ROAD DESIGN MANUAL

If you require assistance accessing this information or require it in an alternative format, contact the Michigan Department of Transportation's (MDOT) Americans with Disabilities Act (ADA) coordinator at www.Michigan.gov/MDOT-ADA.

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CHAPTER 6 • SURFACING AND SHOULDERS

6.01 PAVEMENT SELECTION PROCESS

6.01.01 References

(revised 6-28-2021)

A. Truck Operators' Map, MDOT, issued annually (available from the Utility Coordination and Permits Section of the Development Services Division)

B. Pavement Selection Manual, MDOT, Current Edition

C. Standard Specifications for Construction, MDOT, Current Edition

D. Michigan DOT User Guide for Mechanistic-Empirical Pavement Design, MDOT Current Edition

6.01.02 Equivalent Single Axle Load (ESAL)

Recognizing that automobile traffic has little deleterious effect on the load carrying capacity of a pavement, the Department has adopted the concept of 18 kip (18,000 lbs.) axle load repetitions or ESAL as a meaningful unit of traffic measurement. (While there is no hard data available, some consider that it requires something on the order of 5,000 passenger cars to equal one 18 kip axle load. A General Accounting Office study has estimated that one 80,000 lb. truck causes wear equal to 9,600 cars.) The Bureau of Transportation Planning, in determining future traffic volumes for design purposes, is able to convert average daily commercial vehicles counts into ESAL repetitions. ESALs are available from the Project Planning Division.

6.01.03 Survey and Mapping Methods

Legal truck weights in Michigan, for vehicles exceeding 80,000 lbs. gross weight, are 18,000 lbs. per single axle and 13,000 lbs. per axle in tandem groups, with one 32,000 lbs. tandem pair permitted, provided certain minimum axle spacings are met. For vehicles less than 80,000 lbs. gross weight, maximum weights of 20,000 lbs. per single axle and 34,000 lbs. per tandem axle are permitted. Routes where these loads are permitted, regardless of the season, are shown in green on the Truck Operators' Map, published by the Department.

The maximum gross load is 164,000 lbs. on 11 axles legally spaced. Overweight vehicles may be issued a permit for a specified trip or move.

6.01.04 AASHTO Interim Guide

In the middle 1950's, AASHO conducted the most extensive road test ever on a specially constructed track near Ottawa, Illinois. Utilizing a part of what is now I-80 and military personnel driving loaded trucks 24 hours per day for two years, this provided the data that led to the publication of the “AASHTO Interim Guide for Design of Pavement Structures 1972". The AASHTO design method is an empirically developed method which is used across the country by many public agencies.

6.01.05 Choice between Aggregate, Hot Mix Asphalt and Concrete

(revised 10-23-2017)

It is the general practice of the Department to not leave aggregate as a driving surface on a roadway. Therefore, at minimum, a new or existing aggregate road will generally be paved with a single course of hot mix asphalt material, regardless of how little traffic it serves.

Michigan differs from many of the states in having a wide range of soil types, varying from well drained sands to heavy clays, to rock outcroppings. Concrete has the advantage of rigidity and high strength relative to thickness and requires less elaborate mixing facilities at the plant. Hot mix asphalt is flexible, easier to repair, and it requires less time to open to traffic, needing only to cool. The Department tries to utilize the advantages of each material when selecting a pavement type.

Ramps will usually have the same type of surfacing as is used on the freeway. One exception would be when the mainline is overlaid utilizing a different wearing surface material than the existing ramp. In this case, the new mainline surface material may extend up the ramps part way depending on the condition of the ramps.

Similarly, utility trench replacement is typically the same type of pavement material as surrounds it. Refer to Section 9.04.01 for design of pavement cross-section replacement due to utility trench work.

6.01.06 Pavement Design and Selection Policy

(Approved by EOC 2-9-2012)

(revised 9-22-2025)

6.01.06A Design

Pavement design is performed using a combination of the AASHTO 1993 and Mechanistic-Empirical (ME) design methods. The AASHTO 1993 design method is conducted using the "AASHTO Guide for Design of Pavement Structures", 1993 and the software “DARWin Version 3.1”. The ME design method is conducted using the AASHTO “Mechanistic-Empirical Pavement Design Guide” and the software “Pavement ME Design.” Further details can be found in the Michigan DOT User Guide for Mechanistic-Empirical Pavement Design.

6.01.06B Selection

Pavement selection will be determined using the life cycle cost analysis method when the project pavement costs exceed the $1.5 million threshold as described in the Pavement Selection Manual. Pavement costs are determined by separately calculating the cost of paving with both HMA and concrete. When the cost of either the HMA or concrete exceeds $1.5 million, a life cycle cost analysis is required. For such projects, Pavement Operations of the Construction Field Services Division will conduct the pavement design and life cycle cost analysis in accordance with the Pavement Selection Manual. MDOT staff and industry organizations will be provided an opportunity for review and comment, with final approvals by the Engineering Operations Committee. In accordance with state law, the low cost alternative will be selected.

Pavement designs and the life cycle cost analysis will be done by Pavement Operations for the following project categories.

- All New Construction or Reconstruction projects with pavement costs greater than $1.5 million.
- Major Construction on Existing Road projects (unbonded concrete overlays, rubblized concrete with HMA surfacing, HMA over crush & shaped HMA, multi-course HMA overlays, thin concrete overlays, and multi-course HMA over an Asphalt Stabilized Crack Relief Layer) with pavement costs greater than $1.5 million.

Certain fixes known under a different name (e.g. ‘inlay’) may still require a life cycle cost analysis, regardless of project type. Questions should be directed to Pavement Operations. Assistance will be given to the Regions for other projects on an as-needed basis

Life cycle cost analysis will include the cost of initial pavement construction costs as well as maintenance costs over the service life. It will also include calculation of user costs for both initial construction and all future maintenance shown in the maintenance schedules. User costs will be calculated using the software titled “Construction Congestion Cost.”

Informational life cycle cost analyses may be conducted for a variety of reasons prior to processing of an official analysis. In addition, some circumstances will require re-analysis, such as scope changes or scheduling delays. Projects must be monitored during project development to ensure that a valid life cycle cost analysis is in place prior to advertisement, and that the correct pavement type has been specified in the plans. The Pavement Selection Manual contains details of these and many other aspects of the process.

6.01.07 Alternate Pavement Bidding

(revised 7-29-2024)

At times during pavement selection, the life-cycle cost between the two alternatives may be relatively close and all other design considerations relatively equal. Under these circumstances, bidding the project with alternate pavement options can allow market competition to determine best value.

On September 1, 2011 the Engineering Operations Committee approved a process for the identification and development of alternate pavement bid (APB) candidate projects.

Candidate selection criteria includes;

1. Only freeway projects will be eligible.
2. The project fix type must be either a complete reconstruction or a major rehabilitation (separated concrete overlay or HMA over rubblized concrete).
3. Estimated construction costs must exceed $10,000,000 dollars.
4. Each pavement alternate must be expected to have similar environmental, Right-of-Way, drainage, and utility impacts.
5. Maintaining traffic concepts must be similar for both pavement alternates.
6. Paving must be the controlling operation for the construction schedule.
7. If the project meets all the above criteria, the TSC will request an informational LCCA. The proposed pavement designs will be developed using the MDOT Pavement Selection Manual. The life cycle costs of the two pavement design alternates must be15% to be considered for alternate bid on Design-Bid-Build projects. A Design-Build project will be identified as APB if the project meets the above Selection Criteria, regardless of the LCCA EUAC percentage differential.

MDOT leadership may recommend other projects not meeting the above criteria.

The detailed selection and plan development process for Alternate Pavement Bidding is available on the Plan Development Services website (MDOT only).

6.02 AGGREGATE CONSTRUCTION

6.02.01 General

There are principally two types of natural aggregate produced commercially:

- Gravel and sand that is excavated and possibly washed and screened.
- Crushed aggregates that may be made from gravel or quarried rock, but which are run through a crusher, then perhaps washed and screened for a given gradation.

In recent decades, other types in the form of artificial aggregates have appeared on the road building scene. Two examples are slag and recycled concrete. Both can be crushed and screened to meet most of the specification aggregate gradation requirements.

6.02.02 Glossary of Terms

Bank run - An aggregate excavated from a bank or pit without any subsequent processing.

Chert - An extremely fine-grained, hard rock composed mainly of silica and occurring commonly in limestone beds. It is considered an undesirable particle because of its susceptibility to fracture under freeze-thaw conditions.

Choking - Adding fines to an open-graded aggregate or rock to make it more densely graded.

CIP - Compacted in place.

Daylighted - Usually used when speaking of the drainage plane between the top of subgrade and the bottom of subbase. To daylight this drainage plane is to extend it to the roadway front slope where it can drain.

Dense graded - An aggregate having a range of particle gradation such that most of the voids between larger particles are filled by other smaller particles.

Fines - A silt and/or clay size material which will pass through the 0.075 mm sieve (ASTM No. 200.)

Fly ash - A by-product of the coal combustion process in electrical generating plants. It is a very fine light dust recovered from stack gases, composed primarily of silica, alumina, and various other oxides and alkalies. In the presence of lime and moisture, it has pozzuolanic (cementing) properties.

Foundry sand - The waste core sand from the steel casting process. Usually black or dark brown in color and likely to contain metal fragments and oil. The Department tests for permeability, in addition to the other usual tests. Environmental interests object to foundry sand because of the excessive leaching of the hydrocarbons or other additives, and it has been declared toxic. If used, it requires extensive testing for inertness or encapsulation. A permit is usually required for use.

Freeze-thaw durability - A measure of dilation percentage per 100 freeze-thaw cycles (Michigan Test Method 113 and 115). It is an aggregate's resistance to failure when incorporated in portland cement concrete and subjected to alternating cycles of freezing and thawing.

HMA – Hot Mix Asphalt (formerly referred to as “bituminous”). Also see Section 6.03.02.

Heavy media - A process used in coarse aggregate gravel production to separate low-gravity particles from the product. The aggregates are passed through a tank containing an agitated liquid composed of water, magnetite, and ferrosilicon. The specific gravity of the liquid is adjusted to that of the low-gravity fraction of the coarse aggregate, which contains the majority of the deleterious particles.

LM - Loose measure.

Loss by washing - After an aggregate or soil sample is dried and weighed, it is washed. The fine components (smaller silt sizes and clay) carried off by the water through a 0.075 mm sieve (ASTM No. 200) is the loss by washing.

Metal - A somewhat archaic term, dating back to the days of gravel roads, referring to the road surface structure whether it is aggregate, aggregate and HMA, or concrete. "Edge of Metal" would today be synonymous with **"Edge of Pavement"**.

OGDC - Open-graded drainage course.

Open-graded - An aggregate gradation lacking sufficient fines to fill the voids between the larger aggregate particles. Material, other than fine aggregate, consisting of mostly one-size particles would be open-graded.

Passing 200 - The loss by washing plus the dried portion of the sample that passes the 0.075 mm sieve (ASTM No. 200). Usually about 0.5 to 1.0% more than the loss-by-washing figure.

Pea gravel - A natural gravel, essentially rounded. Usually a by-product of aggregate production for which there may be limited demand.

Processed aggregate - Material that has been mechanically processed in some way either by screening, washing, or crushing, to enhance its usability.

Select Subbase - An obsolete term, no longer proper terminology, but still used conversationally, that refers to a layer of dense graded processed aggregate placed on subbase to stabilize it, thus facilitating the operation of construction equipment. Comparable to what is now called **"Aggregate Base"**.

Separation Course - An HMA or granular course between an old pavement and new pavement that is intended to eliminate or minimize reflective cracking in the new pavement.

Shrinkage - The reduction in volume of a soil or aggregate when compacted, as compared to its natural, in-place state. Sometimes used when referring to the ***additional*** material required to maintain the same volume in the compacted state as existed in the natural, in-place state.

Slag - An artificial aggregate produced as a by-product of the steel (blast furnace slag) and copper (reverberatory furnace slag) refining process, composed of the solidified remnant of the coke, limestone, and mineral impurities that float to the top of the molten metal. Of several different types, it is crushed and screened to specification aggregate gradation.

Stabilization - The process of adding a material to an aggregate to increase its stability and load-supporting capability. Typical stabilizing agents are water, soils high in fines, lime, HMA materials, and portland cement.

Top size - In a given aggregate gradation, the largest size aggregate particle.

Windrow - Aggregate or earth that has been graded into a longitudinal pile, usually parallel with the center of the road.

The following terms are defined in the Standard Specifications for Construction:

- **Earth grade**
- **Subbase**
- **Subgrade**

6.02.03 Method of Measurement

Aggregates are measured in any of the following ways:

- **Ton (t)** - requires scales and an inspector for weighing; applicable where thickness or area is not uniform.
- **Square Yard (Syd)** - (of a given thickness) - requires field measurement for area, plus depth checks.
- **Cubic Yard, LM (Cyd)** - requires "truck count" and measurement of each hauling unit in the field or computation of volume in the stockpile.
- **Cubic Yard, CIP (Cyd)** (of a given thickness) - requires field measurement of area, plus depth checks.

In order for the method of measurement for aggregate bases and surface courses to be related to the nature of the work involved, aggregate measurement should be set up as follows:

6.02.03A Ton

Use where traffic will use the proposed aggregate surface such as:

- Reconstruction - through traffic maintained on an aggregate base.
- Reconstruction where some grade raises are gravel raises only.
- Shoulders on resurfacing projects.

6.02.03B Square Yard

Use where there will be no traffic on the proposed aggregate surface such as:

- New (relocation) construction
- Total reconstruction - through traffic detoured.
- Total reconstruction - part-width, traffic maintained on existing surface and reconstructed surface (not base).
- Widenings - one lane or more requiring new aggregate base.

6.02.03C Cubic Yard, LM

Use where small amounts of aggregate are involved such as:

- Gravel bases and surfaces for temporary roads.
- Gravel-surfaced crossovers.
- Driveway approaches (base or surface)
- Crossroad approaches less than 200 feet long (base or surface).
- Total aggregate in the contract is less than 5,000 cubic yards.

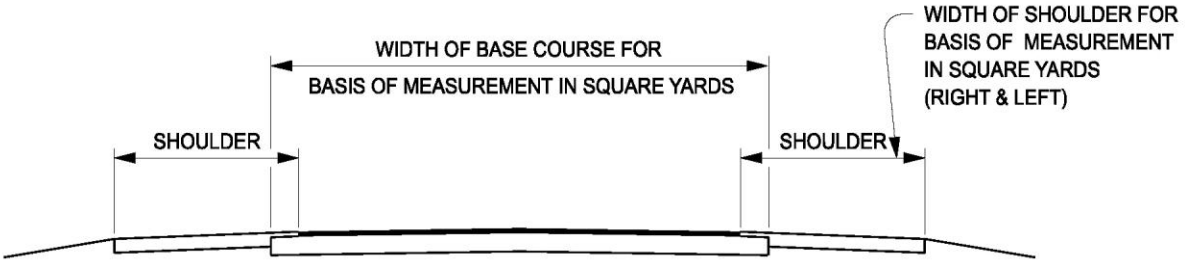
Any combination of these three methods of measurement may be utilized on any one project.

6.02.03D Cubic Yard, CIP

This method is similar in application to the square yard unit of measurement, and is more commonly used with small quantities. Use only when recommended at The Plan Review Meeting.

The ton as a method of measurement for aggregates should not be used in the Detroit Metropolitan area. Use square yard whenever possible and cubic yard, LM or CIP when recommended at The Plan Review Meeting.

When aggregates are measured and paid for by the square yard, the total width of the aggregate should be used for the basis of measurement even though there is overlap, as shown in the example below:



6.02.04 Weight of Aggregates

While different materials in a compacted state weigh more or less than others, for general purposes compacted aggregates are considered as weighing 4,000 lbs/cyd. An exception is slag aggregate. See Section 6.02.08.

6.02.05 Subbase Stabilization

While different materials in a compacted state weigh more or less than others, for general purposes compacted aggregates are considered as weighing 4,000 lbs/cyd. An exception is slag aggregate. See Section 6.02.08.

6.02.05A Purpose

A non-cohesive granular material may be practically impassable to wheeled equipment, and it may be difficult to compact, especially if the sand particles are rounded and one sized. In order to build a project, it is often necessary to stabilize the sand just to enable construction equipment to get on it. By contrast, a clay subgrade, unless it is moisture saturated, can be compacted, and it is quite traversable.

6.02.05B History

The practice of constructing a base with specification gravel on the top of subbase was instituted by the Department in 1955 on all concrete pavement projects. Its purpose was two-fold:

1. To prevent rutting of the subbase (and subsequent contamination with subgrade material) by the contractor's equipment.
2. To provide a stable foundation for placing the paving forms.

The practice was later extended to subbases under flexible surfaces, the material then being changed to the same as the aggregate base course. As the use of paving forms faded from general practice, one of the reasons for placing stabilizing material vanished. Also, about this time, evidence began to show that the compacted aggregate impeded the free drainage below the pavement, defeating to some extent the purpose of the subbase. Currently the Department generally uses this material under HMA. For new concrete pavements, an open graded material with improved drainage characteristics (Open Graded Drainage Course = OGDC) is typically used. See Section 6.02.06.

6.02.05C Thickness (typical)

Aggregate Base, 4 inch

6.02.05D Width

- Under rigid pavements
    - 3 feet (underdrain pipe) or 2 feet (PDS) outside each edge
    - See Standard Plan R-80-Series
- Under flexible pavements
    - Full width of paved surface including paved shoulders.

The additional width beyond the outside edge of concrete pavement is to facilitate the use of slip-form equipment. If curb and gutter is proposed, the width of stabilization should not be increased because of the curb and gutter, unless the plans specify that integral curb and gutter is to be placed (in which case the stabilization should extend 3 feet beyond the back of curb). If the contractor chooses to use integral curb and gutter, then the additional width must be paid for by the contractor. See Pavement Design Engineer for latest details.

When valley gutter or urban freeway curb is used, the Aggregate Base should be extended to include the width of valley gutter or urban freeway curb in order to avoid a marked change in type of base material under the valley gutter or urban freeway curb.

6.02.05E Criteria for Use

Aggregate base is typically used under all HMA and some concrete pavements placed on subbase material. Aggregate base may also be used as a construction platform directly on subgrade when recommended at The Plan Review Meeting.

6.02.06 Open Graded Drainage Course

(revised 6-28-2021)

6.02.06A Purpose

Research has concluded that open graded bases provided the most suitable method for removing water from the roadway section. Materials for OGDC are specifically designed to allow water to drain freely and still provide a suitable paving platform. The OGDC is drained by an open graded underdrain that is located under the shoulder in a geotextile wrapped trench. The trench is backfilled with an open graded material.

OGDC gradations initially required 0-15% passing the 4.75 mm sieve (ASTM No. 4) and 100% passing the 37.5 mm sieve (1½ inches). In some instances contractors reported difficulty paving over this material because of lesser stability than traditional dense graded bases. For this reason this gradation is no longer used. Current OGDC gradations provide improved drainability and stability.

The department has revised the specified gradation several times since the early 1980's. The perceived instability of OGDC continues to be an issue. National studies continue to show the benefits of open graded bases. However, gradations continue to be studied that will maintain drainability and increase stability. Drainability of OGDC is on the order of 300 to 500 feet horizontally per day. The lateral drainage path, to the nearest underdrain, should be no more than 30 feet

6.02.06B Typical Cross Section

The OGDC is usually shown on the typical cross-section extending 1 foot beyond the edge of shoulder. Typically, its thickness is 6 inches or 16 inches in the Metro Region with either a geotextile separator or a dense aggregate separator course placed between the OGDC and the subbase.

6.02.06C Usage

The Engineering Operations Committee, on September 9, 1987, decided that OGDC should be used under all full lane width concrete pavements that are one-half mile or more in length. Exceptions may be made. Contractor equipment, other than spreading and trimming equipment, should not drive directly on the Open Graded Drainage Course. These traffic loadings, directly on the OGDC, cause infiltration of the subbase material into the OGDC layer. This inhibits the drainability of the OGDC.

The designer should review the project with the Construction Field Services Division to determine if construction equipment may run on the open graded base. The designer should check with the Pavement Design Engineer (Construction Field Service Division) for recommendations, if a different base is required.

6.02.07 Crushed Concrete Aggregate

With the development of equipment that can crush concrete on a large scale, it is now feasible to recycle crushed concrete aggregates. Its usage is defined in the Standard Specifications for Construction.

Experience has shown that crushed concrete fines, i.e., crushed concrete sand, causes a very harsh mix, difficult to place and finish, as well as being difficult to consolidate in the field, leading to low compressive strength. For this reason, crushed concrete sand is now prohibited in new concrete. In addition, concrete fines contain chlorides from previous use which causes accelerated rusting of steel in the concrete. MDOT experience has also shown that concrete fines have erratic absorption rates which prevent a consistent water/cement ratio during construction. This can result in less durable concrete.

Crushed concrete aggregates have a tendency to leach out a precipitate that clogs the pores of geotextiles. They are not permitted as OGDC underdrain backfill.

6.02.08 Slag

6.02.08A General

Slag is an artificial aggregate produced as a waste by-product of the iron, steel, and copper industries. Until the downturn in American steel production it was abundant in Michigan, but rather localized. Slag associated with iron and steel making is basically located in the Detroit metropolitan area; in Sault Ste. Marie, Ontario; and in the Burns Harbor-East Chicago area of Indiana. Slag aggregates are available on Great Lakes docks by boat shipment from the Indiana and Ontario sources. The only working copper smelting facility is at White Pine in Ontonagon County. Slag is produced to Department aggregate specifications. When the word "slag" is used alone in the specifications it is understood to mean either blast furnace slag or reverberatory furnace slag.

Blast furnace slag is lighter in weight than natural aggregates, whereas steel furnace slag is heavier. Approximate weights are:

- Blast furnace slag - 144 lbs/cubic foot
- Natural aggregate - 148 lbs/cubic foot
- Steel furnace slag - 184 lbs/cubic foot

6.02.08B Blast Furnace Slag

Blast furnace slag is acceptable for any aggregate use provided it meets the material requirements for that particular use. It is normally blended with other softer aggregates in order to meet AWI requirements.

6.02.08C Reverberatory Furnace Slag

Reverberatory furnace slag is acceptable for all aggregate uses except as fine aggregate for concrete (because it is a manufactured sand.) While it is somewhat heavier than natural aggregate, no weight factor has been applied. It is available in the copper mining area of the Upper Peninsula but is seldom used on trunkline projects.

6.02.08D Steel Furnace Slag

Steel furnace slag often contains ingredients that are still chemically active, causing it to expand, or gases to be released, on contact with water. Its use is therefore restricted; at the present time it can only be used in Hot Mix Asphalt (HMA).

Because of a calcium carbonate leachate, steel furnace slag should not be used as an OGDC in combination with a pavement drainage system. The leachate tends to clog the geotextile wrap, effectively negating the pavement drainage system.

6.02.09 Aggregate Base and Surface Courses

6.02.09A General

By policy, the Department does not construct permanent aggregate-surfaced roadways; i.e., an HMA surface is our minimum. Discussion of Aggregate Surface Course, even though it is included in the Standard Specifications for Construction, is therefore almost a moot subject. It is only used occasionally for surfacing a park and ride lot, county road relocation, or on a lengthy local road approach.

6.02.09B Difference between Base and Surface Courses

When an aggregate is intended for surface use, soil binder (clay) will be added to make it more dense and the surface more stable, i.e., less loose, under traffic. Binder does not materially add to its load supporting capability. On the other hand, binder in a base course is undesirable because it impedes the free drainage of water and is susceptible to frost heave.

6.02.09C Substitution

Occasionally, a project will have a rather large quantity of one type of aggregate and a small quantity of another; e.g., a substantial amount of base course and a little surface course, perhaps for driveways. To avoid a high contract price for the small-quantity material, the designer is encouraged to use the large-quantity type of aggregate for everything. Generally, base course can be substituted for surface course since, if it is too loose, it can be made acceptable by adding soil binder.

Conversely, it is less desirable to substitute surface course for base course.

6.02.09D Conditioning Aggregate Base

Conditioning Aggregate Base is shaping the aggregate surface to the required grade or cross-section as specified in the Standard Specifications for Construction preparatory to HMA resurfacing. It does not apply to the shaping of aggregate base stabilization preparatory to concrete paving.

6.02.10 Aggregate Approaches

It is the practice of the Department to construct an HMA surface on all existing gravel approaches to the trunkline (see Section 12.02.03). The purpose is primarily to keep loose gravel off the through pavement.

6.02.11 Aggregate Additives

(revised 11-28-2011)

6.02.11A General

Calcium chloride and water used to facilitate shaping and compaction are not paid for separately, but are included in other contract items.

6.02.11B Dust Palliative Pay Item

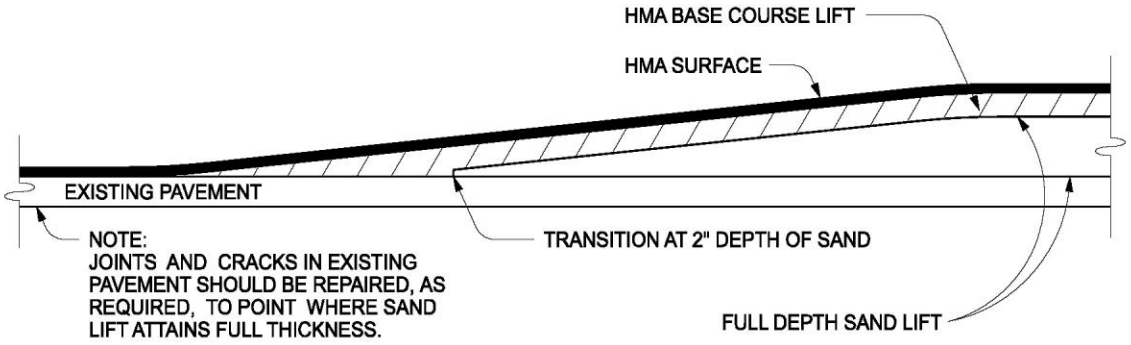
Calcium chloride used as a dust palliative, as when maintaining traffic, should be estimated at the rate of 7.5 tons per mile of two-lane width (or two-shoulder width). The pay item is "Dust Palliative, Applied."

6.02.12 Sand Lift (Grade Lift)

(revised 5-28-2013)

Sometimes, rather than surfacing a road surface or removing it for replacement, a sand lift is used above the old pavement. Use of this method of construction has declined as recycling techniques have been improved thereby increasing the value of old pavement surfaces. A sand and gravel cushion of less than 18 inches should not be used, because there is evidence that reflective cracking is not significantly prevented in a flexible pavement. Experience has also shown that when a **gravel** lift is compacted, the percentage of fines increases, resulting in a dense-graded mixture which tends to trap water. An HMA base course should be used instead. An added advantage to using an HMA base course is the ease of maintaining traffic during construction.

When a sand lift is used and a transition is necessary to meet the existing pavement surface, the transition should be as illustrated below.



LENGTH OF TRANSITION TO BE ADJUSTED
TO SECURE GOOD VERTICAL ALIGNMENT.

SAND LIFT TRANSITION OVER OLD PAVEMENT
To be used when old pavement is not removed.

6.02.13 Pavement Geotextile Separators (Geosynthetics for Base)

(added 6-23-2025)

6.02.13A Purpose

Geotextiles provide separation between pavement cross-section layers, preventing intermixing of materials and mitigating the propagation of underlying distress into new pavement. Specifically, these fabrics are used to separate gap-graded, unbound aggregate layers from sublayers with high fine content or concrete pavements from underlying existing concrete. Geotextiles also aid in drainage by facilitating water movement toward outer underdrains, as the fabric will connect to these drainage systems. Geotextiles can be used as an alternative to other separators such as dense graded aggregate separator layers for unbound aggregate base layers or hot-mix asphalt (HMA) separator layers for unbonded concrete overlays. There are two primary types of geotextiles: non-woven and woven. These are further described in the following subsections.

Note that while the type of geotextile may vary depending on the project and its configuration, always ensure unimpeded drainage from the pavement cross-section. Therefore, when placing geotextiles below an OGDC, use an open-graded underdrain pipe configuration to ensure that water is not impeded from escaping the cross-section, regardless of geotextile type.

During construction, geotextiles are securely tacked to the subsurface layer to prevent excessive bunching and are sufficiently overlapped with adjacent sheeting so that gaps do not occur. To reduce the risk of displacement from construction activity or environmental factors such as wind, placement is often carried out in smaller sections shortly before the surfacing layer is applied.

For further information, see the MDOT Standard Specifications for Construction for construction and material requirements.

6.02.13B Non-woven Geotextile

Non-woven geotextiles are manufactured by bonding synthetic fibers (e.g., polyester or polypropylene) into a felt-like material. This fabric is permeable (roughly ten-times more permeable than a woven), so it is most suitable for configurations that require separation, filtration, and drainage.

For concrete overlays, a non-woven geotextile may be used instead of an HMA separator layer when the existing pavement is in at least fair condition and areas with severe distress have been addressed by pre-overlay repairs. Note that the non-woven geotextile used for concrete overlays should be a heavier type that is 15 oz/syd, whereas the separator for unbound material is typically 8 to 10 oz/syd.

Typically, this fabric type is used between the following layers:

- Cement stabilized open-graded base and OGDC
- OGDC and sand subbase (when pavement is above the OGDC)
- Concrete over existing concrete pavement (if used instead of HMA separator layer)

The pay item for this type is “Geotextile, Separator, Non-Woven”.

6.02.13C Woven Geotextile

Woven geotextiles are manufactured by weaving individual polypropylene yarns into a uniform length of material. This geotextile type has lower permeability than a non-woven, so it is most suitable for configurations that require separation and resistance to water infiltration into sublayers.

Typically, this fabric type is used between the following layers:

- OGDC and subgrade (any subgrade type)
- OGDC and sand subbase (when cement stabilized open-graded base is above the OGDC)

The pay item for this type is “Geotextile, Separator”. It is important to note that since this pay item is generic and does not distinguish between woven and non-woven types, specify the woven type in the project plans when its use is intended.

6.03 HOT MIX ASPHALT (HMA) CONSTRUCTION

6.03.01 General

Asphalt, a refined product of crude petroleum, is a cementing agent in much the same way that portland cement is a cementing agent in concrete. Portland cement forms a cohesive mortar layer around aggregate particles of various sizes, as asphalt cement also does. A fundamental difference between the two is that portland cement concrete is rigid. An HMA mixture, on the other hand, is "flexible" in the sense that, depending on the unique properties of the mixture, it can flow. It is thermoplastic, becoming more pliable as heat is applied. It can be specified so that its temperature, viscosity, and durability characteristics can be matched to specific traffic and climatic conditions.

6.03.02 Glossary of Terms

Aggregate - Mineral substances (natural or "manufactured"), such as gravel, crushed stone, slag, cinders, sand, crushed concrete or combinations thereof.

Aggregate Wear Index (AWI) - A numerical value, derived by the Department, for measuring the resistance to polishing of the coarse aggregate in a given HMA pavement mixture. The higher the number, the greater the friction property. The number is determined by measuring the wet friction of a coarse aggregate concrete sample after it has been subjected to 4 million passes of a weighted, rubber-tired wheel on a circular test track. More recently, AWI numbers are being computed based on the weighted percentages from a petrographic rock analysis of a particular aggregate sample.

Alligator cracking - failure of an HMA surface, usually caused by inadequate base in combination with excess soil moisture, evidenced by closely spaced irregular and interconnected cracks. As deterioration progresses, traffic dislodges the loosened pieces of asphalt and complete failure will occur.

Asphalt cement - An asphalt that is refined to meet specifications for paving, industrial, or a special purpose, in a semi-solid state at ambient temperature. It is a product of the crude oil distillation process.

Asphalt emulsion - Minute globules of asphalt cement that have been mixed with water and an emulsifying agent to form a heterogeneous system. Emulsions are classified as slow-, medium-, or rapid-setting depending on the time it takes for them to break or separate into asphalt and water on application. Each type is available in several grades for particular application requirements.

Asphalt rejuvenator - An additive, somewhat in the nature of a light oil that, when added to an existing HMA surface or to reclaimed asphalt, softens it and increases its penetration. Usually used in conjunction with heater-planing but sometimes in hot-mix recycling. The Department rarely calls for it.

Asphalt Stabilized Crack Relief Layer (ASCRL) - An HMA mixture primarily used as a base course in a multi-course overlay of a concrete pavement to delay reflective cracking. It typically contains less asphalt cement and aggregate fines than standard HMA base course.

Bitumen - A term used synonymously with "asphalt," but more encompassing since it includes materials such as tars. Bitumens are soluble in carbon disulfide.

Black base - A conversational term used synonymously with HMA base course.

Blotter - An application of clean sand, to absorb and soak up an excess of asphalt on a pavement surface.

Blotter course - The first course of a two-course HMA surfacing in which the mix is modified to absorb the excess bitumen from asphalt-rich patches. Used to avoid removal of the patches prior to resurfacing.

Bond coat - See "tack coat."

Break(ing) - The stage during the curing of an asphalt emulsion coating when the asphalt droplets separate from the water and coalesce to form a continuous film of asphalt.

Breakdown rolling - The initial rolling operation after an HMA course has been laid down.

Butt joint - A construction joint, frequently used at the end of a days paving where a vertical saw cut face is provided for ease of resuming paving the next day. It can also be used for tying in to existing pavement. An alternative to a butt joint is a feathered joint.

Cationic emulsion - An asphalt emulsion, generally acidic in nature, prepared with an emulsifier that produces asphalt globules which are electro-positively charged.

Cold milling - The process of removing an existing surface by grinding particles away, usually by means of a machine-driven rotating drum containing a large number of carbide steel-tipped teeth.

Coulter wheel - A sharpened disc that, when brought to bear under pressure on an HMA surface, is capable of cutting through the surface. Sometimes used for trimming, it does the work of a saw faster and more economically, but with less precision.

Cracking stone - A non-technical term, relating to what happens when the thickness of the HMA course being laid is so thin that the paver screed or roller actually breaks some of the larger stone in the mix. This often occurs during feathering, but it is not considered a good construction practice for top course.

Crushing - The process by which an existing HMA surface, on a gravel base, is crushed and broken up in place by equipment such as a milling machine or a hammermill. Resulting particles, which become part of an aggregate base for resurfacing, are no larger than about 2 inches in diameter. Artificial heat is not used.

Cutback Asphalt - Synonymous with "liquid asphalt," the more preferred term used in Michigan specifications.

Drainable HMA base - A mixture composed of mostly one-size coarse aggregate that has an interconnected air void structure that will allow surface water to drain through it.

Drum mixer - A type of HMA plant that combines the drying of aggregates and the mixing of aggregates, asphalt, and mineral filler in a single rotating drum.

Emulsion - See Asphalt Emulsion.

Extraction - A laboratory test that separates the asphalt from the mineral aggregates in an asphalt paving mixture. Once separated, the components of the mix can be measured and tested.

Feathered joint - A construction method whereby the thickness of an HMA course is gradually thinned to "zero" as at the springline of a crossroad approach. While it cannot be thinned to nothing, raking out the large aggregate after paving allows a thin course.

Flow - A test in the Marshall Method of Design that measures the amount of movement or strain (in 0.01-inches) occurring in a prepared specimen during the application of the load in the stability test. It gives an indication of the resistance to deformation (shoving/rutting) that a compacted pavement will have under traffic. See Marshall Test.

Flushing - A phenomenon that occurs when there is more asphalt cement in a mix than is required to coat the aggregate particles and fill the voids. Under traffic and hot sun, the excess asphalt rises to the surface, filling the voids in the surface and being visibly shiny and perhaps slippery. It can also occur, even without an asphalt excess, if traffic is allowed on the mat before it has cooled sufficiently after paving. Moisture in the mix will also cause flushing immediately after paving.

Fog coat - A thin coating of asphalt bond coat, approximately 0.05 gal/syd sometimes used to seal areas that have been milled.

Hot Mix Asphalt (HMA) – (formally referred to as “bituminous” or “hot-mix”) A mixture of asphalt cement and aggregates, usually plant produced, used as a flexible pavement in road construction.

HMA aggregate - The HMA surfacing mixture composed of coarse and fine aggregates, mineral filler (when required), and asphalt. Differentiated from HMA concrete, the aggregate used is a gravel; the percentage of crushed (retained on the 4.75 mm sieve) is less, the aggregates are unwashed, and it is dense graded. This is now an obsolete term within the Department but designers may occasionally encounter it.

HMA base course – An HMA mixture of generally lesser strength and quality than HMA leveling or top courses and incorporating a reduced percentage of asphalt, used as a base for surfacing mixtures. Sometimes called "black base.”

HMA binder course – An HMA concrete mixture incorporating relatively large crushed aggregate particles (100% passing 37 mm). Used as a stable base for surfacing mixtures. Usually more stable than HMA base course because of the aggregate interlock of the crushed particles and the higher asphalt content. While HMA Binder Course was a major pay item a few years ago, the term is now obsolete and is included here principally to aid in understanding old plans.

HMA leveling course - The HMA course under the top course. Besides adding strength and bulk to the total surfacing, it can be used to fill in slight irregularities in the underlying surface.

Lift - A term referring to the layer of HMA mixture laid down in one pass of the paver. A surface paved in two courses is constructed of two lifts.

Liquid Asphalt - An asphalt cement that has been made liquid by blending with petroleum solvents (diluents) of various degrees of volatility. Upon exposure to the atmosphere, the diluents evaporate, leaving the asphalt cement. These materials are devised according to their use. Liquid asphalts fall into three classes:

1. ***Rapid-curing liquid asphalt (RC)*** - Composed of asphalt cement and various amounts of naphtha or gasoline type diluents to make up the different grades of fluidity.
2. ***Medium-curing liquid asphalt (MC)*** - Made similar to the rapid-curing except that the diluent is a kerosene.
3. ***Slow-curing liquid asphalt (SC)*** - Made with a heavy distillate or low-volatile oils.

Used sometimes for blending, it is so liquid that its penetration cannot be measured. Sometimes spoken of in contrast to “penetration asphalt” (the penetration of which can be measured)

Log (log job) - A written narrative that explains to the contractor, and to our own construction forces, the nature and scope of the work to be done. A log job is used for simple projects when the work can, for the most part, be described verbally.

Marshall Test - A laboratory procedure used to design or determine the properties of HMA paving mixtures. It can be used to determine the optimum proportions of aggregates, mineral filler, and asphalt cement needed to provide desired properties in a mix. Generally, thought of as a test for stability.

Mat - A term for the asphalt pavement; likely to be heard during construction.

Mineral filler - A fine mineral aggregate (usually fly ash or crusher dust), at least 70% of which passes the 0.075 mm sieve (ASTM No. 200) used to fill the voids in the mix, increasing the stability. Added in the plant, it tends to stiffen the mix.

Mix design - The laboratory process whereby the proportions of ingredients are determined for an HMA mix having certain predetermined qualities of stability and durability.

Open-Graded Friction Course (OGFC) – An HMA mixture used as a surface course, using predominantly a single size aggregate to form a porous layer. This allows rapid surface drainage and inhibits hydroplaning.

Penetration - The property of asphalt cement that is determined by a laboratory test measuring viscosity semi-solid asphalts, enabling the material to be classified into standard grades. A 1.00 mm diameter needle, with a truncated tip, is weighted to 100 g and allowed to bear on the surface of asphalt, at 25°C for 5 seconds. The penetration, in units of 0.1 mm, is then measured. The results are classified into standard penetration ranges of 85-100, 120-150, 200-250, and 250-300 for HMA mixtures used in Michigan. The lower the number, the harder the asphalt. No longer specified, Performance Grade asphalts are now specified instead.

Performance Grade (PG) - Asphalt binder specification based on climate and attendant pavement temperatures at which the binder is expected to serve.

Plant-mix – An HMA mix produced in a stationary plant, as opposed to road-mix or a stabilized-in-place mixture.

Precoated sand - Sand that has been coated with asphalt. Has been used to impart a more skid-resistant texture, to a new HMA surface having low skid resistance, by uniformly spreading it at up to 2 lbs/syd on the pavement surface, then rolling. No longer used in Michigan.

Prime coat - A sprayed-on application of liquid asphalt, tar, or an asphalt emulsion on an untreated surface, such as gravel, prior to the placement of an HMA mat or seal coat. Its purpose is to close off the aggregate openings, preventing further penetration of succeeding asphalt treatments, and to aid in maintaining the shape of the final grading during paving operations. Not used by the Department.

Raveling - The progressive separation of aggregate particles in a pavement surface under the action of traffic and natural forces. Raveling occurs either from the top down or from the edges inward. A typical failure will occur at the pavement edge where there may be inadequate base support.

Reclaimed asphalt pavement (RAP) - An existing HMA surface, or portion of same, that has been removed, crushed, and may be used for recycling. Proprietary RAP is material owned by a contractor that may have been obtained from an unknown source, e.g., a commercial parking lot, local street, or state trunkline.

Residual - An old term that describes a road oil which has had somewhat limited refining so that it exhibits the properties of a heavier liquid asphalt, such as an SC (slow-cure).

Rubblizing - The process by which a portland cement concrete pavement is broken up into small pieces, ranging from sand size to a maximum of 6 inches, with the majority of pieces in the 1-inch to 2-inch size range. A resonant pavement breaker or multi-headed breaker is specified. Projecting pieces of steel reinforcement are cut off below the surface, the pavement is rolled with a (minimum) 10 ton steel wheeled roller, and depressions of 1-inch or more are filled with coarse aggregate.

Rutting - The formation of longitudinal depressions in the wheel paths that result when an HMA pavement or underlying base has insufficient stability to support traffic. It is usually evidenced as two continuous wheel "tracks" in the traveled lane, sometimes only visible during a rain or when measured with a straightedge.

