

Rail Neutral Temperature Measurement

TUV Rail Sciences Inc.
2 May 2011

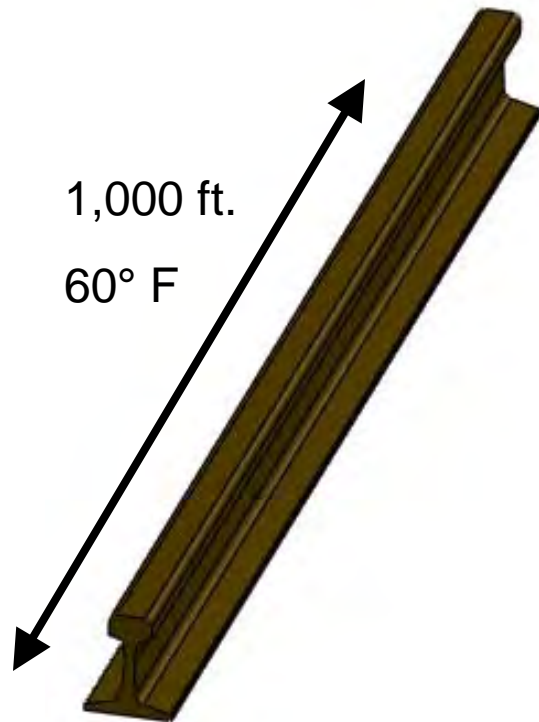
Introduction

- Introduction
- Rail Neutral Temperature
- Measurement Methods
- VERSE® Method and Operation
- Observations
- Accuracy
- Benefits

