Design Standards Letter

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Section/Plan No.: na

Subject: Alternate Pavement Design

Body

Although the concept of using an alternate bidding process to specify pavement types is a relatively new concept to MoDOT, the department is already beginning to realize its benefits by way of monetary savings. Recently, a new aspect of the process has come into being, namely, the concept of alternate bidding on projects less than two lane miles in length. As this represents a change in direction for the process and must be implemented with the October 2004 letting, the Central Office has committed to providing guidance on this issue by July 2004. Given the dynamic nature of the alternate bidding process, however, the Design Division does not wish to release the Project Development Manual (PDM) revision until all of the details of implementation have been determined completely.

The Central Office has already enjoyed a great participation on the part of the Districts in establishing alternate bidding policy. The continuation of this participation into the weeks and months to come will be critical as MoDOT strives to implement this money-saving process in the most efficient manner. This cooperation should minimize the constant establishment and subsequent retraction of policy, which is so detrimental to the production of District design staff. For that reason, this letter will provide interim guidance in the form of draft PDM text in order to allow the process to continue to develop.

Draft revisions to PDM sections 6-03 and 6-04 as well as a special sheet depicting Type A2 shoulder alternates are attached to this letter. Both sections have been greatly revised, but the Districts' attention is called to the following subsections in particular:

6-03.3 (2) Revised to include the requirement for alternate bids on projects less than two lane miles in length.

6-03.3 (4,5,6) Revised to reflect the recent input of several districts as to their maximum design efficiency concerning the implementation of alternate pavement bids.

6-03.6 Revised to strongly discourage the use of composite pavements.

6-04.2 (1)(e) Revised to present the new definition of A2 shoulder as it relates to alternate bidding.

Please review these entire drafts carefully as they will be considered interim policy. Again, the Design Division is working with the paving industry as well as the Districts to create a useable final policy as quickly as possible. Questions or comments concerning the alternate bidding process may be directed to Joe Jones (573) 751-3813, Dan Tschirgi (573) 526-2924, or Travis Koestner (573) 526-2923.

DH/jj
Attachments

DUAL
SECTION 6-03
PAVEMENTS

6-03.1 GENERAL. Pavements are designed to provide adequate support for loads imposed by traffic, and to provide a uniformly firm, stable, smooth, all-weather surface. To achieve these objectives, the subgrade, base, and surface are so designed that the pavement will not fail under design loads. Pavements are divided into flexible or rigid types. Flexible pavement consists of a relatively thin bituminous wearing surface constructed over a bituminous base course. Rigid pavement is constructed of portland cement concrete. Either rigid or flexible pavement may be placed on an 18 in. [0. 45 m] rock base on a compacted subgrade, a stabilized permeable base on a Type 1 aggregate base on a compacted subgrade with a drainage system (see Subsection 6-02.3), or a Type 1 or Type 5 aggregate base on a compacted subgrade, depending on the class of pavement or other factors. However, the preferred base for all new rigid and flexible pavements, light, medium or heavy duty, is an 18 in. [0.45 m] rock base whenever available in suitable quantities on or in close proximity to the job. The primary difference between the two types of pavement, flexible and rigid, is the manner in which they distribute loads over the subgrade. The load carrying capacity of flexible pavements is brought about by the load distribution characteristics of the layered system. The rigid pavement, because of its rigidity and high modulus of elasticity, tends to distribute the load over a wide area of subgrade. Because a major portion of the structural capacity is supplied by the rigid pavement itself, minor variations in subgrade strength have little influence upon the structural capacity of the pavement. Pavement surfaces should be designed to withstand the abrasion and impact of traffic, adverse weather conditions, unfavorable subsurface soil and water conditions, and other deteriorating influences. Until such time that a decision has been reached concerning the design of the pavement to be constructed, all references to pavements are confined to the terms "Heavy Duty Pavement", "Medium Duty Pavement", or "Light Duty Pavement" as hereinafter defined. The category of pavement duty for each route is indicated in Figure 6-03.13, which describes various pavement corridors. The figure is based on projected accumulative ESALs over a 35 year period for each route and is kept current by the Planning Division. Recommendations concerning pavement duty other than indicated by the design traffic may be made by the district in the letter which requests the pavement thickness determination. If such recommendations are made, the letter must include reasons substantiating the recommendation. Pavement thickness determination, however, is made only after consideration of bidding the project with alternate pavements, a thorough analysis of costs, availability of materials, projected traffic volume and type, soils characteristics, and other factors. When necessary, General Headquarters Construction and Materials may use criteria other than that stated in this manual in order to arrive at a design that is appropriate for special circumstances that occur.

6-03.1 (1) HEAVY DUTY PAVEMENTS. Heavy duty pavements consist of all interstate and select primary routes with more than 50 million accumulative flexible or rigid ESALs for a 35 year period. See Figure 4-04.1 for typical sections and Figures 6-03.8, 6-03.9 and 6-03.10 for pavement and shoulder details. All heavy duty pavement is constructed on a drainable base system or, when economically available, an 18 in. [0.45 m] rock base.

6-03.1 (2) MEDIUM DUTY PAVEMENTS. Medium duty pavements consist of all routes with either 25-50 million

accumulative flexible ESALS or 40-50 million accumulative rigid ESALs for a 35 year period. See Figure 4-04.1 for typical sections and Figures 6-03.6, 6-03.7, 6-03.9, and 6-03.10 for pavement and shoulder details. All medium duty pavement is constructed on Type 5 base with a pipe drainage system or, when economically available, an 18 in. [0.45 m] rock base. The pipe drainage system is not provided under the inside shoulders on multi-lane divided highways.

