Ch. 3 – *The Track*
Alignment
- Tangents
- Curves
- Spiral
- Cross Level
- Superelevation
- **Gauge (Gage)**
  - 56.5”
  - 4’8.5”
Track Structure

- Subgrade
- Subballast
- Ballast
- Ties
- Rail
- Fasteners
- OTM
Track Structure

- Typical main-line track
Track-Wheel Relationships

(Dimensions shown are nominal)
Loading of Track Structure

- 3 Types of Loading
- Vertical
- Axial
- Longitudinal
Static Wheel Loads

(Wheel Load)(# of wheels) = Gross Weight of Car

<table>
<thead>
<tr>
<th>Axle Load (tons)</th>
<th>Gross Weight of Cars (lbs)</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>80,000</td>
<td>Light rail transit</td>
</tr>
<tr>
<td>15</td>
<td>120,000</td>
<td>Heavy rail transit</td>
</tr>
<tr>
<td>25</td>
<td>200,000</td>
<td>Passenger Cars</td>
</tr>
<tr>
<td>25</td>
<td>200,000</td>
<td>Common European freight limit</td>
</tr>
<tr>
<td>27.5</td>
<td>220,000</td>
<td>U.K. and Select European limit</td>
</tr>
<tr>
<td>33</td>
<td>263,000</td>
<td>North American free interchange limit</td>
</tr>
<tr>
<td>36</td>
<td>286,000</td>
<td>Current Heavy Axle load weight for North American Class 1</td>
</tr>
<tr>
<td>39</td>
<td>315,000</td>
<td>Very limited use; research phase</td>
</tr>
</tbody>
</table>

Wheel-Rail Contact Stress ~ 100,000 psi
Rail Bending Stress* < 25,000 psi
Tie Bearing Stress* < 200 psi
Ballast Bearing Stress* < 85 psi
Subgrade Bearing Stress* < 20 psi
Basics of freight railcar weight and capacity

- The nominal capacity of a typical, 4-axle railcar today is 110 tons (formerly was 100 ton)
- Maximum Gross Rail Load (GRL) of a 110 ton, 4-axle railcar is 286,000 lbs. (weight of car + contents or “lading”)
- Nominal capacity = 220,000 lbs. or 110 tons
- Often referred to as a “110 ton” car or a “286K” car

Load or “lading”

Nominal capacity approx. 220,000 lbs. = 110 tons

Light weight or “tare” approx. 66,000 lbs. = 33 tons

Carbodies

Trucks or "bogies"

220,000 lbs. + 66,000 lbs. = 286,000 lbs.

Gross Rail Load (GRL)

(actual light weight will vary somewhat depending on car size, consequently the weight-carrying capacity will vary inversely, i.e. lighter car larger capacity)
Freight train size & gross tonnage

- Typical freight train is about 100 cars (generally range from 50 to 150 cars)
- $100 \times 110 = 11,000$ tons of lading
- GRL = 286,000 lbs.
- $100 \times 286,000$ lbs. = 28,600,000 lbs = 14,300 gross tons
- Plus the weight of two locomotives, ca. 300,000 lbs each = 150 tons each
  = $14,300 + 2 \times 150 = 14,600$ gross tons per train
- One train per day for a year = $14,600$ tons $\times$ 365 = 5,329,000 tons
  = 5.329 million gross tons (MGT)
- One train moving 100 miles equals = $14,600$ tons $\times$ 100 miles
  = 1,460,000 gross ton-miles (GTM)
- Rail
  - Inverted “T”
  - Life
  - Defects
  - Lubricators
  - Grinding
  - Bolted/CWR
CWR Installation

Consider a single piece of steel rail 1,500 ft long, initially at a temperature of 100°F:

When the temperature falls to 0°F, the rail will contract 0.06%, or almost a foot in length:

But steel is elastic; a stress of 19,000 psi will cause it to stretch 0.06%, regaining its original length, in the process it gets correspondingly smaller in cross section, or about 0.03% lower and narrower.

The cross-sectional area of 132 lb/yard rail is 13 sq. inches, so if the rail is restrained so as to develop lengthwise tension of about 250,000 lb (13 x 19,000), it will remain the same length despite the 100°F temperature change. In effect, the shrinkage is forced to occur in the cross section rather than in the length; it amounts to about 0.002 of an inch a rail 6 inches wide.

