Improving Switch Life through use of Water Based Friction Modifiers

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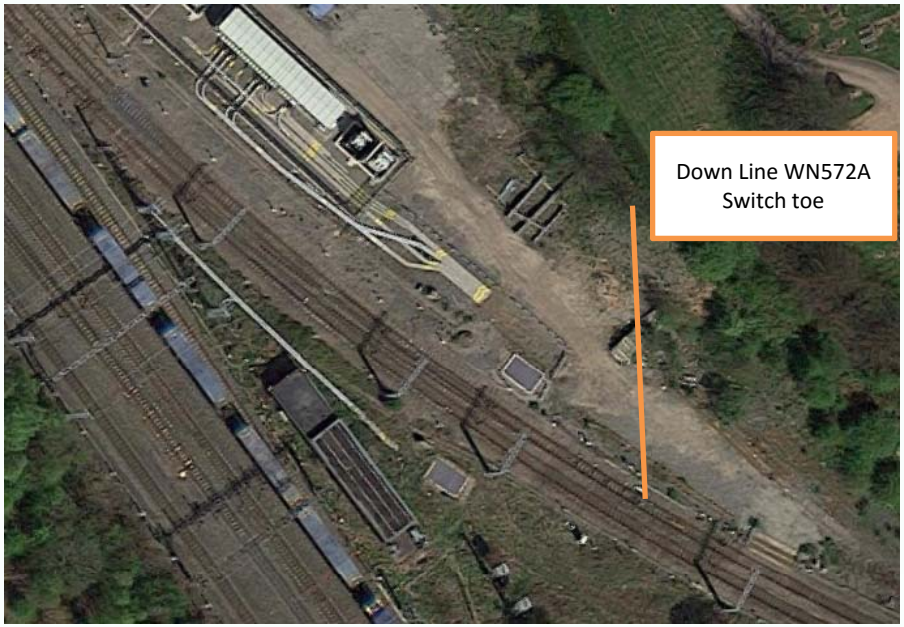
Switch damage – the challenge

- Key issue switch life less than expected
- Weld repairs and replacements costs maintenance department
- Treatment idea based on experience
- What transpired
- How it works
- This case study looks at a switch at Nuneaton Cemetery Junction

Nuneaton Cemetery Junction

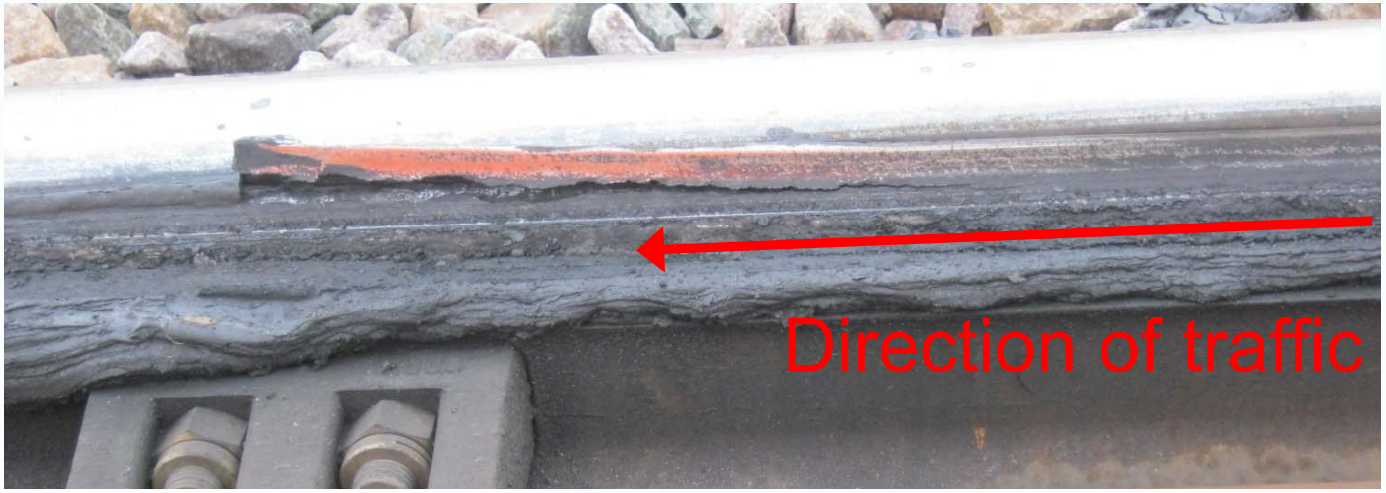
Nuneaton Cemetery Junction

- The WNS runs between Nuneaton and Wigston, connecting the WCML and MML main routes and is a freight corridor.
- Switch WN572A is at Nuneaton Cemetery Junction on the up road and is a shallow depth inclined switch F geometry (1:21.5) that is operated predominantly in the trailing direction.
- The traffic is a mixture of Class 170 multiple units and loaded freight trains.
- Annual tonnage is around 9 million tonnes and the line speed is 40mph (64km/h).
- Between 2004 and 2012 the high-rail half-switch had to be replaced every 15-18 months.



Nature of the Damage

- The damage is caused by pronounced flange contact forces on the machined section of the switch rail circa 2m from the toe
- A small vertical crack is the first apparent damage
- This goes approximately 10mm down from the top of the switch rail and then turns through 90°and “unzips” in the opposite direction of the traffic



Conventional protection

- The switch is well lubricated

Consequence of the damage

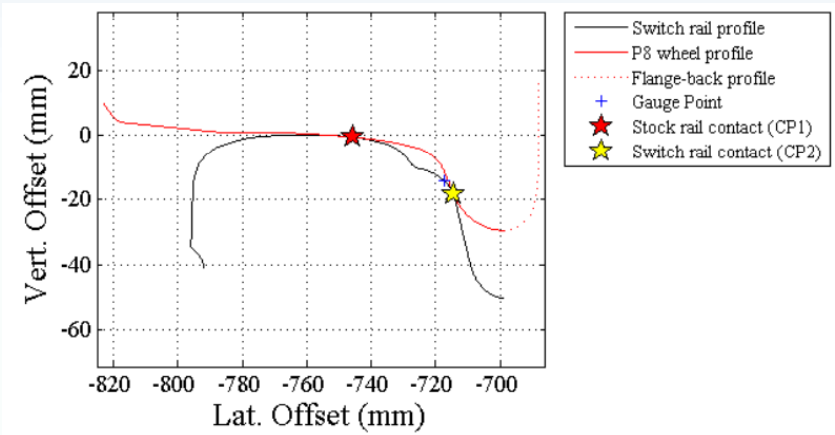
- The first action is to ban the switch to facing moves as this is classified as unsafe once the longitudinal length of the crack is greater than 200mm
  - This has an impact on the operation of the junction
- History of damage dictates an enhanced inspection regime
- Repair work comes in with little notice
  - This has increased safety risks associated with short term planning
  - Also disturbs planned work
- Typically replacement is required after three weld repairs

Hypothesis – steering?

- Barnt Green
  - Curve squeal and rail head corrugations, significant complaints
  - Initially water spray implemented (wrong rail)
  - Following drainage issues, replaced with KELTRACK® in 2007
  - August 2011 observed steering notably influenced - bogie rotation…

Could this work at a switch?

- Hypothesis:
  - Flange contact is a consequence of a high angle of attack (AOA)



Ref Coleman, Kassa & Smith, 2012

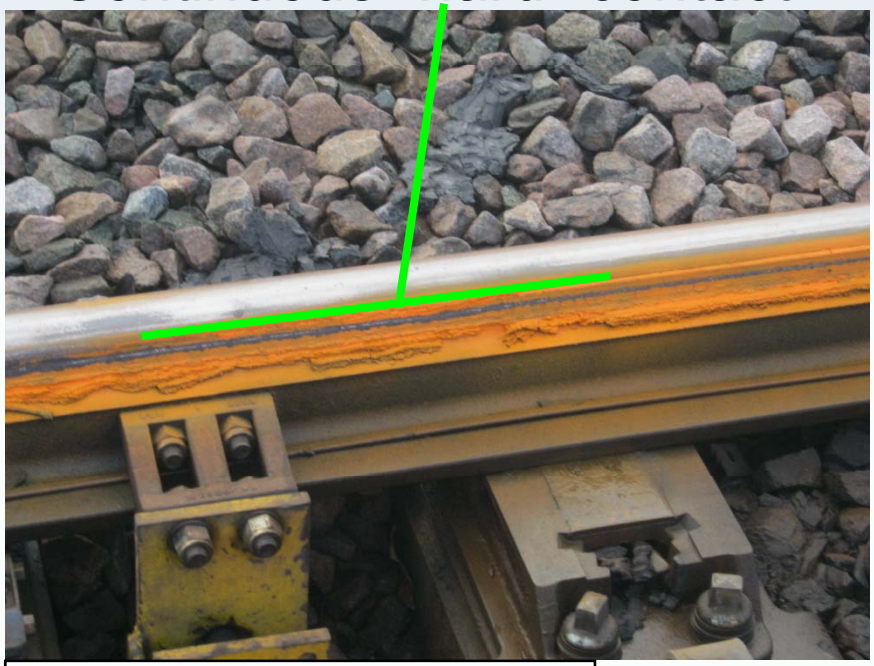
  - AOA is reduced by using KELTRACK® on plain line curves
  - Would the flange contact also be reduced in the switch?
- Proposal
  - Manual application of KELTRACK® to investigate at Nuneaton

Manual application

- Like this (test track in Europe)

