Alternate Procedure to Run a Full-Scale Accelerated Fatigue Test on a Rail Car

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• Transportation Technology Center, Inc. (TTCI), is a wholly owned subsidiary of the Association of American Railroads (AAR). TTCI is a world-class transportation research and testing organization, providing emerging technology solutions for the railway industry throughout North America and the world.

• Headquartered in Pueblo, Colorado, 21 miles northeast of Pueblo Airport, TTCI manages extensive track facilities, and state-of-the-art laboratory facilities.

• There are 48 miles of railroad track available for testing locomotives, vehicles, track components, and signaling devices. Specialized tracks are used to evaluate vehicle stability, safety, endurance, reliability, and ride comfort. Using TTC's tracks eliminates the interferences, delays, and safety issues encountered on an operating rail system.
Challenge: Accelerated Fatigue Test on Different Car Designs With a Single Input Set

Manufacturers, Fleet Owners

Accelerated Fatigue Test

- Structural Analysis
- Car Instrumentation
- OTR Test Results
- Fatigue Test Rig Inputs

- Same Car?
  - Accelerated Test
  - Alternative Approach
  - Accelerated Test
Instrumentation and the OTR Test

- Normal instrumentation for an OTR test includes:

  - Bondable Strain Gages
  - Weldable Strain Gages
  - Accelerometers
  - Instrumented Coupler
  - Thermocouples
  - GPS System
• Additional instrumentation that may be needed:

- Bearing Generators (on-board power source)
- Gyroscope
- Inclinometers
- Solar Panels (on-board power source)
• The previous OTR provided all the necessary information to calculate the fatigue damage at all the instrumented positions, however, since the railcar design to be used during the accelerated fatigue test is different, the strain signals are not valid anymore!

• A new approach is needed in order to generate a new set of strain signals which can be used for the fatigue damage calculations.

• There is some useful information that can be retrieved from the past OTR though, like the longitudinal coupler force and the truck accelerations since these excitations are external to the railcar.
Following figures show the OTR data
Road Environment Percent Occurrence Spectra (REPOS) Data Generation

OTR Test Data

Coupler Force
Bolster Accelerations
Bolster Displacements

Histograms

Histograms Reordering with respect to Range

REPOS Data

Accelerated New OTR Signals

nCode
GlyphWorks
TTCI’s Simuloader (SMU)

- The SMU is a computer controlled, electro-hydraulic structural test device used for applying dynamic inputs directly to full-scale railcar bodies, highway vehicles and other heavy structures.
- It uses up to 11 actuators with capacities up to 750,000 lb and a 12 inch stroke.
Following figures show the REPOS Data
REPOS Data Generation (continued)

A-End Left Side Vertical Displacement
REPOS

A-End Right Side Vertical Displacement
REPOS

Same procedure was followed for the B-End
During the accelerated OTR test, the strains were monitored and recorded for later analysis. Attention is given to the location showing the most structural damage.
Accelerated OTR Test Data Analysis

- Relationship between Coupler Force, Strain, and Damage
Driver Files Generation for the Accelerated Fatigue Test

- First step is the identification and removal of all the non-damaging cycles
- This step is done within nCode GlyphWorks
  - Assessment Process
  - Slicing Process
  - Time Reducing Process
The time reduction process is performed on the longitudinal coupler force as well as the vertical inputs.
These resulting signals are then put together in a file used as the input for the SMU Accelerated Fatigue Test.
• The use of this alternate procedure allowed TTCI to conduct the 2 Million Miles Accelerated Fatigue Test on a car design similar but not equal to a car placed on a previous Over the Road test

• An equivalent test speed to 4500 miles/hr was achieved. This equivalent (accelerated) speed test allowed to run the 2 Million Miles test in less than 2 months

• By the end of the test, a full inspection was performed with no cracks or other major structural damage found. This outcome was consistent with the pre-test fatigue damage calculations
Challenge

To run an Accelerated Fatigue Test on a rail car with a different design than the rail car that provided all the data during a previous Over the Road test.

Solution

An alternate procedure was developed. This procedure is based on the generation of a Road Environment Percent Occurrence Spectra (REPOS) Data in nCode GlyphWorks. These REPOS data allows to recreate an Over the Road test on a condensed period of time.

Results

This procedure helps to:
- reduce the test time and cost by eliminating the need for another OTR test (4-6 months time-saving typical)
- test any number of similar railcar designs of the same type