Upgrading Rail Lines for Higher Speeds

Railroad Infrastructure Diagnosis and Prognosis

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RAIL TEAM

HNTB

Upgrading Rail Lines for Higher Speeds – A Perspective

- True High Speed Rail almost always require new rights-of-way
  - Can use existing terminals
  - Sometimes uses existing regional lines to enter metropolitan areas
- The railway network in the United States was once densely built with almost 230,000 miles of line in 1929
- The size of the freight network has declined to just over half that amount
- In the transition
  - Mileage was transferred to public ownership, primarily for passenger service
  - Freight lines see less traffic as carriers focus tonnage on fewer line
  - Mileage was also transferred to regional carriers
  - On some routes, the number of tracks has been reduced

Upgrading Rail Lines for Higher Speeds – A Perspective

- The changes in the freight rail network open opportunities for improving intercity passenger services
  - On lines where passenger service (usually commuter) is already the focus
  - On lines where freight operations are at low enough levels enabling the two service types to co-exist
- For intercity passenger services to be successful, higher speeds are required than traditionally operated, usually 90 to 110 MPH
  - Many of the legacy lines once operated passenger service at 70 to 80 MPH
  - Capital improvements for higher service levels often benefit existing users
- In the United States, there has been a general reluctance to go through the process of building all-new HSR
- Higher speed lines can still fill an important service role

Upgrading Rail Lines for Higher Speeds – A Perspective

- Today's focus is on the roadbed, including:
  - Line characteristics
  - Track Center Impacts on Roadbed
  - Obstacles to Good Roadbed Design
  - Tools for Getting the Most out of the Roadbed

Focus on Roadbed

- Why focus on roadbed?
- The alignment and roadbed have a 100% correspondence
  - The alignment of the line controls performance
    - Geometry
      - Curvature
      - Spirals
    - Surrounds
      - Towns
      - Adjacent land owners
      - Streams/rivers/ponds/lakes/wetlands
    - Highways
      - Grade crossings
      - Overhead, undergrade and parallel

Focus on Roadbed

- Any changes to try and boost performance will likely involve roadbed modifications which can mean modifications or impacts to surrounds
- Making roadbed changes first impacts the railroad right-of-way
  - In the east, rights-of-way are typically narrow and sell-offs from the bankruptcies of the 60s and 70s are common
  - In the midwest and west the width of the rights-of-way may be more generous
  - Even if the right-of-way is generous, it will have impediments to development
    - Wetlands
    - Endangered species
    - Vegetation, including old growth trees

Focus on Roadbed

- There is a big difference in the way highway engineers view right-of-way versus railroad engineers
- Highway projects are typically designed, pass through environmental review, funded then constructed
- Often railway projects develop in a way that time is of the essence

“The bridge is in the way of wider a road? No problem, we’ll just build a new bridge!”

Line Characteristics

- First step is to decide what the track schematic needs to be to support the service levels
  - Number of main and passing tracks
  - Number of interlockings
  - Station locations
  - Operating speeds
    - Generally, 110 MPH maximum due to highway grade crossings
    - New diesels may be able to make 125 MPH in the future with no crossings
    - Electrification is rare in these cases, but can accommodate any speed
- Overlay that on existing schematic
- The comparison from this overlay immediately identifies areas of work

Line Characteristics

- The existing will provide a base case of running time
- Take existing alignment and see what can be obtained
  - Performance of proposed rolling stock is important
    - Cant deficiency
    - Performance
      - Rate of acceleration
      - Braking rates
  - Existing curvature, with perhaps minor spiral adjustments
  - Elevation maximized to spirals available