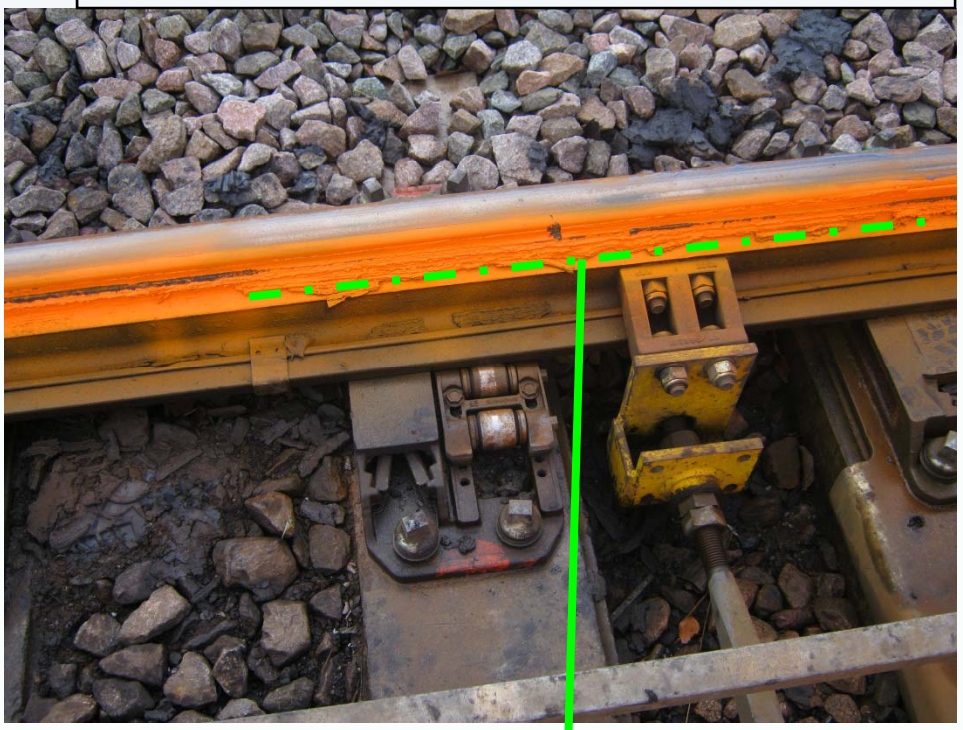
At the normal point of switch damage

Continuous “hard” contact



Before treatment

Both rails KELTRACK® treated



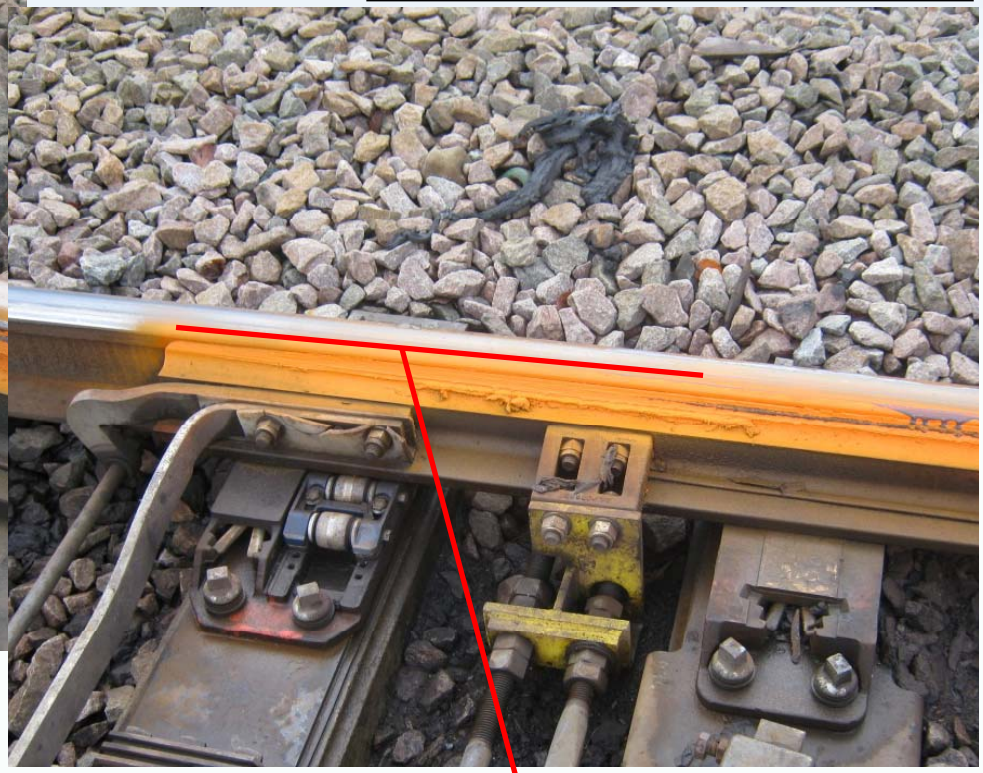
Intermittent “light” contact

At the switch tip

No contact

Before treatment

Both rails treated

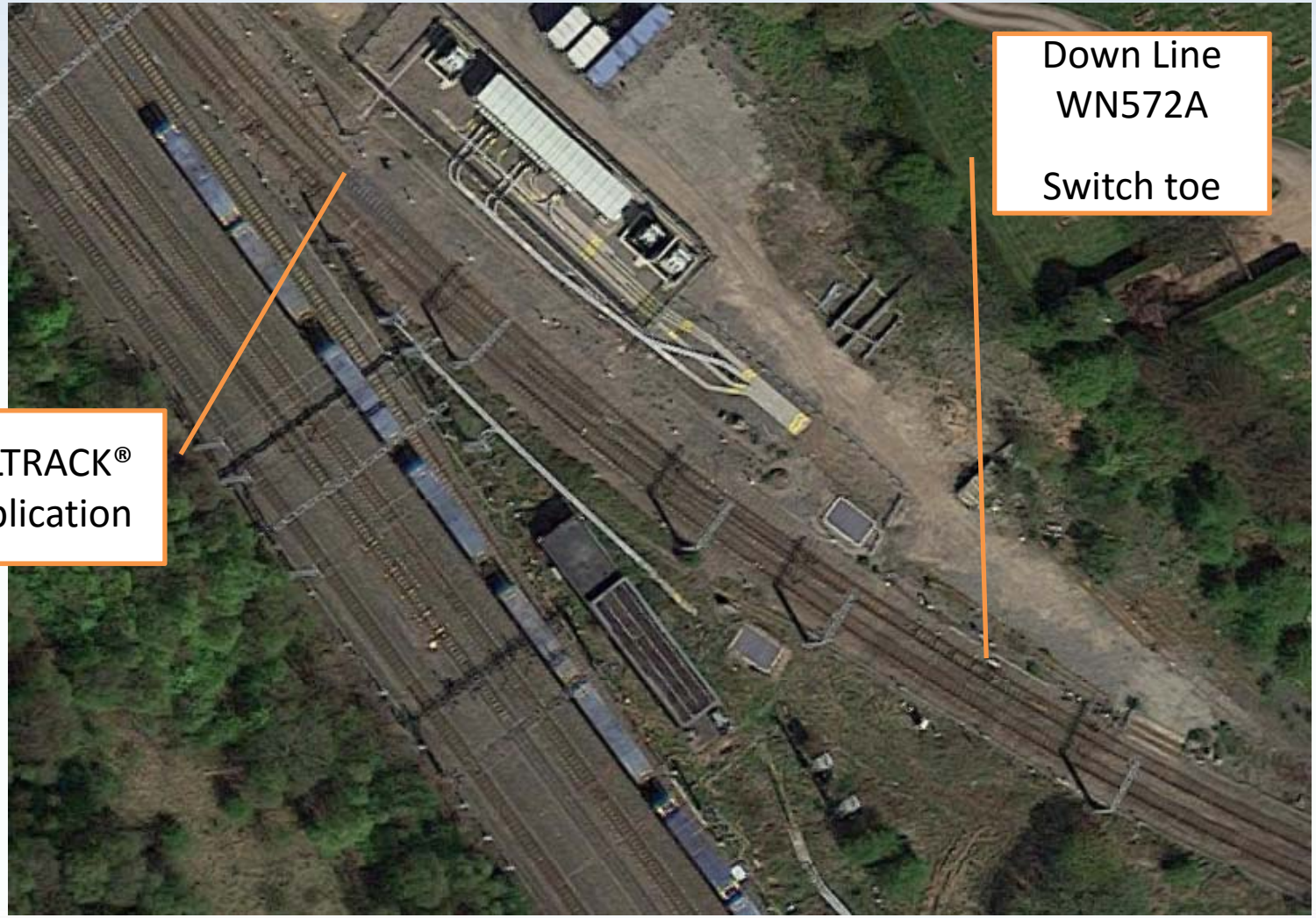


Extended no contact patch

Protector IV® Installation

Application bars

View from above



View toward junction

Monitoring of the treated switch

Timeline

- Dec 2011 – site visit/photos, manual app trial
- Nov 2012 – new switch blade fitted to WN572A
- Feb 2013 – FM fitted and activated
- Feb 2014 – Site visited – no damage visible, no repairs required to date.
- Regular inspections found no defects
- May 2015 – First weld repair (following ~1 month without FM)

Flanging highlighted by white paint

Resulting benefits

- Approximate value of savings £40k, through circa 6 weld repairs and half switch replacement being saved
- I.e. reduction in repairs, increasing the interval by at least 6x at the Nuneaton site
- Increase in replacement interval, similar ratio to repair
- Less inspection (with confidence, the regime can be reduced)
- Fewer man-hours on track (safety)
- Reduced risk of delay and constraint of operation

Photo from www.railtechnologymagazine.com

Other sites

- Crewe Basford Hall & Coal Yard junctions have already been treated
  - 1 year treatment, no repairs required

