From Curve Squeal To Bogie Steering

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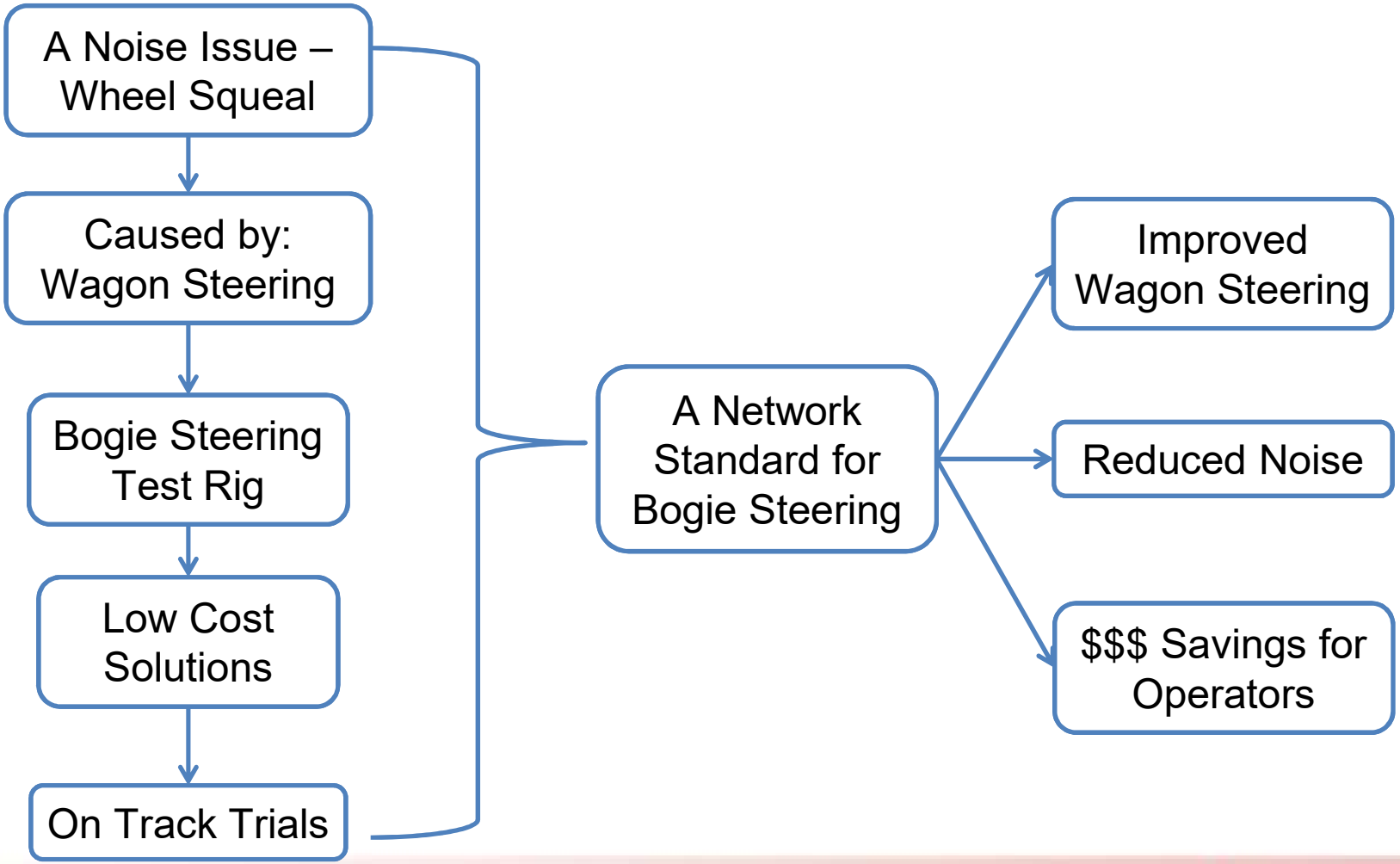
Introduction & Overview



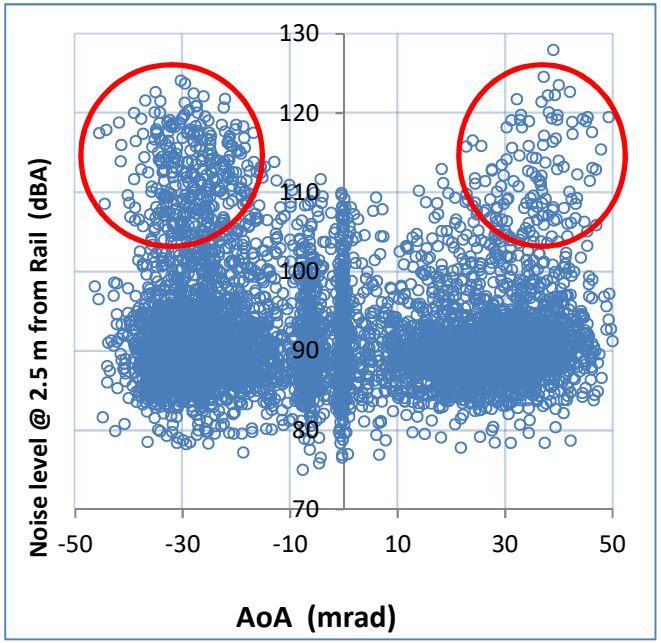
Wheel Squeal - Example

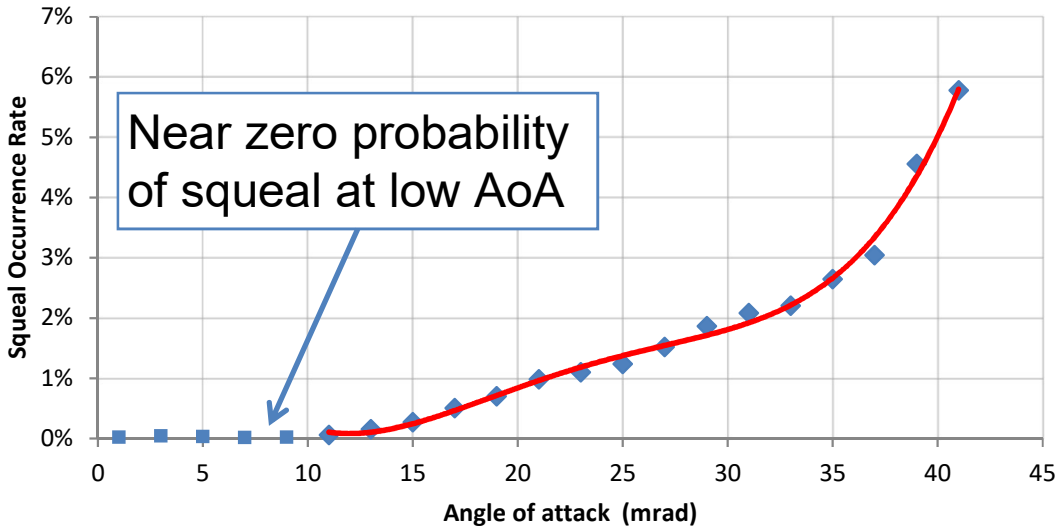
Only some wagons squeal…

Angle of Attack – A New Approach

- Every railway uses AoA…
  - Hunting Detection on Tangent
- New Approach: Wagon Steering
  - AoA Detector (T-BOGI) on 300m Radius Curve
  - Noise Measurements
- Big Data – Millions of Axle Passes

