MWI 1004-01
Asphalt Underlayment for Railroad Projects

PURPOSE: To provide criteria and instruction for selecting materials and construction procedures when placing an asphalt underlayment in the track structure at open track sites and at open track sites and at specific track sites – road crossings, turnouts, railroad crossings, crossovers, and bridge approaches.

SAFETY: Follow all applicable CSX safe job procedures and safety rules and regulations for the removal and placement of track and roadbed materials.

LOCATION: All CSXT tracks and property.

ENVIRONMENTAL: Observe all applicable Federal, State and Local environmental rules and regulations.

I. DISCUSSION

A. Asphalt underlayment can be used in place of granular sub-ballast or geotextile in new construction, rehabilitation and maintenance of track. The asphalt underlayment is a mixture of paving grade asphalt cement and dense-graded mineral aggregates, similar to that used for highway pavement applications. It is produced in a common hot mix asphalt mixing plant, hauled to the site in dump trucks, spread to the desired thickness and compacted while being maintained at an elevated temperature. It is placed as a layer between the roadbed (subgrade) and the ballast.

B. The purpose of an asphalt underlayment are to provide:

1. a strengthened track support layer below the ballast to uniformly distribute reduced pressures to the roadbed (subgrade).

2. a waterproofing layer and confinement to the underlying roadbed thus providing consistent load-carrying capability for the track structure even on roadbeds of marginal quality;

3. an impermeable layer to divert water to adjacent ditches and to essentially eliminate roadbed (subgrade) moisture fluctuations which effectively improves and maintains underlying support;

4. a consistently high level of confinement (hardpan) for the ballast so can develop high shear stress and uniform pressure distribution.

5. a resilient layer between the ballast and roadbed to reduce the likelihood of subgrade pumping without substantially increasing track stiffness; and

6. an all weather, uniformly, stable surface for placing the ballast and track superstructure.

C. The use of asphalt underlayment is applicable to:

1. the construction of new open tracks, yards, terminals, road crossings, turnouts, railroad crossings, crossovers, and bridge approaches;

2. the total out-of-face rebuilding of existing open roadbeds, road crossings, turnouts, railroad crossings, crossovers, and bridge approaches; and

3. the rehabilitation and maintenance of short sections of open roadbeds, road crossings, turnouts, railroad crossings, crossovers, and bridge approaches under traffic.

II. PROCEDURE

A. Site Selection

1. Existing open roadbed locations which qualify for asphalt underlayment are those where one or more of the following conditions exist:

a. The location has previously been undercut or raked and has not stabilized,

b. The surface of the track deteriorates to a condition which requires a slow order or resurfacing in less than six months,

c. The settlement of the roadbed under the track causes the migration of material to the ditches or the toe of the fill.

2. Existing road crossings which qualify for asphalt underlayment are those where one or more of the following conditions exist:

a. The crossing has previously been completely reworked due to roadbed failure.

b. The crossing has failed due to unstable roadbed prior to the normal timbering and surfacing maintenance cycle.

3. Existing special trackwork which qualify for asphalt underlayment are those where one or more of the following conditions exist:

   a. The special trackwork has previously been undercut or raked with or without the installation of geotextile and failure reoccurred,

   b. The track surface deteriorates to the extent that it must be slow ordered or resurfaced within six months,

4. Existing bridge approaches which qualify for asphalt underlayment are those where one or more of the following conditions exist:

   a. The approach has been previously undercut or raked and adequate drainage provided and failure reoccurred,

   b. The surface deteriorates to the extent that it must be surfaced or protected by slow order in less than every six months.

   c. Correction of the following conditions may be an economical alternative for track problems at bridge ends. If asphalt underlayment is determined to be required, the conditions shall be corrected in conjunction with the installation of asphalt underlayment.

      1) Standard embankment section at backwall, including end slopes.

      2) Make-shift retaining structures at or near the ballast line are not acceptable.

      3) End slopes shall be protected with rip rap as needed to prevent erosion.

      4) Embankment side ditches shall be open and properly graded. Alignment of the ditches shall be constructed to prevent the erosion of the embankment and side slopes.