6-03.1 (3) LIGHT DUTY PAVEMENTS. Light duty pavements consist of all routes not included in the heavy or medium duty pavement categories. Light duty pavements are further divided into four categories by ADT (Average Daily Traffic). See Figure 4-04.1 for typical sections and Figures 6-03.1, 6-03.2, 6-03.3, 6-03.4 and 6-03.5 for pavement and shoulder details. All light duty pavement is constructed on Type 1 base or, when economically available, an 18 in. [0.45 m] rock base. The 18 in. [0.45 m] rock base is designed as shown for the Type 5 base with the exception that it will always be sloped at the edge on a 1:1 slope. When sufficient amount of Class C excavation material is available on the project, the 18 in. [0.45 m] rock base should be daylighted to the in-slope or fill-slope.

6-03.1 (4) DEFINITIONS. ESALs are defined as the summation of equivalent 18,000 lb [8,165 kg] single axle loads (ESAL) for the design period. For purposes of pavement thickness determination, the number of ESALs used is adjusted to represent the lane with the heaviest use. Rigid ESALs and flexible ESALs will not be the same for a given section of pavement and both numbers must be determined prior to pavement design. It should be noted that the ESALs provided for a given roadway by the Planning Division is the total bi-directional traffic on that roadway and needs to be divided in half when computing the accumulative number of ESALs for a given project in determination of the pavement thickness. Use 35-year ESALs for all projects except short bridge projects, in which case use 20-year ESALs.

6-03.2 PAVEMENT THICKNESS DETERMINATION.

Pavement thickness determination is made by the district for light duty pavements, including outer roadways, having a design traffic of 750 ADT or less. A pavement thickness request should be submitted on all other jobs to General Headquarters Construction and Materials, with a copy to General Headquarters Design during the early stages of project scoping. The request should be submitted in a separate letter and should include the following:

- a description of the existing and design template for the mainline and any other roadways associated with the project (appurtenances) requiring a pavement structural design
- the existing pavement structure on each end of the new pavement
- special conditions prevalent within the project area that may affect design consideration including alternate pavement consideration
- length of each new pavement to be designed, including log mile [log km] reference and exceptions
- project bid opening date
- traffic data (construction year ADT, design year ADT, construction year flexible and rigid ESAL's)
- soils survey
- the districts recommendation regarding pavement thickness

After the results of the pavement thickness determination have been furnished, the district is fully responsible for its continued applicability. The district should request a review of the study if the project changes, such as (1) being delayed beyond the anticipated construction year, (2) traffic loads change, (3) being expanded or broken into sections, or (4) a revised typical section, etc.

If the number of design ESALs is between zero and 75,000 and if dust can be tolerated, a 2 in. [50 mm] thickness of gravel, crushed stone, or chat is used. The primary applications of an aggregate surface are (1) temporary bypasses, (2) outer roadways, and (3) roadways to be turned over to another agency. When a dust free surface is required, a rigid or flexible design is determined using Figures 6-03.11 or 6-03.12.

6-03.3 ALTERNATE PAVEMENTS. To ensure that every effort is being made to increase the competition for

paving contracts, and that the latest market rate is considered when determining pavement type, contractors will be allowed to bid a selected alternate design. This will enable contractors to structure their bid around availability of suppliers, materials and use methods they are confident in performing. By utilizing alternate bids the result of equivalent long term pavement rehabilitation at the best value for our highway dollars will be obtained. Future maintenance costs will be considered with a life cycle cost adjustment factor, thus resulting in the most equivalent specifications possible to draw in the maximum number of bidders for MoDOT paving projects.

6-03.3 (1) ALTERNATE OPTIONS. Alternate pavement scenarios include for full depth: full depth concrete vs. full depth superpave or bituminous pavement; for long-term pavement rehabilitation; unbonded concrete overlay vs. superpave asphalt over rubbilized pavement. These options will be bid as alternate options with the inclusion of a life cycle cost adjustment factor which will be added to the lowest asphalt bid to take into consideration the future rehabilitation cost for each pavement type. This life cycle cost adjustment factor considers future cold milling and overlay of the surface layer of asphalt at 20 and 33 year intervals and diamond grinding of the concrete surface at 25 years. The last published real interest rates from the United States Office of Management and Budget will be used to bring the future costs to present worth. The Design Division will calculate the cost adjustment factor utilizing the most updated information available.

6-03.3 (2) ADDITIONAL SELECTION CRITERIA. All paving projects should be designed with alternate bids for pavements in mind. Projects that contain more than 2 lane-miles of paving should be bid as alternate pavements and will include the life cycle cost adjustment factor as calculated by the Design Division. Projects with less than 2 lane-miles should be bid with alternate pavement designs but will generally not have a life cycle cost adjustment factor. A lane is defined as pavement 12 2 feet (3.6 0.6 m) wide. Outer roads and full depth paved shoulder widths that have the same pavement type and thickness as the mainline should be included when calculating lane-miles.

Pavements that have constructability or other prevailing issues which make only one type of pavement construction desirable should be justified as to why alternate bids on pavement for that project is not feasible. This may include circumstances such as widening existing pavements with safety and durability issues due to differing pavement types in the driving lanes, urban construction, consideration of how the pavement type effects the major item of work for the project (example if major item of work for the project is bridge work the life cycle costs may be insignificant to the total project cost), total amount of paving compared to existing pavement, project staging and project scoping with regard to long-range transportation goals. The documentation should be submitted to the Technical Support Engineer for your area in the Design Division for approval with assistance from the Construction and Materials Division. Any exceptions should follow the design exception process as outlined in Section 2-01.9.

