Update on IWS Research

Use of IWS in Revenue Service

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CSTT Rail Expertise

- **Physical Testing**
  - Evaluation and Certification
- **Modeling / simulation of vehicle & track interface**
  - VAMPIRES, NUCARS, SIMPACK, FEA
- **Field Evaluation Programs**
  - Rail Grinding Optimazation
  - Friction Management
  - Wheel Rail Interaction Optimization
- **Prototyping and Systems integration**
  - Sensor Technologies

Overview

- **Instrumented Wheelset Testing**
  - **Why?**
  - **Type of Information**
- **IWS Projects**
  - **Project Results**
- **Future Technology**

Monitoring Track Performance and Safety

Currently used performance and safety measuring systems

- **Track Geometry**
- **Accelerometer-based system**
- **Wheel/Rail Forces (IWS / Track Side)**

Monitoring Track Performance and Safety

Why?

- **Excessive Forces Produce Unwanted Effects**

- **Optimize Wheel/Rail Interface**
  - **Decrease Safety Risks**
  - **Optimize and Prioritize Maintenance**
  - **Identifying Maintenance Requirements**
  - **Improve Ride Quality**

Reducing $ and Safety Risk

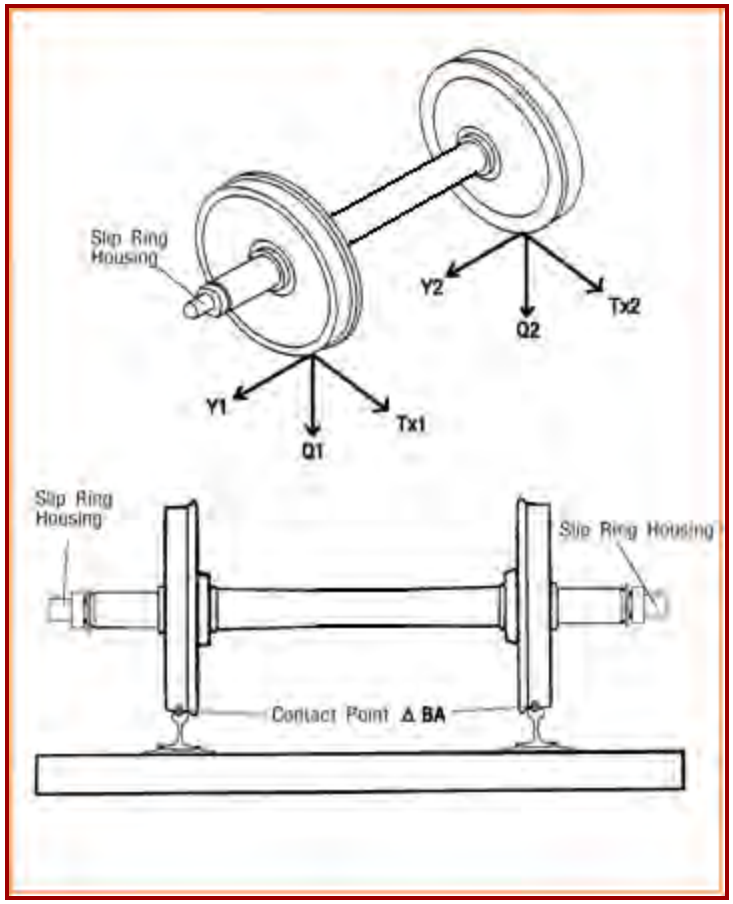
Wheel/Rail Dynamic Forces

Instrumented Wheelsets vs. Trackside

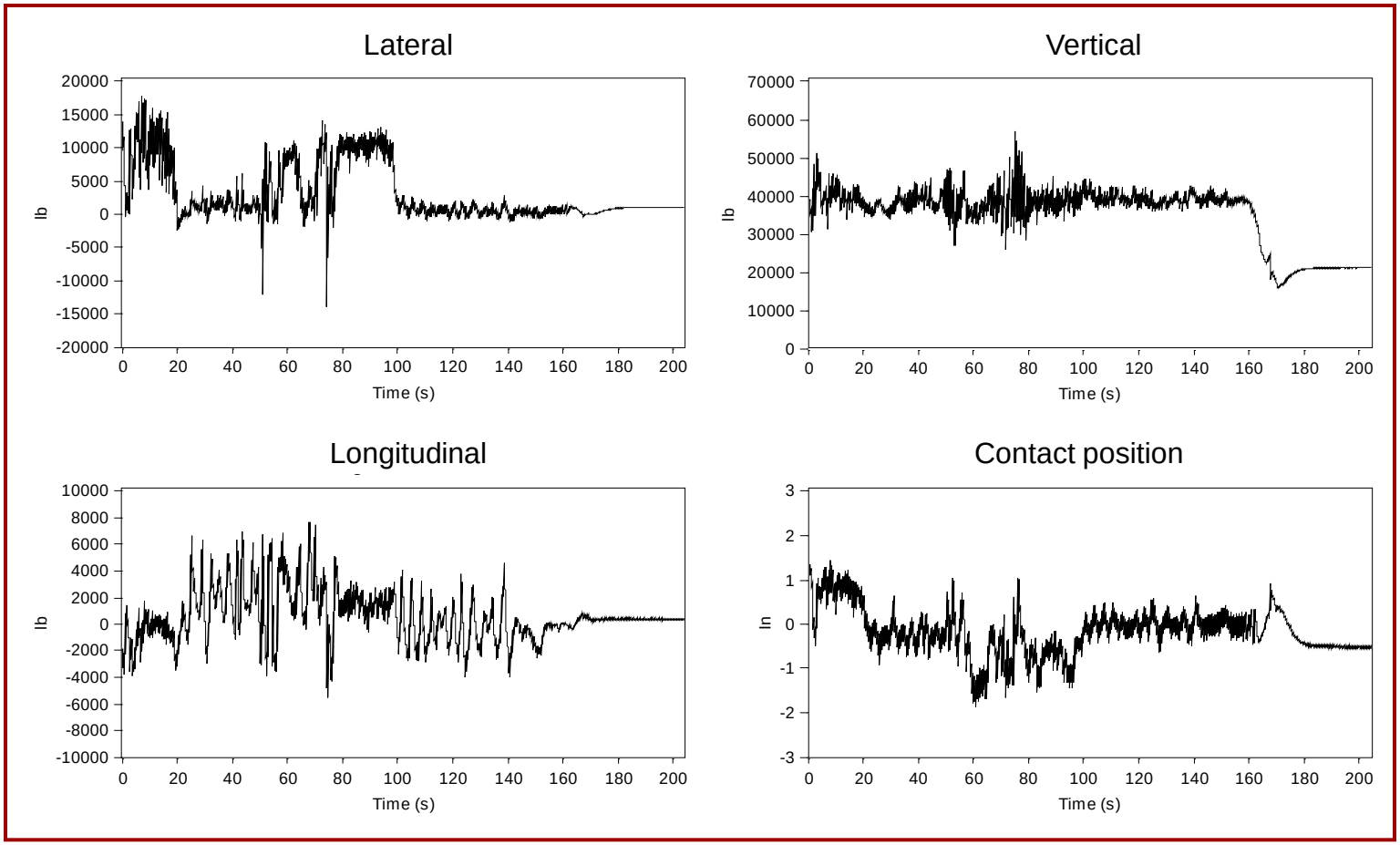
- Two methods for direct measurement of wheel/rail dynamic forces
  - Track instrumentation to measure lateral and vertical forces
    - Gives spectrum of loads at a single track position
  - Instrumented Wheelsets
