1000 PAVEMENT

Highway Design Manual	***Chapter*** EXHIBITS
	Subject Table of Exhibits

HIGHWAY DESIGN

Chapter

PAVEMENT

Subject

Pavement Design

HD-1001.1 OVERVIEW

Pavement design is an integral part of the project decision process. The project team discusses, considers, and documents the pavement design as it relates to the overall project. The pavement is typically one of the major costs of a project. Pavement design affects project cost, maintenance of traffic, constructability, the environment, and other aspects of the project.

This chapter outlines policies determining:

- Who designs a pavement structure
- Who approves the design
- Accepted practices for pavement type selections

The pavement design for a project is determined by:

- Traffic volume and composition
- Soil conditions
- Materials availability
- Historical pavement performance
- Existing conditions
- Maintenance of traffic considerations
- Initial and life cycle costs

Information required for pavement design includes data on traffic information, soil properties, and project specific information. The designer is advised to request this information as soon as possible in order to develop a proposed pavement design at the earliest possible stage of the project. The procedures for determining pavement layer thickness and composition are provided in the *Pavement Design Guide* issued by the Division of Highway Design and available at http://transportation.ky.gov/Highway-Design/Pages/Pavement-Design.aspx.

HD-1001.2 PAVEMENT DESIGN RESPONSIBILITY

The project manager determines who will develop the pavement design, but the submission and approval must be done according to the following criteria:

Criteria*	Submitted By	Approved By	Type Selection Justification and LCCA** Required	Type Selection Determined By
On the NHS	Central Office TEBM for Pavement Branch	State Highway Engineer & if required, FHWA	Yes	State Highway Engineer
Structural Overlay or AADTT > 4,000	C.O. Pavement Branch Staff or Project Manager	C.O. TEBM for Pavement Branch	Yes ***	State Highway Engineer
AADTT ≥ 1,000 and ≤ 4,000; or ≥ 5 Lane Miles	Project Manager	C.O. TEBM for Pavement Branch	Yes	State Highway Engineer
< 1,000 AADTT and < 5 Lane Miles	Project Manager	District TEBM for Project Development	No	Project Manager

** Average Annual Daily Truck Traffic (AADTT) is current year data. NHS is the National Highway System.*
*** LCCA – Life Cycle Cost Analysis*
**** Structural Overlay requires Type Selection Justification and LCCA if overlay is adding more than 4 inches of new pavement.*

The project manager may request pavement designs from the Central Office Pavement Branch by submitting a request to the Transportation Engineering Branch Manager (TEBM) of the Pavement Branch.

HD-1001.2.1 On a NHS Route, or Structural Overlay, or ≥ 4,000 AADTT

The Project Manager may submit a pavement design to the TEBM of the Pavement Branch or request a pavement design from the TEBM by email. The TEBM of the Pavement Branch is responsible for submitting to the State Highway Engineer's Office when required. Any geotechnical or traffic information as well as any other documentation pertinent to the pavement design should be placed in the working pavement design folder in ProjectWise to help expedite the pavement design process. The Pavement Branch staff is responsible for notifying the project manager of the pavement design approval and providing a link to the documentation.

HD-1001.2.2 Off the NHS with AADTT ≥ 1,000 and < 4,000 or ≥ 5 Total Lane Miles

The Project Manager should submit a pavement design to the TEBM of the Pavement Branch or request a pavement design from the TEBM by email. Any geotechnical or traffic information, as well as any other documentation pertinent

to the pavement design, should be placed in the working pavement design folder in ProjectWise to expedite the pavement design process. The Pavement Branch staff is responsible for notifying the project manager of the pavement design approval and providing a link to the documentation.

HD-1001.2.3 Off the NHS with AADTT < 1,000 and < 5 Total Lane Miles

The project manager is responsible for the development of the pavement design and placing the signed pavement design in ProjectWise. The project manager shall notify the TEBM of the Pavement Branch when the document is available and provide a link to the documentation.

HD-1001.3 PAVEMENT DESIGN SUBMITTAL

Prior to final inspection, the project manager should submit the pavement design for approval to the TEBM of the Pavement Branch. The project manager shall provide a link to the appropriate documentation.

The Plan Processing Branch will ensure that all projects with new pavement have an approved pavement design. Projects must have an approved pavement design before proceeding to a letting.

All pavement design submittals should include or reference each of the following:

- Completed, current version of the *Pavement Design Catalog* spreadsheet, including:
  - Pavement Design Folder Cover (**Exhibit 1000-01**)
  - Life Cycle Cost Analysis of alternatives (if required)
  - Pavement type selection justification (if required)
  - Signed Pavement Design Form **(Exhibit 1000-02)**
- Typical sections and details
- Geotechnical information
- Traffic Forecast Request Form (from planning) **(Exhibit 1000-03)**
- Special notes and provisions (if applicable to pavement)
- Subsurface drainage details
- Overlay taper details (project specific)
- Other documentation (if available and applicable)

HD-1001.4 PAVEMENT QUANTITIES

The Department of Highways' standard summary sheets for "Paving Areas" and "Paving Quantities" are to be used in the preparation of plans. See "Weight Factors" (**Exhibit 1000-04**) and "Example Pavement Details" (**Exhibits 1000-05 and 1000-06**) for estimating pavement quantities.

