Creating Value ...

Railroad Engineering 101
Session 38
Tuesday, February 19, 2013

Presented by: David Wilcock
Railroad Engineering 101

- **Outline**
  - Overview of the Railroad
  - Track
  - Bridges
  - Signal Systems
  - Railroad Operations
  - Federal Railroad Administration
  - American Railway Engineering and Maintenance Association
Railroad Engineering 101

- Overview of the Railroad
  - Classifications (Types)
    - Private
    - Common Carrier
  - Classifications (Function)
    - Line Haul
    - Switching
    - Belt Line
    - Terminal
Overview of the Railroad

Classifications (Operating Revenues)
- Class 1: $250 M or more
- Class 2: $20.5 M - $249.9 M
- Class 3: Less than $20 M

Classifications (Association of American Railroads Types)
- Class I: $250 M or more
- Regional: 350 miles or more; $40 M or more
- Local
- Switching and Terminal
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- Overview of the Railroad
  - Class 1 Railroads – North America
    - BNSF
    - Canadian National
    - Canadian Pacific
    - CSX
    - Ferromex
    - Kansas City Southern
    - KCS de Mexico
    - Norfolk Southern
    - Union Pacific
    - Amtrak
    - VIA Rail
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- **Overview of the Railroad**
  - **Organization of a Railroad**
    - Transportation
      » Train & Engine Crews
      » Dispatching
      » Operations
    - Engineering
      » All Right of Way Engineering
    - Mechanical
      » Equipment Maintenance
  - Marketing
Overview of the Railroad

Equipment - Locomotives

- All Units rated by Horsepower
- Horsepower is converted to Tractive Effort to propel locomotive
- Types:
  » Electric – Pantograph trolley or third rail shoe
  » Diesel-Electric – self contained electric power plant
  » Dual Mode – Can use either electric or diesel
Overview of the Railroad

- Equipment - Freight Cars
  - Boxcar
  - Flatcar
  - Gondola
  - Covered Hopper
  - Coal Hopper
  - Tank Car
  - Auto Racks
  - Container “Tubs or Boats”
● Overview of the Railroad

● **Resistance**
  – Resistance is important especially for freight operations as they are dealing with heavy loads. Types include:
    » Internal (Locomotive)
    » Axle Loading - Bearing
    » Flange
    » Air
    » Track Modulus (Rigidity of track structure)
    » Wind
    » External Axle Load
    » Curve
    » Grade
    » Acceleration
    » Starting/Inertia
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- Track
  - Loads
  - Rail
  - Crossties
  - Other Track Materials
  - Ballast
  - Sub-ballast
  - Typical Track Section
  - Roadway
  - Special Trackwork
  - Geometry
  - Track Charts
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- Track Structure - Loads
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- **Track – Rail**
  - **Lengths**
    - 39 foot Sections (Jointed Rail)
    - Continuously Welded (CWR)
  - **Section**
    - Pattern design or cross-sectional shape
    - Standard Sections:
      - RE: American Railroad Engineering Association
      - ARA: American Railway Association
      - ASCE: American Society of Civil Engineers
  - **Weight**
    - Pounds per Yard
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- **Track – Rail**

<table>
<thead>
<tr>
<th>Section</th>
<th>Weight Per Yard (lb)</th>
<th>Area (sq in)</th>
<th>Height (in)</th>
<th>Base Width (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>90 RA</td>
<td>90.0</td>
<td>8.8</td>
<td>5 5/8</td>
<td>5 1/8</td>
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<tr>
<td>115 RE</td>
<td>114.7</td>
<td>11.3</td>
<td>6 5/8</td>
<td>5 1/2</td>
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<tr>
<td>132 RE</td>
<td>132.1</td>
<td>13.0</td>
<td>7 1/8</td>
<td>6</td>
</tr>
<tr>
<td>155 PS</td>
<td>155.0</td>
<td>15.2</td>
<td>8</td>
<td>6 3/4</td>
</tr>
</tbody>
</table>