Scratch coat - A thin course, e.g., ¾ inch of HMA surfacing sometimes used when there is considerable joint and surface deterioration of an underlying concrete pavement after HMA surfacing has been milled off, or to fill ruts. Applied directly to the pavement to be resurfaced, it gets its name from the appearance of the HMA material after it is laid down. The paver screed is set so low that the thickness of the mat may actually be less than the largest dimension of some of the aggregate particles, causing the particles to be pushed ahead of the screed, creating a scratchy appearance.

Screed - The part of the paving machine that levels and compacts the HMA mixture prior to rolling and densification.

Seal coat - The sequence of laying up a thin HMA surface consisting of a prime coat and alternate layers of an asphalt emulsion and stone chips. The terms, single, double, and triple seal, refer to the number of applications of asphalt emulsion and chips. Also known as prime and seal.

Segregation - A separating of the larger from the smaller aggregate particles in an aggregate or HMA mixture. The larger particles, being heavier, have a tendency to roll to the outside of a pile when dropped. The larger particles also have a tendency to rise to the top of a mixture when vibrated because they are unable to sink to the bottom as do the finer, smaller particles. Segregation is objectionable in an HMA mix because the mix will be non-uniform, possess less than design strength, and will have an uneven texture, allowing moisture to enter especially in the areas of the larger particles. This likely will cause raveling of the HMA surface.

Separation course - A layer to prevent bonding of an upper pavement course to a lower pavement course. It may be sand, gravel, or a low asphalt-content HMA mix.

Sheet asphalt - A sandy HMA mixture where the maximum size aggregate is that passing a 4.75 mm sieve (ASTM No. 4) or smaller. (Also called a sand asphalt HMA mixture.)

Shoving - The action of an HMA mixture, lacking stability, moving forward as a result of braking traffic. Most commonly observed as a series of bumps at the approaches to signalized or stop-control intersections.

Slurry seal - A rather liquid mixture consisting of asphalt emulsion and sand used as a thin crack and joint sealer. It is usually applied by a special machine. A variation is a tar emulsion protective coating used in parking lots as protection against deterioration caused by fuel drippings.

Stability - One of the tests used in the Marshall Method of Design to determine the maximum load in pounds, applied at 140°F, which can be applied to a prepared bituminous mixture specimen (4 in. x 2½ in. high cylinder) before it fails. This test, along with the flow test, provides an indication of the ability of the pavement to carry traffic loads. Also see Marshall Test and Flow.

Stabilization – The process of increasing the load-carrying capacity of underlying layers or layers underlying the pavement by adding a stabilizing agent. Asphalt cement is most commonly used as a stabilizing agent, but asphalt emulsions, portland cement or lime have also been used. Other terms of stabilization are stabilization-in-place and in situ recycling.

Stage construction – In HMA construction, delaying placement of the top course until some time after placing the lower courses. Usually requires adding more asphalt cement to the leveling course mix so that it can carry traffic. While sometimes done for economic reasons, it also can occur when the advent of winter brings an end to the paving season.

Stringline – A technique for obtaining accurate grade control by placing taut wire or string alongside the roadway to be paved, accurately set to grade. The electronic controls on the paver are thus guided, which in turn controls the screed elevation.

Stripping - The loss of adhesion between the asphalt coating and the aggregate particle leading to deterioration of the bituminous pavement. Caused by incompatibility of the asphalt and the aggregate, which may be aggravated by moisture in the mat.

Structural number (SN) - An index number derived from an analysis of traffic, roadbed soil conditions, and a regional factor that may be converted to thickness of flexible pavement layers through the use of suitable layer coefficients related to the type of material being used in each layer of the pavement structure. (See the 1993 AASHTO Guide for Design of Pavement Structures.)

Superpave (Superior Performing Asphalt Pavement) - An improved system for specifying the components of asphalt concrete, asphalt mix design and analysis and asphalt pavement performance prediction.

Tack coat - A thin HMA coating of an asphalt emulsion. Routinely sprayed on a paved surface just before HMA paving to increase the adhesion of the new surface. Sometimes called a bond coat.

Tenting - The phenomenon, most noticeable in mid- to late winter, where the HMA surface at a crack tends to heave up on each side of the crack, forming a "peak". This is caused by the action of water entering the crack, then freezing. With the spring thaw, traffic forces the peaks down.

Thermal cracking - Transverse cracks at a somewhat regular spacing found in an HMA pavement, caused by cold weather contraction that exceeds the tensile strength of the surface.

Top course - The last and final HMA course to be placed in a surfacing or resurfacing operation.

Viscosity - The resistance of a fluid to flow under gravity. Performance grading is now used instead of viscosity grading.

VMA - Voids in the mineral aggregate. The space between aggregate particles available for asphalt and the "passing 200" fines. It allows sufficient asphalt content to provide adequate particle coating, as well as a 3-4% air content to help prevent flushing.

Wearing course - Until recently, a term referring to the top course of an HMA concrete pavement. With adoption of the term "top course", the use of this term is being discouraged.

Wedging - The practice of placing HMA material in selected low spots to further level the base prior to resurfacing. If used continuously along the pavement edge, it would flatten an excessive crown. If used along the center portion of the pavement, it would build up a too-flat crown.

6.03.03 Philosophy of the Use of HMA Surfacing

Both the HMA and portland cement concrete industries are vital parts of Michigan's economy. The Department therefore endeavors to make impartial use of both materials. Because of its adaptability to the maintenance of traffic, needing only to cool before traffic can be allowed on it, asphalt is the common type of resurfacing in use. It is also used rather extensively as the pavement type on new construction in the areas of the state having granular soils.

The purpose of resurfacing is to extend the useful life of a pavement for a given length of time, usually for a period of 8 to 12 years, but sometimes for as little as 3 to 5 years. If no design life is specified when a resurfacing project is assigned, assume it to be 10 years. In some situations a shorter design life may be desired.

6.03.04 Surface Preparation

(revised 8-24-2026)

6.03.04A Conditioning Aggregate Base / Surface

When existing aggregate base/surface remains in place see Section 6.02.09D.

6.03.04B Concrete or Composite (HMA on Concrete) Pavement

6.03.04B1 Crown and Superelevation Modification

Current methods for modifying pavement crown and superelevation are expensive and need careful consideration. Many resurfacing projects call for modifying the crown from the former parabolic configuration to the current 2% cross-slope and/or upgrading pavement superelevation. Modification of pavement slope is typically accomplished by wedging with HMA and/or cold-milling. The need for modification will be based on a safety analysis and applicable design standards. Crown modification may include changing the shape, changing the rate of the cross-slope, adjusting the crown point location or a combination of the three. Existing pavement slope(s) should be thoroughly reviewed during the project design (including cross-sectioning where applicable) to minimize construction problems and cost overruns.

6.03.04B2 Cleaning Pavement

The Standard Specifications for Construction state that the pavement surface must be clean prior to resurfacing. Some designers have purposely omitted the item when milling is done on the assumption that sweeping after the milling accomplishes the desired result. The fallacy with this is that several weeks can elapse between milling and resurfacing, giving the pavement time for dirt to be tracked upon it once more. The pay item "Pavt, Cleaning", measured as a lump sum, should therefore be included in all resurfacing projects. It can be deleted during construction if for some reason it is not needed.

6.03.04B3 Removing Pavement for Joints

All joints on the trunkline where HMA surface is started or terminated should be butt joints. Construction of a butt joint requires removal of the existing surface to a depth sufficient to receive the resurfacing, so that it will be flush with the adjacent surface at the joint. Whereas this work was once done by means of a jackhammer, much of it today is done by a milling machine. The pay item “Pavt for Butt Joints, Rem”, measured in square yards, includes removing and disposing of concrete or HMA materials. The removal depth, width and taper shall be according to the Standard Specifications for Construction.

Paving of side street approaches may be ended by feathering unless recommendations to the contrary are received from the Plan Review Meeting. Feathering is much more economical than a butt joint, but it has a tendency to eventually loosen where it is extremely thin unless extra precaution is taken during construction to fine up the mix, especially for feathering. Refer to the Standard Specifications for Construction for the taper rate of feathered joints.

A butt joint, if used on a side street approach, could vary in length depending on the nature of the side street. For a low volume, low speed side street, a 10 foot length generally would be adequate. However, at major intersections where the volume and speed are comparable to mainline, the required length of the transition should also be comparable. Thicker overlays may also require longer transitions.

6.03.04B4 Edge Trimming

An old HMA pavement, whether over gravel or concrete, develops a ragged edge over the years. Sometimes this is merely raveling, other times it may be extruded material overhanging the underlying pavement edge. This loose or uneven material may need to be removed prior to resurfacing by trimming and truing the edge, as determined in the Plan Review Meeting. This is usually done by means of either a saw or a coulter wheel, the base being left undisturbed.

The pay item of "Edge Trimming", measured in feet, covers the work of cutting the pavement edge, prior to removing HMA shoulder material adjacent to the traveled lane, and the removal of the severed debris. If it is necessary to remove HMA over concrete material near the edge, but within the traveled lane, the work will be paid for as HMA Surface, Rem.

6.03.04B5 Cold Milling HMA Surface

The development of the rotating drum milling machine around 1976 opened the way for economical, large scale removal of existing HMA surfaces, i.e., volume production without labor intensity. This capability has subsequently encouraged recycling on a large scale, and has made work such as removal for patching and butt joints comparatively easy. While the difficulty of removal, whether HMA or concrete, varies with the hardness of the aggregate and the depth of removal, it is possible to remove up to 4 inches or 4½ inches of existing HMA in a single pass of the milling machine. (However, it is usually more economical for a contractor to remove a 4 inch thickness of asphalt in two passes.) Machine widths, i.e., drum widths, vary from about 12 inches to about 12 ft.-6 in.. The smaller drums are available on a variety of equipment. Although a minimum 12 inches of width may be removed by milling, for practical purposes provide a minimum of half a lane width when reclaiming a curb face covered by previous resurfacing.

About 1½ inch depth is the minimum that can be cold milled economically. (Lesser depths can obviously be removed, for reasons other than economy.)

Any hand work required when removing HMA surface around catch basins, manholes, or SCANDI loops should not be paid for separately, but noted as included in payment for "Cold Milling HMA Surface". This should be clearly stated on the plans or in the proposal.

Occasionally, when requested by Construction, stringline control may be called for in conjunction with cold milling. This is not feasible where only 1-inch or 1½ inches is being removed, however, as there simply is not enough latitude available for grade adjustment. "Cold Milling HMA Surface" may be measured by either square yard or by the ton. The unit to use will usually be determined at the Plan Review Meeting.

Where there will be varying cold milling depths use tons. When square yards are used, the thickness of HMA surfacing to be removed must be clearly indicated on the plans or in the log. Cores should be taken prior to construction (one every 1000 feet per lane) to verify the thickness to be milled and the condition of the underlying material.

When a milling machine is used to construct a butt joint to receive the full depth of all resurfacing courses, the butt joint should be included in the payment for Cold Milling. When the depth of milling is reduced to less than the full resurfacing depth at the joint, it should be paid for as Pavt for Butt Joints, Rem. Butt joints for driveway approach removal should also be paid for as Pavt for Butt Joints, Rem. The butt joint should be detailed on the plans showing either full or reduced removal depth against the existing pavement and indicating the appropriate pay item.

6.03.04B6 Removing HMA Surface

Use HMA surface, Rem (Syd) when the thickness of the HMA cap to be removed is 12 inches or less and the underlying pavement is either removed or left in place. Use Pavt, Rem (Syd) when the thickness of the HMA cap to be removed is more than 12 inches” and the underlying pavement is either removed or left in place.

There are a number of methods for removing HMA surface:

A. Motor grader with ripper teeth

   Suitable for HMA over aggregate. Largely obsolete for removing an HMA surface from underlying concrete.

B. Jackhammer

   Being labor intensive, only suitable for small areas such as preparing a butt joint.

C. Front end loader

   Suitable for removing an HMA surface from underlying concrete. On recycling projects the material is processed through an aggregate crushing plant.

D. Cold-milling Machine

   Fastest, most modern method for removing an HMA surface over a pavement that is to be left in place. The machines are relatively expensive, however, which may put them beyond the means of small contractors.

E. Heater planer

   By softening the material with either direct or indirect flame, volume production is possible. This method tends to be energy inefficient and environmentally objectionable, if smoke is not controlled. Not many large machines are located in this part of the country. A heat planer may cause damage to the material, if it is to be recycled (direct flame can burn asphalt to ash).

6.03.04B7 Removing HMA Patches

Existing surface patches (not full-depth patches) may need to be removed prior to resurfacing. Generally, they are composed of cold patch material placed by maintenance forces. Cold patch is likely to be rich in bitumen, which tends to bleed through the hot resurfacing causing an asphalt-rich spot that can be weak and lacking in surface texture. Some of the cold patch materials do not need to be removed because they are not sensitive to heat. The pay item is “HMA Patch, Rem” measured by the square yard.

6.03.04B8 Joint and Crack Cleanout

Joint and crack cleanout covers the work of removing existing joint sealant and foreign materials, to a depth of up to 1-inch from transverse and longitudinal joints and cracks prior to resurfacing. The work is usually done with a hooked device, not unlike a stove poker. The pay item is "Joint and Crack, Cleanout", measured in feet of joints and cracks so treated. Cleaned cracks 1-inch wide and greater shall be filled with hand patching.

Neoprene joint seals should always be removed prior to resurfacing. Some hot poured rubber sealants need to be removed as they can cause the mat to slide when hot and while being rolled. See Section 6.03.04B14 for treatment of existing pressure relief joints.

6.03.04B9 Hand Patching

There are two methods of placing HMA patching material: by machine and by hand. Obviously, larger areas that would make machine placement cost effective will be patched by a paver. The pay item of "Hand Patching," measured in tons of HMA material necessary to fill the void, is used to compensate the contractor for the additional effort required to do the work by hand (the pay item includes payment for material as well as for labor).

Depressions must usually be patched prior to paving the first course. Hand patching will generally be used for filling in depressions and where cold patches have been removed.

Hand Patching is a difficult item to estimate because of the many variables involved. When Detail 7 or 8 joint repairs are done using a milling machine, quantities of hand patching will increase about 50%. The problem is magnified because this item has a relatively high cost and is prone to large overruns during construction.

A quantity of Hand Patching should always be included with joint repair items. The following guidelines are offered to aid in estimating Hand Patching:

Joint Repair	Estimate
Detail 7	5 tons / 100 ft of repair
Detail 8	* 10 tons / 100 ft of repair
Holes, old patches, etc.	Approximate Area and Depth

* Based on a depth of 11 inches and a width of 18 inches. This estimate may need to be adjusted based on the size of the repair.

Details for joint and crack repairs are shown on Standard Plan R-44-Series.

6.03.04B10 Repairing Pavement Joints and Cracks

The Detail 7, surface repair for joints or cracks, and Detail 8, full depth repair for joints or cracks, do not include the corresponding "Hand Patching". Design quantities for either repair seldom match as constructed quantities. A cursory surface inspection is unlikely to reveal the extent of joint deterioration and construction forces complain that, for a given number of joints set up on a project for repair, there may be an equal number, equally deteriorated, for which no repair quantities are provided.

It is not unusual for Construction to pay for 12 feet of joint repair as, i.e., 7 feet of Detail 7 and 5 feet of Detail 8. Designers should attempt to break down quantities to the extent possible, but should realize, the extent of joint deterioration can only be determined after the joint is opened up.

There are two pay items involved with Detail 7 and 8 joint repairs, "Pavt Joint and Crack Repr, Det [insert 7 or 8]" and "Hand Patching". See preceding Section 6.03.04B9.

If the project includes milling off the old HMA surface, it may be recommend at The Plan Review that the milling machine drum be lowered perhaps 1-inch into the deteriorated joint to remove the deteriorated concrete and debris. If this is done, the contractor is merely compensated for the additional milled material that is removed, and the additional new surfacing material required to fill the deeper void at the joint. If, after the milling has been done, it appears that the joint is in such condition as to require a bonafide Detail 7 or 8 joint repair, then the engineer will order that this be done. The subsequent repair would then be paid for as an ordinary Detail 7 or Detail 8 joint repair.

6.03.04B11 Pavement Patching

Pavement patching consists of a cast in place concrete patch, in most situations. A concrete patch is used when a Detail 7 or Detail 8 repair method is not sufficient. Standard Plan R-44-Series illustrates a concrete patch design. Full depth HMA patches are used in lieu of concrete patches only when maintaining traffic concerns warrant the change. Full depth HMA patches are typically recommended on low commercial volume routes. Full depth HMA patches should only be used on freeways when maintaining traffic is an overriding concern.

Backfill material for a full depth HMA patch is mainline top course mixture and is paid for as Hand Patching. See Section 6.03.09.

The patching mixture will be placed flush with the surface of the existing pavement. The patch is paid for as “Pavt Repr, Rem” in square yards of material removed, and as “Hand Patching” in tons to the cover the HMA mixture put back.

6.03.04B12 Guidelines for Preparing a Deteriorated Jointed Reinforced Concrete Pavement for an HMA Overlay

The Engineering Operations Committee has approved the following guidelines for repairs to jointed reinforced concrete pavement in preparation for an HMA overlay.

1. Traffic Volume Range 0-5,000 ADT (per roadway)

   Replace all joints and cracks having a distress severity level of 1 with a Detail 8 repair. Remove all cold patch material and loose concrete from all remaining joints and cracks and replace with a Detail 7 patch. All previously placed concrete repairs are to be left as is, except cold milling of concrete repairs faulted more than ¾ inch is optional (in lieu of replacement).

2. Traffic Volume Range 5,000-10,000 ADT (per roadway)

   Repair all joint, cracks, and undowelled repairs having a distress severity level of 1 with a dowelled concrete repair. Remove all cold patch material and loose concrete from all remaining joints and cracks and replace with a Detail 7 patch. Cold mill all undowelled repairs faulted more than ½ inch.*

3. Traffic Volume Range 10,000 and up ADT (per roadway)

   Replace all joints, cracks, and undowelled repairs having distress severity levels of 1 and 2 with a dowelled concrete repair. Remove all cold patch material and loose concrete from all remaining joints and cracks and replace with a Detail 7 patch. Cold mill all undowelled repairs faulted more than ½ inch.*

   * In lieu of cold milling replace all remaining undowelled repairs with dowelled repairs if the replacement cost (based on total pavement repair and overlay cost) is less than 15 percent above the cold milling cost.

6.03.04B13 Additional Uses of Detail 8 Joint Repairs

1. When the expected functional life of the repaired pavement is no greater than 5 years.
2. When the overall integrity of the pavement has deteriorated to the extent that the load transfer and slab flexure capacity no longer allows the pavement to function as a rigid pavement.
3. When the pavement has deteriorated to the extent that it can no longer accept the stresses that would be imposed upon it by the installation or action of load transfer devices.

6.03.04B14 Surfacing Over Pressure Relief Joints

Pressure relief joints have been used in concrete pavement since 1975. The foam filler placed in those joints should be removed prior to resurfacing, if possible to do so. Sometimes the pavement is so compressed that the foam filler is almost a solid. In this case it is not only very difficult to remove but it will do no harm if left in place.

Problems seem to occur when the width of the opening exceeds about 1-inch. Lack of support leads to inadequate compaction of the new surface mix over the crack or joint. The poorly compacted, porous mix is subject to cracking, water penetration, and early failure. When setting up logs for resurfacing of roadways that have had previous joint repair and pressure relief, the designer should call for removing the joint filler if the joint is more than 1-inch wide. The void should then be filled with a sand-asphalt mixture before resurfacing. Payment for sand-asphalt should be included in other surface preparation payment items.

Note: Cracks over 1-inch wide should likewise be cleaned and filled with a sand-asphalt mixture.

6.03.04B15 Wedging

Wedging is used to build up insufficient areas in the existing surfacing, such as to increase insufficient crown, to increase superelevation, or to level out sags that distort the profile. While the regular HMA surfacing can be thickened to take out up to 1-inch of sag, wedging, as a separate operation, must be used for thicker modifications.

Wedging shall be 3 inches or less using the same HMA mix as the top course of the mainline pavement. Additional wedging can be accomplished with variable thickness in the leveling and/or base course.

6.03.04B16 Scratch Coat

An 80 lbs/syd (about ¾ inch thick) scratch coat is usually required whenever a pavement is cracked and seated, or the existing HMA cap is removed from a composite pavement and the exposed concrete surface has joint and surface deterioration. This is to prevent ravelling of the old concrete under traffic, and possibly a rolling ride when the finished pavement is in place. The material is similar to an HMA leveling course, perhaps modified to use a different size aggregate, computed in addition to the regular rate of resurfacing proposed for the project. If, for some reason, the scratch coat needs to be thicker (as recommended at the Plan Review Meeting) then consideration should be given to reducing the regular leveling course by the additional application rate in excess of the nominal 80 lbs. A scratch coat should be provided on all such applicable projects unless it is specifically deleted at The Plan Review Meeting.

A scratch coat can also be used to fill longitudinal irregularities such as rutting or faulting between lanes. Scratch coat quantities should be shown separately from the regular resurfacing quantities, and designated as "scratch coat", e.g. HMA, LVSP (Scratch Coat).

6.03.05 Adjusting Drainage Structures and Utilities

(revised 8-24-2026)

It is the practice of the Department to adjust the elevation of manhole and catch basin covers to fit the finished elevation of proposed resurfacing. Designers should therefore provide quantities for this adjustment, but with the knowledge that site by site decisions will be made on construction relative to tapering the surfacing down (or up) to meet the cover at its existing elevation. Depressed covers, e.g., possibly as much as 1-inch low, can sometimes be tolerated in the gutter, and a manhole cover in the center of a lane that is ½ inch low may not pose a problem. On the other hand, a cover in the lane wheeltrack that is ½ inch low will be a constant annoyance to the motorist. Some local agencies, for reasons of economy, will shape the new HMA to fit the existing elevation of the cover even if it is 1½ inches to 2 inches low. This practice may be acceptable on low volume, low speed residential streets, but it is not acceptable on a street designated as trunkline.

6.03.05A Adjusting Drainage Structures Covers

The item of "adjusting" applies where the elevation of the cover is changed 6 inches or less. It applies to manhole covers, whether drainage or utility, inlets, and to catch basin covers. While adjustment is usually upward, it can apply where the cover is lowered as well, as might occur in a widening situation.

If the existing structure is in poor condition, it should be reconstructed.

Normally, adjustment is by means of raising the casting with a masonry lift. From time to time, various manufacturers introduce adjusting rings that raise the lid or grate without necessitating adjustment of the frame.

Designers should take the maintaining traffic scheme into account when setting up drainage structure adjustment quantities. If it is determined that traffic will be carried on the leveling course for a period of time, it may be necessary to adjust the covers twice. In this case it might be prudent to contact the Region/TSC for confirmation of the need for double adjustment.

There have been occasional problems with settlement of the HMA surfacing in the area for 10 inches to 12 inches around manhole covers, the area usually disturbed during adjusting. There are several theories as to the cause of this settlement: allowing traffic over the cover before normal strength mortar has attained strength, inadequate compaction around the cover, and deterioration of the manhole itself. The problem has been particularly prevalent in the urban areas.

One method that has proven successful in overcoming this problem is cutting out approximately a 6 foot square around the cover, after the leveling course is laid, and recasting it with concrete base course about 2 inches below the finished grade of the top course. This method of adjustment was approved by the Engineering Operations Committee on January 19, 1983.

6.03.05B Drainage Structure Cover, Adjust, Additional Depth

The item of "adjust additional depth" applies where the elevation for the cover is changed more than 6 inches (unless reconstruction to top of footing is necessary, in which case the work is paid for as a new structure). Additional depth adjusting also applies where the corbel (cone) of an existing structure must be rebuilt to adjust the lateral location of the cover.

Frequently, drainage structures set up on plans to be adjusted are found on construction to be in such poor condition that they require additional depth adjusting, resulting in a cost overrun. To compensate for this, designers should set up a lump sum quantity of "entire project" additional depth adjusting of drainage structures equal to 25% of the total of structures set up on the plans to be adjusted. (This figure of 25% will be in addition to the number of structures known to require additional depth adjusting and so set up on the plans.) On projects where the drainage structures are unusually old, or where there is a large volume of heavy trucks, the 25% estimate should be increased to 40%.

6.03.05C Measurement and Payment

The pay item “Dr Structure Cover, Adj, Case 1”, measured as each, applies to structures located in pavement (including curb and gutter). Removal and replacement of pavement is included in this pay item if not already covered elsewhere. Replacement of curb and gutter is paid for separately.

The pay item “Dr Structure Cover, Adj, Case 2”, measured as each, applies only to structures located outside the pavement area.

The pay item “Dr Structure, Adj, Add Depth” is measured per foot beginning 6 inches from the level of the existing structure (in the direction of adjustment) to the limit of the additional depth of adjustment. This also requires payment for, “Dr Structure Cover, Adj, Case [insert 1 or 2].

If a new cover is required in conjunction with an Adjustment it is paid for separately. Also, see Standard Specifications for Construction for details.

6.03.05D Adjusting Water Shutoffs and Gate Boxes

The pay items “Water Shutoff, Adj, Case [insert 1 or 2]” and “Gate Box, Adj, Case [insert 1 or 2]” measured as each, should be set up as applicable. Case 1 refers to structures located in hard surfaced travel areas and unit prices includes saw cutting, removing and replacing existing pavement, curb, or curb and gutter, and adjusting the water shutoff or gate box to final grade. Case 2 refers to structures located outside existing pavement, curb, or curb and gutter and unit prices includes restoring disturbed vegetated or sidewalk areas.

6.03.05E Facilities Owned by Private/Public or Municipal Utility

Manholes, shut-off valves, etc. owned by a private/public or municipal utility that require adjustment or reconstruction ***may*** be altered by the facility owner. The facility owner should be contacted to discuss whether they want to adjust the facility or have the MDOT contractor do this work. The designer should coordinated efforts with the Region/TSC utility coordination engineer for contacting the effected utility. If the work will be done by the utility, such structures should be referenced by a note on the plans to the effect that the work will be done by others. The Region/TCS utility coordination engineer should include language regarding this work in the projects utility coordination clause.

6.03.05F Adjusting and Placing Monument Boxes

Payment for installing or adjusting monument boxes in paved areas will be according to the Standard Specifications for Construction for "Monument Box Adj" or "Monument Preservation"

In addition, it is required that all monument boxes be adjusted whether shown or not. To ensure that all government corners are adjusted or preserved, the designer shall place the following note on the plans or in the log of any project that includes section or quarter corners.

It is the intent that all government corners on this project be preserved and that, where necessary, monument boxes be placed or adjusted whether shown or not.

Monument box castings are furnished by the contractor according to Standard Plan R-11-Series.

If a Design Unit has a resurfacing project to design without benefit of a survey, the Design Engineer should check with the Survey Section to determine if a pickup survey to locate monument boxes could be made within the time available to complete the plans.

Designers may encounter monument boxes in existing pavements at previous survey or construction control points. On a major reconstruction project these monuments probably need not be preserved, whereas on a resurfacing job, a quantity should be set up to adjust or place new boxes. The Lansing Survey Unit should be contacted by the Design Unit whenever these points are encountered on a project.

For additional information concerning monumentation, see Section 5.14.

6.03.06 Special Base Treatments

(revised 11-28-2011)

For detailed information and applications of each of the following specified treatments contact the Region/TSC Soils Engineer and the Pavement Design Engineer. Also contact the Region/TSC Soils Engineer and the Pavement Design Engineer regarding any emerging technologies and applications that may be available.

6.03.06A Concrete Pavement Cracking and Seating

Michigan has used this method on a limited number of projects with mixed results. Pavement Cracking and Seating was developed as a means to reduce or eliminate reflective cracking in an HMA over concrete pavement. The process involves cracking of the old concrete slab prior to placing an HMA overlay. The results of the process have varied from a severely cracked slab with portions literally pounded into the subgrade to cracking so slight that it is hardly visible. Cracking and Seating is only effective when the bond between the steel reinforcement and the concrete is broken. Research has shown that breaking this bond is difficult to accomplish. Cracking and Seating should only be used when the concrete slab is nonreinforced and where an approved base course exists. The Region Soils Engineer and the Pavement Design Engineer should be consulted. An effective Cracking and Seating operation yields concrete pieces ranging from 18 inches to 48 inches.

A major advantage to this method is that traffic can be maintained on a Crack and Seated surface. This is particularly useful on two lane roads where lane closures are difficult. High traffic volumes can cause high dust levels.

The Region/TSC Soils Engineer and the Pavement Design Engineer should be consulted when designing an HMA overlay for a Cracked and Seated pavement. They should also be consulted to determine whether Cracking and Seating is an appropriate fix type for a project. A special provision is required.

6.03.06B Rubblizing Concrete Pavement

Rubblizing is another method used to reduce or eliminate reflective cracking in an HMA overlay. This method results in concrete pieces averaging in size from 1-inch to 2 inches. Rubblizing succeeds in destroying the bond between the concrete and the reinforcing steel, but it results in even less base support than does cracking and seating.

Rubblizing is the predominant method used to rehabilitate badly deteriorated concrete pavement prior to an HMA overlay. Rubblizing should be avoided in areas with a high water table or where an approved base course does not exist. Rubblizing is used on both freeways and nonfreeways. Two lane roads are difficult to rubblize because of maintaining traffic concerns. Traffic cannot travel on a rubblized surface because of possible protruding steel, severe dust from the broken concrete, and roughness of the driving surface.

Experience to date has indicated that a full depth saw cut should be used where the rubblizing abuts concrete pavement that will either remain in place or be removed. Generally a pavement in such poor condition as to warrant rubblizing would also have bad joints. It would be undesirable to leave one-half of a bad joint, therefore this saw cut should be located 10 feet to 12 feet from a joint.

A widening or shoulder reconstruction that extends significantly below the top of the pavement being rubblized should normally be completed before rubblizing. The staging should not require that the shoulder or widening excavation expose the unsupported edge of the pavement being rubblized. Any widening and/or shoulder work shall be completed up to the elevation of the existing pavement surface before rubblizing. These areas can then be utilized to support the pavement breaking unit while rubblizing the existing pavement.

6.03.06C Crushing and Shaping

Crushing, as defined in the Glossary of Terms, Section 6.03.02, is essentially the conversion of an HMA-over-gravel surface to a crushed material, which can be reshaped to the desired cross-section. This type of recycling is appropriate where poor base material is a problem; where the surface is badly cracked; where 1 foot to 2 feet of widening is proposed; or where extensive wedging, crown modification, or superelevation modification is required. Marginal base material can be upgraded with admixtures to provide high quality support. The Bituminous Unit of the Construction Field Services Division should be consulted for guidance in determining the feasibility of the different options. Also see Section 6.03.09 for the placing of HMA over "crush and shape" projects.

Crushing is usually more economical than hot-mix recycling, unless the asphalt surface is quite thick. When the existing mat is quite thick, a common procedure is to mill off part of the HMA, then crush the remainder. A mat of nominal thickness, e.g., 6 inches or less, would probably not be milled off. Normally anything over 6 inches is cold-milled prior to crushing and shaping.

Projects are selected by the Region/TSC by including crushing in the project concept statement in the Call for Projects.

Design quantities should be based upon the limits of the shaping of the crushed material, not the width of the existing pavement surface. If an existing 24-foot wide pavement is to be crushed and shaped to a 30-foot width, quantities should be based on the 30-foot dimension. A bulking factor of about 20% should be used, i.e., 30 feet wide will do about 36 feet at same depth.

6.03.06D Stabilization in Place

The term "stabilized-in-place" is used to describe cold-mix recycling, in situ recycling, in-place recycling, and stabilizing. The stabilized-in-place process involves adding a stabilizing agent to improve the strength of the pavement section. This is accomplished by a special machine that scarifies the existing surface to a given depth, crushes it in a pug mill, adds asphalt cement, and lays the resultant mix back down, almost in its original location. The process has been used in Michigan to upgrade pavement sections varying from a full-depth HMA freeway to sealcoated shoulders. The finished product is considered as a base only, and a hot-mix surface course is necessary.

There are two principal shortcomings of base stabilization, 1) the lack of uniformity, with occasional "fat spots" of excess asphalt cement concentrations, and 2) the cost of both the mixing process and the amount of asphalt cement used. For these reasons, Michigan has done very little stabilization-in-place since 1985.

Following an investigation of the nature and depth of the existing material, the Construction Field Services Division will advise Design as to the depth of stabilization. This depth must then be shown on the plans or an application rate of ½ gallon per square yard per 1-inch of thickness should be used by designers in estimating the amount of HMA Material, Base Stabilizing required. A note should be placed on the typical cross-section sheet, or prominently in the log, indicating the estimated application rate per square yard.

A commonly used depth of stabilization is 4½ inches of base, surfaced with 250 lbs/syd of plant-mixed asphalt.

The HMA base stabilization should be the same width as the proposed asphalt mat that is to be surfaced.

6.03.07 Hot-Mix Recycling

(revised 11-28-2011)

6.03.07A General

Energy and environmental concerns beginning in the early 1970's sparked development of techniques for hot-mix recycling of old asphalt pavements. Two significant technological advances, that seemed to occur almost concurrently, made asphalt pavement recycling feasible. These were the development of the cold-milling machine and the drum mixer asphalt plant. The one opened the door to economical removal of the old material, the other led to volume production of the recycled mix.

As recycling projects were successfully completed, the Department gave the contractors progressively more latitude to generate cost savings through recycling. Initially, a blend of 50% recycled material and 50% new material was used. The recycled material had to be obtained from the project and its use was restricted to lower courses. Recycled Asphalt Pavement (RAP) was eventually allowed in #500 (stability) mix, regardless of the source of the material, provided it had the approval of the engineer. Later, 50% RAP was allowed in #900 and #1100 mixes in leveling courses, regardless of the source. As a general principle, currently:

1. Milled-off material becomes the property of the contractor. Because there is no item for crediting the Department, the value of this is usually reflected in a reduction in the bid price for some other unrelated item (HMA mix).
2. The contractor has the option of using RAP in all courses unless the plans or proposal specifically prohibit it.

6.03.07B Heat-Planers

Before the advent of cold milling machines, and beginning about 1950, heater planer machines were the only practical method of volume removal of old HMA surfaces, while not disturbing the base and even leaving part of the old HMA thickness when desired. These machines were large and ungainly, and required a great amount of energy to heat the asphalt to the point where it was soft enough to scrape off. Additionally, they were environmentally objectionable because of the smoke generated from burning asphalt. Burning was also detrimental to the flexibility of the asphalt. Improvements were made in the form of radiant heaters that alleviated the smoke problem, but it was the cold milling machine that has made the heater planer uneconomical and obsolete. Today, heater planing in Michigan is almost exclusively limited to maintenance work, removing humped pavement joints with small radiant heaters attached to various scraping machines or devices.

6.03.07C Cold-Milling Machines

Michigan was one of the first states to use the cold-milling machine. There are a number of manufacturers of such machines and they are available in a variety of sizes. Most all use the principle of a relatively low speed rotating drum having a number of carbide-tipped teeth. See Section 6.03.04B5.

6.03.07D Factors to Consider Relative to Recycling

There are some pavements that cannot be recycled using current technology. Pavements containing tars or liquid asphalts high in solvents are poor candidates for recycling because of the attendant air pollution problem in connection with drum mixer plants. Sealcoats are not recycled. Tar-bound macadams, which may contain rocks as large as 5 inches to 6 inches, are not recyclable because of both the tar and the size of the aggregates. The decision as to whether or not to recycle, however, should be made by Construction Field Services Division.

When the use of milled material is allowed back on the project as recycled mix, the hot-mix prices will generally be lower than that for virgin hot-mix. Variables affecting this price reduction are: the size of the project, the total amount of RAP available for use back on the project, and the location of the project relative to a permanent asphalt plant. The contractor will normally choose the most economical alternative suited to his operation, which, of course, must be competitive with the operations of other competing contractors. Recycling will reduce the additional required asphalt by about one percentage point. This is where the contractor saves money, not in the aggregate saved. (While aggregate costs may be roughly equal, it remains that recycling conserves aggregates.)

6.03.08 Matching the Treatment to the Project

(revised 6-28-2021)

6.03.08A Alternatives to Consider

1. Overlay
2. Pulverize/Rubblize the existing pavement and resurface
3. Mill the existing pavement and recycle back as hot-mix
4. Combination of #2 and #3

6.03.08B Minimum Structural Requirements

Ensure that for each alternative the minimum structural requirements for the design life are met. See the Michigan DOT User Guide for Mechanistic-Empirical Pavement Design.

6.03.08C Life Cycle Cost Analysis

Reference the Pavement Selection Manual for Life Cycle Cost Analysis.

6.03.08D Selecting a Treatment

Selecting the proper treatment is determined by comparable cost/benefit analyses after consideration has been given to the following variables.

1. **Cause and rate of deterioration** - Poor results are likely, when overlaying a pavement that has failed from thermal cracking. Good results are likely, when overlaying a pavement that has not yet reached poor condition, but has shown signs of age or load related deterioration.

   Regardless of the treatment chosen, pavements that have deteriorated rapidly because of drainage problems, will continue to deteriorate rapidly unless the drainage problem is corrected.

2. **Pavement condition** - Pavements in badly deteriorated condition are not good choices for overlays.

3. **Location** - The location may have an effect on expected contract prices.
4. **Existing pavement layer depths and material types** - These factors affect structural requirements, cost, and feasibility. The pavement depth affects pulverizing cost, a seal coat or oil aggregate may not be recyclable in an HMA (leave this decision to Construction Field Services Division), a pavement with macadam or soil cement may be a poor milling or pulverizing choice.
5. **Subgrade soil** - Subgrade soil will have an effect upon structural requirements.
6. **Amount and Type of Traffic**
7. **Drainage**
8. **Aggregate Wear Index**
9. **Lane width** - Widening a 10 foot or 11 foot lanes to 12 foot lanes and overlaying will create two additional longitudinal cracks, which may lead to premature deterioration and in turn create maintenance problems.
10. **Shoulder condition, type of material, width and depth**
11. **Maintenance of traffic during construction** - Rubblizing may necessitate a detour.
12. **Uniformity of the cross-section** - Correcting an existing pavement distortion or modifying the crown may be necessary.

Predicting the average design life for various treatments is still rather indeterminate. For this reason, each district should make use of the variety of treatments available.

6.03.09 Hot Mix Asphalt (HMA) Mixture Selection Guidelines

(revised 8-24-2026)

This guide is to aid in the selection of Hot Mix Asphalt (HMA) mixtures, asphalt binders and Aggregate Wear Index values. It is the ultimate responsibility of the Region Soils/Materials Engineer to provide appropriate hot mix asphalt and thickness recommendations. Any questions regarding these guidelines should be addressed to either the HMA Unit or the Pavement Design Engineer in the Construction Field Services Division.

6.03.09A Rehabilitation, Reconstruction (R&R) and New Construction Projects

6.03.09A1 Mainline Paving

6.03.09A1a Mixture Selection

All mainline paving shall be composed of Superpave mixtures.

Computed Design BESALs (HMA Equivalent Single Axle Load) will be used to identify the appropriate Superpave mixture type.

Superpave Mix Type	Design BESAL (millions)
EL	Less than 0.3
EML	Between 0.3 and 3.0
EMH	Between 3.0 and 30.0
EH	Between 30.0 and 100.0
SMA	Between 10.0 and 100.0

SMA is to only be used as a top course mixture.

Design BESALs are calculated using the following information:

- Commercial Traffic
- Traffic Growth Rate
- Lane Distribution of Commercial Traffic
- BESAL Axle Load Equivalency for Flexible Pavement
- Total accumulated BESALs for 20 year design

The method for calculating ESALs for flexible pavements (BESALs) is explained in the ***AASHTO Guide for Design of Pavement Structures,*** 1993. Design BESALs should be requested from the Project Planning Section of the Project Planning Division. The Pavement Design Engineer of the Pavement Management Section of the Construction Field Services Division can provide an approximate BESAL value (for estimating purposes only). Show the 20 year design BESALs on the design plans.

6.03.09A1b Superpave Mixture Number Designation and Thickness Guidelines

After mixture selection has been determined, based on design BESALs, the mixture number for use in the various pavement courses can be determined**.** The mixture number will be 2, 3, 4 or 5 depending on the nominal maximum size aggregate. Following are the mixture numbers, minimum/maximum application rates and course type application:

Mixture #	Minimum Application	Maximum Application	Course Application
2	435 lbs/syd	550 lbs/syd	Base
3	330 lbs/syd	440 lbs/syd	Base and/or Leveling
4	220 lbs/syd	275 lbs/syd	Leveling and/or Top
5	165 lbs/syd	220 lbs/syd	Top
SMA (⅜" Nom. Max.)	165 lbs/syd	225 lbs/syd	Top
SMA (½" Nom. Max.)	220 lbs/syd	275 lbs/syd	Top
ASCRL	300 lbs/syd	500 lbs/syd	Base

NOTES:

1. Estimated application rate of 110 lbs/syd. per inch of compacted thickness. When using GGSP contact the HMA Unit at the Construction Field Services Division for the estimated application rate. When using ASCRL the estimated application rate is 100 lbs/syd per inch of compacted thickness.
2. Pavement designs requiring greater thickness than the specified maximum will require multiple lifts.
3. Crush and Shape: Use a minimum of two lifts over crushed materials. A minimum of 220 lbs/syd for the first lift is required for construction purposes.
4. Rubblized Concrete: The first lift over the rubblized concrete will be a minimum of 220 lbs/syd. For freeways and divided highways, traffic should not be allowed on the rubblized section until at least two courses have been placed. In those situations where the rubblized roadway must be opened to traffic at the end of each day, traffic may be allowed on the first course provided there is a minimum thickness of 265 lbs/syd.

The following are the Superpave definitions for Top, Leveling and Base course. This definition should be referred to when making the asphalt binder and mixture selections:

- The Top and Leveling courses are defined as the mixture layers within 4 inches of the surface.
- The Base course is defined as all layers below 4 inches of the surface.
- For mixture layers which fall within the 4 inch threshold, If less than 25% of a mixture layer is within 4 inches of the surface, the mixture layer should be considered to be a base course.