When there are multiple pavement mixtures and the quantity of any specific mixture is less than 1,000 tons, substitute a similar mixture on the project that has a quantity greater than 1,000 tons or use the mainline mixture type.

HD-1001.5 STRUCTURAL OVERLAYS

A structural overlay is intended to extend the structural life of the pavement; therefore, it will consist of two or more courses of asphalt or a Jointed Plain Concrete (JPC) course. The project manager shall submit an email request for a structural overlay design to the TEBM of the Pavement Branch, Division of Highway Design. The Pavement Branch will coordinate with the project manager to determine if the existing pavement can be salvaged.

HD-1001.6 ENTRANCES, ACCESS ROADS, AND APPROACHES

The paving limits for entrances, access roads, and approaches should be a tie-down point, limits of the right of way, or other points as determined by the project team. For more guidance on paving limits, see *Standard Drawing RPM-110*.

The existing pavement type is generally used for entrances. Entrances with 10 percent or greater grade shall be paved. Use the *Pavement Design* table below for minimum pavement depths. When greater pavement depths are warranted, refer to the *Pavement Design Guide*.

For curb and gutter sections with sidewalks, use Portland Cement Concrete (PCC) entrance pavement in accordance with the current *Standard Drawing*. From the back of the sidewalk line, replace the existing pavement with one of the same type and depth if it exceeds the *Pavement Design* table below.

For access roads and minor approaches, it is generally desirable to pave with the mainline design to the back of the radius or touchdown point if the distance from the end of the radius to the touchdown point is less than 100 feet. For distances greater than 100 feet, refer to the *Pavement Design Guide* or the *Pavement Design* table below. The selected pavement design is to be structurally equivalent to or better than the existing.

PAVEMENT DESIGNS* FOR ENTRANCES, FRONTAGE ROADS, ACCESS ROADS, & MINOR APPROACHES				
DESCRIPTION	AGGREGATE BASE** (inches)	ASPHALT***		RIGID PCC (inches)
		BASE (inches)	SURFACE (inches)	
ENTRANCES				
RESIDENTIAL	4	2¼	1¼	8 on 4 DGA
COMMERCIAL	6	2¼	1¼	8 on 4 DGA
FRONTAGE ROADS, ACCESS ROADS, & MINOR APPROACHES				
RESIDENTIAL or COMMERCIAL & MINOR APPROACH ROADS	8	3	1¼	

* The pavement designs shown are suggested minimums.
** The same aggregate type as used on the main line is to be used.
*** Surface and base mixture designs should be consistent with other designs used on the project. Small quantities (generally less than 1,000 tons) of mixtures different from that used on the project are to be avoided.

HD-1001.7 SMALL PAVEMENT PROJECTS

Projects involving small quantities where paving or resurfacing is not necessarily the primary project goal (such as bridge or culvert replacements, turn lanes, and horizontal or vertical curve realignments) may be considered small pavement projects.

Pavement lengths involved will generally be on the order of a few hundred feet for a bridge or culvert replacement, or a thousand feet for turn lanes or curve realignments. Pavement typicals, pavement types, nominal aggregate sizes, paving area summaries, and plan notes should be consistent with normal pavement design warrants and plan preparation procedures.

Note: This section is **not** meant to apply to larger realignment projects involving more than one horizontal or vertical curve, nor should it apply to bridge ends and turn lanes located within larger pavement projects. It should not be used to attempt to "short cut" normal pavement design procedures where required. This section is intended to apply to isolated situations that happen to affect small amounts of pavement.

It is highly recommended to obtain cores to determine the existing pavement thickness. Typically for asphalt, the proposed pavement should be one inch thicker than the existing pavement. Concrete pavement should match the existing concrete thickness or the maximum thickness of the concrete if the concrete thickness is variable. If traffic and soils data are available or can be reasonably estimated, normal pavement design procedures should be used to determine the design thickness. If no data is available, values in the table below may be used (assuming the proposed depths meet the minimum requirement stated above).

MINIMUM PAVEMENT DESIGNS FOR SMALL PAVEMENT PROJECTS

DESCRIPTION **	AGGREGATE BASE (inches)	ASPHALT		RIGID PCC (inches)
		BASE (inches)	SURFACE (inches)	
HIGH TYPE	4	12	1¼	10 on 4 DGA
LOW TYPE	4	9	1¼	8 on 4 DGA
VLV ROUTE	6	3 ½	1¼	8 on 4 DGA

** High Type - >2 lanes or ≥4,000 AADTT
Low Type - >400 ADT, <4,000 AADTT
Very Low Volume Route (VLV) - ≤400 ADT (very minor, sometimes aggregate or chipseal type routes).

Note: These loose descriptions are a judgment call and a project could be a higher volume county route that should have pavement thickness matching the Low or High Type descriptions.

