Technical Bulletin: Specifying Hot Mix Asphalt (HMA) Pavements in Ohio (22Feb02)

General

High quality pavements are the result of well engineered pavement designs, high quality input materials, proper placement procedures, accurate and complete contract specifications, and an adequate quality assurance program. The purpose of this Technical Bulletin is to introduce the various asphalt materials available for use in Ohio, to raise awareness of the information necessary to draft complete contract specifications, and to assist agencies in adopting specifications utilizing quality control and acceptance. It is not the intention of this document to supplant proven successful means of specifying asphalt pavements. However, for those agencies who desire to remain current with industry practice this document may prove helpful.

Paving Materials

This section contains a description of the hot mix asphalt and asphalt base materials suggested for use. It is based on the Ohio DOT Construction and Material Specifications (ODOT C&MS).

The ODOT C&MS provides a well-known high standard for paving materials and construction. It is used extensively in local government and private work.

Asphalt Binder

Beginning in 1997, Ohio’s asphalt industry shifted from viscosity graded asphalt cement (AC grades) to performance graded asphalt binder (PG grades). This new specification system for paving asphalt is one result of research conducted under The Strategic Highway Research Program (SHRP). The term “binder” rather than cement is used because the specification is intended for modified as well as unmodified asphalt cement.

Physical tests were developed to measure engineering properties of paving asphalt over a range of temperatures and rates of loading. The specification based on these tests promises more predictable performance under actual field conditions.

The asphalt binder grade adopted by ODOT for medium or light traffic is PG 64-22. PG stands for performance grade. The numbers are the temperatures (in degrees celsius) for which the binder was designed. The 64 stands for the average seven day maximum pavement temperature and the minus 22 stands for the minimum pavement temperature at which the pavement will perform satisfactorily.

A complete discussion of PG binders can be found in Asphalt Institute publication SP-1, Performance Graded Asphalt Binder Specification and Testing.

Mixtures

The hot mix asphalt mixtures suggested for use are ODOT C&MS Items. These mixtures are available from hot mix asphalt producers throughout the State. Many hot mix producers have developed their own mixtures for special uses.

The ODOT C&MS includes items for which mixtures are formulated in two ways, formulations by ODOT and formulations by the contractor. The items in those two groups are as follows:

Items With Mixtures Formulated By ODOT

301 Asphalt Concrete Base

For this Item, ODOT specifies the proportion of coarse and fine aggregate in terms of the percentage passing the No. 4 laboratory testing sieve and the percentage of asphalt binder. Both of these factors may vary somewhat from one hot mix asphalt producer to another depending upon the characteristics of the aggregates being used.

The ODOT formulations were based on laboratory tests on aggregates from the many sources throughout Ohio and on experience in the field. They have been called “historical mixtures” and are on record for repeated usage.

ODOT C&MS Section 403 has provided for production quality control and acceptance of the 301 mixture. The contractor observes production operations, conducts tests and prepares daily reports of all activities affecting the quality and quantity of mixtures produced and shipped to the project site. Acceptance of the mixture for composition is based on monitoring the contractor’s quality control testing and on the analysis of samples by ODOT.

Items With Mixtures Formulated By The Contractor

302 Asphalt Concrete Base

442 Superpave Asphalt Concrete

446 and 448 Asphalt Concrete—Types 1, 1H, and 2 (Intermediate and Surface Courses)
For Item 302 the contractor is required to develop a job mix formula (JMF) within limits for composition and within limits for characteristics of the mixtures determined by laboratory tests. Production quality control and acceptance of the mixture are as provided in ODOT Section 403.

For Items 442, 446 and 448, the contractor is required to develop JMFs within limits for composition and within limits for characteristics of the mixtures determined by laboratory tests. The contractor also is required to do quality control testing.