Below are examples of Superpave Pay Items and descriptions:

- HMA 3EML - A leveling or base course with a minimum application rate of 330 lbs/syd on a project that has design BESALs between 3 and 30 million
- HMA 4EL - A top or leveling course with a minimum application rate of 220 lbs/syd on a project that has design BESALs less than 3 million

6.03.09A1c High Stress HMA

High Stress HMA is to be used at locations that are susceptible to rutting early in a pavement's life. This typically occurs at signalized intersections, areas of stop/start traffic, roundabouts and areas where there are high levels of commercial turning movements. The difference between the High Stress HMA and the typical Superpave HMA is the Performance Graded binder. High Stress HMA requires the upper temperature limit to be increased one level as can be seen in the Asphalt Binder Selection tables of Section D. The increase in the high temperature number results in an asphalt binder with improved high temperature stiffness or rutting resistance for both the leveling and top course. High Stress HMA is only applicable for top and leveling courses.

Application Guide:

- Use High Stress HMA 1000 feet on either side of the center of signalized intersections, other areas where stop/start traffic occurs, and at locations that experience high levels of commercial traffic turning movements (for quantity calculations use 1100 feet).
- Intersecting roads and commercial drives that are adjacent to the High Stress HMA mainline should use High Stress HMA Approach.
- Use High Stress HMA between signalized intersections when they are spaced 1 mile or less.
- Use High Stress HMA Approach for the circulating lanes and the entry and exit legs of a roundabout to the point where the roadway returns to the normal approach road width.

When developing plans the designer should set up the pay item of High Stress HMA. Standard pay items exist for all Superpave Mix Types that are applicable to High Stress HMA. When the pay item of High Stress HMA is set up on a project the applicable frequently used special provision should be included in the proposal. Additionally, the appropriate High Stress binder grade must be identified in the HMA Application Estimate Table. It is recommended that High Stress HMA not be used for quantities of less than 500 tons of individual leveling or top course mixture.

6.03.09A1d Asphalt Binder Selection

The following pages contain the Asphalt Binder usage table for all Superpave mixtures and High Stress HMA. Asphalt Binders with the suffix P denotes that polymer modified performance grade binder is required. It is the responsibility of the designer to select the appropriate binder for each mixture and course. The selected binder (including the suffix P when applicable) needs to be clearly identified in the binder column of the HMA Application Estimate Table.

Metro, North, Grand, Bay, Southwest and University Region

Mixture Type	HMA Mainline and Ramps		High Stress HMA	
EMH^, EH, SMA	PG 70-28P PG 64-22*	Top & Leveling Course Base Course	PG 76-28P PG 64-22*	Top & Leveling Course Base Course
EML, EMH^^	PG 64-28 PG 58-22**	Top & Leveling Course Base Course	PG 70-28P PG 58-22**	Top & Leveling Course Base Course
EL	PG 58-28 PG 58-22**	Top & Leveling Course Base Course	PG 64-28 PG 58-22**	Top & Leveling Course Base Course

Superior Region

Mixture Type	HMA Mainline and Ramps		High Stress HMA	
EL, EML, EMH^^	PG 58-34 PG 58-28	Top & Leveling Course Base Course	PG 64-34P PG 58-28	Top & Leveling Course Base Course

^ Greater than 10 Million ESALs

^^ Less than 10 Million ESALs

* Use PG 64-28 for North Region

** Use PG 58-28 for North Region

NOTES:

1. For shoulders paved greater than or equal to 8 feet or in a separate operation, use PG 58-28 for top and leveling course and PG 58-22 for base course for all Regions
2. For Temporary Roads, commercial and private Approaches, Wedging, and Hand Patching, use PG 64-22 for all Regions except Superior and North, use PG 58-28.
3. This table represents standard selection guidance. Variations may occur subject to approval by the Bituminous Section, Pavement Design Engineer, or designated pavement design personnel.

6.03.09A2 Non-Mainline Paving

Non-mainline paving mixture selection should be based on the following table:

Non-mainline mixture selection should be based on the following table:

Design BESALs (millions) Mainline	Shoulders ≥ 8 feet or shoulders paved in a separate operation All Courses (2)		Temporary Roads All Courses		Street Approaches and Wedging (1) (3)	Hand Patching and Private Drive Approaches (4) (5)
	Mixture Type	Application Rate	Mixture Type	Application Rate	Mixture Type	Mixture Type
≤ 3.0	Mainline Mix	meet appropriate min/max application rates	5EL Top 4EL Level	165-220 lbs/syd 220-250 lbs/syd	Mainline Top Course	EL
> 3.0	5EML Top 4EML Top	165-220 lbs/syd 220 lbs/syd	5EML Top 4EML Top	165-220 lbs/syd 220 lbs/syd	Mainline Top Course	Mainline Top Course or EL
	4EML Level 3EML Level	220-275 lbs/syd 330 lbs/syd	4EML Level 3EML Level	220-275 lbs/syd 330 lbs/syd		
	3EML Base 2EML Base	330-410 lbs/syd 435-540 lbs/syd	3EML Base 2EML Base	330-410 lbs/syd 435-540 lbs/syd		

NOTES:

1. The appropriate shoulder or mainline mixture (determined from 20 year design BESALs) may be used on driveways and low traffic volume approaches.
2. Shoulders paved integrally with the mainline will use the same mix as used on the mainline.
3. If more than one mixture and/or binder combination is required for HMA approach, it should be clearly shown in the HMA Application Estimate Table.
4. Show the mixture type for Hand Patching in the HMA Application Estimate Table.
5. When using SMA, use 5EML or 5EMH for hand patching.

6.03.09B Capital Preventive Maintenance Projects (CPM)
Mainline and Non-Mainline Paving

Selection is based on present day two-way commercial ADT. This table is to be used for CPM projects only.

Mixture Type and Binder Selection

Commercial ADT 0 - 300	Commercial ADT 301 - 1000	Commercial ADT 1001 - 3400	Commercial ADT ≥ 3401
5EL	5EML	5EMH	SMA or 5EMH
PG 58-28 *	PG 64-28 *	PG 64-28 *	PG 70-28P *

*Use PG 58-34 asphalt binder in the Superior Region for full depth flexible pavements.

*Use PG 58-28 asphalt binder in the Superior Region for composite pavements.

NOTES:

1. For shoulder paving, use a EL mixture.
2. For mainline paving the application rate is 165 lbs/syd (1½ inches compacted thickness) for all mixes unless approved by the CPM Engineer. For shoulder paving the maximum application rate is 330 lbs/syd (3 inch compacted thickness).
3. For hand patching, use the appropriate mainline mixture. Use a PG 58-28 binder for all regions.
4. When using SMA, use 5EML or 5EMH for hand patching.

6.03.09C Aggregate Wear Index
(All R&R, CPM and New Construction Projects)

Aggregate Wear Index (AWI) is required for all aggregates used in bituminous top course mixtures. The following table identifies the required minimum AWI, based on the present average daily traffic (vehicular and commercial) per lane (ADT/Lane):

ADT/Lane	Minimum AWI
< 100	None
100 - 200	220
> 200	260

It is the responsibility of the designer to select the appropriate AWI for each top course mixture. When a bituminous top course mixture requires an AWI, the appropriate number corresponding to each top course mixture should be clearly identified in the HMA Application Estimate Table.

6.03.10 Plan Development Using HMA Mix Selection Guidelines

(revised 3-25-2024)

6.03.10A General

The Designer should consult with Department HMA experts when questions arise concerning HMA mixtures. These experts consist of members of the Bituminous Section, the Pavement Design Engineer, and other department personnel who are responsible for pavement design.

6.03.10B Past Mixture Designations

Designers researching plans for old projects should have some familiarity with HMA mixture designations formerly used, as well as those in present use. Beginning with the 1957 Standard Specifications for Construction, there were basically three HMA plant mixtures: 4.09 Bituminous Aggregate Surface Course, commonly referred to as oil aggregate; 4.11 Bituminous Aggregate Surface Course-Hot Plant Mix, commonly referred to simply as bituminous aggregate; and 4.12 Bituminous Concrete Pavement, called bituminous concrete. The oil aggregate mixture was rarely if ever used on state trunkline projects, and bituminous aggregate was used only on the lesser traveled trunklines. Bituminous concrete was most frequently used for trunkline resurfacing and for state projects in cities.

Beginning with the 1979 Standard Specifications for Construction, designations were changed. The 4.09, 4.11, and 4.12 mixtures became No. 9, No. 11, and No. 12 respectively. There were a number of sub-designations relative to stone size in the mix, as well as the material being either leveling course or top course.

In late 1981 the Department adopted a supplemental specification that labeled HMA mixtures with a number corresponding to their minimum required Marshall Test stability. (These have come to be called "stability mixtures" or "performance mixes".)

In early 1992, the Department revised the HMA Specifications once again. This was in response to wheel rutting problems experienced with the former stability-based mixes. These new mixes are referred to as Marshall Mixes.

The following historical HMA mixtures are listed with their approximate replacements in terms of their former designations:

Stability Mixes	Marshall Mixes
#500	11A
#700	11A
#1100	13 or 13A
#1300	“B” series
#1500	“C” series

In 1997, the Department began implementing Superpave Mixtures. Superpave (short for SUperior PERforming Asphalt PAVEments) was developed from the Strategic Highway Research Program of the late 1980's and early 1990's. It consists of a classification system for asphalt binders (PG grading system), and a mix design methodology that replaces the Marshall method.

In 2000, the Department went to full implementation of Superpave for all mainline pavements. Marshall Mix designs (13A, 36A, and the C series) were still allowed for non-mainline paving such as shoulders wider than 8 feet, ramps, and low-volume Capital Preventive Maintenance projects.

In 2008, the Department moved to phase out the use of Marshall Mix designs. See Section 6.03.09 for the current HMA selection guidelines.

6.03.10C Traffic Volumes

Designers should obtain total Annual Average Traffic Volumes (AADT). Total AADT is necessary in determining the Aggregate Wear Index (see Section 6.03.10D following). The Bureau of Transportation Planning, Data Collection Section publishes maps yearly that show total AADT for all trunklines. The Data Collection Section may also be contacted directly if the Designer requires more up to date traffic data.

For pavement thickness determination and mix type selection, designers should obtain the number of Equivalent Single Axle Loads (ESALs) over the design life of the project. See Section 6.01.02 for information on obtaining ESALs. ESAL values for HMA (referred to as BESALs) and concrete (referred to as CESALs) will be different due to differences in material response under loading. BESALs are used to determine the Superpave mix type (see Section 6.03.09) and are also used in the AASHTO design method to determine the HMA thickness.

6.03.10D Aggregate Wear Index

Starting in 1965 and continuing for a number of years afterward, the specifications included a footnote, in the table of physical requirements for coarse aggregates and surfacing aggregates, prohibiting aggregate from limestone quarries for use in HMA top courses. In addition, aggregates from natural gravel sources containing more than 70% carbonates were prohibited in the top course. The reason is that limestone in HMA pavements tends to polish under traffic, with a subsequent loss of skid resistance. The specification restriction imposed a hardship on projects in the tip of the thumb and in the counties of both peninsulas bordering the Straits; US-2 is a classic example of a route so affected. The restriction was too all-inclusive, however, as some limestones are better than others with respect to polishing. Indeed, aggregates produced from different parts of the same pit or quarry may vary in polishing characteristics.

In an effort directed at more utilization of the better limestones, the Construction Field Services Division constructed a circular test track whereby coarse aggregates from a given source could be cast into thin concrete slabs and subjected to 4 million passes of a pneumatic-tired wheel. Data collected from these tests gave a good indication of the polishing potential of aggregates from a large number of sources, and led to the establishment of an Aggregate Wear Index wherein the higher the number, the greater the resistance of the aggregate to polishing under traffic. Enough data was collected to allow AWI evaluation to be based on aggregate types used in an HMA mix. Wheel track testing is still performed. Blending of aggregates is frequently required of the contractor in order to meet a specified AWI.

Because polishing is primarily a function of the vehicle tire interaction with the pavement, and not of vehicle weight, passenger car traffic volumes share equal consideration with trucks. For the table of minimum aggregate wear index (AWI) values based on ADT, see Section 6.03.09C.

Note that the design year ADT received from the Bureau of Planning includes trucks. It is the responsibility of the designer to select the appropriate AWI, or to determine that the project does not require one. If possible, only one AWI should be specified for a project, or two at the most. When more than one is needed, e.g., as when the project includes top course surfacing of both a freeway and a lesser road, three asterisks (***) should be shown in the AWI blank, with the asterisks explained by a supplementary note below the body of the special provision indicating the respective AWI numbers and where, or with what mixtures, they apply.

In assigning an AWI to a project and basing that selection on traffic counts, it must be remembered that the number is based on ADT per lane. Errors that result in specifying an AWI that is too high can materially increase the bid prices and perhaps unnecessarily eliminate an aggregate source from consideration.

6.03.10E Application Rates

The application rate ranges in the HMA Mix Selection Guidelines reflect Department policy and should be adhered to unless the Bituminous Section, the Pavement Design Engineer, or other department personnel who are responsible for pavement design are consulted. Minimum lift thicknesses are based on 3 times the nominal maximum aggregate size in the mix. The maximum lift thickness is based on 4 times the nominal maximum aggregate size. In addition, the maximum is based on the maximum thickness that can be adequately compacted in one lift. However, the designer should remember that the specified application rate indicates ***average*** thickness.

Generally, an HMA surface weighs about 110 pounds per square yard per 1-inch of thickness.

The minimum application rate of a single course resurfacing should be 165 lbs/syd. A two course resurfacing should have minimum total application rate of 385 lbs/syd.

An old HMA surface, worn to such an extent that the coarse aggregate becomes the predominant material exposed, should probably be resurfaced in two courses to ensure proper adherence.

6.03.10F HMA Application Estimates

Projects that include HMA surfacing have a tabulation entitled "HMA Application Estimate" on the typical cross-section sheet as shown in the Road Sample Plans. The tabulation is basically an attempt at simplifying the typical cross-section sheet by showing in tabular form, information that would otherwise be duplicated, perhaps several times on the typical cross-sections. It also serves to reduce clutter. The number and letter designations shown in the column "Ident. No." are shown on the various typical cross-sections and refer to rates and types of application that apply to the project.

6.03.10G Unusual Conditions

When it is proposed or the designer is asked to incorporate construction that is outside the norm of generally accepted procedure, the Pavement Design Engineer and the Bituminous Section of the Construction Field Services Division should be consulted. The staff in these divisions may in turn elect to take the proposed treatment to the Pavement Committee for further comment and consideration.

6.03.10H Asphalt Usage Guidelines

MDOT adopted the use of Superpave HMA Designs in 1996. Superpave mixes resulted from the Strategic Highway Research Program (SHRP). The asphalt used in Superpave mixes are classified based on Performance Grade (PG). Performance Graded Asphalts are classified using the minimum and maximum temperatures that an HMA mix will experience at the location placed. The Department has monitored pavement temperatures around the state using temperature sensors. The data was used to determine which asphalt grades should be used in various regions of the state. Performance Graded Asphalts may or may not require an additive (Polymer) to meet the minimum and maximum temperature requirements specified. The MDOT 1996 Standard Specifications for Construction replace penetration grade asphalts with performance grade (PG) asphalt binders. Usage guidelines for PG asphalt binder grades are based on seasonal temperature variations and various traffic conditions. The EOC approved guidelines are shown in Section 6.03.09A(1d).

6.03.11 HMA Construction Considerations

(revised 9-28-2026)

6.03.11A Bond Coat

Bond coat is commonly an asphalt emulsion used to enhance the adhesion of an HMA surface to an underlying paved surface. Several factors affect its need; e.g., an old, polished asphalt surface on a 50° F day would probably need it, whereas the second lift on a clean new leveling course, on a hot day, would probably not need it. Thin applications (approximately 0.05 gal/syd) are frequently referred to as "fog" or "tack" coats.

Bond coat is no longer a pay item, although the contractor must use it when it is determined necessary on construction. It must therefore be shown on the HMA Application Estimate, with a rate of application of up to 0.15 gal/syd indicated. Quantities should not be shown on the plans or in the log.

6.03.11B Prime Coat

Prime coat was formerly a medium-curing asphalt used at a rate of 0.25 gal/syd to seal off a gravel surface preparatory to paving with HMA and to aid in stabilizing the aggregate base so that trucks could run on it. Construction experienced delays waiting for it to cure, and with the dense-graded aggregate mixtures in use, it was often determined that prime coat was unnecessary. If prime coat is needed, Construction will add it by authorization. Designers are instructed to omit any reference to it.

6.03.11C Feathering and Tapering

(See Section 6.03.04B(3)) Feathering, as a method of discontinuing HMA surface at the ends of the project, or longitudinally at a curb face, is not as widely used as it was before the advent of the milling machine. There is still an occasional project, however, which requires that feathering be done. While more economical than constructing a butt-type joint, it is more prone to deterioration because of insufficient compaction at the thickness where the large-size aggregate tends to support the roller. This can be helped somewhat by using a finer mix for constructing approaches. Generally, the designer should provide for making butt joints along the trunkline, and for feathering at intersecting roads and streets, unless recommended otherwise at the Plan Review Meeting.

When feathering at a curb face, do not show the taper sharply breaking or a dimension for the width of the feathered area. The typical cross-section should illustrate the leveling course feathered out somewhat short of the curb and gutter, with the top course feathered at the curb. Quantities should be computed on the basis of full thickness to the curb face.

Sometimes it is necessary to transition a resurfacing to meet the existing top of pavement elevation, as when resurfacing a bridge deck or meeting railroad tracks. The proposed transition required to wash out the added thickness should be on the order of ¾ inch in 25 feet. This transition length should be shown on the plan or in the log.

6.03.11D Stage Construction

Occasionally, it is planned that a new HMA roadway will be constructed in stages, usually by delaying placement of the top course for a period of from 1 to 5 years. The reason may be to conserve finances, but a side benefit is that weak spots and areas of settlement show up under traffic, so they can be corrected when the top course is eventually laid. There are other times when the contractor fails to get the top course on before the onset of winter, and traffic must be allowed on the leveling course until the following spring. In any case, the designer need not particularly concern himself as the Construction Field Services Division will adjust the design of the leveling course by adding more asphalt cement to the mix.

6.03.11E Joint Lines Coinciding with Lane Lines

It is highly desirable that longitudinal construction joint lines in the top course coincide with the lane lines that will eventually be painted. Even when the joint is constructed perfectly, it will usually show up prominently at night and when wet, and traffic is prone to follow the most distinguishable line resembling a lane marking. Paving to coincide with lane lines is now a requirement of the Standard Specifications for Construction. However, there are certain situations, e.g., where a lane is picked up or dropped, when the designer should detail the lane striping on the plans or in the log.

6.03.11F "Paving Through"

There have been occasions in the past when a contractor, paving a shoulder ribbon or a full width shoulder prior to paving approaches, has paved through cross road approaches or freeway ramps in a continuous operation, coming back later to pave the approach or the ramp. At the least, this type of construction is unsightly, and it may lead to premature deterioration of the approach or of the ramp when the shoulder edge, now a transverse joint, opens up. The designer should give consideration to adding a note or detail to address this issue.

6.03.11G Bridges

When resurfacing projects include resurfacing on or under bridges, a standard form letter (available from the Bridge Management Unit) is to be sent to Bridge Management Unit for either a load analysis or a review of underclearance requirements, as appropriate. Minimum standard underclearance can be found in Section 3.16. If the resurfacing will reduce the underclearance below minimum, it may be necessary to remove some of the existing surfacing under the bridge.

The preferred method is to remove old concrete pavement and replace with either concrete or HMA base course, and run the overlay under the bridge. This is done to improve the appearance and ride. In cases where the existing underclearance is adequate, the alternatives of thinning up the overlay or grinding the existing concrete pavement should be investigated.

If pavement removal is not cost effective, other methods such as gapping the section under the bridge may be used to retain existing underclearance within minimum standards. Measures must be taken to improve pavement integrity and ride. This may include pavement repair/rehabilitation within the gapped section. In all cases where the resurfacing is gapped, the final driving surface must be diamond ground to improve ride.

For cases where additional underclearance must be obtained, site by site studies will be required to determine the most economical method. To improve appearance and ride, the riding surface at the underpass should be the same material as the abutting section of the roadway.

6.03.11H Paving Over Neoprene-Sealed Joints

Concrete pavements to be overlaid with HMA require removal of the Neoprene Seals. The plans or proposal should note that the neoprene seals are to be removed prior to resurfacing. This is to avoid expansion of the seal in contact with the hot asphalt which will cause cracking of the new HMA overlay.

6.03.11I Stringline Grade Control

The Standard Specifications for Construction provide that pavers must, with certain exceptions, have a 30-foot (minimum) grade referencing attachment, usually a ski, for grade control on all lower courses and the first pass of the top course. Generally this is adequate to ensure a smooth riding pavement. There are conditions, however, e.g., building up superelevation, when it is desirable to have a more elaborate control, an accurately set "stringline" for the pavers electronic sensors to guide on. Actually, the stringline is usually a high tensile wire on stakes 25 feet apart, offset laterally from the path of the paver. Machine accuracy is on the order of ⅛ inch in elevation, with start-up distance as short as the length of the paver.

Stringline control is usually not paid for separately, but it has been on occasion when requested by the Region/TSC. It adds about 2% to the cost of material placed, not including the cost of additional quantities required for wedging that may be called for by the grade control.

The following situations may warrant calling for stringline grade control:

1. When paving covers the gutter pan and the longitudinal grade is less than 0.5%.
2. Wedges greater than 100 feet in length. When paving a wedge to increase superelevation, the tangent section of the transition should be included with the curve.
3. The first course on an aggregate grade or the first course on a grade from which material has been removed for recycling. (A stringline would ***not*** be required, if removal and replacement of the old surface is to be done part-width. In this case, a stable surface would always be available on one side from which to operate a ski for grade control.)
4. Over portions of old pavements in such condition that the 30 foot ski will not take out surface irregularities (as recommended by the Region/TSC or determined at the Plan Review Meeting).
5. Next to concrete median barrier when the longitudinal grade is less than 0.6%.

It may be difficult to determine whether the stringline should be required, when the grade is slightly more or less than 0.5% or 0.6%. Where there is doubt the designer will have to rely upon Region/TSC recommendations.

The grade of the stringline will be established during construction. The designer's concerns are:

1. The need for a special provision,
2. Specifying the areas where stringline control will be required,
3. Whether or not stringline control will be paid for separately. The designer should note that use of stringline control inherently requires more material to fill low spots to achieve the smooth surface. An alternative to consider is milling off existing ***high*** spots, thus reducing the depth of low spots. A cost analysis will sometimes reveal that milling, in conjunction with a stringline, is the more economical alternative.

6.03.11J Longitudinal Joint Density Quality Initiative

The quality of HMA pavements at longitudinal joints can be affected by the method and circumstance in which the joint is formed. Whether a cold joint is formed adjacent to existing surfaces or adjacent to new pavements from preceding stage construction, or a hot joint is formed with echelon paving, influences the ability to achieve sufficient density at the joint.

The specifications for Longitudinal Joint Density Quality Initiative is applied to all trunkline HMA projects (except non-motorized paths) and includes a pay item for incentives to the contractor for achieving acceptable ranges of density. The incentive payment is applicable to longitudinal joints between two new adjacent HMA pavements (Type 1). It does not apply to longitudinal joints adjacent to existing pavements or surfaces (Type 2), or where the contract documents specify the paving method (echelon paving, etc.).

The dollar amount of the incentive is prescribed by the Standard Specifications for Construction or special provision and is dependent on the level of density achieved. The designer should base the estimated dollar amount on the maximum achievable incentive rate. This provides the Engineer the resources to encourage, reward, and maximize contractor effort and pavement quality.

6.03.11K Temporary Pavement Markings

There are two basic types of wet reflective temporary pavement markings. Type R (removable) is an adhesive backed tape. Type NR (non-removable) may be either a tape or a painted stripe. Measurement is based on the length of marking actually required, not including the skips in the dashed lines. Temporary pavement marking quantities are determined as part of the maintaining traffic design.

For detailed information on temporary pavement markings, including type application, staging, payment, removal, and more, see Chapter 6 of the Work Zone Safety and Mobility Manual.

For specific details on temporary marking size and layout please refer to the pavement marking standard PAVE-904-Series Temporary Longitudinal Line Types & Placement for detailed information.

The pay items that can be used are listed below:

- Pavt Mrkg, Wet Reflective, Type NR, Paint, [Insert width] inch, (color), Temp
- Pavt Mrkg, Wet Reflective, Type NR, Tape, [Insert width] inch, (color), Temp
- Pavt Mrkg, Wet Reflective, Type R, Tape, [Insert width] inch, (color), Temp

If a project has multiple stages and configurations, pavement markings for each stage need to be calculated. If the project is going to be over more than one construction season, additional quantities to refresh or replace the temporary markings should be accounted for.

6.03.11L Admixtures

Over the years, a number of admixtures have been used in asphalt pavement to improve the properties of the mix, reduce reflective cracking, or, in the case of sulphur, as a substitute for asphalt. Many of these admixtures have been used in Michigan. In addition to those listed in the following paragraphs, these have been used: asbestos, crushed glass ("glasphalt"), Trinidad Lake (a natural asphalt found in its pure form in Trinidad, high in ash but requiring no refining), resins ("Whyton"), rejuvenators ("Reclaimite"), and special aggregates ("Lakelite"). While the use of an admixture will only be used if recommended by others, the designer should be acquainted with some of the ones in more common use, and their advantages and disadvantages.

1. Rubber - Rubber comes in two forms, scrap and virgin latex. There are two types of scrap rubber: reclaimed, which involves a heated chemical process that breaks down the vulcanization, and ground rubber, which is simply ground up old auto tires. Rubber is used in two ways: as a binder in hot asphalt cement (latex and reclaimed) and as a resilient filler modifying the aggregate (ground rubber). Claimed benefits are improved skid resistance, reduced reflective and thermal cracking, better stability at high temperatures, and more pavement flexibility at low temperatures.

2. Polyester fibers - Polyester fiber asphalt is currently the common type of waterproofing used on bridge decks. It is laid at the rate of about 70 lbs/syd and is called a waterproofing membrane, rather than a lower course of asphalt. The fibers resemble 1½ inches to 2 inches long pieces of yarn and are used in conjunction with a small-size aggregate (⅜ inch maximum), a higher than usual asphalt percentage, and mineral filler. The resultant mix tends to have a sticky consistency. A conventional wearing course is used over the membrane.

Another admixture that has been used experimentally, with mixed success, is sulphur. Elemental sulphur, when melted to the liquid state, has qualities very similar to asphalt and in fact, can be substituted for up to 50% of the asphalt in an HMA mix. Because of transportation costs and the need for special equipment, it is more expensive than asphalt and has been used experimentally only to prove its feasibility in the event that asphalt, a petroleum derivative, is ever in short supply.

6.03.11M Causes of Contract Overruns

1. **"Vertical" edge** - It is impossible to pave succeeding bituminous lifts and maintain a vertical edge. Practically, the edge assumes a slope of about 60° from the horizontal. On a long project with thick lifts, the extra material required because the base must be wider than the finished surface is quite significant, and extra quantities should be provided. Assuming a 4 inch thick pavement, this extra material amounts to about 22 tons per mile (two sides).

2. **Edge settlement** - Characteristically, the existing crown is likely to be accentuated in a fill section and reduced in a cut section. This condition is not always evident on casual inspection, unless unusually severe. Field review personnel should be watchful to see if this condition does exist and if it is severe, wedging quantities should be provided.

3. Wedging quantities are difficult to estimate. The tendency is to underestimate the severity of the condition to be modified.

4. HMA base course widening tends to squeeze outward, e.g., a nominal 12 inches widening might be 15 inches wide at the bottom.

6.03.11N Ramps

An advantage of the current method of designing pavement cross-section is the capability to fine tune various component thicknesses. In its extreme this practice could yield a slightly different pavement section for every ramp in an interchange. Because of the possibility of future changes in traffic patterns and to minimize construction inconvenience (which translates to increased cost) and potential for confusion, the Engineering Operations Committee has decided that no more than two different ramp cross-sections should be used on any one project. This decision is in the context, however, of thickness, not width. Unless there is a substantial variation in thickness requirements, a single ramp cross-section is even more preferable.

Pavement design standards may call for HMA shoulders to be thinner than the HMA mainline pavement. To construct, this cross-section might require three paver passes for every course of HMA. Two passes might suffice if all elements were at the same level for each course. Occasionally, it will be found more economical to construct the shoulders the same thickness as the mainline pavement, if it will mean fewer passes of the paver are required.

6.03.12 HMA Base Course

6.03.12A General

Several decades ago, as part of a national promotion of its product, the asphalt industry coined the phrases "deep strength" and "full depth." More recently the term “perpetual pavement” has been used to mean the same thing. These terms refer to an HMA pavement design that includes a surface course that is supported by a base mix having a reduced asphalt content. The Department also describes lower course as HMA Base Course or "black base." Because it generally has about 1.5% less asphalt than the conventional surfacing mixes, black base is a comparatively economical, quite stable base material that can be laid in lifts of 3 inches (or more, if permitted) to create bulk paving. It facilitates ease of construction staging and maintaining traffic. For nominal additional cost, a stable HMA material can be obtained rather than plain stabilized aggregate.

6.03.12B Wedging

See Section 6.03.04B(15).

6.03.12C Widening

Black base has an advantage over other types of pavement widening in that it can be laid directly on the subgrade, provided the grade isn't subject to frost heave. This sometimes reduces the construction problem associated with confined excavations that have no drainage outlet.

Thickness of the widening is usually determined by computing the required structural number. Major widening will be approved by EOC after a review of possible alternative cross-sections.

When widening an existing concrete pavement, Region/TSC forces should be requested to investigate the condition of the existing pavement edge. Deteriorated concrete, and its residue, should be removed and replaced as part of the widening operation.

6.03.12D HMA Separation Course

As a separation course over old concrete pavements in poor condition, experience has shown that a thickness of 6 inches is about minimum for a significant reduction in reflective cracking. If used as a separation course, the HMA base would take the place of the sand lift shown in the drawing in Section 6.02.12.

6.03.12E Minimum Cover Over HMA Course

The Standard Specifications for Construction provide the smoothness tolerance for HMA base course surfacing mixtures. To attain the desired smoothness, pavements should be designed with at least two courses, a top over a base course.

6.03.13 Deleted

Section deleted.

6.03.14 Small Tonnages of HMA

When HMA quantities on a project are less than 500 tons, the use of a single HMA mixture should be considered. This item is especially important when the HMA plant is located an appreciable distance from the project. This item should also be discussed at the Plan Review Meeting.

6.03.15 HMA Approaches and Auxiliary Lanes

(revised 11-28-2011)

The separate pay item for HMA approaches is intended to compensate the contractor for the additional work involved in doing very short runs with a paver, often in conjunction with considerable hand labor, especially in constructing the fillets. In other words, the payment is for a relatively small tonnage combined with more than average work. Besides approaches, the HMA approach pay item should be used for miscellaneous non-production HMA paving, such as driveways and traffic control islands, crossovers, and tapered lanes.

It is difficult to set forth a "rule" relative to approaches as the reconstructed and regraded approach road may extend several hundred feet back from the trunkline, of which a considerable portion could be considered production paving.

A corollary problem occurs along the mainline when long tapers are used, often in conjunction with auxiliary widening, that vary in length from 50 feet to several hundred feet.

It has been agreed upon by Construction staff that the Designer should set up the stippled portion of the sketches shown in Section 12.02.03 as HMA Approach, and this should be clearly described on the plans or in the proposal. Even though the taper length or the paving distance along the crossroad may be greater than that depicted, the pay item will still be HMA Approach. However, in extreme cases involving 500 feet or more of auxiliary lane or repaving of the crossroad, the designer should discuss the situation with Construction to determine if handling and payment should be different.

6.03.15A Guidelines for Use of HMA Approach Pay Item

1. The pay item HMA Approach includes all HMA mixes used in the approach area (Including top, leveling and base materials).

   The HMA Approach pay item is not used in areas where paving by machine is likely. Typically this is where the length (including tapers) along the mainline (or crossroad where applicable) is greater than 500 feet and the width is 10 feet or greater. Mainline pay items should be used in these areas rather than HMA Approach. If there is any uncertainty about paver capabilities or appropriate HMA pay items, the designer should consult with the Construction Field Services Division.

2. On HMA jobs, the HMA Approach pay item is typically used on all crossroad or cross-street intersection approaches back to the spring line or 50 feet minimum from the edge of the mainline if the crossroad is gravel. Provide additional HMA Approach quantities for any necessary resurfacing or crown modification beyond this point.

3. HMA Approach material and rate of application (commensurate with the usage) should be specified for all drive and street approach work.

4. There have been instances when the contractor has requested that approaches be exempted from the AWI requirements of the mainline top course. Even though traffic volumes may be reduced from that on the mainline, there is more localized starting and stopping, which would tend to polish the pavement. Approaches should have the same AWI as the mainline.

5. In most cases HMA approaches should be surfaced with a minimum of 220 lbs/syd. This will provide a sufficient quantity of material for wedging and edge trimming.
6. Use High Stress HMA Approach for the circulating lanes and the entry and exit legs of a roundabout to the point where the roadway returns to the normal approach road width.
7. Sand trails, such as are frequently encountered in the northern part of the state, should have minimal HMA approaches. Approach Treatment Detail I is typically used in these areas (see Section 12.02.03).

   See Section 12.02.03 details of approaches.

6.03.16 HMA Curb

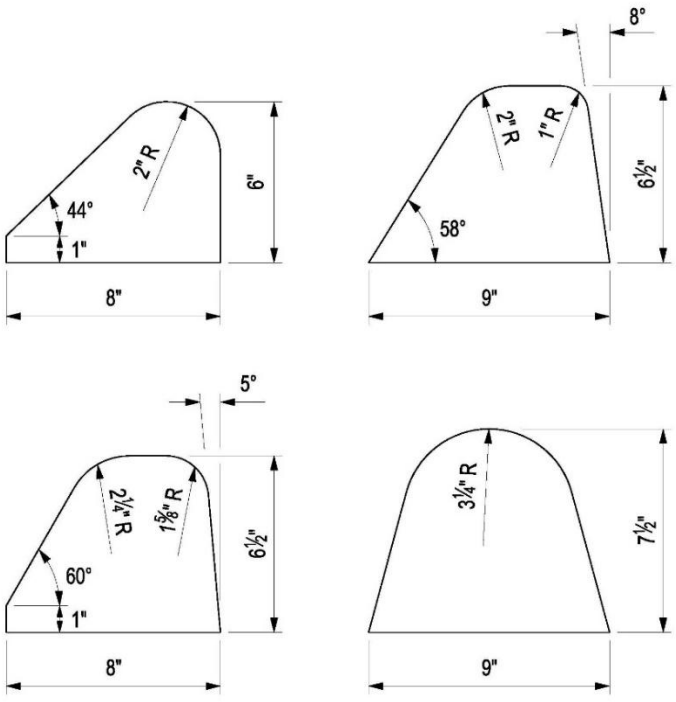
(7-26-2021)

6.03.16A Guideline for Use

The use of HMA curb on trunkline projects should be restricted to replacement in kind, work of a temporary nature, or for maintenance-type erosion control at the edge of shoulder.

6.03.16B Curb Shapes

The Standard Specifications for Construction indicate that HMA curb shapes will be according to the cross-section shown on the plans. Shown below are four shapes, based on commercially available templates that have been adopted by the Department. The shape to be used must be detailed on the plans or in the proposal.



6.03.16C Pay Items

Designers are reminded that the pay items are “Curb Slp, HMA” and “Curb Vertical, HMA”.

6.03.17 Open Graded Asphalt Friction Course

While open graded asphalt friction course (OGAFC) is no longer used by the Department, designers should be aware of its history and use because a number of projects were constructed in the late seventies with an OGAFC riding surface. It as characterized by a very open texture that was created by gap grading of the aggregate. Its purpose was to provide space and drainage for surface water, in effect making up for the possible lack of tread on a vehicle tire, and thereby reducing hydroplaning. It was more expensive than ordinary mix so it tended to be used more for intersections than for entire project resurfacing. Problems with durability caused a moratorium to be placed on its use in the early eighties; this moratorium has never been lifted.

Other disadvantages of OGAFC are: more salt is required for ice control, the pavement is slower drying after a rain, adhesive-type pavement markings do not adhere as well, and hand work is difficult and therefore prone to be unsatisfactory.

6.03.18 HMA Paved Ditches and Valley Gutters

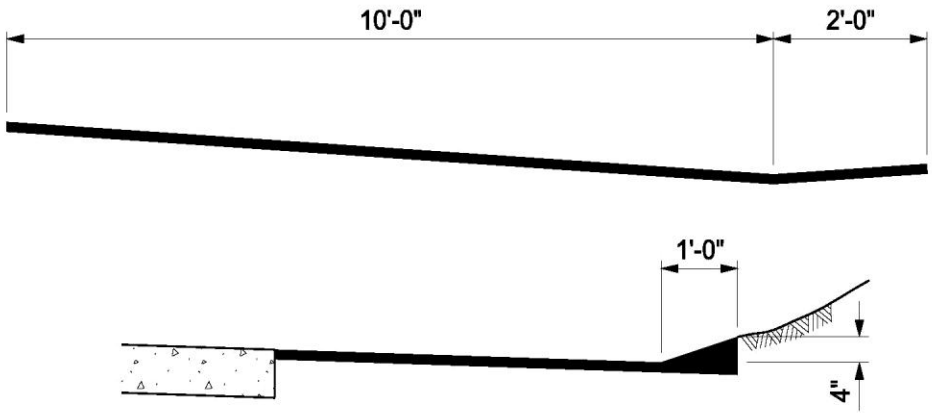
6.03.18A General

HMA paving of anything other than a reasonably flat surface is difficult. Although there are special pavers on the market with curved and V-shaped screeds, few contractors have them. Drum-type rollers are geometric cylinders. Combine the difficulty of paving directly on earth with the difficulty of obtaining compaction with a roller that doesn't "fit" the surface, and the result will often be less than desired. Even with these drawbacks, HMA paving of drainage courses, when necessary, is often a satisfactory, more economical alternative to concrete paving or placing riprap.

6.03.18B Thickness and Cross Section

A typical HMA paved ditch section (the pay item is “Paved Ditch, HMA”) is depicted on Standard Plan R-46-Series. The HMA requirements and the placement on the prepared base are described in the Standard Specifications for Construction, which also state that it be measured and paid for by the square yard.

Other configurations than the one shown on Standard Plan R-46-Series may be used, but must be detailed on construction plans. Where conditions permit, a better and more economical "V" ditch may be constructed as shown below.



This section permits the use of a paver with vibrating screed and a 2-foot extension. The 2-foot section requires the use of a small roller, however.

A variation of a valley gutter, in conjunction with a paved shoulder, is also shown below. This treatment is applicable in a tight Right-of-Way situation, as might be encountered adjacent to a cemetery, where the proximity of a cut slope prohibits a ditch beyond the shoulder. Obviously, the runoff capacity of this valley gutter is limited, but it can be a solution to a cut-slope problem of short length, i.e., of 200 feet to 300 feet. It is usually paid for as "Shoulder Gutter, HMA", per foot (not a standard pay item). The additional quantity of HMA material required is included in the shoulder quantity, however.

The second variation of an HMA "curb" has also been used with success to reduce runoff erosion on long fills. The wedge-shaped curb is usually 1 foot to 2 feet wide and approximately 3 inches to 4 inches in increased thickness. With periodic outlets, there should be no limit to the length such a run can be.

This second variation has also been used in conjunction with guardrail as shown in Section 6.06.16. It is important that the effective height of the guardrail not be reduced. Therefore, none of the increased thickness of the wedge should be in front of the vertical plane of the rail.

6.03.19 Miscellaneous HMA Surfacing

6.03.19A Traffic Control Islands

If not surfaced with concrete, traffic control islands up to about 6 feet in width should be surfaced with HMA, either with a single course of "HMA Approach" (170 lbs/syd) or a double course (250 lbs/syd), as recommended at the Plan Review Meeting. Wider islands up to 10 feet and, in the extreme, 15 feet might be HMA surfaced if it is likely that the grass would not be mowed.

The use of a soil sterilant should be considered under HMA surfacing of islands, as it is not uncommon for the hardier weeds, e.g., thistles, to literally force their way up through 2 inches of new asphalt.

Traffic control islands should have 4 inches of Class AA Approach Material under the surfacing.

6.03.19B Splash Areas

When recommended at the Plan Review Meeting, a strip of HMA 3 feet wide may be provided behind the curb and gutter on major urban projects. This is to cover an area subject to winter salt splash where grass would not ordinarily flourish. Surfacing type and thickness would be as described under "Traffic Control Islands," preceding.

6.03.19C Rumble Warning Areas

There have been locations, such as on the dead-end leg of a T-intersection, where the accident history has dictated unusual means are needed to warn the approaching driver of an upcoming stop condition. Milled-in rumble strips have proven quite effective in this application, and long lasting as well. The depressions are milled in across the approaching lane approximately ½ inch deep by 4 inches wide, on 12 inches centers. Another option is the use of thermoplastic rumble strips. Contact the Pavement Marking Specialist of the Design Division for assistance on determining the type and placement of rumble strips on traveled lanes.

For Shoulder Corrugations, see the Standard Specifications for Construction and Standard Plan R-112-Series.

6.03.19D Emulsified Coal-Tar Pitch Protective Seal Coat

Leaking gasoline and diesel oil, such as may overflow from cars and drip from trucks, is detrimental to an HMA surface because it dissolves the asphalt. Diesel fuel is worse than gasoline in this respect because, taking longer to evaporate, it has more time to "work" on the asphalt. While not a problem in roadways under moving traffic, this can be a real problem in parking areas. A protective coating of coal tar emulsion, followed by a coating of coal tar emulsion and sand slurry, helps to protect the pavement from these drippings.

