



# Development of the MnDOT Pavement Design Manual

*19<sup>th</sup> Annual TERRA Pavement Conference  
February 12, 2015*

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We all have a stake in **A**  **B**



# MnDOT Pavement Design Manual

<http://www.dot.state.mn.us/materials/pvmtdesign/index.html>



Minnesota Department of  
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## Pavement Design



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### MnDOT Pavement Design Manual

Standards and guidelines for pavement design, pavement-type selection, and documentation.

[Entire MnDOT Pavement Design Manual](#)

#### Chapters

- [Chapter 1 - Introduction](#)
- [Chapter 2 - Investigation](#)
- [Chapter 3 - Pavement Subsurface](#)
- [Chapter 4 - HMA](#)
- [Chapter 5 - PCC](#)
- [Chapter 6 - Ramps, Shoulders, Turn Lanes, and Miscellaneous Pavements](#)
- [Chapter 7 - Pavement-Type Selection](#)
- [Chapter 8 - Documentation](#)
- [Chapter 9 - Construction and Rehabilitation Alternates](#)



# Why make a new pavement design manual?

1. Document current pavement design practices.
2. Introduce and document new M-E pavement design programs.
3. Update and document the new pavement-type selection process and alternate bidding.
4. Suitable as a reference for consultants.



# Step 1 – Outline

Chapter	Title
Chapter 1	Introduction
Chapter 2	Investigation
Chapter 3	Pavement Subsurface
Chapter 4	HMA
Chapter 5	PCC
Chapter 6	Ramps, Shoulders, Turn lanes, and Miscellaneous Pavements.
Chapter 7	Pavement-type Selection
Chapter 8	Documentation
Chapter 9	Construction and Rehabilitation Alternates



# Step 2– Draft

- ▶ One primary author.
- ▶ Started from scratch but re-used existing materials.
- ▶ Talked to a lot of people.
- ▶ Focused on covering the intended scope and making a working document.
- ▶ Let technical items be corrected with review.
- ▶ Try to develop a consensus opinion.



# Draft: Chapter 1 – Introduction

- ▶ Scope – What is in/what is not in the manual.
- ▶ How the manual and changes to it will be reviewed and accepted.
  - ❑ Accepted when a chapter is signed by MnDOT Pavement Engineer.



# Chapter 2 – Investigation

- ▶ 200 – Falling–Weight Deflectometer (FWD)
- ▶ 210 – Friction Testing
- ▶ 220 – Borings
- ▶ 230 – Cores
- ▶ 240 – Ground Penetrating Radar (GPR)
- ▶ 250 – Traffic Data
- ▶ 260 – Roadway Construction History
- ▶ 270 – Visual Condition Assessment
- ▶ 280 – Pavement Management System
- ▶ 299 – Chapter 2 Appendix