    - Gives spectrum of loads for a given vehicle type
    - Also gives information on vehicle performance

Instrumented Wheelsets (IWS)

- Normal wheelsets instrumented with strain gauges and turned into load cells
- The strain-gauge bridges are combined to give contact forces in all three axes
- Gives information on wheel/rail contact point
- Processes data in real-time
- Accurate



IWS Sample Output



Instrumented Wheelsets

- Advantages:
  - Direct track performance measurement
  - Measures lateral, vertical and longitudinal forces for a specific vehicle configuration over all track
  - Gives position of the wheel on the rail
  - Very accurate
  - Customer benefits
- Disadvantages:
  - Limits measurement to a single configuration per test
  - Requires personnel and dedicated track time

Use of Instrumented Wheelsets

- Specialized Test Track
- In-Service Track (Option 1)
  - Closed section or Dedicated Train and track time
- In-Service Track (Option 2)
  - Revenue Service Train

Example – Comparison of track geometry measurements to IWS Forces

- Study Aim
  - Track Geometry standards to include track curvature
- Approach
  - Field Test
  - Instrumented Wheelsets
  - Track Geometry

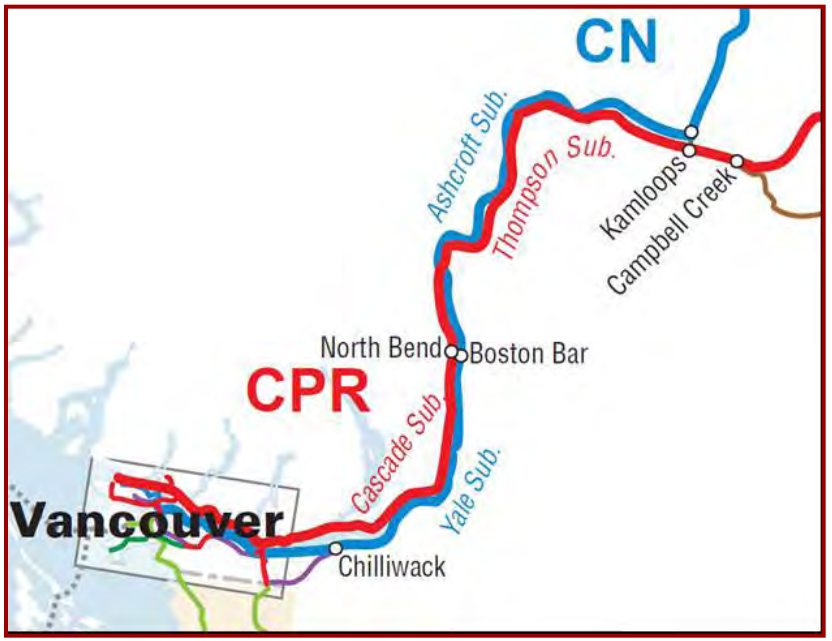
Example – Comparison of track geometry measurements to IWS Forces

- Key Parameters
  - Gauge
  - Alignment
  - Superelevation
  - Surface
  - Twist / Warp (difference of cross level)
  - Runoff of rail
  - Combined defects
  - Others