Subsurface drainage (drainage blanket and/or edge drains) should be used when it exists on the existing pavement. If no subsurface drainage exists, then no drainage will be required for these small projects. In this case, use dense graded asphalt (DGA) only and no crushed stone base (CSB) unless the CSB can be daylighted.

Provide the Pavement Branch Manager with a link to any documents relating to the pavement design. For projects qualifying as "Small Pavement Projects," provide the Pavement Branch Manager with a link to the Pavement Design Form (**Exhibit 1000-02**) in the Pavement Design folder in ProjectWise. In the note section of the form, state which of the standard designs from this section was used.

HD-1001.8 CONCRETE PAVEMENT JOINTS

The Non-Reinforced Concrete Pavement (RPN) and Standard Reinforced Concrete Pavement (RPS) series of *Standard Drawings* depict the typical conditions for

cement concrete pavement joint types and spacing. For projects where standard joint placements are impractical or undesirable, joint details shall be a required component of the construction plans. For more detail, see *Pavement Design Guide* and *Standard Specifications for Road and Bridge Construction*.

HD-1001.9 PAVEMENT DRAINAGE AND AGGREGATE BASE SELECTION

Adequate drainage must be provided to the pavement structure to insure a successful pavement service life is achieved. DGA should always be used when using a drainage blanket and piping system. **Anytime CSB is used, it must be daylighted or a piping system must be used.**

HD-1001.10 SHOULDERS

Show the shoulder pavement thickness in the pavement design document. The cross-slope for a 2-foot paved shoulder is to be the same as the mainline pavement. For shoulders greater than 2 feet, use a 4 percent cross-slope in normal sections. Full-width DGA shoulders are not recommended and should not be utilized without prior approval from the Pavement Branch Manager. For paved shoulders 4 feet or less in width, specify the same mix as used for the mainline pavement. Thickness should be determined to insure adequate structural support is provided to meet any anticipated shoulder traffic. Typically, shoulders should be designed to accommodate a minimum of 20 percent of the mainline Equivalent Single Axle Loads (ESALs). This generally correlates to carrying the top asphalt base and surface courses onto the shoulder with full-depth DGA below.

Note: Extend the surface course under the guardrail wedge curb as required. When the useable shoulder is paved and guardrail is used, consideration should be given to extending the pavement to the face of the guardrail.

When using aggregate at the outside edge of the paved shoulders, an asphalt seal is required from the outside edge of the paved shoulder to a point at least two feet down the ditch or fill slope. See *Pavement Design Guide* for more details.

HD-1001.10.1 Paved Shoulders at Bridge Ends

Paved shoulders are to be used at bridge ends for all bridge and approach projects as a means of minimizing erosion at bridge ends. See *Standard Drawings* RBB-001 and RBB-002 for details on shoulder paving at bridge ends.

HD-1001.11 INTERSECTIONS

Intersections may require special design consideration when developing the pavement design. Contact the Pavement Branch Manager for more details.

HD-1001.12 ON-SITE DETOURS (DIVERSIONS)

The pavement design of detours should be determined from project-specific conditions such as duration and traffic. A minimum pavement design is 1 inch of asphalt surface, 1½ inches of asphalt binder, and 4 inches of DGA base. Traffic-bound base (approximately 6 to 8 inches) is permitted for detours with less than 400 Average Daily Traffic (ADT) and a service life of less than 30 days. If any single course type (base, binder, or surface) amounts to less than 1,000 tons total for the project, the mainline mixture type (or the minimum mixture type used on the project) is to be substituted for that course type.

HD-1001.13 PROJECT TIE-INS

Example project tie-ins are shown in **Exhibits 1000-07, 1000-08, 1000-09**, and **1000-10**. These drawings should be modified to project specific dimensions.

Project tie-ins shall be as follows:

- **Tapers at entrances:** Tie into the existing entrance at a 1-inch to 15-inch taper (**Exhibit 1000-07).**

- **Speed less than 45 mph:** The asphalt concrete surface is to be carried full thickness into the existing pavement or bridge end. Mill the existing asphalt pavement to tie into the existing pavement surface course at a 1-inch to 10-foot taper (**Exhibit 1000-10).**

- **Speeds between 45mph and 65mph:**
  - Rigid pavement (existing): Remove the existing pavement through the taper area, backfill as necessary, and pave as shown in the pavement design at a 1-inch to 50-foot taper.
  - Flexible pavement (existing): Mill the surface as required to extend the asphalt surface course full depth into the existing adjacent pavement at a 1-inch to 50-foot taper (**Exhibit 1000-08).**

- **Speed greater than or equal to 65 mph:**
  - Rigid pavement (existing): Remove the existing pavement through the taper area, backfill as necessary, and pave as shown in the pavement design at a 1-inch to 100-foot taper.
  - Flexible pavement (existing): Mill the surface as required to extend the asphalt surface course full depth into the existing adjacent pavement at a 1-inch to 100-foot taper (**Exhibit 1000-09).**

HD-1001.14 PARKING LOTS

Pavement designs for parking lots should be addressed on a project-by-project basis. Contact the Pavement Branch Manager for further assistance.

