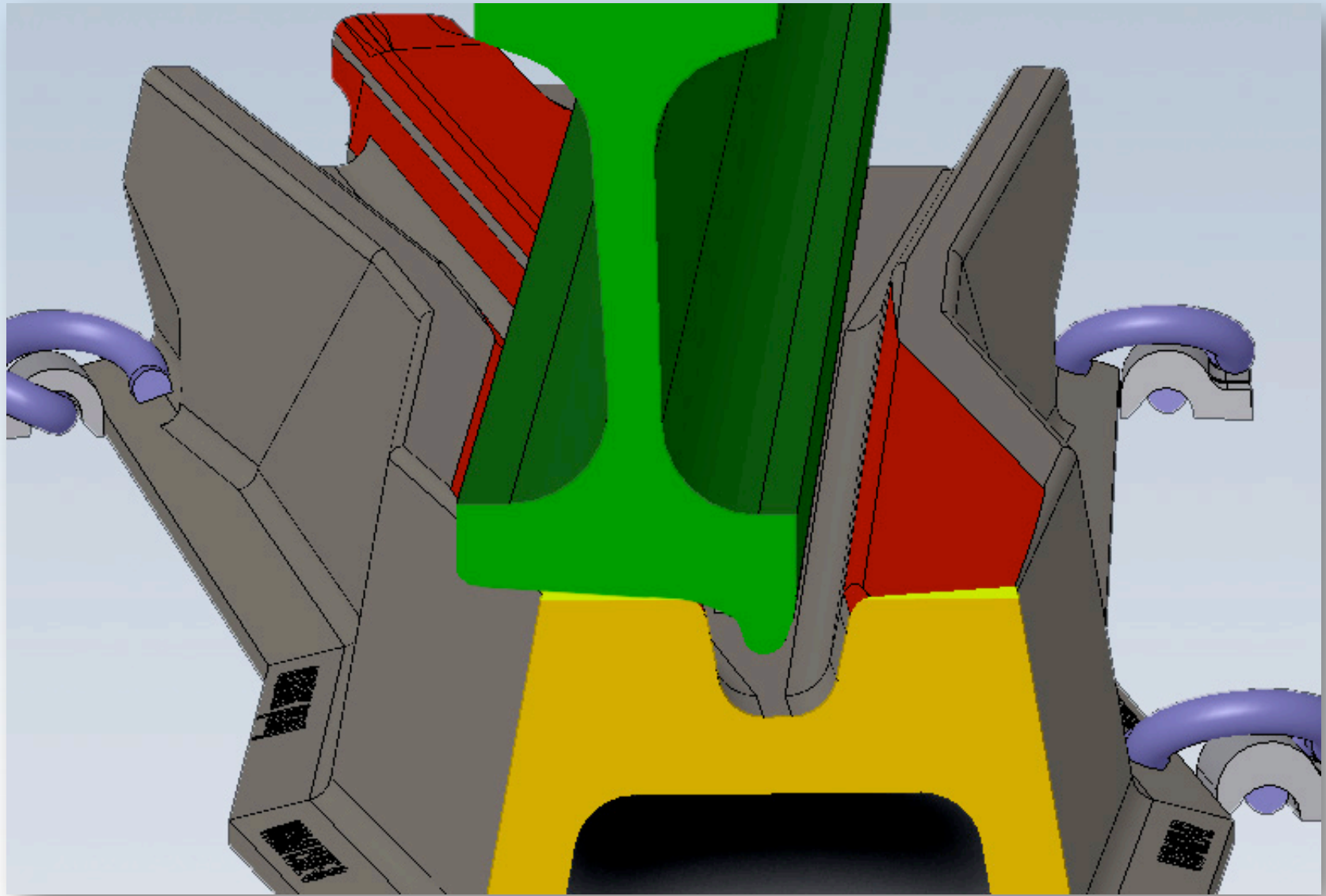




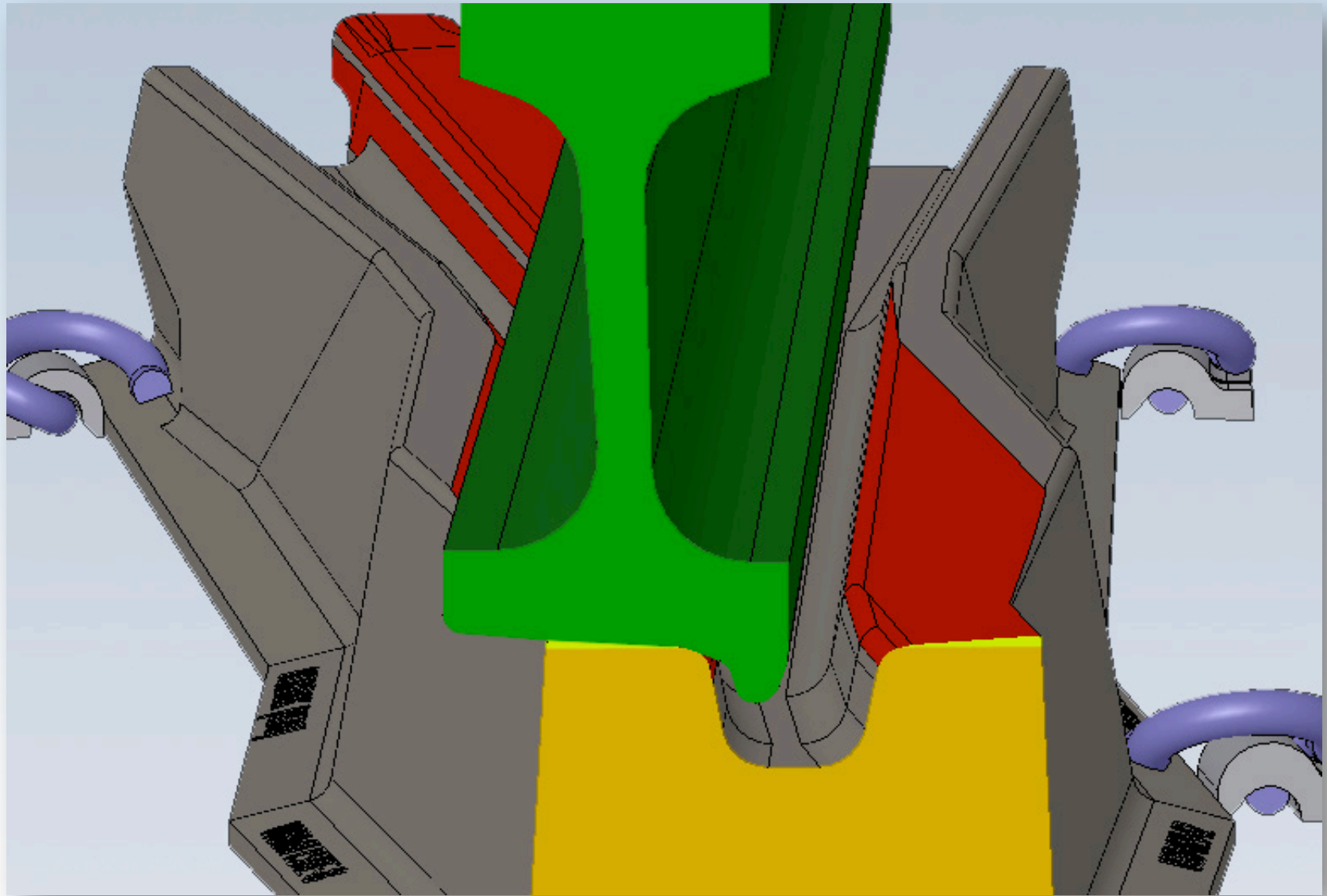


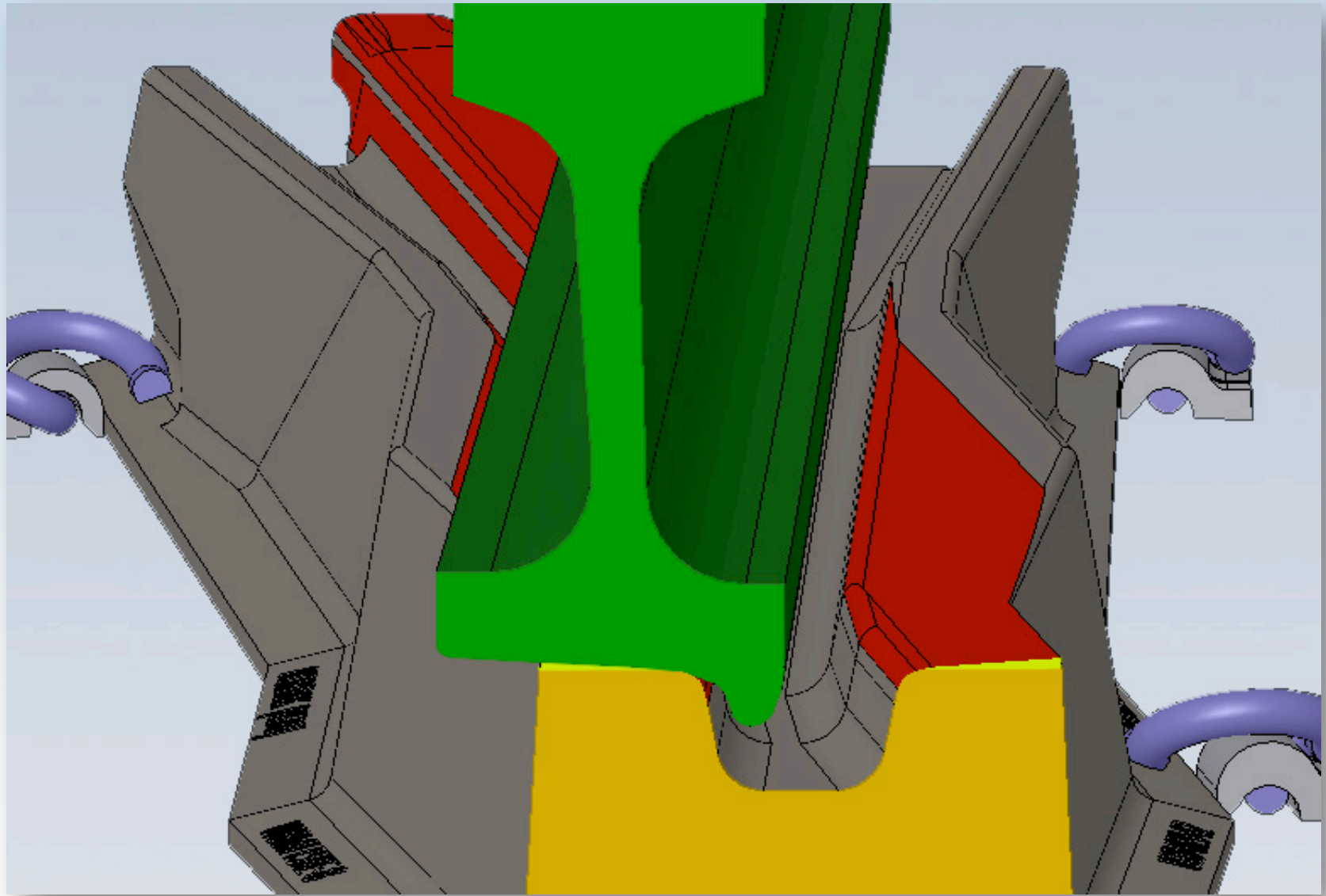
4mm high
weld layer