Test Track

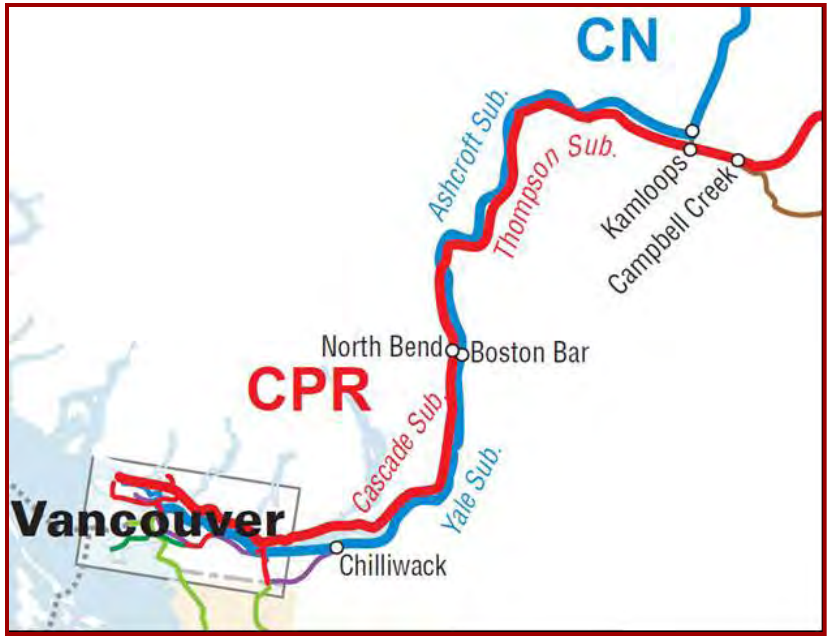
- Four Subdivisions
  - CNR: Yale and Ashcroft
  - CPR: Thompson and Cascade

- Test Routes
  (1) One Way Eastbound
  (2) Two (2) Round Trips Thompson Sub
  (3) One Way Westbound



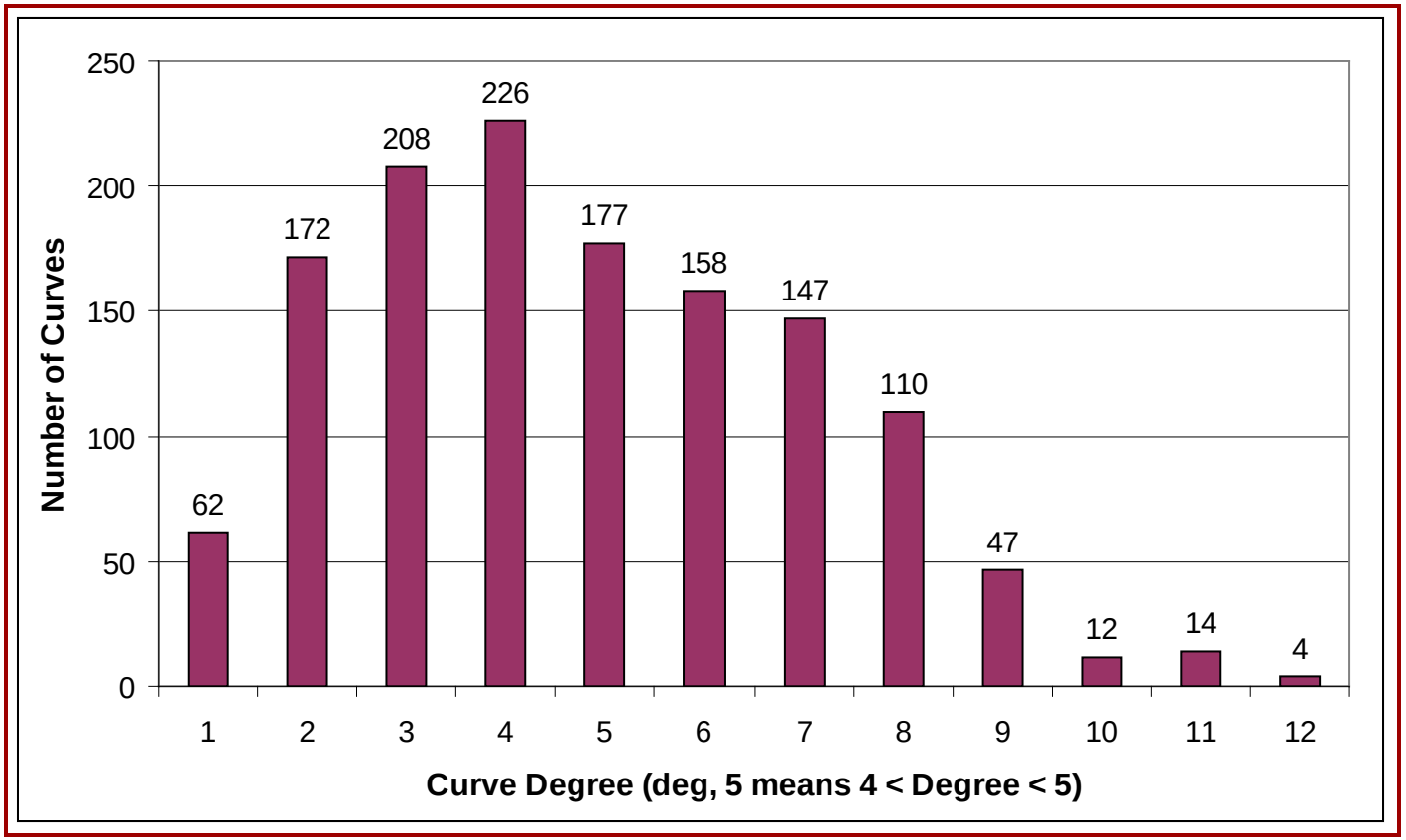
Data was recorded and processed over 335 miles of track, 124 miles on CNR and 211 miles on CPR

