Railway/Highway At-Grade Crossing Surface Management

By

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Kentucky Transportation Cabinet through the Kentucky Transportation Center at the University of Kentucky

and

National University Rail Center (NURail), a U.S. DOT OST Tier 1 University Transportation Center
Lead Institution -- University of Illinois (UIUC)
Representative Governmental Agencies and Railroad Companies
The Best Crossings ----GRADE SEPARATED -- Over or Under

But Most Crossings are -- AT-GRADE LEVEL CROSSINGS
NEW CONSTRUCTION
or
DOUBLE TRACKING
Typical Crossings can Deteriorate, thus Low Ride Quality

R-0-U-G-H
&
L-O-W

Not as Applicable Today using Newer Technology
PERMANENT SETTLEMENT

- Impact Loadings
- Low Spot
- Impaired Drainage
- Deterioration
- Rehabilitated Frequently
PURPOSE OF AN AT-GRADE CROSSING

Provide a **SMOOTH** Surface for the **SAFE** & **UNINHIBITED** Passage of Rubber-Tired Highway Vehicles Across the Railroad Tracks
IDEAL OBJECTIVES
Crossing Management Program

- Crossings will stay Smooth and Stable (not settle) For long periods of Time – Long Serviceable Lives

- Minimize Costly Frequent Interruptions to Railway and Highway Traffic for Rehabilitation of Crossings

- Improve Operating Performance & Safety for the Railway and Highway Traffic
TWO TYPES OF CROSSING ROUGHNESS

Surface Roughness

Profile Roughness
Material Costs Per Track Foot

$100/ft (Track Only)

$100/ft + $50-100/ft (Standard Surface)

$100/ft + $300-400/ft (Premium Surface)
IDEAL ARRANGEMENT

- Cooperative Effort to Optimize Expertise of Local Highway Agency and Railroad Company

- Thus -- Can Reduce Costs, Improve Quality, And Minimize Traffic Disruptions to the Railroad and Highway
IDEAL OBJECTIVES

• Provide Adequate Strength and Support
• Minimize Deflections
• Reduce Permanent Deformations (Settlement)
• Waterproof Sublayers
• Provide Long-Life, Smooth Crossing
• Achieve 20-Year Design Life
IDEAL PRACTICES

- Rapidly Install/Renew (As Required)
- One Day (Railroad 4 hours/Highway 8-12 hours)
- Use Layered Support
- Properly Engineered
- Structurally Designed
- Use Premium Support Materials
DETERMINE *(Optimum)*

REHABILITATION PROCEDURE

• Each Project is Site Specific

• Decisions are Performance Driven based on Experience and Prevailing Conditions

• Costs (Economics) are Important – Vary from Site to Site

• Engineering Evaluation must be Conducted

• At-Grade Crossing Evaluation Form is Useful
HIGHWAY/RAILWAY AT-GRADE CROSSING CONDITION EVALUATION FORM

- Identification & Description of Crossing

- Qualitative Assessments of
  - Pavement Approaches
  - Crossing Surface Material
  - Roughness/Rideability
  - Highway Geometrics
  - Drainage
  - Crossing Foundation

- Overall Assessment for Rehabilitation

  Only Adjustments/Improvements of the Highway Pavement Approaches

  Only Renewal of the Crossing Surface

  Complete Renewal of the Crossing Surface, Track Panel, and Trackbed Support
Agency ___________________________________________ Date __________________

Location of Crossing:

DOT Number __________________ Route Number/Street Name _____________________________

County __________________ City (specify in or near) ________________________________

GPS: Latitude __________________ Longitude ________________________________

Highway Classification:

Rural Highway ____ or City Street ____; Primary ____ , Secondary ____ , or Collector ____

Highway Information:

Mile Point _____________, ADT _____________, % Trucks _____________, Haul Route (y/n)________ 

Railroad:

Company ____________________, Division ____________________, Mile Post ____________

Primary Limits, From __________________ To __________________

Complete Form is in References 6 and 9
Railroad Company and Governmental/Highway Agency Must Agree on Three Aspects for a Project:

