



MATES

MATERIALS AND TECHNOLOGY ENGINEERING AND SCIENCE

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MATES II? MATES, Jr.? We had a few alert readers who tumbled us to the fact that there is another M.A.T.E.S. This is a brochure describing the Design Divison's Michigan Automated Transportation Engineering System. We chatted with the man in charge, Terry Butts, and decided that due to the dissimilarity of the two publications we'd both continue using the name. We also bawled him out for thinking-up our name before we did!

THE ABC'S OF HOT MIX ASPHALT - PART I

Like other fields of technology, asphalt road construction has evolved through the years. Some changes have been improvements, some changes have caused problems, and some have been a bit of each. MATES will be presenting an intermittent series of articles, beginning with this one, discussing asphalt road construction. We hope they will help promote a better understanding of this complex and very important subject.

Today's bituminous pavements must perform under more severe stress than ever before. For one thing, there is more traffic and it is heavier than it used to be. Compounding that problem is the fact that tire pressures are much higher than in past years. Added together these factors can result in the stress in road surfaces being increased very significantly over that experienced in the past.

Most of our bituminous surfaces today are being constructed as overlays over old pavements that are badly cracked and damaged. Those existing cracks will quickly 'reflect' through the new surface and will grow larger under traffic and winter weather allowing infiltration of water and causing further surface damage. In the past, asphalt pavements were commonly built on a fresh new base so there was nothing to cause reflection cracking.

Let us begin our efforts to achieve a better understanding of asphalt pavements by looking at the material we're dealing with. A hot asphalt mixture is a combination of mineral aggregates that are uniformly mixed and coated with an asphalt cement of a selected grade (penetration or viscosity) in an asphalt hot mix plant. Before mixing, the aggregate is heated to drive off excess moisture, and the asphalt cement is heated to obtain the necessary fluidity for mixing.

Much of the effort in the mix design process is aimed at getting as stable and durable a pavement as possible with

the materials used. Economy and workability are two important influences on mix design, as it is desirable to allow a contractor to use the most economical aggregate available that will meet all physical requirements and will provide a mix meeting MDOT specifications.

Hot mix asphalt may be designed and produced from many different aggregate types and a wide range of blends of those aggregates. This results in mixes of widely varying characteristics. Forgetting the asphalt cement for the moment, the type of mix is essentially determined by the relative amounts of:

- 1) Coarse aggregate (retained on the No. 8 sieve),
- 2) Fine aggregate (passing the No. 8 sieve),
- 3) Mineral dust (passing the No. 200 sieve), where the mineral dust may consist of natural dust in the aggregate and/or added mineral filler.

Designing asphalt mixes involves selecting and proportioning the ingredients in such a way as to obtain the desired construction and performance properties. We allow a contractor leeway to try to find an economical blend and gradation of aggregate and asphalt to provide a mix that meets MDOT specifications and that will, therefore, have the following characteristics.

- 1) Enough asphalt cement to ensure a durable, compacted pavement by thoroughly coating, bonding, and waterproofing the aggregate.
- 2) Enough mix stability to handle traffic loads without distortion (rutting) or displacement (shoving).
- 3) Enough voids in the compacted mix to allow a slight amount of additional compaction under traffic without 'flushing' or losing stability. (The volume of voids, however, should be low enough to prevent entry of harmful air and moisture. Air and moisture can oxidize asphalt cement, causing it to become brittle. Moisture also can displace the asphalt cement from the aggregate surface, causing what commonly is known as stripping.)
- 4) Enough workability to permit placing and compacting the mix without segregation.
- 5) Enough low temperature toughness or flexibility to prevent cracking.

The illustration provides a look at the components of a typical asphalt mix.

For many years, mixtures were designed in the field by MDOT mix inspectors, based on: 1) Past experience with the aggregate source(s) being used, and 2) Trial and error if a new source(s) was to be used. Michigan, together with other states, built many miles of good pavement where the proportioning of materials was done at the plant by an experienced mix inspector. However, as more was learned about asphalt technology, it became apparent that more sophisticated methods were needed to balance all the variables

Testing Laboratory
U of M 1913

Research Laboratory
MSU 1939

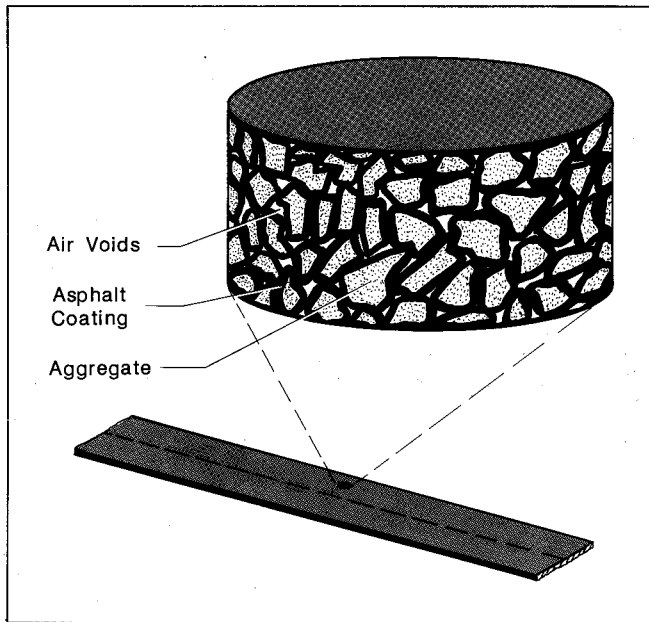
Investigation and Research Division
1924

