Kentucky Method 64-448-~~04~~09
~~Approved 1/5/04~~Revised 5/13/09
Supersedes KM 64-448-04
Dated 1/5/04

EVALUATION OF ASPHALT PAVEMENT WITH SUBSTANDARD PROPERTIES

1. SCOPE

1.1. The Department has developed this method in terms of a checklist for use by project personnel when evaluating ~~hot-mix~~ asphalt ~~(HMA)~~ pavement with substandard properties. This method is referenced in the footnotes of the Lot Pay Adjustment Schedules for Compaction Option A and B mixtures in the Department's *Standard Specifications for Road and Bridge Construction*.

1.2. The items noted in this document are for the consideration and benefit of project personnel in formulating a decision concerning ~~HMA~~asphalt pavement with substandard properties. Specifically, this decision will validate if it is appropriate to require removal of the pavement in question. Through the statewide use of this checklist, the Department seeks to establish a consistent approach in evaluating ~~HMA~~asphalt pavement with substandard properties.

1.3. This checklist provides guidance to project personnel concerning those pavement factors and characteristics most critical to satisfactory performance. Many different facets of the construction operation are discussed; it is crucially important that all applicable factors be carefully considered prior to formulating a decision regarding removal and replacement of a section of pavement.

1.4. Because each project and mixture is unique, probably no single factor will determine the outcome of the pavement in question. Rather, it is likely that a preponderance of evidential information and observations from various sources, coupled with sound engineering judgment, will result in the ultimate decision.

2. EVALUATION OF TEST DATA AND PAVEMENT PERFORMANCE

2.1. *Re-examination of test data*

The Asphalt Mixtures Acceptance Workbook performs the necessary calculations for acceptance and verification testing. As such, no computation errors should occur if the test results are entered 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.

2.2. *Review of process-control, verification, and independent assurance data*

2.2.1. *Process-control data*

In addition to the required acceptance testing, the contractor also performs process-control testing to ensure the quality of ~~HMA~~the asphalt mixture produced between acceptance tests. Depending on the particular timing and frequency, some process-control tests may fall near an acceptance test whose results revealed substandard mixture properties. In these cases, the results from the process-control test should be compared to the results from the acceptance test. While it is true that materials or plant operations may change between process-control and acceptance tests, resulting in different mixture properties, the examination of process-control data may prove valuable in validating questionable property values.

2.2.2. *Verification data*

According to the Department's *Standard Specifications*, Department personnel are required to verify the contractor's acceptance test at a frequency of one sublot per lot. In the case where the substandard mixture properties from a given acceptance test fall in the particular sublot that the Department verifies, the results from the verification test should validate the questionable values. Depending on whether or not the same testing equipment was utilized, the similarity in results between the contractor's acceptance test and the Department's verification test will vary. However, provided the results compare within the tolerances from the Department's *Standard Specifications*, any substandard mixture properties from the acceptance test should be considered valid.

2.2.3. *Independent assurance data*

For particular projects on the National Highway System, using a dedicated sample for this purpose, Department personnel are required to compare results obtained with the sampling procedure and testing equipment used for the contractor's acceptance test. ~~When possible, it is~~It is further required that Department personnel utilize different testing equipment than that used when testing for acceptance. Depending on the sample selected for the comparison, some independent assurance tests may compare directly with, or fall near, an acceptance test whose results revealed substandard mixture properties. In these cases, the results from the independent assurance test should be compared to the results from the acceptance test. In most circumstances, the testing equipment will differ between the independent assurance 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 independent assurance test are similar, comparing within the tolerances from the Department's *Standard Specifications*, any

substandard mixture properties from the acceptance test should be considered valid.

2.3. *Review of test data and pavement performance for previous lots of production*

2.3.1. While it is true that ingredient materials or plant operations may change between sublots of production, resulting in 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.

2.3.2. 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 (AV) are performing in a significantly different manner, then one of the AV 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.