All interstate projects, with the exception of 4R projects on Route I-70 or 4R projects involving short-term rehabilitation strategies, will normally involve alternate bids on pavements. The rehabilitation strategy for interstate routes should be alternate bids on pavements with the alternates being an 8" concrete unbonded overlay over a 1" AC bond breaker or 1 3/4" SP125BSM over 3" SP250B over 7 1/4" SP250C over rubbilized concrete pavement. At a minimum, the top 4 3/4" of the HMA overlay need to use polymer modified asphalt in accordance with Section 6-07 and the remaining lifts PG 64-22 asphalt binder. Justification must be given and approval received from the Central Office to use anything less than these two alternates, such as a 7 3/4" AC overlay. Route I-70 has been exempted from alternate bids at this time because long-term rehabilitation strategies are not under consideration until it has been established what existing lanes will be used in the future capacity expansion of the facility.

6-03.3 (3) ALTERNATE ESTIMATES. For alternate bid projects on pavements, it is recommended that job cost estimations during the early scoping stages of the project be based upon the following:

(a) For projects involving new construction, base costs on the construction of concrete pavement, using the appropriate design thickness provided in Figure 6-03.12.

(b) For projects involving a concrete unbonded overlay, base costs on the construction of a 8-inch [200 mm] concrete unbonded overlay as the design thickness plus an additional one inch [25 mm] thickness to allow for adjustment of the

profile grade in order to eliminate existing undulations in the pavement and to re-establish a smooth profile grade. See Subsection 6-05.18 for guidance on reestablishing a smooth profile grade on concrete unbonded overlay projects.

The following are design guidelines for different project scenarios:

6-03.3 (4) GRADING PROJECT SEPARATE FROM PAVING WITH 18 IN. [0.45 m] ROCK BASE. *(For medium and light duty pavements with 18 in. [0.45 m] rock fill base there is no difference in pavement thickness between concrete and asphalt pavement designs.)*

- For this scenario, there will only be a 1" difference in pavement thickness between concrete and asphalt pavement designs on heavy duty pavements. There is not a thickness difference for medium and light duty pavements.
- The subgrade profile should be designed for the thicker pavement alternate.

If the thinner option is constructed the profile grade will be achieved by either adjusting the base or placing thicker pavement and be included in the contract unit price for sub-grading and shouldering, class 1 or the pavement item(s).

6-03.3 (5) GRADING PROJECT SEPARATE FROM PAVING PROJECT, WITHOUT 18 IN. [0.45 m] ROCK BASE.

- Maximum difference between the concrete and asphalt pavement thickness is 6 inches (150 mm).
- Grading project is designed for thinner pavement design.
- The design profile grade is maintained for either alternate pavement.
- In the paving project the removal of sub-grade material for asphalt pavement design will be paid for as subgrading and shouldering, class 1.
- Design profile to accommodate minimum cover *(asphalt pavement thickness should control)* of crossroad structures.

6-03.3 (6) GRADING AND PAVING TOGETHER IN ONE PROJECT. *(Preferred method)*

- Design for pavement as per pavement thickness determination process outlined in Section 6-03.2 (Alt. A).

Design profile grade to accommodate minimum cover *(* thicker pavement should control*)* of crossroad structures.

- The plans should show one set of cross-sections with volumes for each of the pavement alternates. The cross sections are designed according to the pavement thickness determination process (Alt. A), with added or deducted yardages for Alternate B noted in profile balances of the plan/profile sheets and 2B sheets.
- For pavements less than 2 lane-miles design for the thinner pavement. No differing quantities need to be set up for the alternates. If they choose to build the thicker pavement, the contractor will be responsible to meet the final profile at the contract unit prices for any item set up in the project which was designed for the thinner.

6-03.3 (7) PLANS FOR ALL ALTERNATE BIDS FOR PAVEMENT PROJECT.

Plans for all alternate bids for pavement projects should contain:

- Typical sections for both alternates, including station limits, and all side road connections shall have the pavement type designated.
- One set of 2B sheets with Alt. A and Alt. B items separated by alternate and clearly labeled.
- Using the "Estimate 2000" program, the pavement, base and grading quantities for Alternate A should be designated as "Section 02" and the pavement, base and grading quantities for Alternate B should be designated "Section 03". This will enable summation of the appropriate subtotals to compile an estimate total cost per alternate.
- Pay items should not be repeated in "Section 01" and an alternate section, "Section 02 or 03". For example Class A should not show up twice in the same project, this would lead to differing bids for Class A and cause confusion when administering the contract. If the Class A quantities differ include the appropriate total Class A quantity in each of the alternates.
- Design Special Provision-ALTERNATE FOR PAVEMENTS DSP-96-04F. Life Cycle Cost adjustment factor to be

calculated by Headquarters office.

- All pay items for alternate bid full depth pavements shall be in square yards for the entire pavement surface.
- All pay items for alternate bids for rehabilitation projects shall be tons [Mg] for asphalt or cubic yards [m3] for concrete.
- To calculate the Life Cycle Cost Analysis factor, quantities for the traveled way are needed. These quantities need to be included with the submittal letter. For example the traveled way will include 12 ft lanes [3.6 m] for mainline and 18 ft [5.4 m] lanes for ramps, any area considered as shoulder is not the traveled way.

6-03.4 FLEXIBLE PAVEMENT DESIGN.

6-03.4 (1) THICKNESS DESIGN. The design table shown on Figure 6-03.11 is used as a basis for determining flexible pavement thickness. The thickness design table has been developed according to the theory that the thickness should vary with the increase in traffic loads. Flexible pavement thickness is also dependent upon the characteristics of subgrade, and for this purpose the group index, calculated from the results of soil tests, is the most reliable indicator. Knowing the group index of the soil that will comprise the subgrade, and the volume of traffic loading, the appropriate entry is selected from the design table, which was developed using the AASHTO design equations, to determine the required thickness. Although final decisions regarding pavement design are made by Central Office Construction and Materials, the districts are at liberty to employ the use of this flexible pavement design table in order to make specific recommendations regarding the principal roadway, outer roadway, service road, or temporary bypass pavement thickness.