Tar emulsion protective seal coat is expensive because of a number of restrictions on its application; e.g., a minimum of 30 days of prior curing time of the mat, it cannot be applied in wet weather or when rain is predicted within 8 hours, air and pavement temperature must be between 50° and 80° F, and there should be at least 3 hours of sunshine remaining after application.

Provide quantities for tar emulsion on HMA surfaces in:

1. Rest Areas – in the truck parking area only.
2. Weigh stations - 100 feet each side of the scales.
3. Maintenance garages - in the vicinity of fuel pumps, as requested by Maintenance.

Current instructions are to provide for this item in the regular surfacing contract for the parking area requiring it. See the latest Special Provision covering tar emulsion.

Do ***not*** provide this treatment for park-and-ride lots where the need is less because there is less vehicle turnover.

“Tar Emulsion" is measured and paid for by the gallon. Quantities should be estimated on the basis of 0.35 gal/syd of pavement to be covered.

6.03.20 Seal Coats

(revised 11-28-2011)

Seal coats were widely used by the Department until about 1972, when it was concluded that, for a little more cost, a single course HMA could be used instead. For a period of about 15 years there was virtually no seal coat work done under contract and what little that was done was by maintenance forces. During this time a number of the counties continued to do seal coat work, some using their own forces and equipment. Around 1987 the Maintenance Division took note of the generally good results that some counties were getting and concluded that, if it is done right, there is a place in modern technology for seal coats on roads. They have therefore negotiated a few contracts with certain counties to do some seal coat work on state trunklines. While seals are insufficient to keep surface water from entering large joints and cracks, they are quite effective, if properly constructed, in sealing the numerous small cracks that may show up in an older HMA pavement or overlay. If these cracks can be effectively sealed, the life of the old pavement can be extended, with reasonable rideability, until the pavement can be more extensively rehabilitated.

The current practice notwithstanding, designers may be called upon to design a surface treated roadway. In this event, the Construction Field Services Division staff should be contacted for details.

A variation of a seal, sometimes used in conjunction with a mat, is the sprinkle treatment. It consists of a properly graded, precoated aggregate applied to the surface of a hot-mix asphaltic pavement immediately after laydown so that the chips can be rolled into the surface. The objective is to provide a skid-resistant wearing surface.

6.04 CONCRETE CONSTRUCTION

6.04.01 History of Concrete Paving in Michigan

The first mile of rural concrete pavement in the nation was located on Woodward Avenue between 6 and 7 Mile Roads. The 17 ft.-8 in. wide pavement was built by the Wayne County Road Commission and completed in 1909.

The beginning of the state trunkline system can be traced to a law enacted in 1913. At the time, road building was largely HMA and water-bound macadam on the "Class A" roads close to cities; gravel and earth predominated everywhere else. Although records are sketchy, it appears that the first concrete paving project, let for contract by the state, was on Dixie Highway just north of Monroe, in 1918. The circumstances of this project are peculiar in that it appears that the original contract was let by the Monroe County Road Commission. The original contractor went bankrupt so the project was taken over by the Department, which let a new concrete paving contract.

6.04.02 Glossary of Terms

(revised 6-28-2021)

Aggregate interlock - Load transfer that occurs across a concrete fracture by virtue of the irregular nature of the fracture surfaces due to cracking around, rather than through, the aggregate particles. The faces must be held in close proximity to one another in order to develop aggregate interlock.

Base plate - The galvanized metal base of joint dowel baskets that last appeared on Standard Plan E-4-A-130E (October 1963) and on E-4-A-138. Its purpose was to prevent sand from working up into the joint (It was used prior to subbase stabilization).

“Black and white job" - A non-technical term referring to a roadway having both HMA surfaced and concrete surfaced lanes.

Blow-up - The upheaval and sometimes spectacular shattering of a concrete pavement caused by hot weather expansion in combination with loss of room for expansion, infiltration of incompressibles, and loss of cross-section in the lower portion of the joint, with consequential reduction of compressive stability and compressive strength. Usually occurring at a joint, it may commence in the period when the pavement is 8 to 18 years old.

Bonded overlay - A concrete overlay of an existing pavement that is encouraged to chemically and physically bond to the underlying pavement surface. The existing surface must be thoroughly cleaned by milling, grinding, or sand or water blasting prior to resurfacing.

Bulkhead joint - The formed joint, either longitudinal or transverse, between two adjacent concrete slabs, created when one slab is cast up against another already hardened slab.

Cold joint - The division between two concrete pours, one of which has begun to set before the other is cast against it. This disparity prevents the mixture from forming a continuous uniformly consolidated mass and may lead to separation of the concrete along this same line of division at sometime in the future.

Composite pavement - A portland cement concrete pavement with an HMA overlay.

Concrete base course - A concrete pavement slab intended to be overlaid with a surface course, usually an HMA surface course. Hence, more tolerance in the surface finish is acceptable, joints are not separately sealed, etc.

Concrete pavement - As normally used in the Department, a term referring to a pavement on which the portland cement concrete is the riding surface, as distinguished from concrete base course.

Continuously Reinforced Concrete Pavement (CRCP) - Concrete pavement which contains substantial steel reinforcement. Steel reinforcement (commonly #4 or #5 bars) is placed in either the longitudinal direction or in both directions. CRCP pavement does not normally contain joints except at structures.

Contraction Joint - A joint in concrete pavement that serves as a plane of weakness joint. Movement in the slab due to contraction occurs here.

Crg Joint (Contraction-Reinforced-Grouted) - A contraction joint between an existing concrete pavement and a full depth concrete pavement repair. Epoxy coated load transfer bars are drilled and grouted in the existing pavement at the joint.

Curb-cut - A rounded reduction of curb height such as is encountered at a driveway or curb ramp.

D-cracking - Deterioration along transverse or longitudinal pavement joints or cracks, caused by moisture absorption in the concrete coarse aggregate near the joint, with cracking occurring during subsequent cycles of freezing and thawing. This type of cracking takes its name from the characteristic concentric semicircular (as viewed in the vertical plane) hairline cracks that appear as parallel lines on the surface. These cracks often contain calcium hydroxide residue causing a dark surface stain. The deterioration progresses to a series of parallel cracks adjacent to the joint and eventually to disintegration and spalling, under traffic, 1 foot to 2 feet away from the joint.

Dowel basket - See "Load Transfer Assembly”

Dowel Bar Inserter - A machine that inserts load transfer dowels directly into the plastic concrete at contraction joints, eliminating the need for dowel baskets.

Drilled-in anchor - A method for anchoring a bar into an existing concrete structure. The bars are inserted into a previously drilled hole and anchored by an epoxy grout.

Durability, specifically, freeze-thaw durability - A term applied to the coarse aggregate in concrete to indicate its ability to resist the action of freezing and thawing while in a moisture saturated condition. Until 1988, it was expressed in terms of "Durability Factor" (0 = poor to 100 = excellent). In 1988, durability values were changed to dilation (expansion, expressed in units of percent per 100 cycles of freezing and thawing), with values from 0.000% (excellent) to about 0.200% (poor, failure in 12 cycles). Dilation of 0.067% per 100 cycles is equal to a durability factor of 20, which was a minimum specification limit from 1976 to 1988. A value of 0.040% per 100 cycles relates to the former durability factor of 36, and is the current minimum for freeway pavements.

Econocrete - A contraction of "economy concrete" applied generically to a concrete proportion of less strength and durability, utilizing either less cement, a more easily obtained aggregate gradation, a lower grade of aggregate, or a combination of any of these three.

Edge slump - The tendency for the outside edge of a slip-formed pavement to sag from the vertical immediately after the form has passed.

Erg Joint (Expansion-Reinforced-Grouted) – An expansion joint between an existing concrete pavement and a full depth concrete pavement repair. Epoxy coated load transfer bars with expansion caps are drilled and grouted in the existing pavement at the joint.

Expansion Joint - A joint in concrete pavement which is filled with an elastic material to provide opportunity for a small amount of movement (expansion).

Faulting - The vertical displacement of one pavement slab in relation to the adjacent slab. Common when there is no provision for load transfer across the joint. Such movement results from the rearrangement of aggregate fines under the joint, caused by the combined action of water and truck loading. Faulting can occur at a joint or crack.

Flowable fill - A mixture of portland cement, fly-ash, sand and water having sufficient fluidity to allow it to be poured into potholes, utility trenches, abandoned culvert or sewer pipes, and other cavities that need filling. It forms a weak concrete when set up, which can be re-excavated if necessary.

Frozen joint - A pavement joint that, through corrosion or misalignment, seizes up and no longer accommodates movement of the adjacent pavement slabs.

Gutter pan - The portion of curb and gutter, that is exclusive of the curb.

Integral Curb – Curb which is connected to (with reinforcing steel) and usually poured at the same time as the adjacent pavement.

Joint / Construction Joint - A break between successive deposits (slabs) of concrete used to control cracking and facilitate construction.

Jointed Plain Concrete Pavement (JPCP) - Concrete pavement containing no steel reinforcement. JPCP requires no steel mesh due to a very short joint spacing. Short joint spacing minimizes transverse cracking.

Jointed Reinforced Concrete Pavement (JRCP) - Concrete pavement containing steel mesh. The steel mesh is placed to hold anticipated cracks as tight as possible.

Lane ties – Deformed steel bars spaced at a given interval at 90 degrees to a longitudinal joint for the purpose of holding adjacent lanes tightly together.

Load transfer - Mechanism for transferring load carrying capacity across the opening between slabs.

Load transfer assembly - The metal framework that keeps the load transfer dowels in proper alignment through a transverse pavement joint during casting of concrete. Often referred to as a dowel basket.

Longitudinal Joint - A joint that runs parallel to the centerline of the roadway.

Lune widening - A variable widening of a pavement, usually on the inside of a curve, that allows more lane width for negotiating the curve. A 4-foot lune widening would start at nominal zero width at the beginning of the curve, gradually widen to 4 feet in the middle of the curve, then go back to zero width at the other end. The word has its root in the latin word for "moon", from which we get "lunar".

Margin - The area between a curb and sidewalk, usually in a residential area and seeded to grass. Synonymous with outlawn.

Mesh and Dowel - See Jointed Reinforced Concrete Pavement.

Metal - A somewhat archaic term referring to the road surface structure whether it is aggregate, aggregate and HMA, or concrete. "Edge of metal" would today be synonymous with "edge of pavement." The term was not applied to a paved shoulder.

Monolithic - In the context of concrete construction, two or more adjacent structural components cast together as one continuous unit.

Outlawn - The area between the curb and a sidewalk usually used in the context of a residential area where this strip is seeded to grass. This term is not commonly used in the Department. (See "Margin")

Panel - In the context of concrete pavement, the pavement slab between two consecutive transverse joints. See “slab”.

Paving train - The succession of paving equipment used to place and finish the plastic concrete. May consist of a spreader, mesh carrier, paver, float, texturing machine, and cure applicating machine. Other equipment having a specialized function may be used.

Plane of weakness joint - A simple joint formed or cut in a concrete surface to reduce the cross-sectional area and thus encourage any cracking to occur along a predetermined straight line, rather than randomly.

Pressure relief joint (PRJ) - A full depth groove cut in hardened concrete pavement, usually 3 inches to 4 inches wide, filled with an easily compressible filler, to relieve pressure caused by growth of the pavement. Typically installed where a blow-up has occurred.

Profilometer - A device for determining the smoothness of a pavement surface by mechanical, electronic, or optical methods.

Pumping - The water borne ejection of underlying base material from under the pavement, caused by deflection of the pavement during truck traffic loadings. The ejected water carries fine particles from the base, resulting in a progressive loss of pavement support, settlement of the slab, and eventual fracture of the slab.

Reliability - A term used in pavement design. Expressed as a percentage, it is a measure of the probability that the proposed design will succeed, i.e., that it will not fail.

Return - That part of a street intersection consisting of the fillets and the curved portion of any curb and gutter. When considering a mainline, the return would be that part of the sidestreet approach around to the springpoint.

Shapefactor - The ratio of the width to the depth of the joint sealer in a pavement joint.

Slab - A term used to describe a length of concrete pavement between consecutive joints. (See “Panel”)

Sleeper slab - A concrete slab placed at a depth such that the pavement surfacing slab can rest upon it. May accommodate movement of the surfacing slab by means of a bond-breaker between the two slabs. Usually used at bridge approaches.

Springpoint - The point in a paved or curbed intersection where the edge on tangent meets the curved portion of the return radius.

Square – An abbreviation of "square yard”.

Subgrade - The following term is defined in the Standard Specifications for Construction.

Transverse Joint – A joint that runs perpendicular to the centerline of the roadway.

Trg Joint (Tied-Reinforced-Grouted) – A tied joint between an existing concrete pavement and a full depth concrete pavement repair. The existing pavement is drilled and tied to the pavement repair with grouted epoxy coated deformed bars.

Unbonded overlay – A concrete overlay of an existing pavement that is discouraged from bonding both chemically and physically to the underlying pavement surface. This is usually accomplished by using an HMA separation course.

Widened Slab – When the outside slab (truck lane) width between longitudinal joints is 14-feet, instead of the standard 12-ft. width.

Working crack - A random transverse crack in the pavement that accommodates expansion and contraction of the adjacent slabs. For this to happen the pavement reinforcement must first have fractured. Often, an adjacent pavement joint will have "frozen" so that it becomes a non-working joint.

6.04.03 Characteristics of Concrete Pavement

The concrete used in pavement has a coefficient of thermal expansion of 0.0000055 in/in/°F. Considering a pavement with a 27-foot joint spacing, a contraction of just greater than $^{1}/_{16}$ inch would occur at each end of the slab, because of a 90° decrease in temperature from its original casting temperature. It can be seen that a potential contraction of about ⅛ inch must be accommodated in each slab. There is also shrinkage during the curing of the concrete, and this increases with the amount of water in the mix.

Concrete pavement has a tendency to curl upward when saturated by moisture on the underside or when the temperature of the top surface is lower than that at the bottom. This tendency is most evident at night and is manifested in greater pavement edge deflection due to curl.

Concrete pavement has a tendency to lose its ability to accommodate expansion over the years, which is evidenced by open joints that don't close up when warmer temperatures return. This is usually the result of dirt and incompressibles entering joints and cracks and effectively filling up any available expansion space, or from actual expansion of the concrete due to alkali-silica or alkali-carbonate reactions and/or freeze-thaw deterioration. This phenomenon can have serious consequences when, for example, it results in excessive expansion pressures on the backwall of a bridge, or causes blow-ups at weakened pavement joints.

Admixtures can change the characteristics of portland cement concrete, particularly during the casting and setting stages. Plasticizers can increase the slump, and thus the workability, without changing the water-cement ratio. Calcium chloride will increase the heat of hydration, important in the winter time to allow the mix to set up without freezing. It is also used to accelerate the setting, therefore resulting in obtaining higher strength faster and allowing the roadway to be opened to traffic sooner. However, chlorides cause corrosion of reinforcement, so this material should not be used in heavily reinforced structures or those where corrosion will excessively reduce the life of the pavement. Extra cement and/or alternate non-chloride chemical additives can be used for fast strength gain when needed for reinforced concrete.

6.04.04 Concrete Pavement

(revised 9-22-2025)

6.04.04A General

Michigan has constructed three types of concrete pavement in past years. These are: Jointed Reinforced Concrete Pavement (JRCP), Jointed Plain Concrete Pavement (JPCP) and Continuously Reinforced Concrete Pavement (CRCP). JRCP and JPCP have been widely used while CRCP has been used in the past.

6.04.04B Thickness

Conventional thicknesses of concrete pavement range from 8 inches to 12 inches uniform. Many Metro area freeways were built utilizing 10 inches thickness and there are many rural trunklines 8 inches thick.

Some older pavements placed prior to 1950 were constructed with variable thicknesses. For example, a 9 inch-7 inch-9 inch pavement is 9 inches thick at each outside edge, tapering to 7 inch thickness 3 feet in from the edges. When rehabilitating a concrete pavement of this era, the designer should be aware of this possible design. Pavement cores can confirm or deny this

situation if old plans do not exist.

Pavement thicknesses greater than 9 inches are usually required only on the freeway system. The Pavement Designer will make the thickness determination.

6.04.04C Deleted

Section deleted.

6.04.04D Load Transfer

Load transfer can be achieved in three ways: (1) by aggregate interlock at tightly abutting irregular concrete surfaces, (2) by having an adequate base course (adequate stiffness) and (3) by the addition of a mechanical device (dowel bars) at the joint. Michigan has used dowel bars most frequently.

Load transfer is essential at the joints, otherwise faulting will occur. Faulting is caused by pumping of the slab, which in turn causes a migration of aggregate fines from under the "entering" slab to under the "leaving" slab. (Direction of traffic).

The driver will feel and hear the rhythmic "thump" of the faulted joints, even though the joint lines ahead will be barely visible. Looking in the rearview mirror, however, the joint lines will be prominent. Faulting adversely affects ride quality making a pavement less desirable to drive although the structural condition may be good.

Standard Plan R-40-Series, "Load Transfer Assemblies for Transverse Joints," shows the design of a load transfer assembly using a basket design.

Designers should be aware that older pavements, constructed prior to 1965, had metal base plates as part of the load transfer assembly. The department has determined that the presence of base plates is detrimental because they trap moisture and de-icing salts, which accelerates joint deterioration. Transverse joints in these pavements can be expected to be in much worse condition than the surface reveals. A common distress, in this situation, is “D” cracking.

6.04.04E Transverse Joints

The purpose of a transverse joint, besides allowing for expansion and contraction, is to minimize random transverse cracking. A joint acts as a designed crack location which is straight and is aesthetically pleasing.

6.04.04E1 JRCP Joint Spacing

Early reinforced concrete pavements placed in Michigan either had no joints or else joints were placed at almost any spacing conceivable between 15 feet and 100 feet.

Standard reinforced pavement joint spacing has ranged, based on year of construction, as shown below:

- 99 feet or 100 feet used prior to 1965
- 71 ft.-2 in. used from 1966 to 1975
- 70 feet used from 1975 to 1979
- 41 feet used from 1979 to 1996
- 27 feet used currently

Original joint theory was based on minimizing the number of joints constructed. Joints were the principal source of problems in concrete pavement. Therefore, the fewer joints constructed the less joint problems which could develop. The average transverse contraction joint width in a 99-foot slab was approximately ⅝ inch. An economical joint seal material does not exist that can accommodate a possible movement of ⅝ inch. The current 27-foot joint spacing requires a transverse contraction joint width of about ½ inch. Neoprene seals work very well with joint widths in this range.

6.04.04E2 JPCP Joint Spacing

Plain concrete pavements are designed to virtually eliminate random transverse cracking. Standard joint spacings are based on slab thickness and are shown on Standard Plan R-43-Series.

6.04.04E3 Expansion Joints

Expansion joints are placed on both sides of bridge structures and at-grade railroad crossings as specified on Standard Plan R-43-Series.

6.04.04E4 Contraction Joints

With any reduction in temperature, concrete will be subjected to tensile stress because of the frictional restraint along the plane of the base. Since concrete has negligible tensile strength, especially at an early age, a crack will occur. Therefore, concrete should be saw cut as soon as construction allows. A typical “relief” cut is ⅓ the thickness of the slab. Sawing can commonly be done on the day of paving or early the following day. Early relief cutting is intended to reduce early random cracking of the slab. See Standard Plan R-39-Series.

6.04.04E5 Joint Sealants

The Department typically requires hot poured rubber type joint sealing compound in expansion joints and either hot poured rubber or preformed neoprene compression type seals in contraction joints. Cold applied asphaltic sealants are not permitted.

The geometry of the joint reservoir, the sawed groove in which the sealant is placed, is very important. The reservoir must therefore be designed specifically for the joint spacing and type of sealant that will be used. In the past hot poured rubber would retain its adhesion to the sides of the joint groove reasonably well over a long period of time if not required to be extended more than 10% of original width. This would require ¼ inch of initial width for each 4 feet of slab length, i.e., a 1-inch wide joint groove would function for a 16-foot long slab. It follows that the use of hot poured rubber for transverse contraction joints are not practical for slab lengths more than 16 feet. In the 1990’s, the Department began specifying lower modulus hot poured rubber, which can be extended further while maintaining good adhesion. Because of this, in 2004 the joint widths were reduced to ¼ inch for slabs less than 16 feet. Other issues that are improved because of narrower joints are: reduced tire noise, improved ride perception, and decreased spalling. One drawback is that hot poured rubber is somewhat difficult to place on highly superelevated pavements.

Neoprene seals must be in compression at all times, or they will be ineffective and may come out of the joint. In general, neoprene seals are designed to function in a compression range of 20% to 50%, based upon their nominal width. A minimum of 20% compression is required to maintain an adequate seal; compression beyond 50% may cause the seal to extrude above the pavement surface where it may be damaged or lifted out by traffic.

About 10 joints were sealed with neoprene seals on I-96 south of Lansing as part of an experimental project in 1962. Neoprene joint seals first appeared in quantity, by Construction Authorization, on some projects paved in 1965.

Because of the higher cost of neoprene joint seals and specialized equipment needed to maintain them, some local agencies prefer to use hot poured rubber. They are thus reluctant to allow the Department to use neoprene seals on pavements such as service roads and crossroads that they will have to maintain at their expense. Before final plans are completed, a determination should be made as to the joint spacing and type of joint sealer the local agency desires. This information must be a part of the final plan documents; a special provision will likely be required.

In Wayne County, either hot poured rubber or neoprene seals are used, while the City of Detroit prefers hot poured rubber.

Silicone joint seals have been used experimentally in Michigan. Their first use on a relative large scale was on approximately 1.6 miles of I-69 north of Lansing between Airport Rd. and Dewitt Rd., constructed in 1985. In the EOC Minutes of August 4, 1992, because of excessive failures, there was a moratorium placed on the use of silicone sealant for concrete pavement joints. The moratorium was made permanent at the October 2000 EOC meeting.

6.04.04E6 Measurement and Payment

All transverse pavement joint details, except H and U, are paid for separately by the foot. This payment includes any load transfer devices (if required), sawing, and sealing of the completed joint.

In urban areas, joints at intersections are to be provided according to Standard Plan R-42-Series.

The estimate of "Expansion Joints" should include the E3 type expansion joint specified on Standard Plans R-39-Series and R-43-Series, located at bridge headers, even though this joint does not have a load transfer device.

A breakdown of each type of joint by pavement thickness, i.e., 8 inch, 9 inch, or other thickness, should be shown on the plans for information only. The bid items will continue to show the total quantity of each type of joint.

Pay items for concrete pavement joints should be set up regardless of the size of the project. At one time it was practice to pay for pavement joints as a part of the pavement. However, it was found that small contractors, who were more likely to be awarded the contract for a small project, were also the ones least able to recognize the type of joints needed and how to estimate them.

6.04.04E7 Concrete Intersection Joint Layout

Design of concrete intersection plane of weakness joints vary with each intersection's geometry and the location of structure covers within the intersection pavement. On September 2, 2004 the Engineering Operations Committee approved the concept of contractor intersection joint layout. The contractor will be required to submit a joint layout plan to the Engineer prior to concrete placement. Prior to or at the pre-construction meeting, the designer must furnish intersection work sheets to the Resident Engineer. The format should be 11-in. x 17 in. sheets to scale (1-inch = 40 feet) showing all proposed curb, longitudinal lane lines leading up to the intersection and all existing and proposed utility/drainage structure covers within the intersections.

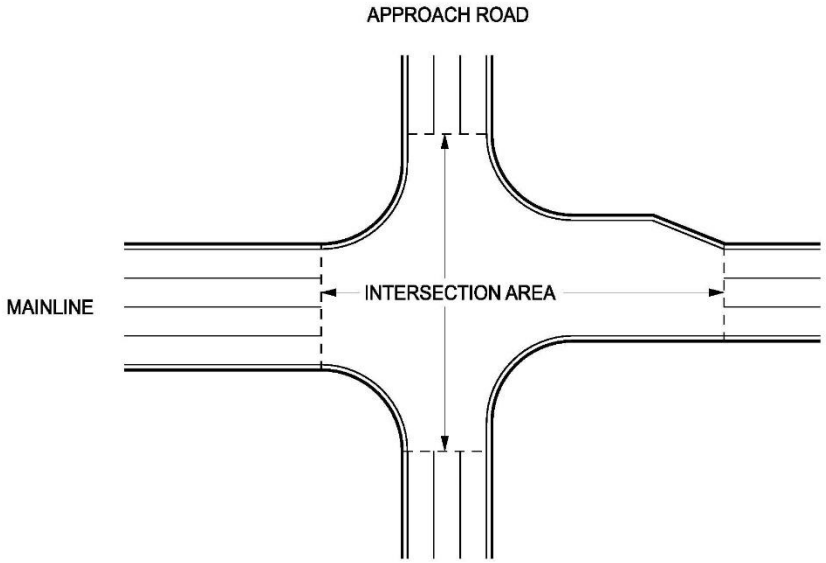
Estimating Transverse Intersection Joints

Compute quantities for mainline transverse joints (Symbol C) with no deduction through intersections. Estimate additional quantities for approach road transverse joints (Symbol C) from the approach road spring points or turn lane tapers to the mainline edge of pavement. Assume the same minimum spacing as mainline.

Assume an additional number of transverse joints for each roadway, equal to the total number of lanes crossed plus one. For the figure below, the mainline crosses three lanes of approach road, therefore, add quantities for four additional transverse contraction joints. Also add quantities for five additional transverse contraction joints on the approach road which crosses four mainline lanes.

Expansion Joints at spring points or turn lane tapers can be estimated using the intersection joint layouts shown in Standard Plan R-42-Series. Assume for estimate purposes that the mainline is not "paved through" the intersection and that the edge of mainline is not tied with an E2 joint through the intersection. This results in estimated quantities for either E2 or Erg joints at each of the intersection terminals.

Finally, estimate a quantity for miscellaneous plane of weakness joints (either symbol D1 or W) equal to 5% of the total length of transverse joints in the intersection.



6.04.04F Longitudinal Joints

Longitudinal joints are used to prevent irregular longitudinal cracks within the slab. Such cracks normally result from the combined effects of load, base weakness and restrained warping under traffic. Rapidly dropping air temperatures during the first night after paving may induce longitudinal cracking due to subgrade frictional restraint. Typically, sawing of longitudinal joints occurs within 24 hours of casting the concrete.

Longitudinal joints should coincide with the location of proposed painted lane lines, unless widened slab is specified (see Section 6.04.04F(6), "Widened Slab"). When the pavement geometry is such that the location of lane lines are not readily evident, the plans should include a joint layout diagram for the area in question.

See Geometric Design Guide GEO-370-Series for details of longitudinal joint lines at a T-ramp intersection with a crossroad.

See Standard Plan R-41-Series, "Longitudinal Pavement Joints."

6.04.04F1 Joint Spacing

Standard longitudinal joint spacing is the same as the specified lane width, which is typically 12 feet. When a widened slab is specified, longitudinal joint spacing matches the specified lane widths, except for the outermost travel through lane (truck lane), which will be 14 feet wide. See Section 6.04.04F(6), "Widened Slab" for further details and guidance.

Maximum width of a concrete pavement slab without a longitudinal joint is 16 feet. A 30-foot wide concrete service road should have one longitudinal joint at the centerline.

Thinner slabs should have longitudinal joints at closer spacing, e.g., an 8 inch thick, 16-foot wide ramp should instead have the longitudinal joint offset 12 feet from one edge and 4 feet from the other edge.

6.04.04F2 Lane Ties

Lane ties are used to hold adjacent concrete pavement structures in close relationship to one another. As a general principle, the more lanes that must be tied together, the closer the required spacing of the lane ties. The closest spacing is needed farthest from the free edge. (See the table on Standard Plan R-41-Series.)

With form paving, bulkhead joints are created at the edges where the forms are used. Deformed bars are used as lane ties across these joints. With slip-form paving, several techniques have been tried, including inserting a straight bar into the plastic concrete immediately behind the slip-form. Currently, most contractors utilize equipment that inserts a bar bent at 90 degrees such that they do not interfere with the paver tracks. After the concrete has set, the bar is bent perpendicular to the edge of pavement.

6.04.04F3 “L” Joints

"L" and "L1" joints are no longer used. The hook bolts used in these joints have been replaced with epoxy anchored lane ties when a future widening is made. The epoxy anchored lane tie is referred to as an "L2" joint and is specified on Standard Plan R-41-Series.

6.04.04F4 External Longitudinal Pavement Joint

Sawing and sealing of longitudinal pavement joints is included in the payment for the concrete pavement. This includes the exterior longitudinal joint between the concrete pavement and a concrete shoulder, concrete curb and gutter, or concrete valley gutter.

The external longitudinal joint between concrete pavement and Detail E (straight) curb, between concrete pavement and concrete dividers, and between HMA surfaced concrete base course and curbings are not required to be sawed and sealed. (The axle protrusion of the saw prohibits sawing a joint adjacent to a vertical face of any appreciable height, and our standards do not provide for either sawing and sealing of joints in base course.)

6.04.04F5 Longitudinal Joint Sealant

Longitudinal concrete pavement joints are generally sealed with hot poured rubber.

6.04.04F6 Widened Slab

If appropriate, MDOT may use a 14-foot widened outside slab (truck lane). The widened slab is intended to reduce stresses and deflections at the outside longitudinal concrete pavement edge caused by vehicle tires running on or near the edge. Widened slabs may also reduce the amount of shoulder maintenance. While widened concrete slabs can be beneficial, they may also be susceptible to longitudinal cracking if the pavement thickness is too thin. Therefore, MDOT recommends using a 14-foot widened concrete slab when the roadway has all of the following attributes:

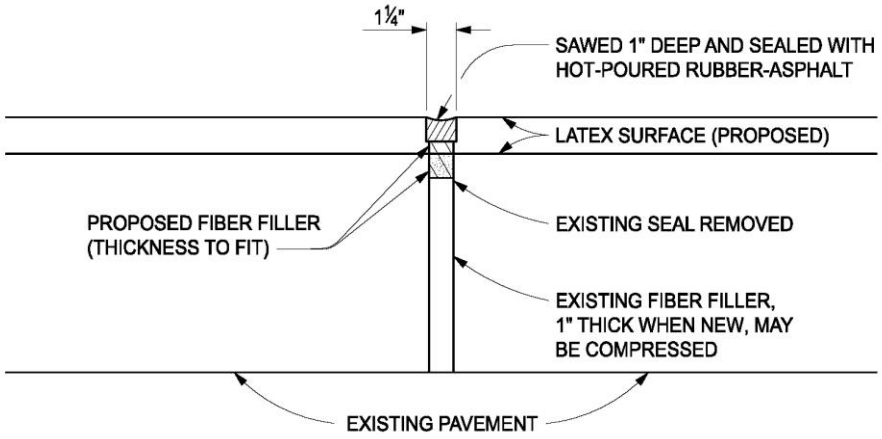
- Is a new/reconstruct project.
- Is a freeway.
- Allowable width for widening (ie. not constrained by curb or Right-of-Way).
- Additional outer lanes are not currently planned.
- Significant length of auxiliary lanes adjacent to the truck lane are not present or planned.
    - The concrete pavement thickness is 9.5 inches or greater.
    - If the pavement thickness is less than 9.5 inches, but a hot mix asphalt shoulder is planned, then consider widening with a slab width of 13-foot.

6.04.04G Joints in Latex Concrete Bridge Approaches

When bridge decks and their approaches are resurfaced with latex concrete, the joints in this approach wedging must be detailed in the plans. Latex concrete is used on approaches, rather than HMA, when the approach concrete is in good condition. Usually there is a series of expansion joints in this area.

Provision must be made to continue the function of the underlying pavement joints through the overlay. The seals in the expansion joints should be removed and the joints resealed. The sketch shown below is to be detailed on the plans when this treatment is used.

The longitudinal joints should also be matched, with a bond breaker such as duct tape placed between the latex pours to continue the joint through the overlay. The joint should then be sawed and sealed as shown for symbol "B" on Standard Plan R-41-Series



6.04.04H Miscellaneous Concrete Pavement

The pay item for Miscellaneous Concrete Pavement is “Conc Pavt, Misc, Nonreinf __ inch”. The pay item is intended to compensate the contractor for the additional cost involved with low production paving and to allow the use of modified equipment and construction methods, when appropriate. Low production paving may be odd or variable width or of limited quantity. Modified equipment and construction methods are warranted when the length of paving is too short for the effective use of a full paving train.

There is no rigid criteria for determining when and how much Miscellaneous Concrete Pavement should be used on a project. The plans or proposal should therefore clearly designate which areas of pavement will be paid for as Miscellaneous. Examples of it are intersection betterment projects, speed change lanes (including uniform width as well as tapered sections), ramps, and collector-distributor roads even though they may include uniform pavement widths exceeding 500 feet in length.

If Miscellaneous Concrete Pavement compose a major part of the total jointed concrete pavement on the project, consider making all of the concrete pavement Miscellaneous.

The pay item should also be used on projects where the paving operation will be continually broken up into short segments because of pavement gapping. However, ride quality requirements (see Section 6.04.05) should still apply if the pavement to be placed is to ultimately function as part of a high speed through lane.

6.04.04I Construction Considerations

6.04.04I1 Pavers

Pavers used in Michigan today are capable of paving two 12-foot lanes and extending, if necessary, to more than 27 feet wide. Pavers 36 feet wide have been used here, but they are unwieldy, particularly in a superelevation transition, and none are presently in active use.

Current paving machines generally have the capability of taking out crown hydraulically, which is required in superelevation. Contractors do not attempt to take out crown during subgrade grading, however, preferring to thicken the pavement through the transition, instead. In cases where an odd number of lanes are involved (3, 5 or 7), designers should avoid calling for the crown high point in the center of a lane because some equipment cannot accommodate it. (Standard Plan R-107-Series presently does not provide for the high point to be in the center of a lane, anyway.)

6.04.04I2 Forms

While use of paving forms has diminished because of the higher efficiency of slip-form equipment, form paving may still be found on some small jobs and projects involving strictly Miscellaneous Concrete Pavement. Contractors on larger projects will use them for paving fillets, etc. (Fillets are usually paved before the curb and gutter is added.)

6.04.04J Gaps in Concrete Pavement

Gapping out portions of concrete pavement, either for one or two lanes, or for the entire width, is frequently done for purposes of maintaining traffic, either on the roadway itself, or for ingress and egress at adjacent businesses.

Concrete gapping is also used where the paving train must be discontinued and the work completed by less mechanized methods. An example may be at a bridge approach where the deck is already cast. Gapping length here may be on the order of 70 feet or less.

6.04.05 Ride Quality

(revised 9-22-2025)

The purpose of a ride quality specification is to obtain a smoother riding pavement than is typically obtained with the traditional 10-foot straightedge smoothness requirements. Michigan first adopted a ride quality specification in 1979. The current specification prescribes classified levels of ride quality requirements described in subsequent paragraphs of this section.

The ride quality specification should be used on new concrete and multiple lift HMA paving projects more than a mile in length. Also use on the following projects of any length:

- Cold mill and one course HMA overlay
- One course HMA Overlays
- Diamond grinding projects

Consult with Construction Field Services Division before using on urban non-freeway projects. Do not use on Local Agency projects except for new concrete or multiple course HMA paving projects on NHS routes.

Unless specifically noted on the plans, the following areas are excluded from ride quality:

1. Ramps other than freeway-to-freeway ramps
2. All ramp tapers
3. Shoulders
4. Railroad crossings
5. Bridges – Within Class II, III, and IV areas, the predetermined excluded area is that area between the two end reference lines or between the outermost limits of any structure expansion joint devices.
6. Designated QC/QA loose material sampling areas on the wearing course of flexible pavement projects within Class II, Class III and Class I sections only.

Ride quality requirements are not intended for application with stand-alone bridge projects. However, bridge deck replacements, and shallow or deep concrete bridge overlays included within the limits of a Class I ride quality section in a corridor project will be subject to ride quality requirements. All other bridges are excluded from ride quality requirements. Consult with bridge designer prior to classification.

The only pay item associated with ride quality is bump grinding. A small quantity should be included for each location where the contractor may be directed to grind *existing* pavement (i.e.: pavement not placed as part of the contract) in order to smooth the transition from old to new pavement. This includes the POB, the POE, and any *existing* bridge or railroad approaches within the project limits. 25 square yards for each lane at each of the above locations should suffice.

Bump grinding is normally not paid for in areas excluded from ride quality. Instead the pavement is accepted or rejected based on the 10-foot straightedge criteria. (Standard Specifications for Construction) If it does not meet the straightedge criteria, it is the contractor's responsibility to grind or replace at their cost.

Specific requirements for ride quality are identified by classification. Each classification (Class I, II, III & IV) specifies criteria for roughness, method of measurement, and applicable incentives and disincentives. The matrix on the following page provides instructions for assigning ride quality classification based on scope of work, design speed, grade control and adaptability to production paving.

Using this criteria, the designer will assign a ride quality classification to each applicable section of paving throughout the project. The locations and classifications are then tabulated for inclusion in the Notice To Bidders.

Ride Quality Classification Selection Matrix

How To Use This Matrix Divide the project into Sections [1] based on the amount of control the contractor will have over the final surface grades, the scope of work, and the design speed. Determine the recommended ride specification type for each section. Confer with Construction Field Services staff for exceptions or unique circumstances.		Contractor **has control** over grades		Contractor **has limited or no control** [2] over grades				
		Construction on Existing Roads [3]	New Construction or Reconstruction [3]	Construction on Existing Roads [3]	New Construction or Reconstruction [3]	Single Course of Flexible Pavement (with/without milling)	Diamond Grinding Projects	Flexible Ultra Thin, Paver Placed Surface Seal
Section length **allows** for production paving [4]	Design Speed below 50 mph	Class II	Class II	Class II	Class II	Class III	Class III	Class III
	Design Speed 50 mph or above	Class I or II	Class I or II	Class II	Class II	Class III	Class III	Class III
Section length **does not** allow production paving [4]	Design Speed below 50 mph	Class III	Class II	Class IV	Class IV	Class IV	N/A	Class IV
	Design Speed 50 mph or above	Class II	Class I or II	Class IV	Class IV	Class IV	N/A	Class IV

Key:

Class I Ride Quality: Complete Projects (mainline only) where no excluded areas are allowed, a thresh hold IRI criteria must be met, and incentives and disincentives apply. Use Class I only on limited access roadway with design speeds 50 mph or greater and where most or all bridges include deck replacement, shallow concrete overlays, or deep concrete overlays. Investigate the feasibility of diamond grinding (at MDOT cost) any bridge decks not being replaced or overlaid. Where diamond grinding a bridge deck is not feasible, a limited section of the project can be designed as Class II Ride Quality such that the bridge would be a pre-determined excluded area within a project that would otherwise meet Class I ride Quality criteria. Consult with the bridge designer prior to classification.

Class II Ride Quality: Sections where threshold IRI criteria must be met, but incentives and disincentives do not apply. (Use Class II if all of the above requirements for Class I are not met.)

Class III Ride Quality: Sections where the pre-construction IRI must be maintained or improved by a certain percentage. Disincentives may apply.

Class IV Ride Quality: Sections where acceptance is based on a 10 foot straightedge criteria. Incentives and disincentives do not apply.

N/A = Not Applicable

Footnotes:

(1) A Section is defined as a length of paving which has the same characteristics (grade control, type of work, design speed).

(2) Locations where a contractor might not have control of grades include locations where they must pave adjacent to an existing lane with marginal ride quality, locations where there are existing curbs to match, and locations where there are frequent existing manholes or structures to meet.

(3) See Chapter 3 for project type definitions and for classification purposes on projects with multiple project types.

(4) Production paving means a slipform paver can be used for concrete paving and that a HMA paver can be used without frequent stopping and starting and there is room for a haul truck to unload directly into the paver or a material transfer device while in motion. MDOT imposed construction staging requirements should be considered when making this determination.

6.04.06 Continuously Reinforced Concrete Pavement

(revised 11-28-2011)

6.04.06A Background

The first CRC pavement in Michigan was constructed experimentally in 1958 on I-96 near Portland (from M-66 easterly to Portland Road). Since then approximately 341 equivalent two lane miles of CRC pavement have been built.

In 1978 a moratorium was imposed on the construction of CRC pavement; this restriction is still in effect. It was precipitated by the following concerns:

1. Difficulty in maintaining the necessary tight construction tolerances and uniformity with respect to steel placement, concrete consolidation, and subbase material and preparation required to achieve the expected life and performance.
2. Reinforcing steel in some sections of freeway was showing serious loss of section because of corrosion, resulting in large crack openings and progressive fracture and delamination of the slab in areas where cover over the reinforcement was minimal.
3. Unique, more costly, and difficult maintenance techniques, combined with higher construction costs, seemed to negate the advantages originally envisioned for CRC pavement, i.e., the elimination of troublesome joints.
4. More specifically, the failure in the summer of 1978 of two wide flange beam terminal joints in the metropolitan area (attributed to stress-corrosion cracking and/or steel fatigue) caused the discontinuance of this type of anchorage. Because this was the type of anchorage then in favor, as well as the most economical, it was not long afterward that the moratorium was imposed.

6.04.06B Principles of CRCP

Continuously reinforced concrete pavement is based upon the principle that temperature, shrinkage, and moisture induced forces in the central portion of the pavement are restrained by friction between the slab and the subbase at the ends. With movement thus theoretically reduced to zero, joints may be eliminated. By increasing the cross-sectional area of the reinforcing steel in the slab (to about four times that in the conventional jointed pavement), the induced tensile forces can be adequately resisted, and the concrete cross-section is sufficient to resist the compressive forces. Frequent, comparatively tight transverse cracks occurring about every 4 feet to 5 feet take the place, in effect, of conventional contraction joints.

