

FLEXIBLE PAVEMENTS OF OHIO

An Association for the development, improvement and advancement of quality Asphalt Pavement Construction.

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Technical Bulletin: **Specifying Asphalt Pavements in Ohio** (6February2017)

General

High quality pavements are the result of well engineered pavement designs, high quality 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 asphalt concrete 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.

The ODOT is constantly improving its specifications. Recent changes to ODOT asphalt concrete specifications have changed the way in which standard asphalt concrete mixes are specified. This update incorporates those changes.

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 delivers more predictable performance under actual field conditions.

The asphalt binder grade adopted by ODOT for medium (normal) traffic is PG 64-22. PG stands for performance grade. The numbers represent the temperatures (in degrees Celsius) for which the binder was graded to perform. The 64 stands for the average seven day maximum pavement temperature and the minus 22 stands for the one day minimum pavement temperature at which the pavement will perform satisfactorily.

See the "Grade of Binder" section below for additional discussion of binder grade options. A complete discussion of PG binders can be found in Asphalt Institute publication MS-26, [Asphalt Binder Handbook](#).

Mixtures

The asphalt mixtures suggested for use are Standard ODOT C&MS Items with the exception of Thinlay Asphalt Concrete, 404LVT and SS 823, Light Traffic Asphalt Mixture described under Specialty Mixes below. These mixtures are available from asphalt mix producers throughout the State. Many asphalt mix producers have developed their own mixtures for commercial or non-specification uses.

The ODOT C&MS includes mixtures that are formulated in one of two ways – recipe mixes formulated by ODOT and formulations by the contractor using a mix design methodology. The items in those two groups are as follows:

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 asphalt mix 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.

Mixtures Formulated By The Contractor

- 302 Asphalt Concrete Base
- 441 Asphalt Concrete, Type 1 and 2 (Surface and Intermediate Courses)
- 442 Superpave Asphalt Concrete, 12.5 mm, 9.5 mm or 19 mm, Type A or B (Surface and Intermediate Courses)

For Item 302 the contractor is required to develop a job mix formula (JMF) within limits for composition and for characteristics determined by laboratory volumetric tests. Production quality control and acceptance of the mixture are as provided in ODOT Section 403.

For Items 441 and 442, the contractor is required to develop JMFs within limits for composition and for characteristics determined by laboratory volumetric tests. The contractor also is required to do quality control testing.

Item Descriptions and Uses

Item 301 Asphalt Concrete Base is an asphalt base course mix 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 an asphalt base mix having the same uses as Item 301 but incorporates larger size aggregate. Its minimum layer thickness is 4 inches (100 mm). If the plan thickness is 7.0- 7.75 inches and mixture production has 95% passing the 1.50 inch sieve, the 302 may be placed in two lifts. The gradation limits are not as constrained and they ensure the coarse aggregate is dominant in providing a strong 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 441 Asphalt Concrete, Types 1 and 2

Specifications for these materials changed substantially on July 18, 2014. All mixtures for these Items are designed by the contractor. Composition and mixture requirements are in ODOT C&MS Section 441. These mixes are designed for traffic applications of less than 1500 average daily truck traffic (ADTT). Section 441 also contains requirements for the contractor's production quality control operations.

Type 1 uses a dense gradation with a 1/2 inch minus top size and is comparable to Items 403 and 404 (1997 ODOT C&MS). Type 2 uses a dense gradation with a 3/4 inch minus top size and is comparable to Item 402 (1997 ODOT C&MS) as to aggregate top size and uses. See table 2 for the specification descriptions for 441 mixes.

Item 442 Superpave Asphalt Concrete mixtures are designed by the contractor based upon Asphalt Institute "Manual (MS-2), Asphalt Mix Design Methods. Composition and mixture requirements are contained in ODOT C&MS Section 442. Mixtures are denoted by the nominal maximum aggregate size (NMAS). [note: NMAS is defined as one sieve larger than the first sieve to retain more than 10 percent in a gradation.] 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 and is the predominant Superpave surface course mix. Uniform thickness Intermediate courses use the 19 mm mix. See table 2 for the 442 mixture specification descriptions.

Acceptance

"Acceptance" is the term used to describe the contractual procedure by which an agency determines the acceptability of an asphalt material that has been mixed, placed and compacted as the final product in the construction of an asphalt pavement. Asphalt mixtures composed under the requirements of 441 and 442 mixes are accepted either by the requirements of Item 446 (i.e. density acceptance) or 448 (i.e. mixture composition acceptance). Further discussion of these acceptance methods is provided below in section, "Item Specification Under Which Material Will Be Placed".

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
- Item quantity
- Language for specifying asphalt composition
- Method & point of acceptance, and
- sometimes the grade of binder and/or Traffic designation

Project Dimensions & Course Thickness

Project dimensions include the width, length, thickness and any other dimensions needed to identify the location of the work and the area to be covered. The asphalt mixture paving process has the unique ability to smooth out rough, irregular pavement surfaces. To accomplish this the asphalt quantity must be sufficient to fill in low spots while maintaining the desired course thickness over bumps. Project dimensions are needed to ensure the proper quantity of asphalt is being placed per unit of area. While a nominal or average thickness is customarily shown on the plan, the quantity is calculated to a volume or weight to be placed per unit area. This is referred to as the "yield" and is the measuring stick to ensure the plan dimension is met when placing asphalt mix over an irregular surface.