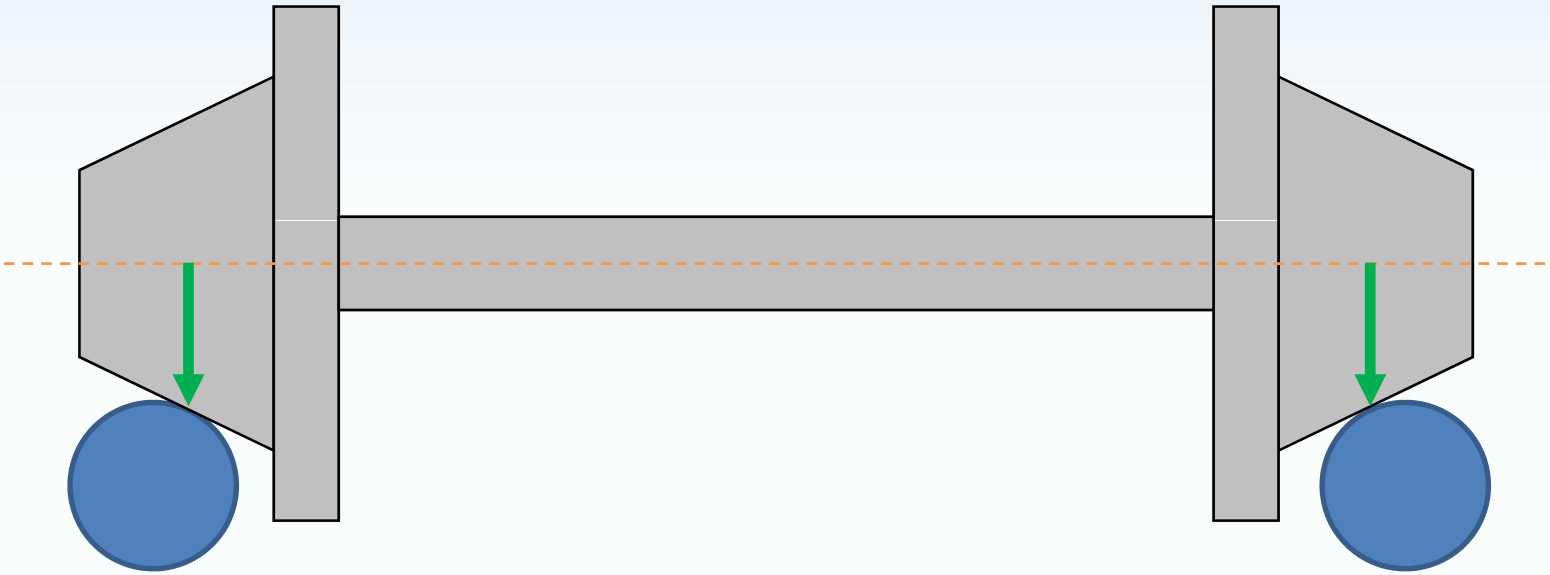
- Reading West
  - Half-switch being replaced every 2½ months (HP switch only 4 months)
  - Following treatment (starting June 2015), no damage observed to date

How does it work?

- The challenge to explain…
- Measurements – would be good
- Simulation could answer some questions and enable analysis of other sites

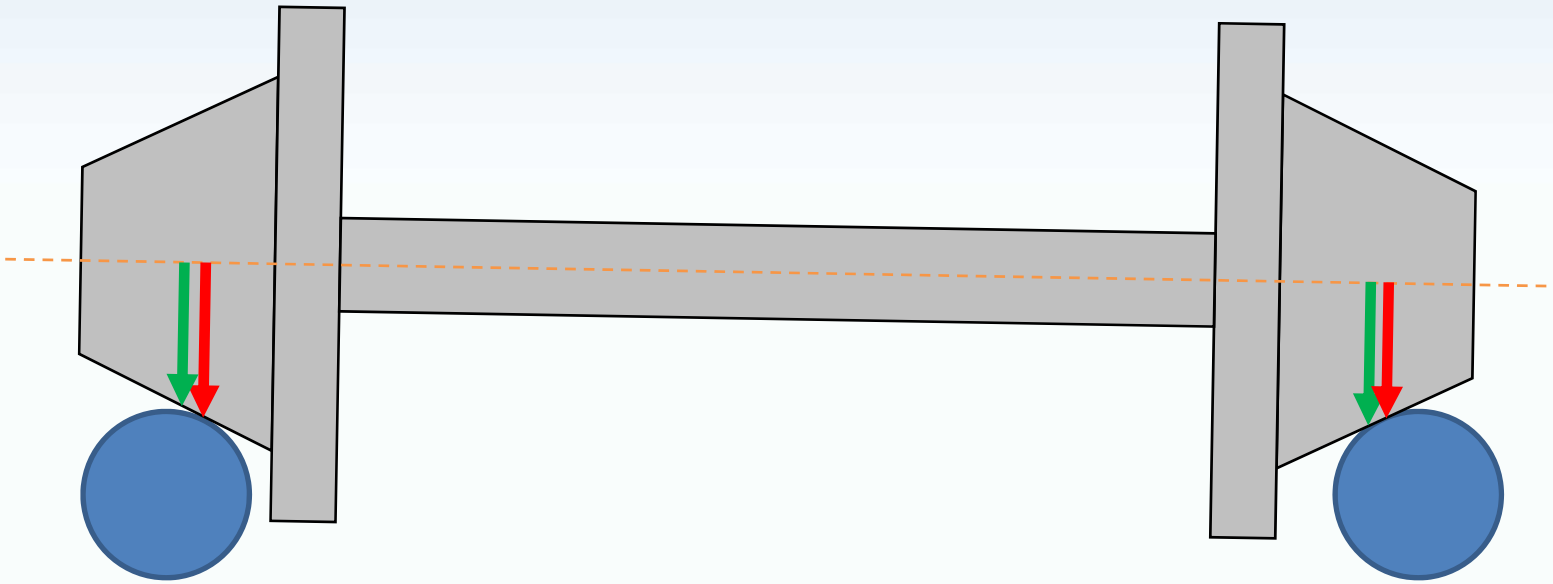
- Simplistic take on how, what and why

Principles of steering

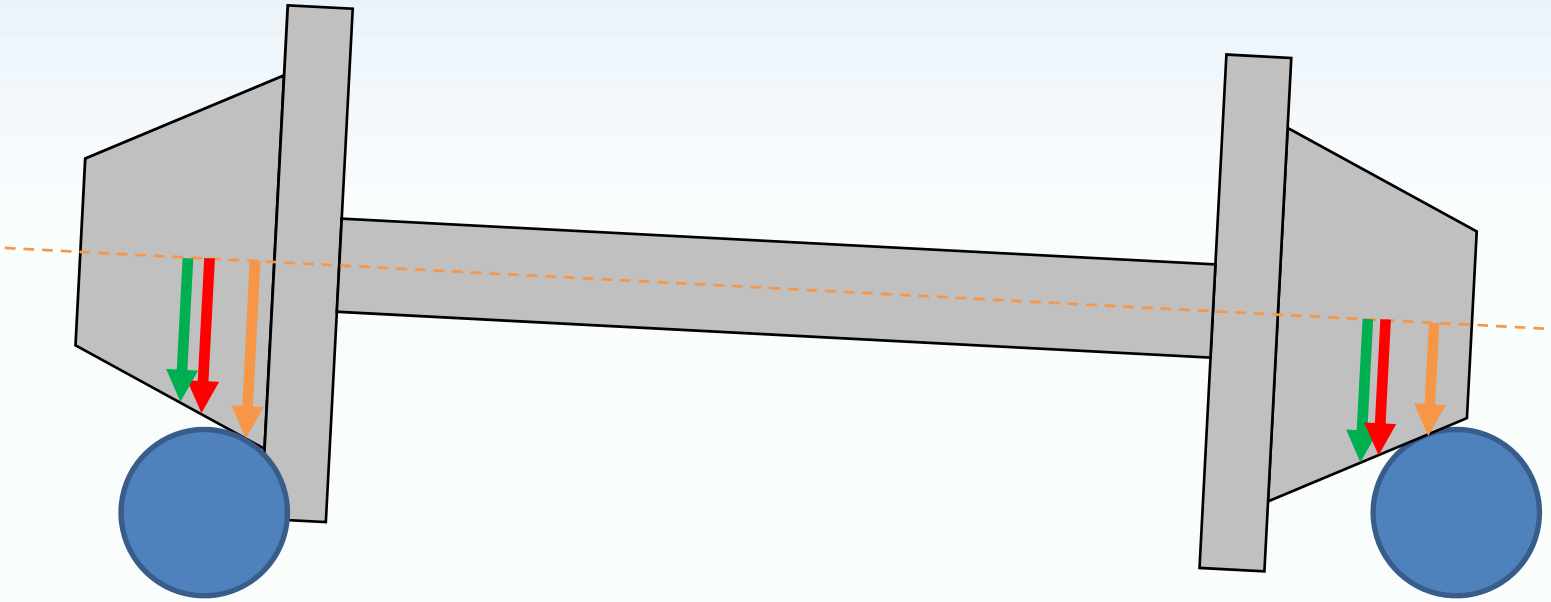


Rolling Radius Difference (RRD)

