Understanding the Transition Behavior of Railroad Track at Level Crossings on US High Speed Rail Shared Corridors

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Outline

• Introduction
• Transition zones
• Why study grade crossings?
• Grade crossings and US high speed rail
• Summary
Introduction

Approximately 200,000 crossings in the United States
Typical Embanked Section

Ballast Sections for Single Tangent Track

Level Crossing Transition

PLAN VIEW OF PANEL WITH TIMBER TIES

- 9'-0" LONG WOOD TIE
- (5) TRANSITION TIES
- INSTALL 3/4" X 12" LG. TORX HEAD LAG SCREWS (TYP.)
- SEE STD DWG 131000 FOR REFERENCE

EDGE OF TRAVELED WAY INCLUDING SHOULDERS

EDGE OF TRAVELED WAY INCLUDING SHOULDERS

8'-6" LONG CONCRETE TIE
- (5) TRANSITION TIES

PLAN VIEW OF PANEL & JOINT WELD LOCATION W/CONCRETE TIES

- CONCRETE PAVEMENT
- 7" MIN. ASPHALTIC CONCRETE OR ASPHALT INSTALLED IN NO MORE THAN 3" LIFTS

BALLAST SECTION 12" MINIMUM BELOW TIE
- COMPACTED SUBBALLAST SECTION
- COMPACTED SUBGRADE

HIGH DENSITY AND CONCRETE TIE TRACKS

6" DIA PERFORATED METAL PIPE, PERFORATIONS TO BE PLACED NEAR FLOW LINE OF PIPE
- PLACE GEOTEXTILE AT NATURAL GROUND AND WRAP PERFORATED PIPES (SEE NOTES)

DRAIN (OPTIONAL) - SEE PIPE LAYOUT AND NOTES

Transition Zone

- A change in the structure of the roadbed
- Different stiffness and deflection behavior of track
- Examples are:
  - Embankment to bridge
  - Tunnel to embankment
  - Embankment to level crossing
- Distribution of stiffness change at transition zones

Kerr & Maroney, 1993
Why Study Transition Zones?
Why Study Transition Zones... … at Level Crossings?
Why Study Transition Zones?

- Because of the different track stiffness present in a transition zone, differential settlements occur.
- One of the areas of major deformation of track (and roadway) surface.
- The “bump” experienced on highway bridges and on passenger trains over bridges and other structures in general is the result of the differential settlement.
- May cause discomfort and possible damage to rolling stock.
- Transition zones are more challenging to maintain compared to other sections of roadway and railroads.
- Over $200 million per year spent on maintenance of transition zones by railroads.
Relevant Work on Transition Zones

• Bridge approaches and culverts are the substructures that have received much of the attention when studying the behavior of track at such transitions

• Some attention has been given to special trackwork (e.g. turnouts, crossings, diamonds)

• However, little relevant work has been devoted to understand the track behavior near a level crossing

• Le Pen et al (2014) monitored the behavior of a track over crossing in Southern England
Effect of the “Hanging Sleeper”

- The graph on the right shows the behavior of the fourth sleeper away from the level crossing being studied.
- Speed of the train: 65 mph (104 km/h)
- Circled in red the effect of the hanging sleeper

DIC: Digital Image Correlation

Le Pen et al. 2014
Possible Solutions?

- Close the crossing
- Grade separate the roadway from the railroad
- Understand the mechanisms behind the differential settlement and develop mitigating solutions to optimize the maintenance cost
- Each of the above solutions has its own consequences and challenges
Level Crossings and High(er) Speed Rail in the U.S.

- The Federal Railroad Administration defines nine classes of railroad track.
- Classes 1 through 7 are tracks with maximum authorized speeds for passenger trains up to 125 mph (201 km/h) where level crossings are permitted.
- Classes 8 and 9 (125 – 200 mph or 201 – 321 km/h) do not allow level crossings to be present.
- The majority of passenger service runs at 79 mph (127 km/h).
- Some of the passenger corridors have been upgraded to accommodate higher speed.
VISION for HIGH-SPEED RAIL in AMERICA

KEY
- **Red**: Designated High-speed Rail Corridor
- **Blue**: Northeast Corridor (NEC)
- **Gray**: Other Passenger Rail Routes

(Akaka Railroad (Juneau to Fairbanks/Kalikona) not shown.)
Chicago-St. Louis

- One of the projects funded by the Stimulus Plan in 2009
- 240 miles (385 km) of renovated track and structures
- Maximum authorized speed 110 mph (177 km/h)
- 252 level crossings present
- At project completion, maintenance of track will be at class 6
Summary

• Over 200,000 level crossings in the U.S.
• A transition zone
• Not easy to eliminate (by closure or grade separation)
• Some of the passenger corridors in the United States are being upgraded to accommodate higher speeds
• There is a need to understand the track behavior at level crossings in order to optimize the maintenance cost of them
Questions?
Thank You for Your Attention

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