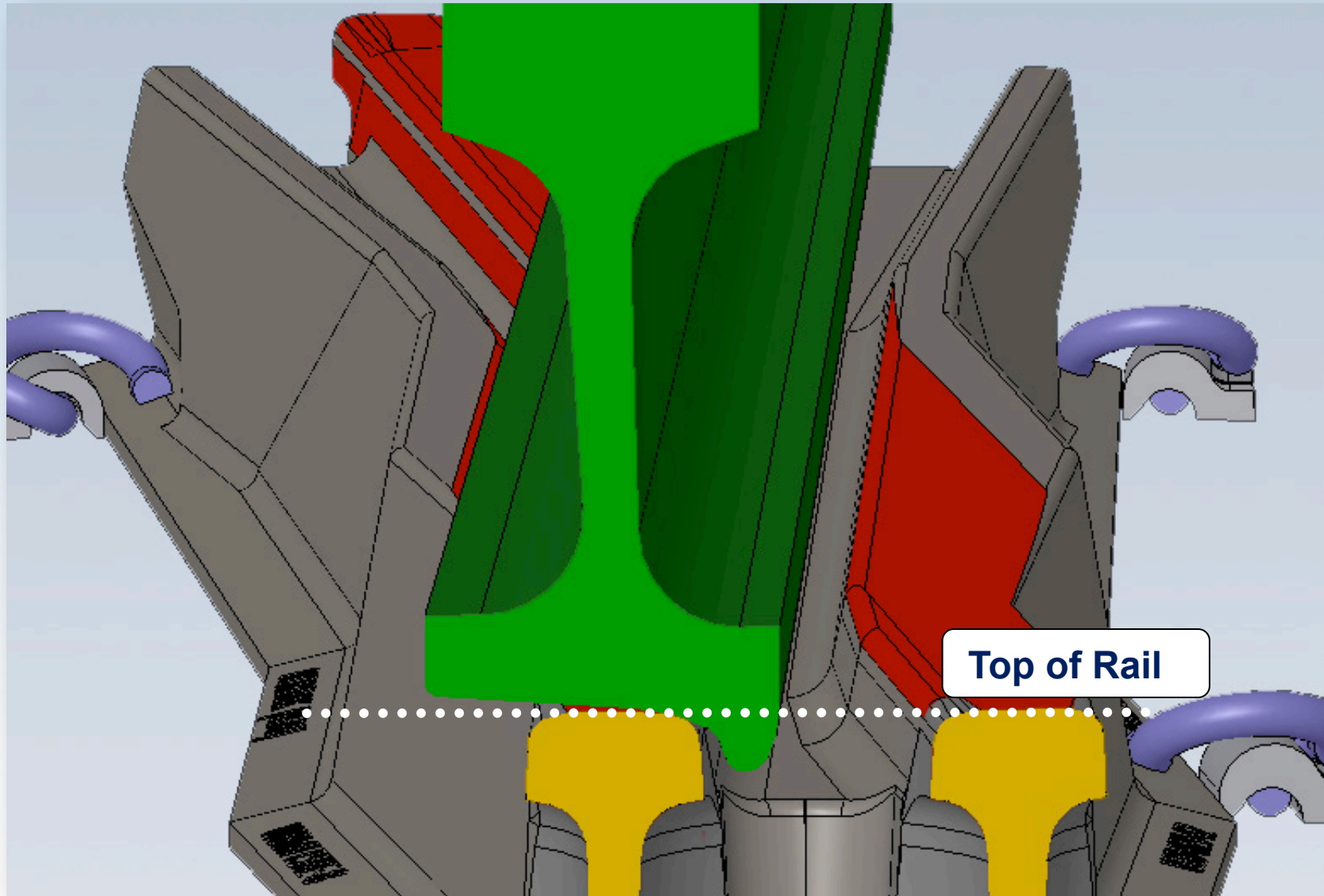




**2mm high
weld layer**

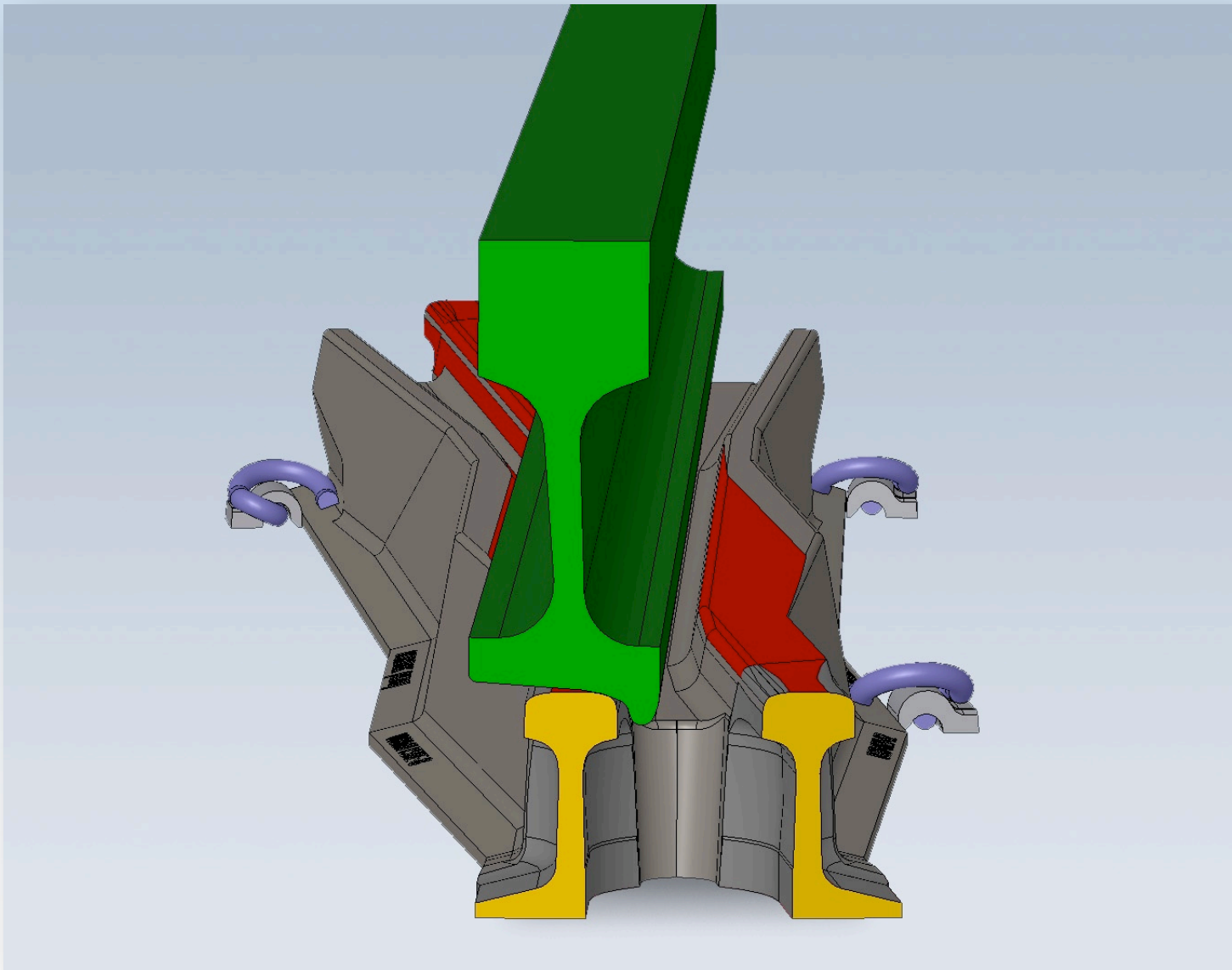


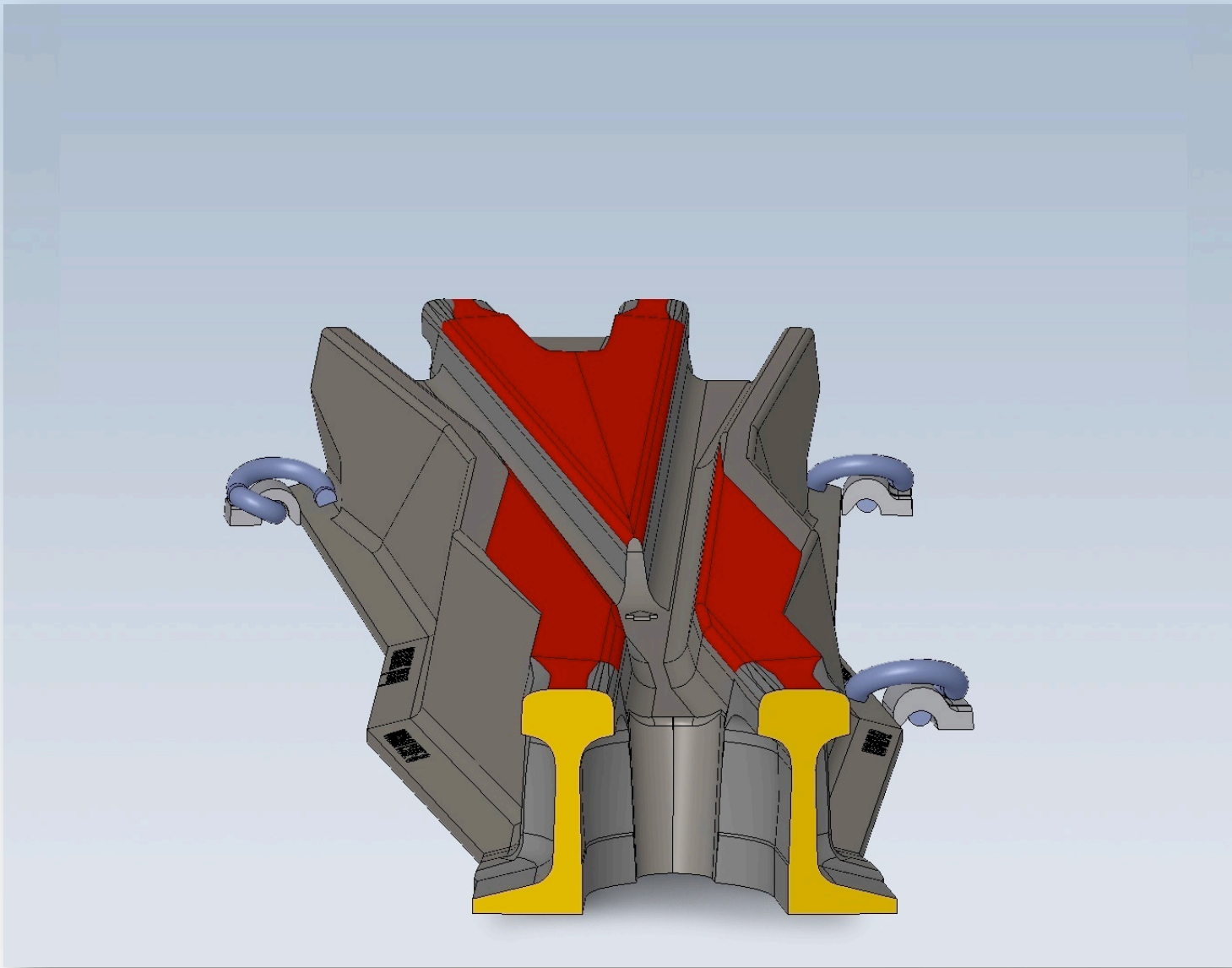