Restraint in the interior portion of a CRC pavement is provided by subgrade friction developed over about 6 inches to 12 inches of length at each end. The movement in the free ends can be either restrained or accommodated. Michigan has used three principal types of end anchorages:

1. **Anchor Lugs**

   A series of three or more 4 feet deep concrete lugs, cast monolithically with an 18 inch doubly reinforced pavement slab. Incorporates the principle of complete restraint. Not suitable for use in granular soils and not economical where there are numerous bridges.

2. **Wide-flanged Beam Terminal Joint**

   A 12 inch wide-flanged steel I-beam embedded in a 10 inch thick concrete sleeper slab. This assembly accommodates the contraction displacement of the CRC slab.

3. **Expansion Joints**

4. A series of six to ten conventional expansion joints at relatively close spacing.

5. Both the wide-flanged beam terminal joint and the series of expansion joints are suitable for use in granular soils.

6. Early experimental projects utilized a steel reinforcement ratio of 0.6% (the ratio of steel cross-sectional area to the cross-sectional area of the concrete) and an 8 inch slab thickness. Later projects incorporated 0.7% steel and 9 inch pavement thicknesses. It should be noted that Michigan never constructed a 10 inch thick CRC pavement. (See Section 6.04.06C.)

6.04.06C CRCP Repair

Because of the moratorium on the construction of new CRC pavement, a designer's involvement will be limited to patching and repair projects on existing CRC pavements. Many of the original CRC projects incorporated variations in design and construction techniques; therefore Construction Field Services Division will prepare specific recommendations for each project. A special provision will be required.

In patching CRC pavement, unless the Construction Field Services Division has determined that deterioration of the pavement is too far advanced, it is essential that the continuity of the steel reinforcement be maintained. This requires that the concrete be carefully chipped away from the ends of the patch to preserve sufficient steel for lapping. The steel in the patch must be welded to the existing steel. It is important that patching be done in the late afternoon or early evening to allow the concrete to gain sufficient strength, and bond to the reinforcement, to resist compressive forces during the following day, and tensile stress the next night. Also, an open patch creates two new free ends of pavement tending to move together during expansion, bowing the welded reinforcement during the heat of the day, and transferring excessive compressive stresses into the adjacent lane in the case of a one-lane patch in a two-lane pavement.

In the extreme when the steel reinforcement has repeatedly failed, a CRC pavement should be patched with conventional patches. This has the effect of eliminating the continuous reinforcement feature and transforming the pavement into a hybrid jointed pavement, with possibly closed joints and working cracks.

When contemplating repair of a CRC pavement, the designer should be familiar with the details of the pavement to be repaired, and should understand the theory that is involved. Indiscriminate altering of an existing CRC pavement, if done in ignorance, can have far-reaching consequences. For example, a past project involved removal of a wide flange beam terminal joint down to the sleeper slab and casting a 10 inch thick patch, longer than the sleeper slab. This meant that the lower 1-inch of the patch would be bearing against the end of the sleeper slab. Any movement would be restrained, with fracture bound to occur in one of the structural elements.

Old plans specific to the project should be used to determine the exact details that were used in constructing the pavement.

6.04.07 Plain Concrete Pavement

(revised 5-28-2013)

6.04.07A Guideline for Use of Plain Pavement

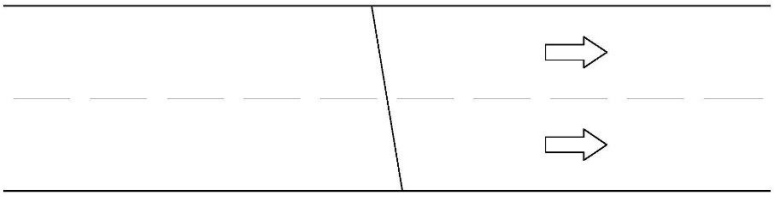
By Department practice, concrete pavements are nonreinforced except at bridge approach slabs and as specifically recommended for isolated special situations.

6.04.07B Joint Type and Spacing

Concrete pavement, if not reinforced, will normally crack transversely at 12 feet to 16 feet intervals. Hence, transverse joints must be within this spacing range if mid-slab cracking is to be avoided. The Department uses 14 feet to 16 feet joint spacing based on pavement thickness.

Skewed joints can be used on service roads when it is the standard used by the local agency for the same class of road or street. The rationale behind skewed joints, which may be combined with randomized spacing, is that rhythmic or resonant responses in vehicles are damped. Skewing also minimizes the effect of any roughness of the joints and improves the riding quality of a pavement if the slabs have curled or if faulting is present. There is some evidence that skewing reduces faulting of plain pavements.

Skewing is generally 2 feet for a 12-foot width, 3 feet for a 16-foot width, and 4 feet for a 24-foot width. The direction of the skew should be as shown below:



(Studies have shown potential for a little less pumping when the skew angle is as shown, rather than the other way.)

When random spacing is employed in conjunction with skewed joints, use the sequence of 12 feet – 13 feet – 16 feet – 15 feet Random spacing is of little benefit on slow-speed roadways, such as rest area ramps.

With reference to Standard Plans R-39-Series and R-41-Series, the following joints should be used in nonreinforced pavement:

1. Service Roads - Use transverse plane of weakness joint, symbol W, skewed 2 feet per 11-foot or 12-foot lane*, spaced at 16 feet. Use lane ties as shown for longitudinal joints, symbol B or D.
2. Concrete Base Course Widening - Use transverse plane of weakness joint, symbol U, spaced at 16 feet, not skewed. (See Standard Plan R-42-Series.) Use lane ties as specified for longitudinal joints, symbol B or D.
3. Urban Streets - Use transverse plane of weakness joint, symbol W, skewed 2 feet per 11-foot or 12-foot lane*, spaced at 16 feet maximum. Use lane ties as specified for longitudinal joints, symbol B or D.

* Skewing of transverse joints may be omitted if cross streets are closely spaced requiring expansion joints at 90° at the spring lines.

6.04.07C Temporary Concrete Pavement

Plain concrete pavement for a temporary road, should have transverse joints at a 16 feet spacing (symbol W, Standard Plan R-39-Series, except that final width shall be ⅛ inch), unsealed and not skewed. The longitudinal joint may be omitted. If the pavement will lay over a winter or longer, a longitudinal joint (⅛ inch relief cut one third the pavement thickness specified for symbol D on Standard Plan R-41-Series, except that final width shall be ⅛ inch), unsealed, should be used. Lane ties should also be provided. If a longitudinal joint and lane ties are desired in temporary concrete pavement, they must be called for in the plans or proposal.

In the event that the "temporary" road will be in service for 4 or 5 years, sealing of joints, mesh reinforcement, load transfer, etc., should be considered on a case-by-case basis.

6.04.08 Concrete Base Course

(revised 6-28-2021)

6.04.08A Criteria for Use

By definition, concrete base course is intended for imminent HMA surfacing. Its use is generally dictated by a desire to maintain the same pavement coloring in a widening as on the original pavement or to differentiate between lanes. For many years expressway ramps and speed change lanes in Detroit were uniformly paved with concrete base course and HMA to make them readily distinguishable to motorists by their contrast with the concrete pavement of the through lanes. This policy is no longer in effect.

A decline in the use of concrete base course in recent years is attributable to the realization that HMA surfacing is not waterproof. Depending on the HMA mixture, a certain amount of moisture can usually be expected to reach the interface between the asphalt and the concrete. In winter this may be salt brine that contributes to deterioration of the concrete and loosening of the HMA surfacing. Reflective cracks also form in the overlay directly above the joints, allowing penetration of water and incompressible materials.

By current practice, concrete base course is limited to widening of existing pavements and patching, and not for full-width new construction. Preferably, it should be further limited to widenings of less than a lane width. For example, a 30-foot asphalt-surfaced pavement being widened to five 12-foot lanes (60 feet) should probably have a 3-foot base course widening and a 12-foot (perhaps monolithic) lane of concrete pavement on each side. (Full-depth HMA construction is an alternative.)

See Section 6.04.09, "Widening of Existing Concrete".

6.04.08B Reinforcement

Concrete base course will not contain mesh reinforcement unless it has been specifically recommended for the project.

6.04.08C Texture and Joints

(See Standard Plan R-39-Series.) Texturing of concrete base course consists of a longitudinal burlap drag. This roughness, combined with a clean, non-oily surface, enables a single-course HMA surface to bond to concrete base course in contrast to a requirement for a two-course

HMA resurfacing over an older concrete pavement previously polished by traffic.

Joints in concrete base course are not sealed.

6.04.09 Widening of Existing Concrete

6.04.09A Criteria for Use of Lane Ties in Longitudinal Bulkhead Joints

The question of whether or not to use drilled and grouted epoxy anchored lane ties arises on every concrete widening project. This question must be answered by investigating the soundness of the existing concrete that, in turn, is an indication of the expected life of the old pavement and the cost effectiveness of epoxy anchored lane ties. This must be determined by a field investigation by Region/TSC personnel prior to the Plan Review Meeting Condition, rather than age, should be the deciding factor.

If the existing pavement is sound, epoxy anchored lane ties should be used for widenings, even if there will be curb and gutter at the outside edge. Epoxy anchored lane ties should also be used when tying a proposed concrete curb and gutter to an existing pavement edge. Concrete curb and gutter in this situation should be paid as the detail type omitting lane tie bars.

Designers are cautioned against committing the error of calling for a 'D' joint where widening abuts the existing pavement. Obviously, this is an impossibility because the lane tie for a 'D' joint must be embedded in plastic concrete on ***both*** sides of the joint. While this might appear to be a minor error, if not caught in time it requires that Construction negotiate either an extra for epoxy anchored lane ties or a rebate for deleted lane ties.

6.04.09B Deleted

Section deleted.

6.04.09C Flush Surfaces

At one time it was customary to cast concrete base course widening at an elevation such that a minimum one-course surfacing of HMA would achieve plan grade. In the event that the existing pavement was to receive a thicker resurfacing, the inner edge of the concrete widening would be higher than the old pavement. Not only does this method create problems in forming the inner edge of the widening, but worse, the inner pavement has no transverse drainage during construction.

When both the existing pavement and the widening must be surfaced with HMA material, the widening should be cast flush with the edge of the existing pavement. This means, of course, that the thickness of resurfacing needed over the old pavement will determine that to be used over the widening. The use of HMA over new concrete is discouraged, however, unless there are compelling reasons for using it. New HMA over new concrete is a source of added expense, and performance of the pavement section is less than ideal. See Section 6.04.08A.

6.04.09D Standard Plans

Standard Plans R-41, R-42, and R-44-Series show various methods to widen pavements.

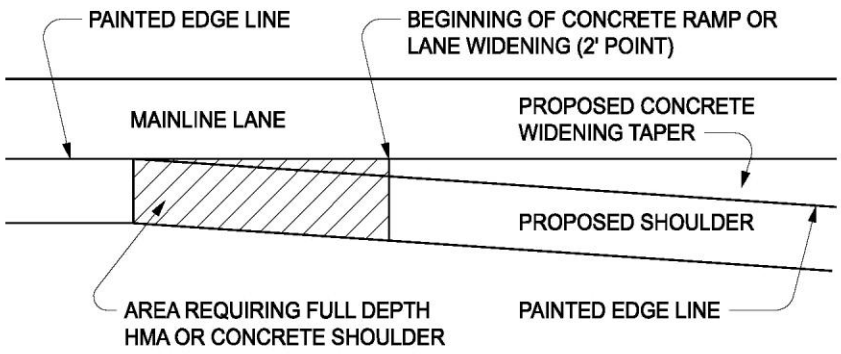
Designers should note the detail on Standard Plan R-44-Series, showing a joint patch adjacent to a proposed pavement repair or widening slab. The intent is to prevent the monolithical keying of the existing pavement to the proposed repair or slab widening which often resulted in corner cracking due to contraction during the first night.

6.04.10 Concrete Tapers

It is characteristic of concrete that thin, pointed tapers will almost always crack and break off. For this reason it previously had been our practice to cast a Concrete Widening Header where the mainline concrete roadway connects to a concrete ramp or concrete lane widening having HMA on aggregate shoulders. Concrete Widening Headers have been found to be very expensive to form, difficult to construct, and a longitudinal crack still forms when this header is used.

Proposed concrete tapers should begin at the 2-foot point. A full depth HMA or concrete shoulder will be constructed from the point where traffic would leave the traveled lane and follow the painted edge line (0 to 2-foot point). The material used in the shaded area below should match the proposed shoulder material.

The painted edge line is typically painted in a continuous straight line from the pavement's edge across the full depth HMA or concrete shoulder and then aligning with the edge of the concrete taper (see sketch below).



6.04.11 Concrete Pavement Overlays

(revised 6-28-2021)

Concrete overlays can be roughly divided into four categories:

1. Bonded overlays of an existing concrete pavement. This is basically a thinner concrete pavement (typically less than 6 inches) poured directly on the existing concrete. Care must be taken to place joints in the overlay within 1-inch of existing joints and cracks. To date, the Department has not constructed such a concrete overlay. Technically, an exception might be the 3 inch thick, steel fiber reinforced, overlay on 8 Mile Rd. in the early seventies. This project failed because of breakup caused by extreme warping, and the pavement has since been replaced.
2. A concrete cap on the order of 4 inches to 6 inches thick, either bonded or partially bonded, probably containing reinforcement and load transfer.
3. An unbonded overlay of an existing concrete pavement. Typically, these are thicker than 6 inches and are separated from the existing pavement by a bond breaker layer. This bond breaker layer is normally a 1-inch layer of HMA. While technically there will be some bonding taking place, the term unbonded is commonly used.
4. Whitetopping, which is a concrete overlay of an existing flexible pavement. Typical thicknesses are greater than 4 inches. When it is less than 4 inches thick, the term ultra-thin whitetopping is used.

6.04.11A Bonded Overlay

While the Department has not constructed a bonded concrete resurfacing, the designer should be aware of what it is, and some of the parameters affecting the design. A reason for using a thin concrete overlay would be to "beef up" a pavement, in good condition and with many years of expected life, to handle increased loads. (Such as might occur if a new heavy manufacturing plant were proposed in a previously low traffic area.) Potholes should be filled with a ready-mixed flowable fill. The thin overlay should be unreinforced, and have transverse joints, both contraction and expansion, matching similar joints in the underlying pavement. Both longitudinal and transverse joints should be sawed to ⅓ the overlay thickness. Bond between the old and the new concrete must be carefully provided for. If such a project is assigned, the designer will be furnished design details by the Construction Field Services Division.

6.04.11B Concrete Cap

The Department constructed about 30 concrete cap projects in the period between 1932 and 1954, with thicknesses varying between 4 inches and 6 inches. While they were moderately successful, it is unlikely this type of construction will be utilized in the foreseeable future.

6.04.11C Unbonded Overlay

This method of pavement rehabilitation provides a new pavement while making use of the old as base and basically involves constructing a new pavement atop the old. The Department completed many such projects since 1984.

While the designer can expect to be furnished details of such construction if a project is ever assigned, it should be noted that, on an I-96 project, from M-66 easterly to the Grand River at Portland, the underlying CRC pavement was sawed into 100 feet long slabs, 7 inches deep sawcut to cut the lowest steel. An 80 lbs/syd (minimum) HMA separation course was used between existing pavement and the overlay. The overlay pavement was 7 inches thick, which necessitated a modified transverse joint design and modified load transfer assemblies. The transverse joints were staggered to keep them at least 3 feet away from joints or open cracks in the underlying pavement.

Some of the obvious disadvantages of a thick concrete pavement overlay are that it raises the level of the pavement sufficiently to render existing guardrail too low, it steepens the foreslope for a few feet beyond the shoulder hinge point, and it usually cannot be used under bridges because of underclearance requirements.

6.04.11D Whitetopping

Whitetopping is a concrete overlay that is bonded to an existing asphalt pavement. In general, whitetoppings are best suited over existing pavements that do not exhibit significant structural distresses, other than where rutting may be present. To reduce curling stresses in the overlay and shear stresses at the asphalt interface, the bonded overlay panels are typically 6 feet by 6 feet It is important that saw cutting occurs as soon as possible. Dowel bars are not used in whitetoppings, but lane tie bars are recommended along the longitudinal joint. Fibers may be considered to control shrinkage cracking. The existing asphalt after milling should be greater than or equal to 4 inches. It is recommended that the existing asphalt pavement be milled to improve bond and reduce rutting.

In 1999, the Department constructed it’s first whitetopping project on M-46 from just east of Carsonville to M-25 in Port Sanilac. It contained two 6 inch sections, one with fiber reinforcement and one without, a small 5 inch transition section, and a 3 inch ultra-thin section in Port Sanilac. The intersection of M-54 and M-83 near Birch Run was also whitetopped in 2000.

6.04.12 Concrete Pavement Patching

(revised 8-24-2026)

6.04.12A References

See Standard Plan R-44-Series, "Concrete Pavement Repair". Also see Section 6.03.04B, Concrete or Composite (HMA on Concrete) Pavement.

6.04.12B General

It is preferable to delay a first-time resurfacing of a concrete pavement as long as possible by patching and joint repair. As the emphasis has shifted from large scale new construction or relocation to improving and expanding the existing trunkline system, and maintaining it, patching and joint repair projects have taken an increasingly larger share of construction dollars.

It is difficult to separate patching from joint repair. Except for construction-induced pavement and base deficiencies, most deterioration of a pavement occurs at the joints, primarily in the transverse joints and, to a lesser extent, in the longitudinal joints and deteriorated transverse cracks.

6.04.12C Distances Between Concrete Patches

The minimum distance between patches should be 8 feet, according to the Standard Specifications for Construction. If less than 8 feet between repairs, the entire section of old pavement should be removed and a longer repair constructed. A note should be included in the plans to this effect. Some judgement should be used, however; if the designer frequently finds that the minimum distance between patches criteria is being encountered, it may indicate that the wrong "fix" has been chosen for the project.

Too many patches per mile is objectionable for two reasons:

1. The motorist visually perceives the pavement to be in bad condition and thus may expect a poor ride even though the patches may actually be quite smooth riding.
2. Excessive patching may indicate that the wrong treatment has been selected and that the money spent on patching could have been better utilized if contributed toward a different type of rehabilitation. A study prepared by Gerald T. Luther in February 1989 concluded that, using a life cycle analysis, about 75 patches per lane mile equates in cost to about 4 inches of HMA resurfacing over a 20-year life span. The HMA project, however, would be ready for total rehabilitation at the end of the 20 years whereas the patched project would still have about seven years of useful life remaining. The Engineering Operations Committee, on March 21, 1989, decided that for design purposes, patches should be limited to a maximum of 60 repairs per lane mile.

6.04.12D Expansion Space to be Provided

Unless the pavement being repaired is to be HMA overlaid, patches and joint repairs should provide 1-inch of expansion space in 1000 feet of pavement. Expansion space is provided by use of Expansion Joint, Erg.

In general, it is preferable to disperse expansion space throughout a project than to concentrate joints at one location. Since most old expansion joints are bound up, providing less than full width relief will only compound the problem. Where the existing joint is an expansion joint, provide a new Erg across all lanes to provide uniform relief. (Do not use an E2 and match the existing joint.) Care must be taken to choose locations where the Expansion Joint, Erg can be placed across all lanes.

6.04.12E Patching Pay Items

The more common pay items applicable to a patching project are:

1.	Pavt Repr, Rem	Square Yard
2.	Saw Cut, Intermediate	Foot
3.	Pavt Repr, Noneinf Conc, [Insert Depth] inch	Square Yard
4.	Lane Tie, Epoxy Anchored	Each
5.	Joint, Contraction, Crg	Foot
6.	Joint, Expansion, Erg	Foot
7.	Joint, Expansion, Esc	Foot
8.	Joint, Tied, Trg	Foot
9.	Non-Chloride Accelerator	Gallon

The following notes clarify the use of these items:

1. **Pavt Repr, Rem**

   The pay item of Pavt Repr, Rem applies to pavement removals from 4 feet (the minimum length of a patch) to 100 feet long. Removals more than 100 feet long are paid for as Pavt, Rem. Removal of concrete shoulders, curb, curb and gutter, and valley gutter are paid for using the same pay item as used for the adjacent pavement.

   It should be noted that Pavt, Rem carries no restriction regarding disturbance of the underlying base, whereas Pavt Repr, Rem does carry a prohibition against disturbing the base, so as to require sawing and lifting methods. Pavement removal for utility cuts, even though unavoidably disturbing the base, should be paid for as “Pavt Repr, Rem.

   If the thickness of the old pavement being removed results in the base being more than 2 inches low, the contractor will be required to bring it up to proper elevation with aggregate. (Concrete would be permitted but payment will be limited to that for aggregate) If the base is 2 inches low or less, or is low as a result of the contractor's removal operation, the contractor must fill the deficiency with concrete at his/her expense. Any disturbed base must be recompacted before casting the patch, otherwise settlement will occur.

2. Saw Cut, Intermediate

Because the pay item Pavt Repr, Rem prohibits disturbing the base, the contractor must lift out the old pavement that is to be replaced. This in turn requires that it be cut up into 6-foot long slabs of a lane width, (a convenient size that will fit a dump truck.) Most repairs occur at a joint or crack where the pavement segment will break into two pieces anyway, but for longer repairs we compensate the contractor for the cost of sawing the old pavement up into 6-foot lengths. For estimating purposes, designers should assume that approximately 75% of the repairs in the over 6-foot to 12-foot range will require one intermediate saw cut. Ten percent of the 6-foot patches should also be set up for an intermediate saw cut. Patches longer than 12 feet (but not exceeding 50 feet) should be set up for one saw cut every 6 feet.

3. Pavt Repr, Nonreinf Conc

The pay item depth for repairs is based on the plan thickness originally specified for the existing concrete pavement plus 1-inch.

If the length of the repair is 100 feet or less, the replaced pavement is paid for as Pavt Repr, Nonreinf Conc, [Insert Depth] inch. If the repair is greater than 100 feet in length, the replaced pavement is paid for as Conc Pavt, Misc, Nonreinf, [Insert Depth] inch.

The texture of the repair should approximate that of the adjacent pavement, e.g., a heavily tined patch in a comparatively smooth textured pavement would not only accentuate the perception of a patched pavement but would provide an audible and tactile discontinuity as well.

4. Lane Tie, Epoxy Anchored

Epoxy anchored lane ties shall be used between the adjoining lanes of full width pavement repairs where the distance between joints exceeds 15 feet and shall be spaced according to Standard Plan R-41-Series. Single-lane pavement repairs, one slab length or longer shall use "Lane Tie, Epoxy Anchored" for that portion of the repair between the joints of the existing pavement. Single-lane repairs greater than 15 feet that are located on curves with radii 3800 feet or less shall also be tied to the adjacent slab. Do not install epoxy anchored lane ties in the offset portion of a tangent repair unless the end aligns with an existing joint or working crack. See Standard plan R-44-Series and Section 6.04.12F for more detailed information.

5. Joint Types

Repairs made in jointed concrete pavements shall be doweled and grouted unless otherwise directed by the Engineer. The transverse joint types used (Tied Joint, Trg, Contraction Joint, Crg, and Expansion Joint, Erg) are specified on Standard Plan R-44-Series. When the repair includes a curb and gutter and an Expansion Joint, Erg, an undoweled Expansion Joint, Esc shall be placed in the curb and gutter portion of the repair.

6. Early Open to Traffic

When requirements for opening to traffic necessitates faster concrete cure times, concrete pavement restoration according to the Standard Specifications for Construction prescribes the use of Grade P-NC concrete. Its use is based on anticipated cure time and minimum flexural strength.

The Engineer may additionally approve the use of Non-chloride accelerators to speed up the setting of concrete. They are used to achieve the shorter end of the intended opening to traffic times for Grade P-NC concrete. When early opening to traffic is anticipated, include a pay item and quantities for Non-chloride Accelerator. For quantities, estimate two gallons per cubic yard of concrete.

6.04.12F Typical Joint Layouts for Concrete Repairs

Concrete pavement repair joint layouts are detailed on Standard Plan R-44-Series to assist the designer in selecting joint types, their location, and placement of lane ties. The designer is responsible to clearly detail the joint layouts on the construction plans. There may be situations where these layouts do not cover a certain situation therefore, judgment must be used to decide the proper layouts.

An Expansion Joint, Erg may be used on the departing joint where a Contraction Joint, Crg is illustrated in the layouts on Standard Plan R-44-Series, but only when expansion is needed and when the joint repair extends across the entire pavement, including adjoining concrete ramps or shoulders. See Section 6.04.12D for maximum allowed expansion space in a given distance.

6.04.12G Reinforcement

The purpose of mesh reinforcement is to hold tightly together any cracks that occur in the repair. Repairs to reinforced concrete pavement are typically reinforced regardless of length. This criterion also applies to concrete base course repairs.

6.04.12H Doweled Repairs

Early concrete pavement patches did not incorporate provision for load transfer across the cold joints at the ends. Primarily, this was because there was no economical method of drilling a large number of holes, necessary for production patching, in the existing concrete. Even as drilling holes became more feasible there were the problems of cleaning out the holes so epoxy grout would bond, getting the grout packed into the hole, and drill bits wearing down so as to produce progressively smaller diameter holes (with a tendency for contractors to use larger drill bits initially, enabling the dowels to move around and rock in the holes). Beginning in about 1983, most pavement repairs were doweled as gang drilling equipment was perfected, and it is now standard practice to provide epoxy anchored dowels as load transfer unless there are extenuating circumstances that would make it unwise.

There are two exceptions to the use of dowels in repairs:

1. When concrete recycling, pavement cracking, or rubblizing is planned within three years.
2. Where a thick overlay (5 inches or more) is planned within three year.

6.04.12I Replacing Previously Undoweled Patches

Pavement patching projects are now starting to include segments of pavement that include previously undoweled repairs, most of which have faulted to some extent. At its meeting on September 20, 1988 the Engineering Operations Committee decided that all undoweled patches, within the projects limits, should be removed and replaced with doweled repairs if the additional cost does not exceed 25%. (It is assumed that this means 25% of the originally programmed project cost.) Undoweled patches in pavement to be HMA overlaid should be repaired as follows:

Severity level, as used below, is a description of the condition of pavement based on the ***Concrete Pavement Condition Survey Manual***.

1. Traffic Volume Range 0 - 5,000 ADT (per roadway)

   Replace all joints and cracks having a distress severity level of 1 with a Detail 8 repair. Remove all cold patch material and loose concrete from all remaining joints and cracks and replace with a Detail 7 patch. All previously placed concrete repairs are to be left as is, except cold milling of concrete repairs faulted more than ¾" is optional.

2. Traffic Volume Range 5,001 - 10,000 ADT (per roadway)

   Repair all joints, cracks, and undoweled repairs having a distress severity level of 1 with a doweled concrete repair. Remove all cold patch material and loose concrete from all remaining joints and cracks and replace with a Detail 7 patch. Cold mill all undoweled repairs faulted more than ½ inch. *

3. Traffic Volume Range over 10,000 ADT (per roadway)

   Replace all joints, cracks, and undoweled repairs having distress severity levels of 1 and 2 with a doweled concrete repair. Remove all cold patch material and loose concrete from all remaining joints and cracks and replace with a Detail 7 patch. Cold mill all undoweled repairs faulted more than ½ inch. *

   * In lieu of cold milling replace all remaining undoweled repairs with doweled repairs if the replacement cost (based on total pavement repair and overlay cost) is less than 15 percent above the cold milling cost.

The use of Detail 8 joint repairs is also intended for the following cases:

1. Overall integrity of the pavement has deteriorated to the degree where load transfer and slab flexure capacity can no longer provide for it to function as a rigid pavement.

2. The pavement has deteriorated such that it can no longer accept the stresses which would be imposed upon it by installation or action of load transfer devices.

3. The expected functional life of the repaired pavement is no greater than 5 years.

6.04.12J Adjusting Drainage Structure Covers in Patches

Whenever a drainage structure cover is located within the limits of a pavement repair, the item of "Dr Structure Cover, Adj, Case 1" should be used. Even though there may be practically a zero adjustment in elevation, the work involved when a structure falls within a patch is almost identical to the work involved in conventional adjusting. Pavement removal around the cover frame will probably loosen the mortar and possibly the first row of bricks or blocks as well. Anything so loosened must be replaced.

If the patch is narrow (6 feet to 10 feet), or if the cover is near one edge, e.g., 3 feet, four #4 re-bars, about 6 feet long, should be laid in a square around the cover to control cracking. This can be included in the other pavement repair items if adequately described.

See Section 6.03.05A.

6.04.12K Longitudinal Joints

Generally, an External Longitudinal Joint is not required between the repair and concrete curbing or shoulders. The only time longitudinal joints are called for when patching, is when more than one lane is patched at the same time.

6.04.12L Patching Utility Trenches

Concrete pavement removal for a utility trench should be at least 4 feet wide, to enable use of a gang drill for boring the holes for dowels. It is important that the contractor not be allowed to drill the holes at an angle as any longitudinal stress on the patch could cause the concrete to fracture in the area of the dowels.

6.04.12M Patching Pavements Having a Concrete Cap

A rather unique situation occurs when there is an attempt to patch a pavement having a concrete pavement cap; special repair measures are required. These special measures consist of:

1. Case 1 Concrete cap over HMA overlaid concrete pavement

   Remove the concrete cap and HMA overlay by sawing both full depth. Leave the original pavement. If the concrete repair is doweled into concrete cap, reinforce patches less than 10 feet long with standard pavement reinforcement having the heavy wires transverse to the roadway. Reinforce patches longer than 10 feet with the reinforcement running the conventional way.

2. Case 2 Concrete cap over concrete pavement (no HMA overlay)

   Remove both the cap and original pavement. The end limit saw cuts should be made as deep as the equipment permits. The remaining original pavement may then be broken in place and removed with a front end loader. Damage to the base should be repaired by placing and compacting additional base material as required. The concrete should be replaced to the thickness of normal uncapped concrete pavement elsewhere on the project or if there is none, to 9 inch thickness. Fill to the bottom of the new concrete with compacted aggregate base. Reinforce patches according to Section 6.04.12F.

3. Case 3 HMA overlay over concrete cap

   Remove the HMA overlay and the concrete cap by sawing both full depth. Leave the pavement under the concrete cap. If the concrete repair is doweled into the concrete cap, reinforce patches less than 10 feet long with standard pavement reinforcement, placing it with the heavy wires transverse to the roadway. Reinforce patches longer than 10 feet with the reinforcement running the conventional way.

   In Cases 1 and 3, removal by other than drilling and lifting may be permitted by the Engineer, since the underlying slab will provide an undisturbed base.

   If a repair contract is contemplated on a pavement known to have been capped, the designer should attempt to identify the exact location of the capped area and its type of construction, so that the plans or log can show the proper repair method for the sequence of the various pavement layers. To avoid disputes in the field, the designer should make their intentions clear as to what is expected of the contractor and how the contractor will be compensated.

   Whether or not the repair can be doweled will depend upon the thickness of the concrete cap, i.e., the existing concrete must be thick enough to allow drilling of the dowel holes without cracking or shattering.

   It should be noted that repairs having a concrete cap or overlay less than 9 inches thick requires more strength prior to opening to traffic because they are thinner. Also because commercial traffic causes higher stresses, the possibility of fracture increases, if the patch is opened too soon to traffic.

6.04.12N Other Pavement Repairs

The technology exists for producing a very high level quality of concrete pavement repairs. Unfortunately, the cost of all the combined treatments can be so high that, under funding constraints, they can not all be utilized on one project. Designers should be aware of the "menu" of the possible treatments, that should be considered when funding and circumstances allow. Some of these treatments are:

- **Partial depth longitudinal joint repair** – Deterioration on either side of the longitudinal joint is milled out no deeper than the tie bars. Any remaining loose concrete is removed and the repair area is cleaned with high-pressure water. A bonding grout is applied to the repair area surfaces and then concrete is cast before the grout sets up. The longitudinal joints, transverse joints, and cracks intersecting the repair, must be re-established by sawing or by compressible inserts. The joints and cracks are sealed with a hot-poured rubber.
- **Spalled joint repair** - The semi-circular spalls occur along one or both sides of a joint, and are only partial depth. Saw the perimeter of the patch as a rectangle at least 2 inches beyond the outside of the spall and associated deterioration, to a depth of 1¾" to 2 inches. Clean out the distressed concrete with a chipping hammer. Place styrofoam along the transverse joint and cast the concrete flush with the surface.
- **Surface pop-outs** - Chip out the area of the pop-out, sand blast the surface, cast a fast set concrete patch material.
- ***Small cracks*** - Saw with an 8 inch diameter random crack saw and seal with hot poured rubber.
- **Re-sealing transverse joints** - Remove existing sealant material and re-saw the joints 1-inch wide to 2¼" deep for pavement with 71-foot and 99-foot joint spacing. Pavements with 27-foot and 41-foot joint spacing may or may not need to be re-sawed depending on the existing joint widths (½ inch minimum). Pavements with less than 20-foot joint spacing can typically just be re-sealed. Install a foam backer rod to the proper depth, blow the joint clean with compressed air, seal with hot poured rubber. In cases where failed silicone sealant is being replaced, re-sealing with pre-formed neoprene can be considered if the joints are in good shape (very little spalling). The joints may need to be re-sawed to the width necessary so the neoprene is compressed approximately 40%.
- **Re-sawing and re-sealing of longitudinal joint** - Saw the joint ⅜ inch to ½ inch wide by 1-inch deep. Seal with hot poured rubber.

These types of treatments are likely to be restricted to early, localized deterioration of pavement in quite good overall condition. With this type of high-cost, high quality treatment, it is recommended that Construction Field Services Division provide Design with a good pavement condition survey before beginning design. The treatment is so finely detailed that it almost must be designed on the project. While the preceding indicates dimensions of joint grooves, etc., the data are given for general information only. Detailed dimensions would be furnished by Construction Field Services Division.

6.04.12O Causes of Joint Deterioration

Deterioration of pavement joints in Michigan can be attributed to five principal factors: 1) freeze-thaw deterioration of the concrete, as evidenced by D-cracking; 2) metal base plates in the load transfer assembly, when present (see Section 6.04.04D); 3) seals inadequate to prevent entrance of water and dirt; 4) high volumes of heavy trucks; and 5) de-icing salts.

Typically, inadequate joint seals allow salt, water, and incompressible material to enter the joint. If the load transfer assembly does have a metal base plate or, in the absence of a base plate the pavement is lying on an impermeable base, the salt-laden water does not drain away rapidly and hastens the deterioration of the lower portion of the pavement slab. The load transfer dowels eventually rust and prevent movement at the joints leading to fracture of the reinforcement at transverse cracks. Expansion and contraction are then accommodated at the cracks which, being unsealed, allow free entrance of dirt and other incompressibles when the pavement is in a contracted state. During subsequent expansion, the room for expansion is taken up by the debris in the joints and cracks, and the pavement actually grows, or becomes longer than when originally cast. This causes high compressive stresses in the concrete. If a joint has suffered a loss of concrete cross-section, the pavement may now be too weak to withstand these high compressive stresses and a sudden and violent shattering may occur at the joint. This is called a blow-up. Blow-ups typically occur during the latter part of the afternoon on a particularly hot day. Blow-ups can result in traffic backups and inconvenience to the motorist and are expensive to repair due to the emergency nature of the situation.

Metal base plates were discontinued around 1965, preformed neoprene seals (combined with shorter joint spacing) have been a major improvement, epoxy-coated load transfer dowels are now standard, and there is increased awareness of a need for more selectivity in the choice and gradation of coarse aggregates to reduce cracking.

6.04.12P Provision for Pressure Relief Joints

To combat the problem of joint blow-ups, the Department launched a program in 1974 to prevent them before they occur. This was initially applied in the old concrete pavements having 99-foot slabs with base plates under the joints, and was accomplished by installing pressure relief joints (PRJ) in pavements that were at the age (10 to 16 years) when blow-ups could be expected to start. This relief was in the form of the PRJ joint and undoweled expansion joints in concrete pavement repairs which are shown on previous Standard Plan II-44F. The PRJ was developed for use in roadways showing signs of expansion pressure buildup, but having long stretches of pavement where repairs were not yet required. Pavements older than 16 years would experience joint failures, too, but usually the concrete in the joint would be in a more advanced state of deterioration such that progressive crushing would occur, without the spectacular results usually associated with initial or widely spaced blow-ups, and with less disruption of traffic.

Pressure relief joints, are now seldom being installed. During the main thrust of constructing PRJ joints, the joint filler was a foam material, usually 4 inches thick and as wide as the pavement depth. Unless in compression all of the time, this joint filler (commonly called "ethafoam", which was a trade name) tended to either float up or to be drawn out of the joint by traffic when the joint opened in cooler weather. More importantly, most all of the pavements needing such pressure relief have already been treated. If pressure relief is needed for a special circumstance, such as at the approaches to a bridge where the pavement may be pushing on the backwall, the designer will be requested to include it and details will be furnished by Construction Field Services Division. Such provision for pressure relief is now in the form of multiples of 1-inch thick expansion felt, incorporated in joint or crack repairs. However, PRJ's with urethane foam have been found to stay in place better than ethafoam because urethane seems to "rebound" after compression. Pavement repair projects are likely to encounter some of these pressure relief joints, which were originally intended to extend the life of the pavement for only about 5 years. Most of these are tightly compressed (on the order of 1-inch wide or less). Any foam extruding above the concrete surface should be removed before HMA surfacing.

Most, if not all, of the problems with blow-ups has been associated with the older 99-foot pavements. The 71-foot slabs, which usually do not have the metal base plate and do have the neoprene seals, have shown a growth rate of about half that experienced with the 99-foot slabs and considerably less deterioration of the lower joint face. The introduction of a large amount of expansion space would allow adjacent seals to loosen and be removed by traffic, hastening the deterioration of the joints. Full-depth concrete pavement repairs should thus utilize expansion and contraction joints as shown in Standard Plan R-44-Series or as recommended by Construction Field Services Division.

Tapered sections, acceleration and deceleration lanes, and concrete shoulders, if tied to the adjacent pavement structure, are to be considered as a full-lane width, and expansion material should be extended through if used in the adjacent main part of the roadway (or consideration should be given to moving the expansion location outside the limits of the variable width portion of the roadway.)

6.05 SHOULDERS

6.05.01 References

A. Various Department Design Guides showing geometrics, particularly shoulder width transitions at ramps.

6.05.02 Glossary of Terms

Flush shoulder - A flat finished shoulder, without curb and gutter that intersects and matches the edge of the adjacent pavement surface. Shoulders with valley gutter are considered flush shoulders.

Graded shoulder - The shoulder width measured from the edge of the traveled way to the hinge point.

Hinge line - The line formed when the plane of the shoulder intersects the plane of the front slope.

Hinge point - The intersection of the shoulder slope with the front slope (also called foreslope).

Shoulder drop-off - The condition where the edge of pavement is considerably higher than the abutting shoulder.

Shoulder ribbon - Paved shoulder surfacing, usually HMA material, placed in a narrow strip adjacent to the traveled lane. Normally, a minimum of 3 feet wide but possibly wider if intended to also be a one-way bicycle path, it serves the important function of reducing the possibility of a shoulder drop-off developing.

Shoulder ridge - An accumulation of excess shoulder gravel that sometimes occurs at the edge of the shoulder adjacent to the front slope. Usually caused by successive shoulder blading operations that tends to dislocate this material to the outside of the shoulder. Such a ridge impedes surface transverse run-off and is particularly difficult to blade back onto the shoulder when it occurs under a guardrail. This condition also occurs naturally over time as vegetation and sand build up adjacent to paved shoulders.

Sympathy crack - A transverse crack that occurs in concrete pavement opposite a transverse joint or crack in an adjacent concrete shoulder. Caused primarily by dissimilar joint spacing in the two pavement structures, but also influenced by other factors, such as relative temperatures at the time of casting and differing reinforcing in the two pavements.

Usable shoulder - The AASHTO 2001 Green Book definition: "...the actual width that can be used when a driver makes an emergency or parking stop. Where the sideslope is 1V:4H or flatter, the usable width is the same as the graded width since the usual rounding 4 to 6 feet wide at the shoulder break will not lessen its usable width appreciably."

The Department's current practice is to extend the outside paved shoulder with 1 foot of aggregate to the shoulder hinge point for stabilization. When widening existing shoulders to meet current standards, this is desirable, but not always feasible.

6.05.03 General

(revised 11-28-2011)

It is the usual practice of the Department to construct hard-surfaced shoulders immediately adjacent to the traveled lanes of state trunklines. There are still many miles of gravel shoulders on the trunkline system, however, so this practice does not mandate that projects be let specifically to pave these shoulders. It is current practice, however, if a resurfacing project is proposed, to include at least a 3 feet shoulder ribbon when the average daily traffic (ADT) is greater than or equal to 750. (See Section 3.09.02)

While existing prime and sealed shoulders are considered as "paved", the Department no longer builds prime and sealed shoulders, except as may be done by the Maintenance Division or by contract as part of heavy maintenance. This means that a 3 feet HMA mat is normally the minimum type of paved shoulder that we would now construct. (Sometimes it is prudent to combine a pavement widening with the laying of a shoulder mat, painting the edge line on the shoulder paving in such a way as to provide 3 feet of paved shoulder.)

Flush shoulders are required on ***new*** urban freeway construction. This requirement does not necessarily apply to urban freeway ***reconstruction***.

6.05.04 Shoulder Width

(revised 1-24-2022)

6.05.04A Freeways

Shoulder widths for freeways and ramps are specified in Appendix 3A.

As a general practice, existing shoulder widths should not be reduced. This is of particular importance when upgrading guardrail as part of the project, as the most recent guardrail shoulder designs may have greater lateral width, than the old. Posts that are 8 feet in length may be used to obtain proper shoulder width in guardrail sections (See Section 7.01.41D).

6.05.04B Paved Ramp Gores

To reduce the need for maintenance in gore areas, additional shoulder paving should be provided to the point in the divergence where the 4-foot ramp paved shoulder and the 10-foot mainline paved shoulder are 8 feet apart. This would typically be a total distance of 22 feet (10 feet + 8 feet + 4 feet) between the freeway mainline and ramp edges. This would still end the surfacing in front of the "Exit" sign. (This practice applies to new freeway construction and may apply to reconstruction and resurfacing, as determined.