# Chapter 3 – Pavement Subsurface

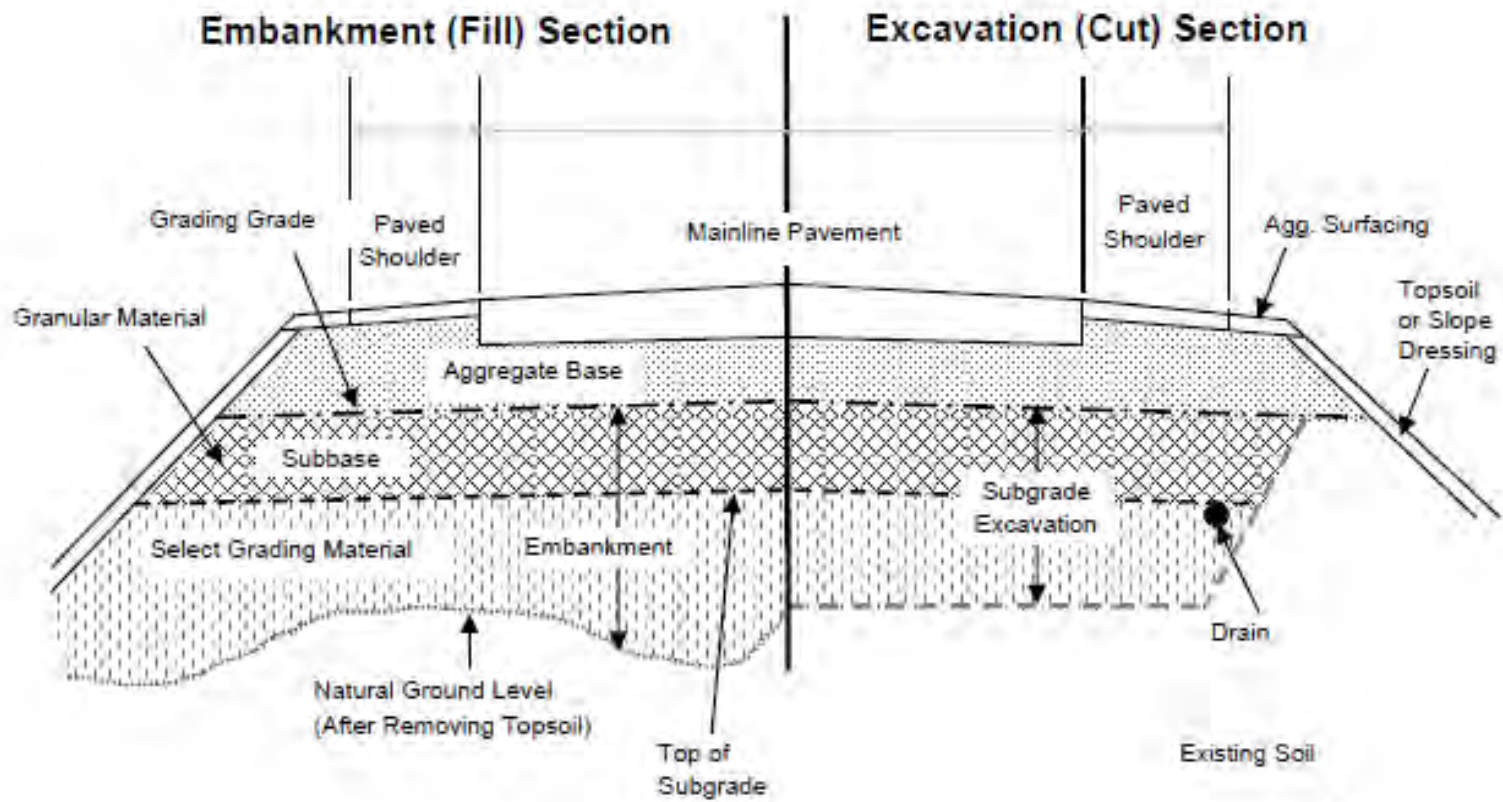
- ▶ 300 – Definitions
- ▶ 310 – Aggregate Base and Subbase
- ▶ 320 – Below the Subbase
- ▶ 330 – Compaction
- ▶ 340 – Shrinkage Calculation
- ▶ 350 – Infiltration
- ▶ 360 – Culvert Backfill Treatments
- ▶ 370 – Subsurface Drainage
- ▶ 380 – Frost Effects





# Section 300 – Definitions

Figure 300. 1 – Example of New Rural Pavement Sections



# Chapter 4 –HMA (Hot-Mix Asphalt)

- ▶ 400 – New/Reconstructed HMA Pavements
- ▶ 410 – Reclamation/Recycling of Existing HMA Pavement
- ▶ 420 – Rubblization and Crack and Seal
- ▶ 430 – Pavement Design using MnPAVE–Flexible
- ▶ 440 – HMA Overlay of Existing Pavement
- ▶ 450 – Materials and Specifications





# Chapter 5 – PCC (Portland Cement Concrete)

- ▶ 500 – New/Reconstructed PCC Pavements
- ▶ 510 – PCC Overlay of Existing HMA – Whitetopping
- ▶ 520 – Unbonded PCC Overlay of Existing PCC – UBOL
- ▶ 530 – PCC Joint Design
- ▶ 540 – PCC Thickness Design using MnPAVE–Rigid
- ▶ 550 – Whitetopping Thickness Design using BCOA–ME
- ▶ 560 – PCC Standard Plans and Plates



# Section 540 – PCC Thickness Design using MnPAVE-Rigid

Figure 540.1 - View of MnPAVE-Rigid

The screenshot shows the MnDOT M-E Design for Rigid Pavements software interface. The window title is "MnDOT M-E Design for Rigid Pavements". The interface includes a menu bar with "Main", "Design Values", "User Guide", "About", and "Defaults". Below the menu bar, there are several input fields and buttons:

- Project name:** A text input field with a "Load from \*.txt file" button to its right.
- \*.txt file path:** A text input field containing "C:\Users\jane\Local\Desktop" and an "Edit" button to its right.
- Project notes:** A large text area for entering notes.
- Design life, years:** A text input field.
- Climate (by district):** A dropdown menu.
- Initial traffic, HCADT:** A text input field.
- Linear yearly growth, %:** A text input field.
- Axle load spectra:** A dropdown menu currently set to "MnDOT WIM Average".
- Widened outer lane?:** A dropdown menu.
- Joint spacing, feet:** A dropdown menu.
- Shoulder type:** A dropdown menu.
- Thickness:** A text input field.

