A Cooperative Fast-Track Rail/Highway Crossing Renewal And Rehabilitation System

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For: Illinois Dept. of Transportation
Springfield, IL

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Goals and Attributes
Rail/Highway Crossing Management

• Cost Effective Crossing
  – Safe
  – Smooth
  – Servicable
  – Long life

• Stable and Smooth
  – No costly disruption
  – Can be skipped over

• Accomplish
  – Minimum of time
  – 4-hour train curfew
  – 8 to 12-hour highway closure

• Utilize Cooperative Approach
  – Railroad company (contractor)
  – Local highway/governmental agency
Strengthens Trackbed Support

Waterproofs Underlying Roadbed

Confines Ballast and Track
Dense-Graded Highway Base Mix
1 – 1 ½ in. Maximum Size Aggregate
Asphalt Binder +0.5% above Optimum
Low to Medium Modulus Mix, 1 - 3% Air Voids
Trackbed Materials Classifications
• Roadbed/Subgrade Moisture Contents
  – At or Near Optimum
  – Thus, HMA Mat not Trapping Moisture
  – For Design - Use Unsoaked Condition

• HMA Cores
  – No Significant Weathering or Deterioration
  – No Loss of Fatigue Life
Panel System
Premium Materials
Planning Meeting

• All Entities Must:
  – Select a date
  – Assign responsibilities
  – Share cost
Local Highway/Governmental Agency

- Public Announcements
- Traffic Control
- Asphalt Paving

Railroad Company

- Remove and Replace the Track and Crossing
Renewal Activities

Preparations

• Obtain Railroad Curfew
• Notify Public of Road Closure
• Arrange for Highway Traffic Control and Detours
• Deliver Track Panel, Ballast, Crossing Surface, and Other Track Materials
• Assemble Equipment, Labor Forces, and Miscellaneous Supplies
• Arrange for Delivery of Asphalt at Prescribed Times
• Saw Pavement Approach - 7 Feet from Rail on Both Sides
• Saw and Bolt Rails at Specified Distance Beyond Immediate Crossing Surface (Optional)
## Actual Work Items

<table>
<thead>
<tr>
<th>Time (hours)</th>
<th>Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2.0 – 2.5</strong></td>
<td>Remove existing crossing surface and track panel (panel will be longer than crossing surface)</td>
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<tr>
<td></td>
<td>Excavate trackbed material to approximately 30 in. below top-of-rail</td>
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<tr>
<td></td>
<td>Evaluate subgrade support, determine action—</td>
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<tr>
<td></td>
<td>No additional activity needed, subgrade is firm and compact</td>
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<tr>
<td></td>
<td>Compact subgrade to densify it</td>
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<tr>
<td></td>
<td>Add ballast and compact subgrade if subgrade is soft</td>
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<tr>
<td><strong>1.0 – 1.5</strong></td>
<td>Dump, spread, and compact 6 to 8 in. of asphalt underlayment</td>
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<tr>
<td></td>
<td>Dump, spread, and compact 8 to 10 in. of ballast to grade</td>
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<tr>
<td></td>
<td>Position new track panel on compacted ballast and bolt or weld joints</td>
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<tr>
<td></td>
<td><strong>Railroad Open</strong></td>
</tr>
<tr>
<td>Time Range</td>
<td>Actual Work Items</td>
</tr>
<tr>
<td>------------</td>
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</tr>
<tr>
<td>1.0 – 2.0</td>
<td>Add cribbing ballast, tamp, raise (if desired), and surface track</td>
</tr>
<tr>
<td>2.0 – 3.0</td>
<td>Place crossing surface</td>
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<tr>
<td></td>
<td>Pave asphalt trenches along both sides of track</td>
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<tr>
<td></td>
<td>Highway Open (pave highway approaches the following day if required)</td>
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<tr>
<td>0.0 – 3.0</td>
<td>Pave asphalt highway approaches the same day (optional)</td>
</tr>
<tr>
<td>6.0 – 12.0</td>
<td>Highway Open (no further paving required)</td>
</tr>
</tbody>
</table>
Removing old crossing

Lifting out old panel

Excavation

Compacting roadbed
Dumping cribbing rock

Surfacing track

Placing concrete surface

Finished crossing
Excavating trackbed and checking grade

Removing old crossing 08:30

KY 3 Condition prior to rebuild

Began excavating

Excavating trackbed and checking grade
Dumping asphalt 10:15

Spreading asphalt

Compacting asphalt and dumping ballast

Dumping and spreading ballast
3 weeks later

Compacting hand-spread approaches

Regulating ballast 12:40

Finished compacting asphalt approaches 16:50

3 weeks later
Placing Asphalt Underlayment
Cleaning Out Track to Appropriate Depth
George’s Branch Crossing Originally
Tearing Out Crossing
Cleaning Out Track to Appropriate Depth
Placing Asphalt Underlayment
Adding Track Ballast