6.05.04C Deleted

Section deleted. See Appendix 3A.

6.05.04D Widening Shoulder Paving in Guardrail Sections

A gravel windrow sometimes forms under guardrail during blading operations. Shoulder paving in front of guardrail should be widened to within 1 foot of the rail face to reduce the occurrence of windrows forming in these areas and thereby avoiding the costly maintenance to have them removed.

Standard Widening

The Design Recommendations Committee (December 14, 1995 Committee Minutes) approved the following standard treatment of shoulders in guardrail sections:

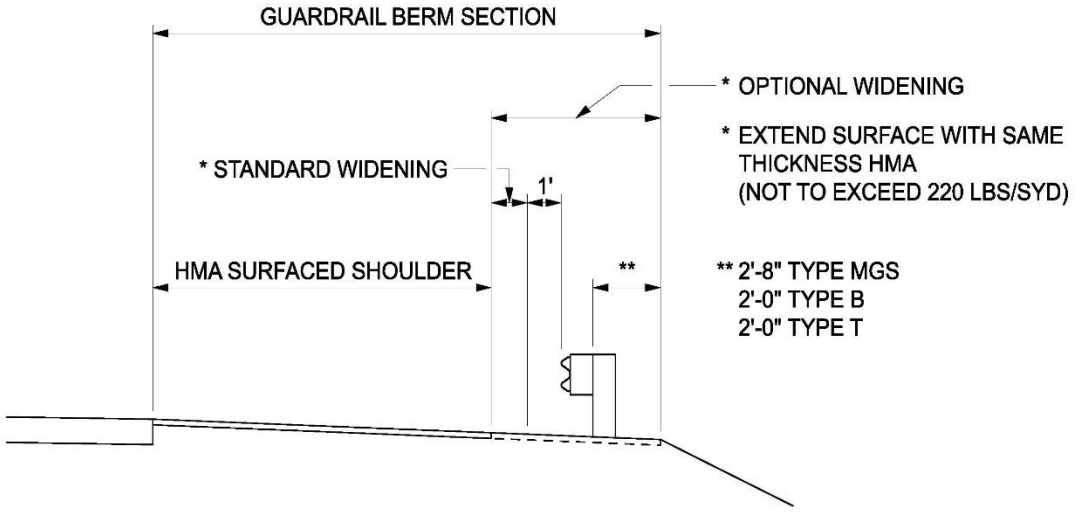
1. HMA shoulders will be paved to within 1 foot of the face of guardrail through areas where the guardrail is parallel to the roadway.
2. Concrete shoulders that are paved full width will not be widened through guardrail areas.
3. Concrete freeway median shoulders (4 feet) will be paved to within 1 foot of the face of the guardrail. The contractor should be given the option of widening with either HMA or concrete.

A 25-foot long transition back to the normal paved shoulder width should begin at the point where the guardrail departs from parallel. A butt joint should be provided at the narrow end of the taper. This transition should be detailed or described on the plans or in the log (See paving transition details).

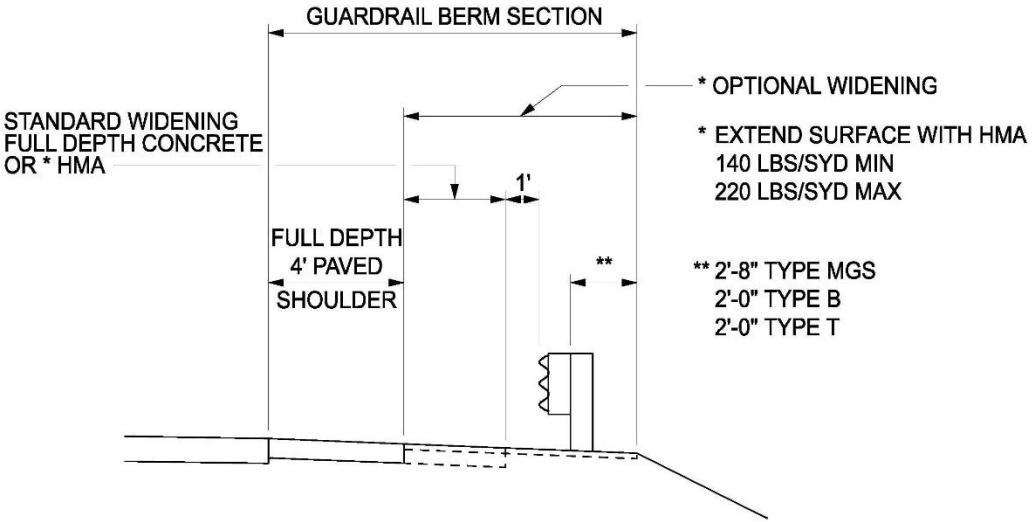
Optional Widening

The Engineering Operations Committee (November 3, 1993 Committee Minutes) has approved the option of extending the HMA shoulder surfacing under the guardrail to the hinge point of the embankment for the purpose of minimizing maintenance in guardrail sections. This option of paving under guardrail is only for new construction or reconstruction projects where new guardrail will be installed. Existing guardrail is not to be removed and replaced for the sole purpose of paving to the hinge point. This option must be specifically requested by the Region/TSC and detailed on the plans.

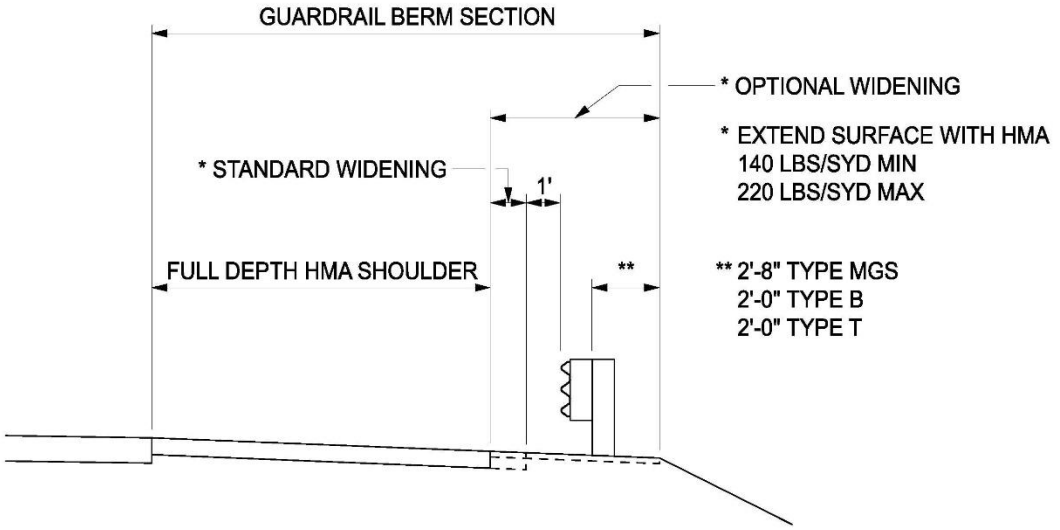
The paving under the guardrail will end at the guardrail flare point or at the end of the non-flared guardrail.



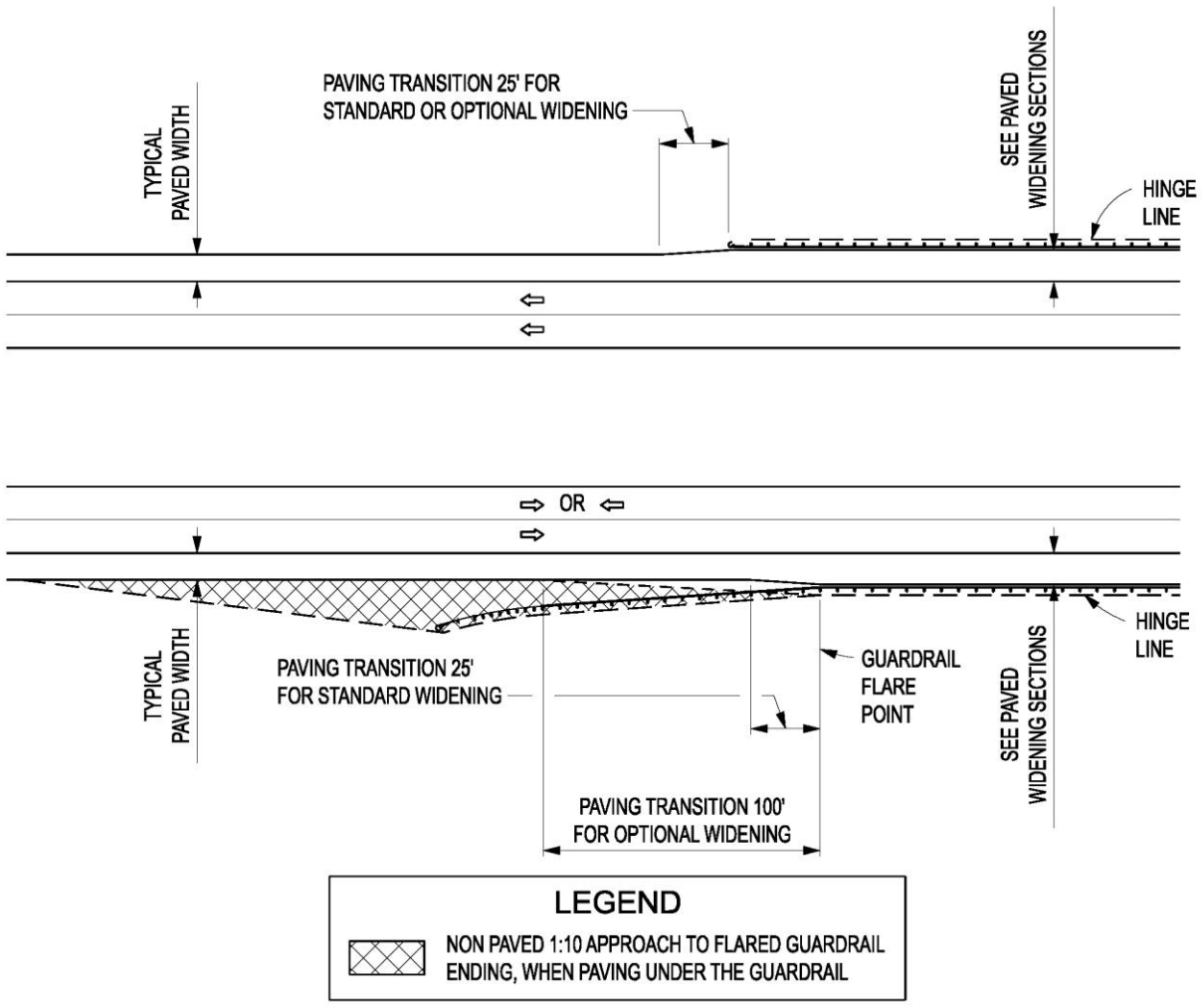
PAVED WIDENING FOR HMA SURFACED SHOULDERS
(220 LBS/SYD OR LESS)



PAVED WIDENING FOR FULL DEPTH
CONCRETE OR HMA 4' PAVED MEDIAN SHOULDERS



PAVED WIDENING FOR FULL DEPTH HMA SHOULDERS



TRANSITIONS FOR ENDING WIDENED SHOULDER PAVING

6.05.04E Adjacent to Truck Climbing Lanes

If possible, the outside shoulder adjacent to a truck climbing lane should be the same width as the normal shoulder, particularly if the climbing lane is long, e.g., on the order of 1 mile. In the case of reconstruction of an existing roadway, where the climbing lane is to be added, this additional width may be very costly to achieve, in which event the outside shoulder should be at least 4 feet wide, and preferably 6 feet wide. Because of the low volume of traffic using the slower outside lane, a parked or disabled vehicle can extend partially into the climbing lane without posing an inordinate hazard or impeding the slow moving traffic.

6.05.04F Adjacent to Auxiliary Lanes

An auxiliary lane, such as might be placed between closely spaced interchange ramps, would normally have the same width shoulder as would be provided elsewhere on the roadway. In the event of limited side conditions, the usable shoulder width may be reduced to a minimum of

6 feet.

6.05.04G Method of Grading Shoulder - Resurfacing Projects

On a resurfacing project, additional shoulder gravel should be called for to bring the shoulders up to grade. There are two methods of grading the shoulders:

1. Maintaining existing shoulder width. This results in a steeper front slope if the proposed shoulder slope is equal to or flatter than the existing shoulder slope. This method is preferable.
2. Maintaining existing front slope. This results in a decreased shoulder width as the front slope is continued up to define the increased thickness of the shoulder material.

It should be determined at the Plan Review Meeting which method is preferable for the project and the plans or log should be clear in indicating which to use. Alternate #1 requires additional fill material for the triangular-shaped added cross-section beyond the shoulder. This may be gravel, topsoil, or earth fill, as recommended by the Region/TSC at the Plan Review Meeting.

6.05.04H With Rolled Curb and Gutter or Valley Gutter

On urban projects, where rolled curb and gutter or valley gutter is used in conjunction with a shoulder, the shoulder width is measured from the edge of the traveled lane and includes the roll curb and gutter or valley gutter.

6.05.04I Berm Behind Curb and Gutter

A berm will always be graded behind a curb and gutter. The width of this berm will be dependent upon available ROW, whether a sidewalk or bicycle path is proposed, and other topographical limitations. This berm is sometimes referred to as a shoulder, although the presence of a barrier curb with a sidewalk all but precludes its use as a refuge for a disabled vehicle. The width of the berm/shoulder, lacking restrictions, will usually be 8 feet, 10 feet, or 12 feet, including the curb and gutter. In an urban cut section, the use of a berm is especially important to control earth sloughing and to reduce the potential for sediment and debris from entering an enclosed drainage system. This berm should be no less than 2 feet wide behind the curb and should preferably be a minimum of 6 feet wide, behind the curb. (See Section 6.05.05E).

6.05.04J Shoulder Ribbon

Shoulder ribbons are generally 3 feet wide for existing 24-foot pavement, and for some 22-foot pavements having low traffic volumes. For a 20-foot pavement, and for some 22-foot pavements, if a decision has been made not to widen it as part of the project, a 4-foot or 5-foot ribbon may be considered at the Plan Review Meeting to achieve a wider lane, with the painted edge stripe located on the shoulder. This latter treatment should include a thickened inner edge to carry wheel loads, unless the shoulder ribbon is somewhat temporary in nature such that a premature weakening or failure would be acceptable. However, in locations where the shoulder is used by bicyclists or pedestrians, designers should consider the effect of narrower shoulders on those users.

6.05.05 Shoulder Slopes

(revised 9-22-2025)

6.05.05A Standard Slopes

Standard slope for gravel- or earth-surfaced shoulders is 6%. Standard slope for paved shoulders is 4%. The rationale for the steeper slope on the gravel or earth shoulder is improved drainage over the rougher surface. No shoulders should be graded flatter than 4% except as may be necessary in superelevation.

The typical cross-section should always show the proposed rate of shoulder slope. Prior to 1983 the rates of slope were expressed on the plans or in the log as fractions of an inch per foot. Since 1983 the rates of slope were expressed as a decimal of a foot per foot until changing to metric system in 1996 which depict rates of slope as a percentage. Thus, 4% replaces 0.04 ft./ft. that was ½ in./ft. and 6% replaces 0.06 ft./ft. that was ¾"/ft. The percentage nomenclature was retained when the Department reverted back the English system.

Non-freeway paved shoulder ribbons (3 feet) and the remainder of the gravel shoulder should be constructed in the same plane with a cross-slope ranging from 4% to 6%. Constructing the shoulder in two planes would complicate maintenance blading and snow removal. Because it is easier and less expensive to make a single pass, the contractor will use the same mix to construct both the shoulder ribbon and the mainline paving. Construction forces should insist that the proper break in slope occur at the edge of the traveled lane, however.

6.05.05B Superelevation

The full superelevation rates of shoulders adjacent to superelevated pavements are specified on Standard Plan R-107-Series. The transition length to full superelevation shall be the same length as that for the pavement.

When transitioning the shoulder slope to/from a bridge section, calculate the transition distance using the superelevation transition slope (∆%) required for the curve, or in tangent sections, use the minimum value for superelevation transition slope (∆%) given in the table in Standard Plan R-107-Series, in the column for the speed of the roadway. (Transition distance = shoulder width x (rate of bridge shoulder superelevation minus rate of road shoulder superelevation) x 100 / ∆%)

6.05.05C Changing Existing Shoulder Slope

Periodic shoulder maintenance may result in changed shoulder slopes, with the greater tendency to steepen them rather than to flatten them, which requires adding material. As part of preliminary engineering for a resurfacing project, the designer should request the Region/TSC to survey the existing shoulder slopes. This is usually done by using a board and spirit level at intervals of 500 feet to 1000 feet, on both sides. This information is useful in computing quantities for additional shoulder material.

If the shoulder slope survey information is more than a year old, the Region/TSC should be requested to verify it or to make a new survey.

Sometimes, particularly in a cut area, an existing aggregate shoulder slope is flatter than the prescribed 6%, as there is no opportunity for maintenance operations to inadvertently grade the material over the shoulder hinge line. Rather than remove and dispose of excess good material, the designer should consider using a finished slope of at least 4% in these areas. It should be clear in the plans or log, however, that additional material should not be brought in to achieve the flatter slope (in the event the shoulders have been regraded to a steeper slope since the survey), because 6% is actually preferred.

When flattening an existing shoulder slope in front of guardrail, the height of the guardrail must be assessed if it is to remain in place. This must be done to determine whether the guardrail will be unacceptably low. The height should be measured directly under the face of the guardrail to the existing ground. Should the height be too low, then it becomes preferable to reconstruct or adjust the guardrail, rather than steepening the shoulder slope beyond 6% to accommodate the existing guardrail. (See Section 7.01.41) As usual, the plans or the log should be clear in portraying the designer's intent.

For Construction on Existing Road project types (freeway and non-freeway), paved shoulder cross-slope may be intermittently increased from the standard 4% to 6% to minimize the change in foreslope or to minimize the need to adjust existing barrier height. It is preferable, when feasible, to maintain a 1:4 or flatter foreslope. Realignment of ditches or backslopes should only be done in extreme cases.

6.05.05D HMA Paver Limitations

Most HMA pavers used on trunkline projects use hydraulically extendable screeds. This affords almost unlimited flexibility in providing a break in slope at the edge of pavement (as when the shoulder and the traveled lane are paved in the same pass), or in changing the slope at any time and in any place. Some of the older machines utilize mechanical extensions to the basic 10-foot long screed, in 6 inch and 12 inch increments. When paving a 12-foot lane and a 3-foot shoulder ribbon with a mechanical extension, the break in slope between the crown slope and the shoulder slope might occur 6 inches onto the shoulder. This is acceptable provided the painted edge line is placed at the normal 12-foot point.

Valleys, such as might be desired adjacent to concrete median barrier, should be avoided because they are difficult to pave and, worse, difficult to roll because of the cylindrical shape of the roller. Such shoulders adjacent to concrete barrier should usually slope in a straight line to the base of the barrier. If there is any doubt as to the feasibility of the proposed paving, the designer should check with Construction Field Services Division.

6.05.05E Graded Berm

(See Section 6.05.04I) Normal slope of a graded berm, whether of normal shoulder width or wider, is 6%.

In a cut section, the berm will slope toward the curb, for drainage.

In a fill section, the berm may slope either toward the curb or away from it. Customarily, it will slope toward the curb if there is the possibility of a sidewalk or bicycle path eventually being built on it. Sloping toward the curb is also preferable from the standpoint of drainage, as it reduces the amount of runoff that may be directed onto adjacent property. Sloping down and away from the curb is usually done when none of these other factors are significant, or where ROW. may be limited.

6.05.06 Selection of Shoulder Surface Types

(revised 6-28-2021)

For guidance as to the type of HMA shoulder surfacing to provide for a project, see the table in the HMA Selection Guidelines, Section 6.03.09.

Freeway shoulders typically employ the same material as the mainline pavement. See Appendix 6A.

Shoulder type on any local roads, constructed or reconstructed as part of the project, will be determined on a location-by-location basis, with input from the local agencies involved.

6.05.07 HMA Shoulder Ribbon

(revised 11-28-2011)

6.05.07A Causes of Low Shoulders

Gravel shoulders typically become low, i.e., exhibit a shoulder drop-off at the pavement edge, because of direct vehicle contact with the shoulder, or because of wind eddies from large passing trucks. These wind eddies blow away the fines and destroy the stability of the gravel shoulder. The narrower the traveled lanes, and the higher the traffic volume, particularly that of semi-trucks, the more pronounced the low shoulder problem can be. Patrol grader maintenance may be required at intervals of only a few days. The HMA shoulder ribbon, usually 3 feet wide, has proven a cost-effective answer to this maintenance problem. Some maintenance personnel state that, with a shoulder ribbon present, routine patrol grading is necessary only once or twice a year.

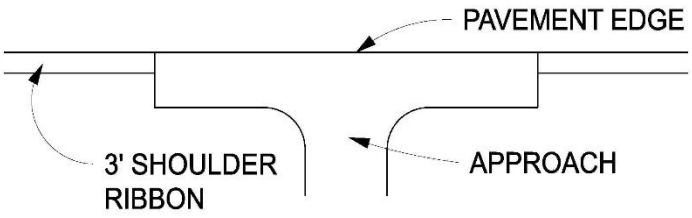
6.05.07B Thickness

The HMA mixture for paved shoulder widths less than 8 feet should be the same as that being placed on the mainline or as recommended by the Region Soils Engineer. When concrete pavement is rubblized, the finished shoulder thickness matches the full depth finished pavement. Guidance for HMA shoulder thicknesses for freeways and ramps are shown in Appendix 6-A.

6.05.07C Construction Considerations

It is preferable to pave narrower shoulders (less than 8ft.) in the same pass as the mainline pavement. This produces a more uniform pavement and reduces the potential for a longitudinal crack to develop at the pavement edge. Since the minimum width of most pavers is 8 feet, constructing the shoulder separately would require a shoulder spreader. This produces less desirable results in pavement quality.

At crossroad approaches the ribbon should ***not*** be carried around the return radius. The entire driving area of the approach is usually paved anyway, and the radius may be too short for the paver to negotiate. If the project is for paving of the shoulder ribbon only, it should be carried across gravel crossroad approaches, as if they were not there. It should be interrupted for paved approaches, however. (See the sketches in Section 12.02.03.)



Occasionally, a crossroad approach will include a paved apron, as shown:

To avoid a misplaced joint line and an undesirable drop-off during construction, any HMA base and leveling course should be paved through for the roadway and shoulder strip combined, followed by the top course for the roadway only, followed by paving of the complete approach.

6.05.07D Aggregate

Use Class I aggregate under the shoulder ribbon. Use Class II aggregate, which has more fines, when an HMA surface will not be used. Full width paved shoulders should have a minimum of 2 feet of aggregate support. See examples in Appendix 6A. Trenched aggregate is often used to reshape the remaining shoulder width if the existing material is acceptable.

6.05.08 HMA Shoulders

6.05.08A Mixtures

HMA shoulders are usually paid for using the same pay items that are used for surfacing the traveled lanes. This reflects the growing practice of paving the shoulder and a lane in one pass. Ideally, or if the shoulder is wide enough to pave in two passes, a separate pay item can be established for the shoulder material, to enable the contractor to obtain a bid price that would reflect the degree of work involved. Also, it is preferable to have a softer material (having a higher penetration) on the shoulder to give it longer life. With one-pass paving, however, it is difficult or impossible to determine a distribution of either material or effort across the width of the pavement plus a shoulder.

See Section 6.03.09 for shoulder treatments. HMA shoulders may be paved in one course if the thickness is 250 lbs/syd or less.

6.05.08B Trenching for Shoulder Construction

Where it is necessary to trench existing material in order to construct the new shoulder, the work is paid for as "Trenching", according to the Standard Specifications for Construction. Measurement is by the station, with trenching on each side of the roadway measured and paid for separately.

Suitable trenched material may be specified for use to replenish low aggregate shoulders outside proposed paved shoulders. Disposal of excess trenched material is at the contractor's expense according to the Standard Specifications for Construction.

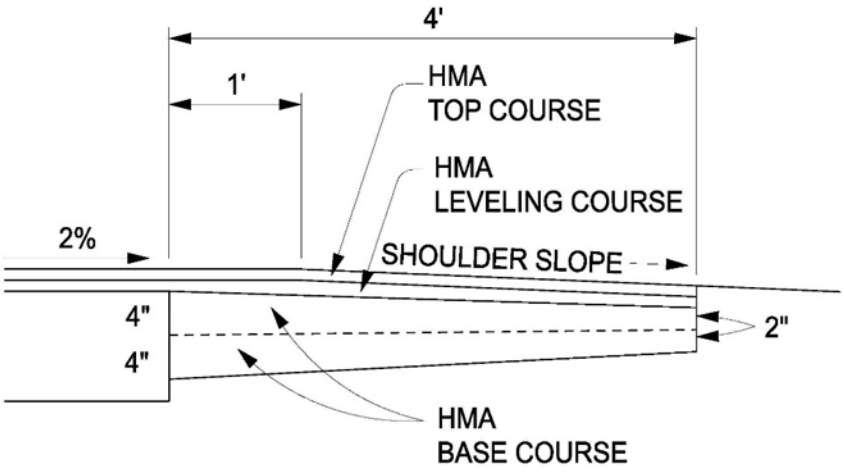
Region Soils should always be contacted for evaluation of existing shoulder materials and condition and for input/recommendations pertaining to proposed shoulder treatments.

See Section 6.05.12, Shoulder Drains.

The method of treatment for varying conditions of existing shoulders will usually be as recommended by the Region Soils and Materials Engineers.

6.05.08C Tapered Thickness

A method of combining a road widening with a paved shoulder involves placing a variable thickness HMA base course shoulder, making it thicker next to the pavement, and tapering it to the minimum shoulder surfacing thickness at the outside edge. There are compaction problems inherent in placing variable thickness HMA lifts, but shown below is a typical method of achieving a 1-foot pavement widening in combination with a 3-foot shoulder ribbon:



Note that the HMA Top and Leveling Course is uniform thickness

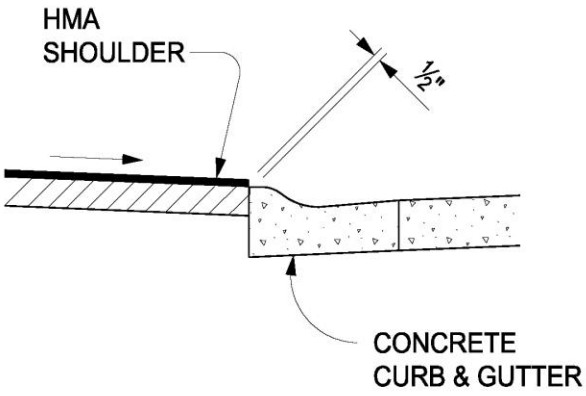
6.05.08D Gravel Windrow Near Hinge Line

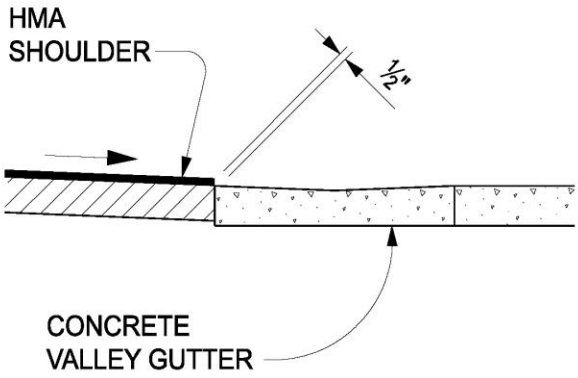
If there is an existing gravel windrow at the edge of the shoulder, it may be possible to ask Maintenance to grade it off prior to construction, perhaps incorporating it back into the shoulder. If the contractor is to remove this ridge, it should be clearly shown on the cross-sections, with instructions relative to what is to be done with the material removed. A special provision will probably be required, indicating whether or not this work is to be paid for and, if so, how it will be measured.

When a windrow builds up under guardrail, it is obviously impossible to simply remove it by grading. Some contractors have devised a plate arrangement, attached to a front end loader, that reaches under the guardrail, shears off the windrow, and then withdraws it for unloading.

6.05.08E Adjacent to Curb and Gutter or Valley Gutter

If there is an existing gravel windrow at the edge of the shoulder, it may be possible to ask Maintenance to grade it off prior to construction, perhaps incorporating it back into the shoulder. If the contractor is to remove this ridge, it should be clearly shown on the cross-sections, with instructions relative to what is to be done with the material removed. A special provision will probably be required, indicating whether or not this work is to be paid for and, if so, how it will be measured.





6.05.08F Deleted

Section deleted.

6.05.08G Existing Sealed Shoulders

It was Department practice from about 1957 to 1973 to place prime and double seal on certain trunkline shoulders. Some of these were paved at 4% (½"/ft.), others at 6% (¾"/ft). When prime and sealed shoulders are encountered on a proposed resurfacing project, the following should be considered:

1. The presence of full shoulder-width sealing does not necessarily mean that the seal should be replaced with a full shoulder-width mat.
2. Scarify/mix the existing seal, outside of the proposed HMA shoulder width, before reconstructing the shoulder.
3. Determine the existing slope so that additional aggregate may be provided if the slope is to be flattened.

6.05.08H HMA “Curb” at Edge of Shoulder

Occasionally, in a cut section combined with a steep longitudinal grade, or in a long guardrail fill section, provision must be made for carrying some surface runoff longitudinally down the paved shoulder. This is done by raising the outside edge of the shoulder to contain the flow. See the sketch and narrative in Section 6.03.16B.

6.05.08I Strip Behind Service Road Curb

Where an urban freeway fence will be within about 5 feet of the service road curb, such as to preclude the use of ornamental plantings, consideration should be given to surfacing the strip with a 170 lbs/syd HMA mat. This surfacing should extend to 1 foot behind the fence.

6.05.09 Deleted

Section deleted.

6.05.10 Concrete Shoulders

6.05.10A General

The first concrete shoulders in Michigan were constructed experimentally in 1971 on three ½ mile segments of I-69 between Charlotte and Olivet. Though some sympathy cracking in the pavement was observed, there was sufficient promise that the concept of concrete shoulders would be a viable and economical alternative to HMA shoulders. This led to other projects in which they were used. Today there are many miles of concrete shoulders on the state's freeway system.

The edge support provided by a full-depth tied concrete shoulder reduces the load stresses in the adjacent pavement and significantly reduces the amount of runoff water reaching the subbase through the joint at the pavement edge.

6.05.10B Compatibility with Adjacent Concrete Pavement

See Appendix 6-A for construction details of concrete shoulders.

Whereas HMA shoulders may be merely adjacent to concrete pavement, concrete shoulders should ideally be tied to the pavement and be similar to the pavement in all aspects of reinforcement, joint type and sealant, and joint spacing. This helps to avoid sympathy cracking that can lead to premature deterioration of the pavement.

It cannot be over emphasized that designers should not neglect this general principle - concrete pavement structures tied together should be as similar as practicable. The only concession to this rule, presently allowed by the standard, is the omission of load transfer in the transverse shoulder joint, an economic trade-off.

6.05.10C Design Considerations

When two-lane pavements are involved, with concrete shoulders, the centerline joint should be designated as a "D" joint on the typical cross-section. This will prevent the contractor from electing to pave a lane and a shoulder monolithically, an option that might be attractive because both slabs are similar. (A "D" joint between lanes is preferred over a "B" joint, other factors being equal.) While the oscillating paving equipment in Michigan is mostly limited to a maximum width of about 26 feet, there might be an incentive to obtain equipment capable of paving two lanes and a shoulder. A "BD" joint should therefore be shown between the lane and the shoulder.

If concrete shoulders are paved integrally with the pavement, the slope of the shoulders in superelevation must be varied according to Standard Plan R-107-Series.

6.05.11 Corrugations in Shoulders and Pavement

(revised 5-24-2021)

Corrugations (also known as rumble strips) provide a visual and audible warning to a driver that their vehicle is either straying off the road or is encroaching an oncoming lane of traffic. Shoulder corrugations also discourage the unauthorized use of the shoulder as a driving lane.

Corrugations are milled into both concrete and HMA pavements. They cannot be formed in. There are two different types of corrugations in use in Michigan; the first being the individual depressions that have been used for decades (herein referred to as “traditional corrugations”), and a relatively new sine wave pattern (herein referred to as “sinusoidal corrugations”, and also known as “mumble strips”). Corrugation cross-sections and locations shall be as detailed on standard plan R-112-Series.

Freeway shoulder corrugations should be used in both median and outside shoulders having paved widths of at least 4 feet. Corrugations are to be included on freeway-to-freeway ramps with the exception of loop ramps, but are otherwise not to be used on freeway exit/entrance ramp shoulders. Corrugations are also omitted where the shoulder is separated from the traveled lanes by a curb and gutter or valley gutter. Freeway shoulder corrugations should be traditional corrugations. Sinusoidal corrugations may be substituted for the traditional corrugations upon evaluation of adjacent land use and discussion with the Pavement Marking Unit.

Existing concrete shoulders might contain intermittent (formed) corrugations that conflict with the proposed placement of retrofit milled corrugations, It should be noted and detailed in the plans that the existing intermittent corrugations should be gapped out rather than milled through.

Non-freeway shoulder corrugations should be used on all rural, 2-lane, 4-lane, and divided trunk line roadways where the posted speed is 55 mph and the paved shoulder is at least 6 feet wide. Non-freeway shoulder corrugations shall be sinusoidal corrugations.

Centerline corrugations should be used on all rural 2-lane and 4-lane trunk line roadways (in both passing and non-passing zones) where the posted speed is 55 mph and the lane plus paved shoulder width beyond the centerline corrugation is greater than 13 feet in width. Centerline corrugations should be traditional corrugations. Sinusoidal corrugations may be substituted for the traditional corrugations where there is either a history of noise complaints from previously installed traditional centerline corrugations or a high anticipated volume of passing maneuvers near residences, and after also consulting Maintenance to discuss the impacts to winter and pavement maintenance practices.

If safety concerns outweigh other issues such as noise and bicycle use, non-freeway shoulder and centerline corrugations can be considered for use on roadways that do not meet the criteria given above. The Region or TSC should contact the MDOT non-motorized coordinator and non-motorized program staff when considering placing corrugations on shoulders paved less than 6 feet wide. When placing non-freeway sinusoidal shoulder corrugations, several modifications to the standard placement shown in standard plan R-112-Series may be applied, and when used must be detailed in the plans. Where the paved shoulder is 3 feet or less or where the paved shoulder is less than 6 feet and has bicycle traffic, the offset may be reduced to 0 inches from the standard 12 inches. Where the lane width is 11 feet or less and the paved shoulder is 3 feet or less, the width of the sinusoidal corrugation may be reduced to 8 inches

from the standard 12 inches. Where the lane width is greater than 11 feet and all available paved shoulder must be maintained due to bicycle traffic or otherwise, the sinusoidal corrugation may be placed as an 8 inches edgeline corrugation.

In locations where horse-drawn buggies utilize the roadway, do not use shoulder corrugations unless a crash history exists. Document this as a context sensitive design decision. When a correctable crash history does exist, consider using corrugations and widening the shoulder 2 feet to accommodate both. Document the decision.

In developed rural areas where driveway density exceeds 30 access points within ½ mile, non-freeway shoulder, edgeline and centerline corrugations may be omitted unless a crash history exists. Document the decision.

6.05.12 Shoulder Drains

With the development of corrugated plastic drainage conduit and prefabricated drainage systems, that can be easily and economically placed at relatively shallow depths, the designer now has a valuable tool for taking subsurface water out from under the shoulder. Many miles of shoulders in marginal soils have been renovated by adding shoulder underdrains, just outside the edge of pavement, and at a depth sufficient to intercept the lateral flow along the plane of the theoretical bottom of subbase.

Circular corrugated plastic drainage conduit is usually a minimum of 4 inches in diameter with 6 inches preferred and is furnished in long rolls that facilitate the plowing-in process. There are several designs of prefabricated drainage systems, but a common one is the "egg crate" configuration, consisting of a hard plastic cellular shape about 18 inches wide and a nominal 1 foot thick. Other widths are available, from 12 inches up to 30 inches to 36 inches, which sometimes have to be used in order to get down to the bottom of subbase. This rectangular section must be trenched-in; it is placed on edge, with the wide dimension vertical, in conjunction with a filter fabric. Both of these types of conduits are outletted through the front slope about every 500 feet, or in sags. The outlets are solid pipe, usually 10 feet of CMP or heavy plastic sewer pipe, with a drainage header at the end.

On new construction, it is now practice to place the prefabricated drainage system directly under the pavement edge, with the width and depth chosen that will allow it to be embedded in the subgrade 1-inch or 2 inches, and to project above the bottom of the open-graded drainage course 1-inch or 2 inches. At one time, it was placed about 24 inches inside the edge of pavement, but this location developed problems because of poor compaction over the underdrain, directly under the pavement wheel track. If the conduit is placed too far outside the pavement, then it falls under the wheel tracks during paving. Circular conduit is centered about 12 inches outside the edge of pavement.

When retrofitting drain to an existing project, the conduit will be trenched or plowed in about 12 inches outside the paved surface, but at a depth as recommended by the Region/TSC Soils and Materials Engineer. It is likewise outletted about every 500 feet. A filter cloth can be incorporated in the plowing-in process.

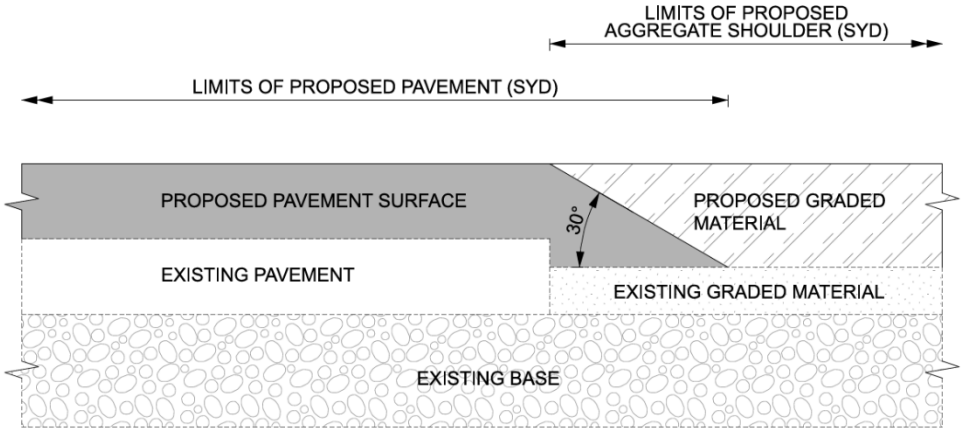
6.05.13 Safety Edge

(revised 6-24-2024)

The safety edge is a beveled pavement edge designed to reduce the severity of vehicle roadway departures and provides increased driver control on re-entry. It is a safer design for motorcyclists and bicyclists, as well as motorists.

On February 6, 2013 the Engineering Operations Committee adopted a policy to incorporate the safety edge.

When the proposed pavement surface and/or proposed graded aggregate shoulder uses square yards as units of measurement, the limits of the respective pay item are to the maximum width of placed material, regardless of depth. This can result in overlap on the plan view between the proposed pavement and proposed graded shoulder at the sloped area of the safety edge. There is no deduction in quantities for either pay item at this location to account for the varying depth at the sloped area when using square yards as the unit of measurement.



The safety edge will be applied as follows for all pavement types:

- **Temporary Pavements -** All newly constructed temporary pavements will be constructed with a safety edge. This includes permanent shoulders that are newly constructed, resurfaced (1½ inches minimum) or widened, and fully or partially used in the course of the same project as temporary lanes with construction speeds of 45 mph or greater. When a safety edge is installed in conjunction with temporary widening that is subsequently staged for removal, construction of a replaced safety edge against the remaining finished shoulder is not required.
- **Confined Edges -** The safety edge should be omitted in those locations where the shoulder is terminated or separated by curb and gutter or valley gutter.
- **Freeway Ramps -** Freeway to freeway ramp shoulders constructed, resurfaced (1½ inches minimum), or widened without shoulder corrugations will be constructed, resurfaced or widened with a safety edge. Regular freeway off and on ramps should not incorporate the safety edge.

- **Narrow freeway shoulders -** (4-foot paved or less) that are constructed, resurfaced (1½ inches minimum), or widened will be constructed, resurfaced or widened with a safety edge.
- **Rural Trunkline –** Trunkline shoulders that are newly constructed, resurfaced (1½ inches minimum) or widened without shoulder corrugations will be constructed, resurfaced or widened with a safety edge where the posted speed is 45 mph or greater .

  The safety edge may be omitted in developed rural areas where driveway density exceeds 30 access points within ½ mile.
- **Safety Application -** If safety concerns are known, the Safety Edge can be considered for use on any roadway or ramp.

Details of the safety edge are shown on Standard Plan R-110-Series. Specifications require that the safety edge be constructed monolithically with the shoulder pavement and that there will be no separate payment for constructing it. Designers should provide additional concrete pay item quantities used for concrete shoulder to construct the safety edge adjacent to concrete shoulder. The locations where the safety edge applies should be identified where appropriate on the typical cross-sections or maintaining traffic details.

The designer should review existing field conditions to identify areas where berming may have developed that would impede positive drainage. Additional details and sperate payment such as station grading modified may be needed to remove the berm.

6.06 CURB AND GUTTER

6.06.01 References

A. Department Standard Plans

1) R-29-Series, “Driveway Openings & Approaches, and Concrete Sidewalk”
2) R-30-Series, “Concrete Curb and Concrete Curb & Gutter”
3) R-31-Series, “Integral Curb and Integral Curb & Gutter”
4) R-32-Series, “Approach Curb & Gutter, Downspouts (For Bridge Barrier on Rural Highways)”
5) R-33-Series, "Concrete Valley Gutter and Urban Freeway Curb”
6) R-38-Series, "Concrete Divider”

6.06.02 Glossary of Terms

Back of curb - The vertical plane of the curb, or curb and gutter, structure, farthest from the roadway.

