NCHRP Asphalt-Aggregate Mixture Analysis System

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A summary of the procedures for an asphalt-aggregate mixture analysis system (AAMAS) developed under NCHRP Project 9-6(1) is provided. Most of the information is documented and reported in *NCHRP Report 338*. The implementation process of the AAMAS procedure is reviewed, and some of the problems that can be incurred regarding the field control of asphalt concrete mixtures being designed by the AAMAS process are discussed.

The asphalt-aggregate mixture analysis system (AAMAS) research project, NCHRP Project 9-6(1), was initiated because AASHTO realized the importance of tying mixture design to structural design and pavement performance variables (*1*). Project 9-6(1) was completed in three phases. The first phase (completed in October 1986) was concerned with evaluating the feasibility for the development of an AAMAS. Phase I identified the primary forms of pavement distress (associated with both load and environment), evaluated current testing and mixture design procedures, and identified new or modified laboratory procedures to be considered in the development of the AAMAS. Items that the Phase I concept emphasized included mixture preparation, conditioning, testing, and analyzing asphalt concrete specimens to duplicate field conditions. Tests to measure the engineering properties of asphalt concrete mixtures for estimating pavement performance were also included and discussed.

Phases II and III were concerned with developing procedures for the AAMAS concepts and tying structural design to mixture design. This project emphasized compatibility between mixture design and structural design, including the AASHTO design manual. Phase II (completed in February 1989) included the initial development work, and Phase III included follow-up field studies and conversion of the AAMAS into a mixture design procedure. Phase III was completed in May 1990, and the final report for this project was published in March 1991. In summary, Project 9-6(1) resulted in the development of an AAMAS for evaluating dense-graded asphalt concrete mixtures proposed for use primarily on high-volume roadways and in a mixture design procedure based on performance-related criteria. These criteria are compatible with the recommendations from NCHRP Project 1-26 (*2*).

The fourth phase of this evolutionary process was initiated through a series of four 2-day workshops sponsored by FHWA. The purpose of these workshops was to review the current procedures and obtain input and information from state highway agencies (SHAs) on problems with the use of AAMAS to design and evaluate asphalt concrete mixtures in their specific laboratories (*3*). These workshops have been completed.

AAMAS OVERVIEW

Mixture Design and Evaluation

AAMAS consists of three basic laboratory steps. The first step is simply the initial mixture design phase, which is accomplished with current mixture design procedures or with the procedure based on the AAMAS concept (i.e., performance-related criteria). The mixture design procedure using the AAMAS concept is included in Part I of *NCHRP Report 338* (*1*). An agency can use either the AAMAS approach or its own current procedure to determine the design asphalt content and job mix formula. The performance-related mixture design procedure using the AAMAS approach is a scaled-down version of AAMAS; it was formulated considering implementation and production factors in SHA laboratories.

Once an initial mixture design has been completed, these materials are mixed, compacted, and conditioned in the second step. This step includes age-hardening simulations (both for production and for the environment), moisture conditioning, and traffic densification. This second step is the mixture compaction and conditioning phase.

After the materials have been mixed, compacted, and conditioned, the specimens are tested in the third step to measure critical mixture properties. This third step provides the data that can be integrated into pavement design and analysis models to predict pavement performance. This third step is the mixture evaluation phase; it is compatible with results from NCHRP Project 1-26 (*2*). The mixture evaluation phase includes the laboratory testing and performance evaluations.

Procedural Manual

These three steps are integrated in the procedural manual for mixture design and evaluation. The procedural manual (*1*, Part I) is divided into four sections. Figure 1 shows the current AAMAS procedure in flow-chart form, identifying

