Strain Response in Insulated Rail Joints

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Background

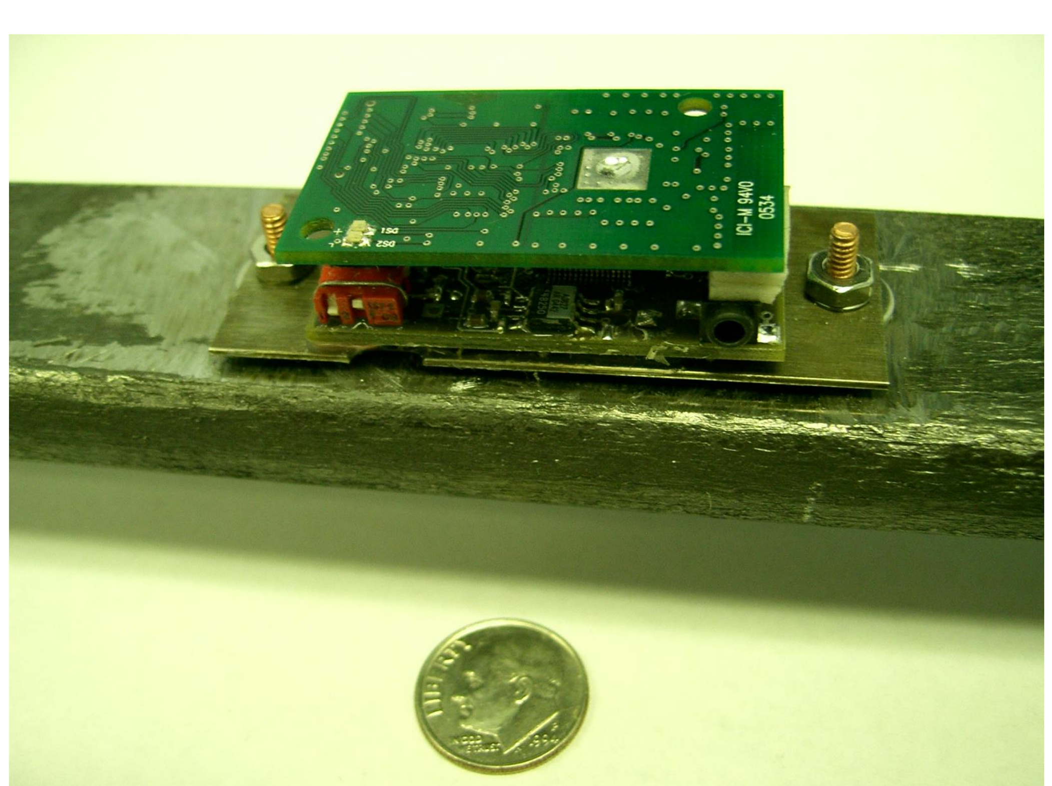
- **Insulated rail joint**: used to break railroad tracks into electrically isolated sections
- Necessary for train detection and rail traffic control
- With use of welded rail, IJ's become the only mainline rail joints

Problem statement

- Insulated joints have the shortest service life of any track components in a heavy-haul environment
- Current inspection techniques not adequate for detecting failure
- Need a better way to monitor the health of IJ's, so that their replacement can be scheduled

Project goals

- Use new wireless sensors (strain gauges, voltmeters) to monitor IJ health without human intervention
- Identify failing joints based on their physical and electrical responses to load

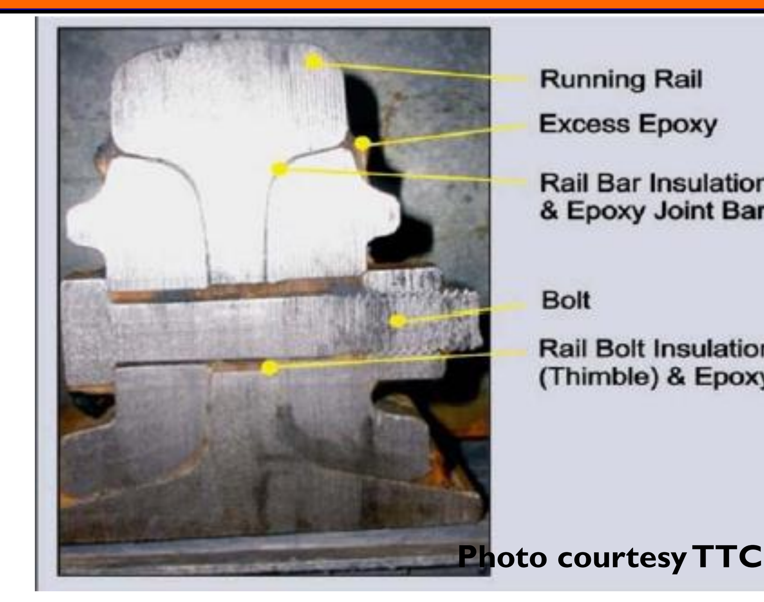


Experimental Technique

- Finite element model of strain response to thermal loads, for both new and degraded joints
- In-field measurements of electrical voltages across both functional and failed joints
- In-lab testing of strain response and electrical resistance under longitudinal loads for both new and failed joints
- Identify signature physical and electrical responses of a failing joint