Introduction

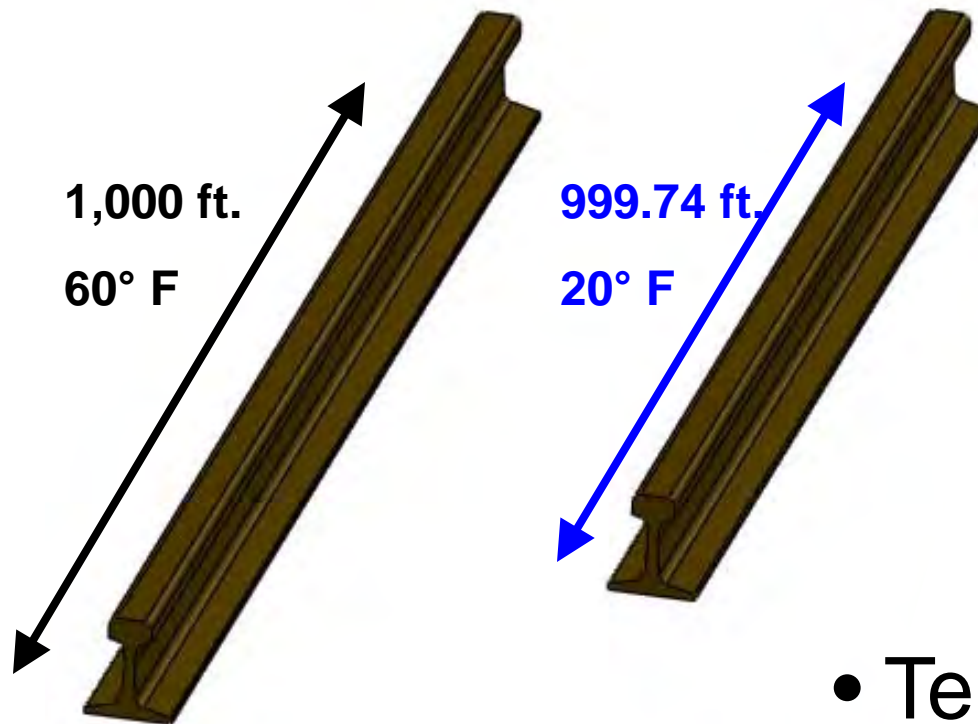


Rail Neutral Temperature



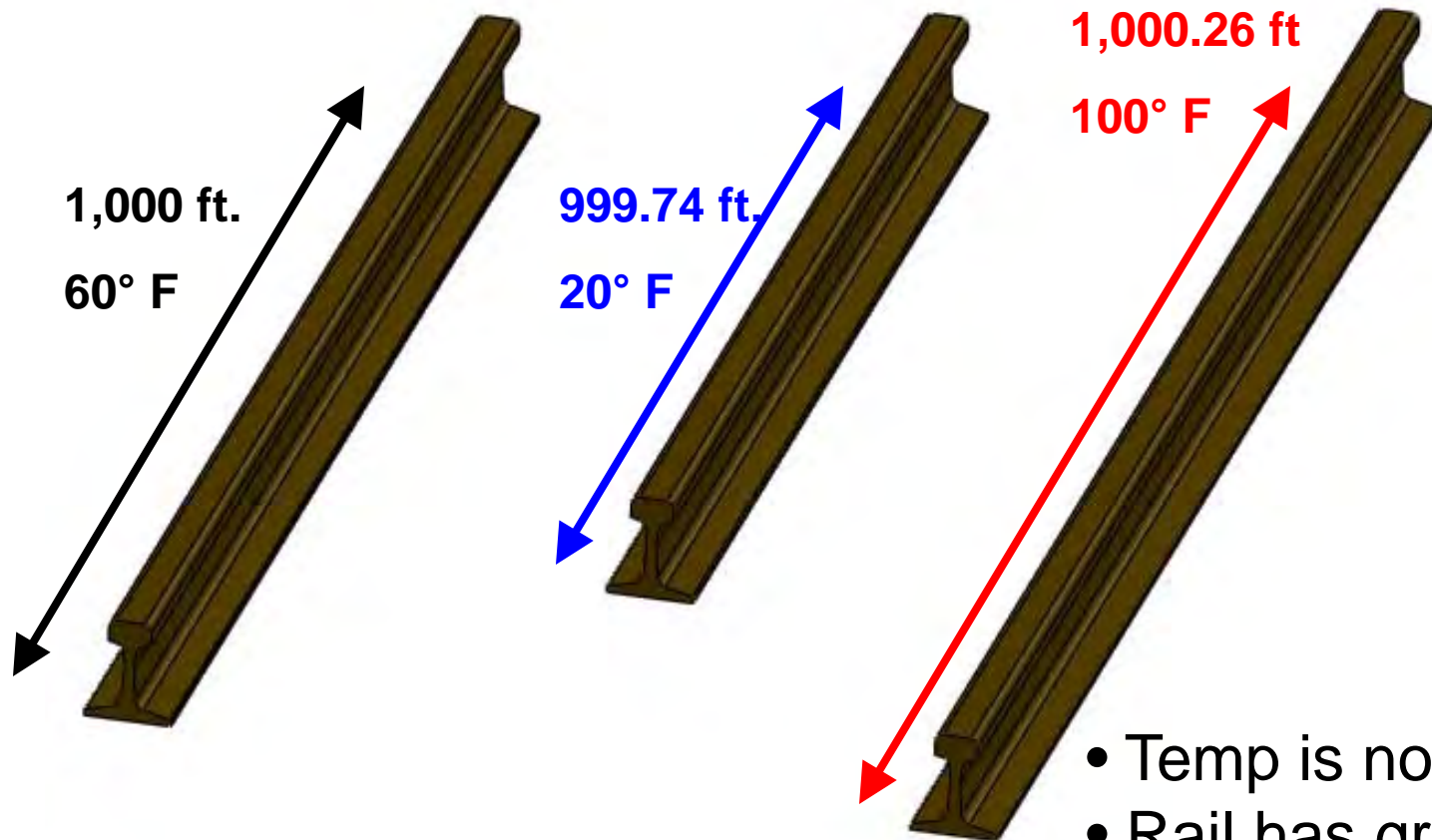
- Free rail
- No restraint
- 1,000 feet long
- 60° F (15.5° C)