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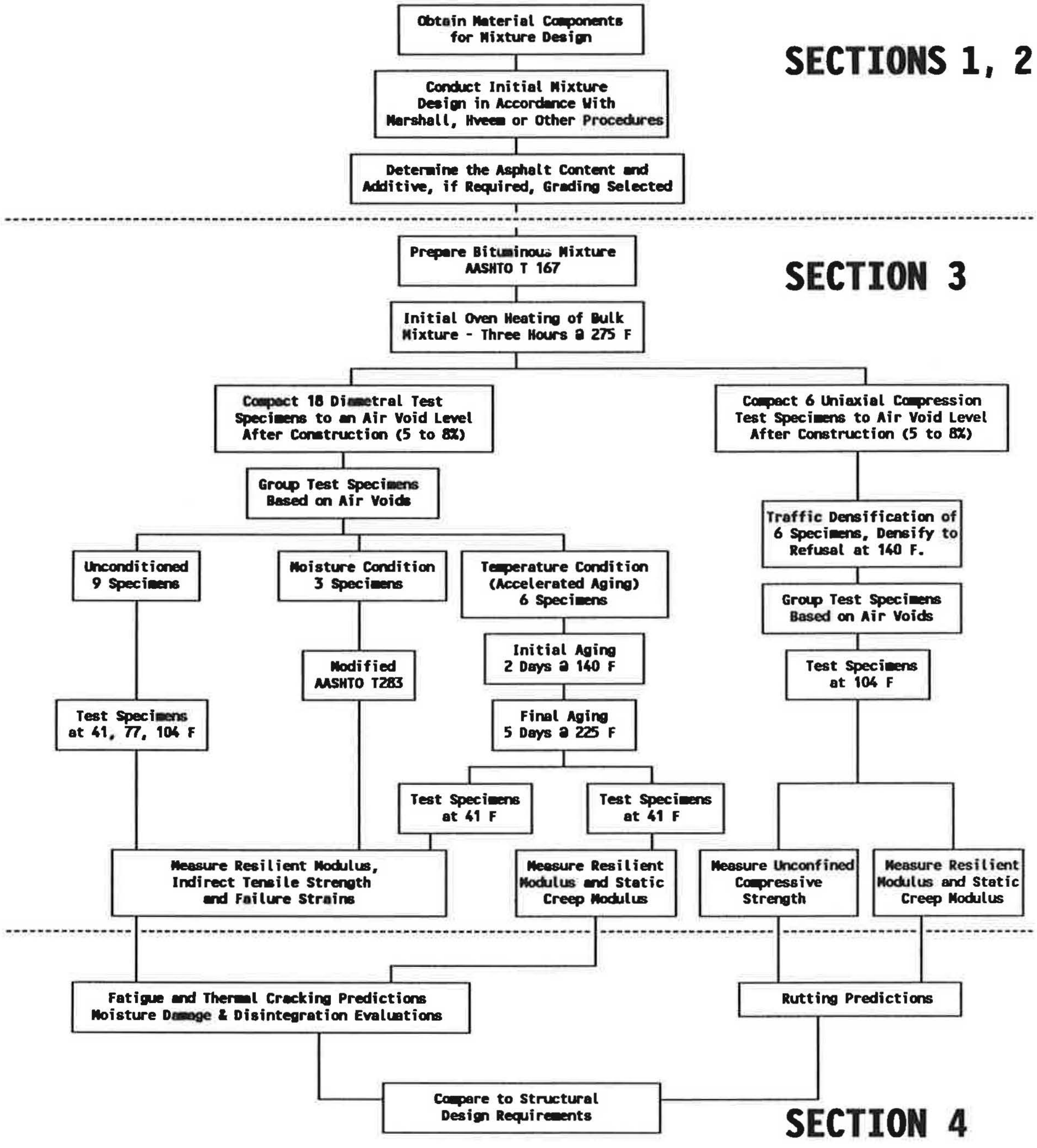


FIGURE 1 Flow Chart for AAMAS.