**Item Descriptions And Uses**

**Item 301 Asphalt Concrete Base** is a hot mix asphalt base course for use in pavement designs where a base layer thickness of 3 inches (75 mm) or more is needed. Item 301 may be placed directly upon prepared subgrade, aggregate base, or existing pavement surface. This may be specified as:

ODOT Item 301 Asphalt Concrete Base, PG 64-22

**Item 302 Asphalt Concrete Base** is a hot mix asphalt base having the same uses as Item 301 but incorporates larger size aggregate. Its minimum layer thickness is 4 inches (100 mm). The gradation limits are not as broad, however, and they ensure the coarse aggregate provides the dominant aggregate structure. That structure is considered necessary to resist shear stresses induced by heavy traffic. This may be specified as:

ODOT Item 302 Asphalt Concrete Base, PG 64-22

**Item 442 Superpave Asphalt Concrete** mixtures are designed by the contractor based upon Asphalt Institute “Superpave Mix Design” manual (SP-2). Composition and mixture requirements are contained in ODOT C&MS Section 442. Mixtures are denoted by the nominal maximum aggregate size (mm). In Ohio the 9.5 mm mix is used for variable thickness, scratch and leveling courses, and surface courses for medium traffic pavements. The 12.5 mm mix is being used by ODOT on heavily traveled pavements as its predominant Superpave surface course mix. Intermediate courses use the 19 mm mix.

**Items 446 and 448 Asphalt Concrete, Types 1 and 2.** All mixtures for these Items are designed by the contractor. Composition and mixture requirements are in ODOT C&MS Section 441. There is a set of requirements for light, medium and heavy traffic. That section also contains requirements for the contractor’s production quality control operations.

Type 1 is comparable to Items 403 and 404 (1997 ODOT C&MS) as to aggregate top size and to uses. Type 2 is comparable to Item 402 (1997 ODOT C&MS) as to aggregate top size and uses.

Pavements constructed under the requirements of Items 446 or 448 utilize common materials. For example, the Type 1, surface course material placed under the requirements of Item 446 is the same in composition as the Type 1, surface course material placed under the requirements of Item 448. Where the Item 446 and Item 448 specifications differ is in the method by which the material is accepted by the agency.

**Contract Specifications**

Contract specifications need to clearly convey the intent of the agency/owner. To accomplish this there are several pieces of information that must be communicated when specifying asphalt mixtures. That information includes:

- Project dimensions & course thickness
- Item specification under which material will be placed
- Description of material
- Traffic designation
- Grade of binder
- Item quantity
- Language for specifying HMA composition
- Method & point of acceptance

**Project Dimensions & Course Thickness**

Project dimensions include the width, length and any other dimensions needed to identify the location of the work and the area to be covered. The hot mix asphalt paving process has the unique ability to smooth out rough, irregular pavement surfaces. Project dimensions are needed to ensure the proper quantity of HMA is being placed per unit of area. This is referred to as the “yield” and is the measuring stick the contractor uses when placing HMA.

A rule of thumb to remember when specifying layer thickness is that the layer should be no less than twice the diameter of the largest particle size used in the mixture. For instance, the layer thickness for a surface course mixture with aggregate having a maximum particle diameter size of ½-inch should never be less than 1-inch. The purpose of this rule is to ensure that sufficient layer thickness exists to promote consolidation of the mixture when the rolling equipment applies compactive effort. Usually, thicker courses than that determined by the “rule of thumb” are used. This is done to account for irregularities in the surface being overlayed, promote mixture density, and improve smoothness. Layer thickness guidelines are provided in Table 1.

**Table 1 – Layer Thickness Guidelines**

<table>
<thead>
<tr>
<th>HMA Material</th>
<th>Thickness (inches)</th>
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<tbody>
<tr>
<td><strong>Surface Courses</strong></td>
<td></td>
</tr>
<tr>
<td>Type 1</td>
<td>1¼ - 1½</td>
</tr>
<tr>
<td>Type 1H</td>
<td>1½ - 2½</td>
</tr>
<tr>
<td>Type 2</td>
<td>1¾ - 4½</td>
</tr>
<tr>
<td>Superpave 9.5 mm</td>
<td>1⅛ - 1½</td>
</tr>
<tr>
<td>Superpave 12.5 mm</td>
<td>1½ - 2½</td>
</tr>
<tr>
<td><strong>Intermediate / Leveling Courses</strong></td>
<td></td>
</tr>
<tr>
<td>Type 1</td>
<td>1 - 1½</td>
</tr>
<tr>
<td>Type 2</td>
<td>1¾ - 4½</td>
</tr>
<tr>
<td>Superpave 9.5 mm</td>
<td>1 - 1½</td>
</tr>
<tr>
<td>Superpave 19 mm</td>
<td>1¾ - 4½</td>
</tr>
<tr>
<td><strong>Base Courses</strong></td>
<td></td>
</tr>
<tr>
<td>301</td>
<td>3 - 10</td>
</tr>
<tr>
<td>302</td>
<td>4 min.</td>
</tr>
</tbody>
</table>
**Item Specification Under Which Material Will Be Placed**