Test Track



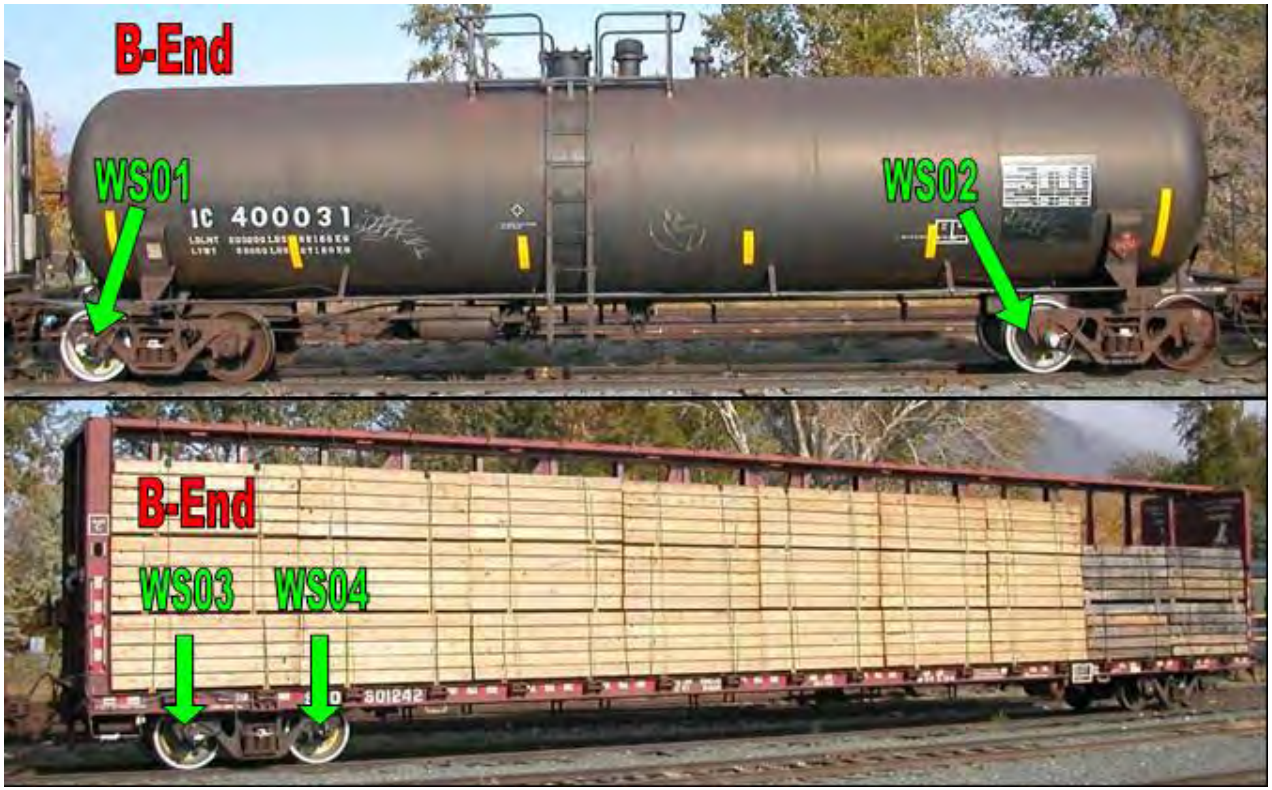
Sub	Processed MP		Speed Limit (mph)		Test Speed (mph)		
	From	to	Min	Max	Min	Average	Max
Ashcroft	0	118	25	50	3	29	40
Yale	0	75	25	65	12	32	50
Thompson	0	120	15	40	4	32	51
Cascade	10	79	25	60	19	31	50

Curve Track Distribution



- Total number of curves processed = 1,337
- Total length of curves (including spirals) = 196 miles
- Some curves tested and counted multiple times

Test Cars and IWS



Day 1 & 3 Test

- Day 1 Test:

  CN Thornton Yard → Yale → Cascade → Thompson → Ashcroft → CN Kamloops Yard

- Day 3 Test:

  CN Kamloops Yard → Ashcroft → Yale → CN Thornton Yard

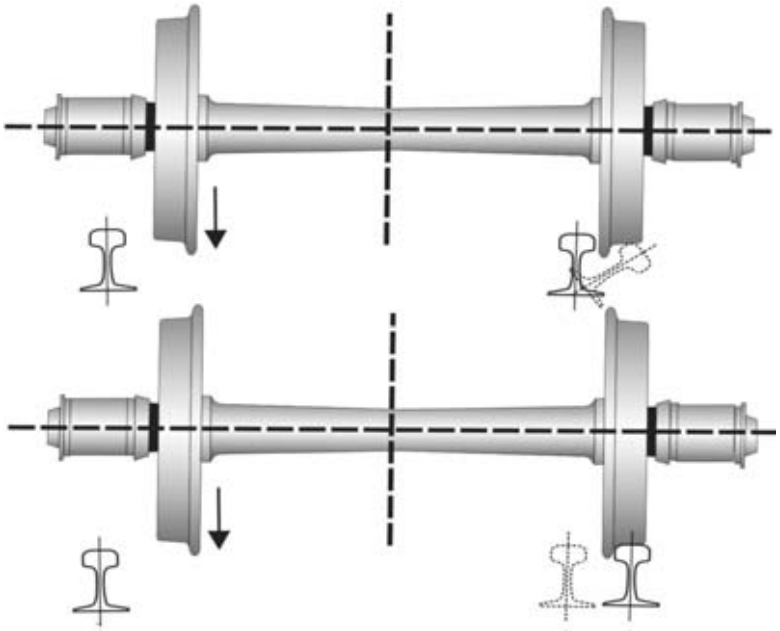
Day 2 Test

Performance Criteria

- Wheel L/V
- Truck Side L/V
- Wheel Unloading

- Others
  - High Lateral Force
  - High Vertical Force (impact)
  - Car Body Lateral Acceleration (hunting)

