



# MATES

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### DRAINAGE - THE SOLUTION TO THE THREE PROBLEMS CRITICAL TO PAVEMENT PERFORMANCE

There are three basic causes of problems with bases for pavement, 1) water, 2) water, and 3) water. Preventing water from entering pavement bases and rapidly removing it when it does is critical to pavement performance. Nearly all weather-associated deterioration of pavement material is related to the presence of water.

Subsurface drainage serves two primary purposes. First, it increases pavement life. Removing water from beneath the pavement surface increases the resistance of the aggregate base to deflections imposed by traffic loading, reduces the deterioration of aggregates, reduces the effect of freezing and reduces pumping or rearrangement of fine materials in the base. Second, more uniform pavement performance will result from proper drainage. Frost 'heaving,' which adversely affects performance, is the result of expansion of the wet soil when it freezes. This is especially detrimental when non-uniform in location and magnitude.

#### Distress Types

Certain types of pavement distress can be identified as being associated with inadequate subsurface drainage. Let us look at these distress types as they appear in concrete and composite pavement materials, and in bituminous pavement materials.

Concrete pavements and composite pavements (bituminous overlay of concrete pavements) react to subsurface moisture in a similar manner. Issue No. 7 of MATES carried an article on D-cracking. One of the three essential conditions identified in that article that promote D-cracking is moisture, which often is present in a poorly drained subsurface. Further, saturated subgrades provide poor support for concrete pavements causing transverse cracks under traffic loads. This problem is particularly critical during the spring thaw when moisture cannot percolate downward into the subsoil because of the frozen layer beneath it. When a joint has deteriorated below the surface into particles which are small enough to impede gravity drainage, water is trapped beneath the joint (Fig. 1). This may cause 'tenting,' or upward movement of the joints in winter, a localized frost heave.

Distress types associated with bituminous pavements are somewhat different. One type of rutting of the surface is a reflection of rutting of the subgrade. Loads transmitted through the pavement surface can rut a softened subgrade. The ruts are visible on the surface but are the result of a poorly drained base and softened subgrade. Lack of support from a fluid base can result in surface roughness. Cracks may occur but surface undulations alone will cause a noticeable loss of ride quality. Shrinkage cracks caused by temperature variations and brittleness of the bituminous pavement during cold weather, are a type of distress that we observe frequently. Adequate drainage does not retard shrinkage or thermal cracking but it does prevent the associated cracks from forming adjacent to the thermal

crack. More details on distress types will be found in a forthcoming MATES article.

#### Basic Principles

Design of the subsurface drainage system must consider four basic principles.

1) Water runs downhill. This is the principle of gravity drainage. Some of the free water in the base and subbase can be removed by gravity.

2) Some of the water, however, does not run downhill. In fine soils water is held in the base; even drawn up in some bases, which act like a wick. This is called capillary water and is drawn into, and held in these base materials because of very small (capillary) sized openings between the soil particles.

3) Water tables which intersect the subbase must be lowered by drains or they can prevent drainage of the subsurface layers, or even contribute to the moisture beneath the pavement.

4) Seepage of water from the sides of an excavation or cut slope must be considered and taken care of if the pavement placed in this area is to provide long service.

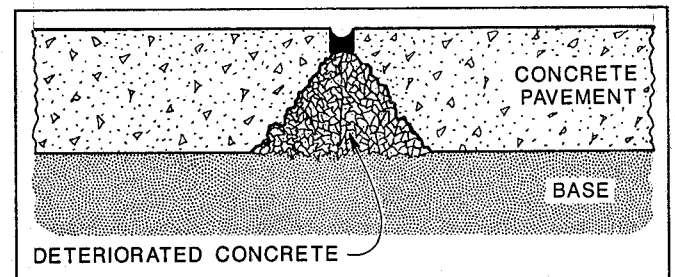


Figure 1.

Design of subsurface drainage must consider the base and subbase layers and drainage hardware for the base, subbase, and subgrade drainage. Materials, their sizes, locations, and shapes are all a part of the design of a drainage system. Base and subbase materials should be highly permeable (i.e., readily allow water to flow through) so that the gravity drainable water will be rapidly removed. High permeability also prevents capillarity, because the voids between particles are larger and will not draw a 'wick' water upward. High permeability, however, does not necessarily provide stability for the operation of construction equipment, hence, trade-offs begin to creep in and some drainability may be sacrificed in order to provide a more stable work platform while the pavement layers are being built. Another problem is that permeability is not easily measured in the field, so another test is used as an indicator of permeability. MDOT uses gradation (particle size distribution) as an indicator test. Base materials of similar gradation can have vastly different permeabilities due to other factors, particle shape, for

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example. By using gradation we may not always get the desired drainage.

Slope of subbase layers should be maximized to increase the rate of gravity drainage within the granular materials. The smaller the spacing between drain pipes and between outlet pipes the greater the rate at which water is removed from the base and subbase layers. All of these, permeability, subbase slope, and drain spacing have an impact upon the cost of a drainage system.

#### Cost or Investment

Many factors associated with good drainage design are costly and some compromise is often required, but it should never be forgotten that these one-time costs are really investments in the pavement system. Poor ride quality, more frequent maintenance during the life of the pavement, and shorter life, are the predictable results of such compromise. The often heard automotive oil filter advertisement, "pay me now or pay me later" was never more applicable.