KENTUCKY TRANSPORTATION CABINET

PAVEMENT DESIGN FOLDER

County ______________ **Item No.** ____________ **UPN** ______________

Road ______________________________ **Route** ____________

Sta. to Sta. ________________ **MP to MP** ________ to ______

Designed By ________________ **Project Length** ______ miles

Type Selection **Design ESAL's** ____________

AC ☐
PCC ☐

☐ **Requires Pavement Section Approval**

DOCUMENTATION

- ☐ **Design Executive Summary**
- ☐ **Pavement Design Form**
- ☐ **Special Notes and Provisions**
- ☐ **Type Selection Justification**
- ☐ **Geotechnical Information**
- ☐ **Traffic Information**
- ☐ **Typical Sections and Details**
- ☐ **Comparison of Alternatives**
  - ☐ Initial Cost
  - ☐ Life Cycle Cost
- ☐ **Other Documentation**

  List:

KENTUCKY TRANSPORTATION CABINET

Submittal Date: ____________

PAVEMENT DESIGN FORM

Pavement Design <4,000 AADTT
& off the National Highway System

County _____ Item _____ UPN _____

Description _____

_____

Current ADT _____ Current AADTT _____ 20-yr ESALs _____

Existing Type _____ Existing Thickness _____

Length _____Miles Design Speed _____M.P.H. CBR _____

FOR TYPICAL SECTION SEE ATTACHED SHEET(S)

ROADBED PREPARATION:

ASPHALT ALTNERNATE:

Traffic Lanes

Shoulders

DESIGNED _____ DATE _____ Designer

APPROVED _____ DATE _____ Project Manager

APPROVED _____ DATE _____ TEBM Pavement(As Required)

CONCRETE ALTNERNATE:

Traffic Lanes

Shoulders

PLAN NOTE NO.:

SPECIAL NOTE FOR:

SPECIAL PROVISION FOR:

COMMMENTS:

TRAFFIC DATA REQUEST FORM

FOR PAVEMENT DESIGN

DESIGNER INPUTS

County: _____ Project Item Number: _____

Funding Code(s): _____

Route: _____ Construction Year: _____

Begin Milepoint: _____ End Milepoint: _____

Total Number of Lanes: _____ Letting Date: _____

Project Description: _____

Designer Comments: _____

_____

Date Needed: _____ Priority: _____

Submitted By: _____ Date: _____

TRAFFIC FORECASTER INPUTS

Functional Class: _____

2-Way Avg. Annual Daily Traffic: _____

2-Way Avg. Annual Daily Truck Traffic: _____

Construction Year Truck Percentage: _____

20 Year ESALs: _____

Truck Traffic Growth Rate (Linear): _____

% Trucks in Design Direction: _____

% Trucks in Des Lane of Des Direction: _____

Forecaster Comments: _____

_____

Forecast Done By: _____ Date: _____

WEIGHT FACTORS FOR PAVING MATERIALS

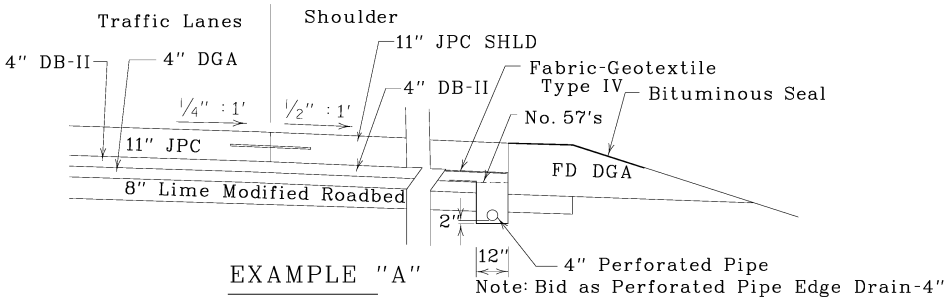
ITEM	LBS./SQ. YD./IN. OF DEPTH
Asphalt Concrete Surface, Base or Binder	110
Asphalt Concrete Surface, Base or Binder - Slag *	102
Drainage Blanket, Type I (Untreated)	95
Drainage Blanket, Type II and III Asphalt & Cement Treated)	100
Dense Graded Aggregate Base	115
Crushed Stone Base	115
Gravel Base Type I, II and III	110
Portland Cement for Gravel Base Type III (2.5% by weight)	2.75
Crushed Sandstone Base for Shoulders and Medians (Plant-Mixed, Untreated)	107
Crushed Sandstone Base (Plant-Mixed, Cement-Treated)	110
Portland Cement (5% by weight)	5.5
Asphalt Curing Seal (one application)	1.6
Sand for Blotter (one application)	5.0

* Selected Counties - Boyd, Greenup, Lawrence, Lewis, Carter

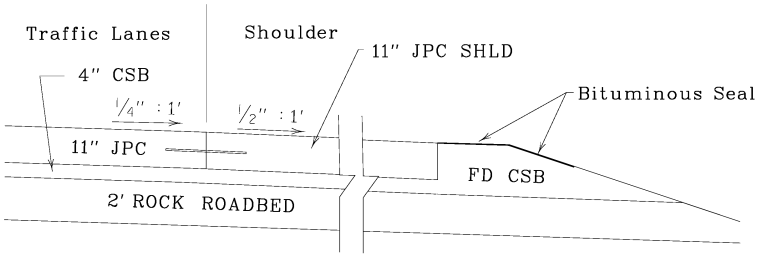
In addition, use the following reference note for Asphalt Concrete Base or Binder in the selected counties:

"Blast furnace slag may be utilized in an aggregate blend in these items in accordance with approved mix designs and current specifications. Estimate at 110 pounds per square yard per inch of depth for Asphalt Base or Binder, and Estimate at 102 pounds per square yard per inch of depth for Asphalt Surface."