3. REVIEW AND OBSERVATION OF TESTING PERSONNEL

3.1. The practices of the individual responsible for the performance of the test and documentation of the data that resulted in the substandard mixture properties may be observed. Although any Superpave Plant Technologist or Superpave Mix Design Technologist is considered qualified to perform the process-control, acceptance, or verification testing that identified the questionable material, an informal review of the procedures employed by the involved technologists may reveal an important deviation.

3.2. 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 utilized. The purpose of this exercise is to verify the continued competency of the involved technologists and thereby eliminate all doubt in this regard.

4. RE-EXAMINATION OF RETAINED MIXTURE SAMPLES

4.1. *Loose asphalt mixture (G_{mm} 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 (G_{mm}) determination. As required by the Department's *Standard Specifications*, the contractor must retain these samples for five working days. The ~~theoretical maximum specific gravity, or~~ G_{mm}~~,~~ of an asphalt mixture is a very important property. This value influences asphalt binder content (AC) when "back-calculation from the G_{mm}" is selected as the method for AC determination. The G_{mm} value also affects the AV and determines the target "solid density" for the roadway cores. It is critically important that the correct G_{mm} value be identified before deciding to remove and replace any pavement.

4.2. *Superpave gyratory compactor (SGC) specimens*

As stated previously, it is absolutely necessary that all available mixture samples from the applicable period of ~~HMA~~asphalt mixture production be scrutinized prior to removing and replacing any questionable asphalt pavement. In addition to the G_{mm} samples, the contractor is required to retain the SGC specimens from all acceptance tests for five working days. The bulk specific gravity (G_{mb}), determined from these SGC specimens, affects both the AV and voids-in-the mineral aggregate (VMA). As with the G_{mm} determination, it is equally important that the correct G_{mb} value be identified before deciding to remove and replace any asphalt pavement.

4.3. *Pavement density cores*

The ~~weights~~masses of the original pavement cores utilized in the density determination should be closely inspected. While it is not apparent when a minor error has occurred in the G_{mb} determination, obvious mistakes in the core evaluation process should be easily identified. Such mistakes may involve recorded masses that are clearly not practicable. As an approximation, it is also possible to ~~reweigh~~determine the mass of the original density cores again. Because it is very difficult to dry the previously tested core back to its original mass, this practice is not appropriate to precisely determine density. However, as a "rough check," this procedure should identify obvious errors in the recorded masses.

5. CONSIDERATION OF THE POSITION OF THE MIXTURE WITHIN THE PAVEMENT STRUCTURE

5.1. *Surface*

5.1.1. 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 endures the environmental conditions. Therefore, the highest standard of quality must be applied to the surface

course. For asphalt mixtures with high AC or in-place density or low AV or VMA, rutting/shoving and flushing/bleeding are serious concerns in the surface mixture. Surface pavements with substantial rutting in the wheelpaths are potentially hazardous due to hydroplaning during heavy rains. Also, surface pavements with extended segments of flushing/bleeding present an increased skidding potential. For asphalt mixtures with low AC or in-place density or high AV or VMA, raveling and stripping are concerns in the surface mixture. Segregation is a major issue as well in the surface course.

5.1.2. For these reasons, asphalt surface mixtures with substandard properties should strongly be considered for removal and replacement. Specific conditions that could develop into a major pavement distress or failure are exacerbated more severely in the surface course than in any other mixture within the pavement structure. In some instances, depending on the particular pavement distress, a fine-textured seal course over the affected area is an option to consider. However, in general, the highest possible standard should be applied when considering surface mixtures. Removing and replacing substandard asphalt surface mixtures may prevent numerous problems in the underlying layers for years to come.

5.2. *Upper base course (top 4 in. of pavement structure)*

5.2.1. Although not as crucial as the surface mixture, upper base courses within the top four inches of the surface are very important as well. These layers provide the strength that ultimately supports the traffic loading and are critical to the drainage characteristics of the overall pavement structure. Larger nominal-maximum sizes of asphalt base mixture are typically permeable and experience significant levels of moisture infiltration. For base mixtures with high AC or in-place density or low AV or VMA, rutting and shoving is possible in the base layers and the surface above. For asphalt mixtures with low AC or in-place density or high AV or VMA, stripping is a major concern due to the likely presence of moisture in the base layer. Also, segregation is a definite possibility in these asphalt base courses.