At the bottom of the window, there are "Exit" and "Run" buttons.





# Section 550 – Whitetopping thickness using BCOA-ME



(Last updated: 10/31/2014)

GENERAL INFORMATION		
Latitude (degree):	<input type="text" value="44.53"/>	<a href="#">Geographic Information</a>
Longitude (degree):	<input type="text" value="-93.14"/>	
Elevation (ft):	<input type="text" value="874"/>	
Estimated Design Lane ESALs:	<input type="text" value="1000000"/>	<a href="#">ESALs Calculator</a>
Maximum Allowable Percent Slabs Cracked (%):	<input type="text" value="25"/>	
Desired Reliability against Slab Cracking (%):	<input type="text" value="85"/>	



# Chapter 6 – Ramps, Shoulders, Turn Lanes & Miscellaneous Pavements

- ▶ 600 – Ramps and Loops
- ▶ 610 – Shoulders
- ▶ 620 – Widening Existing Lanes and Adding Lanes
- ▶ 630 – Turn Lanes
- ▶ 640 – Temporary Median Crossovers
- ▶ 650 – Parking Lots and Driveways
- ▶ 660 – Roundabouts
- ▶ 670 – Shared-Use Paths



# Chapter 7 – Pavement–Type Selection

- ▶ 700 – Steps to Perform Pavement–Type Selection
- ▶ 710 – Pavement Design Categories
- ▶ 720 – Determination of Which LCCA Process to Follow
- ▶ 730 – Formal LCCA Process
- ▶ 740 – District LCCA Process
- ▶ 750 – Alternate Bidding 760 – LCCA Formulas and Standards
- ▶ 770 – LCCA Maintenance Activities





# Chapter 7– Pavement–Type Selection

Update and document the **Pavement–Type Selection** process.

- ▶ Process of choosing a project’s pavement material (HMA or PCC) and method (Overlay, reclamation, crack & seat, etc.) using a Life–Cycle Cost Analysis (LCCA).
- ▶ A Life–Cycle Cost Analysis (LCCA) determines the low–cost option considering Initial construction costs and future rehabilitation.



# Chapter 7– Pavement–Type Selection

- ❑ Replaced two technical memos that had different LCCA processes with a single LCCA process.
- ❑ Update LCCA schedules of future activities.
- ❑ Set prices for use estimating costs in LCCA.



# Chapter 7– Pavement–Type Selection

Document the **Alternate Bidding** process.

Plans contain two pavement–type alternates. A dollar amount (the MAF) that represents the difference in future maintenance cost is added to the bids of one of the alternates before determining the low–cost bidder.

or

Like using an LCCA to determine the low–cost bidder of two alternates but using the contractor’s bid as the initial cost.



# Chapter 7– Pavement–Type Selection

Document the **Alternate Bidding** process.

- ▶ Process to determine which projects may proceed to alternate bidding.
- ▶ The required documentation (Pavement Design Memorandum (PDM)).
- ▶ Document how the MAF is developed.



# Chapter 8 – Documentation

- ▶ 800 – Pavement Design Memorandum (PDM)
- ▶ 810 – Materials Design Recommendation (MDR)
- 820 – PDM Template Instructions
- ▶ 830 – MDR Template Instructions



# Chapter 9 – Construction & Rehabilitation Alternates

- ▶ 900 – Existing Pavement–Types
- ▶ 910 – Rehabilitation with HMA Overlay (>2 inches)
- ▶ 920 – Rehabilitation with PCC Overlay
- ▶ 930 – Rehabilitation with FDR/SFDR/CIR
- ▶ 940 – Rehabilitation with Rubblization/Crack & Seal
- ▶ 950 – New/Reconstruction
- ▶ 960 – Noneconomic Factors