Top of Rail







Conformal Fixed Frog



Process and Application



Weld Preparations and Rework Pattern



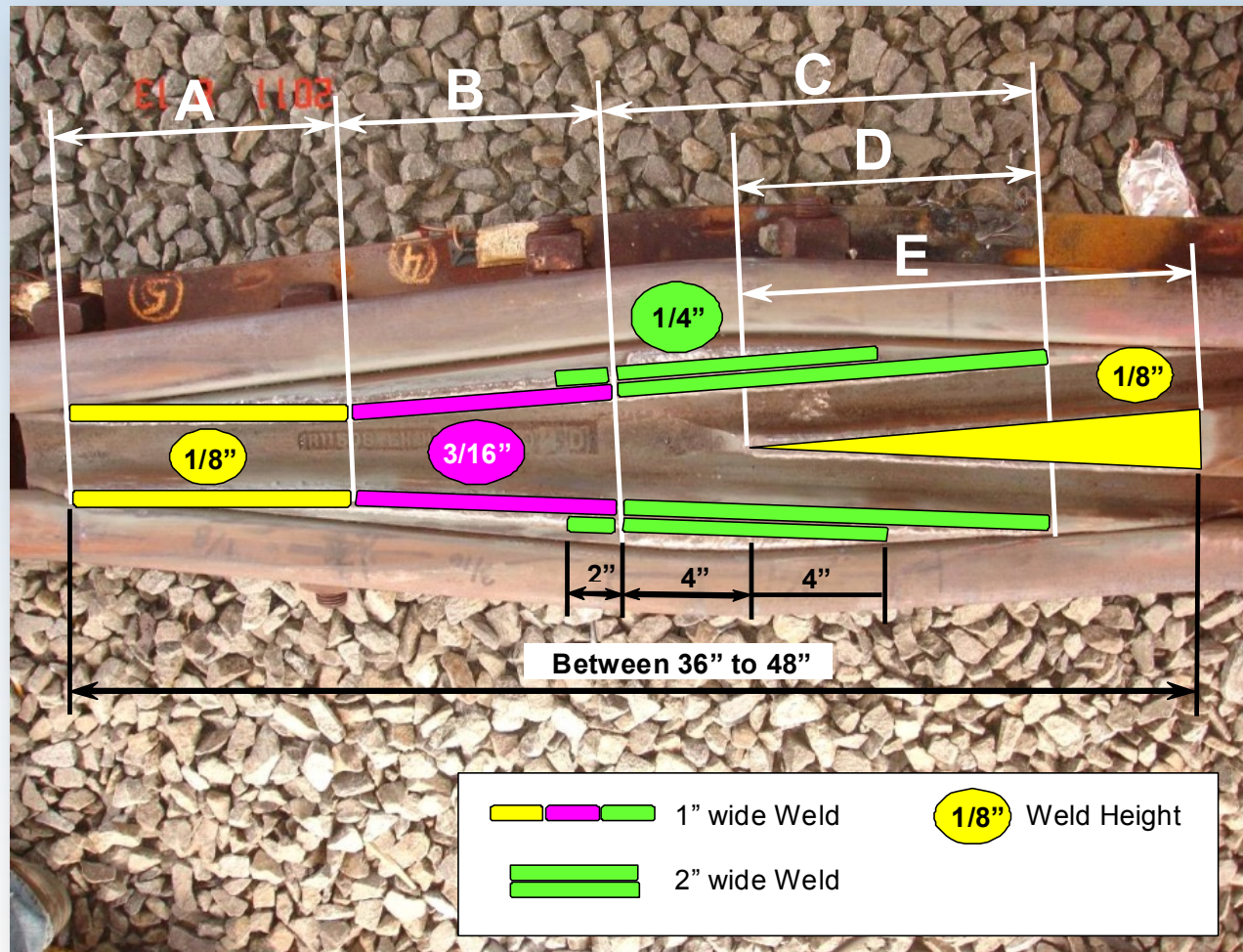
Prep + layout + pre-heat 100C
+ weld + grind + cool

Welding Process and Height Checks



Weld Build-up at Point and Wing

(Up to 5/16" above TOR)