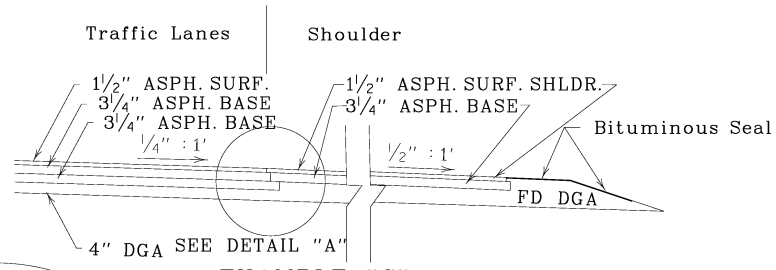
EXAMPLE PAVEMENT DETAILS WITH SHOULDERS



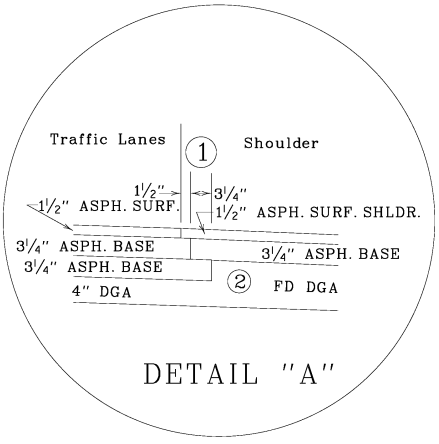
EXAMPLE "A"



EXAMPLE "B"



EXAMPLE "C"



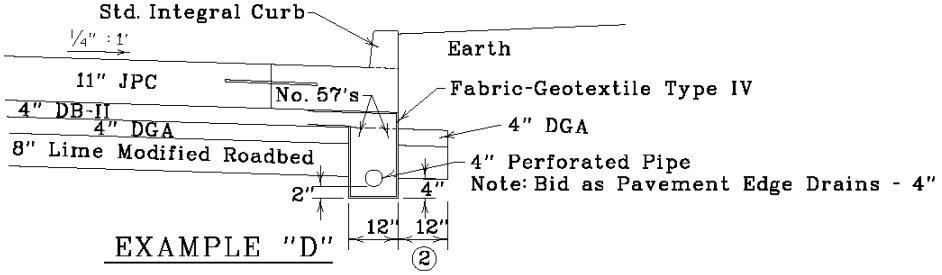
DETAIL "A"

NOTE

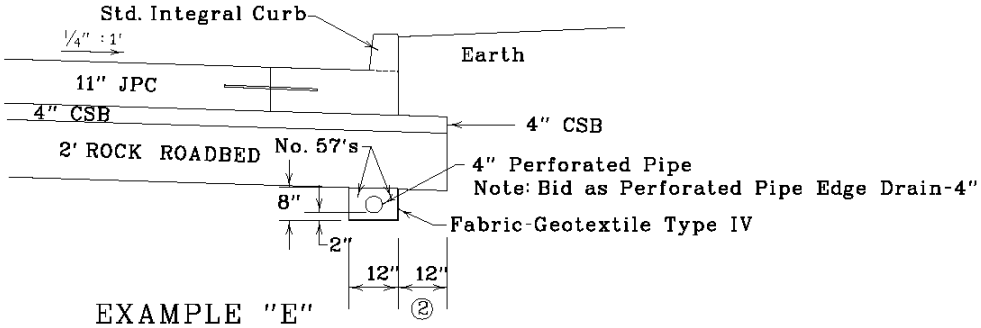
① Use the same step-out width as the thickness of the course above that course.

② Use full depth drainage blanket on 4" DGA where drainage blanket is used.