      5) Existing drainage behind the backwall of abutments should be open and functional. If drainage structures do not exist, the need shall be evaluated and installed as required.

6) Track surface at bridge ends should be maintained on a regular basis. It is suggested that as equipment is being trammed, bridge ends could be surfaced in the direction away from the bridge to prevent "humps" in the track at bridge ends.

5. New construction of open track will not have asphalt underlayment installed unless a complete geotechnical investigation has determined that it is the most economical method to stabilize the roadbed.

6. All new road crossing construction with projected annual tonnage greater than 10 MGT will have underlayment.

7. All new construction of turnouts and crossovers on lines expected to carry greater than 10 MGT will have underlayment.

8. All railroad crossing diamonds, new or existing, will have underlayment installed at the time of construction or replacement, regardless of annual tonnage.

9. All new bridge construction on lines projected to carry greater than 10 MGT and all bridge reconstruction on lines carrying greater than 10 MGT will have underlayment on the approaches. In remote areas where access by construction equipment is restricted, geo-cell may be used as an alternate stabilization technique.

B. Planning

1. This is a critical activity, particularly for in-service track applications where the line must be taken out of service and the track removed for a period of time.

2. Adequate attention must be given to devising means to economically transport the asphalt to the site and place the asphalt on the roadbed. Access is generally not a critical concern since the asphalt can be delivered by highway or hi-rail dump truck. Availability of sufficient track time to remove and replace the track may limit the application to short sections of in-service track. These activities are discussed in more detail in the "Construction" section.

3. The critical steps in the planning process for an in-service track application are as follows:

   a. Determine if conditions warrant an asphalt underlayment (see section IIA - Site Selection),

   b. Determine the extent of the application, i.e., length of track to be removed and quantity of asphalt.

c. Determine the optimum procedure for delivering the asphalt to the roadbed, i.e. dumped directly from highway dump trucks or hirailed and dumped, etc. – depending on access,

d. Determine if a highway paving machine, dozer, or other spreading equipment will be used to spread and shape the asphalt layer.

e. Determine the compaction procedure for the asphalt layer, and

f. Devise the most efficient procedures to remove the existing track, excavate and dispose the existing roadbed material, and place ballast and track. These will largely depend on the extent of the application, track time availability, equipment and labor availability, and access conditions.

g. Disposal of excavated material shall be in accordance with all applicable environmental regulations.

C. Asphalt Mixture Design and Production

1. The asphalt mixture should be similar to a dense-graded highway base mix commonly specified by the state or local highway agency. The maximum aggregate size will be 1.0 to 1.5-in. It is desirable to increase the asphalt cement content of the mix by about 0.5% above that considered to be optimum for a highway base mix.

2. The asphalt production facility should be capable of producing a mix meeting the specifications outlined herein and adequately sized to produce the anticipated volume of mix. The use of surge or storage silos for the mix at the plant is preferred. The mix should leave the plant at a temperature approximately 300°F and the trucks covered to minimize temperature loss. Asphalt mix production facilities meeting the local state transportation department specifications are preferred.

3. Pay items for an asphalt underlayment project should be defined based on the magnitude of the project and the inspection effort available. One suggested pay item for asphalt underlayment projects is by the ton. The hauling, spreading, and compacting of the mixture may or may not be included depending on the particular job. Typically it is more economical on small projects for company forces to spread and compact the mixture.

4. The cost of obtaining and placing asphalt underlayment will vary depending on: the cost of the aggregates and asphalt cement in the local area, the length (time) of haul from the plant to the site, the size (tonnage) of the project, the availability and cooperation of local contractors, and the ease of delivery access and construction maneuverability. The cost of asphalt underlayment can be partially or totally offset by replacing the geotextile (if considered), all or most of the granular subballast, and a portion of the ballast.

D. Asphalt Layer Width, Length; Thickness Designs; and Quantities

1. The asphalt layer should extend 1-1/2 to 2-ft beyond the end of the ties. This normally requires an 11 to 12-ft wide layer on single track installations.