Barrier curb - In Department usage, a curb having a near - vertical front face of over 6 inches in height. (See definition of mountable curb, below, and further discussion under Section 6.06.05.)

Curb cut - A rounded reduction of curb height such as is encountered for an opening at a driveway or curb ramp.

Face of curb - The vertical plane of the curb structure closest to the roadway.

Face-to-face - The distance between the two front faces of curbs on opposite sides of the street, shown on plans as "f-f".

Gutter pan - The horizontal portion of curb and gutter, i.e., that portion of the curb and gutter structure exclusive of the curb.

Integral curb - (Or integral curb and gutter) - The condition when the curb or curb and gutter is cast monolithically with the concrete pavement structure. When so constructed, there is obviously no visible joint line defining a gutterpan width and so it is impossible, by observation, to determine the nominal width, if any, of the gutter pan.

Mountable curb - In Department usage, a low curb height or having a low sloping or rounded face such as to allow a vehicle to drive over rather easily. (See definition of barrier curb, above, and further discussion under Section 6.06.05.)

Roll curb - (Or roll curb and gutter) - A mountable curb having a broadly rounded curb face that allows a vehicle driving over the curb rather easily.

Traffic control - The use of a linear structure, most often curb or curb and gutter, to visibly and physically define preferred points of ingress and egress to or from areas adjacent to the roadway.

6.06.03 Purpose of Curb and Gutter

Curbs serve primarily to (1) control and direct drainage runoff, and to (2) visibly and physically define the edge of the traveled way. Curbs are used primarily in urban or semi-urban areas. Curbs are not needed in rural areas where flush shoulders are used as a vehicle refuge and safety area immediately adjacent to high speed traffic and where open ditches can be utilized for roadway drainage. Curbs serve other corollary purposes, such as promoting the aesthetics of an orderly roadside development, defining points where vehicles may leave the roadway, and, in some cases, allowing the widest possible roadway use in a restricted Right-of-Way.

6.06.04 Curb Types

(revised 7-26-2021)

Department concrete curb types are shown on Standard Plans R-30-Series and R-33-Series. Details B and D are considered mountable or roll curbs, while Details C, E and F are considered barrier curbs. See further discussions of barrier curbs under Section 6.06.05.

While most curb, used for the purposes described under Section 6.06.03 above, are constructed of portland cement concrete, HMA curbs are sometimes used. See Section 6.03.16.

Some of the earlier city streets in Detroit will have cut stone curbs. These are usually granite blocks, about 4 feet long, and would be classified as straight curbs. Whenever these curbs must be removed, they are usually replaced with our current designed concrete curbs, unless, for some reason, it is wished to retain the "old" character of the stone curb by salvaging them for re-setting and re-use.

Whenever it is necessary to modify a standard type of curb to fit a particular situation, the word "modified" must be included in the pay item, and the curb must be detailed on the plans. An example would be to have a Detail C curb gutter slope ***away*** from the curb face. It would be called "Curb and Gutter, Conc, Detail C, Modified". If the change is of greater magnitude and the curb bears little resemblance to one of the standard curb details, then the reference words "barrier" or "roll" could be inserted in the pay item, as applicable, in place of a detail (letter) designation.

6.06.05 Barrier Curb

(revised 7-26-2021)

With particular reference to Detail F curb and gutter, there has been some blurring of the distinction between a barrier and a mountable curb. The Department considers Detail F to be a barrier curb because of its nominally vertical curb face.

Use of the word "barrier", in reference to a curb, should never be construed as meaning that the curb will provide a means of preventing a vehicle from progressing beyond the line of the curb. A vertical-faced curb approaching 9 inches or 10 inches in height will be somewhat effective in vehicular redirection at reduced angles of impact in the lower speed range.

For curb types and application, see Section 6.06.06C.

6.06.06 Criteria for Use

(revised 11-28-2011)

6.06.06A Gutter Pan Width

The standard plans provide for gutter pan widths (excluding urban freeway curb) of 24 inches, 18 inches, 16 inches and 12 inches (and, of course, no width in the case of straight curb). It is preferable to use the widest gutter pan width possible, up to the 24 inches maximum. As site conditions impose restrictions, such as limited ROW, existing sidewalk, or a row of shade trees, the narrower gutter pan widths will usually be preferable to using a narrower lane width. As a last resort, Detail E curb may be considered. An extreme situation might involve the use 11-foot lanes, with 10-foot center turn lane, and straight curb at the edges. This would require approval from the Geometric section of the Design Division.

6.06.06B High Speed Roadways (50 mph or above)

Generally speaking, curbs are no longer used along high speed roadways when clear zone restrictions apply. Most of the earlier Detroit depressed expressways were constructed with a roll curb and gutter along the right edge, and most of the time along the left edge. Newer expressways, and reconstruction projects on the older ones, now incorporate concrete valley gutter. Roll curb and gutter is frequently used to define the radii of rural crossroad intersections, but these are placed beyond the edge of shoulder and therefore are not adjacent to the traveled way.

6.06.06C Application

- **Detail B** - Detail B curb and gutter may be used for any design speed where high visibility mountable curbs are desired for traffic control and driveway delineation. Typical usage would be at rural intersections on the outside of flush shoulders. (See Section 12.02.03)

- **Detail C** - Detail C curb and gutter may be used where the design speed is 40 mph (35 mph posted), or less, and a barrier curb is desired to inhibit vehicles from leaving the roadway. Typical usage would include locations where sidewalks or obstacles such as light poles, trees, etc., are located close behind the curb; in parking areas; or to match existing curb.

- **Detail D** - Detail D curb and gutter may be used at any design speed where drainage control is the main concern and where roadside or traffic control and driveway delineation are not critical concerns.

- **Detail E** - Detail E curb is a barrier type curb used primarily for traffic control islands or where a gutter pan is not utilized. It is used on service roads in the city of Detroit when the curb can not be tied to a new pavement. When a curb is tied to a new pavement, it is permissible to use the shorter (16 inches depth) curb. This is a specific request of the city of Detroit. See Sections 12.01.04 and 12.01.05. Curb height restrictions will be the same as for Detail C and F curbs and shall be determined by speed and the need for visibility and traffic control.

- **Detail F** - Detail F curb and gutter may be used where a high profile mountable curb is desired and the design speed is 50 mph (45 mph posted) or less. Typical usage would be in areas where Detail C curb and gutter is being replaced or where Detail B or Detail D curb and gutter would not yield sufficient roadside control.

- **Detail G** - Detail G curb and gutter is to be used on urban freeways. See Section 6.06.10.

6.06.06D Unlighted Areas

Generally speaking, it is undesirable to introduce or to use a curb, immediately adjacent to the roadway, in unlighted areas.

6.06.07 Deleted

Section deleted.

6.06.08 Bridge Approach Curb and Gutter

(revised 11-25-2019)

The type, length, and method of drainage at bridge approaches is the responsibility of the bridge designer. The quantities, however, are included in the road plans when road plans are involved.

The designer will need to meet the design spread requirements in the Drainage Manual, including 100% capture (no bypass flows) during the design event at locations where the curbing ends at the approaches to reduce the risk of erosion of the road embankment. The actual spacing and type of drainage capture device (downspout, catch basin, spillway) will be site specific.

Following is a guide to the use of the bridge approach curb and gutter details shown on Standard Plan R-32-Series with a 4 inches maximum curb height. It should be emphasized that this criteria is only a guide and that the designer should use engineering judgement in determining the type of structure to use.

- **Detail 5** - Used on the high ends of bridges where the bridge runoff drains toward the bridge or on the departing ends of bridges when guardrail is not needed.
- **Detail 6 (and 6A)** - Used on the low ends of bridges where moderate amounts of drainage area are involved (<2,500 sft of paved area draining to the curb and gutter) and fills are less than 10 feet high.
- **Detail 7 (and 7A)** - Used on the low ends of bridges where greater amounts of drainage may be expected (>2,500 sft of paved area draining to the curb and gutter) and in fills greater than 10 feet high. One downspout header should be provided for each 3,500 sft (approximately) of paved runoff areas or fraction thereof. If it is not readily apparent whether to use Detail 6 or Detail 7, use Detail 7.

If the bridge railing is other than the standard shape, the approach curb and gutter should be modified or transitioned to fit the bridge curb.

The detail and length of Bridge Approach Curb and Gutter should be shown on the plans, and will be paid for as "Curb and Gutter, Bridge Approach" per foot. The length of the Bridge Approach Gutter, used when the bridge barrier railing extends beyond the pavement seat on bridge, is included in the “Curb and Gutter, Bridge Approach” pay item. The concrete spillway is paid for as a continuation of Bridge Approach Curb and Gutter Detail 6 or 6A. The downspout header in Details 7 or 7A is paid for separately, although the pay length for Detail 7 or 7A includes the length occupied by the downspout header.

6.06.09 Concrete Valley Gutter

Michigan's use of valley gutter goes back to 1968, when it was created in response to an FHWA insistence on flush shoulders on freeways. Initially, it was located where curb and gutter had been used previously, between the travel lanes and the paved shoulder. More recent practice, and that used currently, places the valley gutter on the outside of the shoulder, adjacent to concrete median barrier, if there is one. On the outside, it would be placed adjacent to single face barrier. When there is no concrete barrier on the outside, concrete curb and gutter, or one of the urban freeway curbs, should be used in place of the valley gutter.

6.06.10 Urban Freeway Curb

Standard Plan R-33-Series illustrates an urban freeway curb and gutter, and a concrete valley gutter. Application of these curb details is as follows:

- **Detail G1** - Detail G1 curb and gutter is designed to be used on urban freeways and is to be placed only in cut sections and in front of retaining walls. This curb is to be placed on the outside edge of shoulder to reduce the potential of earth to slough onto the shoulder and also to control drainage. Use Cover W, Standard Plan R-23-Series or any drainage structure cover designed to fit a 24 inches gutter pan.
- **Detail G2** - Detail G2 is similar to Detail G1, except the wider gutter pan allows the use of Cover V, as on Standard Plan R-22-Series.

These urban curb details may be used in other situations when approved.

6.06.11 Integral Curb

See Standard Plan R-31-Series.

Unless otherwise specified in the plans or proposal, the contractor may cast curb or curb and gutter integrally with concrete pavement, at his option. Integral curb has the advantage of eliminating a longitudinal joint and the attendant possibility of water leakage into the subgrade. If widening of the pavement is in the foreseeable future, the integral option should be prohibited. Generally, it would not be used with concrete base course. Designers are cautioned not to inadvertently prohibit the construction of integral curb by failing to list Standard Plan R-31-Series on the note sheet.

6.06.12 Reinforcement

(revised 1-23-2012)

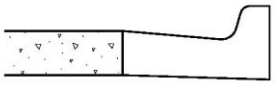
Generally speaking, if the curb and gutter is tied to a reinforced concrete pavement, shoulder or base course, the curb and gutter will be reinforced. Conversely, if it is tied to a non-reinforced pavement, shoulder or base course, reinforcement will be omitted in the curb and gutter.

6.06.13 Curb and Gutter Removal

(revised 1-23-2012)

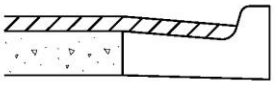
The following five typical cases are to be used where the entire roadway surface is to be removed, together with the adjacent curb and gutter. Pay items, according to the Standard Specifications for Construction, are shown below each sketch:

CONCRETE



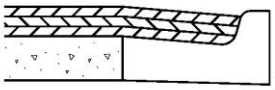
Pavt, Rem
INCLUDES CONCRETE PAVEMENT AND CURB & GUTTER

HMA 12" OR LESS OVER CONCRETE



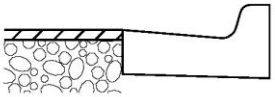
HMA Surface, Rem
Pavt, Rem
INCLUDES CONCRETE PAVEMENT AND CURB & GUTTER

HMA MORE THAN 12" OVER CONCRETE



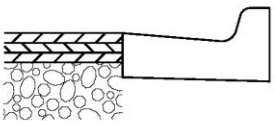
Pavt, Rem
TWO QUANTITIES:
1. ALL OF THE HMA
2. UNDERLYING PAVEMENT AND CURB & GUTTER

HMA 12" OR LESS OVER GRAVEL



HMA Surface, Rem
Excavation, Earth
REMOVAL OF GRAVEL
Curb and Gutter, Rem

HMA MORE THAN 12" OVER GRAVEL

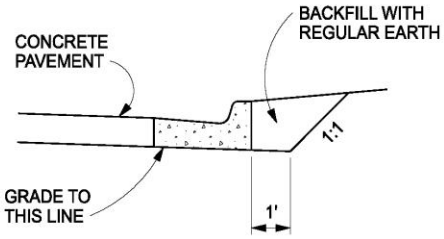


Pavt, Rem
Excavation, Earth
REMOVAL OF GRAVEL
Curb and Gutter, Rem

6.06.14 Grading with Curb and Gutter

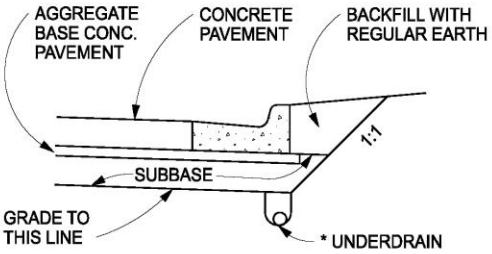
The following sketches illustrate pavement widening with curb and gutter. The grading limits behind the curb would be applicable to new construction as well as to widening.

In a cut section there should be an absolute minimum of 2 feet berm behind the curb, and preferably 6 feet to reduce the potential for earth to slough over the curb, and for debris to collect in the gutter.

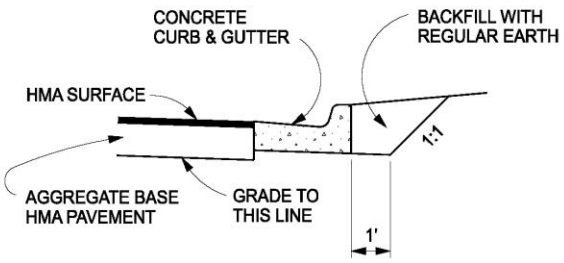


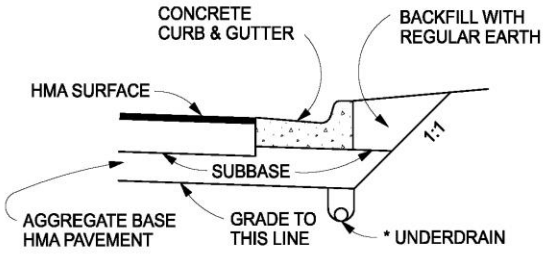
SECTION SHOWING GRADING LIMITS OUTSIDE CURB AND WHEN NO SUBBASE IS USED

(RECOMMENDED FOR SHORT SECTIONS ONLY, UNLESS NATURAL SOILS ARE GRANULAR)

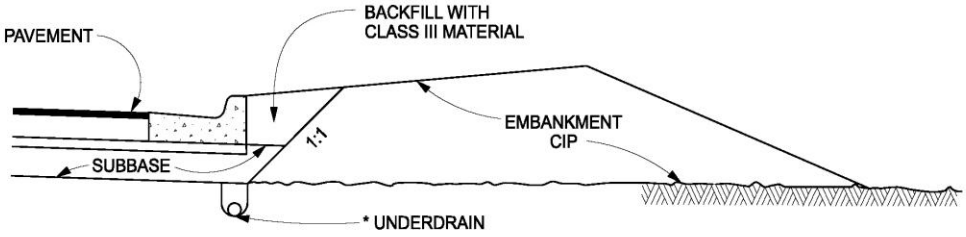


SECTION SHOWING GRADING LIMITS OUTSIDE CURB AND WHEN SUBBASE IS USED





SECTIONS SHOWING FLEXIBLE SURFACE



SECTION SHOWING CURB AND GUTTER IN FILL

* UNDERDRAIN LOCATION MAY BE DIFFERENT FROM THAT SHOWN, OR IF SUBBASE IS DAYLIGHTED THROUGH EMBANKMENT, THE UNDERDRAIN MAY BE OMITTED.

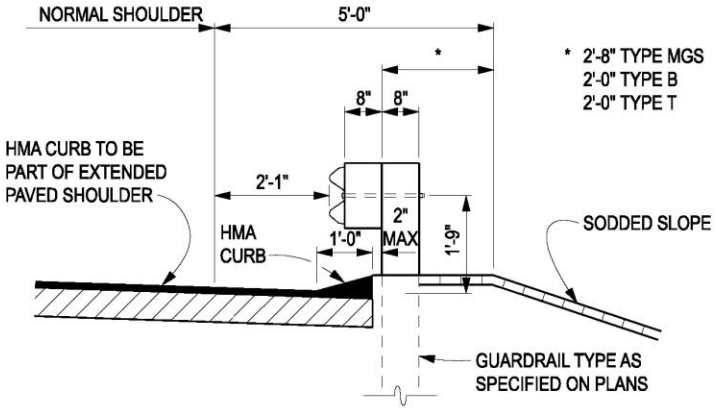
6.06.15 Minimum Curb and Gutter Grades

In lowland urban areas it is frequently difficult to obtain a minimum 0.25% centerline grade and an accompanying minimum gutter grade of 0.30%. In these cases, it is necessary to "roll" the gutter grades to achieve 0.30%. Because of construction tolerances, any grade less than 0.30% makes proper drainage difficult. In critical areas where it is required that this grade be reduced, drainage structure spacing should be reduced accordingly, but under no circumstances should the gutter grade be less than 0.20%.

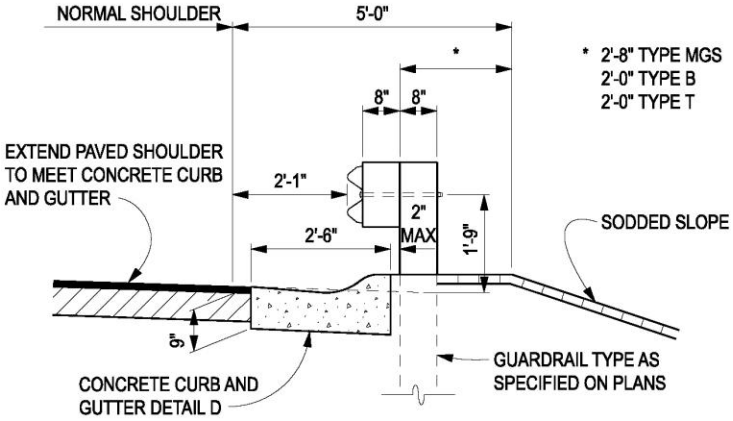
6.06.16 Curb and Gutter for Erosion Control

(revised 1-24-2022)

Long fill sections, usually those requiring guardrail because of their height, are occasionally subject to slope erosion due to concentrations of roadway runoff. This runoff can be controlled by extending the shoulder surfacing and using either a roll curb and gutter, Detail D, or an HMA curb on the outside edge of the shoulder. The placement of the back edge of the curb shall be 2 inches maximum in front of the guardrail post. Concrete downspout headers then conduct the water away. The need for erosion control curb is usually determined at the Plan Review Meeting. The following sketches illustrate this concept.



(HMA CURB)



(CONCRETE CURB & GUTTER)

SKETCHES SHOWING EROSION CONTROL TREATMENT
AT GUARDRAIL EMBANKMENTS RURAL HIGHWAYS

Designers must use some judgment in calling for this type of treatment. It may be necessary to place erosion control curb and gutter on the inside of superelevated curves through guardrail embankments, and on both sides in long tangent sections. FHWA has, in the past, been reluctant to approve widespread use of erosion control curb and gutter; therefore, even if it has been recommended at the Plan Review Meeting, the designer should verify that FHWA has concurred with its use before the Final Project Coordination (FPC) meeting. See Section 6.03.18B.

6.06.17 Concrete Curb Cap

Occasionally a curb will be severely deteriorated or the face exposure lost through repeated HMA resurfacings to the point that replacement of the curb and gutter is considered. If the gutter portion of the structure is sound and if the roadway is not in need of widening, consideration should be given to removing the curb portion of the curb and gutter and replacing it with a new concrete curb, bonded and doweled to the old concrete. A detail must be shown on the plans. Concrete curb cap has generally proven more economical than conventional curb and gutter replacement.

6.06.18 Deleted

Section deleted.

6.06.19 Driveway Openings

The following guidelines apply when a commercial driveway requires curb, unless the driveway rules of the local jurisdiction would conflict:

- **Curbed highways**
  - Roadways with Detail B or D curb, use Detail B for drive.
  - Roadway with Detail C or F curb, use Detail F for the drive.
- **Uncurbed highways**
  - Use Detail B curb unless the adjoining curb types delineating commercial drives are similar to Detail C or F, then use Detail F curb.

Limits of driveway curb construction should coincide with the limits of driveway surfacing construction, but not extend beyond the ROW line unless the driveway construction requires a grading permit.

In general, Detail L curb openings are used at residential drives and Detail M curb returns at commercial drives (as shown on Standard Plan R-29-Series). However, Detail L curb openings may also be used at commercial driveways. Concrete Driveway Opening Detail L is not paid for separately, but included in the pay item of the adjacent type of curb and gutter. “Driveway Opening, Conc, Det M” is paid for by the foot measured from springline to springline. See Sections 12.08.03F and 12.08.03G.

6.06.20 Curb and Gutter Adjacent to HMA Base Courses

Occasionally, an HMA pavement cross-section will be thicker than the curb and gutter, i.e., the HMA will extend considerably below the bottom of the gutter pan. When this occurs, a note should be placed on the plans cautioning the contractor to conduct his operations such as to avoid undermining the curb and gutter.

6.07 CONCRETE DIVIDER

(revised 11-28-2011)

Concrete divider is detailed on Standard Plan R-38-Series, but the width, type and geometrics of the divider must be detailed on the plans. The divider is used to warn the driver of an impending obstacle. It is frequently used in advance of an impact attenuator.

The Geometrics section of the Design Division will advise the designer when a concrete divider is warranted, and will provide the geometric details for the particular site.

6.08 SIDEWALK

6.08.01 Department Position on Sidewalk Construction

(revised 10-20-2008)

On March 29, 2006, Public Act 82 of 2006 was signed into law amending Section 10k of Public Act 51 of 1951. Section 10k requires that one percent of Act 51 funds be expended for construction or maintenance of non-motorized facilities. The amendment allows Act 51 funds to be spent on “the addition or improvement of a sidewalk in a city or village” as eligible Section 10k expenditures.

Sidewalks may be included and paid for as part of trunkline road and bridge construction projects. Through the context sensitive solutions process, the need for sidewalks may be identified, or may be requested by local stakeholders. Regions and TSCs should work with the local agencies to include sidewalks in trunkline projects within a city or village if one or more of the following conditions are met:

1. There is a demonstrated need to include one or more sidewalks along the trunkline
2. There is a reasonable expectation of such need over the design life of the project
3. The community has adopted a non-motorized transportation plan indicating the need for a sidewalk

Maintenance shall be the responsibility of the local unit of government, including liability, removal of debris, snow and ice, and replacement of damaged segments. Any sidewalk construction shall be contingent on a written agreement that addresses ownership, liability and future maintenance being signed by the local agency prior to construction. Sidewalks will seldom be constructed retroactively, but will predominately be in conjunction with ongoing road or bridge work.

For projects where a reasonable expectation of need cannot be determined at the time of design or over the design life of the project, the city or village shall be allowed to construct sidewalks in MDOT right-of-way with their Act 51 or other funds, provided they sign an agreement as described above. Where there is a request or a demonstrated need for a sidewalk along trunkline in a Township, MDOT should work with the Township to enter into an agreement as described above, prior to sidewalk construction.

Sidewalks, curb cuts and driveway aprons removed or destroyed as part of an MDOT reconstruction or rehabilitation project are replaced as part of the MDOT project cost.

6.08.02 Thickness

(revised 5-27-2020)

Concrete sidewalks are normally 4 inches thick. When part of a driveway, it should be constructed to the same thickness as the driveway approach, as detailed on Standard Plan R-29-Series. See Section 12.08.03D.

When it is determined at the Plan Review Meeting that there is evidence of trucks encroaching on curb returns at short-radius intersections or where the potential for encroachment will exist after project completion, the designer should call for 6 inches thick concrete for sidewalk and curb ramps within the return. This thickness can be increased if there is potential for very heavy trucks to encroach on the return.

6.08.03 Reinforcement

Sidewalks are usually not reinforced. Occasionally, a municipality will request the Department to reinforce sidewalk within its limits. If such reinforcing of sidewalk is standard municipal policy elsewhere, the sidewalk may be reinforced at project cost.

The plans should note that 6 in. x 6 in. mesh should be used, with either No. 10 wire weighing 21 pounds per 100 sft or No. 6 wire weighing, 42 pounds per 100 sft, whichever is the municipal standard.

6.08.04 Earth Excavation for Sidewalk

Any earth excavation and backfilling required for construction of sidewalk is included in the pay item for sidewalk.

6.08.05 Curb Ramps

(revised 2-24-2025)

Curb ramps are mandated by Act 8, P.A. of 1973 (amended by Act 35 in 1998), as was the issuance of Standard Plan R-28-Series, “Curb Ramp and Detectable Warning Details". FHWA guidance indicates that ramps be constructed whenever construction involves curb or sidewalk. On May 8, 1973, the Department extended this requirement, by policy to include resurfacing projects that did not ordinarily require the replacement of existing curb or sidewalk.

Federal mandates followed this State law in conjunction with the Americans with Disabilities Act of 1990. The United States Access Board published the Americans with Disabilities Act Accessibility Guidelines (ADAAG) in 1991 and subsequently extended its application to Public Rights of Way in 1994. The Access Board later published the Public Rights of Way Accessibility Guideline (PROWAG) to address accessibility issues specific to public rights of way.

It should be emphasized that there is little permitted reason for failure to place or upgrade a curb ramp on a road construction project if a sidewalk meets a curb in an obvious crosswalk situation. An "obvious crosswalk situation" would be where a sidewalk intersects with the roadway, whether or not there are painted crosswalk lines or a traffic signal present.

6.08.05A Warrants for Curb Ramps and Curb Ramp Upgrades

Based on FHWA guidance, curb ramp construction and/or curb ramp upgrade be incorporated with new construction, and roadway alterations.

- **New Construction** refers to the initial construction of a new roadway facility on a new alignment for which new Right-of-Way is acquired. Curb ramp installation is required and new construction standards are fully enforced.
- **Alteration** refers to changes that affect or could affect the usability of an existing roadway facility. Curb ramp installation and upgrading is required prior to or at the time of a roadway alteration. New construction standards are applicable to the maximum extent feasible.
- **Maintenance** refers to maintenance activities that do not affect the usability of an existing road. Curb ramp accessibility upgrades are not required to be performed in conjunction with maintenance treatments.

The U.S. Department of Justice and the FHWA issued a joint Technical Assistance memo in 2013 to clarify which roadway treatments fall within the definition of an alteration and which are considered maintenance.

Alterations include**:**

- Reconstruction
- Rehabilitation – including cold milling & resurfacing, slab replacement, slab jacking, widening, adding pavement structural capacity.
- Open-Graded Surface Course (open graded friction course)
- Micro-surfacing (includes rut filling)
- Double Chip Seal
- HMA Overlay (regardless of thickness)
- Cape Seal - (Chip seal capped with a slurry seal, micro-surface or other treatment to fill voids in a chip seal).
- In-Place Asphalt Recycling

Other conditions requiring accessibility upgrading include:

- Altered crossings through driveways. See Section 6.08.05F for driveway applications.
- Independent shared use path crossing are treated the same as sidewalks with regard to accessible roadway crossings.
- Installation of pedestrian signals. See Section 6.08.05G.
- Existing curb ramps without detectable warnings but otherwise compliant must be retrofitted with detectable warnings in conjunction with alterations to an existing roadway.

Maintenance includes:

- Crack Filling and Sealing
- Surface Sealing (liquid sealant)
- Chip Seals
- Slurry Seals
- Fog Seals
- Scrub Sealing
- Joint Crack Seals
- Joint Repairs
- Dowel Retrofit
- Spot High Friction Treatments
- Diamond Grinding
- Pavement Patching

Other routine operations where curb ramp upgrades are not required include:

- Signing, pavement marking projects.
- Guardrail/Safety upgrade projects.
- Landscape/Streetscape projects (except where an existing sidewalk or curb ramp is altered)
- Independent Utility Work/Maintenance (except where an existing sidewalk or curb ramp is altered or when work is extensive such that an entire crosswalk is reconstructed)

Two or more maintenance treatments may be combined and still be considered a maintenance treatment. However, if more than one of those treatments contains aggregate and/or filler, the combination will be considered an alteration.

For example a cape seal is an integrated system comprised of two maintenance treatments, a chip seal and a slurry seal. The slurry seal includes aggregate and filler to fill the voids of the aggregate in the chip seal. They combine as an alteration.

6.08.05B Scoping Considerations

If the projects limits include only a portion of an intersection, all ramps within the intersection shall be evaluated for compliance and the project limits extended to include all ramps.

Smaller scale projects such as CPM may still require a Right-of-Way phase to accommodate consent to tie into existing sidewalk outside the Right-of-Way. See Section 5.05.02 for more information on Right-of-Way requirements.

Alteration projects will likely require accurate contour and elevation information prior to designing compliant curb ramps.

6.08.05C Design Standards

Standard Plan R-28-Series details the requirements for ramp width, cross-slope, running slope, landings, curb transition, and detectable warning surfaces. Designers should investigate site conditions in order to determine and design the appropriate treatment for each curb ramp location. Where fully compliant curb ramps are infeasible, compliance is required to the maximum extent feasible. See Section 6.08.05E "Accessibility Constraints". This will require preliminary field work in order to design for maximum feasible compliance.

The curb ramp types detailed on Standard Plan R-28-Series represent some of the more conventional applications. Existing conditions may require variations not shown on the standard. The designer may need to combine the features of two or more ramp types to provide a compliant design.

There are several basic elements that should be incorporated into the design. These are:

1. **Minimum width** (5 feet). The minimum width of 5 feet allows side by side wheelchair passing and is consistent with most sidewalk widths. Sidewalks less than 5 feet wide require a 5 ft. x 5 ft. wide passing space every 200 feet or less. In order to accommodate unavoidable existing width restrictions the PROWAG allows a reduction to not less than 4 feet.

2. **Maximum running slope** (8.3%). The maximum running slope is absolute and therefore a target maximum of 5% to 7% is used to allow for construction inconsistencies. However, the running slope shall not require the ramp length to exceed 15 feet (See Section 6.08.05D "Meeting Existing Sidewalk Grades and Elevations").

3. **Maximum cross-slope** (2.1%). The maximum cross-slope is absolute for ramps at intersections except as stated below. Designers should use a target cross-slope less than the maximum to account for inconsistencies in concrete finishing.

   When resurfacing or reconstructing existing roadways, the ramp cross-slope may be blended to meet existing steeper roadway grades. Significant redesign of an existing cross road to accommodate a ramp cross-slope commonly exceeds the scope of a roadway alteration. The curb ramp cross-slope should be transitioned through the full length of the ramp to minimize abrupt changes. If opportunities within the roadway construction scope of work are available to achieve even partial compliance, they should be pursued.

   For new roadways, the cross-slope of the cross walk must not exceed 2.1% at stop controlled (stop sign) crossings and 5% at signalized and uncontrolled crossings. The cross-slope at mid-block crossings may follow the roadway grade.

4. **Landing -** 5 ft. x 5 ft. minimum, 2.1% max slope in the direction(s) of pedestrian travel. A landing is required at the top of perpendicular ramps. However, if the ramp running slope is less than 5%, it is considered a "blended transition" and does not require a landing. In order to accommodate unavoidable existing width restrictions, the PROWAG allows a reduction to no less than 4 ft. x 4 ft..

5. **Maximum Bottom Counter Slope -** (5% and flush with no vertical lip to the ramp). The maximum counter slope is provided to minimize wheelchair front caster snagging at the bottom of the ramp.

6. **Detectable Warning** - Detectable warnings are truncated domes that serve as surface tactile cues to alert persons with sight disabilities of an upcoming change from pedestrian to vehicular way. The dimensions and location are detailed on Standard Plan R-28-Series.

They are not intended as a way finding device. Square dome alignment within the boundaries of the detectable warning is detailed on the standard plan. However, orientation of the detectable warning surface is relative to placement location. Although preferable, it is not always relative to the direction of travel. Radial alignment is acceptable to match a radial curb alignment.

Detectable warnings are required at the intersection of sidewalks at streets regardless of whether the sidewalk is ramped or flush to the street or shoulder.

In addition to roadway intersections, detectable warnings are also required at mid-block crossings, sidewalk/railroad crossings, and the intersection of sidewalks with controlled commercial driveways (see Section 6.08.05F).

7. **Grade Break Orientation** – The grade break at the curb ramp terminals (top or bottom) should be flush and perpendicular to the direction of travel on the ramp. The objective is to provide a square approach to and from the ramp. The bottom grade break is generally located at the back of curb line for perpendicular ramps. However, it can be located up to 5 feet from one end of a radial curb line in order to maintain a perpendicular orientation (see Standard Plan R-28-Series).

8. **Flared Curb Ramps** - When a sidewalk or pedestrian circulation path laterally crosses the curb ramp, the sides of the curb ramp must be flared with a 10% maximum slope as shown in Standard Plan R-28-Series for Flared Curb Ramps.

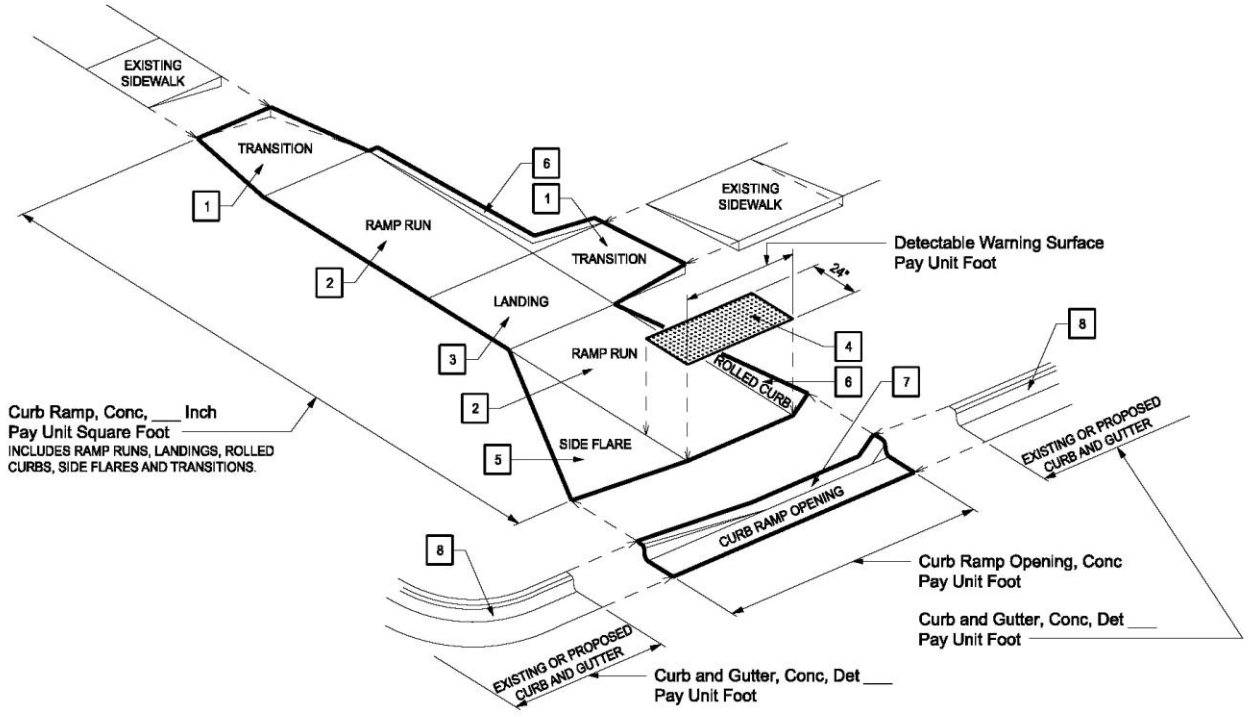
9. **Rolled Curb** - When the side of the ramp borders a non-walking surface such as grass or landscaping or a permanent obstruction, a rolled curb is permitted on the side of the ramp. Rolled curb is not defined as vertical faced or by a specified radius but rather curb not limited by the 10% maximum defined for flared curb. It can be as flat or steep as needed.

10. **Measurement and Payment** - When determining Curb and Gutter, and Curb Ramp Measurements and Payments the following illustration represents the various elements of a curb ramp. It illustrates the breakdown of pay items and their limits of payment.

MICHIGAN DESIGN MANUAL
ROAD DESIGN

Curb Ramp Measurement and Payment Illustration

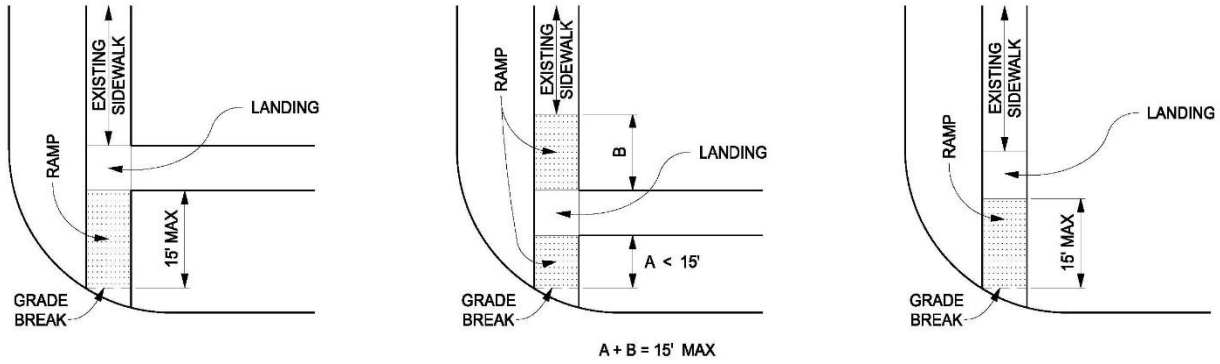
ID	ELEMENT	DESCRIPTION	PAY ITEM
1	TRANSITION	Slab used as needed to transition into existing dissimilar sidewalk cross section (width, depth, cross slopes, etc).	Curb Ramp, Conc, ___ Inch
2	RAMP RUN	Slab(s) carrying ramp running slopes. "RAMP RUN" slabs may combine for a total distance (not including landings and transitions) of at least 15ft. between the back of curb and an existing sidewalk.	Curb Ramp, Conc, ___ Inch
3	LANDINGS	Flat Slab required at the top of perpendicular ramp runs and the bottom of Type P, C and D ramps. See Standard Plan R-28-Series.	Curb Ramp, Conc, ___ Inch
4	DETECTABLE WARNING SURFACE	Truncated dome surface across full width of ramp and 24" minimum in direction of travel.	Detectable Warning Surface
5	SIDE FLARE	1:10 maximum transition flares along walkable surface perpendicular to ramp runs.	Curb Ramp, Conc, ___ Inch
6	ROLLED CURB	Rolled curb (no maximum rate) along non-walkable surfaces adjacent to ramp runs. Also used for ramp infield grading retention up to 18 inch height.	Curb Ramp, Conc, ___ Inch
7	CURB RAMP OPENING	Flattened curb and gutter at ramp opening including transitions to and from full height curb and gutter cross section.	Curb Ramp Opening, Conc
8	CURB AND GUTTER	Full height curb and gutter. Paid separately when called for on the plans.	Curb and Gutter, Conc, Det ___



6.08.05D Meeting Existing Sidewalk Grades and Elevations

Sidewalk grades generally tend to follow the grade of the bordering street. When the existing sidewalk grade is steep, it becomes more difficult to comply with the maximum curb ramp running slope of 8.3% without “chasing grade” to meet the existing sidewalk. In some cases it results in an infinite run. Excessive ramp runs might also result when the existing sidewalk is at a significantly higher elevation than the adjacent road.

When this occurs, the maximum running slope may be exceeded in order to limit the ramp length(s) to not more than 15 feet measured from the ramp grade break. The need to exceed the maximum slope must be documented (See Section 6.08.05E). The 15 feet limit on ramp length does not include the landing or transition slabs to tie into the existing sidewalk. Three examples are illustrated:



Unlike other maximum dimensions, the 15 feet limit is not absolute. If compliance with the maximum running slope (8.3%) can be achieved by extending the ramp by one or two flags of sidewalk beyond the 15 feet limit, it should be considered within feasible limits.

A landing is required at the top of perpendicular ramps. However, if the ramp running slope is less than 5%, it is considered a “blended transition” and does not require a landing.

6.08.05E Accessibility Constraints

When it is infeasible to meet all standard compliance elements, meet the standards to the maximum extent feasible. The curb ramp elements are not listed in any order of preference or importance. Order of importance may vary for each site location. Documentation of infeasibility is not applicable for new roadway construction where full standard compliance must be achieved.

A strict definition of “feasible” is not provided since the potential circumstances for each installation is limitless. Some circumstances of infeasibility are clear such as impacts on structural integrity of surrounding features, or an inability to adapt to existing immovable or unalterable conditions. Other circumstances such as real estate limitations and historic preservation can also represent infeasibilities.

While cost is not itself an acceptable argument for noncompliance, scope can be a prevailing factor. If certain significant efforts required to meet the standards are not otherwise called for in a project, it may be an infeasibility. Examples would be utility relocation or the acquisition of Right-of-Way for a roadway alteration project. If utility relocation or Right-of-Way acquisition is not required in the project for any other reasons, then it is preferred but not required that the same efforts be made solely for ADA compliance. See Section 5.05.02 for more information on fee, easement and consent requirements for sidewalks.

