Maine Department of Transportation

Highway Program

Design Guidance

<table>
<thead>
<tr>
<th>Title: Structural Pavement Design</th>
<th>Issue Date: March 23, 2017</th>
</tr>
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<tbody>
<tr>
<td>Discipline: Pavement Design &amp; Quality</td>
<td>Revised Date: March 13, 2019</td>
</tr>
<tr>
<td>Originator: Stephen Bodge, P.E.</td>
<td>Approved By: Bradford Foley, P.E.</td>
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Background:

This guidance simplifies the methods to determine the travel lane thickness of hot mix asphalt (HMA) and subbase aggregate thicknesses needed to support future traffic loads on low-volume roadways and short-length projects in Maine.

Guidance:

There are three different methods for determining the structural pavement design that depend on the traffic level, subgrade soil type, and the project scope. The applicable categories are as follows:

- Projects with 2,000,000 ESALs or less
- Short-length projects with 2,000,001 to 6,000,000 ESALs
- All projects not meeting the above criteria

ESAL Calculation

ESALs are calculated using the 18-kip Equivalent @ P2.5 value located on the project traffic data sheet provided by the Traffic Analysis Section in the Bureau of Planning. ESALs are calculated with the following equation:

\[ ESALs = (18\text{-kip Equiv. P 2.5}) \times (12\text{-yr or 20-yr design life}) \times (365 \text{ days/year}) \]
Subgrade Soil Type

Subgrade soil type is determined from project subsurface investigations or from the Natural Resources Conservation Service (NRCS) Soil Survey information for the specific project location. The subgrade soil type is requested from the Pavement Design & Quality section for Highway Corridor Priority (HCP) 1 projects and projects greater than 1 mile in length. The NRCS Soil Survey information can be used on HCP 2, 3, and 4 projects less than 1 mile in length by using the NRCS Web Soil Survey website. See the attached Using the NRCS Web Soil Survey to Determine Subgrade Soil Type document for step-by-step instructions on how to use the website. A Type 2 subgrade soil is used for large culvert projects where the subgrade will typically consist of fill.

Projects with 2,000,000 ESALs or less

When the calculated ESAL value is 2,000,000 or less, the HMA and subbase thicknesses needed for the travel lanes are based on the number of ESALs and subgrade soil type, and can be determined from Table 1 for all roadway classifications and HCPs. The subbase thickness in Table 1 is also applicable for the Type C aggregate used in Aroostook County. A 20-year life should be used to calculate the ESALs for projects with an ESAL value of 2,000,000 or less.

### TABLE 1

<table>
<thead>
<tr>
<th>Type 1 Subgrade (0% - 32% passing #200)</th>
<th>ESALs (12-yr or 20-yr)</th>
<th>HMA (in)</th>
<th>subbase (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 900,000</td>
<td>4</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>900,001 - 1,500,000</td>
<td>4</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>1,500,001 - 2,000,000</td>
<td>4</td>
<td>26</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type 2 Subgrade (32% - 82% passing #200)</th>
<th>ESALs (12-yr or 20-yr)</th>
<th>HMA (in)</th>
<th>subbase (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 500,000</td>
<td>4</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>500,001 - 900,000</td>
<td>4</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>900,001 - 2,000,000</td>
<td>5</td>
<td>24</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type 3 Subgrade (82% - 100% passing #200)</th>
<th>ESALs (12-yr or 20-yr)</th>
<th>HMA (in)</th>
<th>subbase (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 400,000</td>
<td>4</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>400,001 - 700,000</td>
<td>4</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>700,001 - 1,000,000</td>
<td>5</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>1,000,001 - 2,000,000</td>
<td>6</td>
<td>24</td>
<td></td>
</tr>
</tbody>
</table>

As per Standard Specification 203.041 - Salvage of Existing Hot Mix Asphalt Pavement, the contractor has the option to use a maximum of 3” of Recycled Asphalt Pavement (RAP) in place of the top 3” of the subbase aggregate. It can also be specified in the project plans or contract documents that the contractor shall use RAP as the top 3” of aggregate (maximum). For pavement design and payment purposes, the RAP is considered ASCG Type D or ABC Type C in Aroostook County.
All pavement designs using Table 1 for guidance must be reviewed and approved by the Pavement Design & Quality section prior to the Preliminary Design Report (PDR) stage of the project. The pavement design review must contain all supporting documentation including the Pavement Design Review Form, a project location map, traffic data sheet(s), subsurface investigation report if available, and any NRCS soil survey information used for the design. The overall pavement and HMA thicknesses may be adjusted for ease of constructability or other reasons following the review.

Short-length projects with 2,000,001 to 6,000,000 ESALs

When the calculated ESAL value is from 2,000,001 to 6,000,000, the HMA and subbase thicknesses needed for the travel lanes are based on the number of ESALs and subgrade soil type and can be determined from Table 2 for all roadway classifications and HCPs if the project meets one of the following criteria:

- is less than 1000’ in length
- is scoped as a large culvert project
- is a bridge approach
- is a lane widening
- is an intersection
- is a railroad crossing

A 12-year design life should be used to calculate the ESALs for the above listed short-length projects. If the project meets the above criteria, but the ESAL value is less than 2,000,001, Table 1 is used for the design. The subbase thickness in Table 2 is also applicable for the ABC - Type C aggregate used in Aroostook County. Note that Table 2 does not contain entries for Type 2 subgrade above 5,000,000 ESALs or for Type 3 subgrade above 4,000,000 ESALs. In these cases, a design is performed by the Pavement Design and Quality section.