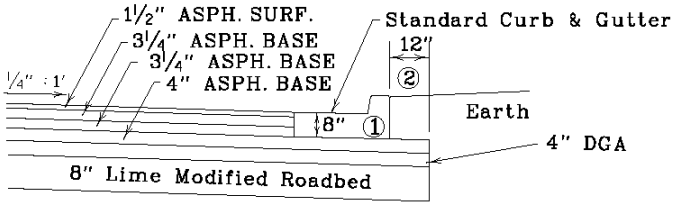
EXAMPLE PAVEMENT DETAILS WITH CURB AND GUTTER



EXAMPLE "D"



EXAMPLE "E"



EXAMPLE "F"

NOTES

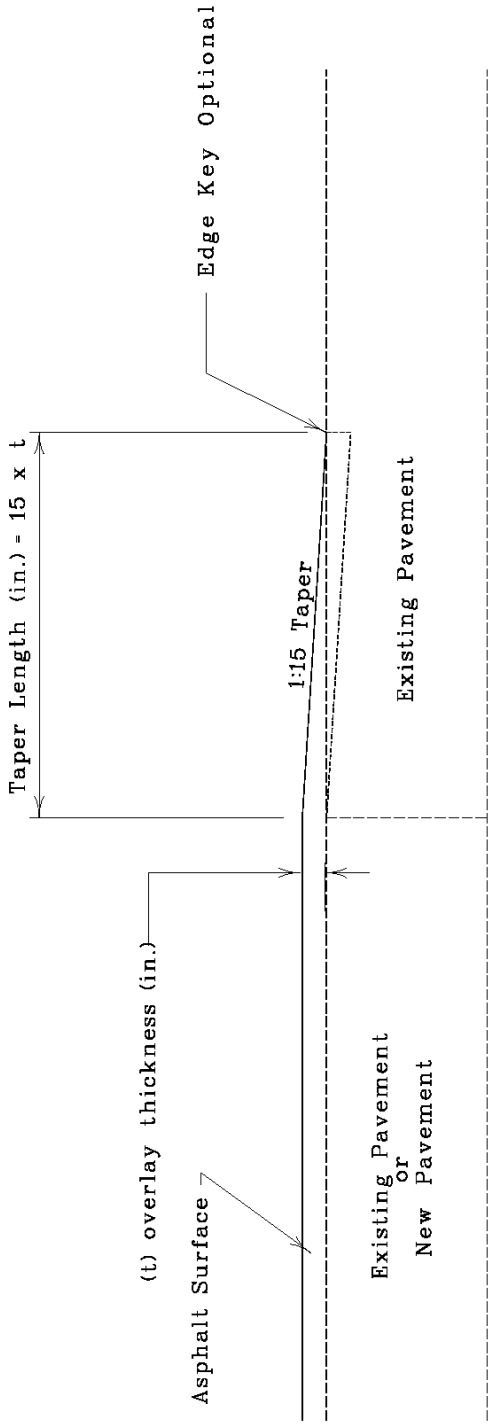
① Adjust asphalt courses such that a course "boundary" occurs at 8" with the standard 8" gutter thickness otherwise use modified curb and gutter.

② The step-out is 12" from the edge of PCCP or from the back of the curb and gutter, to facilitate form placement.

Exhibit 1000-07

TAPER AT ENTRANCES

NOTE TO DESIGNER: DO NOT COPY THIS DRAWING TO
THE PLANS, DIMENSION IT WITH APPROPRIATE DIMENSIONS.

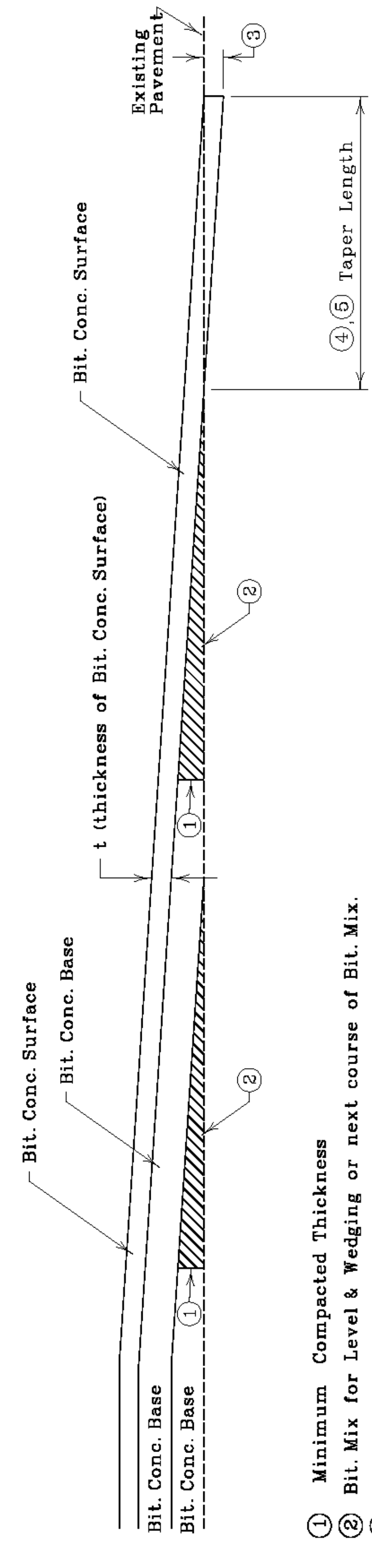


5-28-2015

DRAWING NOT TO SCALE

TAPERING OF OVERLAYS ON MEDIUM SPEED FACILITIES (45mph to 65mph)

RECOMMENDED TAPER RATE 1:600 (1" : 50')



① Minimum Compacted Thickness

② Bit. Mix for Level & Wedging or next course of Bit. Mix.