Curve Squeal & AoA

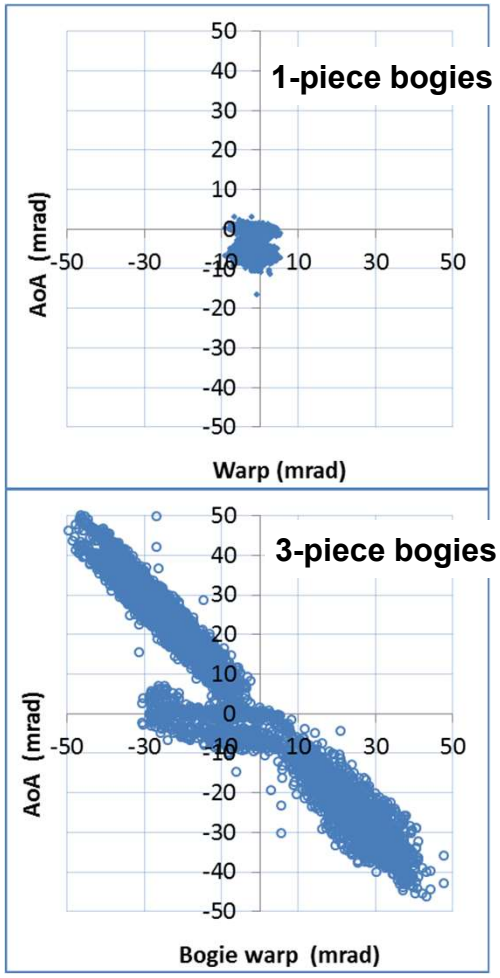


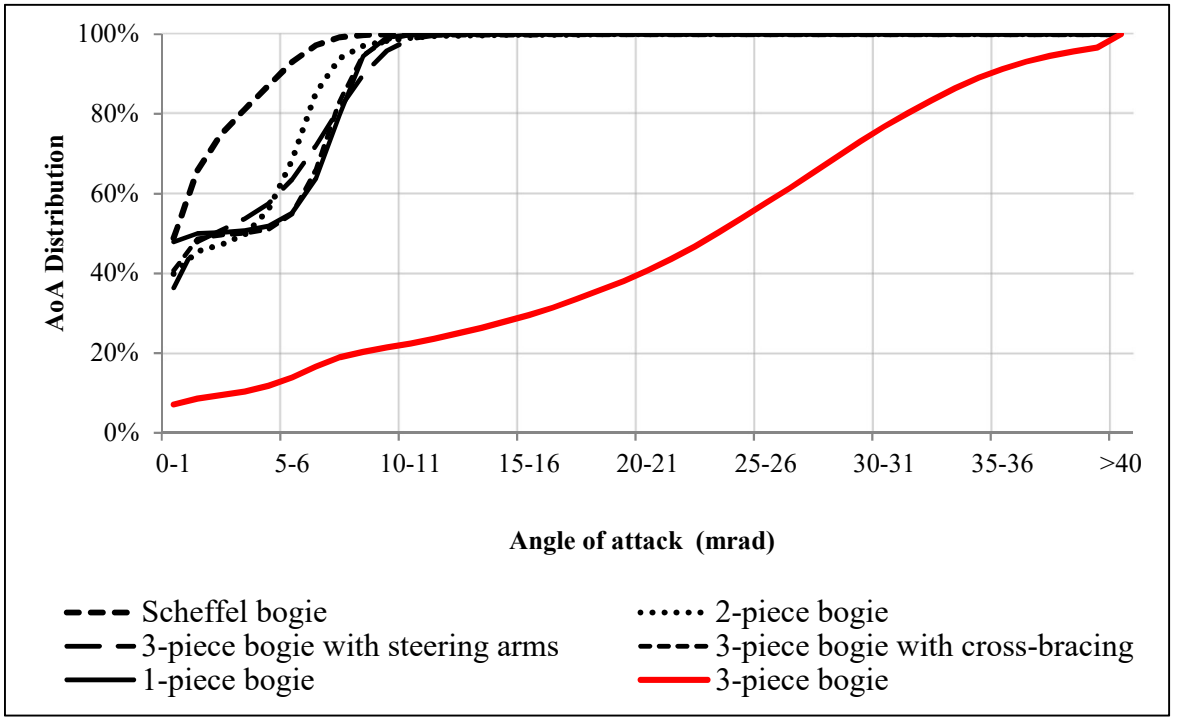


Jiandong Jiang, David Hanson, Bruce Dowell, Wheel Squeal: Insights from Wayside Condition Monitoring, In Proceedings of 12th International Workshop on Railway Noise, Australia,12-16 September 2016.

- A Large AoA is a Pre-Requisite for Squeal
- Only Some Wagons Display Large AoA
  - 3-Piece Bogies