Dragging the Track Section into Place

Replacing the Ballast

Compact the Ballast

Adding Track Ballast
Tamper Compact the Ballast

Place Asphalt

Grading the Asphalt

Compacting Asphalt
Rosemont Garden RR Crossing Renewal 7/24/02 Track #2

8:30  Began work removing panel and excavating
9:45  First load of asphalt arrives
9:50  Unloaded 1st load of asphalt
9:55  Unloaded 2nd load of asphalt
10:05 Unloaded 3rd load of asphalt
10:10 Unloaded 4th load of asphalt – Approx. 42 tons
10:12 Started compacting asphalt
10:20 Finished compacting asphalt
    Started dumping ballast
10:37 Started compacting ballast
10:42 Finished compacting ballast
    Started moving new track panel
Rosemont Garden RR Crossing Renewal 7/24/02 Track #2 (cont.)

10:50   New panel set on ballast bed  
        Started bolting one end  
        Started dumping cribbing rock

11:20   Joint bars in place, no trimming needed

11:25   Started tamping and regulating

12:30   Finished tamping and regulating  
        Started placing concrete surface panels

2:00    Finished placing concrete panels

5:00    Nearly finished placing asphalt approaches

6:30    Arrived back at site, everybody gone, probably finished by 5:30 or 6:00 and opened street to traffic

Primary equipment – two backhoes, one track loader and one steel roller (compactor)
Waller Avenue RR Crossing Renewal 8/7/02 Track #2

8:30  Closed Highway and Started Tearing Out Crossing

9:07  Panel Out, Started Excavating
      Delays with signal cable – approx. 1 hour

11:00 Dumped 1st load of Asphalt

11:30 Finished Compacting Asphalt
      Started Dumping Ballast

11:52 Finished Compacting Ballast

11:55 Panel Positioned on Ballast Bed – no trimming needed

12:08 Started Dumping Cribbing Rock

12:20 Track Bolted in Place – could have run train

12:30 Started Tamping and Surfacing

4:00  Finished Placing Concrete Panels
      Started Placing Asphalt

6:00  Crossing Finished – could have opened to traffic
      Still Placing Asphalt Walkway
      Still Need to Sweep Highway

7:00  Crossing Opened to Traffic – had been closed for 10:30 hours

Primary Equipment – 2 backhoes, 1 track loader, and 1 steel roller (city)
Profile of Rosemont Garden Westbound Crossing
Profile of Waller Avenue Westbound Crossing
Benefits of Asphalt Base (Underlayment)

- Strengthened Support Layer
- Waterproof and Confining Underlying Layer
- Impermeable Layer
- Confine Ballast Layer
- Resilient Layer
- All-weather, Uniform Stable Base
Dense-Graded Highway Base Mix

- 1 – 1 1/2 in. Maximum Size
- 0.5%+ Asphalt Content
- Minimal Oxidation and Hardening
- Minimal Temperature Changes
- Consistent Stiffness
- Optimum In-situ Moisture Contents
Quantities

6 in. thick, 12 ft. wide, 140 lb/ft³

0.42 tons/track foot (0.50 tons/ft.)

$40/ton = $20/track foot
Pressure Cell

- Geokon Model 3500-2
- 9 in. Diameter
- Strain Gage
- Snap-Master
- Thermistor
Cell Placement on Asphalt
Cell Location at Richmond
Loaded Auto Train at Richmond

P-Cell 819 Beneath Rail in Crib

P-Cell 820 Beneath Rail and Tie

P-Cell 821 C/L Track in Crib

P-Cell 822 C/L Track and Tie

Pressure (psi)

Time (s)
Loaded Concrete Truck at Richmond
Cell Location at Lackey
Loaded Coal Train at Lackey

P-Cell 510 Beneath High Rail and Tie

- 2 6-Axle Locomotives
- Initial 2 Cars

Pressure (psi)

Time (s)

P-Cell 511 Beneath High Rail and Tie

- 2 6-Axle Locomotives
- Initial 2 Cars

Pressure (psi)

Time (s)

P-Cell 806 C/L Track and Tie

- 2 6-Axle Locomotives
- Initial 2 Cars

Pressure (psi)

Time (s)

P-Cell 207 Beneath Low Rail and Tie

Pressure (psi)

Time (s)
Empty Coal Train at Lackey

P-Cell 510 Beneath High Rail and Tie

P-Cell 511 Beneath High Rail and Tie

P-Cell 806 C/L Track and Tie

P-Cell 207 Beneath Low Rail and Tie

2 6-Axle Locomotives
Initial 2 Cars
Flat Wheel on an Empty Coal Train at Lackey

P-Cell 511 Beneath Rail and Tie

2 6-Axle Locomotives
95 Empty Cars
Loaded Coal Truck at Lackey
• Matrix-based array of force sensitive cells
• Silver conductive electrodes
• Pressure sensitive ink – Conductivity varies
• Crossing of ink – strain gauge
In Track Placement During First Test