Weld Build-up at Point and Wing

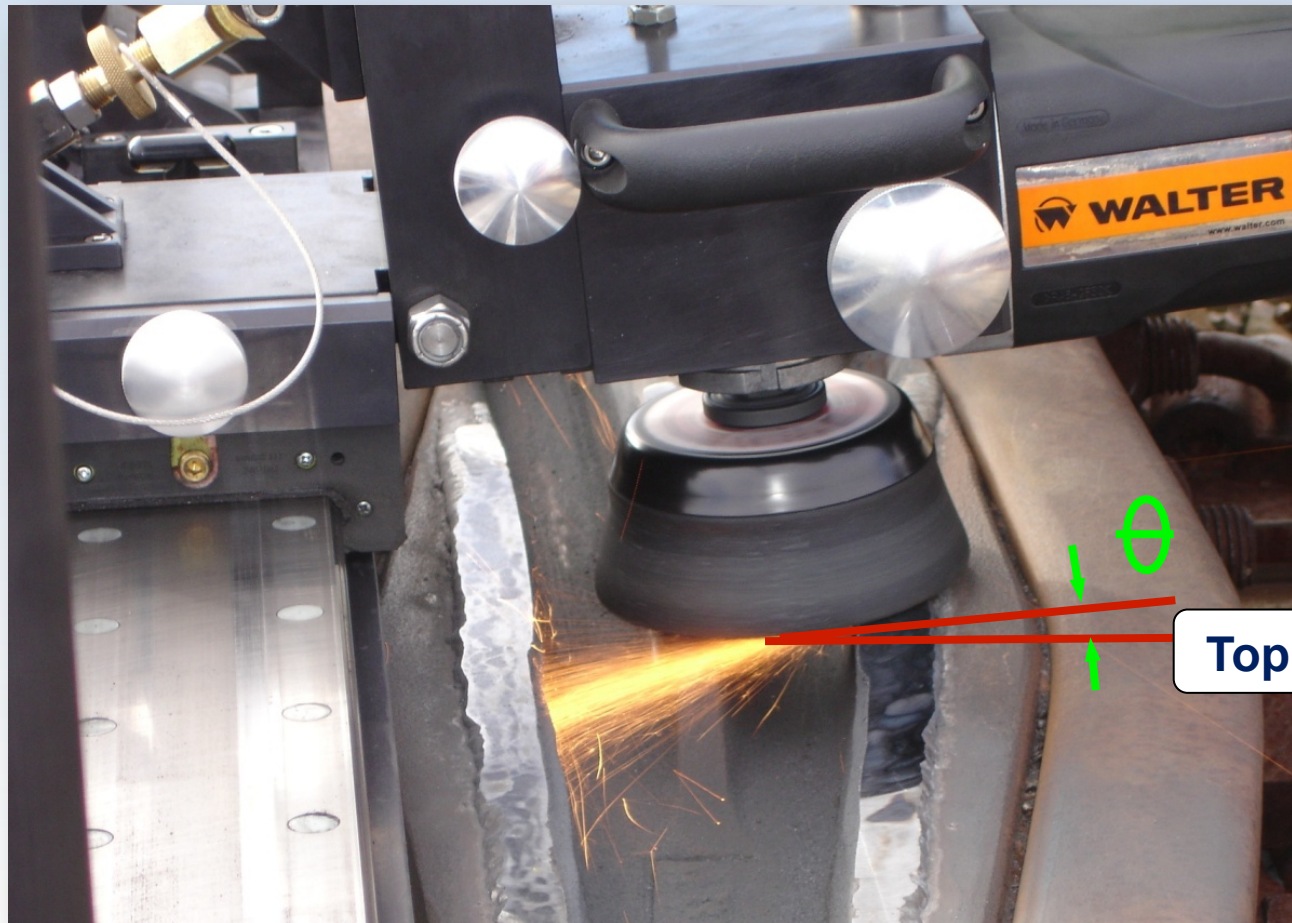
(Up to 5/16" above TOR)



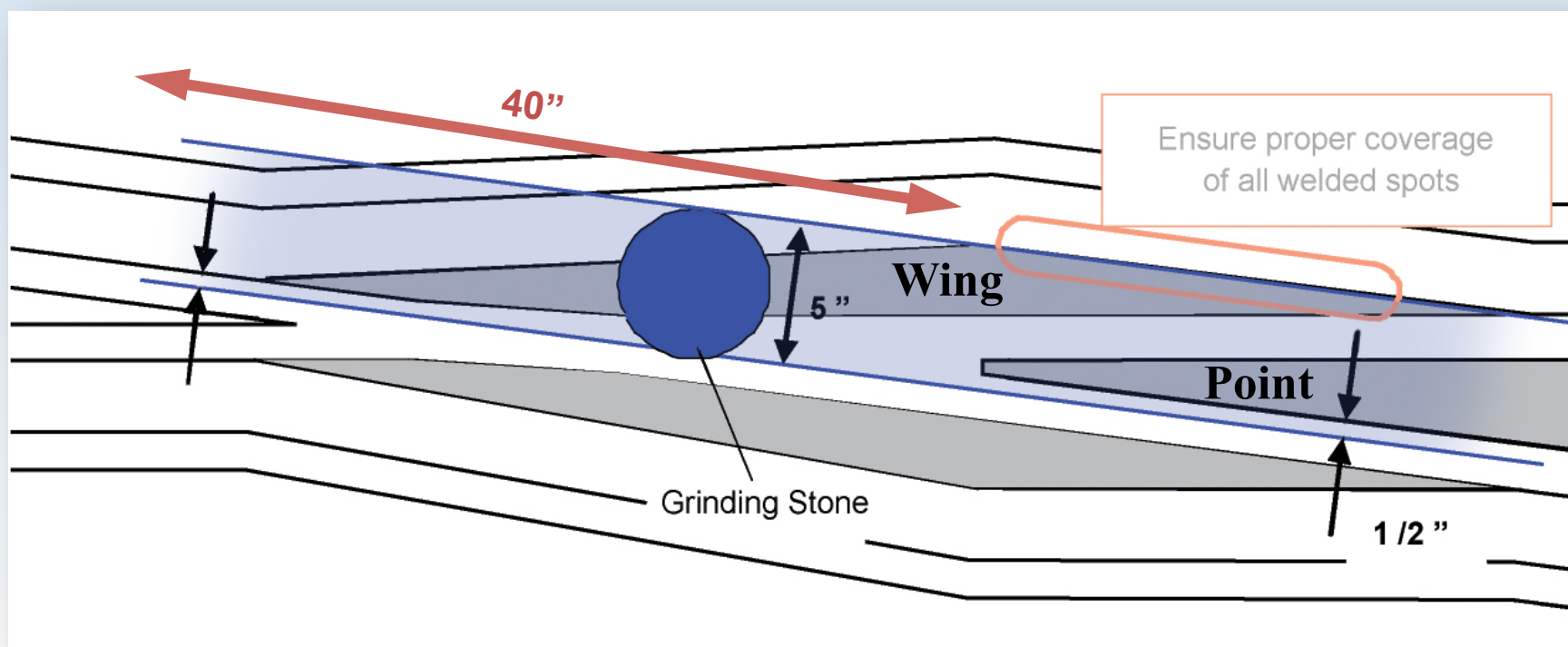
Profile Applied Over Full Crossover Length