6-03.4 (2) BITUMINOUS MIXTURES AND ASPHALT BINDERS. Refer to Section 6-07 for guidelines on selection of bituminous mixtures and asphalt binders to be used in full depth pavements. Where a different type of mixture is specified for the shoulder than the traveled way, the type of material should be changed at the shoulder construction joint as specified on the plans.

All surface lifts will be 1-/ in. [45 mm] thick. Computation of the square yard [m2] quantities for all bituminous mixtures for full depth pavements should be based on the final surface area of the pavement. No allowance should be made for the construction of the required 1:1 slope along the edge of the pavement or an individual lift. When payment is made by the ton [Mg], the material in the required 1:1 slope is included in the volumetric calculation.

6-03.4 (3) BITUMINOUS BASE LAYER. Only the lift thickness of the surface mixture needs to be specified. For medium and heavy duty pavements, the upper 4 3/4 inches [100 mm] of pavement are constructed with polymer modified asphalt mixes, as shown on the typical sections referenced in Section 6-03.1. For the remaining base layer mixtures, the minimum mix quality is shown without lift thicknesses.

6-03.4 (4) SELECTIVE GRADING. The total thickness of a flexible pavement can sometimes be reduced by capping poor (high group index) soils with some thickness of material of better quality and strength. Suitable material may be obtained from either the roadway excavation or from a borrow area. When material with a group index of 0 is available in adequate quantities, a minimum of 18 in. [460 mm] may be placed over the existing subgrade, as a capping material. The properly placed and compacted material may be considered as having a group index of 0 and the pavement designed using the appropriate tables and based on that number. The decision to use capping material is based on its economic cost as a substitute for a thicker pavement structure. Capping materials with group indexes greater than 0 are considered when the use of such material is economically viable. In that instance the thickness of capping material may be increased based on the information available at the time of the pavement thickness determination.

6-03.4 (5) CONTRACTOR FURNISHED BORROW (Embankment In Place and Other Applications). When contractor furnished borrow is to be provided, the contract should state that it will meet or exceed the group index assumed during the pavement thickness determination process.

6-03.5 RIGID PAVEMENT DESIGN.

6-03.5 (1) THICKNESS DESIGN. The design table shown in Figure 6-03.12 is used as a basis for determining rigid pavement thickness. The thickness design table has been developed according to the theory that the thickness should vary with the increase in traffic loads. Knowing the number of rigid ESALs to be accumulated over the life of the pavement structure, the appropriate entry is selected from the design table. The table was developed using the AASHTO design equation. Although final decisions regarding pavement design are made by Central Office Project Operations, the districts may use this rigid pavement design table in order to make specific recommendations regarding the principal roadway, outer roadway, service road, or temporary bypass pavement thickness.

6-03.5 (2) REINFORCEMENT. The rigid design table assumes that the concrete will be non-reinforced and will have tied concrete shoulders. All transverse joints are doweled including rigid shoulders. All longitudinal joints are connected with deformed tie bars. Special consideration for reinforcement may be necessary when new lanes are added adjacent to existing lanes.

6-03.5 (3) JOINTS. Contraction joint spacings are shown on the standard plans. For light duty pavements with greater than 1700 ADT and all medium and heavy duty pavements, the longitudinal joint adjacent to or within the shoulder on the outside lane will be located 2 ft. [0.6 m] from the edge of the outside travel lane, except when the shoulder is expected to be used as a future lane in which case the joint is located at the edge of the outside lane. Minor arterial streets and urban sections as shown in Figures 4-07.2, 4-07.3 and 4-07.4 should have a longitudinal expansion joint located on one side of the median, whether it is barrier, raised curbed, or painted flush. This joint is constructed to avoid an excessively wide monolithic structure. All other longitudinal joints are placed at traffic lane width intervals. Longitudinal joints are located in such manner that the joint will tend to guide traffic. Details for pavement joints and the location of joints for typical pavements, including typical intersections, are shown on the standard plans. The design plans include details for pavement joint layouts of typical sections and intersections not covered on the standard plans.

6-03.6 COMPOSITE PAVEMENT DESIGN. This is the least desireable pavement type but occasionally, Construction and Materials Division will furnish the district a composite pavement design consisting of an asphaltic concrete surface on a portland cement concrete base. This design is generally considered wherever an existing rigid pavement is to be widened and resurfaced for additional lanes. Each composite pavement is considered a special case but typically the appropriate rigid pavement is selected from the table, 1 in. [25 mm] of thickness is deducted and the standard upper lift(s) of a flexible pavement are added. The thickness of rigid pavement so designated is considered portland cement concrete base and is not normally reinforced. An alternate means of selecting composite pavement is to apply the appropriate parameters to the AASHTO design criteria when special needs arise. A joint layout is included in the plans for all portland cement concrete bases.

6-03.7 BASE CONSIDERATIONS. Bases may be provided for several reasons, including to provide drainage, to reduce or eliminate pumping (ejection of fine-grained soil and water from beneath the pavement), to provide a working platform for overlying pavement placement, for improvement of subbase characteristics, or as a separator layer. The breaking of capillary action which pulls water up to the bottom of the pavement when available may be one of the more important functions of a base. Flexure of a pavement under load transmits load to contacted water, which hydraulically transmits to all water saturated and pore-connected materials. This action will eventually destroy most base and subbase materials if the chain is not broken, e.g. by using a base with minimal fine material or removing the water. The department uses several broad, somewhat overlapping, categories of base material in different applications and for differing reasons.