# Chapter 9 – Construction & Rehabilitation Alternates

Table 900.1 – Existing Pavement-Types and Possible Rehabilitation Alternates		
Existing Pavement-type	Description	Possible Rehabilitation*
HMA on Aggregate Base	HMA pavement, including any HMA overlays, placed on several inches of aggregate base.	<ul style="list-style-type: none"> <li>• HMA overlay (&gt;2 inches)</li> <li>• PCC overlay</li> <li>• FDR/SFDR/CIR</li> <li>• New/Reconstruction</li> </ul>
Full-Depth HMA on Subgrade	HMA pavement, including any HMA overlays, placed on sub-grade.	<ul style="list-style-type: none"> <li>• HMA overlay (&gt;2 inches)</li> <li>• PCC overlay</li> <li>• FDR/SFDR/CIR</li> <li>• New</li> </ul>
HMA on PCC	HMA pavement placed on previously constructed PCC Pavement.	<ul style="list-style-type: none"> <li>• HMA overlay(&gt;2 inches)</li> <li>• PCC overlay</li> <li>• CIR</li> <li>• Rubblization</li> <li>• Crack and Seat</li> <li>• New/Reconstruction</li> </ul>



# Chapter 9 – Construction & Rehabilitation Alternates

Table 910.1 - HMA Overlay on Existing HMA	
Manual Location	Section 460.
Description	Paving >2" of HMA on an existing HMA pavement's surface. It is intended to improve ride, reduce surface distress, may improve pavement structure, and preserve the existing pavement. Existing HMA may be milled prior to the HMA overlay to remove surface distresses and to reduce the road's profile.
Design Life	Typically, MnDOT projects use a design life of 13-19 years depending on existing pavement condition, traffic, and HMA overlay thickness.
Good Candidate	<ul style="list-style-type: none"> <li>Structurally sound pavement that needs only minor improvements.</li> <li>Projects in which a limited design life is acceptable.</li> </ul>
Poor Candidate	<ul style="list-style-type: none"> <li>Pavements that exhibit structural problems such as:               <ul style="list-style-type: none"> <li>Deforming or rutting subsurface layers.</li> <li>Large amounts of bottom-up fatigue cracking.</li> <li>Subgrade failures and/or seasonal heaving issues.</li> </ul> </li> <li>Pavements with a large amount of surface distress (rutting, cracking, and poor ride) that will not be sufficiently improved by an HMA overlay.</li> <li>Projects in which a long design life is desired..</li> </ul>
Pros	<ul style="list-style-type: none"> <li>May add structure.</li> <li>Improves ride and reduces surface distresses.</li> <li>Relatively inexpensive.</li> <li>Short construction period.</li> <li>Reduces short-term maintenance.</li> </ul>
Cons	<ul style="list-style-type: none"> <li>Limited ability to improve structure and function.</li> <li>May raise road profile.</li> <li>Limited design life.</li> </ul>





# Step 3 – Review

- ▶ Internally to Materials & Road Research.
- ▶ Chapter Sub-Committees.
- ▶ All District Materials and Soils Engineers.
- ▶ Externally to CPAM, MAPA and FHWA.
- ▶ Hired five consultants.



# Step 4 – Accepted

- ▶ MnDOT Pavement Design Manual completed, October 31<sup>st</sup>, 2014.
- ▶ Signed by the Pavement Engineer, Steve Lund.
- ▶ Placed on the Pavement Design website.



# Step 5 – Website



## Pavement Design

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## Software

### Pavement Design

- [BCOA-ME: bonded PCC overlay \(whitetopping\) design](#)
- [MnPAVE-Flexible: flexible \(HMA\) pavement design](#)
- [MnPAVE-Rigid: rigid \(PCC\) pavement design](#)

*If you cannot download an executable (.exe) file, then right-click on the following link [MnPAVE-Rigid](#) and select "save target as." After saving the file, change the file extension to ".exe".*