Rail Neutral Temperature



- Temp is now 20° F
- Rail has shrunk 3.12 inches

Rail Neutral Temperature



- Temp is now 100° F
- Rail has grown 6.24 inches

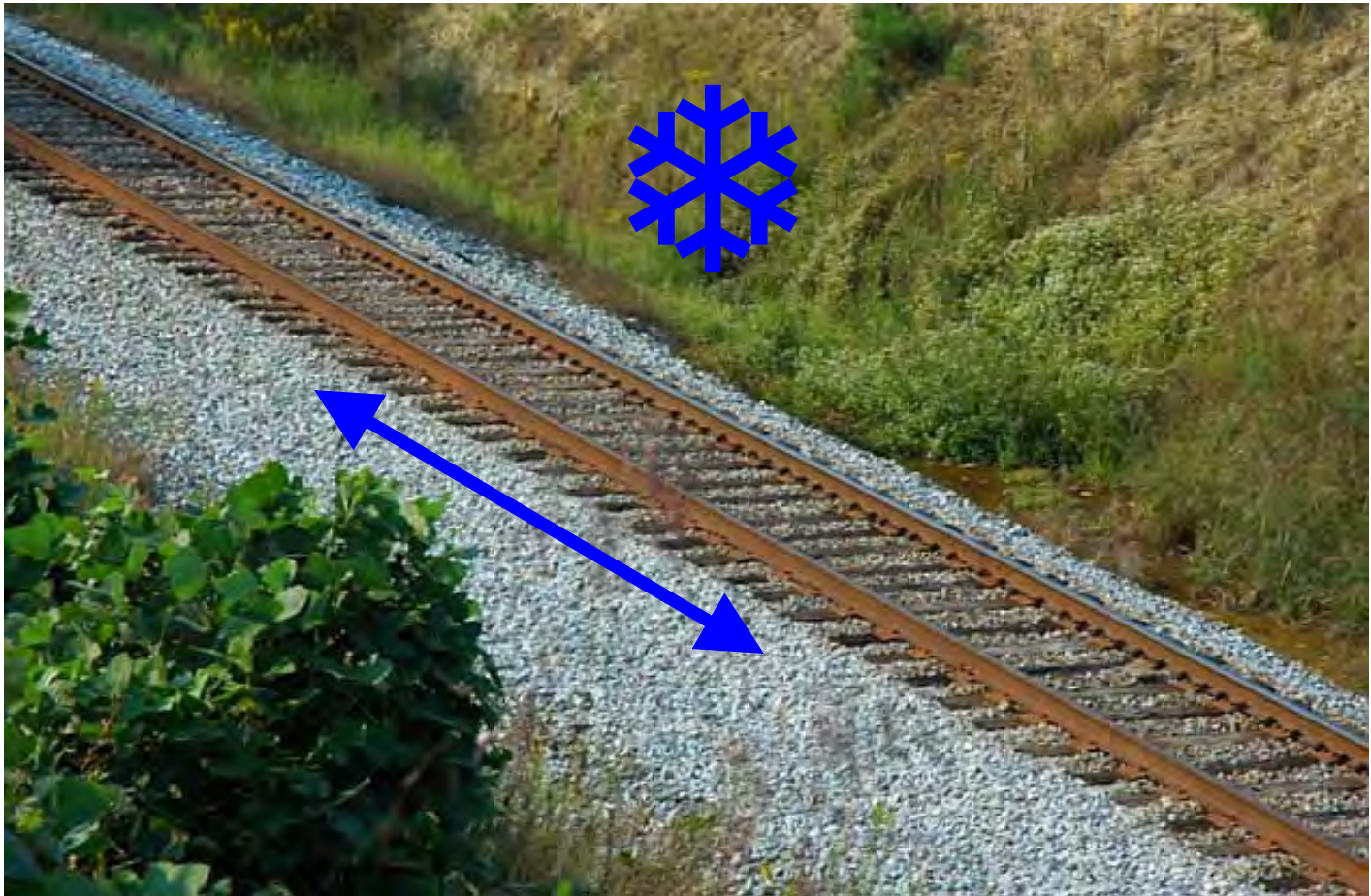
Rail Neutral Temperature

- Anchors and fasteners lock the track in longitudinally
- Anchored track experiences thermal loading