A permeable base or an 18 in. [0.45 m] rock base is used for all heavy-duty pavements. Medium-duty pavements are placed on a Type 5 aggregate base or an 18 in. [0.45 m] rock base. All light-duty pavements are placed on a Type 1 aggregate base. Subsection 6-03.7 (2) details when the 18 in. [0.45 m] rock base should be provided. Recommendations for base are included in the report on pavement thickness determination.

6-03.7 (1) PERMEABLE BASE. Permeable bases are primarily provided for positive and effective removal of water from under the pavement to a drainage system. These bases are typically a coarse aggregate with almost no fine material, thus containing a large pore system which will rapidly drain by gravity forces.

However, such material is typically unstable under construction traffic, thus it is usually stabilized using a cementing material such as asphalt binder or portland cement. Base thickness is typically 4 in. [100 mm]. A separator layer of Type 1 aggregate base is normally required to keep subgrade material from infiltrating the base. Such bases are also typically high-priced, so that use may be limited to cost effective pavements. No structural value is assigned for these bases. Permeable bases are typically required for all heavy duty pavements (see optional Rock Base).

6-03.7 (2) ROCK BASE. For some projects, appropriate placement of suitable Class C excavation will provide effective drainage, a working platform, and modification of base properties for pavement design. Rock base consists of 18 in. [0.45 m] of Class C excavation. It is placed full roadbed width and daylighted to the in-slope or fill-slope, except on the high side of superelevated curves and when not economically feasible under light duty pavements, in which case the rock base is not daylighted to the ditch and soil is used as a fill material at these locations. Undergrading in rock cuts is performed to allow placement of the full specified lift thickness. When available on the project or when economically available nearby, it should be used for the required permeable base and separator layer on all light, medium and heavy duty pavements. A 4 ft. [1.2 m] deep ditch is preferred. Determination of rock base availability must be made early in the project through consultation with the District Geologist and materials personnel, as elevations, pavement structure design and other considerations may be affected when used.

6-03.7 (3) TYPE 5 AGGREGATE BASE. Type 5 base is used to provide moderate drainage, reduce or eliminate pumping, provide a working platform, and may be used as a separator layer under the right conditions. It has a reduced fines content, but still retains some stability. Drainage capability is much lower than permeable base, but still enough to keep water from contacting the pavement bottom when properly sloped. Properly graded granular bases may also function as a separator layer under permeable bases to keep fine subgrade material from infiltrating the permeable base. Some structural value is assigned. Typical thickness is 4 in. [100 mm]. Where Type 5 base is used, it extends a distance from the pavement edge as shown in Figures 6-03.6, 6-03.7, 6-03.8, and 6-03.10, or 18 in. [460 mm] from the back of curbs or curb and gutter sections. The standard specifications permit the construction of pavements by slip-form methods and if the contractor elects to exercise this option, the width of the base must be increased at no additional cost to the department.

6-03.7 (4) TYPE 1 AGGREGATE BASE. Type 1 aggregate base is used to provide a working platform or a separator layer between pavement or permeable base and the soil subgrade. It is a more stable material with a higher fines content. Some structural value is generally assigned to these bases. Typical thickness is 4 in. [100 mm]. Where Type 1 base is used, it extends a distance from the pavement edge as shown in Figures
6-03.1, 6-03.2, 6-03.3 and 6-03.4.

6-03.7 (5) TREATED BASE. Treated bases are typically used to stabilize subgrade or base materials to improve characteristics. They may provide a working platform and/or pavement structure, but generally no drainage. Treatments include cement or lime. Typical minimum thickness is 6 in. [150 mm]. A variation of treated base is lime or other modified base used to stabilize wet subgrades and to provide a working platform. For modification, no permanent structural benefit is assigned.

6-03.8 RAMP AND HIGH SPEED DIRECTIONAL RAMP DESIGN. The structure of high speed directional ramps, including the base, is to be designed as though it were a main line pavement, but should not be designed with a thickness less than the lesser thickness of the two main line pavements connected by the ramp. All other ramps are to be designed with a thickness not less than the lesser thickness of the two pavements connected by the ramp and, if designed as a rigid pavement, not less than 2 in. [50 mm] of the thickness of the thicker pavement, or if designed as a flexible pavement, not less than 3 in. [75 mm] of the thickness of the thicker pavement. They are to be placed on a 4 in. [100 mm] Type 5 base, unless otherwise indicated in the pavement thickness determination study. See Typical Section D-53 for multi-lane ramps, D-50 for diamond/directional (single lane) ramps, and D-51 for loop ramps.

6-03.9 CROSSOVER AND APPURTENANCE DESIGN. These are to be designed using the appropriate table,

flexible or rigid, based on the anticipated ESALS to be accumulated through the intended pavement life, but never less than the minimums shown in the table.

6-03.10 TEMPORARY BYPASS. A temporary bypass should normally be designed as a flexible pavement, including those used on interstates. If the bypass is to be in place for only one construction season, the pavement structure should consist of a plant mix bituminous base (PMBB) mixture, designed to a thickness as determined using the design table shown on Figure 6-03.11, based on the projected total flexible ESALs for a two-year period for the given route and the appropriate soil group index of the subgrade at the bypass location. The PMBB material should be placed directly on the subgrade, with the subgrade being compacted in accordance with Sec 203.4 of the standard specifications.