Testing and Research Division
1933

Materials and Technology Division
1985

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required to produce an asphalt mix of consistently high quality. Today, all 50 states use a laboratory mix design method. Michigan is one of 38 states currently using the Marshall method. Although the Marshall method is not perfect, it is currently the best available. Mixes specified to meet Marshall criteria have, in Michigan, been known as 'stability' or 'performance' mixes.



COMPACTED ASPHALT

The table, taken from MDOT'S Standard Specifications for Construction, shows the Marshall mix design criteria that a mix must meet in order to be used in Michigan pavements. Each requirement listed in the table helps ensure that all the five characteristics of a good asphalt mix listed above, will be achieved. Minimum stability is specified to prevent mat distortion and displacement (rutting and shoving) under traffic loading. Flow, the deformation of a test specimen at failure under loading, can indicate that a mixture is too plastic to resist rutting, or too brittle, and may crack. A minimum VMA (voids in mineral aggregate) is specified to ensure that there is sufficient volume in the compacted aggregate to hold all the asphalt cement necessary to provide good durability. Mixes are designed to have about 3 percent air voids after compaction by both construction and traffic. This volume of air voids is sufficient to prevent flushing of asphalt cement but low enough to prevent entry of harmful air and water.

MARSHALL MIX DESIGN CRITERIA FOR DENSE-GRADED AGGREGATES

Mixture Number	Aggregate Required	Stability, pounds, minimum	Flow, hundredths of an inch	VMA percent, minimum
500	20C	500		
700	20C	700	6 - 19	
900	20B/20A	900	8 - 18	14.5
1100	20A/20AA	1100	8 - 18	15.0
1300	20AAA	1300	8 - 18	15.5
1500	20AAA	1500	8 - 18	15.5
1800	20AAA	1800	9 - 17	15.5

Because asphalt mix design and placement is very complex, it has been necessary to make this first article quite general. Subsequent articles will attempt to elaborate on the finer points of mix design, mixing, placement, and associated problems.

(to be continued soon)

-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.

NEW MATERIALS ACTION

The New Materials Committee recently:

- Approved the following products:
- 'Akwadrain' Highway Edge Drain
- Accident Detector System
- 'Rapid Set' Non-Shrink Grout
- Hilti 'HIT' Anchoring System

For details contact Don Malott at 517-322-5687

MATERIALS OR PROCEDURES ADVISORIES

The third draft of Independent Assurance Test Procedure for aggregates, portland cement concrete, soil and bituminous density, and bituminous mixtures has been sent to the districts for review and comment.

Certification for Concrete End Sections for 4-in. and 6-in. Underdrains. The Department will accept concrete end sections for 4-in. and 6-in. underdrains on the basis of certification. Basis of acceptance will be as follows:

- 1) Concrete Ring - visual inspection,
- 2) Concrete End Section - Type D certification,
- 3) Steel End Section - Type D certification.

Materials and Technology has written a Michigan Test Method (MTM) for testing the calcium nitrite concentration and quality for use in prestressed beams. This will be particularly useful to consultants on local government projects. We'd be happy to send a copy to any interested parties.

FREE PAVEMENT?

The annual material savings of aggregate and asphalt cement from MDOT's asphalt recycling program would pave an additional 120 miles of typical two-lane roadway. The savings in dollars are also substantial and will be discussed in a forthcoming issue.

NEW SPECIFICATIONS OR CHANGES IN SPECIFICATIONS

Geotextile Silt Fence, 2.13 (1), dated 06-20-86. This is a new supplemental which was written as a synthesis of several previously used special provisions written by several Divisions. Products that have been approved for use are listed in the specification.

Hand Chipping, 5.09 (8a), dated 06-13-86. Under the item of Hand Chipping - Other than Deck, a change was made which will reduce the volume of concrete required to be removed. The addition of the phrase, "past the midpoint of the bar," to the description of work, will permit steel reinforcement to be exposed without having to remove concrete from below the steel.

Underdrains, 6.02 (9), dated 08-01-86. This is a new specification which replaces Section 6.02 of the 1984 Standard specifications. The subject specification incorporated several special provisions and the changes required by the revised Standard Plan for Underdrains, IV-8 OD.

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.

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