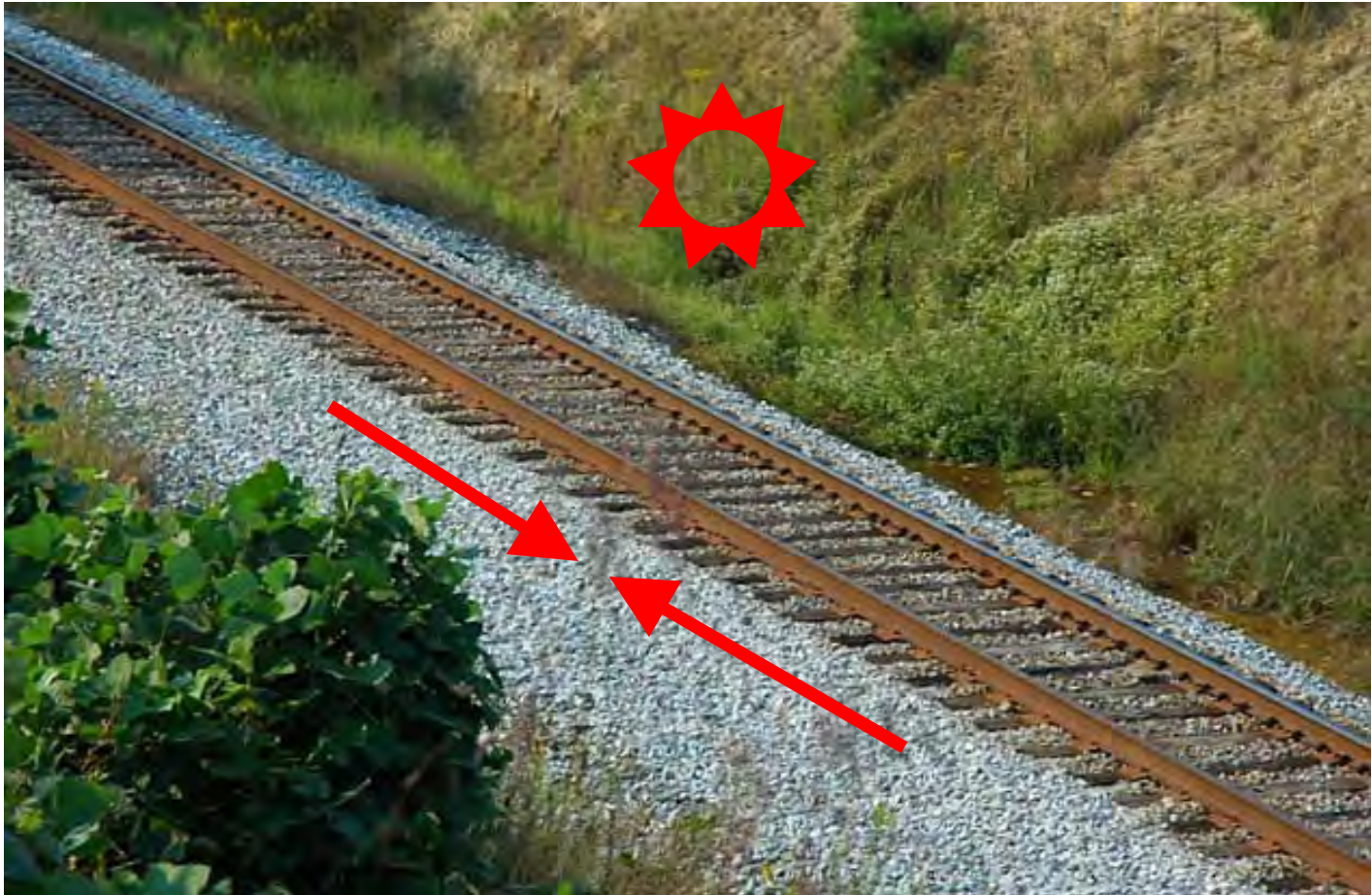
Rail Neutral Temperature

- Tension in cold weather



Rail Neutral Temperature

- Compression in hot weather

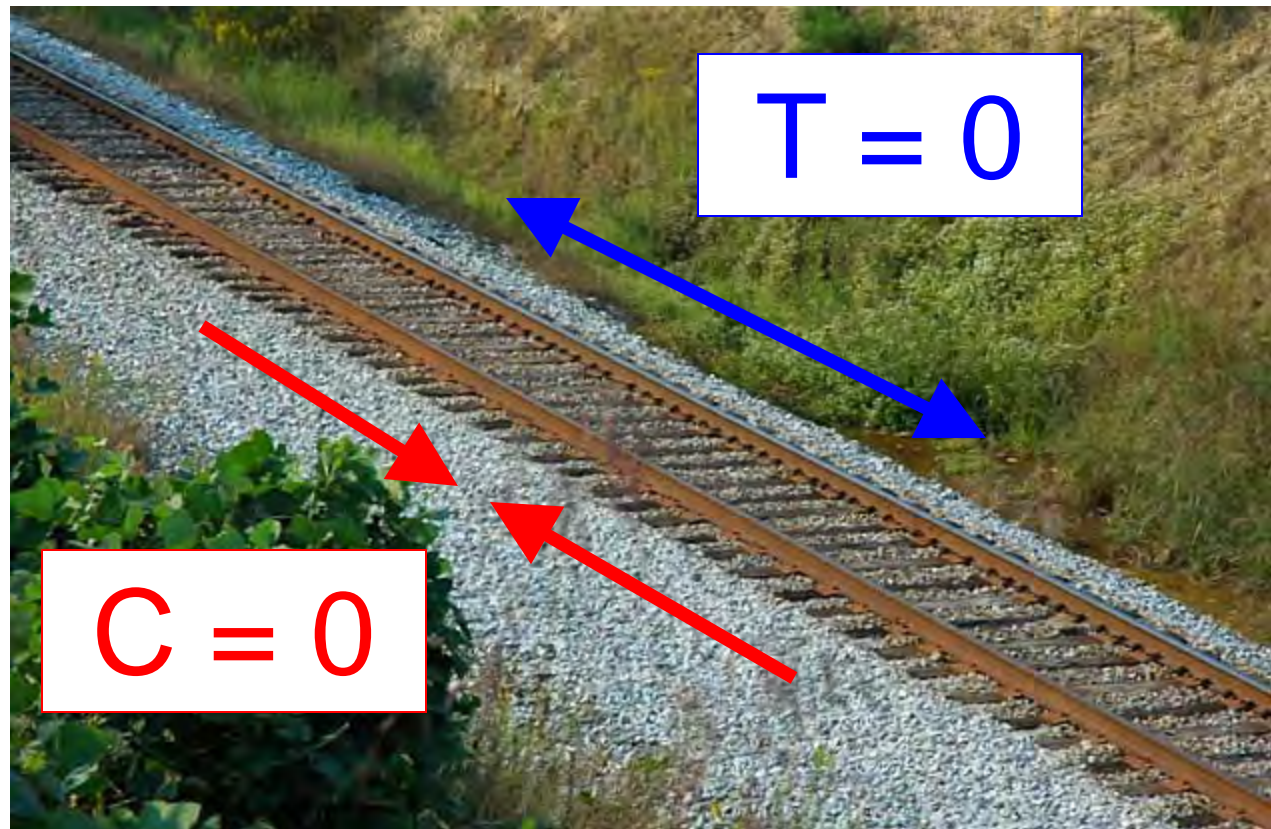


Rail Neutral Temperature

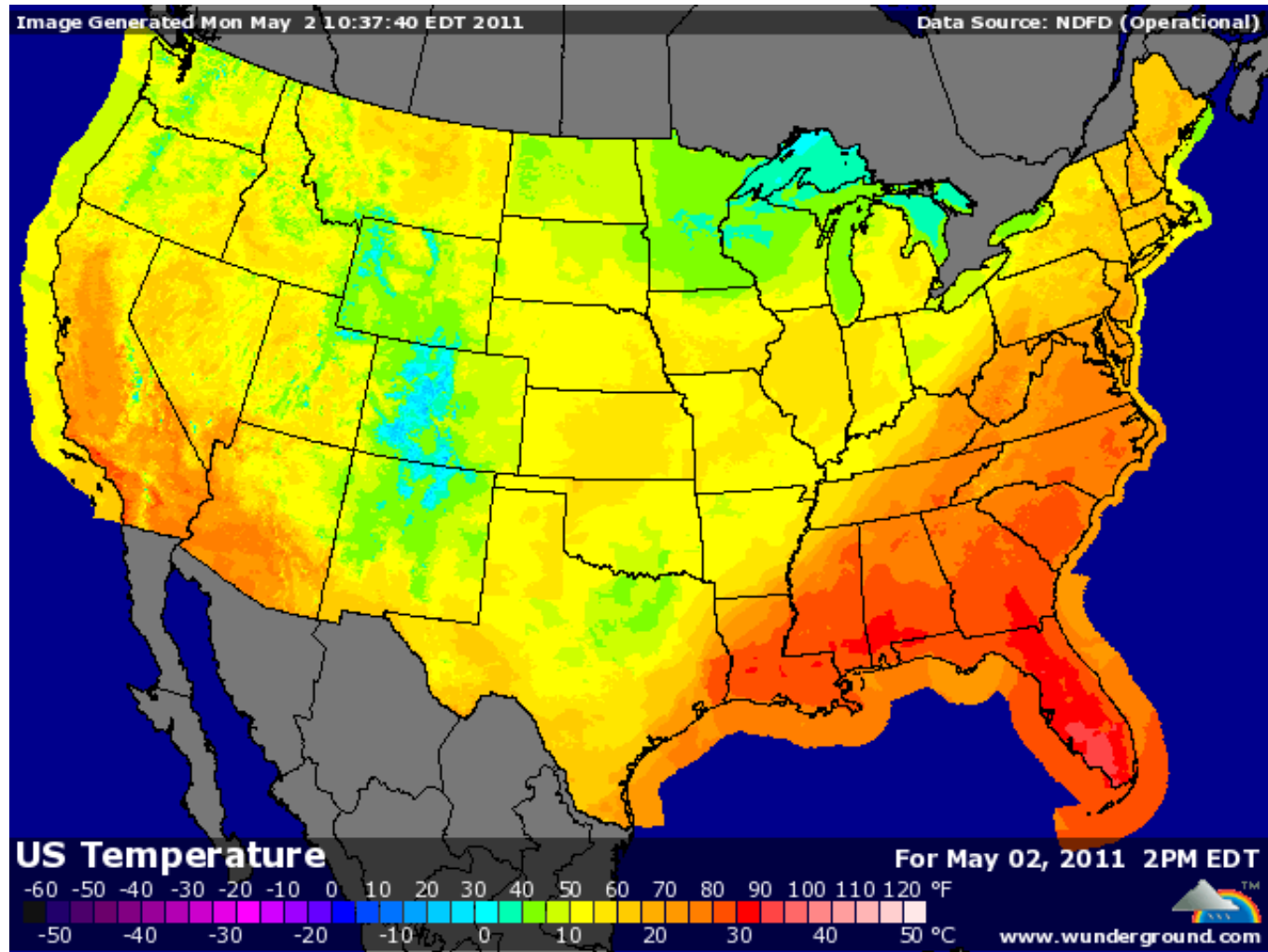
- Force Management
 - Magnitude
 - » 1° F of change = ~2,000 lbf
 - » 40° F swing (day/night) = **~40 tons**
 - Restraint
 - » Lateral
 - 50% - Crib Ballast
 - 35% - Shoulder Ballast
 - 15% - Remaining Ballast
 - » Longitudinal
 - 60% - Fastener or Anchor
 - 40% - Crib Ballast