③ Bit. Surface thickness (Full Depth)

④ Mill existing pavement to receive Bit. Surface full depth (Edge Key)

⑤ Taper Length (ft) = $\frac{t(in.) \times \text{Taper Rate}}{12}$

For a Taper Rate of 1:600 (1" :50')

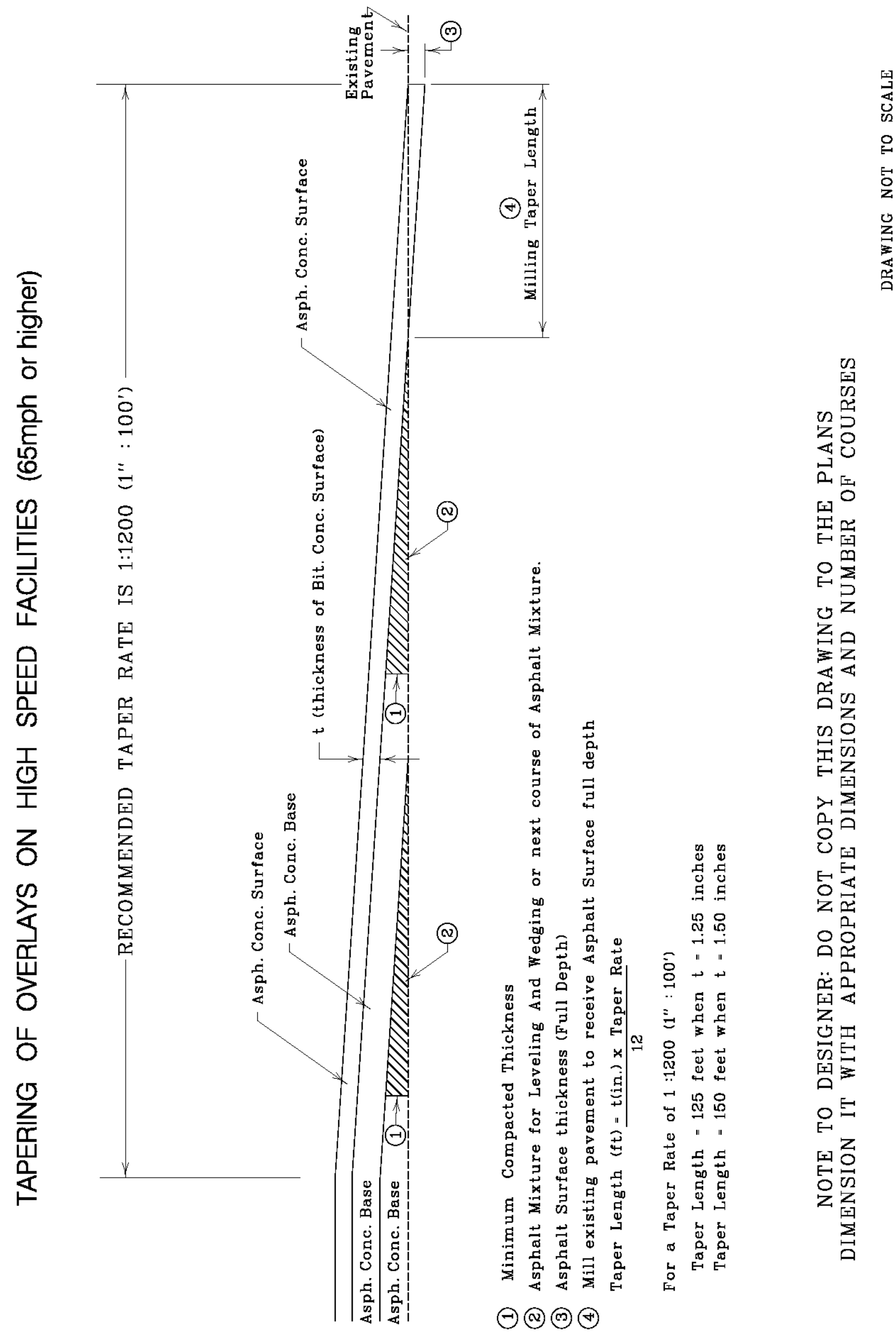
Taper Length = 62.5 feet when t = 1.25 inches

