

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

GUIDE FOR EVALUATION OF ASPHALT
PAVEMENTS WITH SUBSTANDARD PROPERTIES

1. PURPOSE

- 1.1 To provide a consistent approach and checklist for use by construction project personnel when evaluating asphalt pavement with substandard properties and aid in any subsequent decision.
 - 1.2 Identify pavement factors and characteristics most critical to satisfactory performance.
 - 1.3 Validate, if it is appropriate, the removal of the pavement in question.
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2. SCOPE

- 2.1 This procedure shall be applicable to all newly placed Marshall and Superpave mix base layers and wearing courses.
 - 2.2 All facets of construction including quality control, quality assurance, and referee sampling and testing, along with construction practices and methods, and observable distresses and defects in the finished mat should be considered when determining any action required to remediate the newly placed asphalt course(s). It is generally necessary to consider all facets when trying to determine the cause of substandard properties and observed distresses, and then decide on remedial action that needs to be executed.
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3. REFERENCED DOCUMENTS

- 3.1 *WVDOH Standard Specifications Section 410: Asphalt and Wearing Courses, Percent Within Limits (PWL)*
 - 3.2 *Hot-Mix Asphalt Paving Handbook 2000*
 - 3.3 *WVDOT/DOH Asphalt Field Technician Handbook*
 - 3.4 *WVDOT/DOH Construction Manual*
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4. REVIEW OF PROJECT DOCUMENTATION

- 4.1 Procedures and guidelines for testing, recording data and calculating pay deductions or otherwise are documented in our Standard Specifications and Materials Procedures. These steps are generally followed and in most cases done correctly. However, prior to deciding to remove and replace a particular section of asphalt

pavement, the raw data yielding the substandard mixture properties should be examined. All applicable data, including sample/specimen mass and aggregate specific gravity, should be evaluated for obvious errors.

4.2 Quality Control Data

- 4.2.1 As per the requirements of the Division's Standard Specifications and applicable materials procedures, the contractor performs quality control testing to ensure the quality of the asphalt mixture produced. Depending on the particular timing and frequency, some quality control tests may fall near an acceptance test whose results revealed substandard mixture properties. In these cases, the results from the quality control test should be compared to the results from the acceptance test. While it is possible that materials or plant operations may change between quality control and acceptance tests, resulting in different mixture properties, the examination of quality control data may prove valuable in validating questionable property values.

4.3 Quality Assurance Testing

- 4.3.1 Depending on whether or not the same testing equipment was utilized, the similarity in results between the contractor's quality control tests and the Department's verification or acceptance tests may vary. However, provided the results compare within the tolerances from the specifications, any substandard mixture properties from the acceptance test should be considered valid.

4.4 Referee Testing

- 4.4.1 For particular projects on the National Highway System, using a dedicated sample for this purpose, Division personnel are required to compare results obtained with the sampling procedure and testing equipment used for the contractor's quality control test. It is further required that Division personnel utilize different testing equipment than that used when testing for acceptance.
- 4.4.2 Depending on the sample selected for the comparison, some referee tests may compare directly with, or fall near, an acceptance test whose results revealed substandard mixture properties. In these cases, the results from the referee test should be compared to the results from the acceptance test. In most circumstances, the testing equipment will differ between the referee test and the comparison test. However, for the sake of validating the questionable acceptance results, this comparison may prove helpful. Provided the results from the acceptance test and the referee test are similar, comparing within the tolerances from the Standard Specifications, any substandard mixture properties from the acceptance test should be considered valid.

5. REVIEW OF PREVIOUS CONSTRUCTION LOTS

- 5.1 While it is possible that ingredient materials or plant operations may vary between sublots of production and result in somewhat different mixture properties, the examination of test data or pavement performance for previously produced mixtures may prove useful in validating questionable property values. However, when

performing such a comparison, it is extremely important to evaluate the component materials to ensure that the two mixtures, the previously produced material and the material with substandard properties under evaluation, are comprised of essentially the same ingredients and proportions.