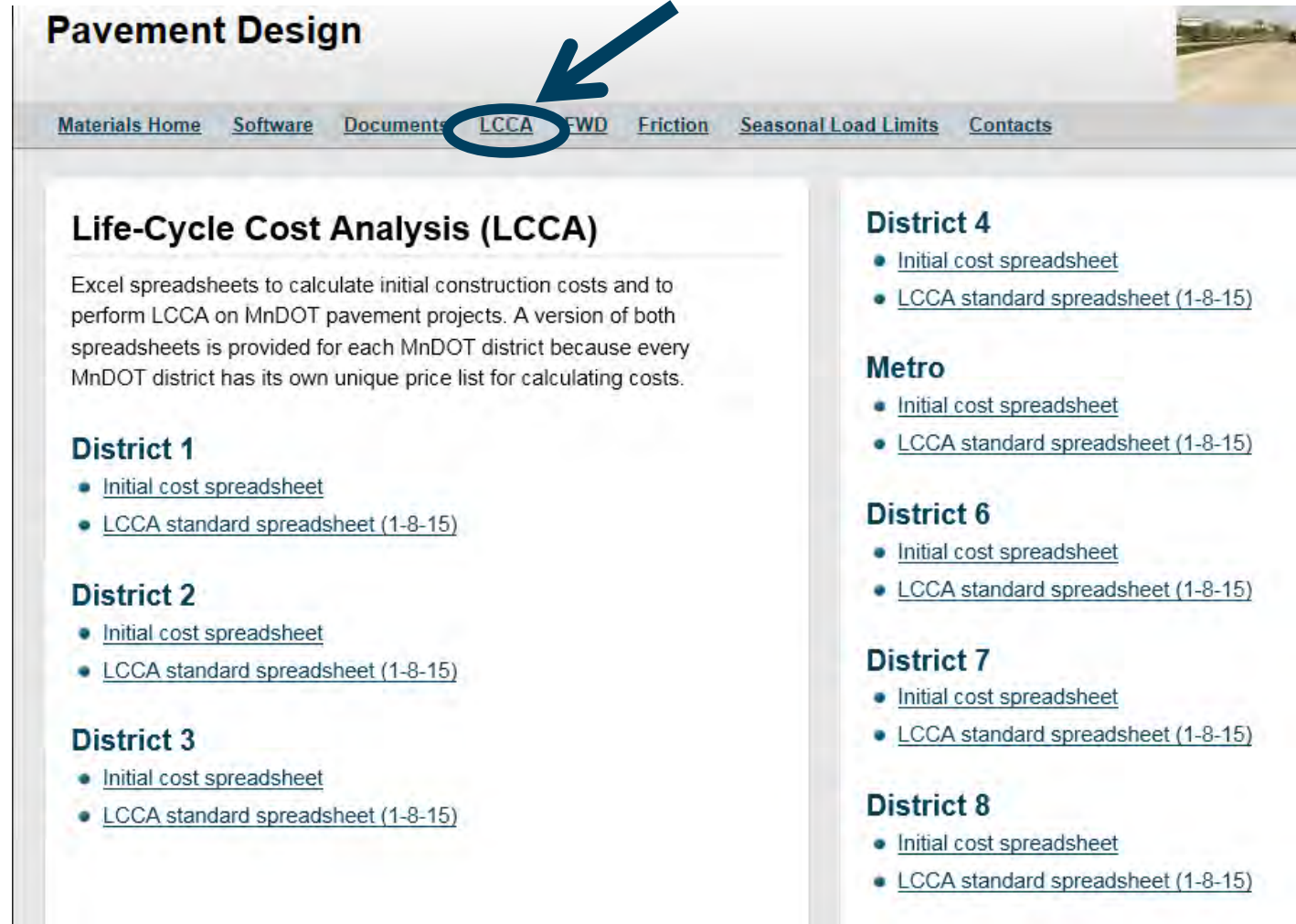
### Other

- [ESAL Forecasting Tool](#)
- [PaveCool: asphalt pavement cooling tool](#)
- [TONN program](#)

Uses FWD deflection data to determine a road's level of seasonal load restriction



# Step 5 – Website



**Pavement Design**

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## Life-Cycle Cost Analysis (LCCA)

Excel spreadsheets to calculate initial construction costs and to perform LCCA on MnDOT pavement projects. A version of both spreadsheets is provided for each MnDOT district because every MnDOT district has its own unique price list for calculating costs.

### District 1

- [Initial cost spreadsheet](#)
- [LCCA standard spreadsheet \(1-8-15\)](#)

### District 2

- [Initial cost spreadsheet](#)
- [LCCA standard spreadsheet \(1-8-15\)](#)

### District 3

- [Initial cost spreadsheet](#)
- [LCCA standard spreadsheet \(1-8-15\)](#)

### District 4

- [Initial cost spreadsheet](#)
- [LCCA standard spreadsheet \(1-8-15\)](#)

### Metro

- [Initial cost spreadsheet](#)
- [LCCA standard spreadsheet \(1-8-15\)](#)

### District 6

- [Initial cost spreadsheet](#)
- [LCCA standard spreadsheet \(1-8-15\)](#)

### District 7

- [Initial cost spreadsheet](#)
- [LCCA standard spreadsheet \(1-8-15\)](#)

### District 8

- [Initial cost spreadsheet](#)
- [LCCA standard spreadsheet \(1-8-15\)](#)



# Step 6 – Keep it current

- ▶ Annual update
  - ❑ References.
  - ❑ Standards.
- ▶ Keep making improvements (any suggestions?)



# Questions



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