Rail Neutral Temperature

- No tension
- No compression



Rail Neutral Temperature



Rail Neutral Temperature

- Good RNT management reduces:
 - Breaks in cold weather
 - Buckles in hot weather



Rail Neutral Temperature

- RNT Degradation
 - Seasonal Thermal Cycles
 - Track Maintenance
 - Train Traffic



Rail Neutral Temperature



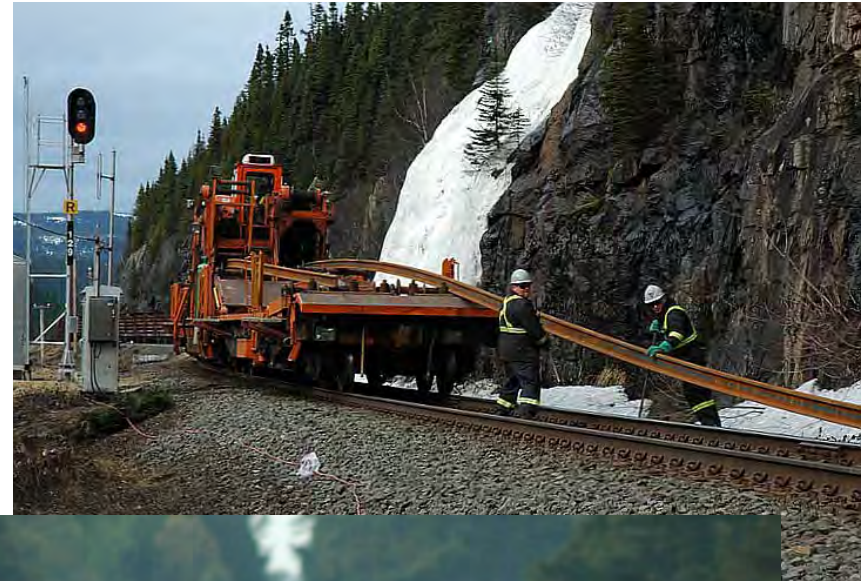
Rail Neutral Temperature

- RNT is very important
 - Break prevention
 - **Buckle prevention**
- How do you measure it?
 - Several methods
 - VERSE® method



Measurement Methods

- “Rail Added” Accounting
 - Actual Laying Temperature
 - Traffic and Other Maintenance factors?
- “Eyeball”
 - Qualitative and Subjective
 - Experience based
- Cut-and-measure
 - Introduces a new field weld
 - Expensive
 - Accuracy?



