FRA Implementation of National Rail Temperature Predictions

— Presented by —
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Rail Temperature and Track Buckling
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Rail Temperature Approximation Using Air Temperature

Add offset to maximum predicted air temperature (30°F or 25°F)

In reality, the offset is not a constant; using a single constant can lead to errors
Previous Work and Publications

Rail temperature prediction principles and model development:


Previous Work and Publications

Model validation and application:


• Radim Bruzek, Michael Trosino, Robert Wilson, and Leith Al-Nazer. Implementation of Rail Temperature Predictions on Amtrak. AREMA 2016 Annual Conference.
Technical Fundamentals of the Model

Based on heat transfer principles

- Radiation energy from sun
- Energy emitted via convection
- Energy emitted via radiation
- Energy emitted / absorbed via conduction

*(Negligible contribution, not considered by the model)*
Technical Fundamentals of the Model

- Heat transfer equation

\[ k \alpha_s A_s G_s \cos(\theta) - \left[ h_{\text{conv}} A_c (T_r - T_\infty) + \varepsilon \sigma A_r \left( T_r^4 - T_{\text{sky}}^4 \right) \right] = \rho c V \frac{dT_r}{dt} \]

- Qualitative explanation of equation

\[
\left( \text{Energy Absorbed} \right)_{\text{Via Solar Radiation}} - \left[ \left( \text{Energy Emitted} \right)_{\text{Via Convection}} + \left( \text{Energy Emitted} \right)_{\text{Via Sky Radiation}} \right] = \left( \text{Rate of Change} \right)_{\text{of Rail Temperature}}
\]
ENSCO Implementation

Uses forecast data from ENSCO Aerospace Division’s in-house weather model and material rail properties as inputs

- Air temperature
- Intensity of solar radiation
- Solar angle
- Wind speed
- Sky temperature
- Heat absorptivity of rail
- Heat emissivity of rail
ENSCO Implementation

• Predictions are continuous and granular
  • 9x9 km grids
  • 30-minute time increments
  • 36 hours ahead
• This implementation was validated in cooperation with CSX, Amtrak, and BNSF
  • Over 160,000 hours of wayside measurements
  • On average within 5° F accuracy
• Other implementations are possible with proper validation
Web-Mobile Application

FRA sponsored development of application to allow users access predicted rail temperatures

• Nationwide current, min, and max rail temperatures, 36 hours ahead
• 7-day rail temperature history
• Estimation of track buckling risk
Web-Mobile Application Demo

Functionalities to be demonstrated:

• Login
• Map screen
  • Information and user control ribbon
  • GPS tracking toggle
  • Color coding
  • Selected grid displays summary information
  • Search by city
• User Settings and Help ribbon
• Individual grid id detailed information
• Buckling estimation
Temporary Web-Mobile Application Access

Guest credentials for AREMA conference
Valid through October 31, 2019

Username: aremauser

Password: arema2019
Application for FRA and Railroad Industry

• More effective slow order management
• Derailment investigation
• Better planning for track and heat inspections
• Assistance with CWR procedures
• Better awareness of rail temperature for track personnel in real time
Next Steps

- Upgrade application to include **calculated rail adjustment values** based on Dr. Kish’s methodology
Thank you. Questions?

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