An essential element of contracts for asphalt paving projects is the item number. Item numbers provide reference to the details needed by the contractor to manufacture and place HMA, and explain the manner in which the material will be accepted by the agency. The agency must select the appropriate item of work for the project conditions. Item specifications typically used in Ohio local government projects and commercial paving work are those established in the ODOT C&MS. The ODOT specifications commonly used for surface and intermediate courses are Items 446 and 448 – for base courses, items 301 and 302.

The acceptance of HMA placed under the provisions of Item 446 is based upon monitoring contractor quality control tests. Acceptance of the compacted mixture is based on the level of density attained as sampled by the contractor and tested by ODOT. If the density of the asphalt layer attains desired levels the material is considered acceptable. The intent of the specification is to encourage compaction of HMA mixtures. This has the effect of enhancing pavement longevity and resistance to rutting brought about by the consolidation of mix under heavy trucks. The use of Item 446 is only to be used when constructing layers having uniform lift thickness and the pavement foundation is sufficiently firm to support the compactive effort of the rolling equipment.

Acceptance of Item 448 mixtures for composition is based on monitoring the contractor quality control testing and on the analysis of samples, by ODOT, for mixture proportions. In this case the hot mix asphalt is separated into its components (i.e. aggregate gradation and asphalt binder content) and a comparison is made to the mixture’s previously approved JMF. If the proportions of the hot mix asphalt produced compare favorably with the job mix formula then the material is deemed acceptable. Mixtures produced under the provisions of 448 can be used in all surface and intermediate course applications.

In recent years the Ohio DOT has adopted the superpave technology. Specification 442 outlines ODOT’s superpave mix design requirements. The Ohio specification outlines requirements for a Type A and Type B mixture. The major difference between the two is the angularity requirement for the coarse aggregate. The Type A mix has the higher angularity requirement [Type A (95% fracture), Type B (65% fracture)]. Acceptance of superpave mixtures is by reference to either Item 446 (density acceptance) or Item 448 (analysis of mixture proportions).

**Description of Material**

A description of the hot mix asphalt material desired for use is also a necessary part of every asphalt paving project. Material description provides information as to the material type, its gradation and whether the material is for use as a base, intermediate, or surface course. A catalog of descriptions is provided in Table 2.

**Traffic Designation**

Hot mix asphalt mixtures for surface and intermediate courses are formulated for the kind of traffic that will use the pavement. Depending on the type of mixture being specified, plans will include the type of traffic or the quantity of truck traffic. Superpave mixtures (Item 442) use Average Daily Truck Traffic (ADTT) as the means of designating formulation criteria. The practice for Items 446 and 448 is to specify formulations either for light, medium or heavy traffic. Some suggestions for specifying traffic designations are as follows:

- **Light traffic** formulations should be specified for such purposes as residential driveways, play areas, walkways, and paths for bicycles and golf carts. Light traffic formulations also are suitable for certain light traffic local roads, light traffic residential streets, and infrequently used parking lots for cars.
- **Medium traffic** formulations generally should be specified for all roads, streets and parking lots used by less than about 300 heavy trucks per day per traffic lane.
- **Heavy traffic** formulations generally should be specified for roads and streets used by more than about 300 heavy trucks per day per traffic lane.

Mixtures formulated for heavy truck traffic are relatively stiff. For that reason, they should be specified only for pavements designed structurally for heavy truck traffic.