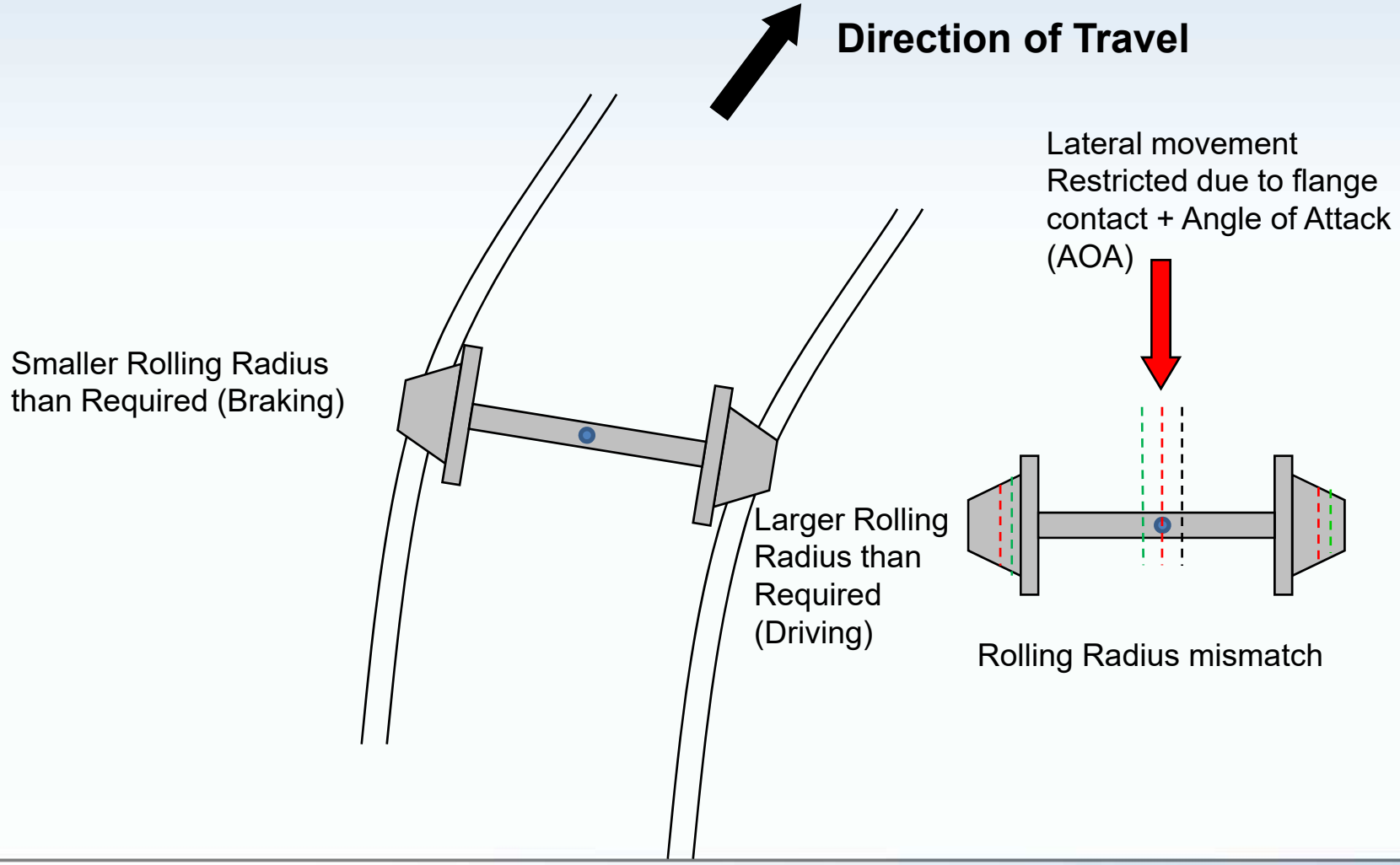
Principles of steering



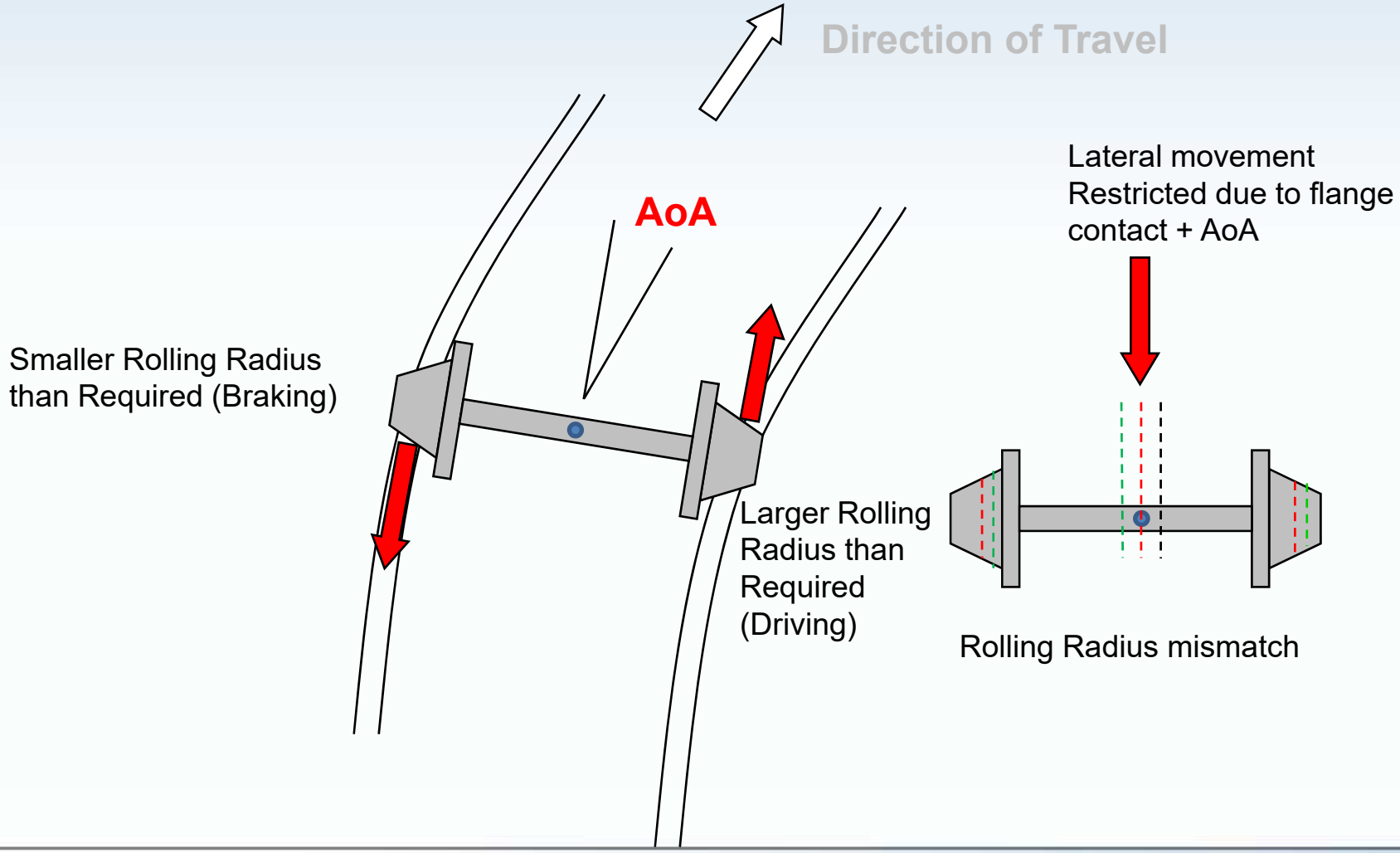
Principles of steering



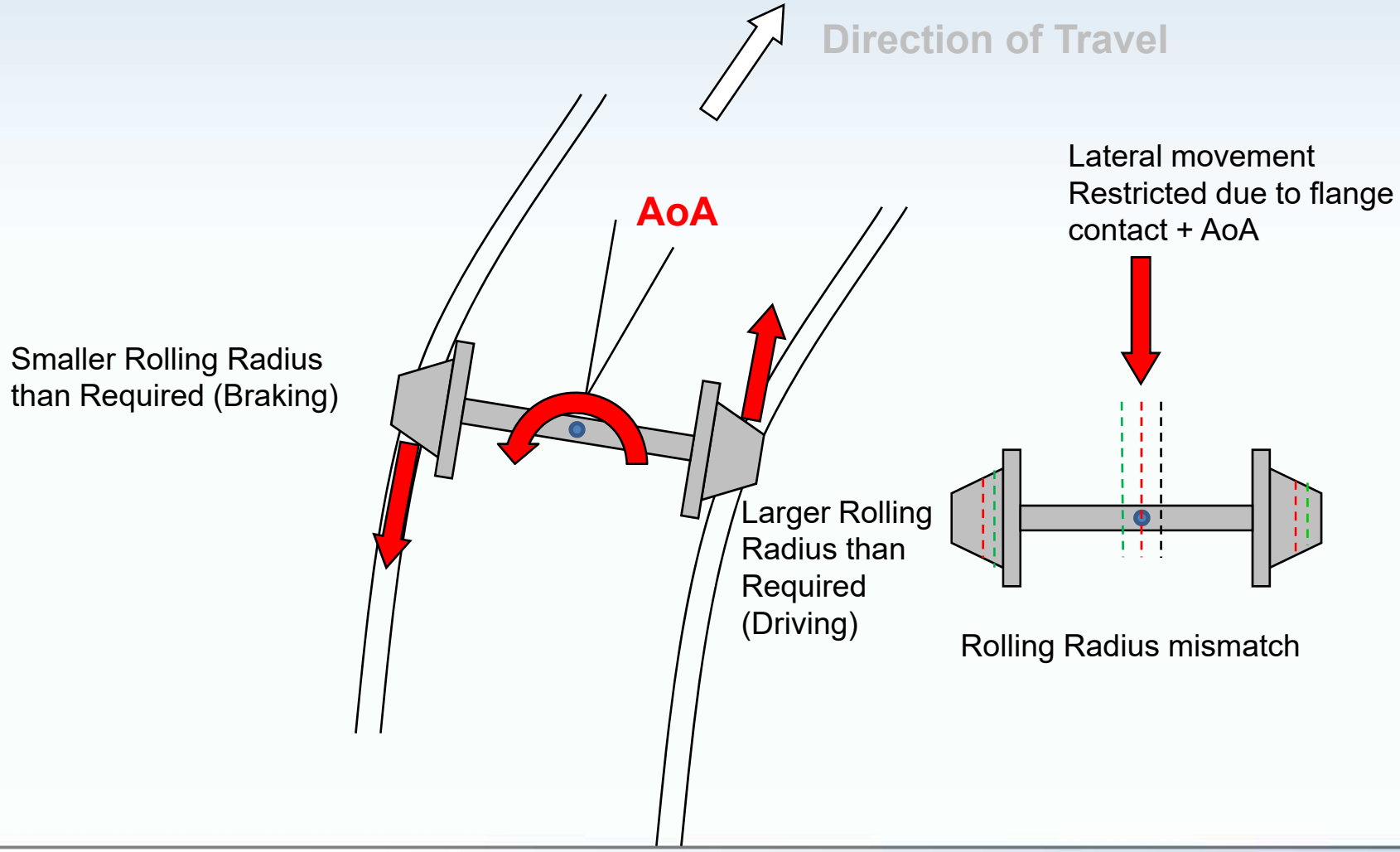
Steering Forces in “Sharp” Curves



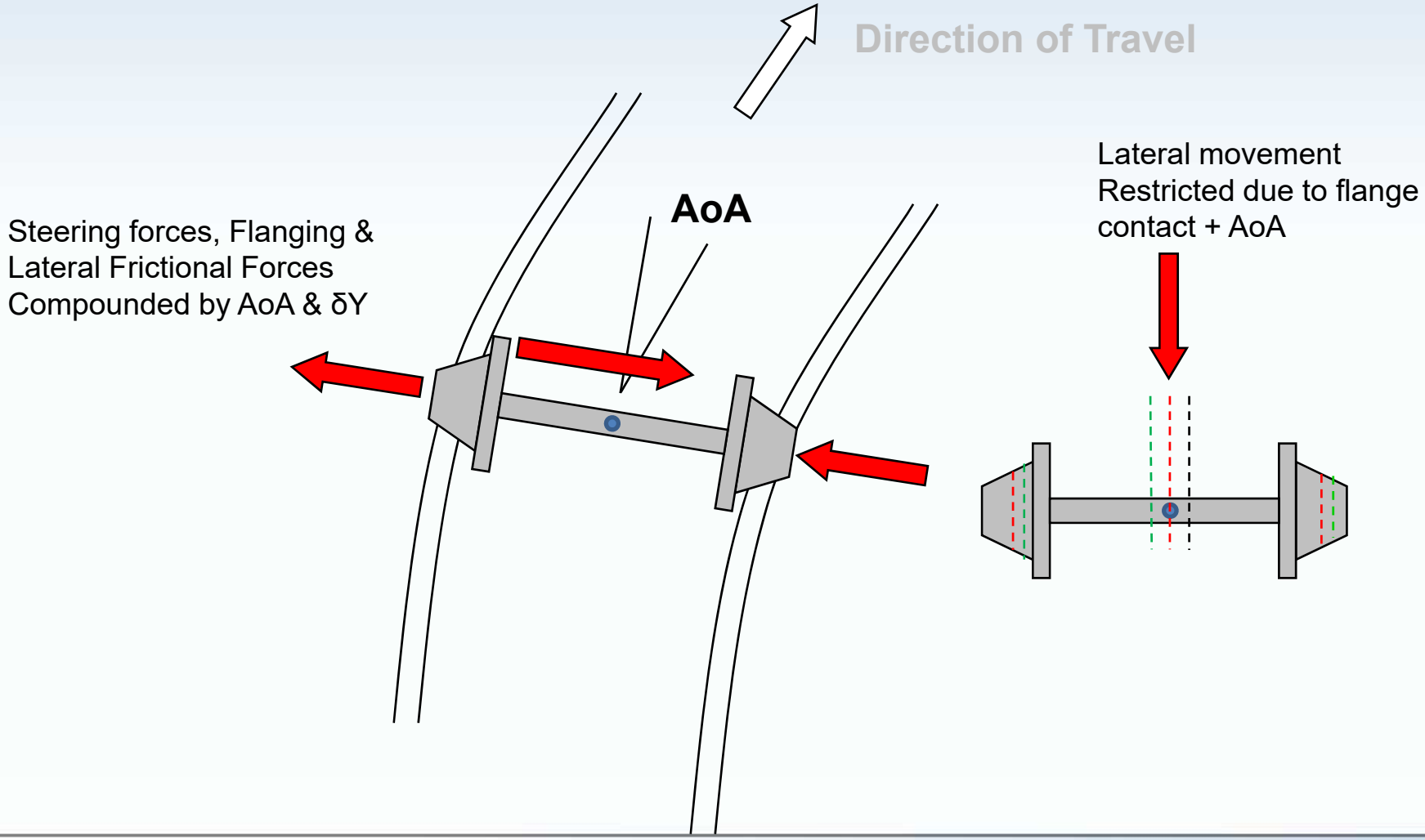
Flange contact restricts RRD