I. **Select Date**

Railway Volume/Schedule

Highway Volume/Critical Detours
II. Assign Responsibilities

I. Arrange Highway Closure and Traffic Control
II. Arrange Public Announcements/Notifications
III. Arrange Railroad Curfew
IV. Arrange Temporary Highway Crossing/Detour
V. Secure Materials, Personnel, and Equipment
VI. Remove and Replace Track and Surface Track
VII. Pave Highway Approaches
III. Share Cost

Removal and Installation of Track, Crossing, and Approaches (includes Materials, Personnel and Equipment),

Traffic Control,

Public Announcements,

Highway Paving
FOUR PARTS OF AN AT-GRADE CROSSING

- Highway Approaches
- Railroad Approaches
- Crossing Surface
- 4 Quadrants

4 Quadrants
Three Categories

- Only Renew Highway Crossing Approaches
- Only Renew Crossing Surface
- Complete Renewal of Crossing Surface, Track Panel and Underlying Support
Highway Pavement Approaches
Adjustments / Improvements

FIRST OPTION
Adjust/Improve Highway Pavement Approaches

Correct Roughness of Pavement Surface Approaches (Short Distance)
- Resurface Approaches
- Mill & Resurface Approaches
- Remove & Repave Approaches

Adjust Pavement/Track Geometry

Raise Elevation of Pavement Approaches (Long Distance)

Lower Elevation of Track (Long Distance)

Undercut Track or Remove Track and Excavate

Drainage Improvement
- Yes
- No

Replace Crossing Surface, Track Panel and Underlying Support
- Yes
- No

Adjust Elevation of Pavement Approaches
- Yes
- No
3 inches in 30 feet $\sim 0.85\%$
SURFACE CHOICES

- All-Asphalt
- Rubber Seal and Asphalt
- Timber and Asphalt
- Concrete Panels
- Full-Depth Rubber
- Full-Depth Timber
- Composite
- Concrete Tub
SURFACE CHOICES

All Asphalt
SURFACE CHOICES

Rubber Seal and Asphalt
SURFACE CHOICES

Timber and Asphalt
SURFACE CHOICES

Concrete Panels
SURFACE CHOICES

Full-Depth Rubber
SURFACE CHOICES

Full-Depth Timber
SURFACE CHOICES

Composite
SURFACE CHOICES

Concrete Tub
General Guideline for Crossing Material Selection

The following table provides guidance for selecting the proper crossing surface material. Recommendations are based on train tonnage, vehicular traffic, and truck traffic; these numbers are expressed in car equivalents per day. Several other factors, as discussed above, may influence the decision on the crossing surface used. In the table “standard” encompasses more economical crossing surfaces, such as rubber seal and asphalt, all-asphalt, and timber and asphalt. “Premium” includes surfaces that are more costly and require more extensive rehabilitation when they deteriorate. Premium surfaces include concrete panel, concrete tub, full-depth timber, full-depth rubber, and composite.

<table>
<thead>
<tr>
<th>RAILROAD MGT</th>
<th>CAR EQUIVALENTS PER DAY</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0-50,000</td>
</tr>
<tr>
<td>0-20</td>
<td>STANDARD</td>
</tr>
<tr>
<td>20+</td>
<td>STANDARD</td>
</tr>
</tbody>
</table>

*Car Equivalents Per Day = # of trucks x 100 per day + # of cars per day*
Complete Renewal of Crossing Surface & Track Panel & Underlying Support

Approach Adjustments
- Surface Track
- Resurface Pavement Approaches

Four Welds
- Ties
  - 9' Wood
  - 10' Wood
  - Concrete
  - Alternative
- Rails & Anchors
  - 115/119 lb.
  - 132 lb.
  - 136 lb.
- Fasteners
  - Cut Spike
  - Premium
- New Surface Material
  - All Asphalt
  - Rubber Seal & Asphalt
  - Timber & Asphalt
  - Precast Concrete Panels
  - Composite
  - Full Depth Rubber
  - Full Depth Timber
  - Concrete Tub

Drainage Improvement
- Yes
  - Install Underdrain (s)
  - Open Quadrant (s)
  - Open Longitudinal Ditches
- No
  - Install Longitudinal Drainage Pipe(s)

