SUPERPAVE MIX DESIGN SP 2 pdf

1: Missouri S&T - Background

The Superpave Mix Design manual presents the concepts and criteria involved with the Superpave asphalt mix design system. The Superpave aggregate tests and criteria are described, including aggregate consensus and source properties, the aggregate gradation control points and the restricted zone.

Page 28 Share Suggested Citation: Volumetric Requirements for Superpave Mix Design. The National Academies Press. This chapter is divided into eight sec- tions: It was found that for these data, the optimum binder content based on min- imum VMA occurred at an average air void content of 3. A variety of models were identified in the literature review for predicting performance-related properties from HMA composition and other properties. Two models for predicting rut resistance were identified, both developed by Witczak and associates 11, In both cases, the model predicted the results of a laboratory test for evaluating rut resistance and not field rutting. The models were similar, and both found that rut resistance increased with decreasing binder volume and air voids and increasing binder viscosity. A serious shortcom- ing of both models was the use of binder apparent viscosity values at The empirical nature of these relationships and their relatively poor accuracy when applied to fatigue of actual pavements are serious shortcomings that lead to the development of a practical continuum damage approach to characterizing fatigue phenomena in HMA as part of NCHRP Projects and A number of researchers in the past attempted to relate mixture volumetrics most often VMA and or asphalt binder film thickness to durability. This work mostly involved conjecture without substantial supporting data and so was inconclusive. The concept of binder film thick- ness remains controversial. Recent research on the permeability of Superpave mixtures in Florida has demon- strated that unlike the relatively fine, dense-graded HMA used in the past, coarse-graded Superpave mixtures can exhibit relatively high levels of permeability unless thor- oughly compacted 3. The substantial data set published by the Florida researchers has been analyzed to generate a use- ful equation for estimating mixture permeability from air void content and aggregate fineness, which is discussed later in this report. This model predicts age hardening of asphalt binder in pavements based upon mean annual air temperature MAAT , binder viscosity, depth in the pavement, and air void content. This model is used later in this report to estimate the effect of changes in mixture composi- tion on typical age hardening of asphalt mixtures and binders. It is essential that this information be included in this report so that researchers attempting to validate the results of this research will under- stand the importance of accounting for the effects of relative compaction. They found that the data could not be used to develop performance models relating in-place air voids to either fatigue or permanent deformation In , Lin- den et al. No analytical studies on the effect of in-place air voids on rut resistance were cited in this study. A number of states have also slightly increased minimum VMA values, providing for somewhat richer mixtures than produced by the current version of Superpave. The lab- oratory tests were designed to provide information concern- ing the rut resistance, fatigue resistance, permeability, and resistance to age hardening of the mixtures studied. The most important of the procedures performed as part of this research included the following tests: The mixtures tested were made using eight different aggre- gates and gradations: All of these mixtures were combined with a performance grade PG binder. In most cases, the design gyration level was , but for some mixtures, Ndesign was All of the California granite mixtures were designed using gyrations. All mixtures were made using three binder contents: The materials used represented a range of aggregate types, gradations, binder grades, and mix- ture compositions. Analysis of Other Data Sets As discussed later in this short report, some of the find- ings made during the research appeared very promising, but somewhat controversial. Therefore, in several cases ver- ification of the findings was attempted using data sets from other research projects. In evaluating the rut resistance of the NCHRP Projects and mixtures, the concept of resistivity was developed and appeared to relate very well to the results of the RSCH test. To further verify these results, field data from three sources was compiled and analyzed: The approach in analyzing the uniaxial fatigue results involved a further development and simplification of con- tinuum damage theory. Because of the variability in fatigue data, the relatively small amount of testing performed as part of NCHRP Projects and and because of the novelty of the approach, further verification of the results was desired. Fatigue Response of Asphalt-Aggregate Mixes Although these data were gathered using flexural fatigue tests, continuum damage theory predicts that the damage in the extreme fiber at the test conclusion for this procedure should be constant and can thus be related to the results of uniaxial tests. The permeability tests performed during this research were very limited. To better understand the rela- tionship between mixture composition and permeability, data from the Florida permeability study was included in this analysis 3. Because understanding the extent and scope of the data used in developing the performance models developed dur- ing this research is essential to interpreting the findings pre- sented in this chapter, the external data sets summarized above are discussed in more detail in the sections below. This unfortunately increases the length and complexity of this report, but makes clear the fact that the findings are based on a much more robust set of data than that which was collected