UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN
RAIL TRANSPORTATION AND ENGINEERING CENTER
*RAILTEC*
TECHNICAL NOTE

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| TECH NOTE NO: | 1 |
| TITLE: | Preliminary Strain Gauge Instrumentation of Rail |
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## 1. Introduction

This technical note summarizes the results of an experiment focusing on the preliminary strain gauge instrumentation of a segment of rail, hereafter referred to as "Tech Note 1". The experiment focused on testing the feasibility of building a load cell via instrumenting a segment of rail with eight (8) total strain gauges placed on the rail, four (4) on each side. The instrumented segment of rail and configuration of loading for this experiment is shown in Figure 1.

Figure 1: Simply supported instrumented segment of rail in 3-point bending

## 2. Experiment

A 24" segment of rail was selected and used for this experiment. This segment was originally taken originally from the field and therefore showed significant signs of head

wear. Furthermore, this segment was originally used in a jointed connection, as evident from the bolt holes in the web of the rail. Due to the head wear and lack of stamp on this rail segment, the actual section of rail is unknown, but it is believed to be 100RE.

The segment of rail was instrumented with a total of eight (8) strain gauges, four (4) on each side, Figure 2 shows a model of the rail segment with the locations of gauges highlighted, two (2) on the base of the rail and two (2) below the rail head on each side. This instrumented segment of rail was simply supported and tested in 3-point bending. The span between the simple supports was approximately 18". The vertical point load was applied in the center of the span on the head of the rail.

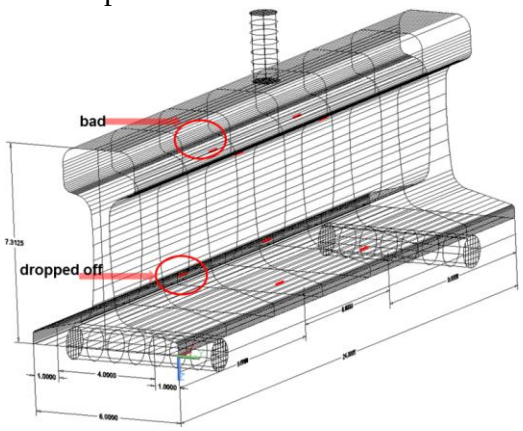


**Figure 2: Modeled section of rail showing placement of strain gauges.**

## 3. Loading history

All loads applied were static. Table 1 shows the loading history the segment of rail experienced during the experiment. At each load, data was acquired through the actuators' displacement transducers and voltages from the Vishay strain indicator.

**Table 1: Loading history of rail segment**

| Loading History of Rail Segment | |
|---|---|
| Load Number | Load (kips) |
| 1 | 15 |
| 2 | 20 |
| 3 | 25 |
| 4 | 32.5 |
| 5 | 15 |
| 6 | 20 |
| 7 | 25 |
| 8 | 32.5 |
| 9 | 5 |
| 10 | 0 |

## 4. Results

The strains read from the test were compared to the theoretical values calculated by hand and this comparison is shown in Figure 3. These hand calculations neglected shear deformation. The values appear to match very well. The strains recorded via the Vishay strain indicators were extremely close to one another and therefore it was assumed that the gauges were placed carefully and values could be considered accurate.

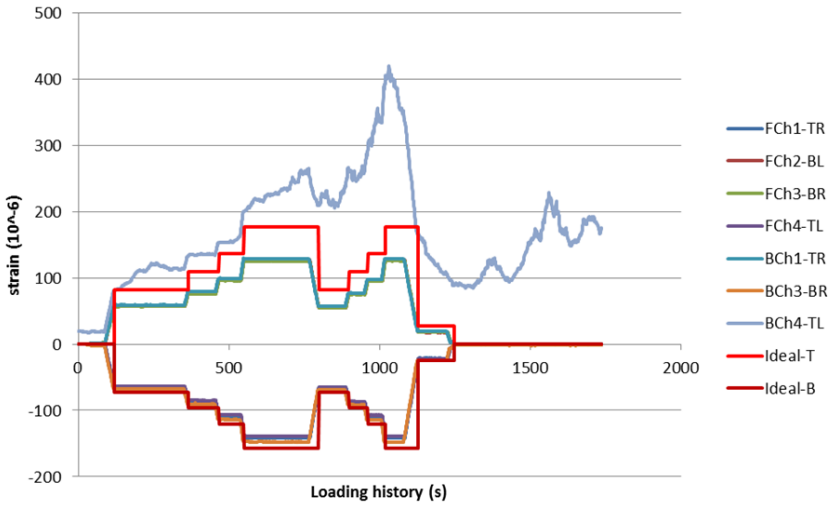


**Figure 3: Comparison between test and hand calculated strains**

## 5. Final Remarks

The preliminary instrumentation of a segment of rail utilizing strain gauges to prove the concept of using the rail as a load cell produced desirable results. It appears that surface strain gauges can be used to measure bending of the rail based on this 3-point bending experiment.. The rail segment appeared to express elastic behavior during the static loading test for bending; the strains go back to 0 when load is removed. The maximum stress experienced during the test was 5.1 ksi which is no more than 5% of the estimated rail steel yield point. It should be noted that two (2) strain gauges were found to be defective prior to loading. These gauges are highlighted in Figure 2. The method of using the rail as a built-up load cell will continue to be pursued.