Attention to details in subsurface drainage system specifications, design, and construction, will go a long way toward improving pavement life and performance. MDOT's Research Laboratory is continuing to investigate methods of improving drainage. Your assistance is vital in implementing what we already know.

-Larry Heinig

#### **A COOPERATIVE SEARCH FOR A BETTER BITUMINOUS PAVEMENT**

There are occasions when the M&T Division does not initiate--or even conduct--a research project, but provides liaison between the experimenter and the other Divisions of the Department and at the same time can offer advice drawn from the pool of diverse expertise within the Division. Often, a university, outside governmental agency, or private industry, wishes to 'borrow' a pavement or a bridge, to use in an experiment of their own. If a review of their proposal looks promising, i.e., the outcome of the research might provide something positive that the Department could use, we become a 'partner' in the project to a greater or lesser degree.

One such project involved the Dow Chemical Co., which was seeking a bituminous resurfacing project in a cold-wet region, in this case the Upper Peninsula, in order to test bituminous admixtures. The project required a 7,000-ft length of roadway, and a batch plant was needed in order to introduce the admixtures. A resurfacing project scheduled for a section of M 35 in Marquette County filled the bill with minimum modification. The Testing Laboratory developed a Work Plan for the project, which was approved by the Federal Highway Administration. Prof. Jon Epps, of the University of Nevada, was hired by Dow to design the experiment and evaluate the results.

Identical test roads were constructed in Texas, Idaho, Maine, Alabama, Georgia, and Arizona in order to test the material over a wide range of conditions (hot-wet, hot-dry, cold-wet, and cold-dry). Two types of plastic pellets, plus a latex, were used as admixtures. These have been developed to prevent stripping of asphalt from aggregate, to improve resistance to rutting at high temperatures, and to increase low temperature flexibility.

The test areas consist of seven sections, each 1,000 ft long, and constructed as follows: 1) no additives (this section will be used for comparison); 2) admixture of 3 percent latex; 3) admixture of 5 percent plastic #1; 4) admixture of 5 percent plastic #2; 5) admixture of 3 percent latex plus 2 percent plastic #1; 6) admixture of 3 percent latex plus 2 percent plastic #1; 7) admixture of 3 percent latex plus 5 percent plastic #1. The test areas were constructed in October, 1986 by the contractor, Payne and Dolan; MDOT Project Engineer was Ron Kamarainen. Dow Chemical Co. provided the admixtures, labor for adding them to the bituminous mix, plus performance surveys, and all testing of the materials. Professor Epps will evaluate the results and write the report.

A period of at least five years will be needed to properly evaluate the materials. Low temperature cracking and high temperature load deformation, as well as stripping, continue to cause problems with asphalt pavements. Any admixtures that show promise of cost effectively decreasing such problems would be of great value to the Department.

-Fred Copple

#### **TECHADVISORIES**

The brief information items that follow here are intended to aid MDOT technologists by advising or clarifying, for them, current technical developments, changes or other activities that may affect their technical duties or responsibilities.

#### PERSONNEL CHANGES

Bryan Simon has joined the Division as an Equipment Technician, filling a vacancy in our Instrumentation and Data Systems Unit of the Research Laboratory. C. D. 'Dave' Church is on temporary assignment in Washington D.C. for the coming year. He is acting as Assistant to the Director of the Strategic Highway Research Program (SHRP), and is looking forward to the new and challenging experience. During Dave's absence, Larry Holbrook is acting head of the Divisions' Administrative & Technical Support Section.

#### SPECIFICATION UPDATE

Plastic Drum Alternates for Type II Barricades, 6.31(8d), dated 10-29-87. This revision adds the Generation III One-Piece Channelizer and the Generation IV Two-Piece Break-away Channelizer to the list of approved alternates for Type II Barricades. These two plastic barrels were approved by the New Materials Committee, at their October 8, 1987 meeting.

Tapered Overlapping Longitudinal Joints in Bituminous Pavements, 4.00(11), dated 06-05-87. This new specification permits the Contractor to construct tapered overlapping longitudinal joints in lieu of longitudinal butt joints in bituminous pavements. The intent is to eliminate the drop off, allow additional one-way, one-day paving length, and improve user safety and contractor productivity.

Use of Fly Ash in Portland Cement Concrete, 7.01(2), dated 06-12-87. This new specification, which permits the use of fly ash in additional concrete mixtures at the option of the Contractor, is required in order to meet final Federal guidelines. Project Engineers should send results of testing for air content of fly ash concrete used in bridge decks to Ralph H. Vogler, M&T Division.

Curing Structural Concrete, 5.03(13), dated 06-12-87. This new specification changes the curing requirements for structural concrete from "so many days" to an "anticipated flexural strength." The reason for the change is that fly ash is now a Contractor's option for use in concrete for structures and fly ash concrete may require a longer curing period before attaining the specified strengths.

This document is disseminated as an element of MDOT's technical transfer program. It is intended primarily as a means for timely transfer of technical information to those MDOT technologists engaged in transportation design, construction, maintenance, operation, and program development. Suggestions or questions from district or central office technologists concerning MATES subjects are invited and should be directed to M&T's Technology Transfer Unit.

Technology Transfer Unit  
Materials and Technology Division  
Michigan DOT  
P.O. Box 30049  
Lansing, Michigan 48909  
Telephone (517) 322-1637