If the bypass is to be used for more than one construction season, i.e., in place over winter months, the thickness of the pavement structure should be determined as above, except for a period equal to twice the amount of years the bypass is to be in use. The top lift of the pavement structure should consist of a 1-¾ in. [45 mm] plant mix bituminous pavement, with the remainder design thickness consisting of a PMBB mixture. The bituminous pavement should be placed on a 4 in. [100 mm] Type 5 aggregate base over a subgrade compacted in accordance to Sec 203.4 of the standard specifications. If the bypass is to be left in place for more than three years, Superpave mixtures should be considered in lieu of the plant mix bituminous mixtures.

In cases where the bypass pavement can be incorporated into a permanent roadway pavement, the bypass should be designed to the same thickness and type as the future pavement.

If the number of design ESALs is between zero and 75,000 and if dust can be tolerated, a 2 in. [50 mm] thickness of gravel, crushed stone, or chat may be used for the temporary bypass. When a dust free surface is required, a flexible design is determined as described above.

DUAL
SECTION 6-04

SHOULDERS

6-04.1 SHOULDER TYPES. Shoulders adjacent to either rigid or flexible pavements are constructed from several distinct materials depending on the traffic and expected use of the shoulder. Earth shoulders are provided in areas where minimal use of the shoulder is expected. Aggregate stabilized shoulders and paved shoulders consisting of either asphalt or concrete are normally used in all other areas.

6-04.1 (1) EARTH SHOULDERS. When earth shoulders are recommended, consideration is given to careful selection of soils which have low shrink and swell characteristics and which are relatively permeable. Heavy, plastic, and high volume change soils are avoided if possible since they lead to wide shrinkage cracks along the traveled way edges. In general, soils with plasticity indexes less than 25, and volume change characteristics less than 45 percent will give satisfactory results. District soils and geology technologists are available to help locate suitable materials for shoulder construction. At some locations soil properties may be unsuitable for use as earth shoulders and if recommended by the district operations engineer aggregate stabilization may be considered.

6-04.1 (2) STABILIZED SHOULDERS. Aggregate stabilized shoulders and paved shoulders provide a more secure surface to accommodate vehicles for emergencies and other uses. Paved shoulders are an integral part of the pavement structure and are considered as part of the pavement design configuration.

6-04.2 SHOULDER TYPE SELECTION. Shoulder types are selected based on pavement classification and design year average daily traffic. Shoulders are further classified by type for the various categories.

6-04.2 (1) LIGHT DUTY PAVEMENT

6-04.2 (1) (a) RIGID & FLEXIBLE - WITH LESS THAN 400 ADT. Earth shoulders, Type E, are provided. Aggregate stabilized shoulders, Type D, consisting of a 3 in. [75 mm] thickness of Type 1 Aggregate may be recommended by the district operations engineer and justified based on soil properties. See Figure 6-03.1.

6-04.2 (1) (b) RIGID & FLEXIBLE - WITH 400 TO 750 ADT. Aggregate stabilized shoulders, Type D, are provided. They consist of a 3 in. [75 mm] thickness of Type 1 aggregate. Type C aggregate stabilized shoulders may be provided if recommended by the district operations engineer and justified based on soil properties. See Figure 6-03.1.

6-04.2 (1) (c) RIGID & FLEXIBLE - WITH 750 TO 1700 ADT. Aggregate stabilized shoulders, Type C, are provided. The stabilized shoulder material consists of 6 in. [150 mm] Type 1 aggregate and is placed directly on the compacted subgrade. See Figure 6-03.1.

6-04.2 (1) (d) RIGID & FLEXIBLE - WITH 1700 to 3500 ADT. Aggregate stabilized shoulders, Type B, are provided. They consist of 8 in. [200 mm] Type 1 aggregate and is placed directly on the compacted subgrade. Pavement widths for roadways with 1700 to 3500 ADT are widened by 2 ft. [0.6 m] and delineated at the edge of the travel lane by appropriate lane marking. See Figure 6-03.2.

6-04.2 (1) (e) RIGID & FLEXIBLE - WITH OVER 3500 ADT. Paved shoulders, Type A1 or A2, are provided. Type A1 shoulders are provided on the median side of dual lane facilities. They consist of the same material and thickness as the roadway pavement and are an integral part of the pavement structure. The pavement width is widened 4 ft. [1.2 m] and there is no longitudinal joint between the Type A1 paved shoulder and mainline pavement. Type A2 shoulders consist of 5-/ in. [145 mm] of asphaltic concrete and the pavement width is widened by 2 ft. [0.6 m]. Payment for base is included in the pay item for Type A2 shoulders. For rigid pavement, options shall be provided. These options include 6" tied concrete shoulders, tied concrete shoulders that are 6" minimum on the outside edge, or asphalt shoulders. For those projects that are alternate pavement projects with optional shoulder types the Life Cycle Cost Adjustment Factor shall be calculated for mainline pavement only. Superpave mixtures may be substituted for Type A2 shoulders if Superpave mixtures are used elsewhere on the project. For flexible pavement, the Type A2 shoulder should be of the same material as the traveled way. For Type A1 and A2 shoulders, the edge of the travel lane is delineated by appropriate lane marking. See Figures 6-03.3, 6-03.4 and 6-03.5.

6-04.2 (2) MEDIUM DUTY PAVEMENT RIGID & FLEXIBLE - ALL ADT's. Paved shoulders, Type A or A1, are provided. Type A and A1 shoulders consist of the same material and thickness as the roadway pavement and are an integral part of the pavement structure. Type A shoulders are provided next to the outside traveled way, the pavement width is widened by 2 ft. [0.6 m] and the rigid shoulder is tied to the pavement structure with tie bars. Type A1 shoulders are provided on the median side of dual lane facilities, the inside pavement width is widened 4 ft. [1.2 m] and there is no longitudinal joint between the Type A1 paved shoulder and mainline pavement. For Type A and A1 shoulders, the edge of the travel lane is delineated by appropriate lane marking. See Figures 6-03.6, 6-03.7, 6-03.9 and 6-03.10.