Support Materials
- Granular Subballast & Ballast
- Asphalt & Ballast
- Granular Subballast & Asphalt & Ballast
- Granular Subballast & Geotextile & Ballast
- Geotextile & Ballast

Third Option
Completely Renew Crossing Surface, Track Panel, & Underlying Support
Examples of Rough and Settled Crossings
Concrete Panel – Poor Condition

All Timber – Poor Condition
Rubber Seal and Asphalt – Poor Condition  

Full-Depth Rubber – Poor Condition
Primary Concern for an At-Grade Crossing is Maintaining Adequate Support so that the Trackbed and Pavement Approaches Achieve Similar Levels of Stiffness/Support
Classic All-Granular Trackbed Support

Without Separation Layer, Structural Layer, and Adequate Drainage?
Layered Trackbed Support

Figure 2a. Asphalt Underlayment trackbed without granular subballast layer

Figure 2b. Asphalt Combination trackbed containing both asphalt and subballast layers

Figure 2c. Ballastless trackbed containing thickened asphalt and subballast layers
Strengthens Trackbed Support Waterproofs Underlying Roadbed Confines Ballast and Track

Asphalt Binder +0.5% above Optimum (optional)
Low to Medium Modulus Mix, 1 - 3% Air Voids (optional)

Dense-Graded Highway Base Mix 1 – 1 ½ in. Maximum Size Aggregate
KYDOT Heavily Involved
Example Asphalt Underlayment Costs and Economics
(Assume Crossing will be Paneled)

Asphalt = $80/ton delivered

~½ ton/track-foot
(layer: 6 in. thick, 12 ft. wide)

$40/track-foot X 80 ft. long
= $3,200 for Underlayment

A Typical Crossing Renewal
≈ $10,000 to $40,000+
Benefits of an Asphalt Supported At-Grade Crossing

- A strengthened track support layer beneath the ballast that uniformly distributes reduced pressures to the roadbed and subgrade,

- A waterproofing layer that confines the underlying roadbed; this offers consistent load-carrying capacity for track structures, even on marginal quality roadbeds,

- An impermeable layer that diverts water to side ditches and essentially eliminates roadbed or subgrade moisture fluctuations, effectively improving and maintaining underlying support,

- A consistently high level of confinement for the ballast, which enables the ballast to develop high shear strength and distribute pressures uniformly, and

- A resilient layer between the ballast and roadbed, which reduces the likelihood of subgrade pumping without substantially increasing track stiffness.
- Bridge Decks and Approaches
- Turnouts and Crossovers
- Highway Crossings
- Yards
Standard for All Highway-Rail Grade Crossings

6-inch Thickness of HMAC Underlayment

Installed An estimated 60 to 70 Highway Crossings with Asphalt Underlayments between 2007 and 2012

Performance has been Excellent
SCARIFY SUBGRADE ROADBED 6" DEEP AND COMPACTED WITH STEEL VIBRATORY ROLLER TO 90% ASTM D-155.

COMPACTED HOT MIX ASPHALT CONCRETE (HMAC) SECTION, 6" MINIMUM COMPACTED WITH STEEL VIBRATORY ROLLER TO 95% CROWN AT CENTER OF TRACK, 2% SLOPE AWAY FROM CENTERLINE, PLACE AC IN SINGLE 6" THICK LIFT. SEE NOTE 3 (TYP)

10' TIMBER TIES SEE NOTE 1

TRACK SECTION FOR HORIZONTAL TANGENT

3'-0" MIN.
5'-0" PREFERRED
8'-0" MAX.