Since rail steel can withstand at least 75,000 psi without permanent deformation, all normal temperature variations can be accommodated within its elastic range. If laid at a temperature near the upper end of the range in the area, the rails will be in tension (tending to straighten rather than buckling the track) at all times when the temperature is lower.
- Crossties
  - Wood
  - Concrete
  - Others
Fasteners
- Ballast
- Subballast
- Subgrade
Special Trackworks

- Turnouts
- Crossings
- Crossovers
Trackwork

**Crossovers**
A crossover is a pair of turnouts connecting two parallel tracks.

- **Trailing-point**
- **Normal direction of traffic**
- **Facing-point**

(Shown in "normal" position)
(Shown in "reversed" position)

**Crossings**
A crossing carries one track across another.

- **Rigid**
- **Moveable-point**
  (angle of intersection less than 8°)

**Double Slip Switch**
Shown in position connecting (B) and (D).

- (A)
- (B)
- (C)
- (D)

The double slip, used only where space is limited, combines the functions of a crossing and turnouts to allow any one of four routings.

**Ladder**
A ladder track is a series of turnouts providing access to any of several parallel yard tracks.
The Turnout (Left-Handed)

<table>
<thead>
<tr>
<th>Frog No.</th>
<th>Turnout Lead, Ft</th>
<th>Sharpness of Curve</th>
<th>Max. speed on Diverging Route</th>
<th>Typical Locations</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>48</td>
<td>21°</td>
<td>10 mph</td>
<td>Industry tracks</td>
</tr>
<tr>
<td>8</td>
<td>67</td>
<td>12°</td>
<td>15</td>
<td>Yards</td>
</tr>
<tr>
<td>12</td>
<td>97</td>
<td>5°</td>
<td>25</td>
<td>Low-speed crossovers</td>
</tr>
<tr>
<td>16</td>
<td>131</td>
<td>3°</td>
<td>30</td>
<td>Passing tracks</td>
</tr>
<tr>
<td>20</td>
<td>152</td>
<td>1 1/2°</td>
<td>45</td>
<td>Junctions, end of double track</td>
</tr>
</tbody>
</table>
Track Maintenance Standards

- Tie
- Rail
- Surface
- Drainage
- Bridges
  - Open or ballast deck
  - Deck or through
FRA Standards

Track Safety Standards
Part 213

§ 213.9 Classes of track: operating speed limits.

(a) Except as provided in paragraph (b) of this section and §§ 213.37(b), 213.59(a), 213.113(a), and 213.137(b) and (c), the following maximum allowable operating speeds apply—

<table>
<thead>
<tr>
<th>Subpart A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Over track that meets all of the requirements prescribed in this part for—</td>
</tr>
<tr>
<td>Exception track</td>
</tr>
<tr>
<td>Class 1 track</td>
</tr>
<tr>
<td>Class 2 track</td>
</tr>
<tr>
<td>Class 3 track</td>
</tr>
<tr>
<td>Class 4 track</td>
</tr>
<tr>
<td>Class 5 track</td>
</tr>
</tbody>
</table>

(b) If a segment of track does not meet all of the requirements for its intended class, it is reclassified to the next lowest class of track for which it does meet all of the requirements of this part. However, if the segment of track does not at least meet the requirements for Class 1 track, operations may continue at Class 1 speeds for a period of not more than 30 days without bringing the track into compliance, under the authority of a person designated under § 213.7(a), who has at least one year of supervisory experience in railroad track maintenance, after that person determines that operations may safely continue and subject to any limiting conditions specified by such person.

§ 213.307 Class of track: operating speed limits.

(a) Except as provided in paragraph (b) of this section and §§ 213.329, 213.337(a) and 213.345(c), the following maximum allowable operating speeds apply:

<table>
<thead>
<tr>
<th>Subpart C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Over track that meets all of the requirements prescribed in this subpart for—</td>
</tr>
<tr>
<td>Class 6 track</td>
</tr>
<tr>
<td>Class 7 track</td>
</tr>
<tr>
<td>Class 8 track</td>
</tr>
<tr>
<td>Class 9 track</td>
</tr>
</tbody>
</table>

1 Freight may be transported at passenger train speeds if the following conditions are met:

(1) The vehicles utilized to carry such freight are of equal dynamic performance and have been qualified in accordance with Sections 213.345 and 213.329(o) of this subpart.

(2) The load distribution and securement in the freight vehicle will not adversely affect the dynamic performance of the vehicle. The axle loading pattern is uniform and does not exceed the passenger locomotive axle loadings utilized in passenger service operating at the same maximum speed.

(3) No carrier may accept or transport a hazardous material, as defined at 49 CFR 171.8, except as provided in Column 9A of the Hazardous Materials Table (49 CFR 172.101) for movement in the same train as a passenger-carrying vehicle or in Column 9B of the Table for movement in a train with no passenger-carrying vehicles.

2 Operating speeds in excess of 150 m.p.h. are authorized by this part only in conjunction with a rule of particular applicability addressing other safety issues presented by the system.

(b) If a segment of track does not meet all of the requirements for its intended class, it is to be reclassified to the next lower class of track for which it does meet all of the requirements of this
Testing (FAST)
New Developments…

- Improve turnouts to reduce maintenance costs
- Develop new inspection devices
- Continuous-action track machines