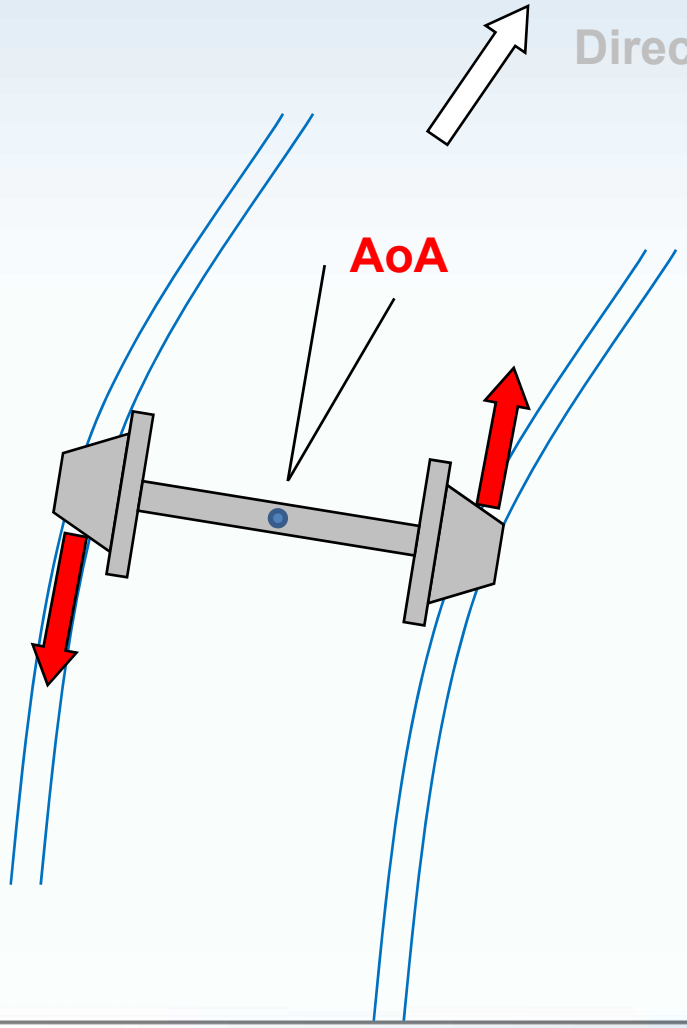
Longitudinal forces create anti-steering moment



Lateral Effects



“Change” of TOR COF



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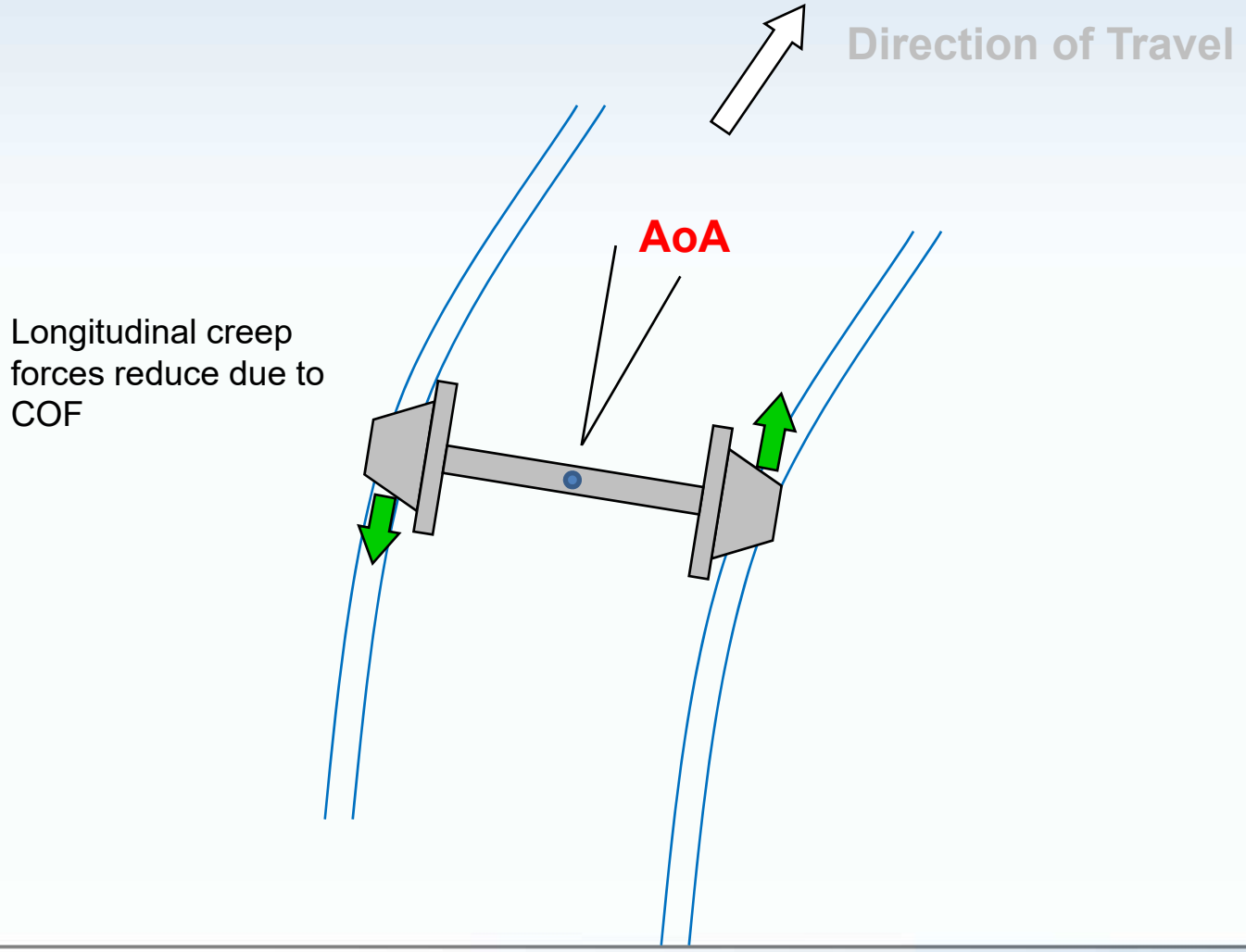
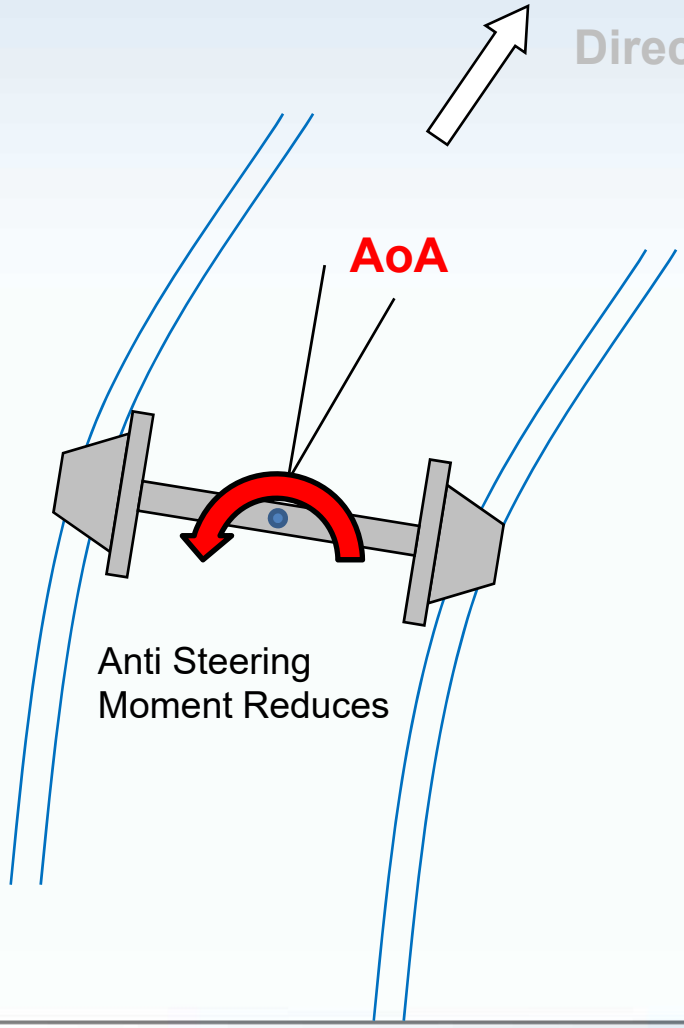
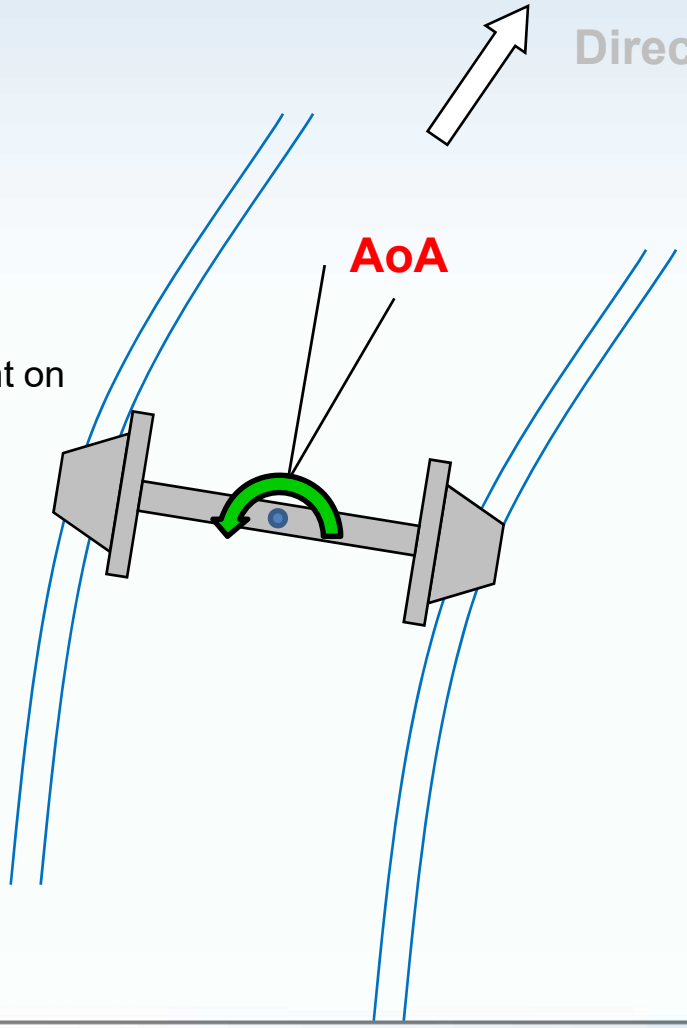


