Example Project Findings and Impact on Recommended Design Practices

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Marcus Dersch, Ryan Kernes, Brent Williams, Matt Greve
Outline

• Lateral Force Distribution
• Rail Seat Pressure Distribution
Lateral Force Measurement Methodology

- Lateral Load Evaluation Device (LLED)
  - Original shoulder face is removed
  - Insert designed as a beam and optimized to replace removed section and maintains original geometry
  - Measures bending strain of beam under 4-point bending

- Measuring bending strain is a proven technique
Tie-to-Tie Lateral Load Distribution

Force, $F$ (lb) vs. Force, $F$ (kN)

- 0 kips
- 10 kips
- 20 kips
- 30 kips
- 40 kips

- 0 kN
- 10 kN
- 20 kN
- 30 kN
- 40 kN

The graph shows the distribution of forces on a tie-to-tie lateral load, with a peak force of 40 kips at 0 kN.
Lateral Loads Within Fastening System
Curved Track (High Rail), Passenger and Freight Peak Loads

![Graph showing force vs. speed for different categories: Lateral Wheel Load (Freight), Shoulder Response, F (Freight), and Passenger.](#)
Lateral Loads Within Fastening System
Curved Track (Low Rail), Passenger and Freight Peak Loads

- Lateral Wheel Load (Freight)
  - Force, F (kN)
  - Force, F (lbf)
  - Speed (mph)

- Shoulder Response, F (Freight)
- Passenger

Points for each category at various speeds:
- 0 mph: Passenger 25,000 (6,000 kN)
- 15 mph: Passenger 15,000 (6,000 kN)
- 30 mph: Passenger 10,000 (6,000 kN)
- 45 mph: Passenger 5,000 (6,000 kN)

Graph showing the decrease in force with increasing speed.
Rail Seat Load Concentration

% Initial Contact Area
3: 100%
11: 100%

Unloaded to Increasing Pressure

40 kips
0 kips
Rail Seat Load Concentration

Unloaded

Increasing Pressure

% Initial Contact Area

3: 62%
11: 58%

40 kips

20 kips

40 kips

20 kips
TLV Varying Lateral Load at RTT

40,000 lb (178 kN) Vertical Load

Percent of Initial Contact Area

L/V Force Ratio

TLV Varying Lateral Load at RTT

40,000 lb (178 kN) Vertical Load

Percent of Initial Contact Area

L/V Force Ratio
TLV Varying Lateral Load at RTT

20,000 lb (88.9 kN) Vertical Load

Percent of Initial Contact Area vs. L/V Force Ratio
Concentration of Rail Seat Load

40,000 lb (178 kN) Vertical Load

Distance from Field Shoulder (mm)

Distance from Field Shoulder (in)

Load (lb)

Load (kN)

L/V Force Ratio

0.0

0.1

0.2

0.3

0.4

0.5
Definition of Rail Seat Load Index (RSLI)

- A quantifiable design value which describes the sensitivity of the rail seat load distribution to changes in the L/V force ratio.
- Rail Seat Load Index (RSLI) is defined as the percent of total rail seat load imparted onto a critical region of the rail seat, defined as the area of the rail seat not more than 1 inch (25.4 mm) from the field side shoulder, normalized to a theoretical, uniform distribution.

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RSLI = \frac{\text{Load in Critical Area}}{\text{Total Rail Seat Load}} \times \frac{1}{6} = 6 \times \frac{\text{Load in Critical Area}}{\text{Total Rail Seat Load}}
\]
Theoretical Optimized RSLI

Excessive loading on field side of rail seat
Accelerated fastener component wear
Increased RSD potential

Optimal Design Zone

Excessive loading on gauge side of rail seat
Accelerated fastener component wear
Increased RSD potential