- 5.2 When the similarity between the previously produced material and the material with substandard properties has been verified, obvious errors in test results should become apparent. For example, if adjoining sections of pavement with similar levels of air voids (VTM) are performing in a significantly different manner, then one of the VTM test results from the two periods of production is likely incorrect. General instructions on reviews such as these are very difficult; performing such comparisons requires considerable experience and should be performed on a case-by-case basis. Familiarity with a particular aggregate, mixture, or mixing plant is invaluable in these instances.

6. REVIEW AND OBSERVATION OF TESTING PERSONNEL

- 6.1 The practices of the individuals responsible for the performance of the test and documentation of the data that resulted in the substandard mixture properties may be observed. Although Asphalt Plant or Field Technicians are considered to be qualified to perform the corresponding quality-control, acceptance, or verification testing that identified the questionable material, an informal review of the procedures employed by the involved technicians may reveal an important deviation.
- 6.2 Also, as part of a continuing evaluation, it is often beneficial to routinely review the practices of all testing personnel to ensure that the proper sampling and testing techniques are being routinely utilized. The purpose of this exercise is to verify the continued competency of the involved technicians and thereby eliminate all doubt in this regard.

7. RE-EXAMINATION OF RETAINED MIXTURE SAMPLES

- 7.1 *Loose asphalt mixture (Gmm samples)* - Prior to deciding to remove and replace a particular section of asphalt pavement, all available mixture samples from the affected production should be analyzed. These samples include the loose asphalt mixture obtained for theoretical maximum specific gravity (Gmm) determination. The Gmm of an asphalt mixture is a very important property. This value influences asphalt binder content (AC) when "back-calculation from the Gmm" is selected as the method for AC determination. The Gmm value also affects the VTM and determines the daily target density which is used with roadway cores to determine the level of compaction achieved. It is critically important that the correct Gmm value be identified before deciding to remove and replace any pavement.
- 7.2 *Superpave gyratory compactor (SGC) or Marshall compacted specimens* - As stated previously, it is absolutely necessary that all available mixture samples from the applicable period of asphalt mixture production be scrutinized prior to removing and replacing any questionable asphalt pavement. In addition to the Gmm samples,

the bulk specific gravity (Gmb), determined from the compacted specimens, affects both the VTM and voids-in-the mineral aggregate (VMA). As with the Gmm determination, it is equally important that the correct Gmb value be identified before deciding to remove and replace any asphalt pavement.

- 7.3 *Pavement density cores* - The masses of the original pavement cores utilized in the density determination should be closely inspected. While it is not always apparent when a minor error has occurred in the Gmb determination, obvious mistakes in the core evaluation process should be easily identified. Such mistakes may involve recorded masses that are clearly not practicable. As a check, it is also possible to determine the mass of the original density cores again. For example, error in the test method can result from the collection of air bubbles underneath portions of the plastic used to seal the core specimen when Gmb is evaluated with the vacuum seal method. All of these values should be inspected for potential error when making a decision regarding removal of pavement or otherwise.

8. MIX OR LAYER POSITION CONSIDERATION

- 8.1 A flexible pavement structure is typically composed of several layers of material. Each layer receives the load from the above layer, dissipates the stress from that load, and then passes the dissipated or lessened stress to the next layer below. Thus, the further down in the pavement structure a particular layer is, the lesser the stress (in terms of force per area) it must carry.
- 8.2 The most critical mixture in any pavement structure is the surface course. This mixture directly supports the traffic loading, provides the necessary level of skid resistance, and is the first defense against environmental impact on the pavement structure. Therefore, the highest standard of quality must be applied to the surface course. For these reasons, asphalt surface mixtures with substandard properties should strongly be considered for removal and replacement.
- 8.3 The HMA base course may comprise of one or more layers. It is critical in distributing traffic load and dissipating stress within the pavement structure down to a drainage layer, which is generally constructed on top of the subgrade. The higher up the layer is in the pavement structure, the more critical this layer can become. It should be noted that the use of Marshall Base 2 or Superpave 19 mm mixes just below surface courses of less than two inches in thickness generally results in a fair amount of distress being transmitted to the surface of the pavement. Therefore, consideration should be given to removal and replacement of the affected area in these mixes when such mixes are shown to have failing substandard properties. The lower in the pavement structure the layer is, the more forgiving. Substandard properties may be allowed to remain in place in many instances.