Typical Pressure Distribution Plot from Tekscan System

Scale in PSI
This represents a typical pressure distribution between a machined steel tie plate and the rail with an included rubber bladder.
Positioning of Lead Wheel with Respect to Sensor

Lead Wheel Position

Average Pressure (psi)

- 5 Ties Before Sensor
- 4 Ties Before Sensor
- 3 Ties Before Sensor
- 2 Ties Before Sensor
- 1 Tie Before Sensor
- Directly Above Sensor
- 1 Ties Past Sensor
- 2 Ties Past Sensor
- 3 Ties Past Sensor
- 4 Ties Past Sensor
- 5 Ties Past Sensor

F = 20985 lbf, P = 437 psi

Snapshot of the Lead Wheel Directly above the Sensor

Lead Wheel Over Sensor

F = 20985 lbf, P = 437 psi
Rear Tires of Tractor of a 151,000 lb Loaded Coal Truck on Concrete Crossing of Kentucky Coal Terminal, Mile Post 6.6. May 25, 2004

9842 lb

135 psi

72.93 in^2

Force vs. Frames

Pressure vs. Frames
Front Tire of a CSXT Suburban on Asphalt Parking Lot in Ashland Oil Company. May 25, 2004

1652 lb

75 PSI

22.15 in^2

Force vs. Frames

Pressure vs. Frames
Rear Tire of a CSXT Suburban on Asphalt Parking Lot in Ashland Oil Company. May 25, 2004

- 2197 lb
- 81 PSI
- 27.15 in^2

Force vs. Frames

Pressure vs. Frames
Top-of-Rail Settlements
Top-of-Rail Settlements

- Procedures of Measurement
  - Conventional Rod and Level
  - 19-20 Fixed Stations at Each Location
  - Crossing Area = Stations 9-12
Top-of-Rail Settlements

US 60 Stanley
Top-of-Rail Settlements

US 60 Stanley

Graph showing top-of-rail settlements over time with different dates indicated on the graph.
Top-of-Rail Settlements

Top of Rail Settlement: US 60 Stanley

- Approaches
- Crossing

Settlement (in.) vs. Months
Top-of-Rail Settlements

KY Coal Terminal
Top of Rail Settlements

KY Coal Terminal #2 Track (North Rail)

Elevation (ft)

Station

WB
EB
Top-of-Rail Settlements

Top of Rail Settlement: KY Coal Terminal #2

- Approach
- Crossing

Settlement (in.)

Months

- Approach
- Crossing

0.22
0.24
0.40
0.55
1.42
1.71
0.90
Top-of-Rail Settlements

Isom
KY 15- Isom, KY (West Rail)

Top of Ballast Platform

Station

Elevation (ft)

98.75 99 99.25 99.5 99.75 100

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

NB

SB
Top-of-Rail Settlements

Top of Rail Settlement: KY 15 Isom

![Graph showing top-of-rail settlements over time with data points for Approach and Crossing]
Top-of-Rail Settlements

Flagspring
Top-of-Rail Settlements

Flagspring (North Rail) NO ASPHALT: Milepost CA637.3

13 Months  32 Months  46 Months
Avg. approach settlement (both rails) 0.969 in  1.491 in  1.727 in
Avg. crossing settlement (both rails) 0.812 in  1.245 in  1.680 in
Note: Bold lines indicate crossing area
Top-of-Rail Settlements

Top of Rail Settlement: Flag Spring

- Approaches
- Crossing

Graph showing settlement in inches over months.
Top of Rail Settlements

Fish Camp (North Rail) NO ASPHALT: Milepost CA 625.0

13 Months  32 Months  46 Months
Avg. approach settlement (both rails)  1.031 in  1.469 in  1.133 in*
Avg. crossing settlement (both rails)  0.969 in  1.467 in  1.677 in

Note: Bold lines indicate crossing area
*Approaches raised between 2/22/05 and 3/14/06
Top of Rail Settlements
Top of Rail Settlement: Fish Camp

Graph showing settlement in inches over months for Approaches and Crossing.
Pavement Profiles
Pavement Profiles

• Procedures of Measurement
  – Total Station Instrument With Prism
  – Fixed Benchmark Assigned at 100.000 ft.
  – Vehicle Travel Paths Used as Lines of Measurement
  – Measurements Taken at Regular Intervals and Points Where Deviations Occurred
Pavement Profiles

- Highway Centerline
- Outside Wheelpath Line
- Inside Wheelpath Line
- Crossing material
Rosemont Garden

Before

After
Waller Avenue

Before

After
Hillsborough County, FL
US 129 Alcoa/Maryville, TN
State St.-- Ann Arbor, MI
Acknowledgements