Line Characteristics

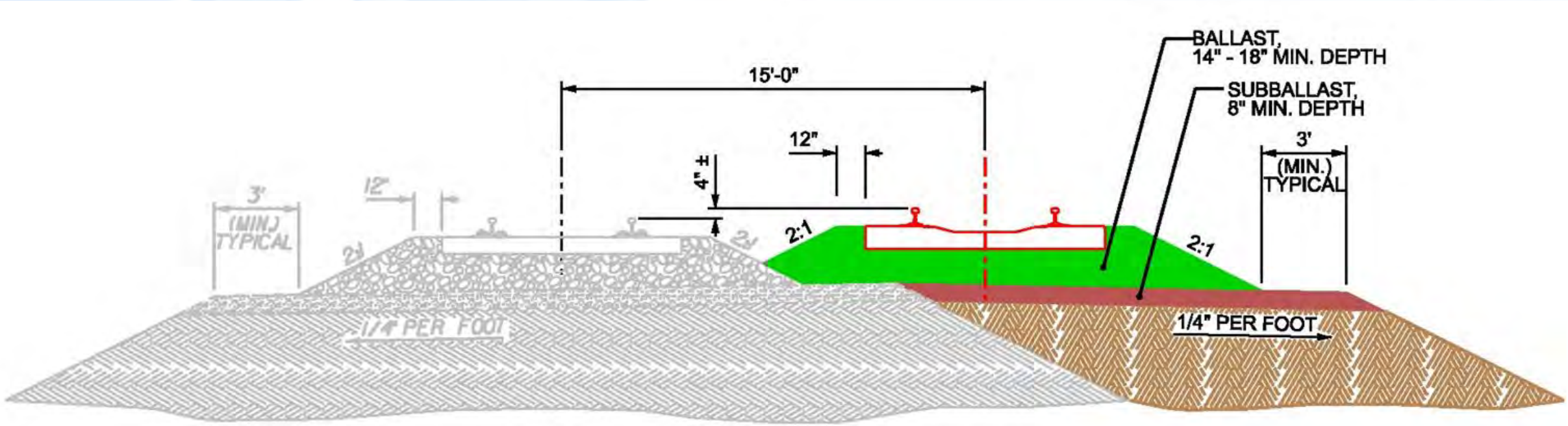
- Next follows an iterative process similar to value engineering
  - What improvements in alignment are possible?
    - Move curves to increase radius
    - Lengthen spirals
    - Improve civil speed restrictions
  - Look hard at improvements close to station stops where higher speeds are impacted by braking and accelerating
  - Look hard at curve speeds if speeds on adjacent curves cannot match
  - Look hard at improvements around civil restrictions that cannot be removed
- At the end of this process, the required improvements from the new schematic can be combined with recommended list of upgrades to complete the scope of work

Track Center Impact on Roadbed

- Elevated curve on along Hudson River, New York Central Railroad four-track main line showing ballast section associated with jointed rail. August 1941 photo date.

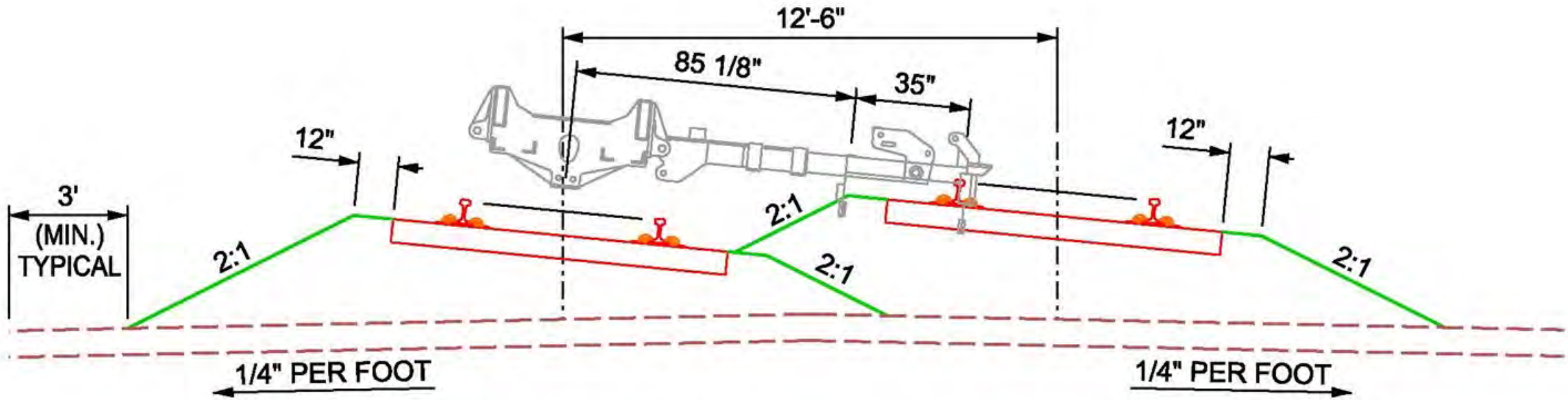
Photo by Edward L. May, from collection of Richard Stoving