Effect on AOA

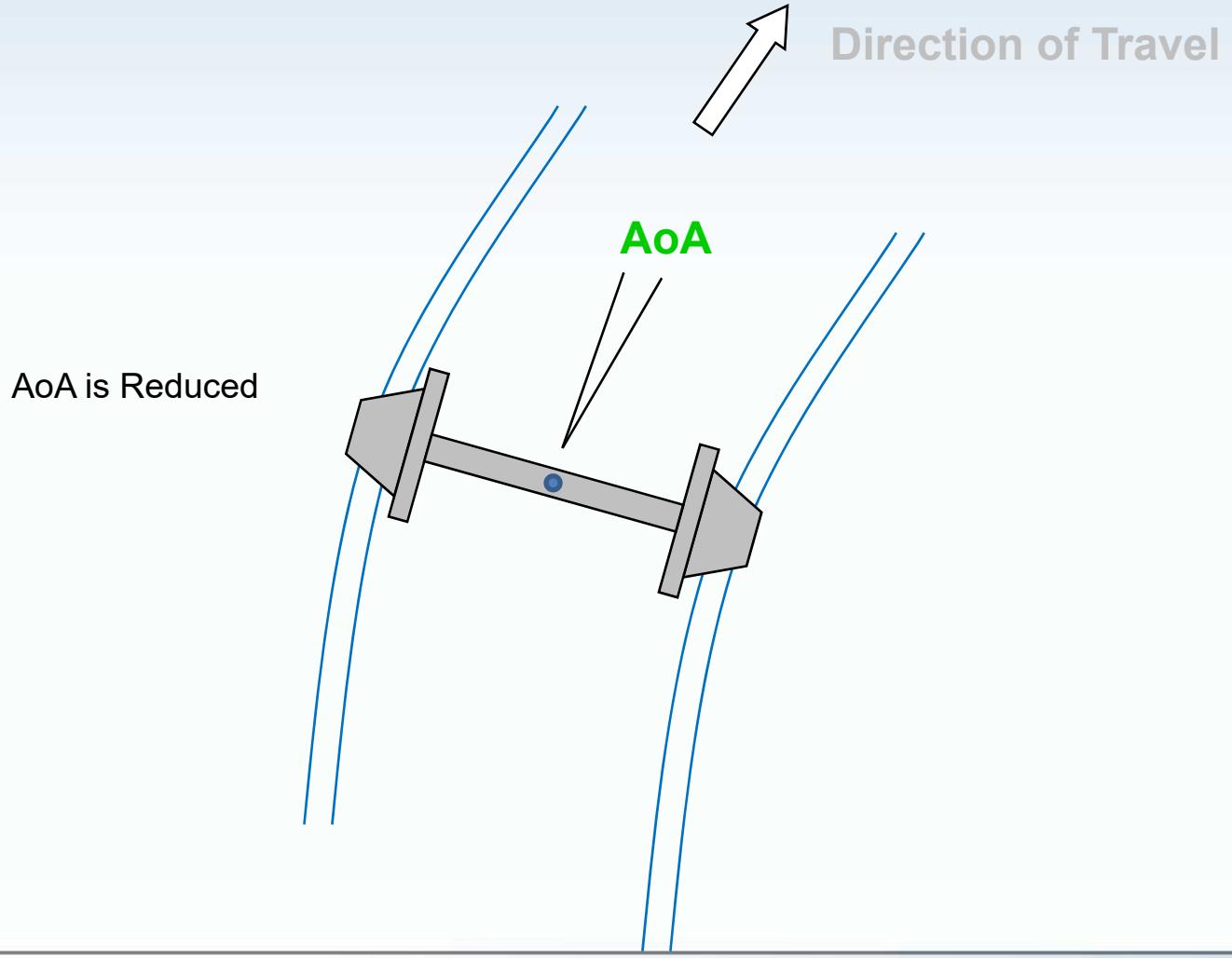


Effect on AOA

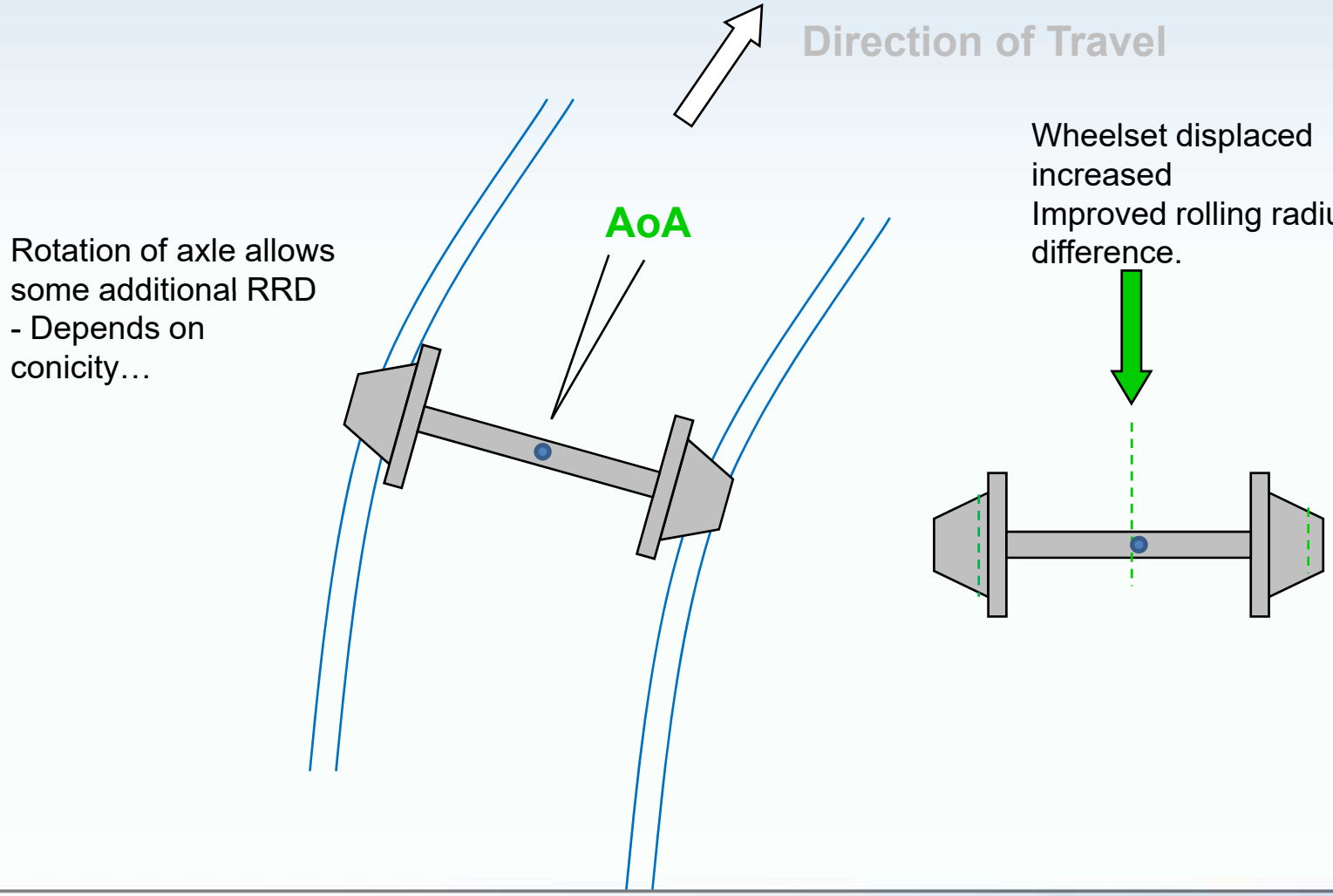


Anti-steering moment on lead axles reduces

