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|  | <p><i>Chapter</i></p> <p>PAVEMENT</p> |
| | <p><i>Subject</i></p> <p>Pavement Design</p> |

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 maintenance of traffic, constructability, and the environment, as well as other aspects of the project.

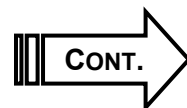
This chapter outlines policies determining:

- Who designs a pavement structure
- Who approves the design
- What the accepted practices for specific pavement conditions are

The pavement design for a project is determined by:

- Volume and composition of traffic
- Soil conditions
- Availability of materials
- Costs (initial and life cycle)

Information required for pavement design includes data on (1) traffic and axle loads from the Division of Planning and (2) soil characteristics from the Division of Materials. The designer is advised to request this information as soon as possible. The procedures for determining pavement layer thickness and composition are provided in the *Pavement Design Guide* issued by the Division of Highway Design.



PAVEMENT DESIGN

RESPONSIBILITY: On the basis of the criteria listed below, the project team shall determine whether the pavement is to be designed by district or consultant personnel or by the Rehabilitation/Pavement Branch of the Division of Highway Design.

| Criteria* | Design Responsibility | Submitted By | Approved By |
|---|---|---|--|
| NHS, Structural Overlays ≥ 20 million ESALs, ≥ 15,000 ADT, & ≥ 20% Trucks | Central Office Division of Highway Design Rehabilitation/ Pavement Branch | Central Office Division of Highway Design Rehabilitation/ Pavement Branch | Central Office Division of Highway Design and, if required, State Highway Engineer & FHWA |
| < 20 million ESALs, Off the NHS, < 15,000 ADT, & < 20% Trucks | Project Designer | District TEBM for Preconstruction to Central Office | Central Office Division of Highway Design Rehabilitation/ Pavement Branch |
| ≤ 5 million ESALs & ≤ 1 mile | Project Designer | Project Designer to District TEBM for Preconstruction | District TEBM for Preconstruction |

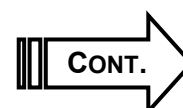
* Average daily traffic (ADT) and percent trucks are current data. Equivalent single axle loads (ESALs) are for a 20-year design. NHS is the National Highway System.

**NHS, STRUCTURAL
OVERLAYS,
≥ 20 MILLION ESALs,
≥ 15,000 ADT, &
≥ 20% TRUCKS:**

For pavement designs that are to be designed by Central Office Division of Highway Design, the project manager shall submit a written request for a pavement design to the Transportation Engineering Branch Manager (TEBM) of the Rehabilitation/Pavement Branch of the Division of Highway Design.

**< 20 MILLION ESALs
BUT > 5 MILLION
ESALs OR
1 MILE:**

The district TEBM for the Preconstruction Branch shall recommend the design to the Rehabilitation/Pavement Branch and forward it to the Central Office Division of Highway Design. Documentation and justification supporting the selection of a specific pavement type (asphalt vs. PCC [Portland Cement Concrete]), along with supporting economic analysis, shall be included in the submittal to the Central Office.



**< 20 MILLION ESALs
BUT > 5 MILLION
ESALs OR
1 MILE (cont.):**

The TEBM for the Rehabilitation/Pavement Branch shall decide whether to approve the design. The Rehabilitation/Pavement Branch staff in the Division of Highway Design is responsible for distribution of the approved pavement design for these projects. The distribution list includes the location engineer, the Plan Processing Section, and the consultant, if necessary. The project manager is responsible for submitting an updated TC 61-29E form when final plans are submitted to the Central Office Division of Highway Design.

**≤ 5 MILLION ESALs
& ≤ 1 MILE:**

Pavement designs prepared by a consulting engineering firm are to be submitted to the district. The district is to forward the pavement design (whether designed by a consultant or by district personnel) to Central Office Rehabilitation/Pavement Branch for archival and pavement management purposes and, if necessary, for review of pavement type selection justification.

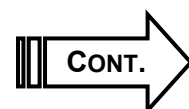
If designing a pavement for a new location or if the proposed pavement type is different from the existing pavement, the designer is to seek approval of the pavement type selection from the Branch Manager for Rehabilitation/Pavement in the Division of Highway Design. Documentation and justification supporting the selection of a specific pavement type (asphalt vs. PCC), along with supporting economic analysis, shall be included in the submittal to the Central Office.