**HOT STAMP**

<table>
<thead>
<tr>
<th>Weight Per Yard (lb)</th>
<th>Rail Section</th>
<th>Cooling</th>
<th>Mfg</th>
<th>Plant</th>
<th>Year Rolled</th>
<th>Month Rolled</th>
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</thead>
<tbody>
<tr>
<td>132</td>
<td>RE</td>
<td>CC</td>
<td>BSCO</td>
<td>STEELTON</td>
<td>1961</td>
<td>I I I I I I</td>
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</table>
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- **Track – Crossties**
  - **Materials**
    - Wood
    - Concrete
  - **Functions**
    - Hold gage and line of rail
    - Transmit train weight from rail to ballast
    - Distributes train weight
    - Provide a base to anchor rail
    - Provide support to distribute load maintaining more uniform cross level of rails
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- **Track – Crossties**
  - **Dimensions**
    - Wood: 7” x 9” x 8’-6”; 200 lb
    - Concrete: 8’-6”; 600 lb
  - **Spacing**
    - Wood Ties: 19” Main Line, 24” Light Traffic Lines
    - Concrete: 24”
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- Track – Other Track Materials
  - Joint Bars and Bolts
    - Standard Joint
    - Compromise Joint
    - Insulated Joint
  - Tie Plates
  - Track Spikes
  - Concrete Tie Fastenings
  - Tie Plugs
  - Rail Anchors
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- Track – Ballast
  - **Function**
    - Support
    - Distribution of Load
    - Stability
    - Drainage
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- Track – Typical Track Section
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- Track – Roadway
- Right of Way - Valuation Plans
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- **Track – Roadway**
  - **Grade**
    - Generally as flat as possible: 2.5 to 3% is the general “rule of thumb” for maximum main line grades
    - Compensated Grades: adjust for horizontal curve and/or stopping on grade (.03 to .05% reduction in grade/degree of curve)
    - Ruling Grade: Limiting grade on a route
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- Track – Roadway
- Clearances
Track – Roadway

- Gage
  - Standard gage: 4’-8 ½”
  - Minimum Allowable: 4’-8”
  - Gage Variance: 4’-8” to 4’-9 ¾ “ depending on class of track and tangent vs. curved track
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- **Track – Roadway**
  - **Grade Crossings**
    - Types:
      » Paved
      » Timber
      » Concrete Panel
      » Rubber Panel
    - Key Elements:
      » Flangeway
      » Good Drainage
- **Track – Special Trackwork**
  - **Turnouts**
    - Designated by Frog size
    - Preference is to orient turnout in trailing point position; train passes over frog before passing point of switch

<table>
<thead>
<tr>
<th>Frog No.</th>
<th>6</th>
<th>8</th>
<th>10</th>
<th>15</th>
<th>20</th>
<th>26.5</th>
<th>32.75</th>
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<tbody>
<tr>
<td>Maximum Authorized Speed (MPH)</td>
<td>5</td>
<td>15</td>
<td>15</td>
<td>30</td>
<td>45</td>
<td>60</td>
<td>80</td>
</tr>
</tbody>
</table>
Track – Special Trackwork

- Turnouts – Frog
  - Frog No. is the ratio of its length to its width (inches)
  - A No. 8 Frog spreads 1 in 8
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- **Track – Special Trackwork**
  - **Slip Switch**
    - Used primarily in passenger terminal areas
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- **Track – Special Trackwork**
  - Slip Switch
    - Union Station, New Haven CT
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- Track – Special Trackwork
  - Bolted Rail Crossing
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- Track – Geometry
  - Railroads use chord definition for degree of curve
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- Track – Geometry
  - Superelevation
轨道路线工程 101

- 轨道 - 几何
  - 螺旋过渡 - 用于平缓进入曲线和超高
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- Track – Track Charts
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- Bridges
  - Many types of rail bridges:
    - Movable:
      » Bascule
      » Swing Span
      » Lift Span
    - Fixed:
      » Through Truss
      » Through Girder
      » Plate Girder
      » Deck Girder
Bridges

- **Four types of bridge decks:**
  - **Open Deck**
    - Less costly to maintain; free draining; lighter
    - Inability to adjust line/grade w/o replacing timbers
  - **Ballasted Deck**
    - Easy to adjust line/grade; conventional ties; better ride quality
    - Heavier dead load; more costly to const; retain moisture
  - **Trough Floor**
  - **Direct Fixation**
    - Only used on open deck steel bridges
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- Bridges
  - Open Deck Timber Dapping
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- **Signal Systems**
  - Used to provide for the safe and efficient movement of trains
  - **Types of Controls:**
    - Train Orders
    - Manual Block
    - Automatic Block
    - Automatic Train Control
    - Centralized Traffic Control
Signal Systems

- Automatic Block Signals
  - Track is divided up into blocks
  - block length based on maximum train length and safe braking distance
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- Rail Operations
  - Main Line Operations
    - Freight Rail
      » Longer, heavier, slower trains
    - Passenger Rail
      » Shorter, lighter, faster trains
  - Yards and Terminals
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- Federal Railroad Administration
  - Railroad Safety
    - Track Safety Standards
    - Work Force Rules
    - Grade Crossing Safety
    - Trespass Prevention
  - Rail Network Development
    - High Speed Rail
    - Freight Rail
  - Research & Development
    - Track
    - Rolling Stock
  - Grants & Loans
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- American Railway Engineering and Maintenance Association
  - Manual for Railway Engineering
    - Recommended Practices for:
      » Track
      » Structures
      » Infrastructure and Passenger
      » Systems Management