Surveys conducted by UIUC report that North American Class I Railroads and other railway infrastructure experts ranked rail seat deterioration (RSD) as one of the most critical problems associated with concrete crosstie and fastening system performance (2008, 2012). RSD is the degradation of concrete directly underneath the rail pad, resulting in track geometry problems.

- **Research objective**: measure the magnitude and distribution of pressure at the concrete crosstie rail seat and investigate crushing as a feasible failure mechanism loading to RSD
- **Experimentation** is being performed to compare pressure distributions on rail seats under various loading scenarios and fastening systems, and identify regions of high pressure while quantifying peak values.
- **Results** from experimentation with MBTSS are providing a better understanding of the load transfer from the wheel/rail interface to the rail seat.

### MBTSS Technology
- Sensors are comprised of two thin sheets of polyester with a total thickness of 0.004 inches.
- On one sheet, a pressure sensitive semi-conductive material is printed on rows; on the other, in columns, which forms a grid when overlaid.
- Conductive silver leads extend from each column and row to the “tab” from which data is collected by a data acquisition handle.
- Known input loads are currently applied to MBTSS data to measure the pressure distributions.
- Sensors can be trimmed to fit various concrete rail seat dimensions.

### MBTSS Layout and Installation
- The sensor is placed at the interface between the concrete rail seat surface and the rail pad component of the fastening system assembly.
- To protect from shear forces and puncture, the sensor is covered on both sides with thin layers of polytetrafluoroethylene (PTFE) and biaxially oriented Polyethylene Terephthalate (BoPET).
-传感由Amsted RPS拥有。三个35 kip actuators:两个垂直和一个水平
- 允许通过模拟各种垂直/水平力（L/V）比进行试验
- 用于全尺寸混凝土轨和紧固系统测试
- 伴随AREMA测试6—磨损和剥落
- 建立于Advanced Transportation and Research Engineering Laboratory (ATREL)

### Laboratory Experimentation – Rail Pad Test Results
- **Contact Area (in²)**: 26.8, 27.9, 27.3, 25.8, 24.0, 21.3
- **Peak Pressure (psi)**: 2,139, 2,573, 2,800, 2,925, 3,162, 3,400

### Laboratory Experimentation – Rail Pad Test Setup
- **Pressure (psi)**
- **Contact Area (in²)**: 24.9, 24.0, 23.9, 23.9, 23.4, 23.4
- **Peak Pressure (psi)**: 2,550, 2,821, 2,877, 2,990, 3,201, 3,325

### Conclusions from Laboratory Experimentation
- Effect of L/V force ratio
- Lower L/V force ratios distribute the pressure over a larger contact area
- Higher L/V force ratios cause a concentration of pressure on the field side of the rail seat, resulting in higher peak pressures
- **Rail Pad Test**
- Lower modulus rail pads distribute rail seat loads over a larger contact area, reducing peak pressure values and mitigating highly concentrated loads at this interface, though allowing greater rail base rotation.
- Higher modulus rail pads distribute rail seat loads over a smaller contact area, possibly loading to localized crushing of the concrete surface, while reducing rail base rotation.
- The two-part pad assembly maintains a relatively consistent contact area under increasing L/V force ratios while yielding peak pressures similar to the lower modulus TPV pad, and reducing rail base rotation similar to the MDPE pad.
- Crushing does not appear to be a feasible mechanism of RSD under these loading conditions.
- **Peak values** do not approach the 7,000 psi minimum design compressive strength of concrete as recommended by the American Railway Engineering and Maintenance-of-Way Association (AREMA).
- It is still believed that a “perfect storm” of poor track support and high impact loads in the field could result in peak values that cause crushing of the concrete surface.

### Future Work
- Continue investigating common North American fastening systems
- Perform field experimentation at Transportation Technology Center in Pueblo, CO to understand pressure distribution varying track and loads.
- Incorporate rail seat pressures into other RSD mechanism studies.

### MbTss Layout and Installation
- The sensor is placed at the interface between the concrete rail seat surface and the rail pad component of the fastening system assembly.
- To protect from shear forces and puncture, the sensor is covered on both sides with thin layers of polyethylene (MDPE) – higher modulus
- Medium-Density Polyethylene (MDPE – higher modulus)
- Sand Gradients – 0.25 force ratio
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