Point-to-wing Transfer With 0.2 Degree Accuracy



Profile Applied Over Full Frog Length



Full-Length Profiling









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WRI 2016





Conformal Fixed Frog



Service Inspections



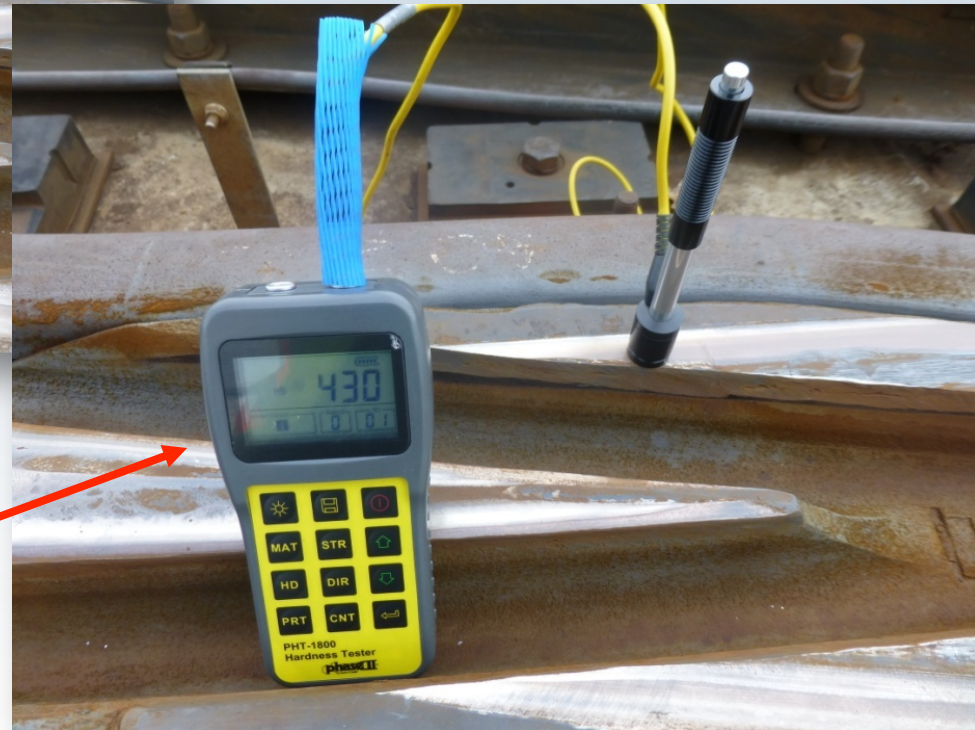
Profile Accuracy Inspections After Rework (+/- 0.2)



Developing Profile Hardness After Rework



**Rail head
hardness 266 BH**



**Welded contact band
hardness after 3 weeks
increased from 220 BH
to > 430 HB**



Frog Profile Inspection Template



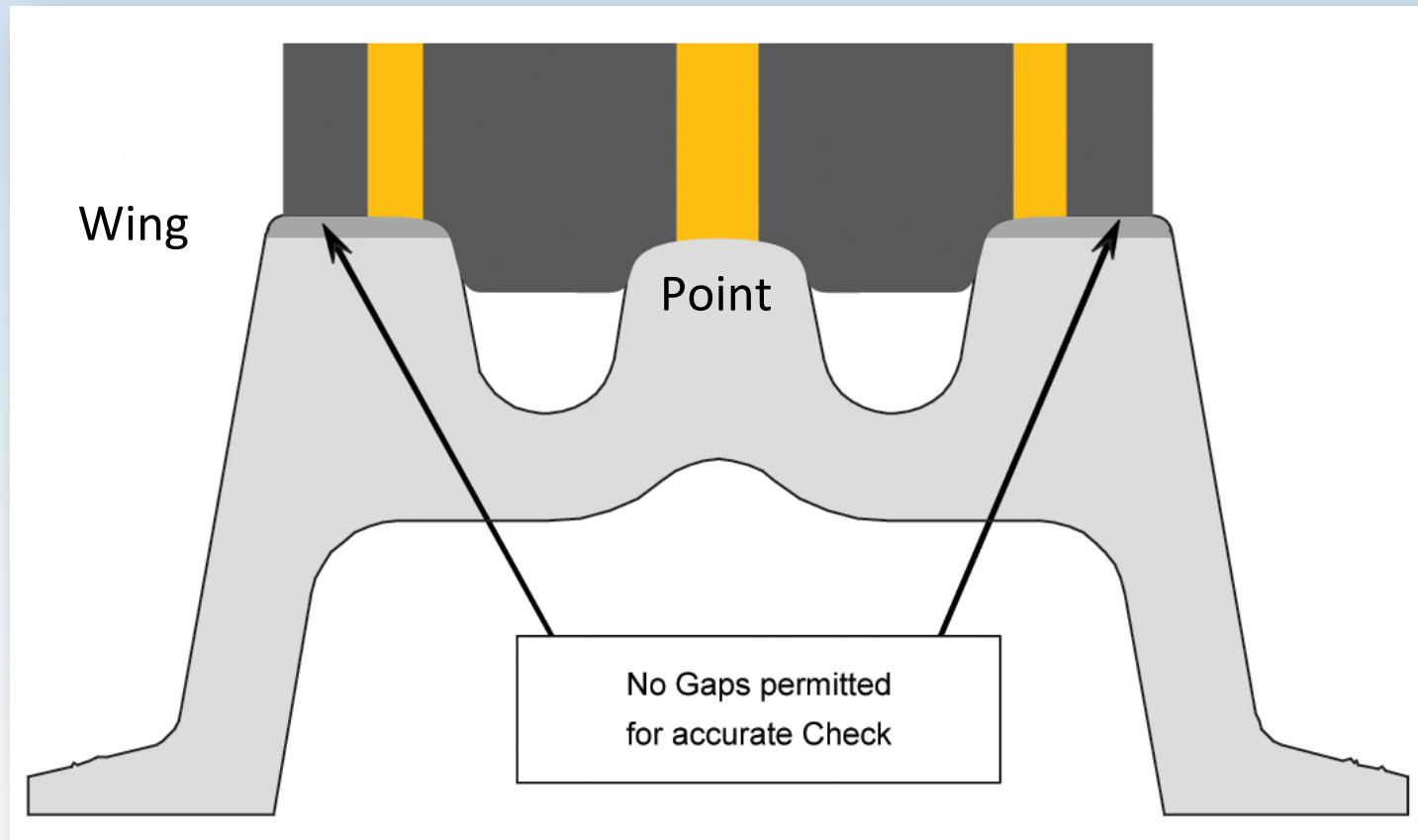
Wheel Contact Band for TOR height -schedule re-weld when measured gap with frog surface greater than 0.15"