6-04.2 (3) HEAVY DUTY PAVEMENT RIGID & FLEXIBLE - ALL ADT's. Paved shoulders, Type A and A1, are provided. Type A and A1 shoulders consist of the same material and thickness as the roadway pavement and are an integral part of the pavement structure. Type A shoulders are provided next to the outside traveled way, the pavement width is widened by 2 ft. [0.6 m] and the rigid shoulder is tied to the pavement structure with tie bars. Type A1 shoulders are provided on the median side of dual lane facilities, the inside pavement width is widened 4 ft. [1.2 m] and there is no longitudinal joint between the Type A1 shoulder and mainline pavement. For Type A and A1 shoulders, the edge of the travel lane is delineated by appropriate lane marking. See Figures 6-03.8, 6-03.9 and 6-03.10.

6-04.2 (4) AREAS WHERE EXPANSION IS CONSIDERED IMINENT. Paved shoulders, Type A, are provided as an integral part of the pavement structure except that they are constructed as a full width lane for

potential future lane use.

6-04.2 (5) FLEXIBLE AND RIGID - URBAN, LESS THAN 20,000 ADT. Stabilized or earth shoulders, Type U2, are provided. They consist of a 3 ft. [0.9 m] concrete curb and gutter section and a 5 or 7 ft. [1.5 or 2.1 m] width of stabilized surfacing or earth shoulder. The use of the stabilized or earth shoulder is optional with the district; however, the maximum use of the earth shoulder is encouraged to reduce cost. The selection may be based upon expected usage and aesthetic considerations. The stabilized portion consists of a 2 in. [50 mm] bituminous surface on a 4 in. [100 mm] thickness of Type 5 aggregate. If a shoulder structure other than the above is considered appropriate, a recommendation is made to the Design Division for consideration. The earth shoulder may be sodded or seeded. See Figure 6-04.1.

6-04.2 (6) FLEXIBLE AND RIGID - URBAN, 20,000 ADT OR MORE. Paved shoulders, Type U1, are provided. For the rigid pavement design, the paved shoulder consists of portland cement concrete of the same thickness as the adjacent travel lane, with an integral curb, and on an aggregate base as provided for the traveled way. For the flexible pavement design, the paved shoulder consists of the same structural design as the travel lane, and is provided with a Type S curb, or 3 ft. [0.9 m] concrete curb and gutter section, as applicable. For both rigid and flexible designs, in anticipation of needed expansion, and whenever practical, adequate width will be provided such that the curb can be removed, a new shoulder added with minimum disturbance of the existing pavement and traffic flow and the original shoulder used as a traffic lane. See Figure 6-04.2.

6-04.3 RAMPS. Paved shoulders, either Type A, Type A1, or Type A2, are provided. For ramps with integral curbs, the shoulder material and thickness will be specified in the pavement type selection study.

6-04.4 RESURFACING, RESTORATION AND REHABILITATION PROJECTS. Shoulders for resurfacing projects (non-freeway projects) utilizing 3R design standards are provided as follows. Interstate and freeway projects utilizing 4R design standards have the shoulder design included in the three alternate pavement design strategy. 3R design standards are based on 10-year projected traffic for the following traffic volume ranges:

For 3R resurfacing projects having a 10-year traffic volume of less than 400 ADT, Type E shoulders are provided. Type D shoulders may be recommended by the district operations engineer and justified based on soil properties. See Figure 6-03.1.

For 3R resurfacing projects having a 10-year traffic volume of 400 to 750 ADT, Type D shoulders are provided. They consist of a 3 in. [75 mm] thickness of Type 1 or Type 2 aggregate. See Figure 6-03.1. The 3 in. [75 mm] aggregate thickness may be increased to 6 in. [150 mm] if recommended by the district operations engineer and justified based on soil properties.

For 3R resurfacing projects having a 10-year traffic volume of 750 to 1700 ADT, Type C stabilized shoulders consisting of a 6 in. [150 mm] thickness of Type 1 or Type 2 aggregate are provided. See Figure 6-03.1. If the 3R design criteria requires the travel lanes to be widened, the existing pavement shall be widened the required 1'-9" or 2'-9" [525 or 825 mm] with full depth (10 in. [250 mm]) base widening. The edge of traveled way shall be striped 9 in. [225 mm] from the edge of widening. See typical section drawings D-70 and D-71 for widening and resurfacing details.

For 3R resurfacing projects having a 10-year traffic volume of 1700 to 3500 ADT, and requiring lane widening to meet 3R design criteria, Type B aggregate stabilized shoulders consisting of an 8 in. [200 mm] thickness of Type 1 or Type 2 are provided. See Figure 6-03.2. If the 3R design criteria requires the travel lanes to be widened, the required widening, either 1 of 2 ft. [0.3 or 0.6 m], is increased by 2 ft. [0.6 m] and delineated at the edge of the travel lane by appropriate lane marking. The aggregate stabilized shoulders may be increased to a thickness equal to the depth of pavement widening (10 in. [250 mm]) plus the resurfacing thickness, if recommended by the district operations engineer and justified based on soil properties.