The project manager is responsible for distribution of the approved pavement design for these projects. The distribution list includes the location engineer, the Plan Processing Section, and the consultant, if necessary.

**PAVEMENT DESIGN
SUBMITTAL
FOLDER:**

The procedure for submission of the pavement design folder is as follows:

1. The designer shall submit the pavement design folder to the district TEBM for Preconstruction for approval or recommendation.
2. The project manager submits all pavement designs to the Rehabilitation/Pavement Branch of the Division of Highway Design for review and record keeping.



**PAVEMENT DESIGN
SUBMITTAL
FOLDER (cont.):**

3. The Rehabilitation/Pavement Branch reviewer examines pavement type justification, pavement bid items, and format.
4. The Central Office returns the comments to the project manager.
5. The project manager forwards the comments to the project engineer or the consultant.
6. To ensure a proper pavement type selection, a consistent format, and appropriate use of bid items, the Rehabilitation/Pavement Branch reviews and provides comments on pavement designs, regardless of who is responsible for approval.

The pavement design folder includes the following:

- TC 61-29E form, *Pavement Design* (**Exhibit 1000-01**)
- Design executive summary
- Typical sections and details
- Design calculations
- Cost comparison of alternatives
- Pavement type selection justification
- Geotechnical information (indicate if estimated)
- Traffic information (show calculations if estimated)
- Special notes and provisions
- Other documentation, if available and applicable

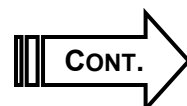
**PAVEMENT
QUANTITIES:**

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 1000-02**, and "Example Pavement Details," **Exhibits 1000-03 and 1000-04**, for estimating pavement quantities).

When there are multiple pavement mixtures and the quantity of any specific mixture amounts to 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. Minimize the number of mixtures in this manner when possible. Special consideration should be given to intersections of different classifications of roadways.

**STRUCTURAL
OVERLAYS:**

A structural overlay is intended to extend the structural life of the pavement. Therefore, it will consist of a surface course plus leveling and wedging. The project manager shall submit a written request for a structural overlay design to the Transportation Engineering Branch Manager (TEBM) of the Rehabilitation/Pavement Branch of the Division of Highway Design.



**ENTRANCES,
ACCESS ROADS,
& APPROACHES:**

The paving limits for entrances, access roads, and approaches should be 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. Pave entrances with a 10 percent or steeper grade. 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 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.

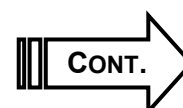
For access roads and minor approaches, it is generally desirable to pave with the mainline design to the back of the radius or touchdown point if the distance from the end of the radius to the touchdown point is less than 100 feet. For distances greater than 100 feet, refer to the *Pavement Design Guide*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

| PAVEMENT DESIGNS⁽¹⁾ FOR ENTRANCES, FRONTAGE ROADS, ACCESS ROADS, & MINOR APPROACHES | | | | |
|---|--|---|-----------------------|------------|
| DESCRIPTION | AGGREGATE BASE ⁽²⁾ (inches) | ASPHALT ⁽³⁾ BASE SURFACE (inches) (inches) | RIGID PCC (inches) | |
| ENTRANCES | | | | |
| RESIDENTIAL | 4 | 2 | 1¼ | 8 on 4 DGA |
| COMMERCIAL | 6 | 2 | 1¼ | 8 on 4 DGA |
| FRONTAGE ROADS, ACCESS ROADS, & MINOR APPROACHES | | | | |
| RESIDENTIAL or COMMERCIAL & MINOR APPROACH ROADS | 8 | 3 | 1¼ | |

⁽¹⁾ The pavement designs shown are suggested minimums.

⁽²⁾ The same aggregate type as used on the main line is to be used.

⁽³⁾ 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.



SHOULDERS: Show the shoulder pavement thickness in the pavement design document. For those sections with a two-foot paved shoulder and the remainder an earth shoulder, use the mainline pavement structure for the shoulder. The cross-slope for the two-foot paved shoulder is to be the same as the mainline pavement. Do not use full-width DGA (Dense-Graded Aggregate) shoulders.