5.2.2. Therefore, asphalt base courses within the top four inches of the surface with substandard properties should be considered for removal and replacement. If the volumetric properties are grossly deficient, removal and replacement of the affected area is recommended. If the properties are marginally substandard, the base courses may be accepted in place. In the case of segregated base or low AC or in-place density, a fine-textured seal course over the affected area is an option to consider.

5.3. *Lower base course*

5.3.1. Asphalt mixtures placed as lower base courses, more than four inches from the surface, are more forgiving than the other layers previously discussed. These mixtures contribute to the strength of the matrix that supports the traffic loading; these layers also experience a significant amount of moisture infiltration as the pavement drains from upper layers. However, substandard mixture properties in lower base courses are not as likely to develop into pavement distresses. In fact, high AC or in-place density or low AV or VMA may be desirable in some cases. Higher AC and lower AV may be beneficial in lower base courses as protection from moisture damage and as a deterrent to "bottom-up" fatigue cracking. For these reasons, lower base courses comprised of asphalt mixtures with substandard properties may be allowed to remain in place in many instances.

5.3.2. Lower base courses with low AC or in-place density or high AV or VMA are more disturbing. Because these mixtures are located deep within the pavement structure, visible distresses at the pavement surface resulting from substandard mixture properties in lower base courses are less likely. On the other hand, damage resulting from moisture infiltration and saturation would be the more probable pavement failure mechanisms. Due to their "open" nature, asphalt mixtures with low AC or in-place density or high AV or VMA are more susceptible to moisture damage. In these cases, a fine-textured seal course is an option to consider for the affected locations to protect the underlying "open" mixture.

6. CONSIDERATION OF THE LOCATION OF THE PAVEMENT

6.1. *Intersection*

More stresses are applied to asphalt pavements at intersections than probably any other location of the highway. Deceleration, acceleration, turning movements, and increased temperatures due to engine heat make intersections a prime location for a number of pavement distresses. Intersections occasionally suffer from rutting, shoving, or occurrences of flushing, bleeding, or fat spots. For these reasons, asphalt pavement with questionable properties placed at, or within 500 feet of, intersections should be removed and replaced. Particularly, asphalt pavement with high AC or in-place density or low AV or VMA should be removed and replaced at or near intersections. Due to the punishing conditions, asphalt mixtures with acceptable properties at placement sometimes do not perform desirably at intersections over the expected life of the pavement. Certainly, asphalt mixtures with substandard properties cannot be expected to perform either.

6.2. *Turning lane*

Much the same as intersections, turning lanes experience severe stresses due to the nature of the traffic behavior in these areas. Rutting, shoving, or occasional occurrences of flushing, bleeding, or fat spots are possible. Due to the criticality of these locations, asphalt pavement with substandard properties placed in turning lanes should be removed and replaced. Mixture properties of particular concern in these locations include high AC or in-place density or low AV or VMA. As in intersections, asphalt mixtures with these characteristics cannot be expected to perform under such conditions.

6.3. *Truck lane*

Much the same as intersections and turning lanes, truck lanes experience severe stresses due to the nature of the traffic behavior in these areas. Typically, the traffic utilizing such locations is slow, heavily loaded vehicles. As a result, rutting, shoving, or occasional occurrences of flushing, bleeding, or fat spots are possible. Asphalt pavement with substandard properties placed in truck lanes should be removed and replaced. Mixture properties of particular concern in these locations include high AC or in-place density or low AV or VMA. As in intersections and turning lanes, asphalt mixtures with these characteristics cannot be expected to perform acceptably under such heavy loads and slow loading conditions.