Track Center Impact on Roadbed



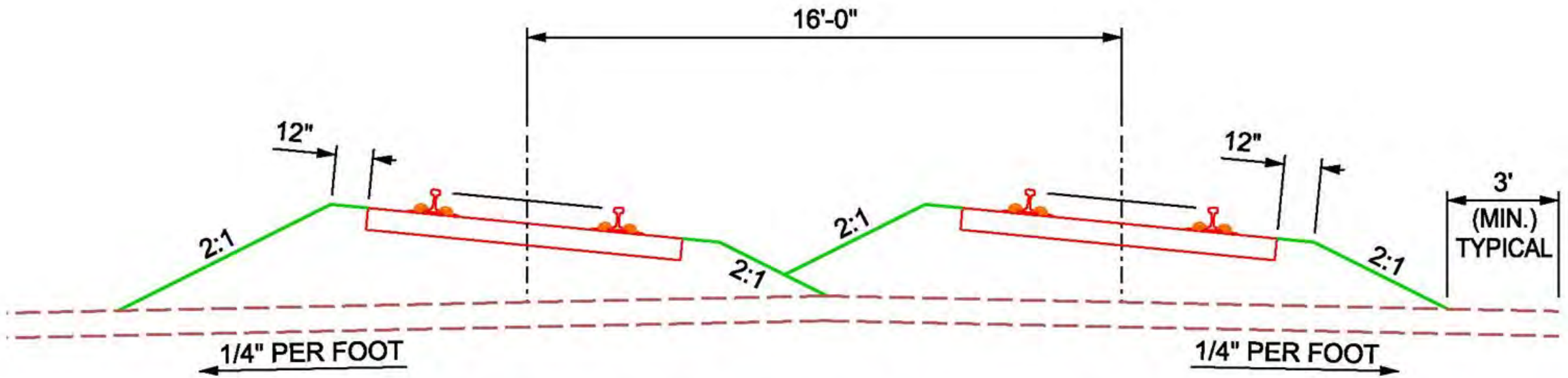
2 MAIN TRACKS - ON TANGENT
15'-0" TRACK CENTERS

Track Center Impact on Roadbed



2 MAIN TRACKS - 5 1/2" SUPERELEVATION
12'-6" TRACK CENTERS - (6" HIGHER)

Track Center Impact on Roadbed



2 MAIN TRACKS - 5 1/2" SUPERELEVATION
16'-0" TRACK CENTERS

Obstacles to Good Roadbed Design

- Here is a happy place, room to widen track centers, room to enhance drainage

Obstacles to Good Roadbed Design

- Old obstacle, but historical none-the-less. Had to be documented before removal

Obstacles to Good Roadbed Design

- Private road crossing on a curve needing additional elevation, leaving poor geometrics. Only access to property, required purchase.

Obstacles to Good Roadbed Design

- Insufficient roadbed width for holding shoulder and walkway, with substandard slope on fill….

Obstacles to Good Roadbed Design

- Close and overhanging vegetation will be across tracks in a storm. Not an issue if it holds up a freight train. Needs attention for passenger ops. Problem is when the tree is on adjacent property.

Obstacles to Good Roadbed Design

- Ditch filled in, not functioning. To restore flow, lower water table, provide for proper ballast section will require clearing trees, bank excavation, perhaps with retaining wall.

Obstacles to Good Roadbed Design

- Second track will require widening the fill, with inadequate slope and utility in the way

Obstacles to Good Roadbed Design

- Curve will require additional elevation, bank work will be required for adequate ballast section and walkway. Existing bank slope may be inadequate, road will be in the way of widening.

Obstacles to Good Roadbed Design

- Existing bridge cannot be replaced due to adjacent parallel highway. Superelevation limited due to inadequate clearances once second track is installed. Curve will have speed restriction

Obstacles to Good Roadbed Design

- Historic bridge seen ahead….

Obstacles to Good Roadbed Design

- Historic bridge has much larger opening than highway. Still can't be replaced. New parapet will solve part of the problem and maintain general character of the bridge.

Obstacles to Good Roadbed Design

- Interlocking required with double tracking and freight branch line junction, industrial spur….right on top of another historic arch (see handrail in distance.