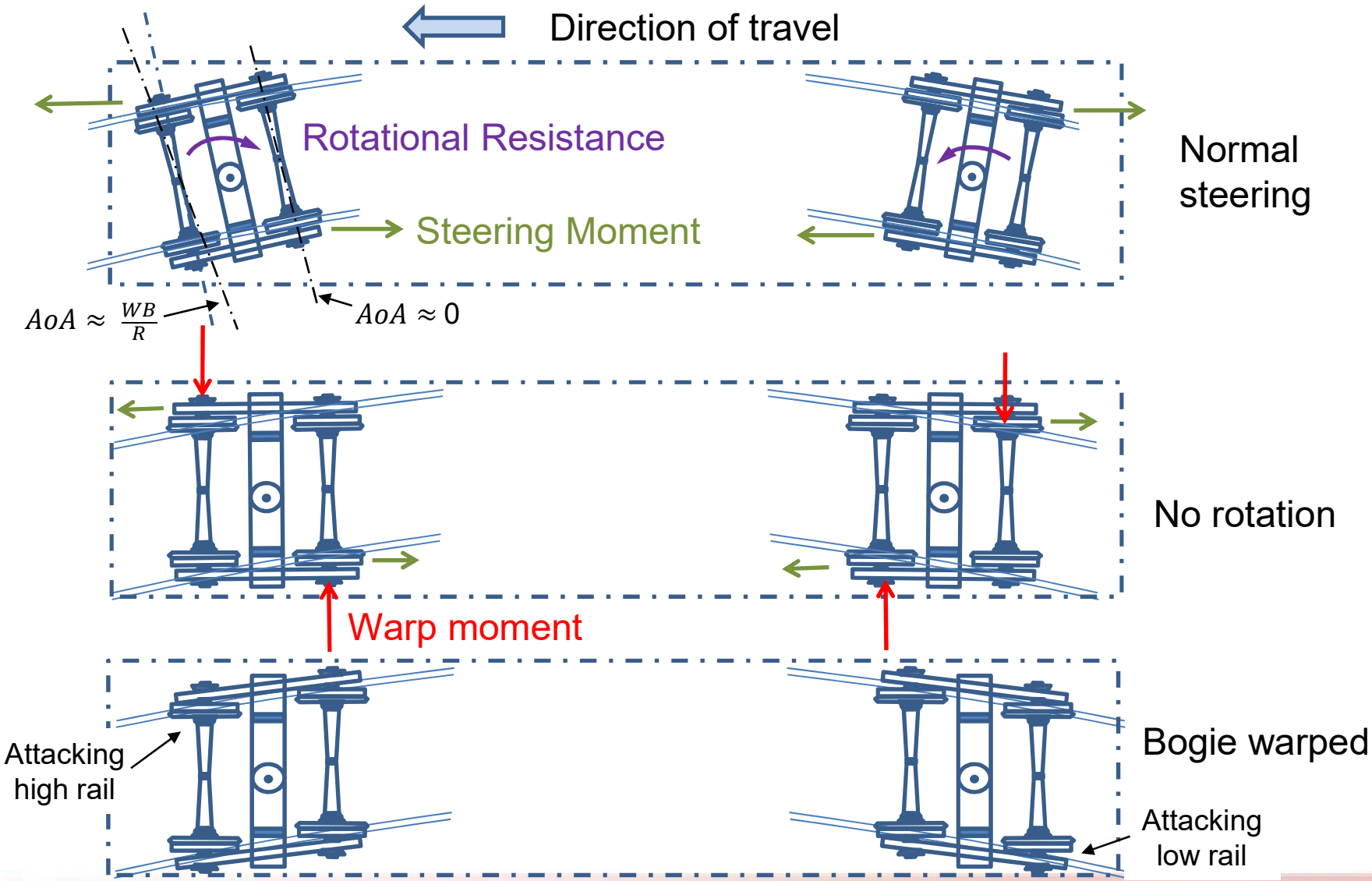
3-Piece Bogies Display Large AoAs





Hanson, David; Jiang, Jiandong and Dowdell, Bruce. Freight wagon steering - insights from wayside condition monitoring measurements, In: CORE 2016: Maintaining the Momentum. Melbourne: Railway Technical Society of Australasia, 2016: 248-253.

No Rotation = Warp = Large AoA



Warp, Rotation and Steering

Rotational Resistance = **Steering Moment** + **Warp Moment**

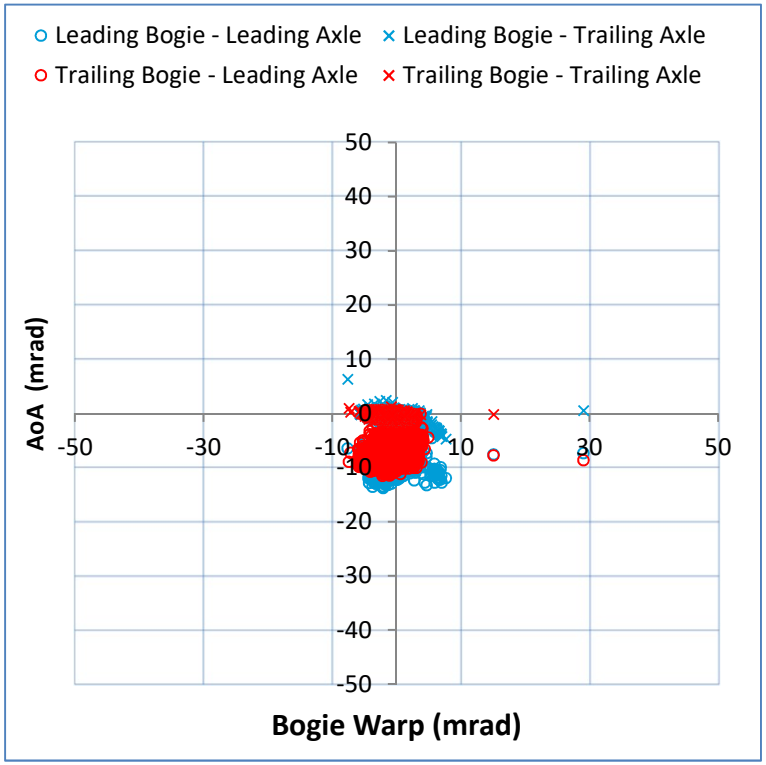
- Rotational Resistance: Centre Plate; CCSBs
- Steering Moment: Lubrication; Wheel/Rail Profiles
- Warp Moment: Warp Stiffness

Steering Moment is Relatively Fixed…

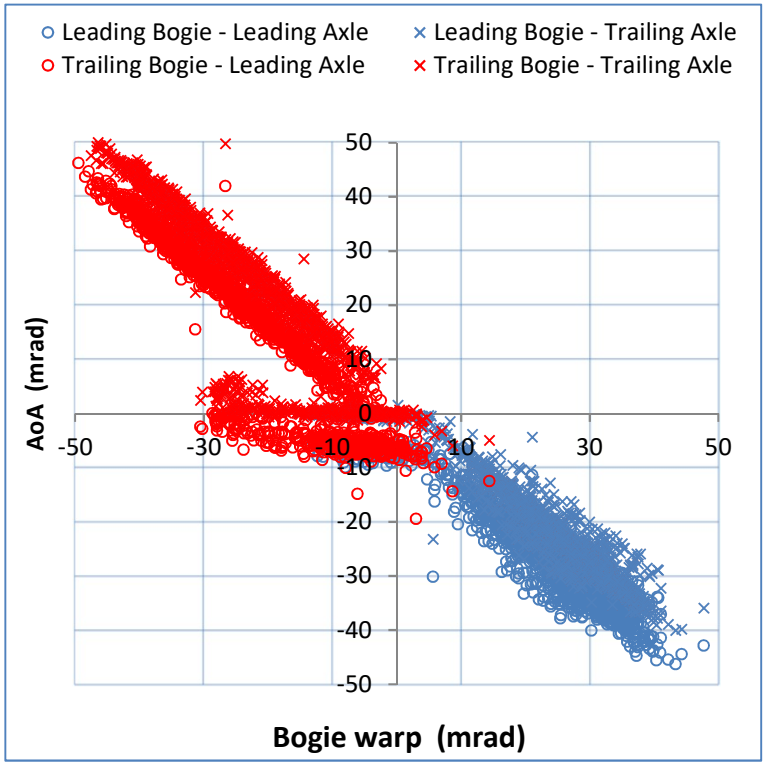
So, for a 3-Piece Bogie with Low Warp Stiffness:

High Rotational Resistance = **Large Warp Angle** = **Large AoA**

Warp & AoA – On-Track Measurements

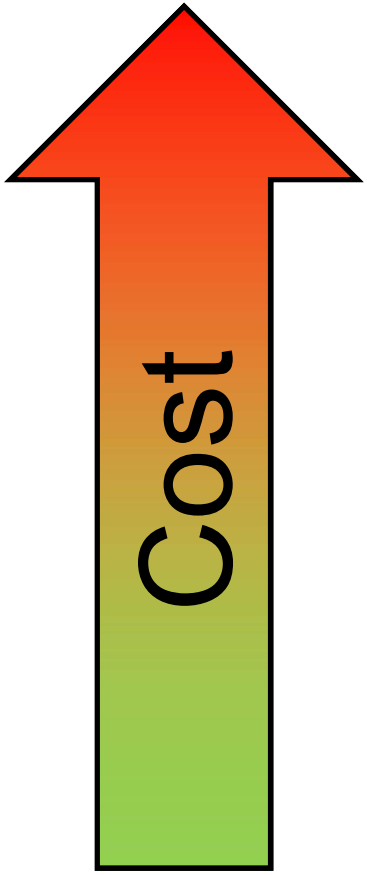


Typical 1-piece bogie



Typical 3-piece bogie

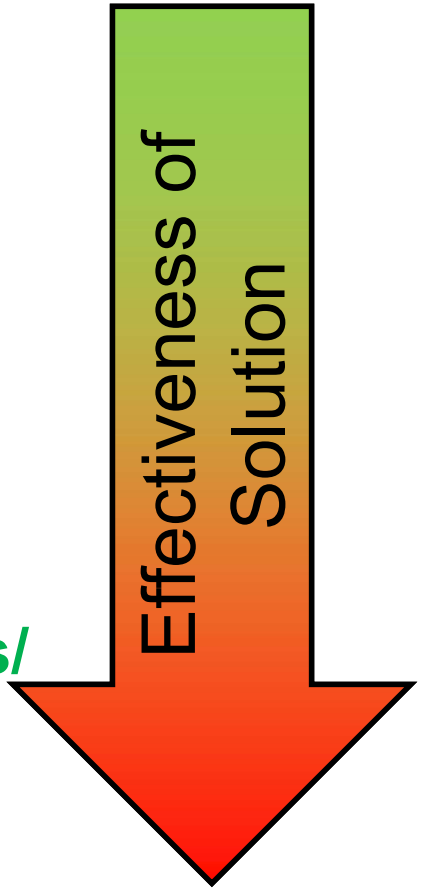
So, how do we fix steering on 3-piece bogies?