2. The recommended limits for the use of asphalt underlayment are as follows:

   a. Open Track -- The asphalt layer should extend a specified distance beyond ends of the immediate affected area to provide a transition zone overlapping unaffected track. The distance will vary depending on local conditions. A minimum distance of 25 to 100 ft is required.

   b. Road Crossings – The asphalt layer should extend a specified distance beyond ends of the crossing to provide a transition zone so that subsequent track surfacing operations will not impinge on the crossing area. The distance will vary depending on local conditions. A minimum distance of 25 to 100-ft is required.

   c. Special Trackwork – The asphalt layer should extend a specified. Distance from the special trackwork to provide a transition zone so that subsequent track surfacing operations will not impinge on the approaches. The distance will vary depending on available track time and existing track conditions. For the construction of new special trackwork or the total out-of-face rebuilding of existing special trackwork, the asphalt layer should extend for the distance of 100 ft under all tracks from the special trackwork. When rehabilitating special trackwork under traffic with limited track time, the asphalt layer should extend for the distance the approach has been adversely affected, with a minimum distance of 40 ft.

   d. Bridge Approaches – The asphalt layer should extend a specified distance from the abutments to provide a transition zone so that subsequent track surfacing operations will not impinge on the approaches. The distance will vary depending on available track time and existing track conditions. For the construction of new bridge approaches. The distance will vary depending on available track time and existing track conditions. For the construction of new bridge approaches or the total out0of0face rebuilding of existing bridge approaches, the asphalt layer should extend a distance of 200 ft from the abutment. When rehabilitating bridge approaches under traffic with limited track time, the asphalt layer should extend for the distance the approach has been adversely affected, with a minimum distance of 50 ft.

3. The thickness of the asphalt layer will vary depending on the quality of the roadbed (subgrade) support, traffic loadings, and type of installation. The thickness for the asphalt underlayment is as follows:

   a. Open Track and Road Crossings – A 6-in. thick layer is the specified. For unusually poor roadbed support conditions, a minimum of 8-in. thickness is recommended.

   b. Turnouts and Crossovers –A 6-in. layer is specified under turnouts and crossovers. For unusually poor roadbed support conditions, an 8-in. thickness is recommended. The asphalt thickness should be tapered to a minimum of 4-in. thickness at the end of the asphalt approach.

   c. Railroad Crossings – An 8-in. thick layer is specified under railroad crossings. For unusually poor roadbed support conditions, a 12-in. thickness is recommended.

   d. Bridge Approaches – An 8-in. thick layer is specified for half the distance from the abutment. The asphalt thickness is to be tapered to a minimum of 4-in. thickness at the end of the asphalt approach. For unusually poor roadbed support conditions, a 12-in. thickness is specified for half the distance from the abutment and tapered to a minimum of 4-in. thickness at the end of the asphalt approach.

4. The following table provides the quantities of asphalt underlayment required for Various compacted layer thickness. It is assumed that the layer is 12-ft wide and is compacted to a density of 140 lb/ft3. For estimating purposes, it is common to use 0.50 tons per track foot.

QUANTITIES OF ASPHALT UNDERLAYMENT

Layer Thickness, (in.)	Tons of Mix	
	Per Track Foot	Per Square Yard
4	0.28	0.21
5	0.35	0.26
6	0.42	0.32
7	0.49	0.37
8	0.56	0.42

Based on a compacted density of 140lb/ft^3 and a layer width of 12 ft.

E. Ballast Thickness

Ballast thickness normally ranges from 8 to 12-in. but should conform to standard designs. Ballast thickness will be a minimum of 8-in.

F. Construction of Asphalt Underlayment Section

1. The asphalt underlayment should be placed on a new subgrade or existing roadbed constructed in accordance with CSXT Standard Drawing 2601, Roadbed Sections. The roadbed should be reasonably well-compacted, well-drained, and capable of accommodating the hauling and spreading equipment without excessive rutting or deformation. Requirements are no more stringent than those typically imposed for conventional granular roadbeds. A 95% compaction level is desirable. It is sometimes necessary to place an initial layer of asphalt mix or granular material to serve as a working platform on which to compact the required thickness of asphalt underlayment. A slight crown or side slope is desirable. The need to purposefully improve surface or sub-surface drainage will depend on an analysis of the situation at the specific site.