Measurement Methods

- Strain Gauge
 - Accurate
 - Research vs. Production
- Magnetic Field
 - Rail Reference Library
 - Non-destructive
- VERSE
 - Non-destructive
 - Accurate



VERSE Overview

- VERSE stands for **Vertical Rail Stiffness Equipment**
- Non-destructive
- Rail Force-Displacement Relationship
- Accurate
- Repeatable
- In use by many transits and freight railroads
 - Washington Metro
 - DART
 - Class 1's
 - ~21 VERSE machines in North America

Method and Operation

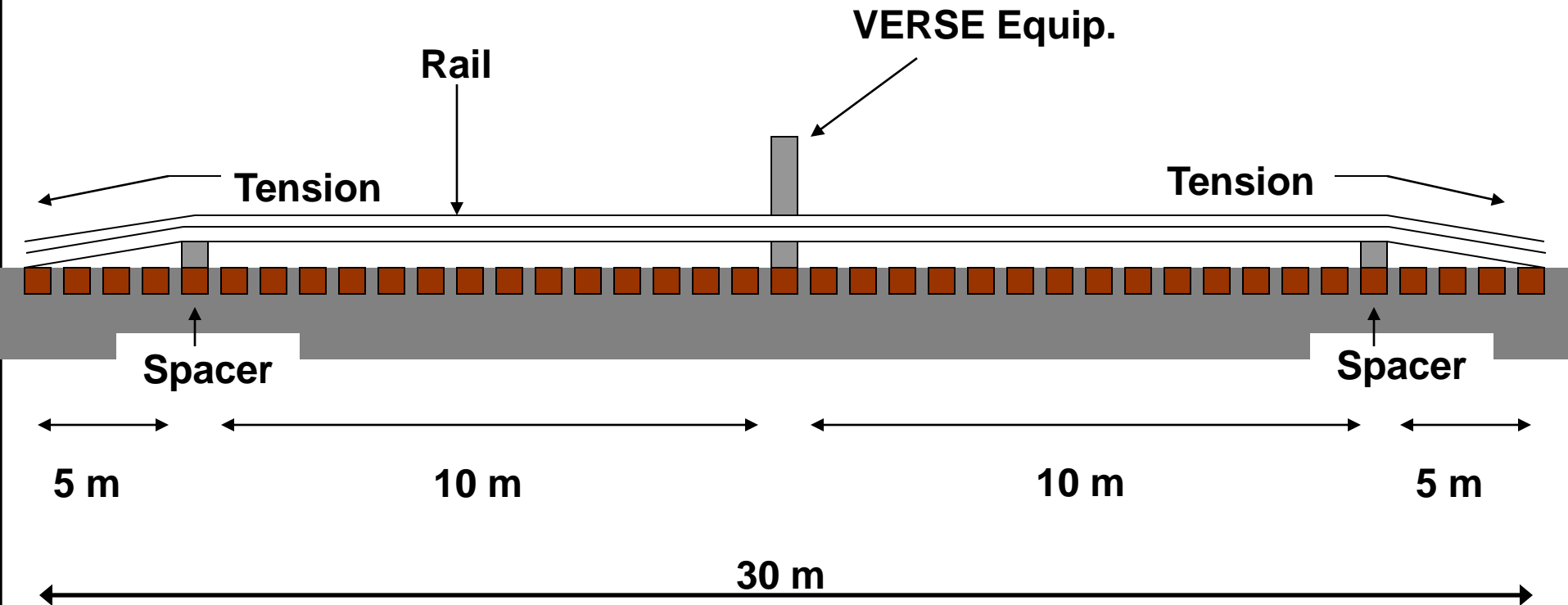
- Beam in tension (think: Guitar string)
- Vertical force-displacement relationship is related to tension in rail.
- Tension in rail and actual rail temperature are related to the RNT.



Method and Operation

- Site Layout
- Rail Measurement
- Unclip / Unspike
- Lift onto blocks
- Perform three lifts (averaging)
- Computed RNT
- Store in database

Method and Operation



Method and Operation

- Rail Measurement
 - Type / Weight
 - Height (Head Loss)
 - Temperature



Method and Operation

- Unclip / Unspike
- Lift Blocks



Method and Operation

- Perform three lifts
- Handheld computer will calculate RNT
- Site layout to release of track requires approximately 1 hour for both rails.