Buy New Premium Bogies

Retrofit Cross Bracing

Polymer Centre Liners/
Resilient Pedestal Adaptors/
Tune Springs

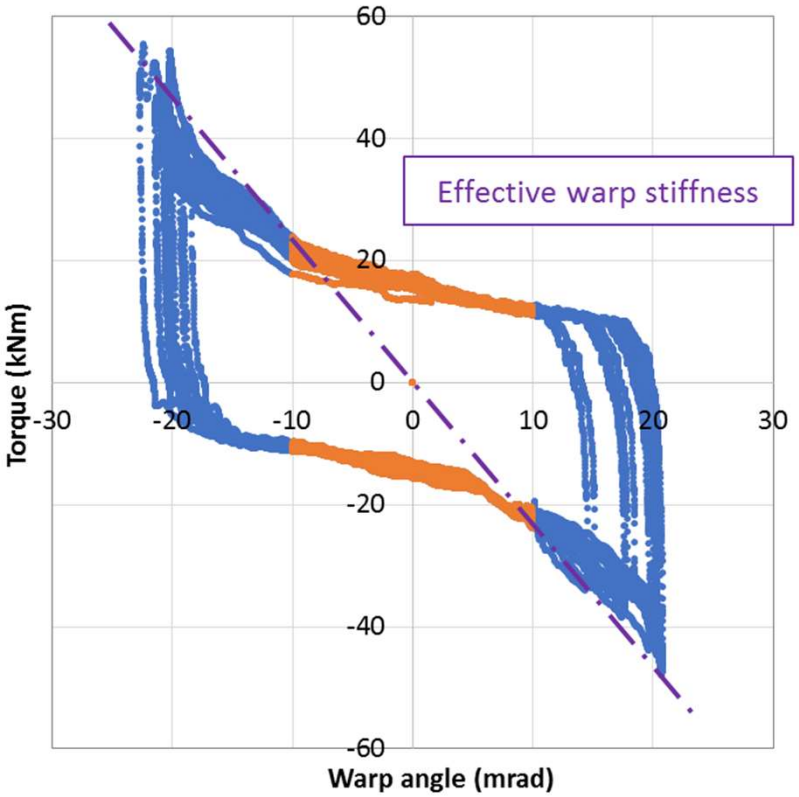


Need to Develop Low Cost Solutions

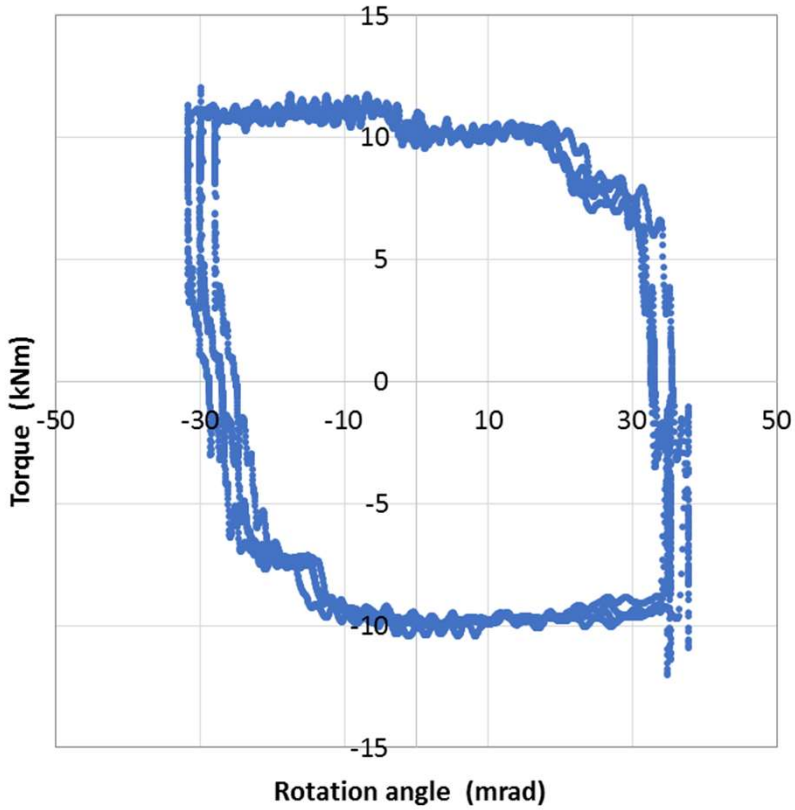
Test Rig for Measuring Bogie Warp Stiffness & Rotational Resistance

- Low cost and rapid testing
- Safely trial modifications
- Develop low cost solutions
- Shortlist solutions for subsequent on-track testing

