THE EFFECT OF FASTENING SYSTEM DESIGN ON THE OCCURRENCE OF RAIL SEAT DETERIORATION

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Rail Seat Deterioration and Fastening System Design

- Rail Seat Deterioration (RSD) – high rate of wear in rail seat, reduces service life dramatically.
- Occurs on heavy haul (HH) lines in North America. Tight curves and inclined sections are most prone.
- Research has now led to an understanding of the main factors in occurrence of RSD.
- Recommendations for RSD mitigation follow from these - AREMA Chapter 30, Section 4.1.6.
AREMA Recommendations for RSD Mitigation

• Most of the recommendations can be implemented through fastening system design:
  i. Reduce contact stresses at rail seat
  ii. Reduce relative movement at rail seat
  iii. Increase abrasion resistance of materials
  iv. Minimise intrusion of abrasive fines and moisture

• These represent clear design objectives for new fastening systems on HH lines in North America
How to Address these Objectives?

- Field or laboratory testing not suitable for evaluating a range of design concepts
- Use Finite Element (FE) computer models to evaluate design concepts against recommendations i.* and ii.
- Consider recommendations iii. and iv. from concept design stage forwards
- Present the work done in response to these four AREMA recommendations.
FE Model of Fastening System

- Simple FE models – linear, no friction.
- Load case - track measurements made at RSD site (10 deg curve) and Nonlinear track model.
- All DOF constraints on rear of side post insulator.
- ‘Sliding only’ constraints on bottom face of rail pad and ‘cut’ faces of rail
- ‘Bonded’ mating condition assumed between rail foot and rail pad
- ‘No penetration’ at rail foot/side post insulator and at rail pad/side post insulator
Fastening System A

- Conventional HH fastening system
- Dimpled PU pad, no abrasion plate, 120mm long side post insulator
- No RSD mitigation features – starting point for treatment of RSD

Lateral displacement on underside of pad

Normal stress on underside of pad
Fastening System B

- Add 5mm thick studded Nylon abrasion plate – higher stiffness and abrasion resistance than PU pad
- Abrasion plate constrained by shoulder on field side. Bonded to rail pad.
- Abrasion plate reduces lateral movement by factor of 4 in high compression area

**Lateral displacement on underside of pad**

**Normal stress on underside of pad**
Fastening System C

- Increase width over which abrasion plate restricts lateral movement of rail pad from 120mm to 220mm.
- Shape abrasion plate to reduce ingress of moisture/fines to rail seat – shroud entry on all 4 sides.
Fastening System C

- Provision of lateral support over much greater width:
  - prevents ‘flow’ of rail pad around lateral support, reduces lateral movement
  - distributes normal stress more evenly over rail seat width
- Long-term track trial required to show effect of shrouding on rail seat ingress
Summary

**Outcomes so far**

- Each design step brings factor of 3-4 reduction in lateral movement
- Reasonable basis for confidence that improvement in RSD mitigation effect follows

**Remaining issues to study – effect of track stiffness?**

- Improve distribution of load along length of track – less load on each fastener
- Increased lateral movement for a given load

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**Max. lateral movement of rail pad in high compression area**
Thanks for Your Attention

• Do you have any questions?