during testing performed under NCHRP Proj- ects and Resistivity can be calculated using the following formula: Instead, it is the inverse of an existing equation for estimating the per- meability of a granular material Therefore, the choice of variables, the values of the exponents, and the value of the constant 4. For laboratory tests, the viscosity should be determined at the same temperature at which the HMA is being characterized. The value used should be some tempera- ture estimated to be characteristic of the overall potential for permanent deformation in the given climate. For example, within the current Superpave system, the critical temperature for rutting used in selecting PG binders is the yearly, 7-day- average, maximum pavement temperature, measured 50 mm below the pavement surface. Furthermore, some researchers and engineers may prefer other approaches to estimating characteristic temper- atures for rutting in HMA pavements. Multiplying resistivity by Ndesign is neces- sary to account for differences in compaction energy, which can increase resistance to permanent deformation independ- ent of mixture composition. The specimens tested represent a wide range of mix composition and Ndesign levels. One possible explana- tion for this is that the limestone aggregate, being relatively soft, breaks down during the RSCH test more than do the harder aggregates. The data used in calibrating the rutting model is summarized in Tables 1 and 2. In calculating resistivity, the 7-day average high pave- ment temperature at a depth of 50 mm was used. A statistical analysis of this data resulted in the following semi-empirical equation: The relationship between this function and the observed rutting rate is shown in Figure 4. The air void content at Ndesign will, in this case, often deviate from 4. Properties of mixtures used in calibration of rutting model. The difference between these rutting rates will then provide an estimate of the effect on rutting rate of deviations from the mix design. Note that the magnitude of the effect of changes in design air void content and in-place air void content appear to be nearly identical. In fact, if in-place air void content is allowed to vary with design air voids i. Summary of factors and levels included in calibration of rutting model. If in-place air voids are assumed to be independent of design air voids, increasing design air void content will improve performance because greater compaction energy is required to reach the target value for in-place voids. Under these conditions, decreasing design air void content will reduce performance because less com- paction energy is then required to reach the target in-place air void level. However, if in-place air voids more or less follow changes in design air voids, there will be little effect on per- formance as a result of changing design air voids. Engi- neers contemplating changes in design air void content should carefully and realistically consider the ways in which such changes will affect pavement performance. The main practical problem is how to establish such control without being unduly restrictive in the requirements for VMA and aggregate gradation. In order to put the previous analysis into perspective, Fig- ure 8 was constructed, which shows the relationship between rutting rate, asphalt binder grade, and Ndesign. Binder PG grade, like FM, is a very important factor in determining mixture rutting rate; in this analysis, increasing the binder grade from a PG to a PG increases the rutting rate by a factor of 2. The effect of compaction is not nearly as large as that of binder grade. Several comments should be made concerning this analy- sis. Therefore, there is some confounding of these effects. Because the proposed relationship for rut resistance was based on mixtures that were mostly made with cubical, well-crushed aggregates with little or no natural sand, extreme caution should be used in applying this model to mixtures containing poor quality aggregates. However, no open-graded mixtures were included in these data. A second important limitation to the proposed model for rut resistance involves the behavior of mixtures at very low air void contents. This is attributable to excessive asphalt binder content, which prevents aggregate particles from developing the internal friction needed for good rut resistance. This phenomenon is not directly addressed in the resistivity equation Equation 1 or the associated equation for rutting rate Equation 2. Therefore, the proposed approach to accounting for the effect of mixture composition on rut resistance should not be applied to mixtures with very low air void contents. Although these caveats to the proposed rutting model are substantial, in essence the proposed model should be valid for mixtures meeting or nearly meeting current require- ments for Superpave mixtures, heavy-duty Marshall mix designs, and SMA mixtures. As discussed in Chapter 3, it appears that the overall level of rut resistance in the vast majority of HMA designed using the Superpave system is adequate. However, some agencies have noted a decrease in fatigue resistance and an increase in permeability with the widespread adoption of Superpave mix design require- ments, and some have increased minimum VMA require- ments to improve fatigue resistance of these materials. The findings above suggest that aggregate specific surface should be increased along with VMA in order to maintain good rut resistance. As discussed below, this will have the added ben- efit of helping to limit HMA permeability. This and other ramifications of the findings presented above are discussed in greater detail in Chapter 3.

2: Superpave Mix Design: Superpave Series No. 2: asphalt-institute: www.enganchecubano.com: Books

Superpave Mix Design: Superpave Series No. 2 Paperback - January 1, The answer is yes - comparing my copy of SP-2 to my friend's SP-1, the two books have.

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