Method and Operation

- VERSE Test Requirements
 - 30 m clearance from joints, turnouts, etc
 - Rail in tension
 - Track crew with 4 laborers
 - Hydraulic tools (on track w/ wood ties and cut spikes)
 - Sufficient track time



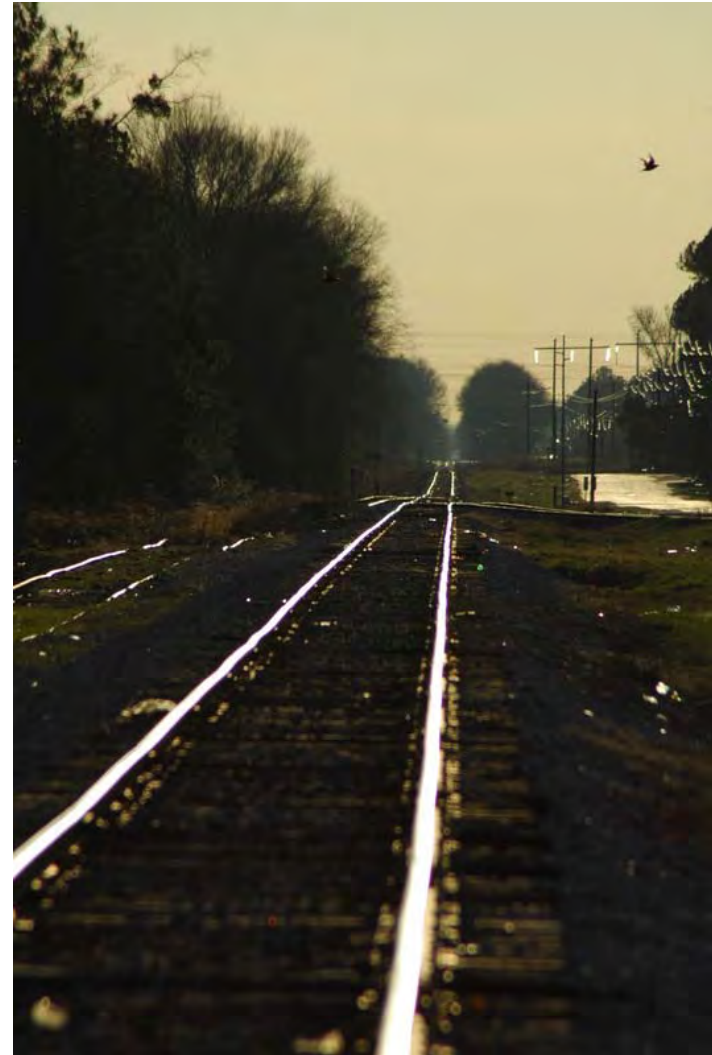
Observations

- Left/Right Rail RNT Differential
 - Usually near welds / plug rails
 - Recordkeeping of rail added not up to date
- Track Features
 - Turnouts
 - Bridge Approaches
 - Crossings
 - Crests (High RNT's)



Observations

- Ballast
 - Insufficient shoulders
 - Ballast voids
- Track Work
 - Timbering
 - Welding
 - Surfacing
 - Undercutting



Accuracy

- The VERSE method has been tested at the following railway technical test centers:
 - TTCI – Pueblo, CO, USA
 - VUZ – Prague, Czech.
 - AEA – Derby, England

Accuracy

- Free rail was instrumented with strain gauges
- Rail was pulled to a known load (tensor equipment shown on right)
- VERSE tests performed at middle of stressed rail.



Accuracy

- Measurement Accuracy
 - Temperature – 1 deg = 1.0° F
 - Rail Height – 1 mm = 1.1° F
 - Inner Span – 10 cm = 3.0° F
 - Total Span – 10 cm = 0.4° F

Accuracy

- Strain gauges were used as the control.
- Temperature fluctuations were accounted for.
- Test conditions encompassed RNT values between approximately 60° F and 150° F.
- VERSE calculated RNT values were within:
 - 2.5° F at TTCI
 - 1.8° F at AEA
 - 2.7° F at VUZ

Benefits

- A single track buckle derailment on a freight railway can easily exceed \$1M USD, just in FRA reportable costs.
- Track buckle derailments with passenger trains can have a much greater cost, both human and financial.
- VERSE testing at night (lower rail temps) accommodates commuter schedules.
- Rail neutral temperature testing can be viewed as an insurance policy against track buckles that may result in costly derailments.
- Non-destructive RNT testing is becoming a requirement on transit lines for post-construction RNT verification.

Questions and Answers

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