Provide safe refuge for the pedestrian (when possible) when full compliance is infeasible and compromises are necessary. Flush transitions and flatter entrances or a marked refuge area in the pavement allows persons in wheelchairs to leave the vehicular way prior to traversing possible steeper ramp grades or cross-slopes that result from infeasibility.

Follow engineering judgment when determining the correct balance to provide maximum extent feasible. Compromises may be needed for more than one standard element. If full compliance is infeasible, strive for maximum overall improved accessibility. Do not overcompensate to favor one element. Over emphasis on a single element may cause a reduction in overall accessibility in comparison to the original condition.

Document accessibility constraints using MDOT Form 0370 ADA Statement of Accessibility Constraints. The documentation should include location, non-compliant element(s), reason(s) for infeasibility and maximum extent feasible. Complete, review, and stamp the Form 0370 by the Designer (MDOT Design or a consultant) and the MDOT Project Manager, respectively, to document design decisions using the “Reviewed” stamp. Note: When this arrangement is unable to be facilitated, or when the Designer and MDOT Project Manager are the same individual, identify a different reviewer (i.e. the Associate Region Engineer – Development or the Project Manager’s supervisor) to stamp the form, as appropriate.

Retain Form(s) 0370 ADA Statement of Accessibility Constraints in the “ADA Documentation” folder within ProjectWise per MDOT record retention requirements as justification to address possible future inquiries and/or claims. Send an email (including the ProjectWise Project folder link) to MDOT-ProjectWise@michigan.gov requesting the “ADA Documentation” folder be created in ProjectWise. This folder will be utilized by MDOT teams and applicable external Design and Construction teams and has been configured to comply with the record retention schedule of all documents contained within. Place each Form 0370 within this folder with the following file name format: “0370_‘Location’_YYYY-MM-DD”. For example, “0370_28th St & M-96 SW_2020-07-13.pdf.”

6.08.05F Driveways

When project work alters a driveway that crosses a sidewalk or alters the sidewalk abutting a driveway, the crossing through that driveway must be ADA compliant. Sidewalks are normally continuous through residential driveways and don't require either curb ramps or detectable warnings. However, commercial driveways with curbed returns may present a barrier that requires a curb ramp.

Detectable warnings at commercial driveways are only used when the crossing is signalized or stop controlled with a regulatory stop sign. When this level of traffic control is needed, the driveway presents more of a street-like encounter for persons with sight disabilities and therefore warrants detectable warnings. Otherwise only the curb ramp is required. Overuse of detectable warnings cause misinformation for persons with sight disabilities.

The path crossing through the driveway must meet the standards for sidewalks including width, slope and cross-slope. If continuous sidewalk construction or reconstruction is not in the scope of work, a short transition may be required to meet the existing sidewalk cross-section at either end of the driveway crossing.

6.08.05G Curb Ramp Location

Federal Code 28 CFR, Part 36 states;

"4.7.1 Location. Curb Ramps complying with 4.7 shall be provided wherever an accessible route crosses a curb."

As stated earlier in this section, there are few permitted reasons not to provide curb ramps where a sidewalk crosses a curb. The absence of signals or marked crossings is not sufficient justification to exclude a curb ramp.

However, there are some circumstances, both obvious and obscure, that may affect the determination of curb ramp need and location.

- **Absence of Sidewalk**

  In most cases the absence of sidewalk (existing or planned) coincides with exemption from the requirement to provide curb ramps. The ADA does not require the installation of ramps or curb ramps in the absence of a pedestrian walkway with a prepared surface for pedestrian use. The ADA also does not require the provision of sidewalk where none currently exists. However, certain circumstances may require some minimum treatment for a quadrant without sidewalk.

  The installation or presence of a pedestrian signal (whether pedestrian activated or not) suggests implicit intent of pedestrian travel. Accessibility from the road to a pedestrian activated signal would be required despite the absence of sidewalk. This may include curb ramps and an accessible path to a level surface at the push button. Where signals are not pedestrian activated and sidewalks are not present, the vertical portion of any curb should be gapped to provide a minimum 5 feet wide clear opening to the implied path. See Section 6.08.05H for information on Traffic and Pedestrian Signals.

- **Evidence of Pedestrian Travel**

  Where sidewalk is not provided or planned at either side of a street crossing but there is evidence of pedestrian travel (worn path), a curb ramp is not required. However, the vertical portion of any curb should be gapped to provide a minimum 5 feet wide clear opening to the path.

- **Prohibited Crossings**

  Where a sidewalk meets a road and pedestrian crossing is prohibited, a curb ramp is not required at either side of the road. The end of the sidewalk should be delineated by both visible and tactile cues. A sign should be provided prohibiting crossing for all pedestrians. The tactile cue must be either detectable by cane or foot. A barrier approximately six inches in height can be detected by cane. Since a barrier is not always practical or context sensitive, a planted or gravel strip between the end of the sidewalk and the curb can serve as a tactile indication of the end of the pedestrian path. The strip should have a minimum dimension of two feet in the direction of travel.

- **Detrimental Crossings**

  As previously stated, the absence of cross walk markings or signals does not imply an exemption for the provision of curb ramps. However, even where crossing is not expressly prohibited but is clearly not intended, circumstances may make it prudent to exclude ramps leading to undesirable crossing points. As with prohibited crossings, it may be desirable to end the sidewalk by separating it from the curb with a planted or gravel strip to provide underfoot detection of the path's end.

  Examples of undesirable crossing situations are at mid-block locations or three legged intersections where crossings may lead to or near driveways. Turning traffic from driveways may not expect pedestrians where a crossing is not clearly marked. The same may also be true where cross roads are slightly jogged across the mainline roadway. An unmarked crossing that is offset too far from an intersection may cause a hidden vehicle/pedestrian conflict.

  Logical crossing opportunities should be selected at reasonable intervals that provide safer direct corner-to-corner crossing. It may be acceptable at times to direct pedestrians to a safer alternate quadrant or nearby intersection.

  When evaluating crossing intent, high consideration should be given to providing ramped crossings to public service destinations such as public transit stops, schools, hospitals, libraries, post offices, etc.

6.08.05H Traffic and Pedestrian Signals

While signal maintenance does not warrant a curb ramp upgrade, new signal installation might. Circumstances requiring curb ramp installation or upgrade in conjunction with signal installation include:

- Alteration to existing sidewalk/curb ramp.
- Absence of a curb ramp where a sidewalk is curbed at the street intersection.
- Absence of a curb ramp where a crossing is served by a pedestrian signal (with or without sidewalk).

See Section 6.08.05G for signal accessibility in the absence of sidewalk.

Existing ramps may remain in place without upgrade if they are not otherwise altered by the signal work.

For roadway alteration projects without signal work, consideration should be made to improve accessibility to push button signals. If the curb ramp is to be upgraded, designers are encouraged to extend paving to provide access to pedestrian activated signals where access is not currently provided.

Curb ramp construction should not reduce the existing level of accessibility of the existing pedestrian signal.

ADA requirements for pedestrian push button signals are addressed separately in Traffic and Safety standards and guidelines. ADA requirements for signal upgrading apply in conjunction with alterations to external components of the signal. Sidewalk or curb ramp construction alone does not activate a requirement to upgrade the signal.

6.08.06 Building Entrances

(revised 11-27-2023)

When constructing or reconstructing a public sidewalk, access to adjacent buildings might be impacted. Adjusting grade or cross-slope on the sidewalk can change or compromise connectivity to adjacent buildings.

Accessibility requirements and responsibilities differ between public and private entities. In general, access to buildings that abut or encroach on the public Right–of-Way is the responsibility of the building owner. The building owner is accountable for accessibility under Title III of the ADA if the building provides services or accommodations to the public. When constructing sidewalks, the Department’s responsibility is to construct sidewalks and street crossings compliant with the ADA under Title II. Private residences that do not serve the public are not regulated by the ADA.

While the building owner is responsible for ADA compliance, the building owner may be entitled to restitution or compensation under the Uniform Relocation Act (URA) of 1970. When obtaining the Consent to Construct Sidewalk, Region Real Estate should discuss both temporary and permanent access with the property owners. See Section 5.05.02.

6.08.06A Building Access Alterations

When steps or ramps are removed or altered by sidewalk construction, The Department will offer to reconstruct or restore them. To promote accessibility, the proposed replacement will be one that is compliant with ADA Title III to the extent feasible. The designer should consult the Roadside Development Unit for ADA building access requirements and accessibility options. The work necessary to make the facility accessible is eligible for federal participation.

The Department is not a Title III enforcement agency. If a property owner refuses a compliant replacement, the Department will honor the owner's preference and document the refusal. When an owner's preference of steps over ramps is accommodated, ADA guidelines for steps will be followed to the extent feasible.

The feasibility of accommodating private access will be based largely on structural and spatial limitations. If the installation of an ADA-compliant private access compromises the accessibility of the sidewalk, this may be a basis for a determination of infeasibility for full compliance of the building access.

In all cases, replaced access to a building entrance must not be made less accessible than the previous existing condition. If restoration to the existing level of accessibility is infeasible, the building owner may be entitled to compensation for the loss of the entrance. The compensation would be a Real Estate action and ADA compliance remains the owner's responsibility.

Existing building access can also be replaced by the property owner, under the provisions of existing permits, without action by MDOT. New installation of stairs/ramps undertaken by the property owner in public Rights-of-Way would require a permit. In all cases, stairs/ramps once constructed become the responsibility (ownership and maintenance) of the private property owner.

6.08.06B Historic Buildings and Districts

Historic Preservation laws must be taken into consideration when altering access to a building entrance. The replaced access must not threaten or destroy the historic significance of buildings or districts. Historic preservation requirements supersede ADA requirements and may constitute an ADA compliance technical infeasibility.

Obtaining permanent easement or fee purchase in order to meet ADA requirements in an historic district is considered a threat to historic significance. Therefore, any alterations must be made within the Right-of-Way or by obtaining consent to construct sidewalk. See Section 5.05.02 for consent to construct sidewalk.

If buildings appearing to be 50 or more years in age are located on the project, contact the appropriate Historian in the Bureau of Development Environmental Services Section early in the planning/scoping process. If the Historian verifies historic properties or districts are present, a determination of impact will be made. Designers should work with the MDOT Historian and the Roadside Development Unit to ensure the viability of alternatives and to gain consensus on the strategy to maximize accessibility. An on-site review with all stakeholders held early in the process can expedite the resolution of conflicts. Depending on the severity of the impact, the Historian may need to subsequently coordinate with the State Historic Preservation Officer (SHPO) to assess the impact and discuss alternatives.

6.09 PAVEMENT CROWNS AND CROSS-SLOPES

6.09.01 Department Practice

The Department uses the 2% crown slope shown on Standard Plan R-107-Series, with the high point of pavements located as follows:

- 2 or 4 lanes undivided locate at center
- 5 lanes undivided locate at the edge of an inside lane
- 4 or 6 lanes divided locate one lane in from the outside
- one way (ramp) locate at one edge

The same crown is used for both concrete and HMA pavements.

Occasionally, a local agency will request a different crown for a road that will eventually be under its jurisdiction. The Department attempts to comply with these local agency requests.

Bridges are normally crowned at the same cross-slope as the road, subject to local preference, when applicable.

The high point should always be at a lane line. Designers working on projects involving some older freeways built in the era from the middle 'fifties to about the middle 'sixties will encounter the high point in the middle of a lane. (Some 24-foot pavements had the high point located 6 feet from the median edge, a provision for the addition of a future third lane on the median side.)

6.09.02 Crown Modification in Urban Areas

Sometimes, in the reconstruction of urban streets, it is necessary to tilt the pavement to meet sidewalks and other side controls. Or, when the area is very flat, the pavement cross-slope must be varied to achieve minimum gutter grades steeper than the nominal grade of the road centerline. The following basic approaches are available to avoid causing flat spots.

The crown can be modified by offsetting the high point from the centerline to another point on the cross-section. The cross-slope can be varied according to Section 3.04. The HMA pavement can be milled or partially milled to establish the desired crown. Or, a combination of these methods may be used.

In any case, the designer should study the independent gutter grades and other side controls to determine the best method of modification to the crown. Consult the Geometrics section of the Design Division for crown modification.

6.09.03 Crown in Superelevation

Crown in superelevation should be modified as shown on Standard Plan R-107-Series. Generally, crown or adverse cross-slope is eliminated in superelevation. Many older pavements, particularly those of concrete, will be encountered where the crown was retained throughout the curve. This was a concession to paving equipment of the era that did not possess the capability of in-motion adjustment of the screed.

6.10 PAVEMENT SURFACE TEXTURE

6.10.01 Friction Number

The Department has a program for testing the friction levels of all state trunkline pavements, with particular attention given to those locations experiencing a greater than normal rate of wet pavement crashes. Testing is done by using a calibrated trailer, usually traveling at 40 mph, with brakes locked, on a wetted surface. Results are in the form of a friction number that may vary between the approximate extremes of 0.10 and 0.80, the higher values representing higher friction levels.

Generally, friction numbers from different states cannot be directly compared, although they will appear to be similar. The FHWA has made an attempt at standardization by constructing a field test and evaluation facility in Ohio, to which the states are invited to bring their equipment for calibration.

6.10.02 Conventional Methods of Creating Pavement Texture

Concrete pavements were formerly textured by means of a burlap drag during the paving process. This texture did not last long so the current method of transverse wire tining evolved, though burlap or Astroturf may still be used ahead of the tining. The rather deep grooves lengthen the effective life of the texturing.

For vehicles traveling at low speeds, the most skid resistant HMA pavements are those having a "sandpaper" texture obtained by using hard, sharply pointed fine and coarse aggregate. Unfortunately, these materials are not plentiful, so trade-offs are made incorporating coarse aggregates for durability and locally available fine aggregates for economy. Coarse aggregates with a high tendency to polish are avoided for top course surfaces on high-traffic volume HMA pavements. (See Section 6.03.10D) For vehicles traveling at highway speeds, both sandpaper and coarse textures are important. Coarse texture is provided by control of aggregate gradation.

6.10.03 Pavement Grooving

(revised 9-27-2021)

Sawed pavement grooves 0.12 inch (±0.03 inch) wide by 0.16 inch (±0.03 inch) in depth and 0.75 inch (±0.05 inch) apart may be either transverse or longitudinal. The problem that they are to alleviate determines the groove direction. Although the tendency to hydroplane may be reduced by grooves oriented in any direction, longitudinal grooves are almost always used because of their lower cost. The grooves provide space for water to exit under pressure of the vehicle tire, in effect compensating for the lack of tread on a smooth tire. Transverse grooves are used principally at signalized or "stop" intersections to provide a better gripping surface. They also produce a different tire noise that serves as an audible warning to the driver, at the approach to the intersection.

A special provision 20SP-603A is available that uses the pay item "Longit Grooving of Conc Pavt", measured in square yards, based on the full width of the pavement.

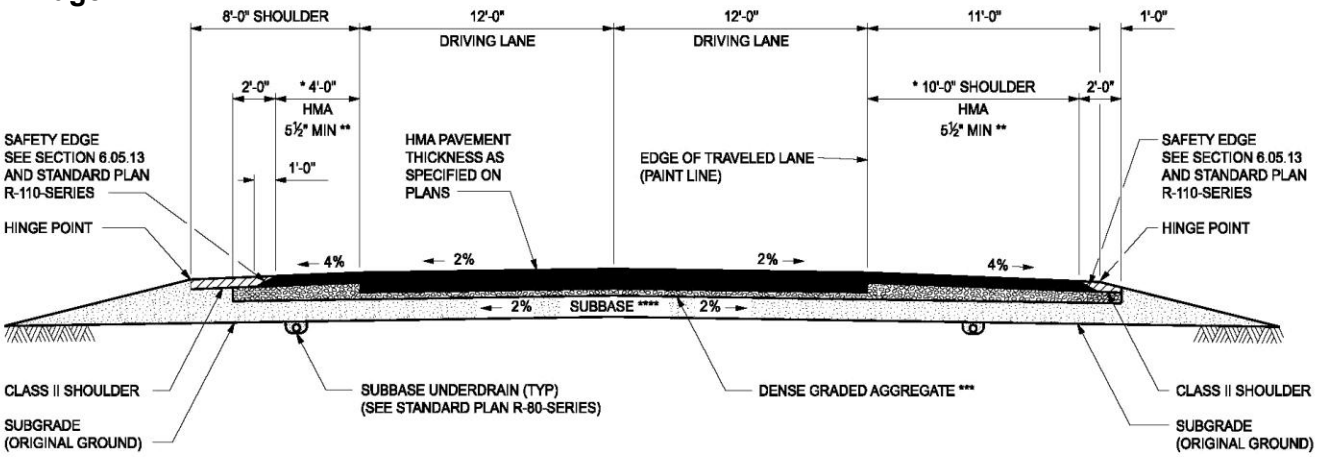
6.10.04 Cold Milling / Diamond Grinding

(revised 9-27-2021)

Skid resistance can be improved by cold milling HMA pavement or diamond grinding concrete pavement, removing only enough material to roughen it. The cost effectiveness of cold milling HMA pavements, for the purpose of increased skid resistance can vary but is usually low because of the "healing" properties of asphalt. Therefore, cold milling of HMA pavements for texture is a treatment MDOT no longer performs. If a friction issue exists on a HMA pavement it should be addressed with a micro-surface or other surface treatment.

APPENDIX 6-A

Page 1



* SEE CHAPTER 3, APPENDIX 3A FOR LEFT (MEDIAN) AND RIGHT (OUTSIDE) SHOULDER WIDTH GUIDELINES.

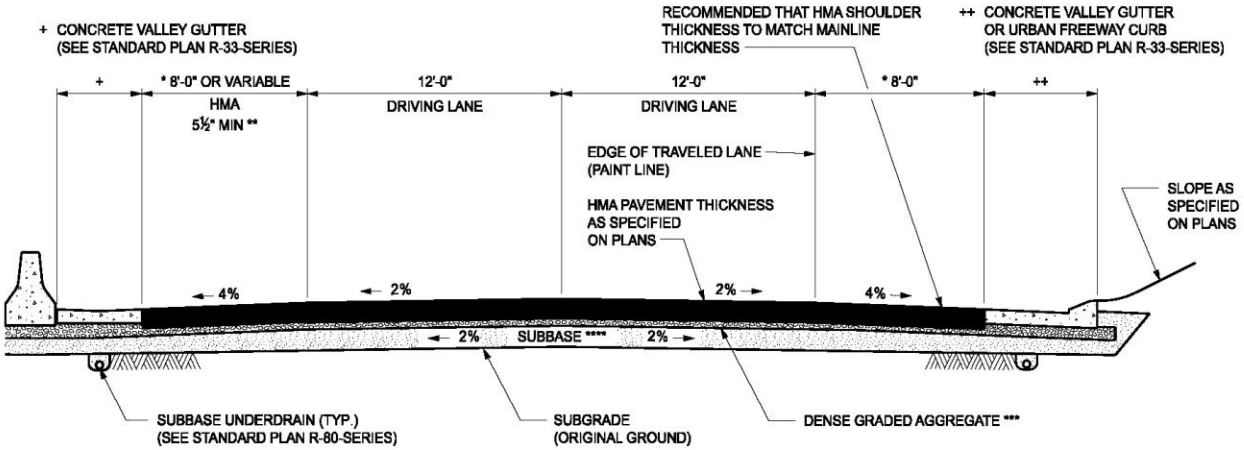
** SHOULDER THICKNESS DETERMINATION MUST ALSO FOLLOW OTHER DEPARTMENT GUIDELINES INCLUDING THE HMA MIXTURE AND SELECTION GUIDELINES.

*** TYPICALLY, 6" DENSE GRADED AGGREGATE OR 16" OPEN-GRADED DRAINAGE COURSE IN METRO REGION.

**** TYPICALLY, 18" SAND SUBBASE OR 8" SAND SUBBASE IN METRO REGION.

RURAL FREEWAY WITH HMA PAVEMENT

(SHOWN WITH OPEN DRAINAGE AND PARTIAL DEPTH SHOULDERS)



* SEE CHAPTER 3, APPENDIX 3A FOR LEFT (MEDIAN) AND RIGHT (OUTSIDE) SHOULDER WIDTH GUIDELINES.

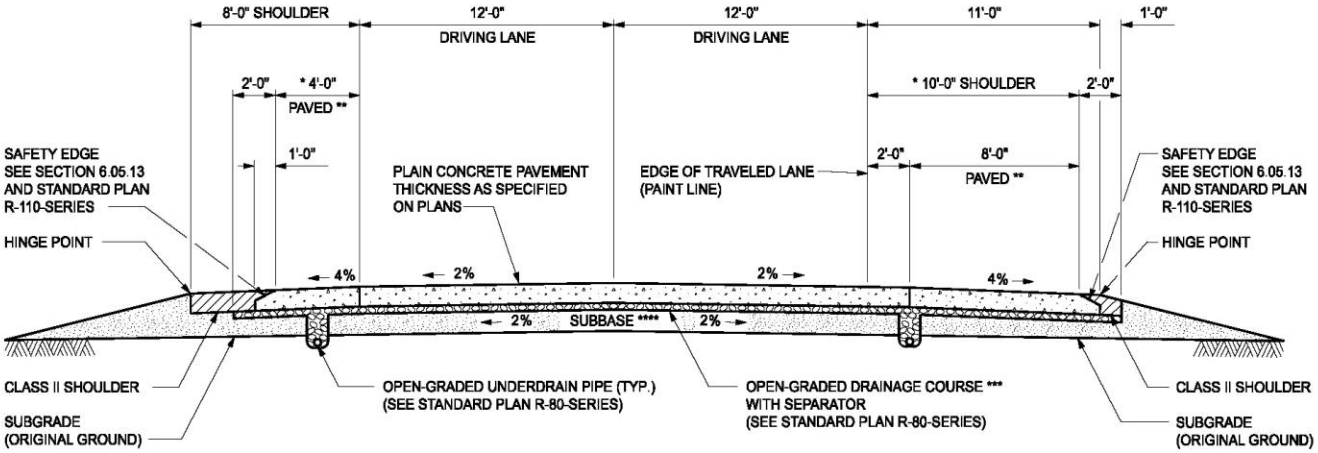
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**** TYPICALLY, 18" SAND SUBBASE OR 8" SAND SUBBASE IN METRO REGION.

URBAN FREEWAY WITH HMA PAVEMENT

(SHOWN WITH ENCLOSED DRAINAGE SYSTEM, CONCRETE MEDIAN BARRIER INSIDE AND URBAN FREEWAY CURB OUTSIDE)



* SEE CHAPTER 3, APPENDIX 3A FOR LEFT (MEDIAN) AND RIGHT (OUTSIDE) SHOULDER WIDTH GUIDELINES.

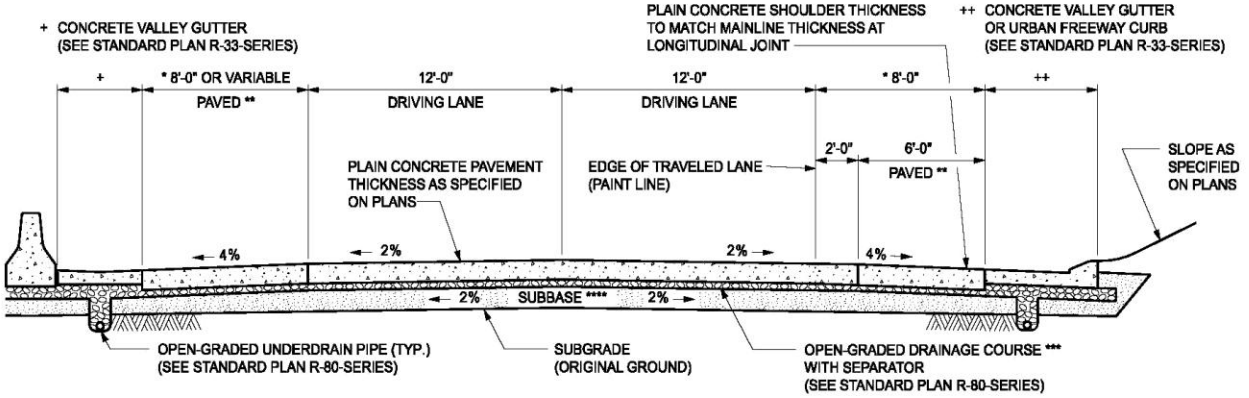
** IF WIDENED SLAB, FREEWAY SHOULDERS CAN BE HMA OR PLAIN CONCRETE. SEE WIDENED SLAB FREEWAY SHOULDER OPTIONS BELOW.

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**** TYPICALLY, 10" SAND SUBBASE OR N/A IN METRO REGION.

RURAL FREEWAY WITH PLAIN CONCRETE PAVEMENT

(SHOWN WITH OPEN DRAINAGE, WIDENED SLAB, AND FULL-DEPTH SHOULDERS



* SEE CHAPTER 3, APPENDIX 3A FOR LEFT (MEDIAN) AND RIGHT (OUTSIDE) SHOULDER WIDTH GUIDELINES.

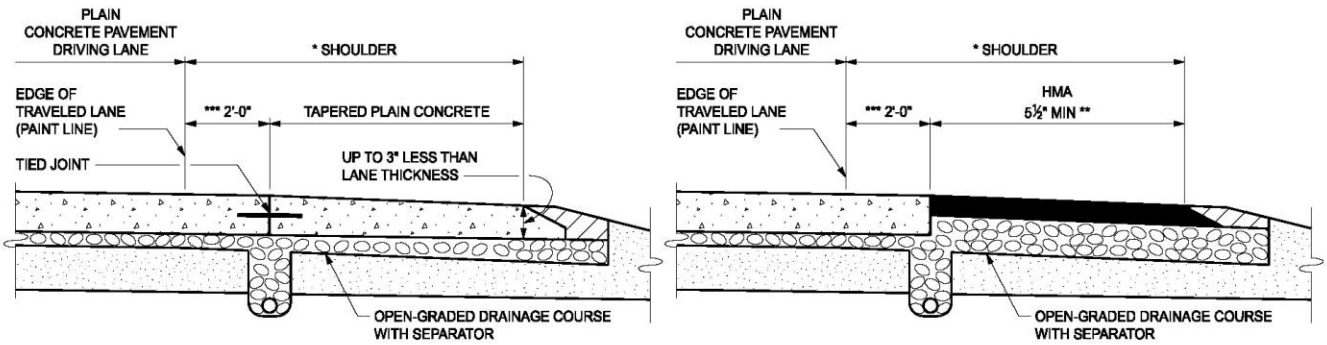
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URBAN FREEWAY WITH PLAIN CONCRETE PAVEMENT

(SHOWN WITH ENCLOSED DRAINAGE SYSTEM, WIDENED SLAB, FULL-DEPTH SHOULDERS, CONCRETE MEDIAN BARRIER INSIDE AND URBAN FREEWAY CURB OUTSIDE)



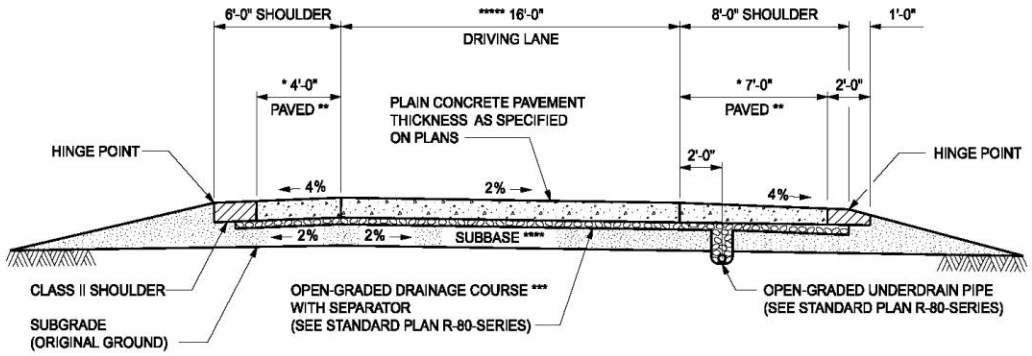
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*** THE UNDERDRAIN OFFSET IS FROM THE EDGE OF TRAVELED LANE (PAINT LINE).

WIDENED SLAB FREEWAY SHOULDER OPTIONS

(OUTSIDE SHOULDER SHOWN WITH PARTIAL DEPTH SHOULDERS)



* SEE CHAPTER 3, APPENDIX 3A FOR LEFT (INSIDE) AND RIGHT (OUTSIDE) SHOULDER WIDTH GUIDELINES.

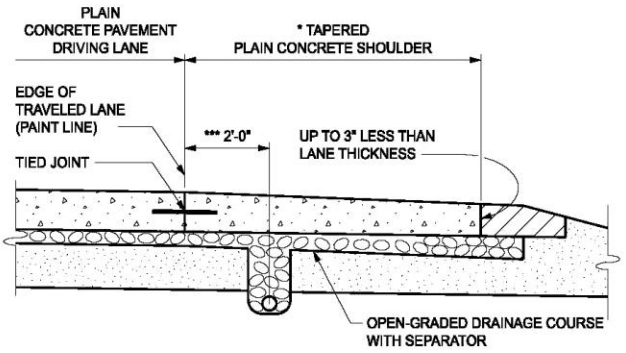
** SHOULDERS CAN BE HMA OR PLAIN CONCRETE. SEE FREEWAY RAMP SHOULDER OPTIONS BELOW.

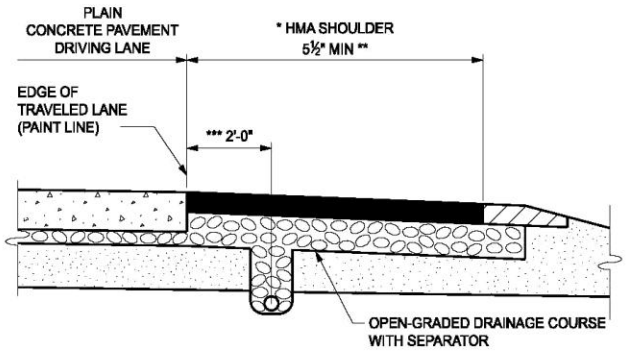
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**** TYPICALLY, 10" SAND SUBBASE OR N/A IN METRO REGION.

***** FOR LOCATION OF LONGITUDINAL JOINT, SEE STANDARD PLAN R-42-SERIES. TYPICALLY, 10" SAND SUBBASE OR N/A IN METRO REGION.

RAMP WITH PLAIN CONCRETE PAVEMENT
(RURAL AND URBAN)



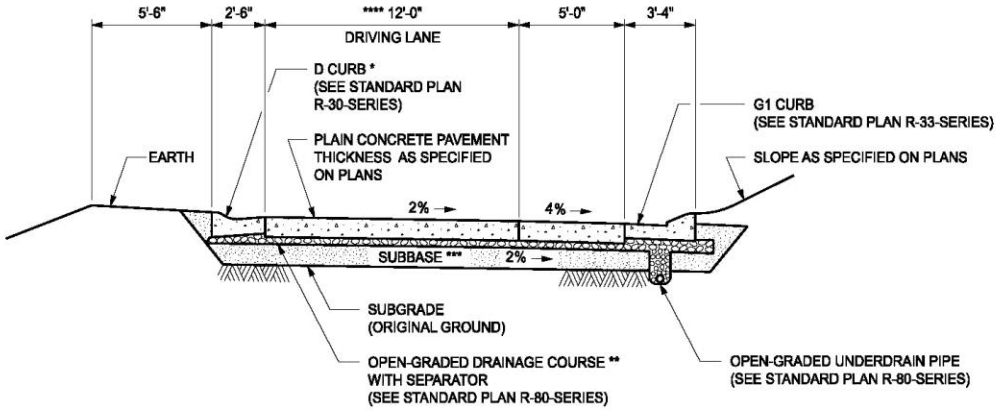


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*** THE UNDERDRAIN OFFSET IS FROM THE EDGE OF TRAVELED LANE (PAINT LINE).

FREEWAY RAMP SHOULDER OPTIONS
(OUTSIDE SHOULDER SHOWN WITH PARTIAL DEPTH SHOULDERS)



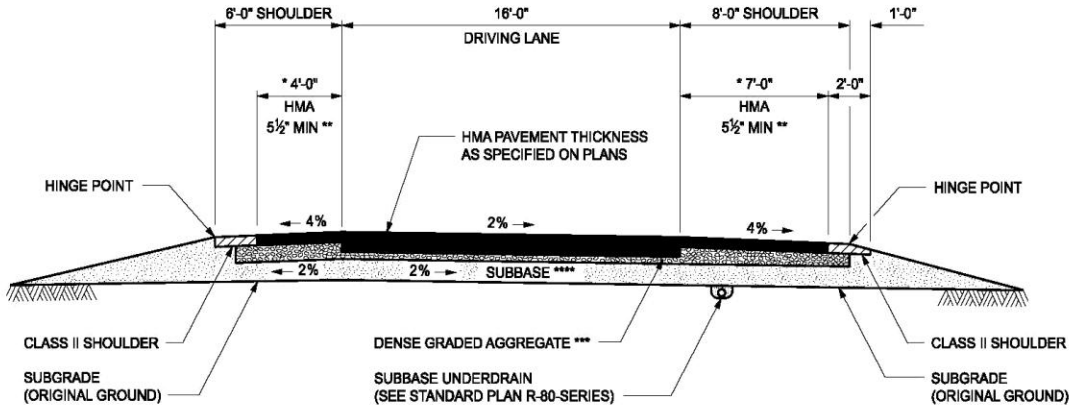
* IF A SLIP RAMP APPROACHES A SLIP RAMP STRUCTURE, TRANSITION TO G1 OR G2 CURB TO MATCH BRIDGE SHOULDER WIDTH.

** TYPICALLY, 6" OPEN-GRADED DRAINAGE COURSE OR 16" OPEN-GRADED DRAINAGE COURSE IN METRO REGION.

*** TYPICALLY, 10" SAND SUBBASE OR N/A IN METRO REGION.

**** FOR LOCATION OF LONGITUDINAL JOINT, SEE STANDARD PLAN R-42-SERIES.

URBAN SLIP RAMP WITH PLAIN CONCRETE PAVEMENT



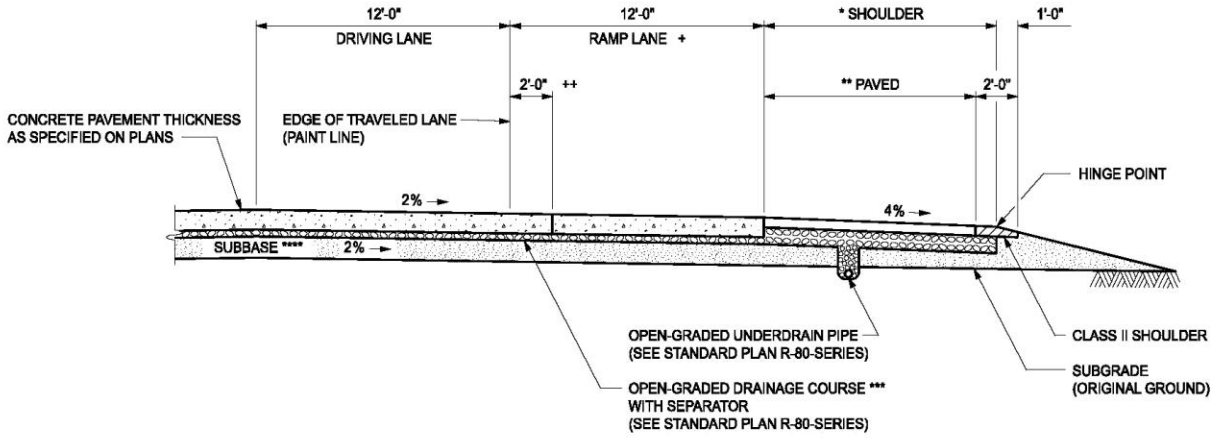
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RAMP WITH HMA PAVEMENT
(RURAL AND URBAN)



* SEE CHAPTER 3, APPENDIX 3A FOR LEFT (MEDIAN) AND RIGHT (OUTSIDE) SHOULDER WIDTH GUIDELINES.

** IF WIDENED SLAB, FREEWAY SHOULDERS CAN BE HMA OR PLAIN CONCRETE. SEE WIDENED SLAB FREEWAY SHOULDER OPTIONS.

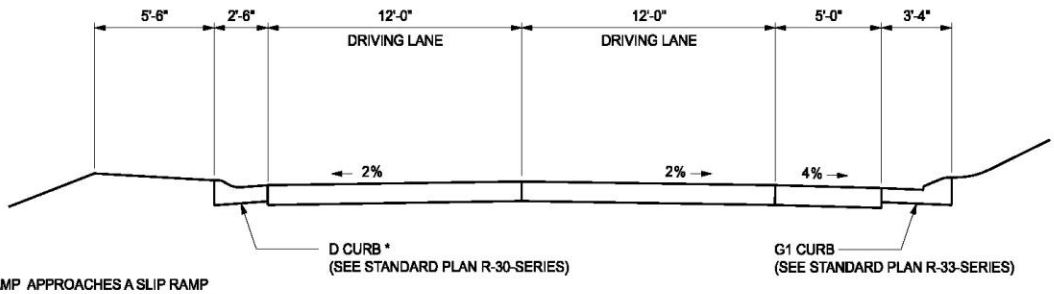
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**** TYPICALLY, 10" SAND SUBBASE OR N/A IN METRO REGION.

FREEWAY WITH PLAIN CONCRETE PAVEMENT AND RAMP LANE
(RURAL AND URBAN)

† RAMP (ACCELERATION / DECELERATION) LANES ARE DESIGNED ACCORDING TO THE DEPARTMENT'S GEOMETRIC DESIGN GUIDES. THE RIGHT EDGE OF THE FREEWAY DRIVING LANE IS CONSIDERED TO BE THE EDGE OF TRAVELED LANE (PAINT LINE) WHEN REFERRING TO THE GEOMETRIC DESIGN GUIDELINES.

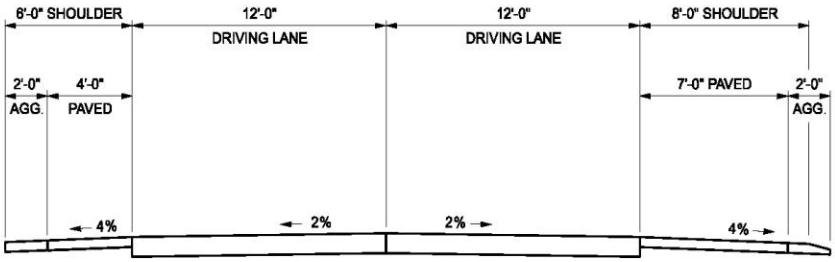
†† SLAB EXTENSION 0'-0" TO 2'-0". SEE SECTION 604.04F(6) FOR AUXILARY LANES.



* IF A SLIP RAMP APPROACHES A SLIP RAMP STRUCTURE, TRANSITION TO G1 OR G2 CURB TO MATCH BRIDGE SHOULDER WIDTH.

DIMENSIONS FOR A TWO LANE SLIP RAMP

(SEE SINGLE LANE SLIP RAMP DRAWING OF APPROPRIATE PAVEMENT TYPE FOR OTHER DETAILS)



DIMENSIONS FOR A TWO LANE RAMP (RURAL AND URBAN)

(SEE SINGLE LANE RAMP DRAWING OF APPROPRIATE PAVEMENT TYPE FOR OTHER DETAILS)

NOTES:

THIS GUIDE FOR FREEWAYS SETS GUIDELINES FOR FREEWAY CROSS SECTIONS. THE ACTUAL DESIGN AND MATERIAL USED TO CONSTRUCT THE COMPLETE ROADWAY SECTION WILL BE ACCORDING TO THE PLANS AND CURRENT SPECIFICATIONS.

SEE STANDARD PLAN R-107-SERIES FOR CROSS SLOPES ON SUPERELEVATED PAVEMENTS.

SHOULDER CORRUGATION CROSS-SECTIONS AND LOCATION SHALL BE AS DETAILED ON STANDARD PLAN R-112-SERIES.

FOR URBAN ROADWAYS, IF THE CURB & GUTTER IS RESTRAINED ON THE OUTSIDE BY A RETAINING WALL, ABUTMENT, OR SLOPE PAVING HEADER, PLACE A 1" EXPANSION JOINT FILLER BETWEEN THE CURB & GUTTER OR VALLEY GUTTER AND THE STRUCTURE. SEE STANDARD PLAN R-33-SERIES.

WHEN CONCRETE SHOULDERS ARE CAST SEPARATELY FROM MAINLINE CONCRETE PAVEMENT, A KEYWAY MAY BE USED TO FACILITATE THE PLACING OF LANE TIES. WHEN A KEYWAY GROOVE IS USED, IT SHALL BE CONTINUOUS AND UNIFORM.

THE LOCATION OF TRANSVERSE JOINTS IN CONCRETE SHOULDERS SHALL MATCH THE LOCATION OF ADJACENT TRANSVERSE PAVEMENT JOINTS.

CORRESPONDING TRANSVERSE JOINTS IN PLAIN CONCRETE SHOULDERS TIED TO PLAIN CONCRETE PAVEMENT SHALL BE (C3p) SHOULDER WITH (Cp) PAVEMENT, (C4) SHOULDER WITH (C2) PAVEMENT, (E4) SHOULDER WITH (E2) PAVEMENT, AND (E3) BEING THE SAME IN BOTH SHOULDER AND PAVEMENT.

SEE STANDARD PLAN R-39-SERIES FOR DETAILS OF TRANSVERSE PAVEMENT JOINTS.

ALL CONCRETE SHOULDER SLABS ADJACENT TO BRIDGE STRUCTURES SHALL BE REINFORCED AS SPECIFIED ON STANDARD PLAN R-45-SERIES.