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**Table 2 – Material Descriptions**

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>301</td>
<td>Asphalt Concrete Base</td>
</tr>
<tr>
<td>302</td>
<td>Asphalt Concrete Base</td>
</tr>
<tr>
<td>442</td>
<td>Asphalt Concrete Surface Course, Type 1</td>
</tr>
<tr>
<td></td>
<td>Asphalt Concrete Surface Course, Type 1H</td>
</tr>
<tr>
<td></td>
<td>Asphalt Concrete Intermediate Course, Type 1</td>
</tr>
<tr>
<td>446 and 448</td>
<td>Asphalt Concrete Surface Course, Type 1</td>
</tr>
<tr>
<td></td>
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</tr>
</tbody>
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Grade Of Binder

The asphalt binder grade specified depends upon the location of the material in the pavement cross-section and the type of traffic to which the pavement will be exposed. Table 3 provides binder grades recommended for various material types.

Table 3 – Recommended Binder Grades

<table>
<thead>
<tr>
<th>Binder Grade</th>
<th>To Be Used With:</th>
</tr>
</thead>
<tbody>
<tr>
<td>PG 64-22</td>
<td>301 – Asphalt Concrete Base</td>
</tr>
<tr>
<td></td>
<td>302 – Asphalt Concrete Base</td>
</tr>
<tr>
<td></td>
<td>446 – All surface and intermediate courses having light or medium traffic</td>
</tr>
<tr>
<td></td>
<td>448 – All surface and intermediate courses having light or medium traffic</td>
</tr>
<tr>
<td>PG 64-28</td>
<td>442 – Asphalt Concrete Intermediate Course</td>
</tr>
<tr>
<td></td>
<td>446 – Asphalt Concrete Intermediate Course, Type 2, Heavy Traffic</td>
</tr>
<tr>
<td></td>
<td>448 – Asphalt Concrete Intermediate Course, Type 2, Heavy Traffic</td>
</tr>
<tr>
<td>PG 70-22M</td>
<td>442 – Asphalt Concrete Surface Course</td>
</tr>
<tr>
<td></td>
<td>446 – Asphalt Concrete Surface Course, Type 1 &amp; 1H, Heavy Traffic</td>
</tr>
<tr>
<td></td>
<td>448 – Asphalt Concrete Surface Course, Type 2, Heavy Traffic</td>
</tr>
<tr>
<td></td>
<td>448 – Asphalt Concrete Surface Course, Type 1 &amp; 1H, Heavy Traffic</td>
</tr>
<tr>
<td></td>
<td>448 – Asphalt Concrete Surface Course, Type 2, Heavy Traffic</td>
</tr>
<tr>
<td>PG 76-22M</td>
<td>446 &amp; 448 – High Stress Paving Mixtures*</td>
</tr>
</tbody>
</table>

*High stress paving mixtures are specially formulated to mitigate surface deformation taking the form of rutting, depressions, or shoving. For additional information on the treatment of high stress locations, reference the Asphalt Pavement Design & Construction Guide, Section 4.4

Item Quantity

Unit price contracts require that the quantity of each type of hot mix asphalt be determined and provided in the contract documents for bidding purposes. Units of measure used are either cubic yards or tons. Ohio DOT specifications use cubic yards. By using cubic yards the desired thickness is obtained without quantity overages. This is accomplished by taking into consideration the unit weight (pounds per cubic foot) of the hot mix asphalt during placement operations.

Language For Specifying HMA Composition

Ohio utilizes quality assurance (QA) specifications for the production of hot mix asphalt. Under QA provisions, prior to the start of mix production for a project, the contractor has the responsibility of developing a job mix formula and submitting it for approval by the agency. In many cases local agencies find themselves in the position where they are unable to fulfill this role. Due to a lack of knowledge of hot mix asphalt mix design, they are unable to determine if a contractor’s JMF meets the mix design requirements. In such instances it is beneficial for the agency to rely upon the expertise of ODOT by requiring the use of mixtures that have been previously approved by the Department. To accomplish this the following contract language is suggested:

“Compose the hot mix asphalt mixture with aggregate, asphalt binder, and modifiers (where specified) meeting Ohio Department of Transportation (ODOT) requirements. Prior to producing hot mix asphalt for this contract, submit a Job Mix Formula (JMF) for approval.