6.4. *Ramp*

Much the same as intersections and turning and truck lanes, ramps also experience severe stresses due to the nature of the traffic movements in these locations. Normally on ramps, the traffic is decelerating, accelerating, or turning. The stresses generated as a result of these actions occasionally lead to rutting, shoving, or occurrences of flushing, bleeding, or fat spots. Again, asphalt pavement with questionable properties placed on ramps should be removed and replaced. Specifically, mixture properties such as high AC or in-place density or low AV or VMA in these areas are highly undesirable. As in intersections and turning and truck lanes, asphalt mixtures with these properties cannot be expected to perform for the expected life of the pavement on ramps either.

6.5. *Steep grade*

Much the same as intersections, turning lanes, truck lanes, and ramps, pavement located on steep grades also experiences severe stresses due to the traffic speed in these locations. On such grades, the traffic may be moving more slowly than in other areas. Heavily loaded trucks are especially susceptible to decreased speeds on steep grades. The stresses generated as a result of these slow-moving, heavy loads occasionally lead to rutting, shoving, or occurrences of flushing, bleeding, or fat spots. As a rule, asphalt pavement with substandard properties placed on

steep grades should be removed and replaced. Specifically, mixture properties such as high AC or in-place density or low AV or VMA in these areas are highly undesirable. Asphalt mixtures with these properties cannot be expected to perform for the expected life of the pavement in such locations.

6.6. *Low-traffic facility*

6.6.1. Facilities that carry lower amounts or loads of traffic are certainly more forgiving than the other conditions previously discussed. Lesser traffic levels do not exacerbate potential pavement distresses as do higher amounts or loads of traffic. Asphalt mixtures with high AC or in-place density or low AV or VMA may perform adequately on low-traffic facilities. For these reasons, asphalt mixtures with marginally substandard properties may be allowed to remain in place in many instances.

6.6.2. Of more concern would be mixtures with low AC or in-place density or high AV or VMA. Because rutting/shoving or flushing/bleeding is less likely on these facilities, the damage resulting from environmental conditions would be the probable cause of any premature pavement failure. Due to their "open" nature, asphalt mixtures with low AC or in-place density or high AV or VMA are more susceptible to environmental damage. In these cases, a fine-textured seal course is an option to consider for the affected locations to protect the underlying "open" mixture.

6.7. *High-speed facility*

Similar to low-traffic facilities, high-speed facilities can be more forgiving than other traffic conditions. Although many of these facilities carry heavy amounts and loads of traffic, the speed of the traffic ensures that any given portion of pavement is loaded only for a small period of time. For this reason, mixture properties that could result in various pavement distresses on facilities with lower speeds may not develop into distresses on high-speed facilities. Asphalt mixtures with high AC or in-place density or low AV or VMA may perform adequately on these facilities. Therefore, asphalt mixtures with marginally questionable properties may be allowed to remain in place for many such pavements. However, this determination is difficult: even though the traffic may be categorized as "high-speed," the amount and loading of that traffic is critical. If the pavement in question exhibits any potential distress whatsoever, strong consideration should be given to removal and replacement on high-speed facilities with heavy amounts or loading of traffic.

6.8. *"Straight-through" facility*

Facilities that carry little or no "stop and start" or turning traffic are also sometimes forgiving. As stated previously, these sorts of actions apply severe stress to the pavement structure. In turn, these forces often develop into various

pavement distresses. As with high-speed facilities, pavements whose traffic is primarily steady and "straight through" may perform successfully even though the asphalt mixture that comprises the pavement exhibited substandard properties. In particular, asphalt mixtures with high AC or in-place density or low AV or VMA may perform adequately on these facilities. Therefore, asphalt mixtures with marginally substandard properties may be allowed to remain in place for these conditions. As with high-speed facilities, though, the decision is a difficult one. These "straight through" facilities may carry light, moderate, or heavy traffic. When the amount and loading of that traffic is considered moderate to heavy, serious consideration should be given to removal and replacement.

7. CONSIDERATION OF THE APPEARANCE OF THE PAVEMENT

7.1. *Flushing/bleeding/fat spots*

A relatively new pavement mat that displays locations of excessive asphalt binder such as flushing, bleeding, or a significant number of fat spots should be considered for removal and replacement. These characteristics may result from a high AC or in-place density, low AV 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 rut, shove, and present numerous safety concerns. The best action is to remove and replace the affected area.