2. New lines and extensions and new classifications and intermodal yards represent ideal conditions since the exposed subgrade is available for placing the asphalt underlayment with conventional highway asphalt paving and spreading equipment prior to placing the ballast and track.

3. For existing lines, the track must first be removed and the underlying material excavated to the desired grade (disposal of excavated material above the natural subgrade shall be in accordance with all applicable environmental regulations). The depth of the excavation will vary, depending on the replacement thickness of the asphalt and ballast layers, the depth of the existing hardpan (if one exists) and the desired track raise (if any). The depth of the excavation below the bottom of existing ties will equal the sum of the asphalt underlayment and ballast thickness minus the amount of track raise, as follows:

Depth Of Excavation	=	Asphalt Underlayment Thickness	+	New Ballast Thickness	-	Desired Track Raise

4. It is not desirable to excavate into the hardpan area to achieve this depth. It is acceptable to use less ballast thickness (the 8-in. minimum ballast section must be maintained) or raise the track where possible to minimize the excavation depth where the hardpan would be disturbed.

5. It is also desirable for the top of the asphalt (bottom of ballast) to be at or above the elevation of the adjacent side shoulders. This will provide positive drainage away from the ballast so that the ballast can purge itself of fines and not foul from degradation of the ballast, wind-blown fines and car droppings. In some situations it may be desirable to lower the shoulder to achieve a positive drainage away from the track.

6. The excavation should be accomplished with track-type loaders, dozers, or excavators on roadbeds (subgrade) of marginal quality. Rubber-tired equipment will likely rut and pump the roadbed unless the passages are kept to a minimum.

7. The asphalt mix is hauled by dump trucks from the mix. For short, in-service track projects where track time availability is limited, it is desirable to have all of the asphalt on site prior to the anticipated placement time. The placement of the asphalt requires a minimum period of time and should be continuous. Delays are normally experienced when trucks have to make additional rounds to the plant. The mix can be dumped directly into a standard highway asphalt paving machine for spreading or backdumped on grade and spread with a dozer blade, loader bucket, or excavator bucket. The paving machine is applicable for long sections of track. For short sections and special trackwork, it is generally more economical and expeditious to backdump on grade and spread with on-site equipment. Procedures selected fore transporting and spreading the mix should be expedient to minimize temperature loss.

8. The asphalt layer is normally placed in 4-in. compacted lifts, although lifts of 6-in. can be adequately compacted. Compaction is best achieved with a standard roller, preferably a steel-wheeled, vibratory type, while the mix is between 200 to 300°F. Other means of obtaining compaction can be applied to small areas if a roller is not available, such as a "jumping jack," running a crawler-equipped machine over it repeatedly, or tamping with the backside of a backhoe or loader bucket. A well-compacted layer with minimum air voids (less than 5%) is desirable, but is difficult to achieve if the mix chills excessively before compaction, if the compactive effort is insufficient, or if the underlying support is weak. A compaction level of 95% or higher is desired. Ideally, the top surface of the asphalt should be slightly crowned or sloped to facilitate surface drainage. This can be accomplished by adjusting the screed on the paver or by tilting the blade on the dozer.

9. After the asphalt layer is compacted, the track can be rebuilt or dragged back on the hot asphalt layer. The use of rubber-tire equipment is preferred. Cranes can be used to lift panels. Snaking techniques are applicable for longer track panels. Adequate space must be available to facilitate removal and replacement of the track panels and provide access for the asphalt paving operations.

10. The ballast can be distributed with conventional unloading and spreading equipment. However, it is desirable to preballast prior to placing the track panel when conditions permit. This will expedite the process. Ideally the preballast can be compacted with a vibratory roller (already on-site and previously used to compact the asphalt) to grade so the track panel can be positioned at the desired elevation. It is possible to eliminate or minimize the need to surface the track using the compacted preballast procedure unless the approaches have to be raised. Normally the track panels must be lifted into place on the ballast layer. Dragging the track will likely disturb the compacted ballast. Additional ballast will be distributed with a loader or dropped from ballast cars to fill the crib areas between the ties and provide a 6 to 12-in. wide shoulder.

III. Reports

None.

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