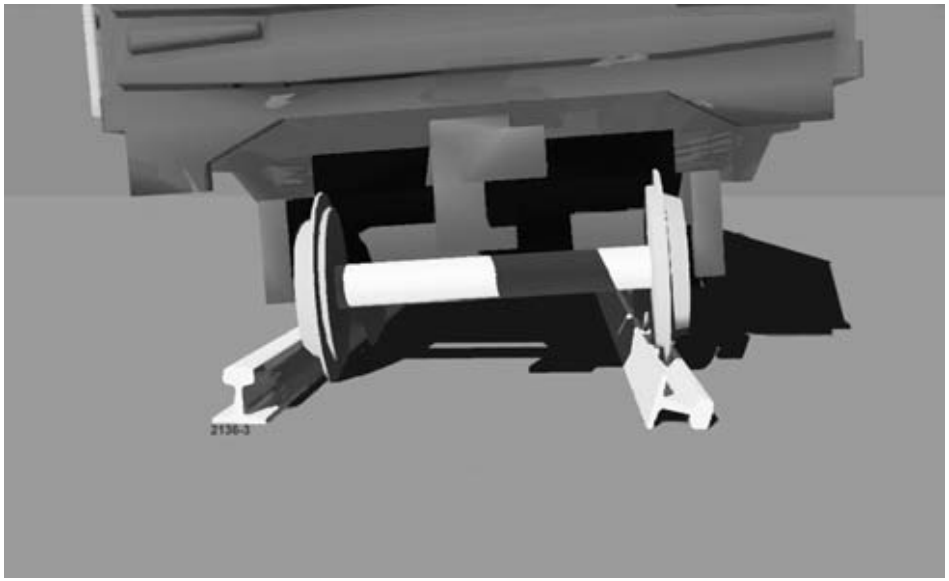
DERAILMENTS CAUSED BY GAUGE WIDENING AND RAIL ROLLOVER



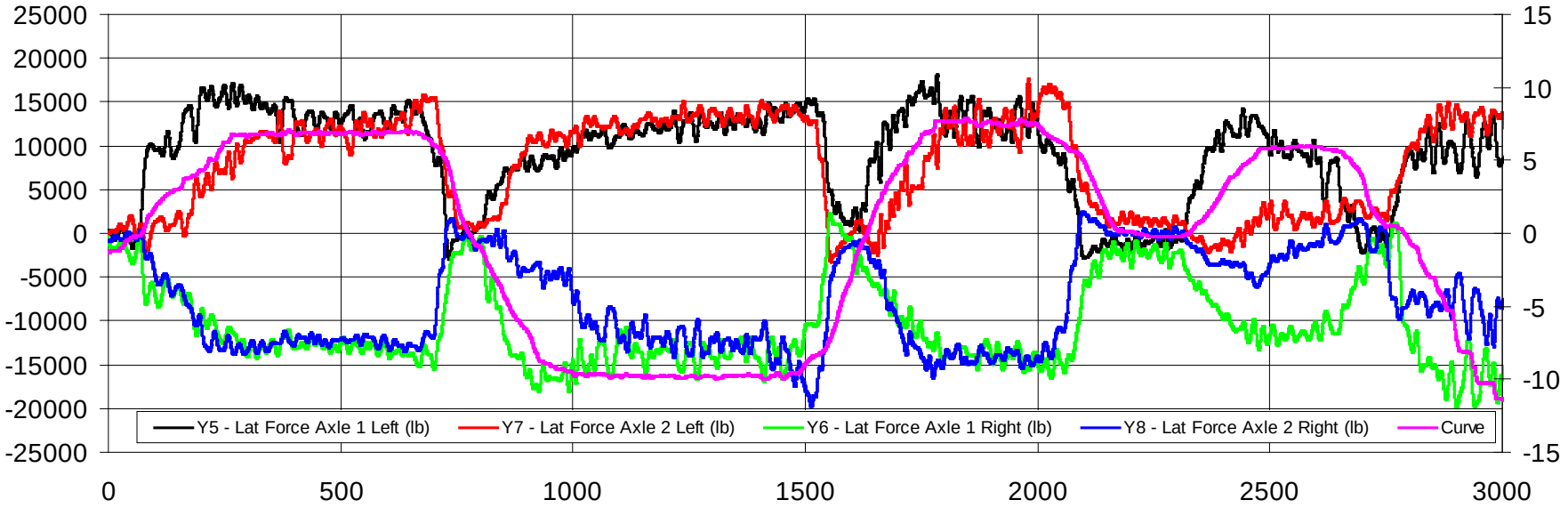
From “Handbook of Railway Vehicle Dynamics”, p.209