BOMBARDIER
NO. 8 RBM TEMPLATE
KSK-12829-02
PATENT PENDING

2011 11 10

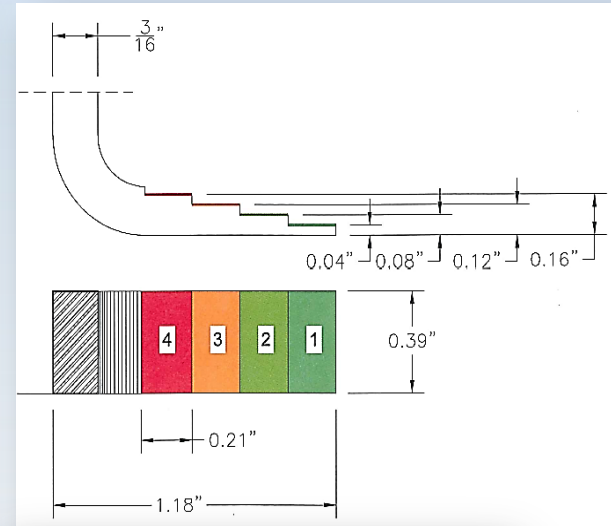


Frog Profile Inspection Template



Wheel Profile Inspection Wear Data Sheet

JFK Frog Wear Inspection Sheet		
DATE	INSPECTOR	WORK ORDER
TURNOUT ID	INSPECTION RESULTS	
TURNOUT TYPE	No Comments (Green) <input type="checkbox"/> Monitor for Impact Forces (Yellow); Schedule Re-inspection <input type="checkbox"/> Schedule Repair (Red) <input type="checkbox"/>	
No. 6 RBM		
Template #	Fill in the Rail Wear Gauge Reading from Key (note: color and step # on key): - < 0.04 inch (No-Gap) -- < 0.08 inch (Green #1) --- < 0.12 inch (Green #2) O < 0.16 inch (Yellow #3) X ≥ 0.16 inch (Red #4)	
-15 -12 -9 -6 -4 -2 0 (Point) +2 +4 +6		
Observations / Comments / Photos (attach separately)		



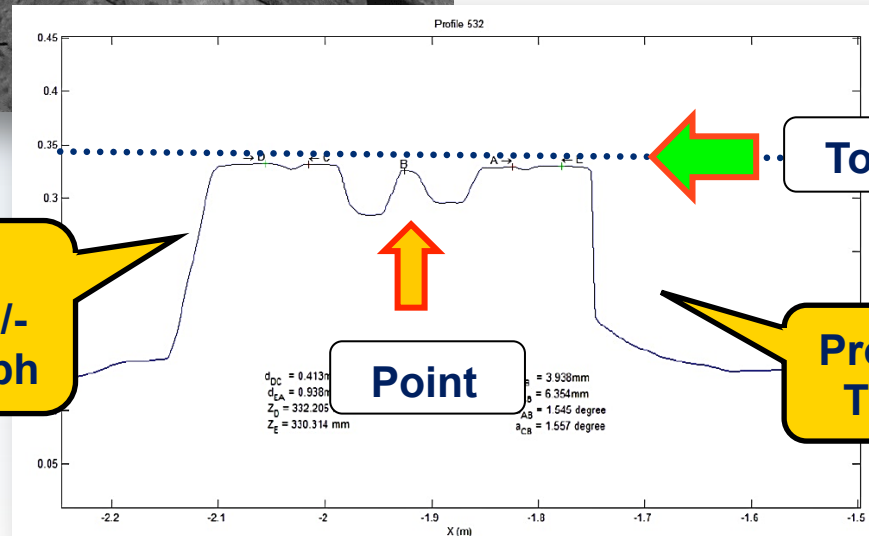
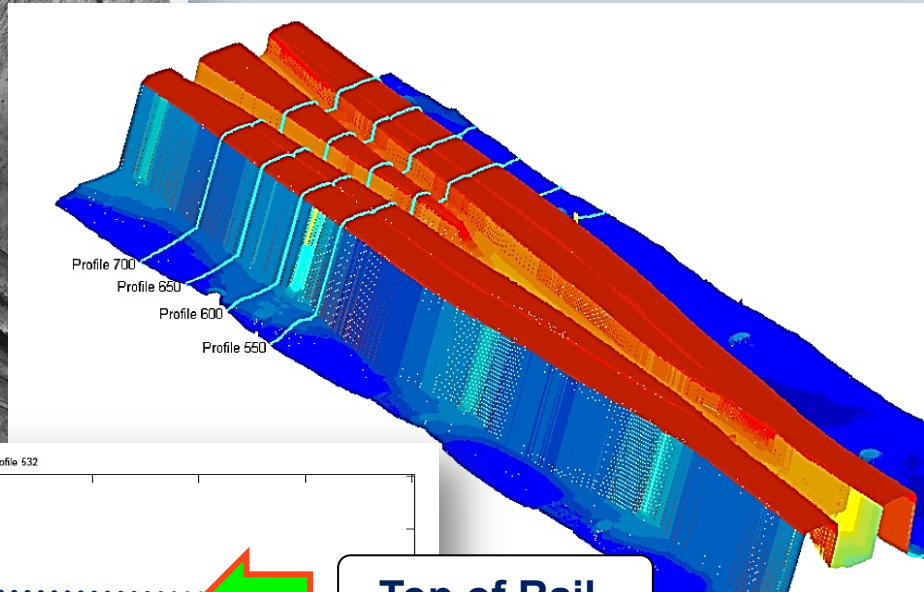
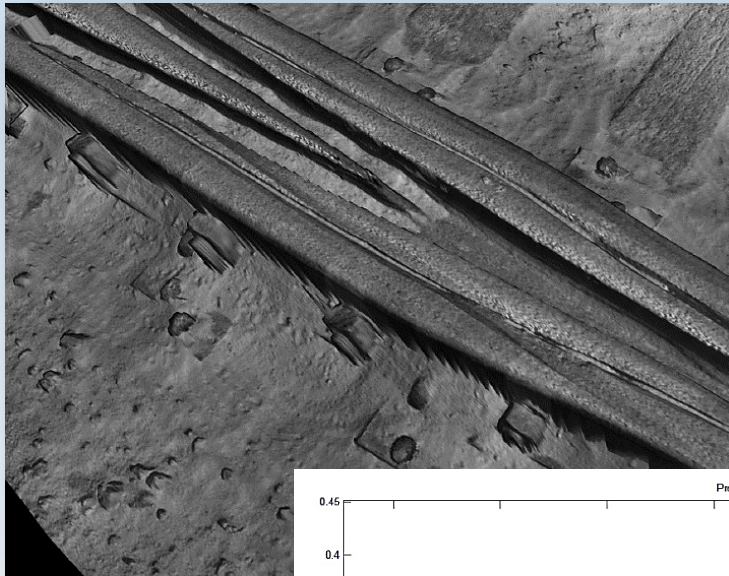
Off-site Frog Rework