A rule of thumb to remember when specifying layer thickness is the layer should be 2 to 4 times the

aggregate top size in the mix. For instance, the layer thickness for a surface course mixture with aggregate having a top size of 3/8-inch should normally not be less than 1 1/4-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 are used than that determined by the "rule of thumb". This is done to provide sufficient asphalt to correct irregularities in the surface being overlaid, promote mixture density, and improve smoothness. Layer thickness guidelines are provided in Table 1.

Table 1 – Layer Thickness Guidelines

Asphalt Mixtures	Thickness (inches)
Surface Courses	
Type 1	1¼ - 1½
Superpave 9.5 mm	1¼ - 1½
Superpave 12.5 mm	1½ - 2½
Intermediate / Leveling Courses	
Type 1	1 - 1½
Type 2	1¾ - 4½
Superpave 9.5 mm	1 - 1½
Superpave 19 mm	1¾ - 4½
Base Courses	
301	3 - 10
302	4 min.

Item Specification Under Which Material Will Be Placed

Asphalt work items bid using ODOT specification designations require the designer to identify in the contract line item the specification under which the asphalt mixture is to be composed, and the item number for which it will be accepted. An example is the following:

Item 441, Asphalt Concrete Surface Course, Type 1, (448), , PG 64-22

Item numbers (e.g. 441) provide reference to the details needed by the contractor to manufacture and place asphalt, and explain the manner in which the material will be accepted (e.g. 448) 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 441 and 442 with 446 or 448 acceptance – for base courses, items 301 and 302.

446 Acceptance - The acceptance of asphalt mix 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. The intent of the density specification is to encourage thorough compaction of asphalt mixtures. This enhances pavement longevity and resistance to rutting that can occur under heavy traffic. 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.

448 Acceptance - Acceptance of Item 448 mixtures for composition is based on monitoring the contractor quality control testing performed at the mixing plant and on the analysis of samples, by ODOT, for mixture proportions. In this case the asphalt mixture is separated into its components (i.e. aggregate gradation and asphalt binder content) and a comparison is made to the mixture's approved job mix formula (JMF). If the proportions of the hot mix asphalt produced compare within acceptable tolerance of the JMF then the material is deemed acceptable. If a uniform thickness course > 1 inch thick and 1 mile long is being placed, 448 may require density quality control and acceptance per Supplement 1055.

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 coarse aggregate angularity requirement. The Type A mix has the higher angularity requirement [Type A (95% fracture), Type B (65% fracture)].

Description of Material

A description of the asphalt mix 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.

Table 2 -- Mix Type Descriptions

301	Asphalt Concrete Base, PG 64-22
302	Asphalt Concrete Base, PG 64-22
441	Asphalt Concrete Surface Course, Type 1, (446 or 448), PG 64-22 or PG 70-22M
441	Asphalt Concrete Intermediate Course, Type 1 (448)
441	Asphalt Concrete Intermediate Course, Type 2 (446 or 448)
442	Asphalt Concrete Surface Course, 9.5 mm, Type A or B (446 or 448)
442	Asphalt Concrete Surface Course, 12.5 mm, Type A or B (446 or 448)
442	Asphalt Concrete Intermediate Course, 19 mm, Type A or B (446 or 448)
442	Asphalt Concrete Intermediate Course, Type a or B, (448)

Traffic Designation

Asphalt mixtures for surface and intermediate courses are formulated for the kind of traffic loads (trucks) that will use the pavement. Depending on the type of mixture being specified, plans may include the type of traffic or the quantity of truck traffic. Superpave mixtures (Item 442) are formulated for heavy truck traffic Average Daily Truck Traffic (ADTT) > 1500. ODOT uses 441 mixes for normal traffic of < 1500 ADTT. This truck traffic may be too high for good performance on urban streets. Some suggestions for specifying mixes for various traffic designations are as follows:

Light traffic applications for such purposes as residential driveways, play areas, walkways, and paths for bicycles and golf carts, certain light traffic local roads, light traffic residential streets, and infrequently used parking lots for cars. Use 441 mixes or special light traffic mixes such as Thinlay Asphalt Concrete Type Light or Ultralight, 404LVT or mix formulated under ODOT Supplemental Specification 823, Light Traffic Asphalt Mixture

Medium traffic applications include all roads, streets and parking lots used by less than about 300 heavy trucks per day per traffic lane. Use 441 mixes or 442, 9.5 mm mixes.

Heavy traffic applications generally include 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. Use 442 12.5 mm and 19 mm mixes.

Grade of Binder

The asphalt binder grade specified depends upon the climate, 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 specified by ODOT for various standard material types.