Note: Extend the surface course under the guardrail wedge curb as required. Where the usable shoulder is paved and guardrail is used, the project team may want to consider paving to the face of the rail for ease of maintenance and mowing.

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.

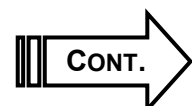
**PAVED
SHOULDERS AT
BRIDGE ENDS:**

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.

INTERSECTIONS: Intersections may require special design consideration. See *Pavement Design Guide* for more details.

**ON-SITE
DETOURS
(DIVERSIONS):**

The pavement design of detours should be determined from project-specific conditions like 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 ADT and a service life of less than 30 days. If any one 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.



PROJECT**TIE-INS:**

Project tie-ins shall be as follows:

- **Tapers at entrances:** Tie into the existing entrance at a 1-inch to 15-inch taper (see *Taper at Entrance*, **Exhibit 1000-05**).
- **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 (see *Tapering of Overlays on Low-Speed Facilities*, **Exhibit 1000-06**).
- **Speed greater than or equal to 45 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 (see *Tapering of Overlays on High-Speed Facilities*, **Exhibit 1000-07**).

PARKING LOTS:

Pavement designs for parking lots should be addressed on a project-by-project basis.

**CONCRETE
PAVEMENT
JOINTS:**

The RPN and RPS series of *Standard Drawings* depict the typical conditions for cement concrete pavement joints, types, and spacing. For projects where these 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*.

**PAVEMENT
MARKINGS:**

Pavement markings are to conform to the *Standard Drawings* TTC, TPM, TTD, and TTS series. For further guidance, refer to the Division of Traffic Operations or to the *Manual on Uniform Traffic Control Devices*.



KENTUCKY TRANSPORTATION CABINET
Department of Highways
Division of Highway Design

TC 61-29E
Rev 06/03
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PAVEMENT DESIGN <20,000,000 ESAL's & OFF THE NATIONAL HIGHWAY SYSTEM

Authorization Number _____

County _____ Item _____ UPN _____

Road Name _____ F.P. _____

Description :

Sta. _____ to Sta _____ MP _____ to MP _____

Traffic _____, Year, _____, _____, Year, _____ E.S.A.L _____

Existing : Type _____ Thickness _____

Length _____ Miles. Design Speed _____ M.P.H. Design CBR _____

Type Selection

- | | |
|------------------------------|---|
| <input type="checkbox"/> AC | <input type="checkbox"/> Requires Pavement Section Approval (>5,000,000 ESALs and 1 mile) |
| <input type="checkbox"/> PCC | <input type="checkbox"/> Pavement Design Update |

DOCUMENTATION

- | | | |
|---|--|--|
| <input type="checkbox"/> Design Executive Summary | <input type="checkbox"/> Traffic Information | <input type="checkbox"/> Other Documentation |
| <input type="checkbox"/> Special Notes and Provisions | <input type="checkbox"/> Typical Section and Details | List: _____ |
| <input type="checkbox"/> Type Selection Justification | <input type="checkbox"/> Comparison of Alternatives | _____ |
| <input type="checkbox"/> Geotechnical Information | <input type="checkbox"/> Initial Cost | _____ |
| | <input type="checkbox"/> Life Cycle Cost | _____ |

DESIGNED _____ DATE _____
Pavement Designer

APPROVED _____ DATE _____
T.E.B.M. for Preconstruction

APPROVED _____ DATE _____
T.E.B.M. for Pavement Design (As Required)