Examples of Measured Bogie Warp Stiffness & Rotational Resistance

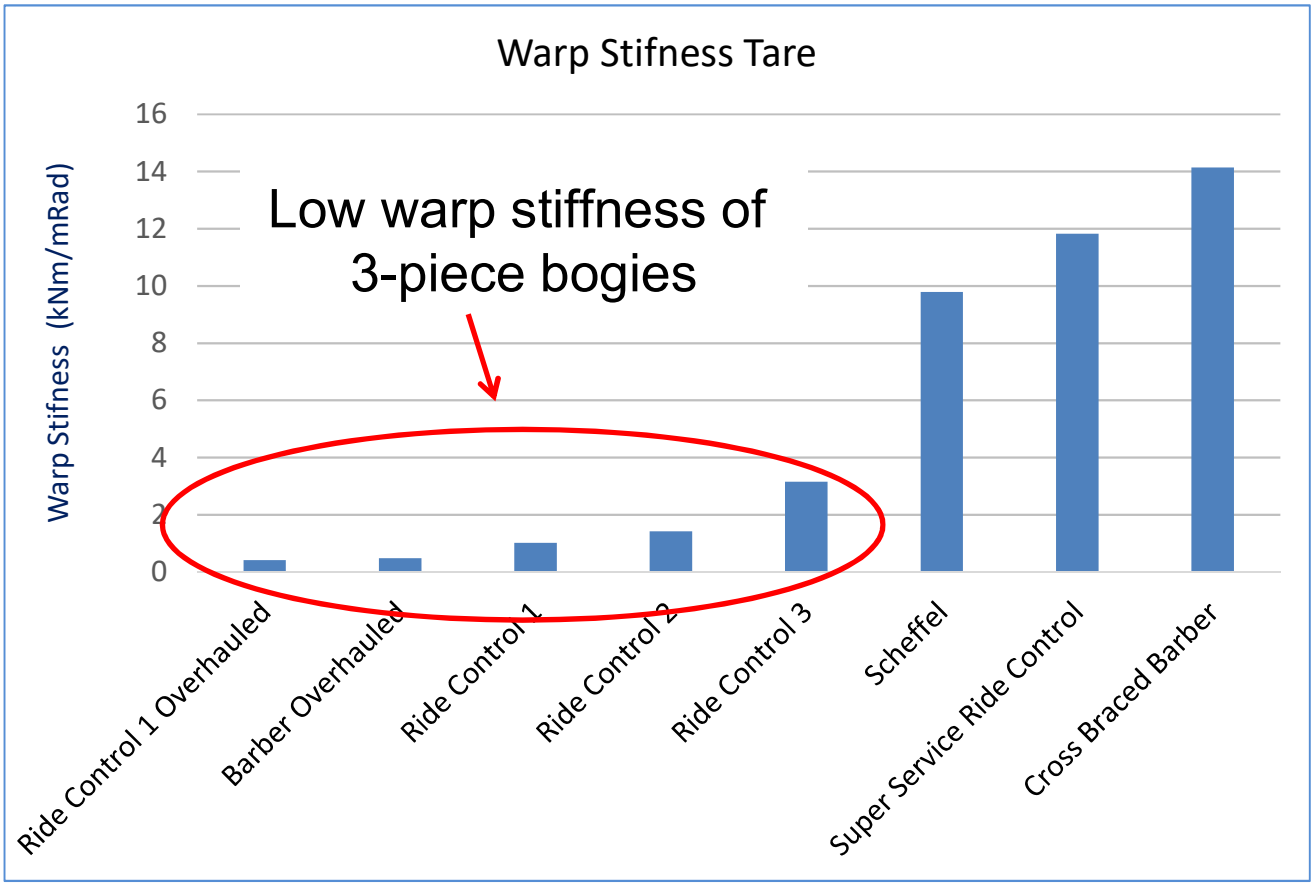


Warp Stiffness

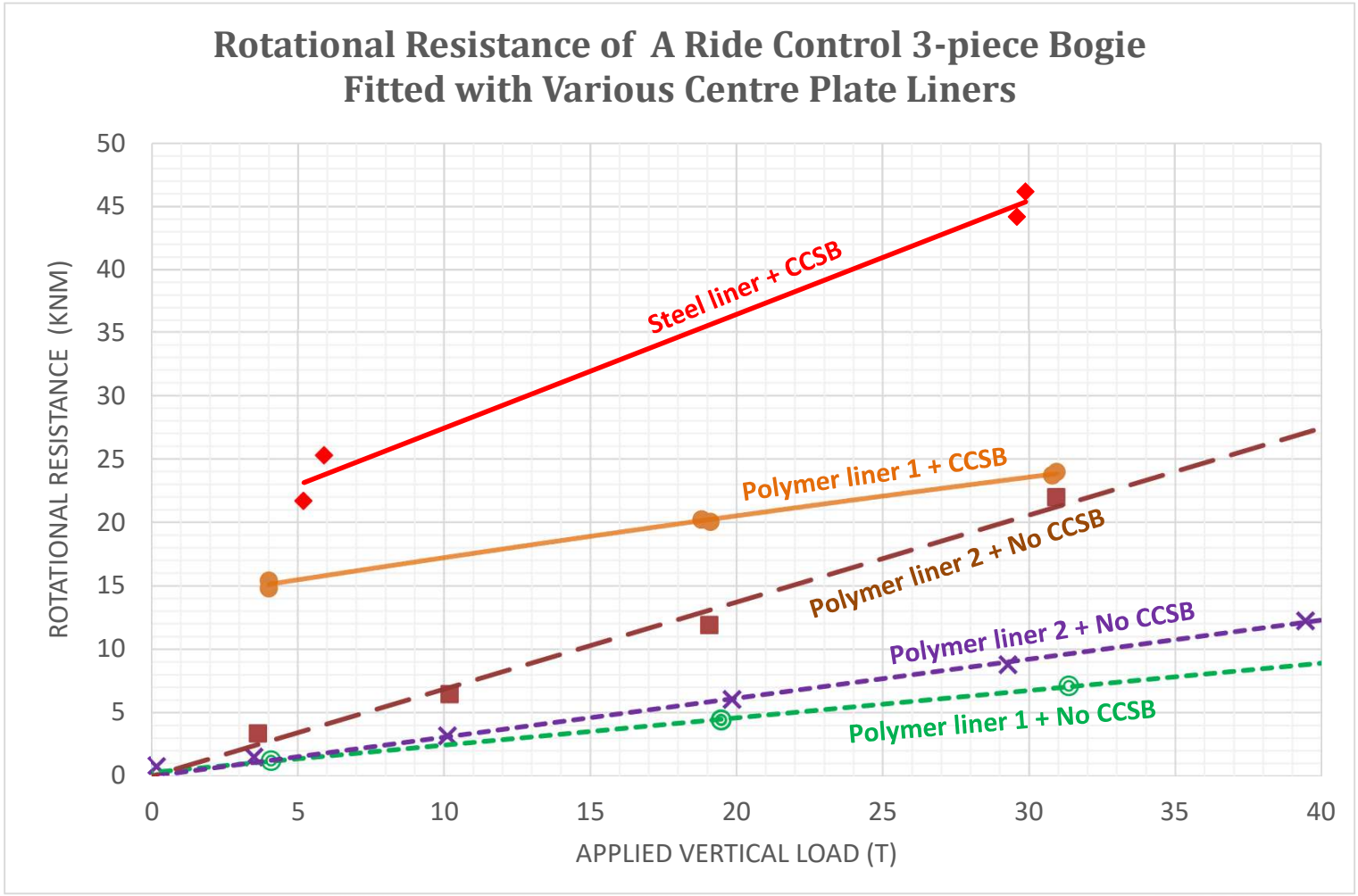


Rotational Resistance

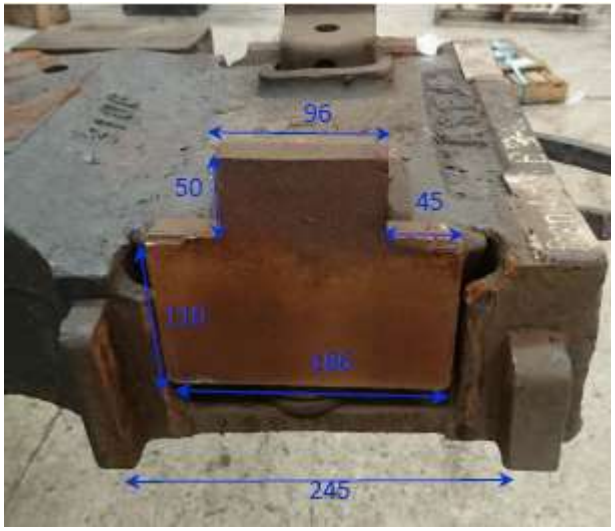
Results: Warp Stiffness of Various Bogies