### Table 2

<table>
<thead>
<tr>
<th>Type 1 Subgrade (0% - 32% passing #200)</th>
<th>ESALs (12-yr)</th>
<th>HMA (in)</th>
<th>subbase (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2,000,001 - 4,000,000</td>
<td>5</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>4,000,001 -6,000,000</td>
<td>6</td>
<td>24</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type 2 Subgrade (32% - 82% passing #200)</th>
<th>ESALs (12-yr)</th>
<th>HMA (in)</th>
<th>subbase (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2,000,001 - 5,000,000</td>
<td>6</td>
<td>24</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type 3 Subgrade (82% - 100% passing #200)</th>
<th>ESALs (12-yr)</th>
<th>HMA (in)</th>
<th>subbase (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2,000,001 - 4,000,000</td>
<td>6</td>
<td>24</td>
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</table>
As per Standard Specification 203.041 - Salvage of Existing Hot Mix Asphalt Pavement, the contractor has the option to use a maximum of 3” of Recycled Asphalt Pavement (RAP) in place of the top 3” of the subbase aggregate. It can also be specified in the project plans or contract documents that the contractor shall use RAP as the top 3” of aggregate (maximum). For pavement design and payment purposes, the RAP is considered ASCG - Type D or ABC - Type C in Aroostook County.

All pavement designs using Table 2 for guidance must be reviewed and approved by the Pavement Design & Quality section prior to the Preliminary Design Report (PDR) stage of the project. The pavement design review must contain all supporting documentation including the Pavement Design Review Form, a project location map, traffic data, subsurface investigation report if available, and NRCS soil survey information. Note that the overall pavement and HMA thicknesses may be adjusted for ease of constructability.

Projects Not Meeting the Criteria to Use Tables 1 or 2

All projects not meeting the criteria to use the two previous Tables shall require a pavement design performed by the Pavement Design and Quality section. All pavement design requests must include the Pavement Design Request Form, the traffic data sheets requested from the Traffic Analysis Section in the Bureau of Planning, and any subsurface information if available.

Related Guidance

Please refer to Design Guidance - Structural Pavement Design with a Recycled Layer for more information for the design of pavement structures with a recycled layer.

Example Designs

A. Determine the HMA and subbase layer thicknesses for a project that has a 12-year design life, an 18-kip Equivalent P 2.5 value of 250, has a Type 1 subgrade, and is 3 miles in length.

SOLUTION:

\[
ESALs = (18\text{-kip Equiv P } 2.5) \times (12\text{-yr or 20-yr design life}) \times (365 \text{ days/year})
\]

\[
ESALs = (250) \times (12 \text{ years}) \times (365 \text{ days/year}) = 1,095,000
\]

Since the ESALs are less than 2,000,000, use Table 1

Using Table 1, the final pavement structure = 4” HMA, 24” ASCG (subbase)
B. Determine the HMA and subbase layer thicknesses for a project that has a 12-year design life, an 18-kip Equivalent P 2.5 value of 525, and is large culvert project.

**SOLUTION:**

\[ ESALs = (18\text{-kip Equiv P 2.5}) \times (12\text{-yr or 20-yr design life}) \times (365 \text{ days/year}) \]

\[ ESALs = (525) \times (12 \text{ years}) \times (365 \text{ days/year}) = 2,299,500 \]

Since this is a large culvert project, use Table 2 for a Type 2 subgrade soil.

Using Table 2, the final pavement structure = 6” HMA, 24” ASCG (subbase)
Using the NRCS Web Soil Survey to Determine Subgrade Soil Type

Use this link: https://websoilsurvey.nrcs.usda.gov/app/. Click the green Start WS button.

1. Go to the Quick Navigation section.

2. Select Address and enter Route, Town, State. Latitude and longitude coordinates may also be used. Click the View button.
3. Use the Hand Tool to navigate to project location. Use the magnifying tool to pinpoint the exact project limits.

4. Select the Area of Interest Button located just above the map. The choice of area to be drawn is a rectangle or irregular shape. The irregular shape button works the best for roadway projects.

5. Draw the project limits and double click to close the polygon and create the Area of Interest. The square will automatically close. A hatched area will appear when created.
6. Click the Soil Map tab located at top of screen. The soil map will be created.

7. Click the Printable Version button and then View. A PDF of the Soil map is created. Save the map and then close the PDF.

8. Select the Soils Data Explorer tab, and then the Soil Reports tab.

10. Select Printable Version and then View. A PDF of the Engineering Properties is created. Save the PDF.

Determine the Subgrade Soil Types

1. To determine the subgrade soils type on your project, find all the soils under the roadway along the project using the Soil Map PDF.

2. The Soil Map PDF includes a chart that shows the percentage of soils in the area of interest. If you used the irregular shape area of interest, select the soils with the highest Percent of AOI on the roadway as representative.
3. Go to the Engineering Properties pdf and the Percent Passing Sieve Number columns, and then the 200 column.

4. Select the middle value (R value) for the % passing the #200 as determined above for the layers 18” to 36” below the surface.

Selecting Subgrade Type from NRCS Information

MaineDOT Subgrade soil types are:
Type 1 Subgrade - 0% - 32% passing #200
Type 2 Subgrade - 32% - 82% passing #200
Type 3 Subgrade - 82% - 100% passing #200

From the above Engineering Properties example, the #200 values are 91 and 93, therefore the subgrade is a Type 3 Subgrade.