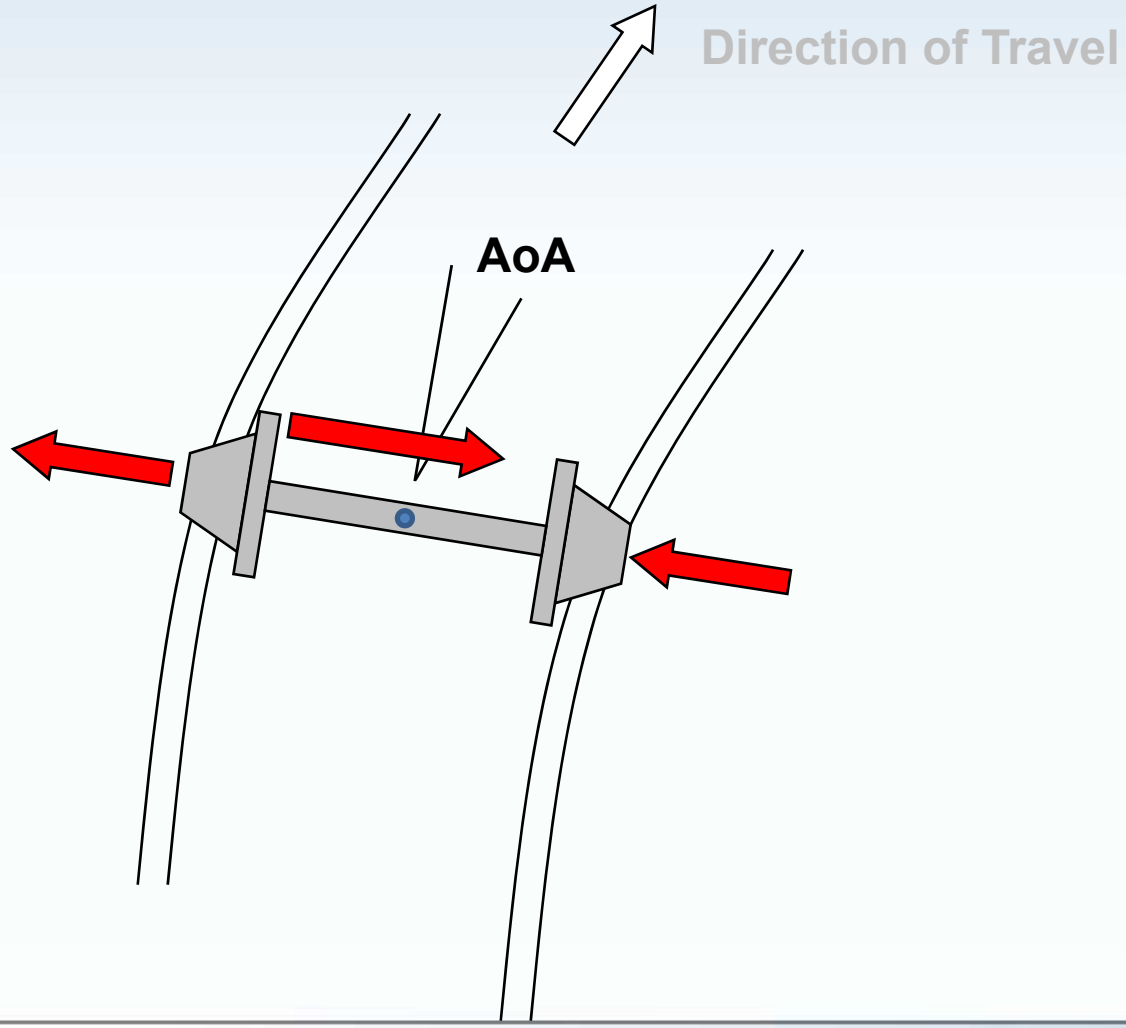
Effect on AOA



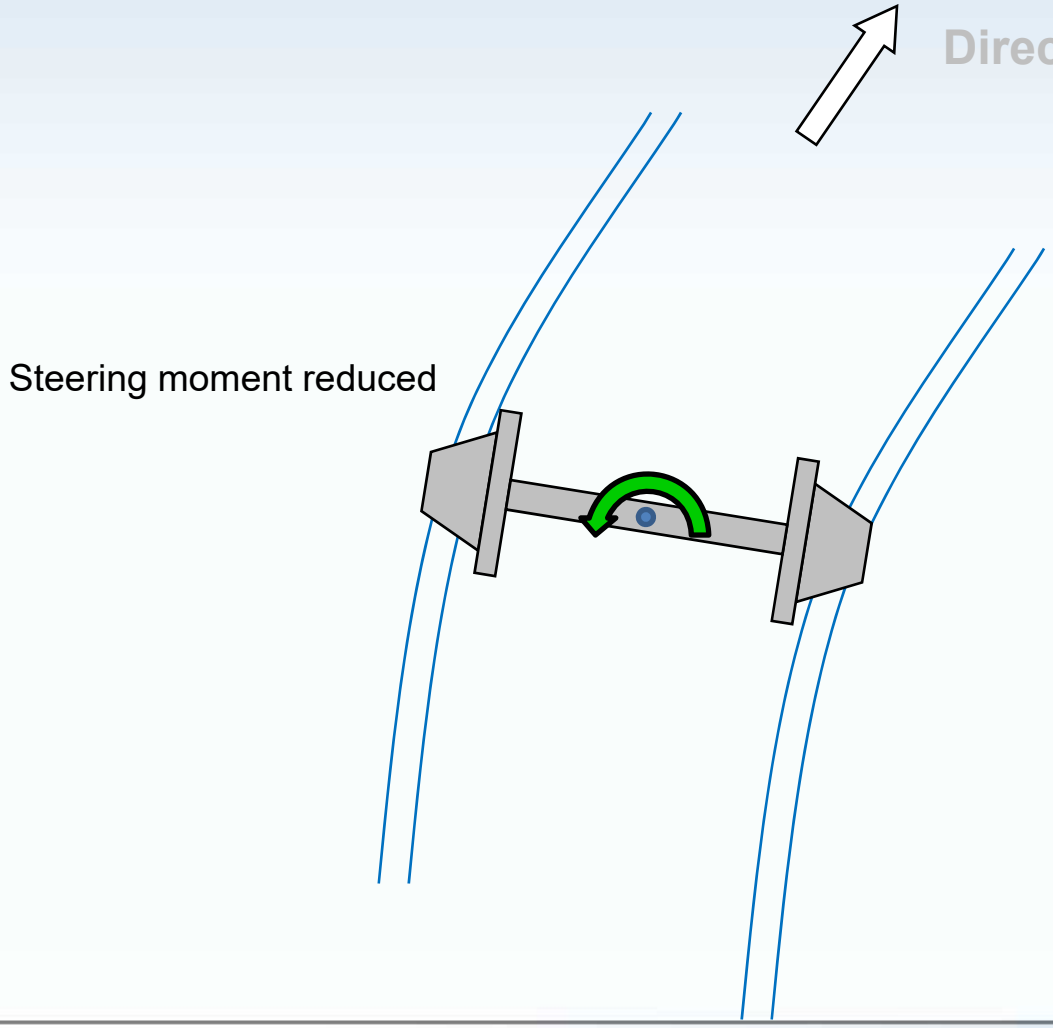
Effect on available RRD



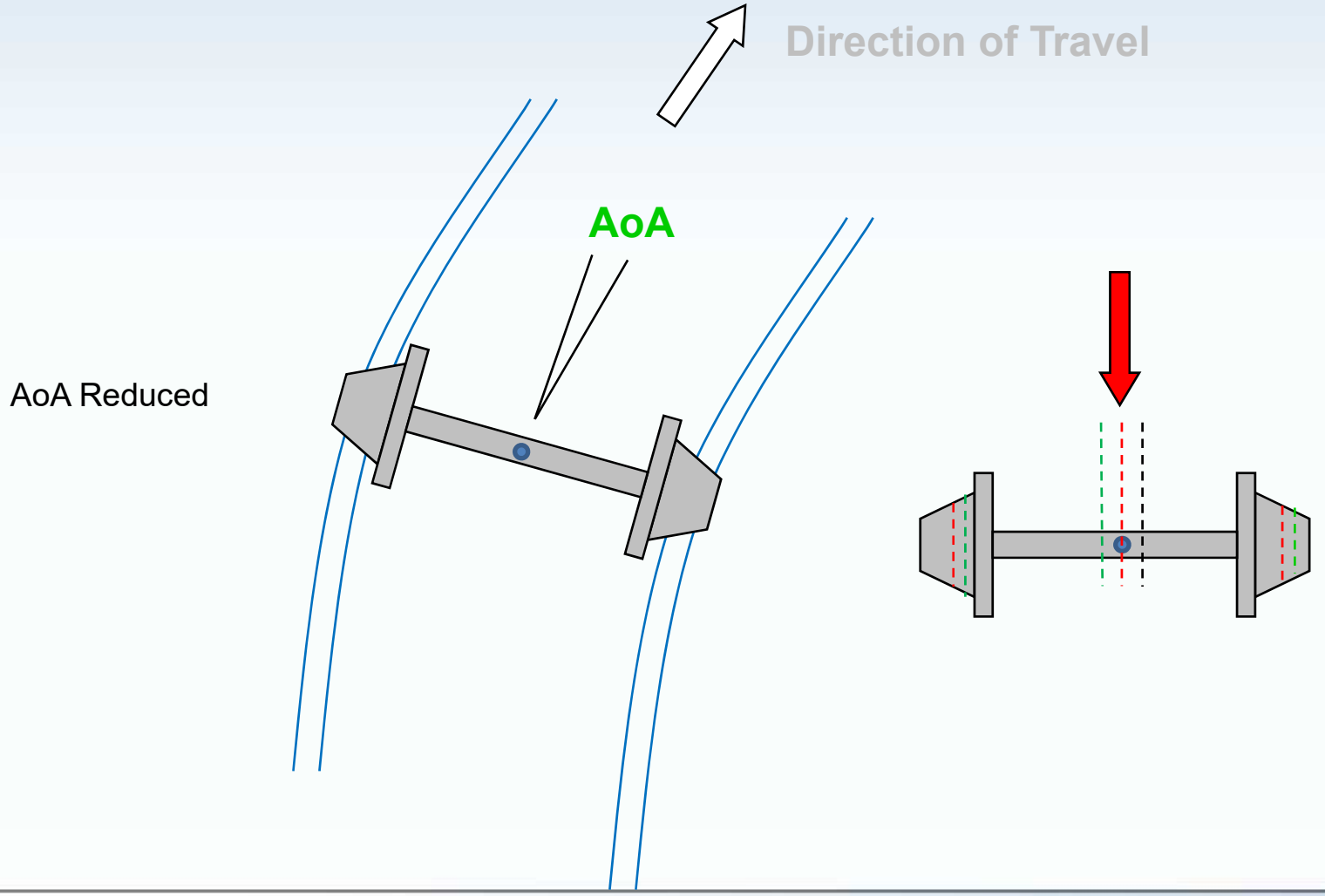
What about lateral?