Results: Rotational Resistance



Trials of Low Cost Solutions for 3-Piece Bogies

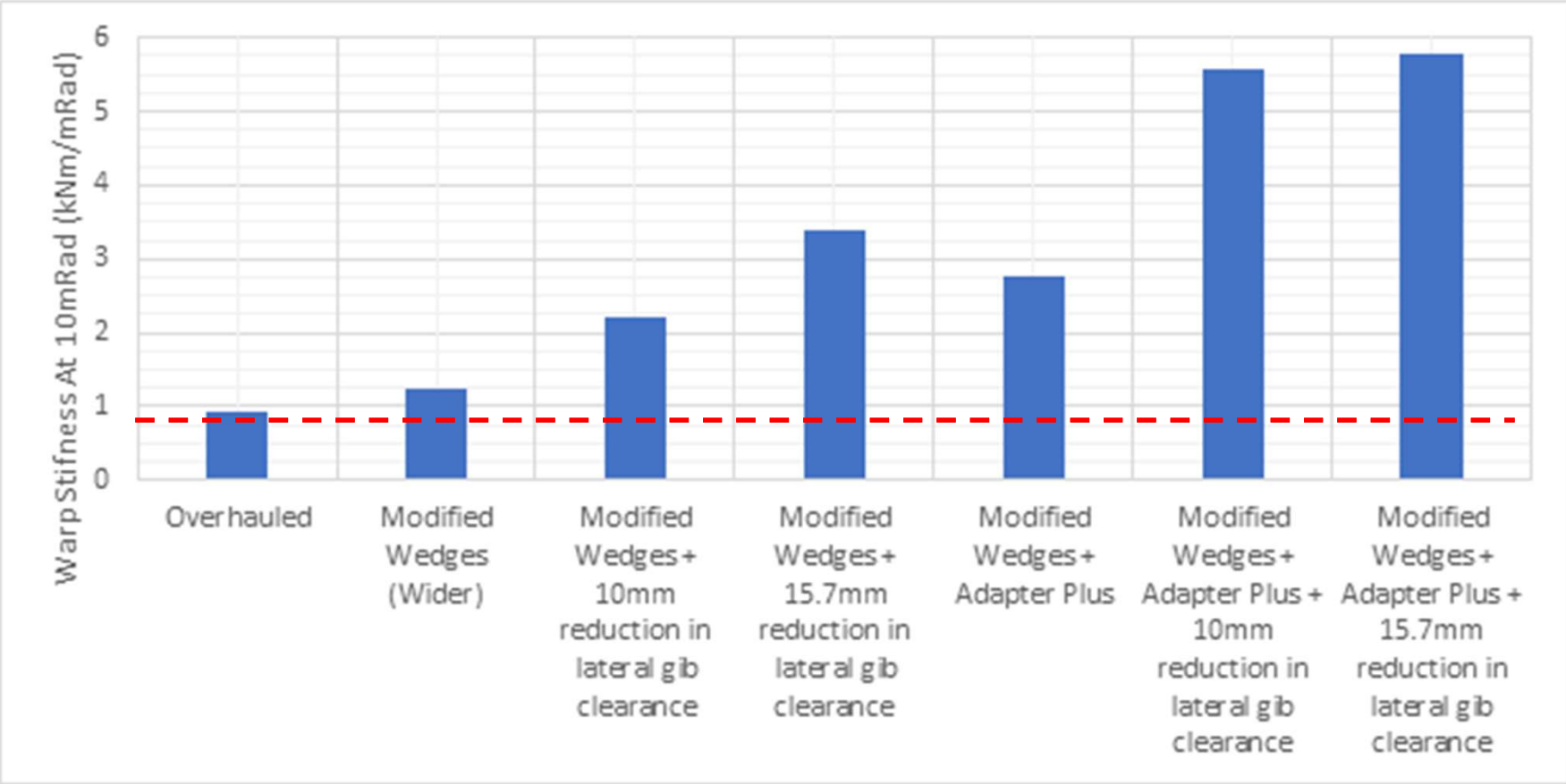


(1) Wider wedge

(2) Reduced gib clearance

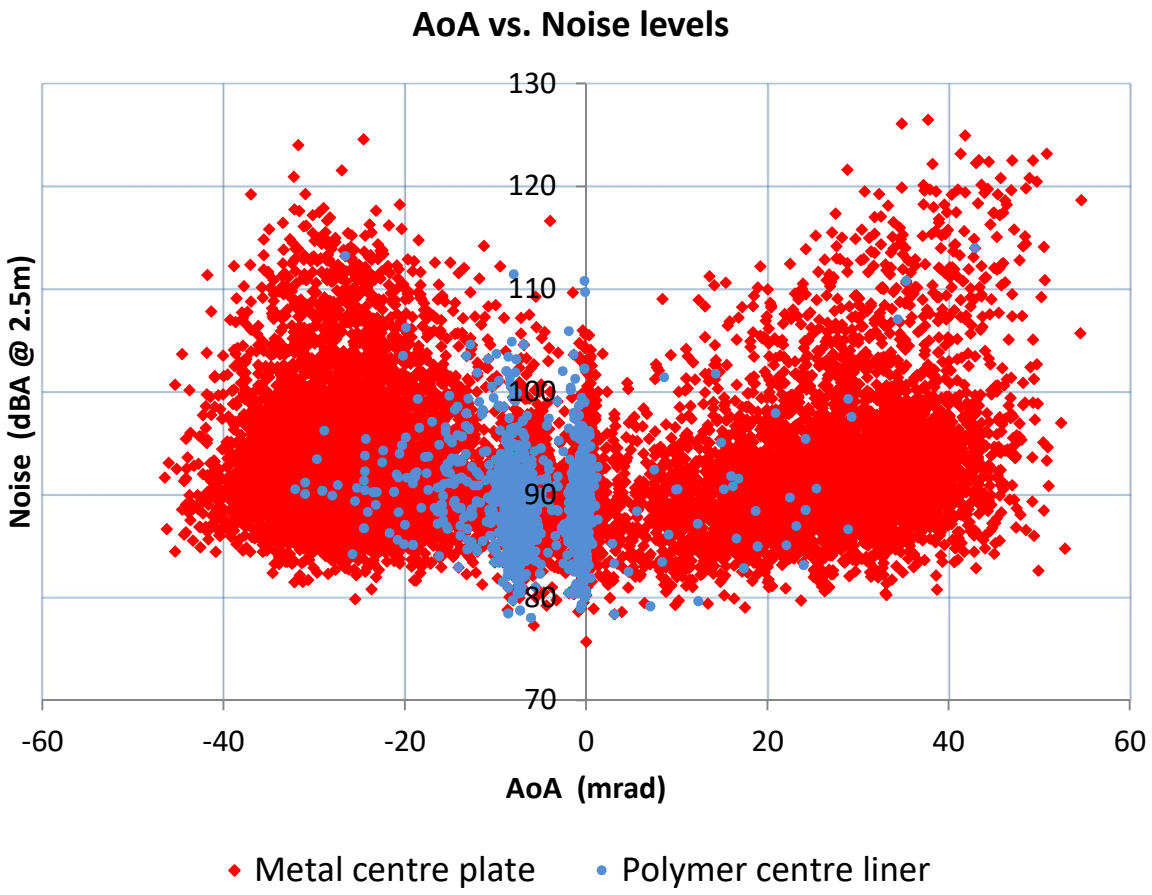
(3) Resilient pedestal liner

Results



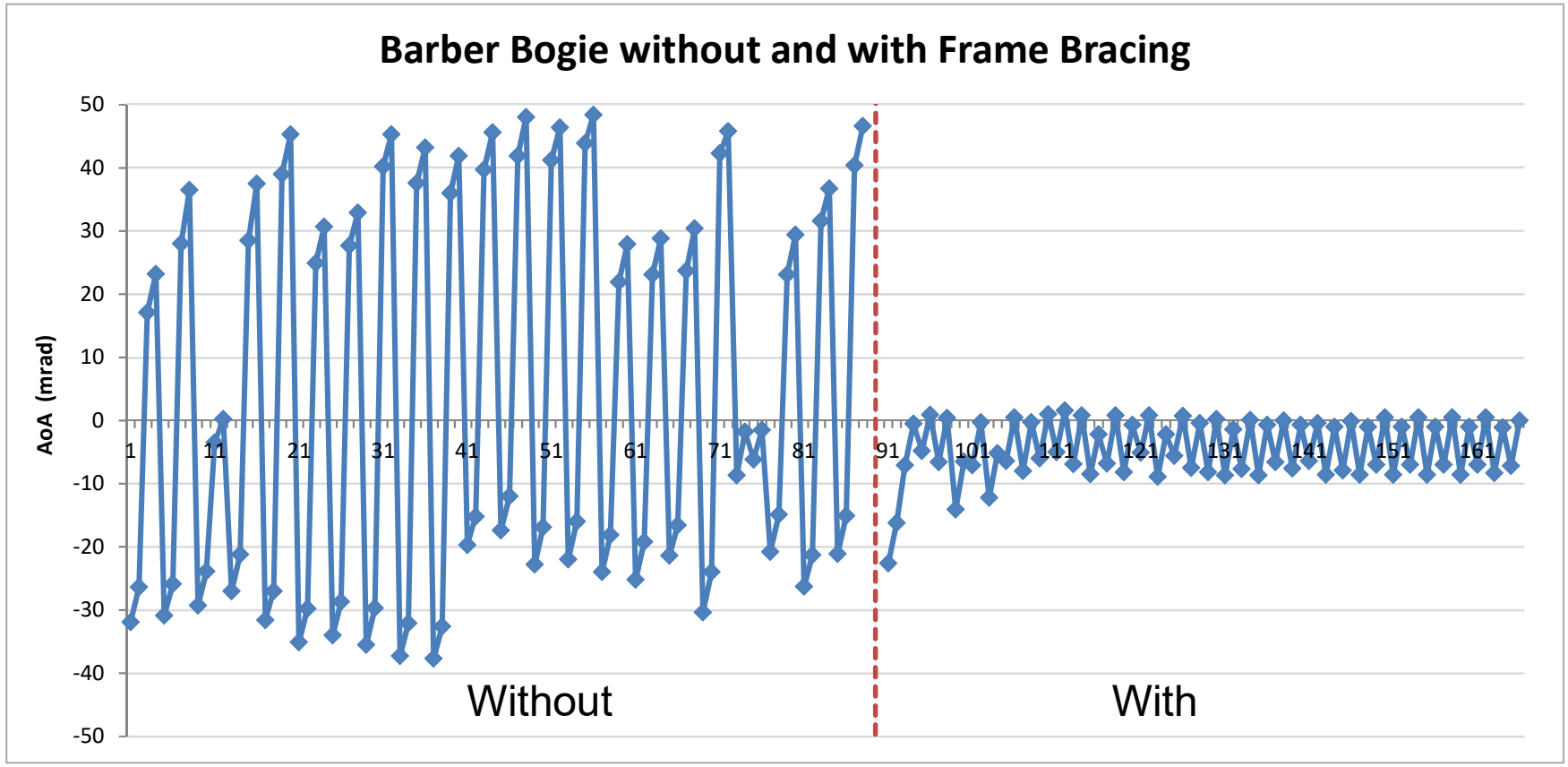
Next Step: Test Promising Solutions On-Track…