Item Number _____

SUBGRADE PREPARATION

PAVEMENT
Traffic Lane

Shoulders

Plan Notes, Special Provisions and Special Notes

WEIGHT FACTORS FOR PAVING MATERIALS

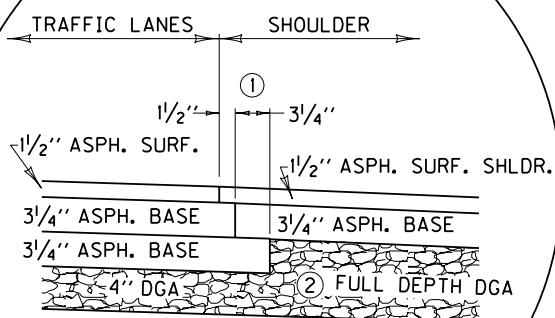
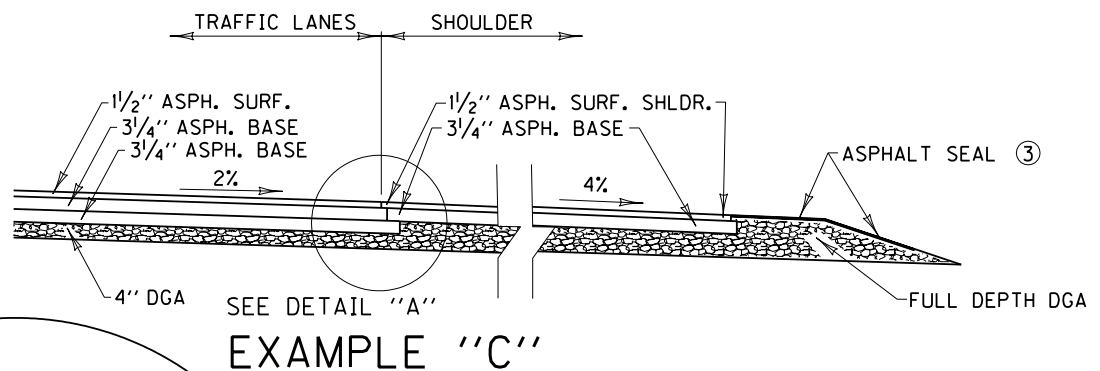
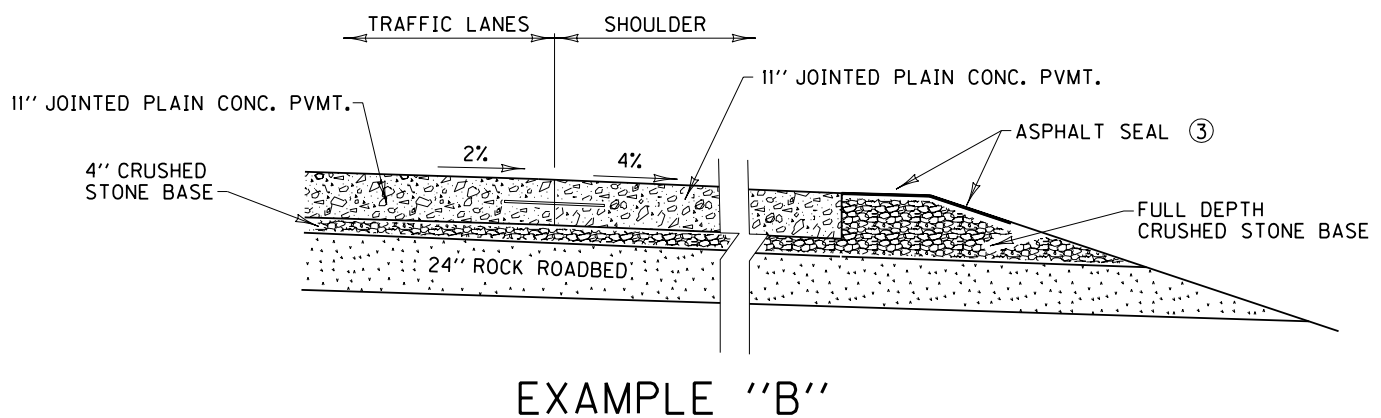
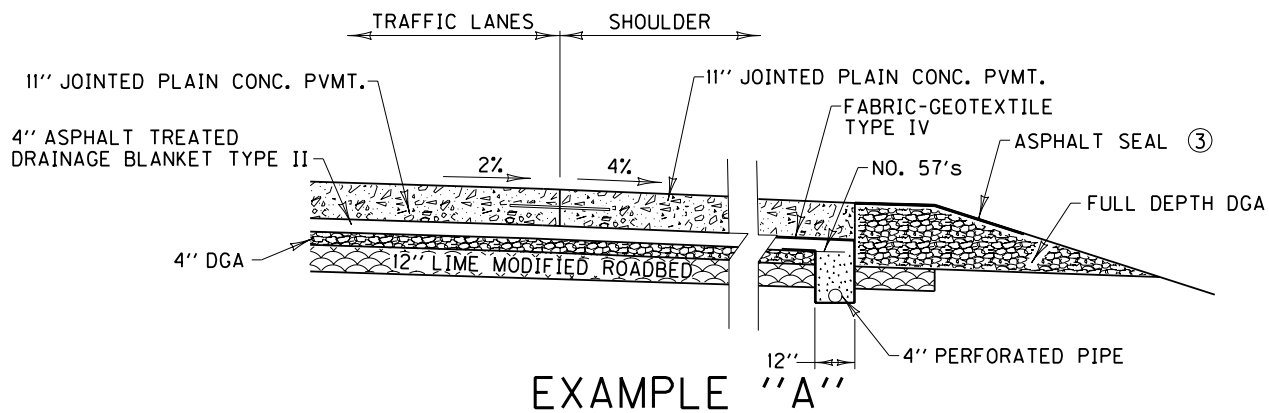
| ITEM | LBS./SQ. YD./IN. OF DEPTH |
|--|----------------------------------|
| Asphalt Concrete Surface, Base or Binder | 110 |
| Asphalt Concrete Surface, Base or Binder - Slag * | 102 |
| Drainage Blanket, Type I (Untreated) | 95 |
| Drainage Blanket, Type II and III (Asphalt & Cement Treated) | 100 |
| 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