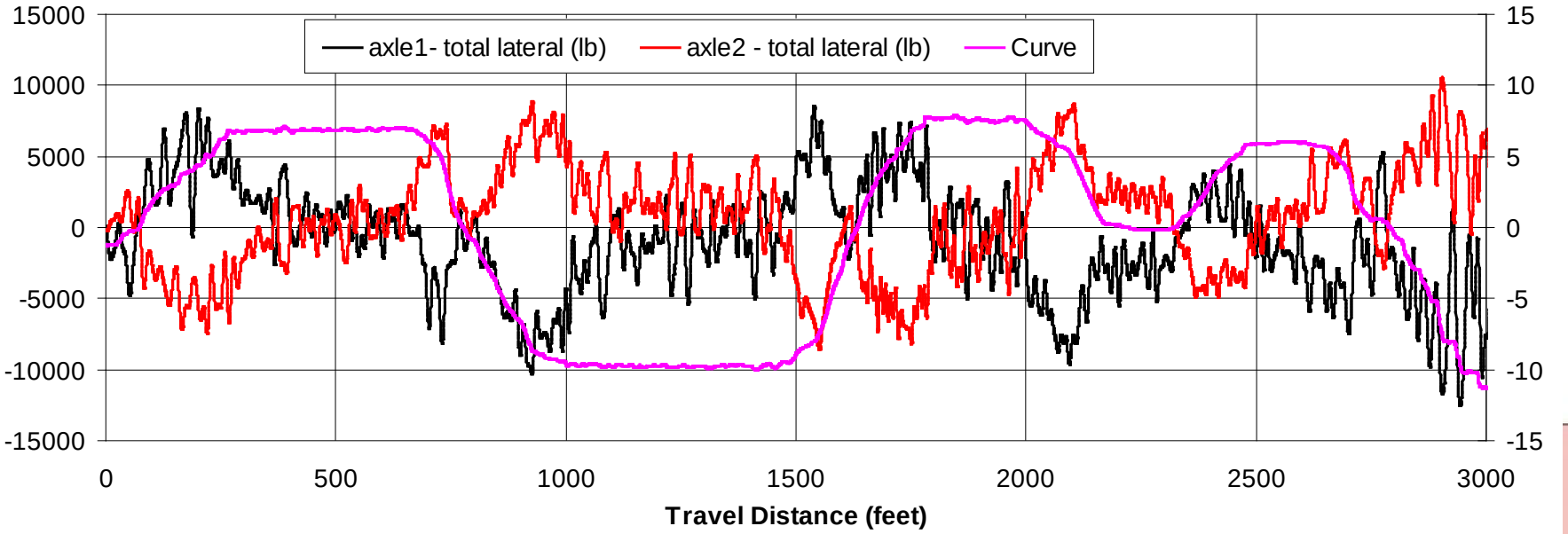
AAR Chapter 11:

$(L1+L2)/(V1+V2) < 0.6$

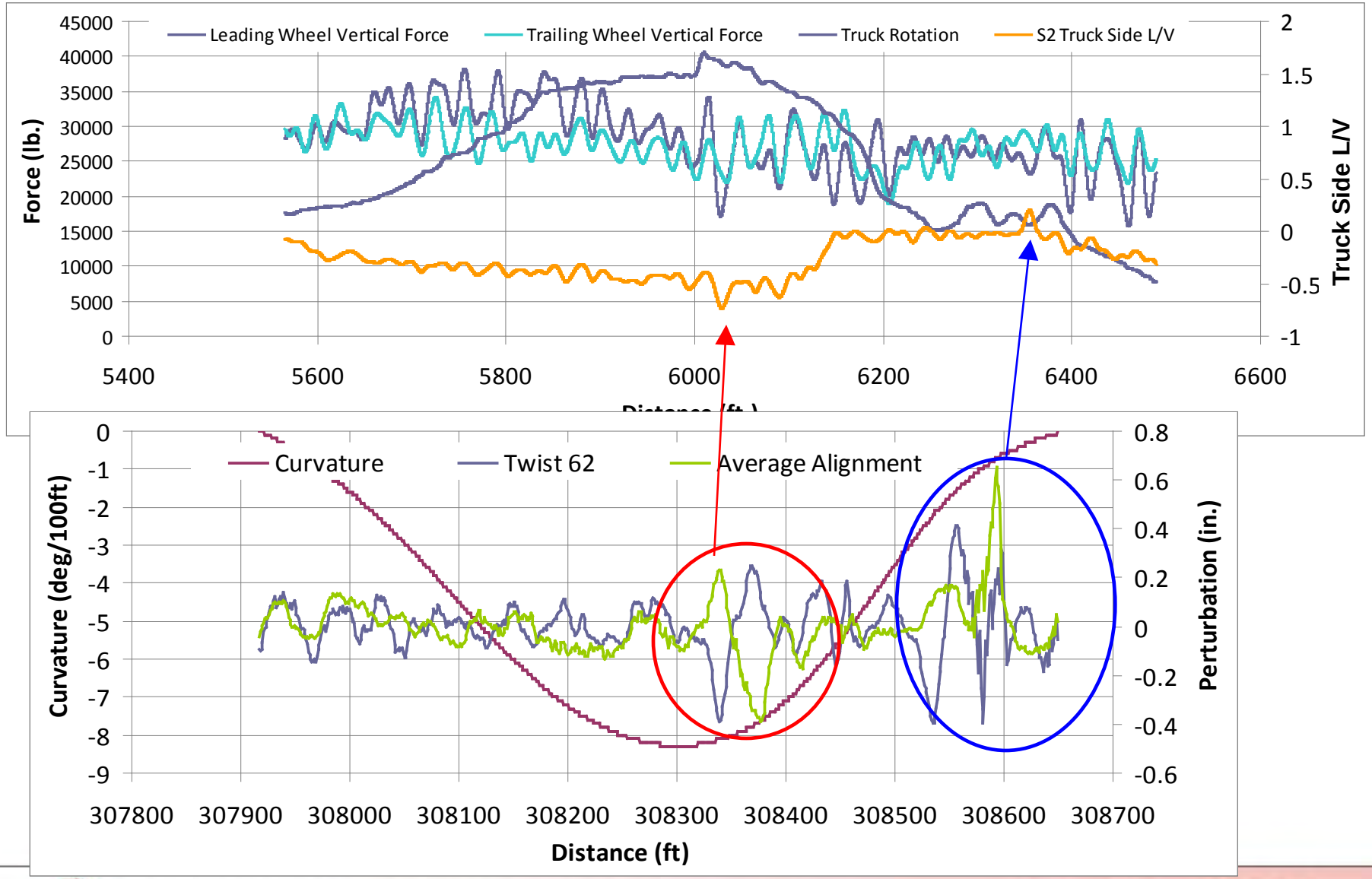


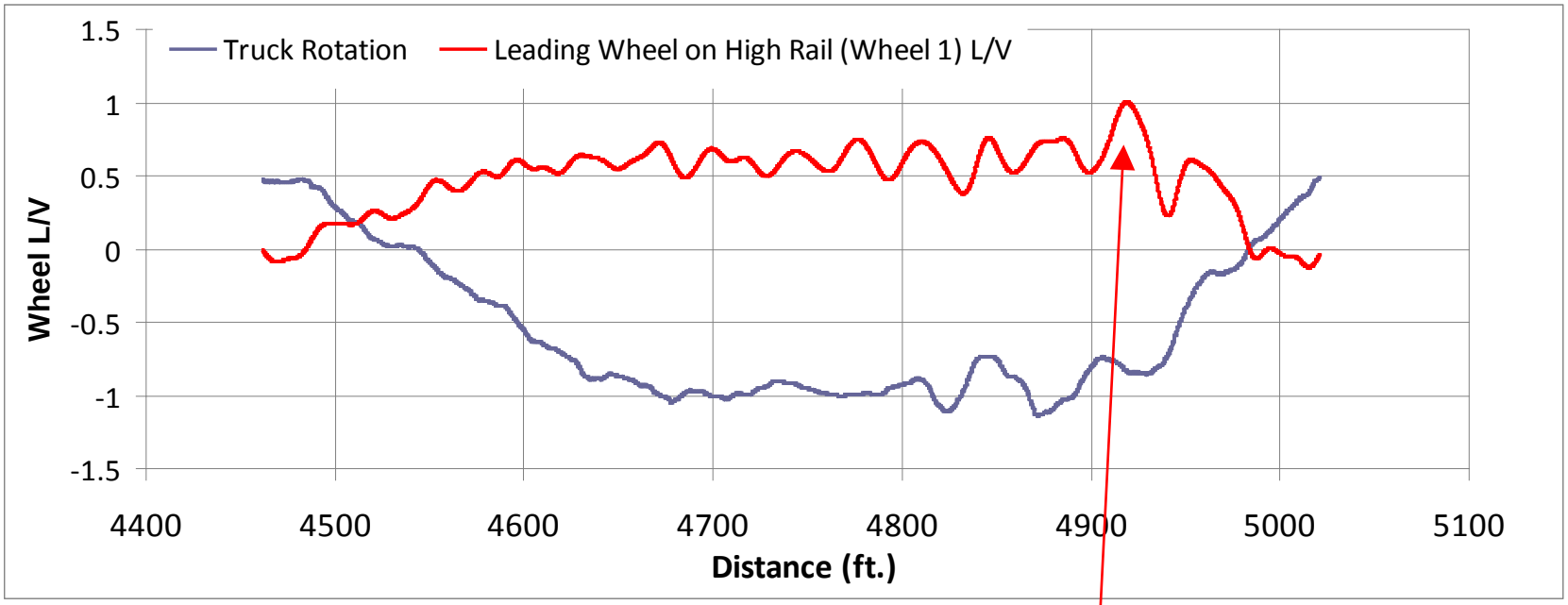
Lateral Force Example
Loaded Lumber Car

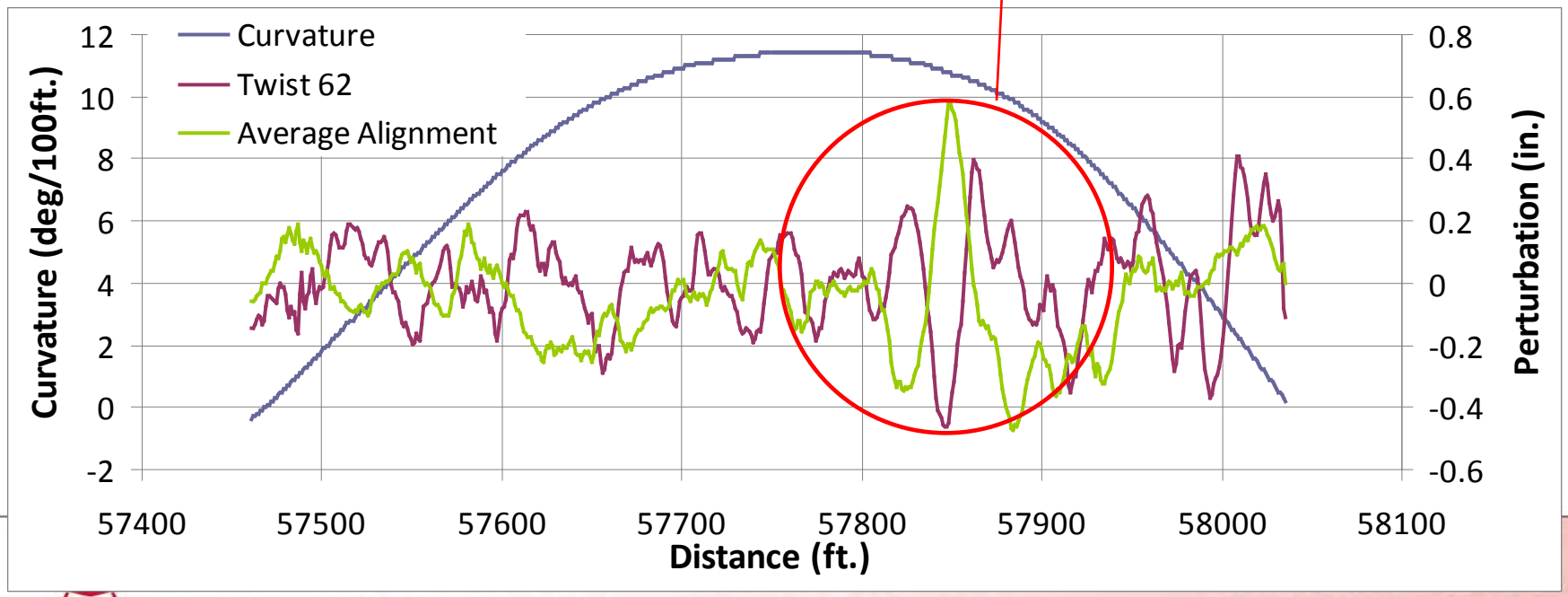




Truck Side L/V = 0.74 Case




Truck Rotation
Leading Wheel on High Rail (Wheel 1) L/V
Wheel L/V
1.5
1
0.5
0
-0.5
-1
-1.5
4400
4500
4600
4700
4800
4900
5000
5100
Distance (ft.)

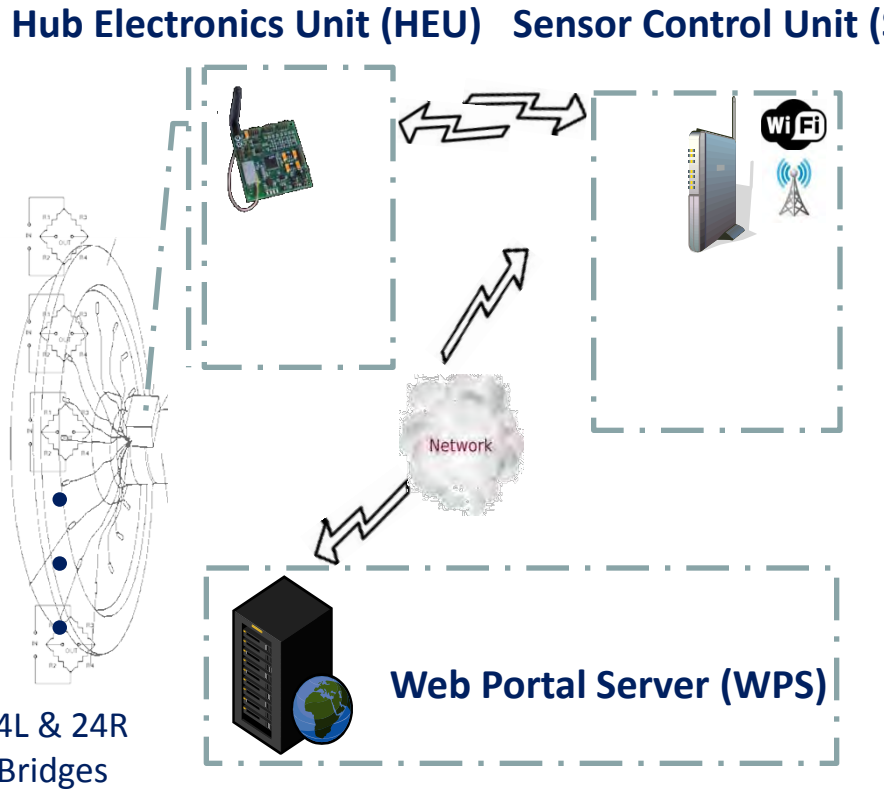

Curvature
Twist 62
Average Alignment
Curvature (deg/100ft.)
12
10
8
6
4
2
0
-2
Perturbation (in.)
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
57400
57500
57600
57700
57800
57900
58000
58100
Distance (ft.)

Project Summary

- Wheel rail force parameters such as the truck side L/V and single wheel L/V are strongly affected by curvature
- Combination of track geometry measurements are important indicators to L/V ratio.
- Truck side L/V should be used as an important safety index in performance based track geometry evaluation

Future Development

- Track safety standards going towards performance standards.
- Currently, IWS are expensive to deploy and requires personnel to conduct the test.
- Autonomous Un-Manned Monitoring
- Wireless



Thank You!

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