Off-Site or Factory Profile Inspections



Frog Wear Inspections 3D Laser Scanning



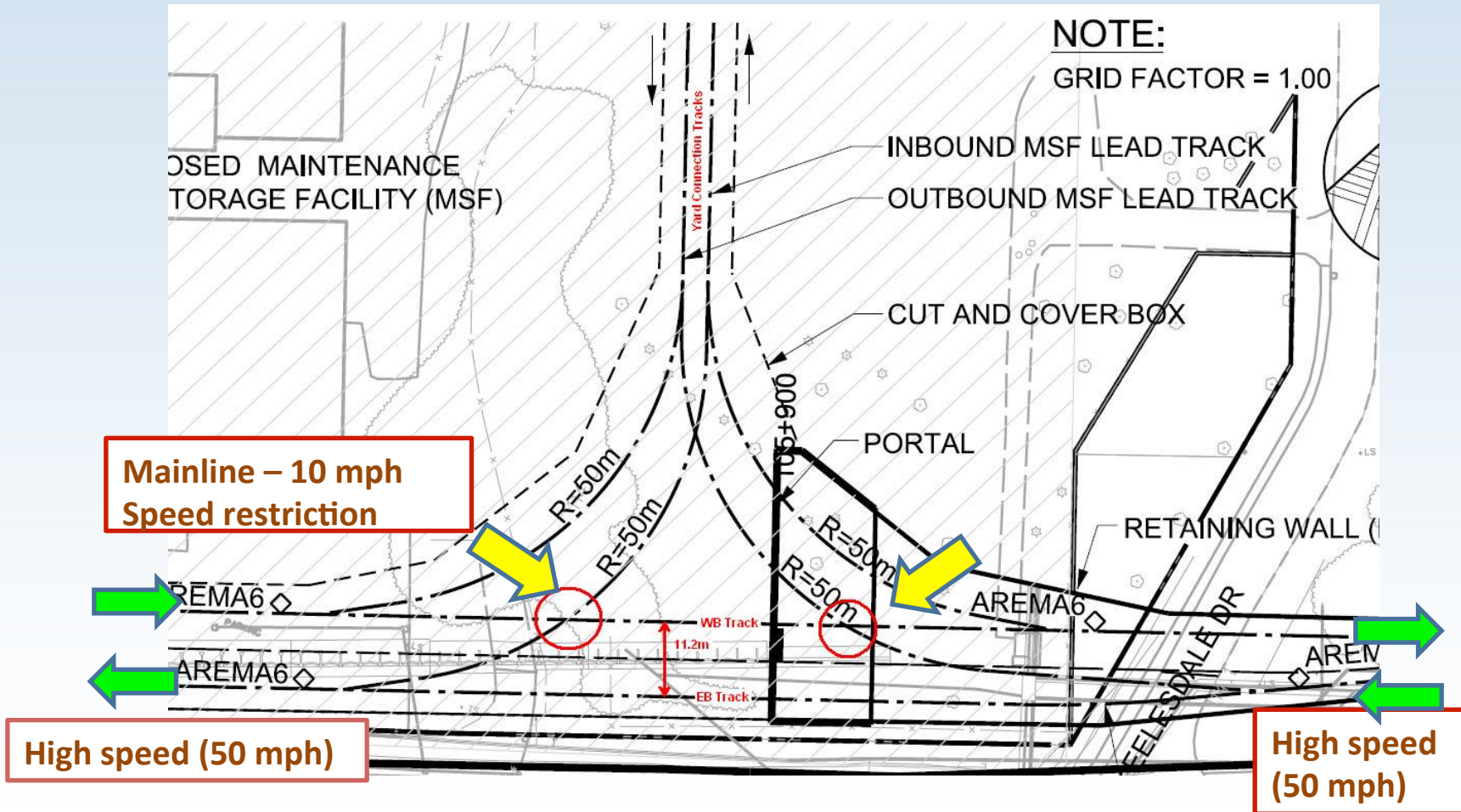
Courtesy of
Pavemetrics Inc.



Applications



Double Crossovers



Frogs within Double Crossover



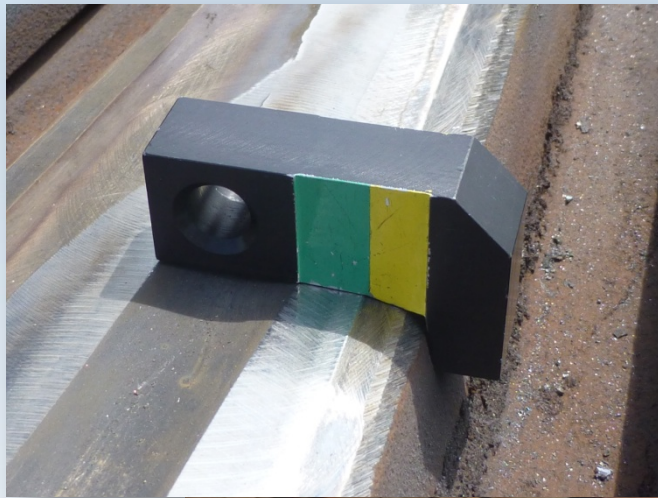
Frogs within Double Crossover



Next - WMT Diamond Profiles



Repairing Battered Rail Joints



Removing Rail Corrugation



Summary

- AirTrain JFK has 44 mainline No. 6 and No. 8 AREAM frogs and 4 double crossovers ... 20 frogs profiles corrected to-date with Repair process plus 12 New WMT replacements installed ... 60 mph max operating speed.
- 100% mainline to be up-graded by 2017 – significant track repair and vehicle overhaul cost savings over system life.
- Conducting N&V monitoring program of Repair vs. New WMT replacement frogs to investigate service life expectancy – *after 4 years*, near identical (*2mm wing wear*) performance.
- Discussions in progress to advance WMT Product and Process into international light and heavy rail markets.
- Patents approved for Process, Equipment, and Special Tools



ACKNOWLEDGEMENTS

- [1] Bombardier Transportation, AirTrain JFK System Services, New York, New York, USA
- [2] Bombardier Transportation, Systems Division, Kingston, Ontario, Canada
- [3] Port Authority of NYNJ, New York, New York, USA

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