FIELD PANEL (TYP)

6" MIN.
SEE NOTE 4

3'-0" - 3'-6" FROM GATE

FIELD PANEL (TYP)

COMPACTED HOT MIX ASPHALT CONCRETE (HMAC) SECTION, 6" MINIMUM COMPACTED WITH STEEL VIBRATORY ROLLER TO 95% CROWN AT CENTER OF TRACK, 2% SLOPE AWAY FROM CENTERLINE, PLACE AC IN SINGLE 6" THICK LIFT. SEE NOTE 3 (TYP)

TRACK SECTION FOR HORIZONTAL TANGENT AT CROSSING

WITH EXIT GATES AND INDUCTION LOOPS
Metrolink
Los Angeles
Pierce Street
Polymerized Cold-Mix Asphalt

METROLINK
• Began AUC in 2000
• Do 7 to 8 AUC per year
  (14 in 2013, 12 in 2014, 11 in 2015, 6+ in 2016)
• Estimate over 150 AUC Installations
• Typically use Concrete Surfaces
• AU is 6 inches thick
WVDOT pays for:

- Crossing Materials
- 6-in. Asphalt Underlayment
- Traffic Control
- Drainage Pipe
- Tie Differential

- No Failures due to Lack of Support
- Standard Practice if State Money is Used
- Considered a Betterment Program to Upgrade Crossings for Improved Performance
Fifth Avenue
Huntington

US 50
Bridgeport
Ashton, WV
WV 2
Installed November 2001
CSX
55 Miles Long
Trains per Day -- Caltrain (92), UP (3)
Used Asphalt Underlayment Since 1999
1999 to 2013

- Crossovers #20 = 10
- Turnouts = 12
- Street & Pedestrian Crossings = over 59
- Stations since = 10
- Tunnel Approaches = 4
- Tunnel Inverts = 2
- Bridges Approaches = 15
Portland & Western Railroad
WES – All 18 Public Crossings plus an Underpass

P&W – Do 12 to 15 Crossings per year,

Oregon DOT pays for Materials, RR Railroad pays for Labor/Equipment
Fairly standard procedure,

Perfect performance, no mud, no surfacing required.
Junction City, OR
April 23, 2014, 3500 feet long
Also, Independence, OR, 2000 feet long
Many completed ranging from 30 to 350 feet long
Several more crossing planned for rehabilitation
Typical Crossing on P&W Freight Line

SW Teton Avenue in Tualatin May 2010

SW Teton Avenue in Tualatin May 2009
Salem Avenue SE in Albany

Geary Street in Albany
Iowa Department of Transportation
Primary Highway Crossing Program

Mary Jo Key, Grade Crossing Project Manager

Travis Tinken, Construction Inspector

September 25, 2012
State Surface Repair

- Road Use Tax Fund
- Application based
- First come, first serve
- 60% fund, 20% local, & 20% RR
- 10 year back log in 1998
- Crossing life was 2 years
- Since 2000 – 80 to 90 of the 167 crossings on the Iowa DOT primary system have been underlain with asphalt
- No crossings failures to date due to structural failures or settlement
Russell, Iowa
BNSF Double Main
Placed in 2000

Rt 69 Story City, Iowa
Placed in 2000
4000 ADT, 4% Trucks
50 MPH Traffic
Completed

Flood

Concrete failure

6 out of 7
Iowa DOT and Driver Benefits

- Safer, smoother, longer lasting crossings
- Limited crossing complaints
- IowaDOT manpower, equipment, funding and resources can be used elsewhere
- Streamed line processes allows fewer IowaDOT staff members to manage
- Fewer highway closures and driver disruptions
• RR production track work done by gangs do not have to go thru the crossings -- skip
• The signal department has significantly fewer false activation issues
• Less maintenance time spent on surface failures and repairs
• Fewer slow orders
ILLINOIS DEPARTMENT OF TRANSPORTATION
REGION and DISTRICT BOUNDARIES

Region 1
Diane M. O'Keefe
DISTRICT 1
211 WEST CENTER COURT
O'Fallons, Illinois 62269-1001
PHONE: 618-770-4500

Region 2
Eric S. Thorkildsen (Acting)
DISTRICT 2
211 DEPOT AVENUE
DECATUR, ILLINOIS 61732-2227
PHONE: 217-546-2227

DISTRICT 3
700 EAST MORRIS DRIVE
OTTAWA, ILLINOIS 61350-1828
PHONE: 815-434-0131

Region 3
Joseph E. Crowe
DISTRICT 4
401 MAIN STREET
PEDOYA, ILLINOIS 61862-1111
PHONE: 217-467-1234