For 3R resurfacing projects having a 10-year traffic volume over 3500 ADT, and requiring lane widening to meet 3R design criteria, bituminous shoulders are provided. The thickness of the bituminous shoulders will

equal the depth of the pavement widening as described in Subsection 6-05.6. For projects that do not require pavement widening to meet 3R design criteria, 5-½ in. [145 mm] bituminous shoulders, except as otherwise noted below, are provided. The 5-½ in. [145 mm] bituminous shoulders will consist of extending the 1-½ in. [45 mm] resurfacing top lift full width across the shoulder on top of a 4 in. [100 mm] bituminous base. If the thickness of the proposed resurfacing is greater than 5-½ in. [145 mm], then the bituminous shoulder should be the same thickness as the proposed resurfacing. If localized areas warrant a thicker bituminous shoulder, those areas should be designed to handle the expected traffic conditions. Some possible conditions that may warrant a thicker bituminous shoulder are where the shoulder may be used as a future lane, used as a bypass during construction, used as a climbing lane by truck traffic, used as part of a turning radius or an acceleration or deceleration lane at an intersection or a driveway, or used to facilitate expected overload or wide load traffic or known truck parking. When numerous conditions as listed above exist throughout a project, a thicker bituminous shoulder should be considered for the entire project to reduce complexity or to improve constructability. The total shoulder thickness including the resurfacing should never be designed thicker than the total thickness of the roadway pavement. See Figure 6-04.3.

The surface lift should be in accordance with Subsection 6-03.3. No aggregate base material is provided beneath the bituminous shoulder unless it will match the existing pavement and base configuration or it is recommended by the district operations engineer and justified based on soil properties. Prior to placement of any bituminous material on the shoulder, the subgrade must be properly stabilized and compacted. Recommendations for measures to be taken to prepare the shoulder subgrade should be requested from the district operations engineer.

When shoulders (earth, aggregate or bituminous) are to be resurfaced with a bituminous overlay, it is critical that several considerations be made. The intent of the shoulder is to be capable to support a reasonable load, both size and frequency. While deformation or even moderate rutting may be acceptable and easily maintained for an earth or aggregate shoulder, it is not acceptable for a bituminous shoulder. If designed improperly, a bituminous shoulder is difficult to maintain, dangerous to traffic and will be required to be removed and rebuilt under future projects. To prevent this, bituminous shoulders must be constructed properly from the subgrade up and addressed during the design process.

The existing condition of the shoulder is often the best gauge for potential problems. All potholes and wet areas must be removed and replaced with compacted, select material or Type 1 aggregate base. If the shoulder is already bituminous material, all soft material should be removed as deep as necessary and replaced with a similar section, i.e., earth or aggregate followed by a bituminous material to the existing thickness prior to resurfacing. In some cases, drainage may also need to be improved. Rutted and deformed areas are indicators of not only soft spots, but often identify areas where there is a traffic need to use the shoulders.

Once existing localized distresses are addressed, the designer should specify some sort of compaction effort of the existing shoulder to provide a good, stable base for the bituminous overlay. The following guidelines are offered to assist the district in preparing a job special provision for shoulder subgrade preparation: (1) For stabilized aggregate shoulders with no cut, a self-propelled steel wheel roller weighing not less than 5 tons [4.5 Mg] be used in preparing the subgrade as specified under Sec. 213.2.1 of the standard specification; (2) when cutting into earth or adding on an existing earth surface, require four complete coverages with a tamping-type roller or two complete coverages with a vibratory roller as specified under Sec. 203.3.5 of the standard specifications; or (3) when the shoulder is on a new grade, require compaction with moisture and density control as specified under Sec 203.3 of the standard specifications.

Consideration for using a lower type shoulder stabilization on those routes where future improvements are planned is recommended.

For 3R resurfacing projects having a 10-year traffic volume over 1700 ADT where shoulders have previously been stabilized with bituminous material, the resurfacing is either carried full width over the shoulder or tapered to a zero thickness dependent to some extent upon the existence of guardrail. Good engineering judgment is exercised in the resurfacing of these shoulders. The district operations engineer should make recommendations regarding the adequacy of the existing shoulder structure prior to resurfacing. If the existing shoulder is not

adequate for resurfacing, then the shoulder structure will consist of the same material and thickness as described in (4) and (5) above. The accepted AASHTO range in cross slope for bituminous surfaced shoulders is 2 to 6%. See Subsection 4-09.7(2) for guardrail details.

6-04.5 USED-IN-PLACE PAVEMENTS. For pavements to be used-in-place as part of an otherwise improved project and on which shoulders have not been previously stabilized, stabilized shoulders are provided in accordance with the appropriate pavement design categories and design traffic.

6-04.6 SHOULDER RUMBLE STRIPS. Shoulder rumble strips (SRS) should be included on projects with new or resurfaced shoulders that meet the following conditions:

The design speed is at least 50 mph.
The outside shoulder has a minimum width of 2 ft. [0.6 m].
The shoulder does not have a curbed section or the shoulder is not intended to be used as a future travel lane.
On multiple-lane divided roadways, SRS should be installed on the inside shoulder if it is at least 2 ft. [0.6 m] wide.
The shoulder is concrete or the final lift of bituminous material is at least 1-3/4 in. [45 mm] thick, and the shoulder has a final paving thickness of at least 3-3/4 in. [95 mm].

Shoulder rumble strips are to be milled into bituminous and portland cement concrete. See Standard Plan 626.00. Shoulder rumble strips are omitted between the radius points for side road approaches, entrances and median crossovers. Shoulder rumble strips should be omitted on bridges and on ramps for diamond, single point, partial cloverleaf and similar types of interchanges, but may be considered on longer ramps for directional or other large interchanges. The length of shoulder rumble strip installation should be estimated and pay items provided.

Addendum Issued 07/23/04

General Letter No. 5, 2004 included a special sheet depicting Type A2 Shoulder alternates. A note on that sheet stated that shoulder and base were included in a single pay item. Due to contract administration issues, the shoulder and base will be paid for separately as shown on the attached revised special sheet. This addendum replaces the special sheet distributed on 7/8/04. The next revision of the Project Development Manual will include this change.

Shoulders_lightduty2.pdf

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