On-Track Trials: Polymer Liners



- Extreme AoA Substantially Reduced
- Incidence of Wheel Squeal Substantially Reduced
- Fixed Steering in Some, but NOT ALL, Bogies

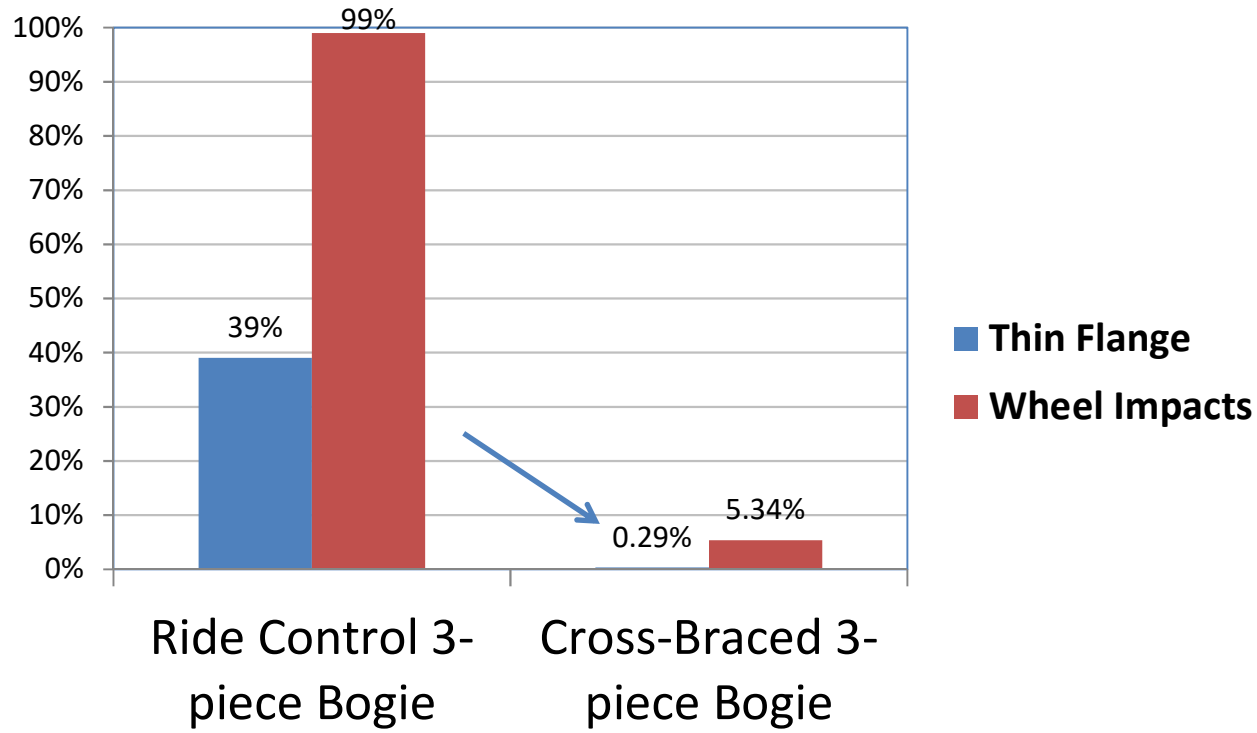
On-Track Trials: Retrofit Cross Bracing



On-Track Trials: Next Steps

- Ride control bogies fitted with:
  - Resilient pedestal adaptors
  - New and/or stiffer control springs
  - Other?
- Note: wagons must first pass high speed test (127km/h) without hunting before being approved to operate on the network

Why Should Operators Fix Steering?



Source: 2017 WRI Presentation by Tony Talbot (PN, Australia)

Cost Savings $$$

Consider a daily Melbourne-Brisbane Intermodal Service…

- Fuel Burn
  - ~5% saving = $750
- Wheel Wear / Maintenance
  - ~$250 saving per trip
- ~$350k saving per year
- Cost of upgrade
  - 350 wagons = $350k
- Payback ~ 12 months

Implementation: Wagon Steering Standard

- To drive implementation we have introduced a wagons teering standard (T HR RS 00400 ST Section 2.7)

$$|\mathrm{AoA}| < \frac{2.5 \times WB}{\mathrm{R}}$$

Where, AoA - angle of attack (radians)

WB - bogie wheel base (m)

R - radius of track curvature (m)

- Came into force 1st January 2018
- We are now collaborating with freight operators to help them implement the standard on their fleets

Summary

- Wheel Squeal → High AoA → Bogie Warp → 3-Piece Bogies
- Test Rig to Develop Low Cost Solutions Complimented by On-Track Trials
- New Network Standard for Wagon Steering Introduced
- Implementation will Save Operators $$$