DISTRICT 5
100 E. MAIN
PEARCE, ILLINOIS 61844-0610
PHONE: 217-467-1234

Region 4
Roger L. Driskell
DISTRICT 6
120 EAST MAIN STREET
SPRINGFIELD, ILLINOIS 62704-4792
PHONE: 217-786-5911

DISTRICT 7
400 W. ABASH
SPRINGFIELD, ILLINOIS 62701-2999
PHONE: 217-592-3351

Region 5
Mary C. Lamie
DISTRICT 8
1322 EASTPORT PLAZA DRIVE
COLLIERVILLE, ILLINOIS 62234-6198
PHONE: 618-770-4500

DISTRICT 9
STATE TRANSPORTATION BUILDING
P. O. BOX 100
CARROLLTON, ILLINOIS 62620-0100
PHONE: 618-770-2711

January 2011
The Grade Crossing Protection Fund (GCPF), administered by the ICC, was established by the Illinois General Assembly in 1955. Beginning with state fiscal year 2010 (beginning July 1, 2009), the ICC was given permission to utilize the GCPF to help pay for grade crossing surface renewal projects. The GCPF is used to reimburse railroads for all materials, including contract labor (i.e., asphalt paving, traffic control, etc.). The railroads pay all labor costs to install the new crossing surfaces.

Since 2010, 32 crossings renewals have utilized asphalt underlayment. The asphalt layer is specified as 6-in. thick, 12-ft wide and extend a minimum of 25 ft beyond ends of the crossing.

Asphalt underlayment is designated for all crossings on designated truck routes and all crossings on roads/streets with traffic volumes > 5,000 vehicles per day.
Guidelines for Railroads
Applying for GCPF Assistance to Renew
Public Highway-Rail Grade Crossing Surfaces
(Local Roads and Streets ONLY)

Below are guidelines for the renewal of highway-rail grade crossing surfaces located on the local roads and streets system where assistance from the Grade Crossing Protection Fund (GCPF) is requested.

SAMPLE

LETTER OF REQUEST
(Use LETTERHEAD of Railroad Company Making the Request)

Current Date

Mr. Michael E. Stead
Rail Safety Program Administrator
Illinois Commerce Commission
527 E. Capitol Avenue
Springfield, IL 62701
IDOT Manages 760 Public Crossings on State/Federal Routes

- The Nine Districts are primarily involved utilizing “Railroad Corridors”.
- IDOT is similarly involved as ICC relative to utilizing asphalt underlayment.
IL Rt. 119, Vermilion County
KBSR RR, Installed 2009
Picture 2016
US 51 Clinton
De Witt County
CN, Installed 2004?
Picture 2013
IL Rt. 33    Palestine
INRD Renewal 2013
Picture 2016
Began using asphalt underlayment in 1996
Since then 30+ crossings underlain
(20+ with state funds)
Major Crossings

All in Perfect Condition
(Two changed out During Widening)

Have 180 Public and 60 Private Crossings
Austin, IN – SR 256
Installed in 2007
Picture – Feb. 22, 2016
New Rail Laid In Fall 2015
Crossing Placed in 2007

February 22, 2016
Route 46 --- Bloomington
Installed 2011 – Picture 2013
Route 46 Bloomington
Installed 2011 – Picture 2016
3rd Street --- Bloomington
Installed 2011 – Picture 2013
3rd Street --- Bloomington
Installed 2011 – Picture 2016
INDOT
Ft. Wayne District
Projects
SR 8 east of Auburn
NS, installed Aug. 2012

2013.02.26
SR 8 in Auburn
Shortline RR, installed March 2012
Long-Term Trackbed Settlement

Longitudinal view of highway/rail crossing containing asphalt underlayment

<----Approach----> <----Extent of asphalt underlayment----> <----Approach---->  
<----------Crossing---------->
KY Coal Terminal—Heavy Train and Extra Heavy Highway Traffic with ASPHALT
Stanley (US 60)--Medium Train and Heavy Highway Traffic with ASPHALT
Average Asphalt/Approach Settlement for US 60 Stanley

Installed 5/16/2002

Approaches
Crossing

Time (Months)
Settlement (in.)
REFERENCES


Thank You for Your Attention Any Questions

Represent Typical Activities

Not All-Encompassing

Represent Current Practices

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