9. PAVEMENT LOCATION CONSIDERATION

- 9.1 In making the decision to remove and replace a section, the location of the pavement is a key factor.

- 9.2 Intersections, turning lanes, truck lanes, ramps, and steep grades are locations that experience high stress due to the nature of traffic behavior. Deceleration, acceleration, turning movements and/or slow, heavily loaded vehicles are traffic activities that can strain the pavement. Mixture properties of particular concern in these locations include high AC or in-place density or low VTM or VMA. The pavement cannot be expected to perform with mixtures having substandard properties. Strong consideration should be given to removal and replacement on high-speed facilities with heavy amounts of traffic loading.

10. PAVEMENT SURFACE APPEARANCE DEFECT CONSIDERATIONS

- 10.1 *Flushing and Bleeding* occur when the liquid asphalt cement comes to the top of the mix surface generally under traffic loading and are usually in the form of long streaks or strips along the wheel paths within the mat. *Fat Spots* are more isolated areas where liquid asphalt comes to the surface of the mix, but are not necessarily concentrated in the wheel paths. They can occur anywhere across the mat and generally occur during the laydown and compaction process, and in many cases result in very thick patches of free liquid asphalt on the surface of the mat. These characteristics may result from a high AC or in-place density, low VTM or VMA, or an excessively fine gradation. These types of distresses are serious in nature and not easily addressed with remedial treatments. Pavements in this condition often eventually rut, shove, and can present numerous safety concerns.

See the photos below for examples of flushing, bleeding, and fat spots.



Excessive Bleeding and Flushing along wheel paths in new asphalt pavement.



Excessive Fat Spot in new asphalt pavement.

Additional guidance on the evaluation of and severity of flushing can be found in Standard Specifications Section 410, Part 410.7.4 and use of MP 401.07.24.

- 10.1.1 The above defects are all indications of excess binder in the mix and should be considered for removal and replacement if the areas are large enough, occur in a pattern and affect a significant portion of the mix. Specifically, any flushing that extends more than about 30 feet in length and occurs in multiple locations as opposed to an isolated area is a cause for concern. Fat spots that are relatively small (less than approximately 12 inches in diameter) and occur only occasionally are not generally a concern. However, large fat spots (greater than 12 inches in diameter) and/or fat spots prevalent throughout the mat are a concern. The best action is to remove and replace the affected area.
- 10.2 Locations of *rutting or shoving* often occur corresponding to areas exhibiting flushing and bleeding. Again, these types of distresses are serious and present numerous safety concerns. Excessively deep pavement ruts can be a significant hazard to drivers. Along with a likely decreased skid resistance to begin with, water can pond in ruts and create a potential for vehicular hydroplaning and excessive spray, which can obscure a driver's vision. Ponded water may also freeze in cold temperatures and result in the formation of ice.
- 10.2.1 Therefore, rutting that occurs within the first three months of service life and exceeds $\frac{1}{4}$ inch may be an indication of further rutting and should be monitored further. Additionally, rutting that occurs within the first three months of service life and exceeds $\frac{1}{2}$ inch is considered a safety hazard and remediation is required. The best action is to remove and replace the affected area.



Excessive rutting and shoving in new asphalt pavement. Note the displacement of the road lettering. Also note the presence of corresponding flushing of liquid asphalt.