Include in the JMF the mix type proposed for use, aggregate source, type, and gradation, percentage of asphalt binder by weight of mixture, grade of asphalt binder, description and source of modifier (if applicable), and unit weight of the mixture. Use a JMF that meets all requirements established in this contract and has previously been approved for use on ODOT work.

Where no previously approved JMF is available, develop one meeting all criteria established in this contract and have it reviewed and approved by an independent testing laboratory prior to submission to the owner representative. The person performing the review for the testing laboratory must be of its employ and be Level II Bituminous Concrete approved from ODOT.”

It remains necessary that the agency verify that the job mix formula submitted is for the mix type desired for the given traffic condition.

Method And Point Of Acceptance

QA provisions require the contractor to perform quality control testing during the production of the hot mix asphalt. Acceptance testing and monitoring of mix production are performed by the agency. The ODOT specifications detail these requirements. For local agencies, however, it may be necessary to modify the method and point of mix acceptance to account for a lack of physical resources to perform acceptance testing. To accomplish this the following suggested additions to the contract language are provided:

Suggestion 1:

“Acceptance of the mixture will be in accordance with Ohio Department of Transportation (ODOT) procedures, except that an independent testing laboratory will perform the testing and report the data to the owner’s representative for the purpose of determining the pay adjustment. The person performing the testing must have a current Level I Bituminous Concrete approval from ODOT. Include the cost for the acceptance testing in the price per unit of mix.”

Suggestion 2:

“Acceptance of the mixture will be based upon the owner representative’s observation that production and quality control operations are resulting in an acceptable product.”

Suggestion 3:

“Certify that the mixture was produced according to the approved JMF within the production control and composition tolerances of the specification.”
Specialty Mixes
There are many specialty mixes available to treat a variety of pavement conditions. Modifiers such as polymers, fibers, and stiffeners play an important role in enhancing mix performance. Provided below is a sampling of such mixtures.

For preventive maintenance treatments thin hot mix asphalt overlays have been used over the past 30 years with very good success. Smoothseal, a fine graded polymer modified asphalt mixture, can be specified for pavements having good structural integrity and only the need for surface restoration. ODOT Supplemental Specification 854 outlines the mixture requirements.

For rutting resistance stone mastic asphalt, ODOT Supplemental Specification 856, combines high internal friction mixes with polymer binders to resist deformation induced by heavy truck loads in high stress areas. Fiber modified mixtures and mixtures using stiffeners, ODOT Supplemental Specifications 826 and 857, have also demonstrated effectiveness.

For longer life the use of polymers as a mix additive has proven very successful. Ohio has experience with pavement surfaces lasting as long as 29 years when latex polymer (SBR) has been used in the hot mix asphalt. SBS polymer modified mixes are similarly promising.

Conclusion
Item specifications typically used in Ohio local government projects and commercial paving work are those established in the ODOT C&MS. The ODOT specifications commonly used for surface and intermediate courses are Items 446 and 448 – for base courses, items 301 and 302.

Contract specifications need to clearly convey the intent of the agency/owner. This is accomplished by ensuring that the following information is communicated to the contractor:
- Project dimensions & course thickness
- Item specification under which material will be placed
- Description of material
- Traffic designation
- Grade of binder
- Item quantity
- Language for specifying HMA composition
- Method & point of acceptance

An example item description is:
448, Asphalt Concrete Surface Course, Type 1, medium traffic, PG 64-22

Under Ohio’s QA specifications the responsibility for development of the job mix formula, and the quality control during mixture production lies with the contractor. The agency approves the contractor’s mix design and performs the acceptance testing.

Specialty mixes are available to treat a variety of pavement conditions. Preventive maintenance, high stress areas, and increased pavement life are all instances where modifiers have demonstrated good success.

All reasonable care has been taken in preparation of this Bulletin. However, Flexible Pavements of Ohio can accept no responsibility for the consequence of any inaccuracy that it may contain.

References:
- Pavement Design & Rehabilitation Manual, January 1999, Ohio Department of Transportation
- QA/QC Presentation, William Fair, P.E., Flexible Pavements of Ohio