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. Estimated at 110 pounds per square yard per inch of depth."

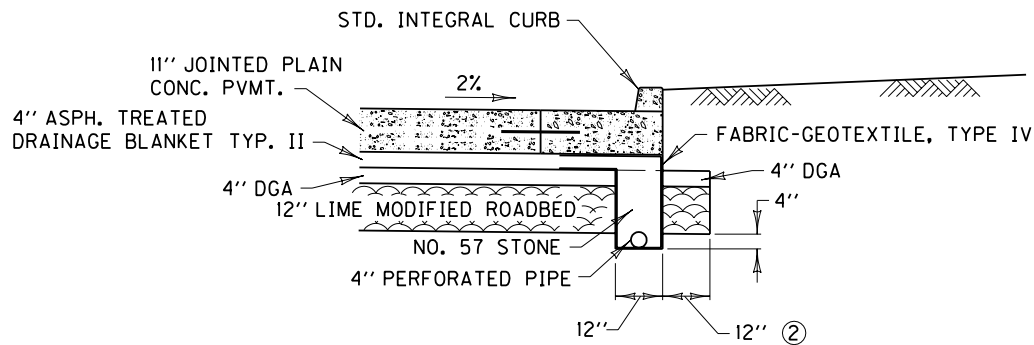
EXAMPLE PAVEMENT DETAILS WITH SHOULDERS



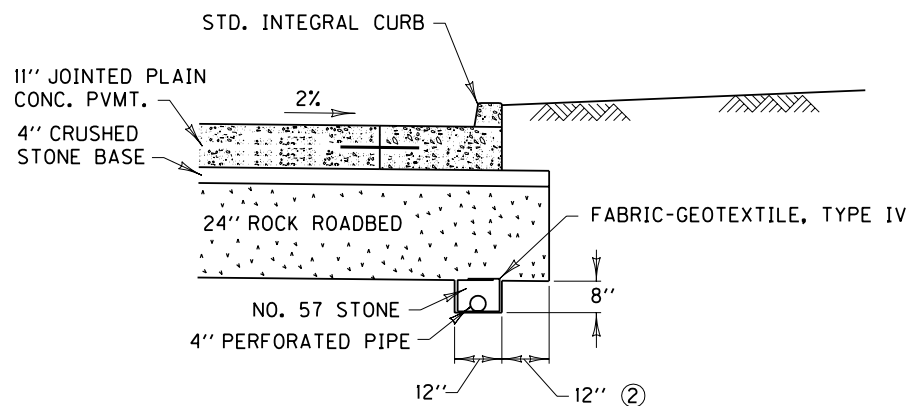
NOTES:

- 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.
- ③ ASPHALT SEAL REQUIRED FROM THE OUTSIDE EDGE OF PAVED SHOULDER TO A POINT 2'-0" DOWN THE DITCH OR FILL SLOPE.