Table 3 – Recommended Binder Grades¹

Binder Grade	To Be Used With:
PG 64-22	301 – Asphalt Concrete Base
	302 – Asphalt Concrete Base
	441 – All surface and intermediate courses having light or medium traffic
PG 64-28	442 – Asphalt Concrete Intermediate Course
PG 70-22M	442 – Asphalt Concrete Surface Course
	441 – Asphalt Concrete Surface Course, Type 1, (for heavy traffic)
PG 76-22M	442 – High Stress Paving Mixtures ²
PG 88-22M	442 – Extreme High Stress Paving Mixtures*, Bridge deck waterproofing

1. Agencies will sometimes find it useful to change the binder grade from the default grade shown in the ODOT specifications for heavy traffic or greater longevity. In such cases the bid item must include the desired grade, or a plan note indicating the change be provided.

2. 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 ODOT Pavement Design Manual, Appendix B.

Asphalt binders are specified in Item 702.01 of the C&MS. Un-modified, Performance Graded (PG) binders are specified by reference to AASHTO M320-10. Modified binders are specified in table 702.01-1. In looking at M320-10 one might infer that a wide variety of binder grades are available for specification. In practice

only a few essential grades are generally available and used in Ohio.

PG 64-22 is the basic grade of un-modified binder used for climate conditions in Ohio in normal (medium) traffic applications. Binder grades for use in heavy and slow-moving traffic applications are PG 70-22M and PG 76-22M. Under ODOT specifications grades including the “M” designation are polymer modified binders.

PG 64-28 is used in 442 intermediate courses. It is not required to be a modified asphalt binder though it is used in pavements for heavy traffic use.

A relatively new grade of highly-polymerized asphalt, PG 88-22M, has recently been added to ODOT specifications. This material may be used for a variety of applications. It provides enhanced stability for extreme resistance to deformation (i.e. rutting and shoving), improves cracking resistance, and increases pavement strength – allowing for pavement thickness reduction. PG 88-22M is also useful for low permeability asphalt mixtures used for bridge deck waterproofing.

Traffic Considerations When Choosing Binder Grade

- For ordinary, constantly-moving traffic applications, use the standard 441 mix types with PG 64-22. For heavy, constantly-moving traffic applications use the standard 441 or 442 mix types with PG70-22M. Where deformation is a particular concern, because of very heavy traffic and/or conditions that cause traffic to be slow-moving, stopping, starting or turning, Use 442, Type A and change the binder type with an "as per plan" note to PG 76-22M or PG 88-22M.

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.

Language for Specifying Asphalt Mixture Composition

Ohio utilizes quality assurance (QA) specifications for the production of asphalt mix. 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. Where an agency is unable to fulfill this role it is beneficial 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 asphalt mixture with aggregate, asphalt binder, and modifiers (if specified) meeting Ohio Department of Transportation (ODOT) requirements. Prior to producing asphalt mix 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 being used), 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 3 Asphalt Concrete Mix Design Technician approved by 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 asphalt mixture. Acceptance testing and monitoring of mix production are performed by the owner agency. The ODOT specifications detail these requirements. For local agencies, however, it may be necessary to modify the method and point of mix acceptance. The following 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 2 Asphalt Quality Control Technician 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 (pavement preservation) surface treatments Thinlays (thin 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 Item

424, Fine Graded Polymer Asphalt Concrete, outlines the mixture requirements.

For other pavement preservation thin overlay applications, FPO has developed a Thinlay Asphalt Concrete specification for mixes intended for thin overlays on a variety of traffic applications from heavy to ultralight. These mixes are intended to improve performance in Thinlay applications over standard mixes.

For rutting resistance stone mastic asphalt, ODOT Item 443, 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 and as well, ground tire rubber (GTR).

For low volume traffic roads and streets FPO has developed a specification known as 404LVT to provide a 404-like, fine-graded mixture especially suited to use on low traffic volume roadways. The specification, 404 LVT is based on the Ohio Department of Transportation’s historical mix formulations and can be found on the FPO website. Alternatively, an agency might choose a Thinlay Asphalt Concrete mix formulated for light or ultra light traffic or a mix designed under SS 823.

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 441 and 442 – 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
- Item quantity
- Language for specifying asphalt composition
- Method & point of acceptance, and
- Sometimes, the grade of binder and traffic designation.

An example item description is: *441, Asphalt Concrete Surface Course, Type 1, (448), PG 64-22*

Under ODOT’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.

instances where modifiers have demonstrated good success.

Specialty mixes are available to treat a variety of pavement conditions. Preventive maintenance, high stress areas, and increased pavement life are all



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 Manual, July 2014 with revisions, Ohio Department of Transportation
- Construction & Materials Specifications, 2016, Ohio Department of Transportation Asphalt Institute publication MS-26, Asphalt Binder Handbook
- Asphalt Institute publication MS-2, Asphalt Mix Design Methods
- QA/QC Presentation, William Fair, P.E., Flexible Pavements of Ohio
- Asphalt Pavement Design & Construction Guide, February 1, 2000, Flexible Pavements of Ohio
- Thinlay Asphalt Concrete (20January2016)
- Item 404-LVT (LowVolume Traffic) Asphalt concrete 95June2015)