Taper Length = 75 feet when t = 1.50 inches

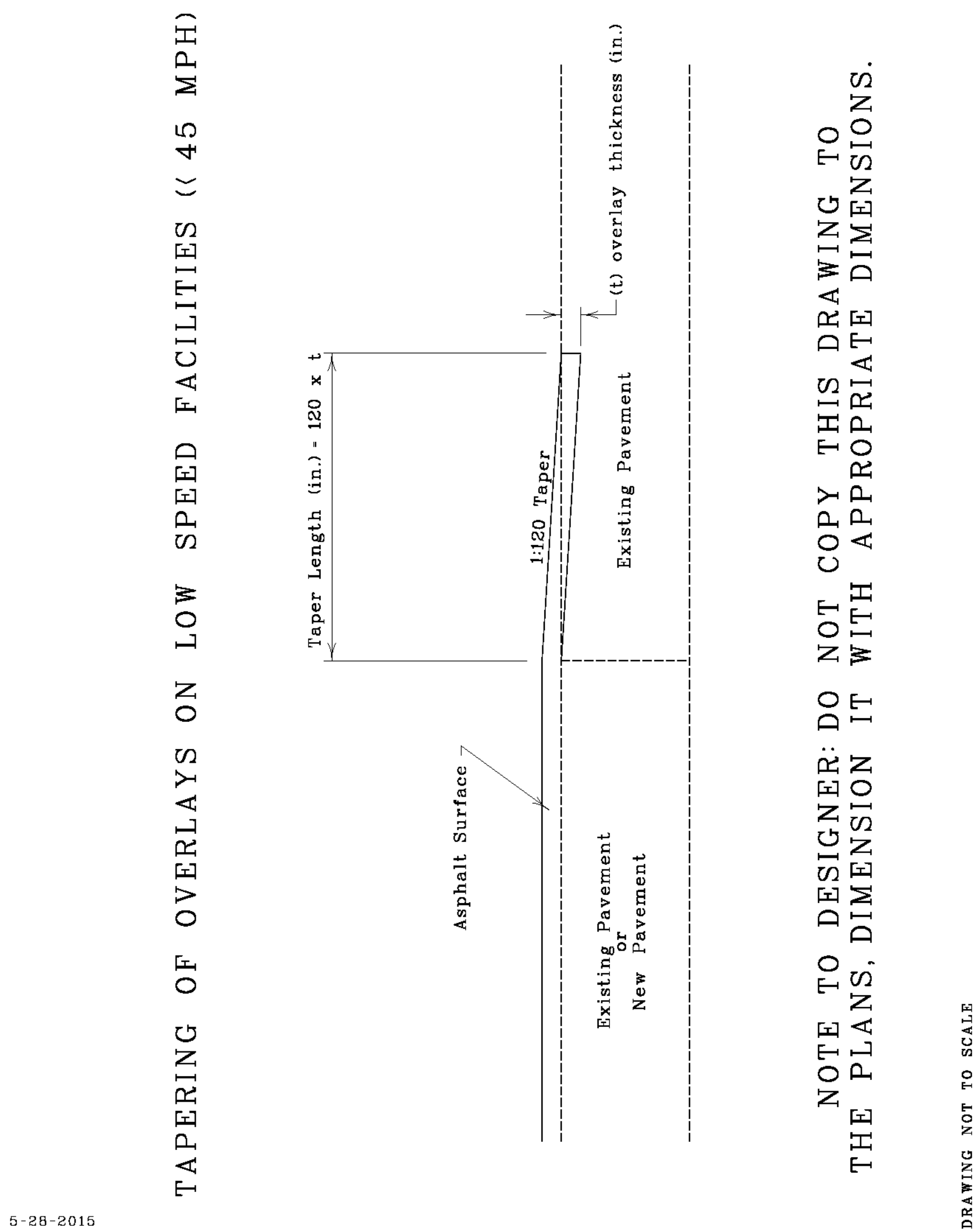
TAPERING OF THICK OVERLAYS

(PROJECT TERMINI, BRIDGE ENDS & CLEARANCE UNDER STRUCTURES)

NOTE TO DESIGNER: DO NOT COPY THIS DRAWING TO THE PLANS DIMENSION IT WITH APPROPRIATE DIMENSIONS AND NUMBER OF COURSES


TAPERING OF OVERLAYS ON HIGH SPEED FACILITIES (65mph or higher)
RECOMMENDED TAPER RATE IS 1:1200 (1" : 100')
Existing Pavement
Asph. Conc. Surface
t (thickness of Bit. Conc. Surface)
Asph. Conc. Surface
Asph. Conc. Base
Asph. Conc. Base
Asph. Conc. Base
Milling Taper Length
1 Minimum Compacted Thickness
2 Asphalt Mixture for Leveling And Wedging or next course of Asphalt Mixture.
3 Asphalt Surface thickness (Full Depth)
4 Mill existing pavement to receive Asphalt Surface full depth
Taper Length (ft) = t(in.) x Taper Rate / 12
For a Taper Rate of 1 :1200 (1" : 100')
Taper Length = 125 feet when t = 1.25 inches
Taper Length = 150 feet when t = 1.50 inches
NOTE TO DESIGNER: DO NOT COPY THIS DRAWING TO THE PLANS
DIMENSION IT WITH APPROPRIATE DIMENSIONS AND NUMBER OF COURSES
DRAWING NOT TO SCALE

5-28-2015


TAPERING OF OVERLAYS ON LOW SPEED FACILITIES (< 45 MPH)
Taper Length (in.) = 120 x t
(t) overlay thickness (in.)
1:120 Taper
Existing Pavement
Asphalt Surface
Existing Pavement or New Pavement
NOTE TO DESIGNER: DO NOT COPY THIS DRAWING TO THE PLANS, DIMENSION IT WITH APPROPRIATE DIMENSIONS.
DRAWING NOT TO SCALE
5-28-2015