10.3

A *segregated* mat can result from a number of factors ranging from the aggregate stockpiles at the asphalt mixing plant to the paving equipment at the project site. If segregation is widespread over several hundred feet of continuous pavement, removal and replacement of the affected area is probably the best option. When the segregated areas are discontinuous or “spotty,” removing and replacing various areas introduces a number of new construction joints. This scenario may often be less desirable than the original, segregated mat. In these cases, a fine-textured seal course is an option to consider for the affected locations.



Segregation in new asphalt pavement, Superpave 9.5 mm mix.

Additional guidance on the evaluation of and severity of segregation can be found in Standard Specifications Section 410, Part 410.7.3 and use of MP 401.07.24.

- 10.4 *Raveling* generally begins with the loss of surface fines or smaller aggregates, and then progresses to include larger aggregates sizes. It often occurs within a segregated mat after exposure to traffic and climate. For this reason, raveling is considered serious because some amount of coated aggregate has already been lost at the pavement surface, presenting more opportunity for moisture infiltration or premature oxidation.



Photo shows excessive raveling of pavement within an area of segregation during first year of service – 12.5 mm Superpave mix.



Photo showing close view of raveling from photo above.



Photo shows advanced raveling and segregation of a Superpave 12.5 mm mix.

As with segregation, if the raveling is widespread and generally continuous, removal and replacement of the affected area is probably the best option. Excessive raveling and segregation can result in premature cracking of the asphalt pavement. However, when the raveled areas are discontinuous, removing and replacing various unconnected areas introduces a number of new construction joints. This scenario may often be less desirable than the original pavement. In these cases, a fine-textured seal course or micro surfacing may be an option to consider for the affected locations.

- 10.5 *Tearing or pulling* is another defect that can be found in newly placed mat. The mat can be torn or pulled by a paver that is traveling too fast, a paver with a screed that is worn or not heated properly, compacted by a roller that is traveling too fast or rolling a tender mix. The areas affected will have reduced density and are more susceptible to raveling and to the adverse effects of moisture. Depending on the severity of the tears, it may become a safety concern. The best option is to remove and replace the affected area.



**Tear in new asphalt pavement. Note water stains along cracks.
Area has been marked for repair.**

- 10.6 *Checking* is defined as short transverse cracks, usually 1 to 3 inches in length and generally a little less than 1 inch to as much as 3 inches apart, that develop in the surface of the mat during the compaction process. Although the cracks generally extend from about 3/8 inch to 1/2 inch in depth, they are considered detrimental to long-term pavement performance. It is necessary to determine if the cause for checking is primarily mix deficiencies resulting in a tender mix, or excessive deflection in a pavement structure under the compaction equipment. Mixes that exhibit checking are a direct indication of likely insufficient density; therefore, the pavement life under traffic will likely be greatly reduced.



Typical observations of checking in new asphalt pavement – Superpave 9.5 mm mix.

- 10.6.1 If it can be determined that checking is caused by the presence of a yielding foundation (such as by means of proof rolling to detect deflection or otherwise) under the new asphalt layer, the best solution is to remove and properly repair the existing pavement structure by also removal and replacement of the yielding sub-base and/or subgrade material. This work may be outside of the scope of the original contract and will need to be evaluated prior to the repair process for contractual considerations.
- 10.6.2 If checking is determined to be the result of mix characteristics only, it may also be possible to seal the course affected by use of a fine textured asphalt mix or microsurfacing course or other seal course to the satisfaction of the Engineer. Otherwise, it may be necessary to remove and replace the areas affected.
- 10.7 *Bumps* in the surface may be the cause of slight shoving and transverse tearing of the pavement, and will at a minimum cause an increase in roughness. If they are bad enough that tearing is present, they can lead to other issues described above. If not torn, the pavement's structural capacity is only affected if the bumps are severe enough to cause vehicles to bounce significantly as they traverse the uneven pavement. This would increase impact loading and thus increase the overall

loading to which the pavement is subjected. In such severe cases, the likely best action is removal and replacement of the affected area.



Photo showing excessive transverse bumps and associated transverse tearing as well. This photo also shows longitudinal cracking in the center of the mat.


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