Typical Failure Mode

- Joints consist of two rails and two "joint bars", all held together with a strong, insulating epoxy layer (bolts are of secondary importance)
- Cyclic high-impact stresses lead to epoxy fatigue failure



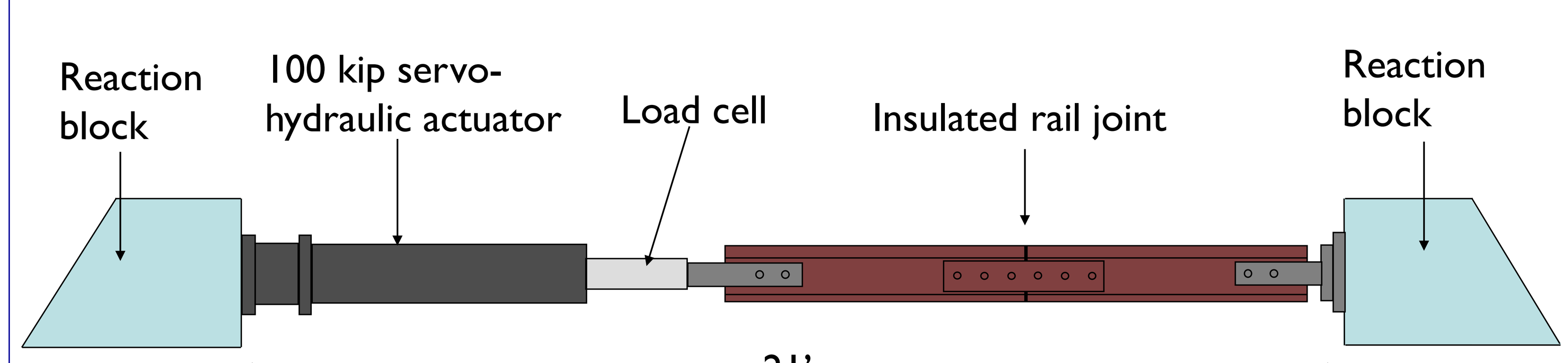
Epoxy loss and rust between rail and joint bar

- Epoxy debonds outward from center of joint
- Increasing deflections cause wear on insulating materials, allows short circuit to develop

NSEL Testing Goals

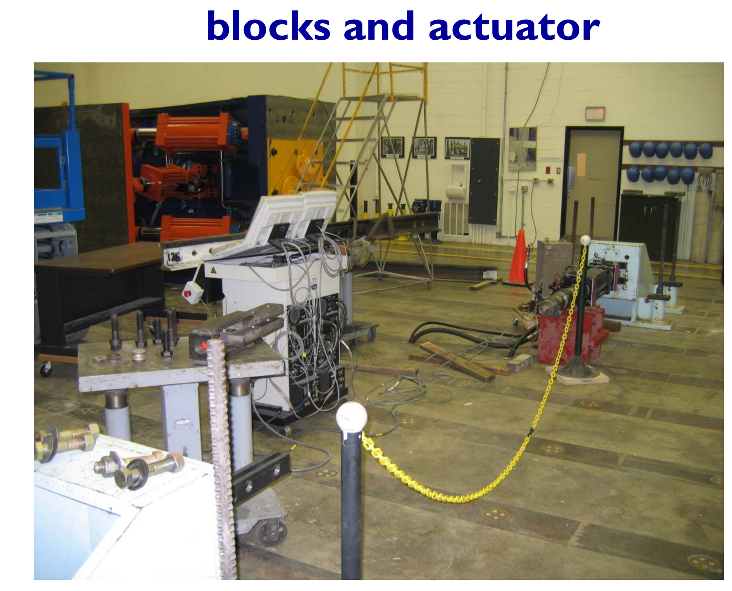
- Apply tensile loads to rail ends
  - Simulates thermal stresses normally present in railroad track
  - Relatively easy to model
- Measure strains at critical locations
  - Test accuracy of finite element model
  - Compare strain response of new joints to failed joint specimens
- Measure joint's electrical resistance versus load
  - Determine parameters for an electrical monitoring system
  - Characterize load-related intermittent insulation failures
- Proof-test prototype smart sensors' ability to measure strain in rails / joint bars

NSEL Testing Setup



- 100 kip (tension) design load for all components
- Both conventional and prototype wireless strain gauges
- Static, non-cyclic loading
- Joint length approximately 11'
  - Minimum length at which "new" joints remain serviceable for future use
  - Instrumented joints will be placed in track for further testing

Test area, showing reaction blocks and actuator



Acknowledgements

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