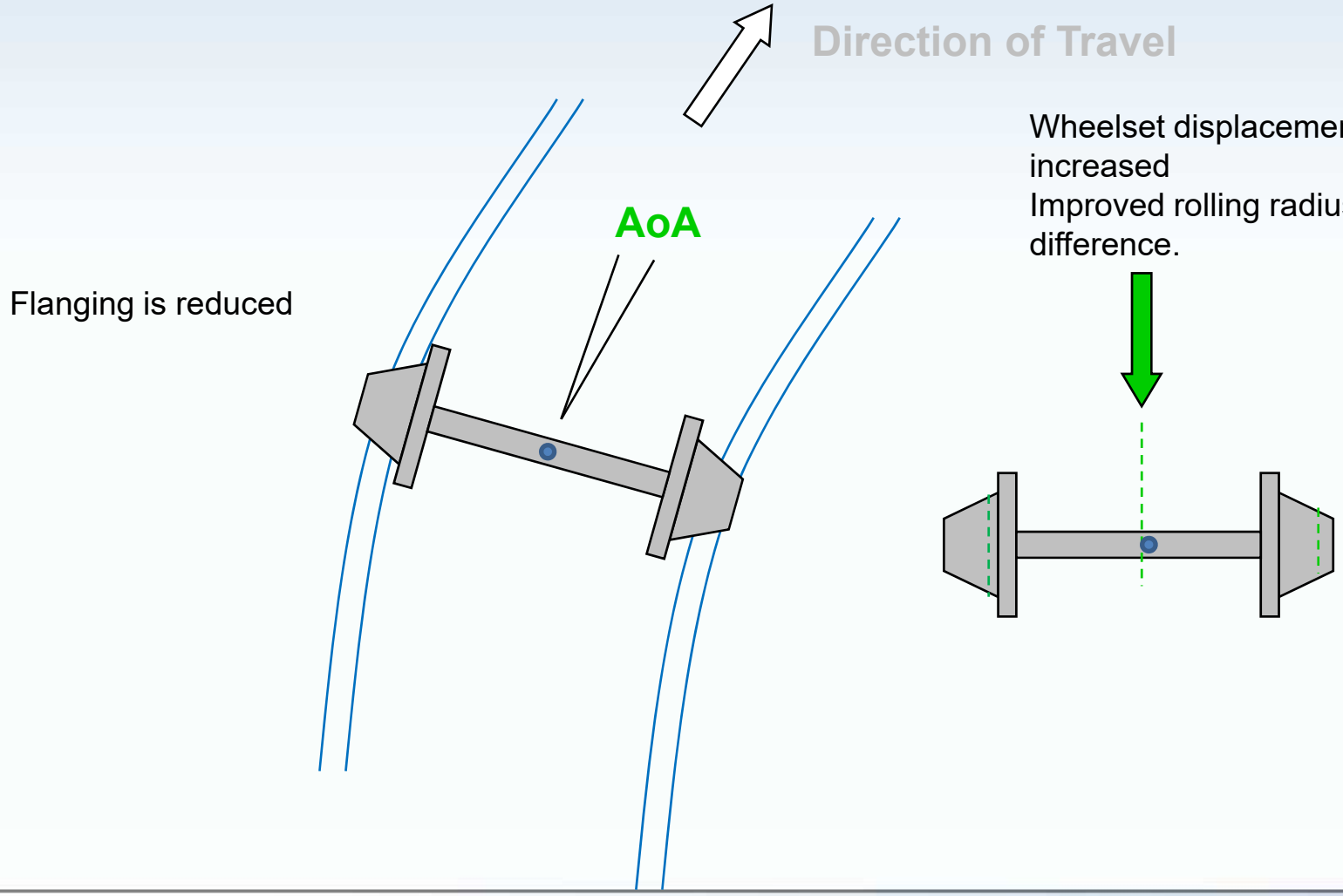
Reduced COF benefits lateral forces



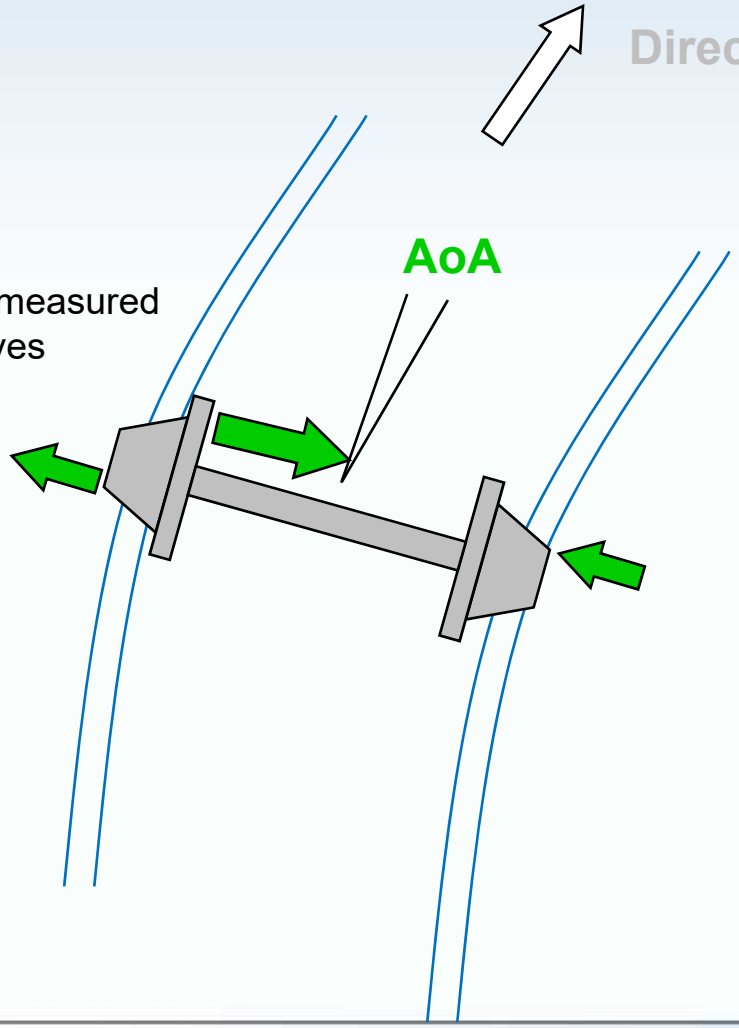
Angle and position



Wheelset lateral shift

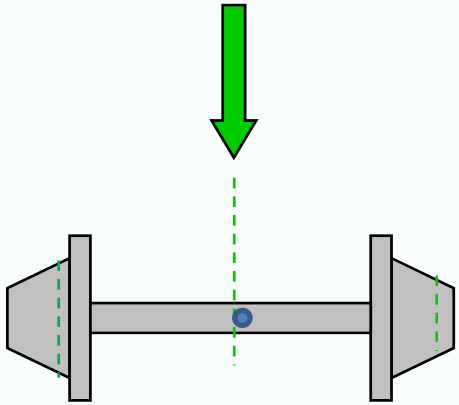


Lateral forces reduced



Lateral force reductions measured
Well known effect in curves

Wheelset displacement increased
Improved rolling radius difference.



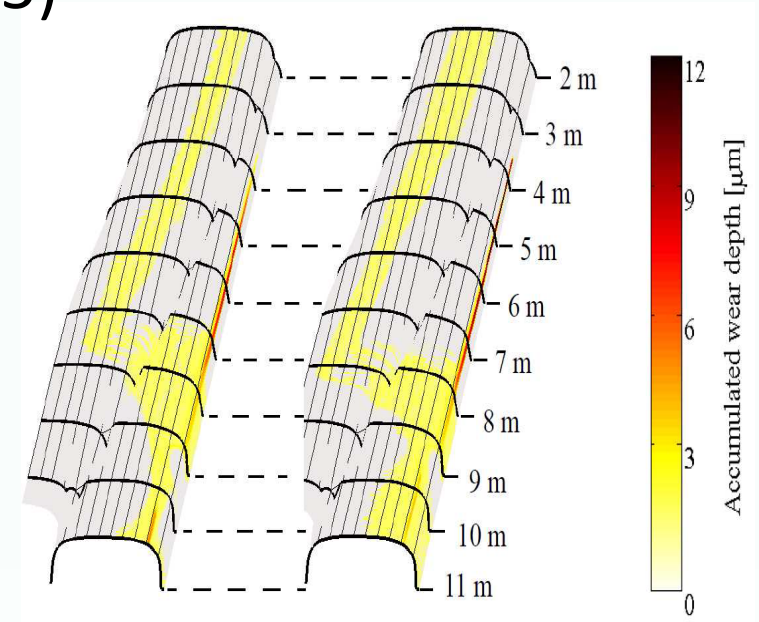
Recommendations

- Ideally, measurements would be taken to show the precise magnitude of force reduction
- Simulation work could explore the theoretical effect of friction as an input parameter which can be controlled
  - Simulation could then compare different geometries, vehicles and speeds
  - Real geometry could also be explored
  - Facing direction of travel could be tested theoretically and by experimentation

Modelling

- Objective - identify root cause of damage
- Propose that friction parametric study is undertaken
- Related simulation work undertaken by Chalmers University (Nielsen et al CM 2015)

Accumulated wear plot from combinations of worn wheel profile, friction coefficient and vehicle speed (Nielsen, Pålsson, Torstensson, “Switch panel design based on simulation of accumulated damage in a railway turnout”, CM2015)



Conclusions

- The hypothesis was demonstrated by the experience to date
- The friction modifier is exceeding the benefits that were expected in terms of increased availability and extended life of the switch blade
- Further switch sites could be targeted by inspection of their maintenance requirements (frequency of weld repair and switch replacement)
- An application test can be undertaken to help decide the potential

Thank you for your attention!

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