  Wetlands on the left…

Obstacles to Good Roadbed Design

- Right-of-way encroachment when construction starts. Folks sometimes get unreasonable when you want your property back

Obstacles to Good Roadbed Design

- Flood prone area with roadbed width already inadequate. Flow must make a hard left turn and opening cannot be widened due to downstream impacts

Obstacles to Good Roadbed Design

- New drainage structure required for area being double tracked. Must use two levels to accommodate flows

Obstacles to Good Roadbed Design

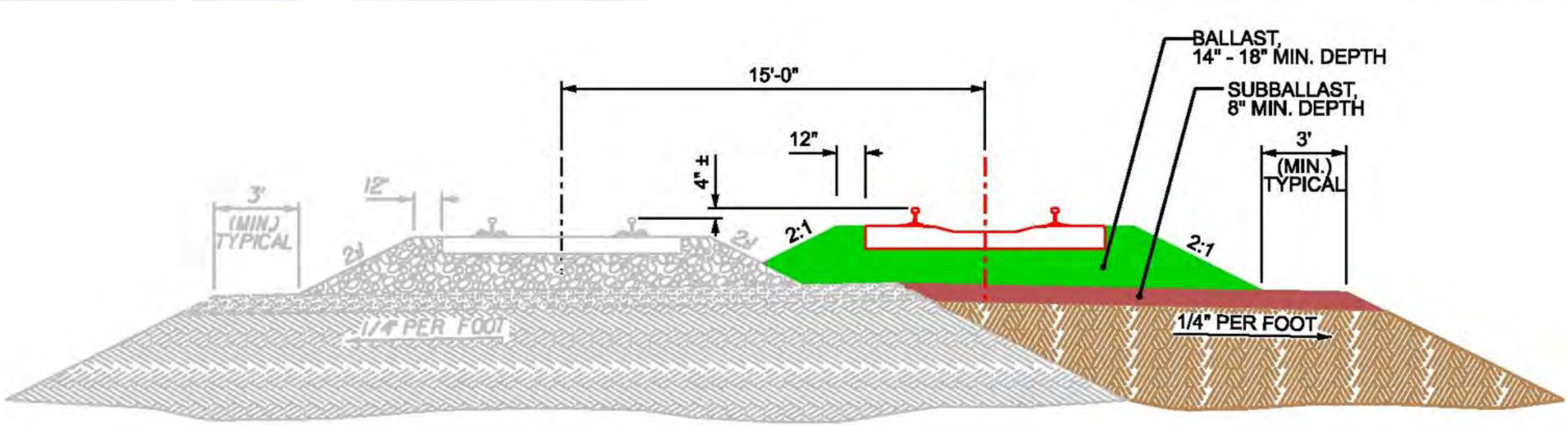
- Replacing old structures may require backwalls to be replaced/rehabilitated with existing structure remaining in service

Tools for Getting the Most out of the Roadbed

Tools for Getting the Most out of the Roadbed

- GPR
  - On existing tracks to find potential problem areas
    - Ballast pockets
    - Areas of high moisture
    - Areas of uneven subgrade
  - On old roadbed proposed for reuse, for the same reason
- Cone penetrometer – characterize strength of roadbed
  - How strong
  - Find out how far down the consolidated layer is
  - Thickness of consolidated layer
- Granular layer models to see what thickness is needed

Tools for Getting the Most out of the Roadbed



2 MAIN TRACKS - ON TANGENT
15'-0" TRACK CENTERS

Tools for Getting the Most out of the Roadbed

- Slope analyses
  - Slope requirements based on actual materials on site
  - Retaining walls where extension of fill necessary
    - Wetlands
    - Property boundaries
    - Improve inadequate slopes
  - Monitor impact on culverts
- Environmental laws sometimes prevent moving excavation off property
  - Look for areas needing to be extended
  - Look for areas where it can be wasted
  - Consider screening if it contains a high percentage of old ballast

Summary

- Getting higher speeds out of older rail lines is possible, but not easy
- Roadbeds are the key to getting those speeds
- To get higher speeds out of old roadbeds real engineering is required
  - Sometimes cookbook standards have to be challenged
  - Sometimes new technology must be employed, a de facto new standard
- The design process is iterative; value engineering approach is needed
- The rail industry, especially the passenger sector, needs to develop an approach closer to that used by the highway
  - Railways, of all types, provides public service and benefits
  - Railways take up less room than highway expansion