7.2. *Rutting/shoving*

As mentioned previously, a relatively new asphalt pavement that displays locations of rutting or shoving may suffer from a high AC or in-place density, low AV or VMA, or an excessively fine gradation. Locations of rutting or shoving often occur "hand-in-hand" with flushing and bleeding sites. Again, these types of distresses are serious in nature and present numerous safety concerns such as potential opportunities for hydroplaning and decreased skid resistance. The best action is to remove and replace the affected area.

7.3. *Segregated*

A segregated mat can result from a number of sources, from the aggregate stockpiles at the asphalt mixing plant to the paving equipment at the project site. However, considering mixture properties, low AC or in-place density, high AV or VMA, or an excessively coarse gradation may contribute to segregation. When such properties are identified through normal acceptance or verification testing and mat segregation is apparent, remedial actions are possible. 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.

7.4. *Raveling*

A raveled pavement may display many of the same characteristics as a segregated mat. Accordingly, many of the same mixture properties that contribute to segregation also can lead to raveling. These properties include low AC or in-place density, high AV or VMA, or an excessively coarse gradation. In fact, raveling often occurs within a segregated mat after exposure to traffic and climate. For this reason, raveling is somewhat more serious because some amount of coated aggregate has already abandoned the pavement structure, presenting more opportunity for moisture infiltration or premature oxidation. As with segregation, if the raveling is widespread and generally continuous in nature, removal and replacement of the affected area is probably the best option. 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 is an option to consider for the affected locations.

7.5. *Inadequately coated*

A mat containing inadequately coated aggregate may exhibit many of the same characteristics as a raveled pavement. The obvious mixture property causing this phenomenon is low AC. Inadequate coating will often lead to raveling and a variety of other pavement distresses. Since the mixture in such a condition is fundamentally flawed, possible corrective actions are few. Simply sealing the affected area is not desirable; the weak plane of poorly coated material remains in the pavement structure. Removal and replacement of the affected area is normally the proper decision.

7.6. *Stripping*

Stripping normally does not occur in a new asphalt pavement. The process of stripping requires prolonged exposure to moisture and traffic. However, if some of the other distresses previously discussed were present and sufficiently severe, stripping could possibly occur early in the life of the pavement. Severe segregation, raveling, or inadequate coating could result in stripping. As with inadequate coating, stripped pavement is fundamentally flawed and significantly weaker than desirable. Sealing the affected area simply serves to "trap" the stripped layer in the structure. Again, the best action is removal and replacement of the affected area.

7.7. *Broken aggregate*

7.7.1. A new pavement mat with broken aggregate is normally a sign of overzealous compaction, improper rollers or roller patterns, or inadequate lift thickness-to-nominal maximum aggregate size ratio. However, low AC could result in a "dry" mixture that is difficult to compact. In turn, this situation could result in broken aggregate in the mat. Also, breaking aggregate while attempting to compact segregated or inadequately coated mixture is possible.

7.7.2. Even though broken aggregate is normally a construction issue, a pavement mat in this condition may experience some of the distresses discussed previously that result from substandard mixture properties. In many cases, the broken aggregate in an asphalt pavement will disintegrate, leaving "pock-marks" in the mat that present an opportunity for moisture infiltration. This condition may further deteriorate into raveling or stripping over time. As with segregation and raveling, if the broken aggregate is widespread and generally continuous in nature, removal and replacement of the affected area is probably the best option. When the areas of broken aggregate 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 containing the broken aggregate. In these cases, a fine-textured seal course is an option to consider for the affected locations.

APPROVED _____
Director
Division of Materials

DATE _____~~1/5/04~~5/13/09_____

Kentucky Method 64-448-~~04~~09
~~Approved 1/5/04~~Revised 5/13/09
Supersedes KM 64-448-04
Dated 1/5/04