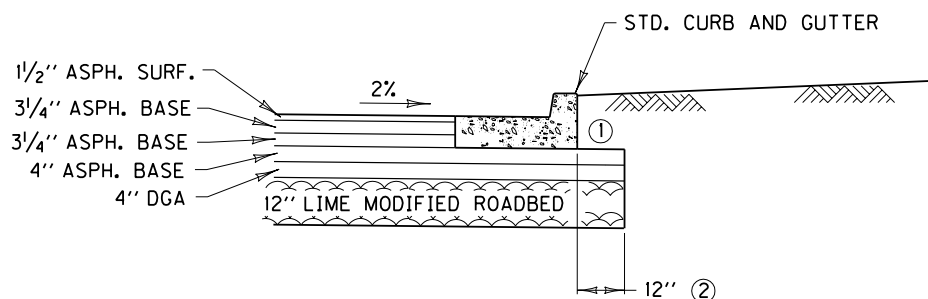
EXAMPLE PAVEMENT DETAILS WITH CURB AND GUTTER



EXAMPLE "D"



EXAMPLE "E"

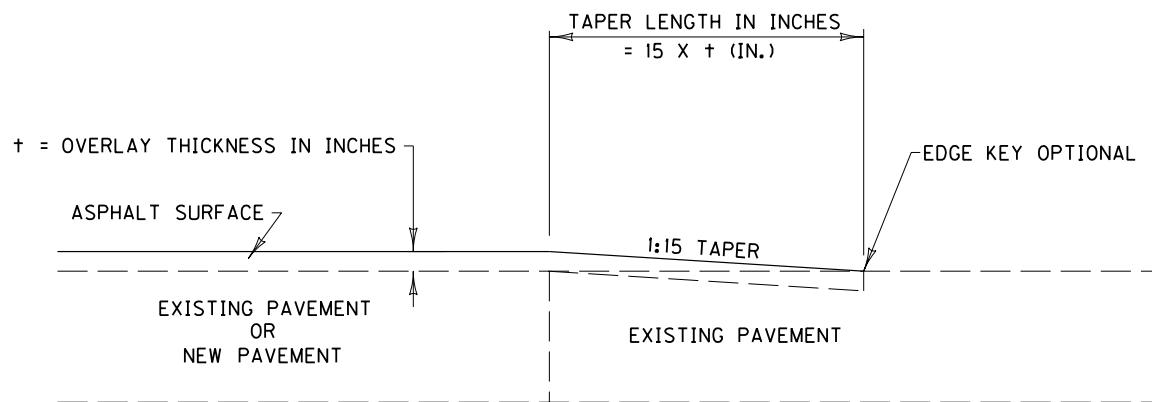


EXAMPLE "F"

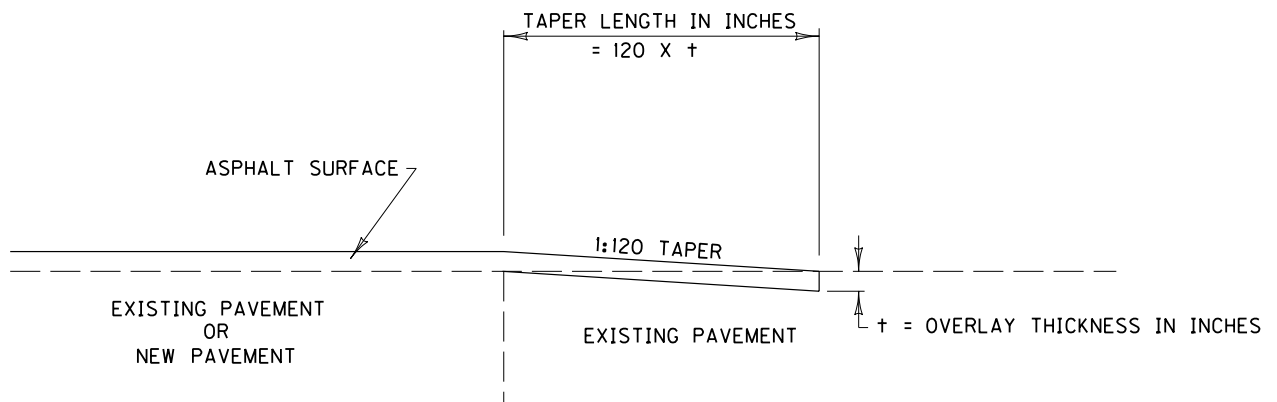
NOTES:

- ① ADJUST ASPHALT COURSES SUCH THAT A COURSE "BOUNDARY" OCCURS AT 8" WITH THE STANDARD 8" GUTTER THICKNESS FOR EASE OF CONSTRUCTION OR USE A MODIFIED CURB AND GUTTER PLACED ON THE 4" DGA COURSE.
- ② CONSTRUCT STEP-OUT 12" FROM EDGE OF PCC PAVEMENT OR BACK OF CURB AND GUTTER, TO FACILITATE FORM PLACEMENT.

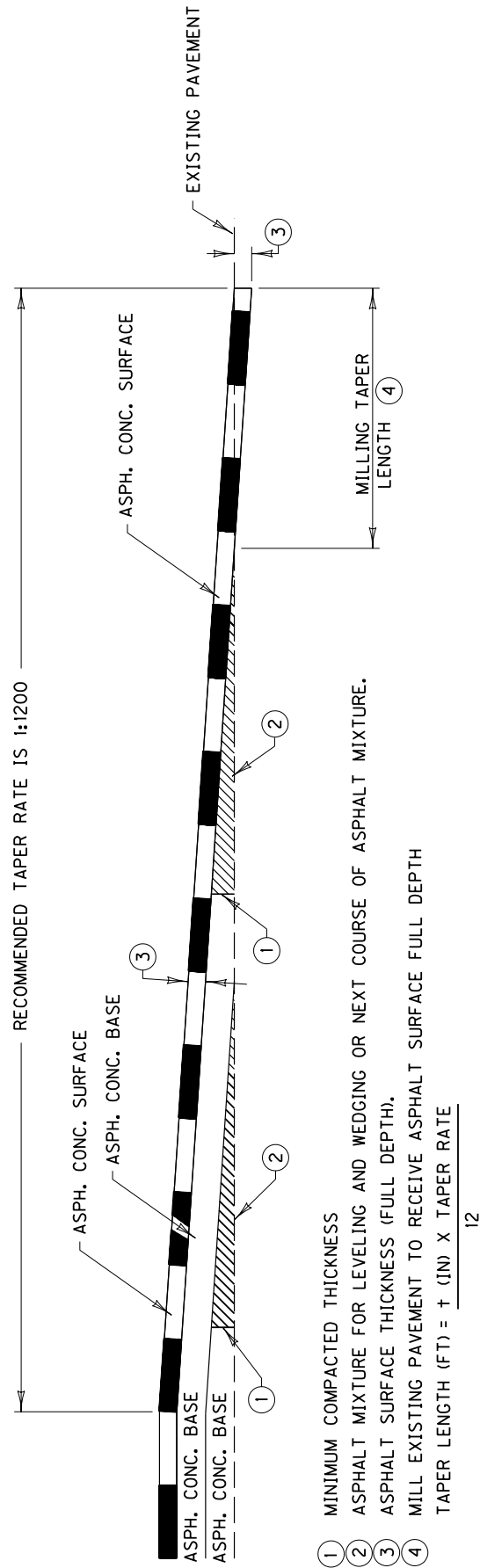
TAPERING AT ENTRANCES



TAPERING OF OVERLAYS ON LOW SPEED FACILITIES (< 45 MPH)



TAPERING OF OVERLAYS ON HIGH SPEED FACILITIES (≥ 45 MPH)



FOR A TAPER RATE OF 1:1200
TAPER LENGTH = 125 FEET WHEN $t = 1.25$ INCHES
TAPER LENGTH = 150 FEET WHEN $t = 1.50$ INCHES