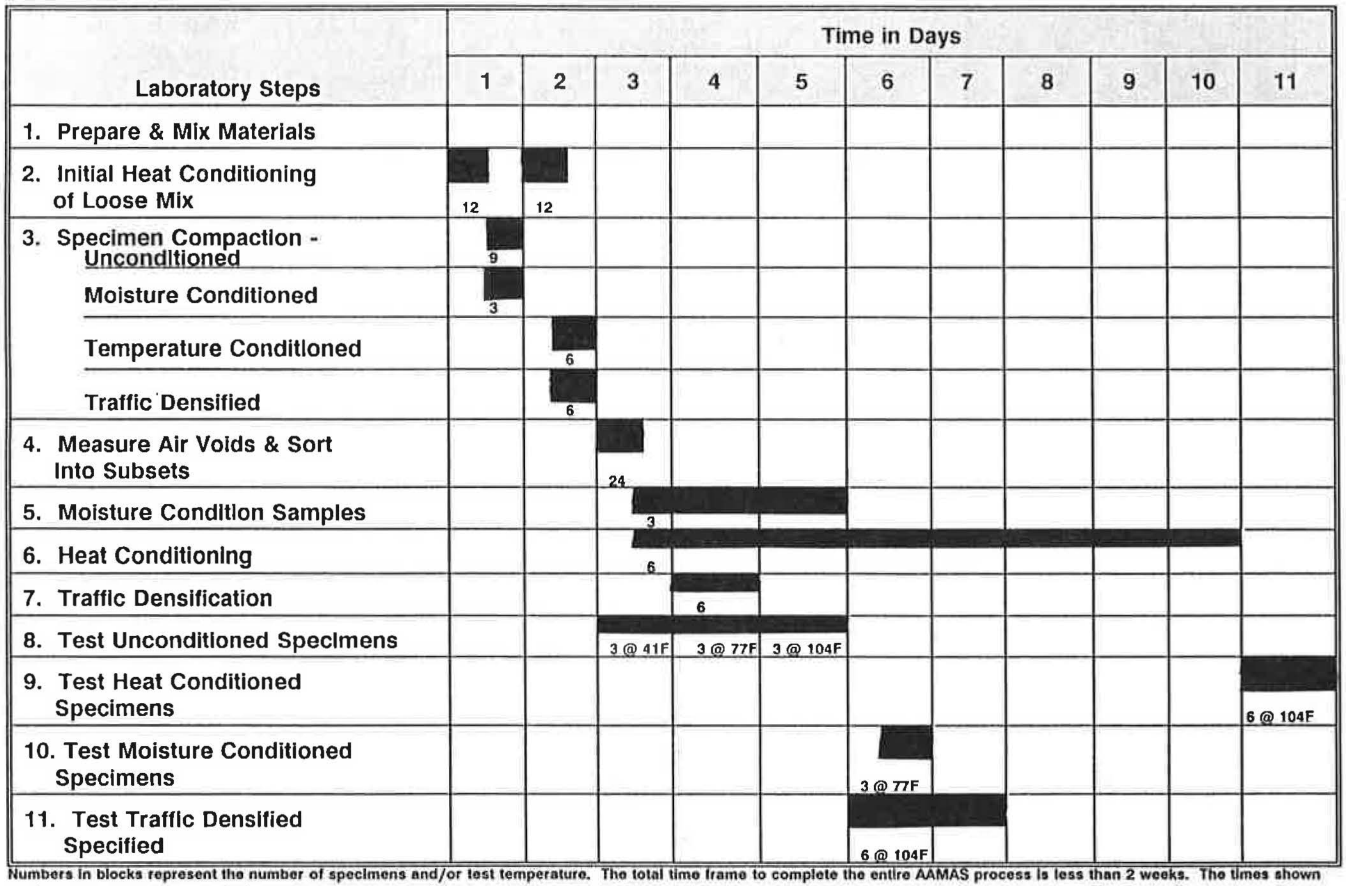
the four sections; Table 1 summarizes the approximate time required for the laboratory compaction, conditioning, and testing of asphalt concrete mixtures. Section I provides criteria and values recommended for selecting the mixture components, and Section II presents the procedures used to design dense-graded asphalt concrete mixtures. Figure 2 shows the mixture design procedure (including Sections I and II) in flowchart form. Section III, the mixture analysis section, includes procedures for preparing, conditioning, and testing specimens for measuring properties required for structural design and evaluation. Section IV, the mixture performance evaluation, discusses mechanistic-empirical models used to evaluate asphalt concrete pavements.

PARAMETERS AND TESTS INCLUDED IN AAMAS

Pavement Distress

Distresses selected for incorporation into AAMAS include rutting, fatigue cracking, low-temperature cracking, and

TABLE 1 Summary of Approximate Time Required for Laboratory Compaction, Conditioning, and Testing of Asphalt Concrete Mixtures Using AAMAS



Numbers in blocks represent the number of specimens and/or test temperature. The total time frame to complete the entire AAMAS process is less than 2 weeks. The times shown are in relation to the time needed to run the Marshall and Hveem mix design methods.

moisture damage. Secondary consideration is given to raveling or disintegration and loss of skid resistance.

Mixture Tests

To evaluate in the laboratory how asphalt concrete mixtures will perform under traffic and the environment, a review and a study of various test procedures were conducted. To design mixes for preventing the aforementioned distresses, it is necessary to use a test that measures the engineering properties and characteristics of the asphalt concrete mixture that are related to the distress or performance measure. Tests were selected on the basis of simplicity, efficiency, reliability, reproducibility, and sensitivity of mixture variables. Special consideration was given to sample size. For AAMAS to be useful and applicable for a range of mixtures, the test procedures and equipment must be capable of preparing and testing different size specimens that are compatible with the aggregates used in the mix.

Five tests are used as tools for mixture evaluation in AAMAS. These tests are the static cylindrical (unconfined compression) creep and recovery test, the diametral resilient modulus test, the indirect tensile strength test, the indirect tensile creep and recovery test, and the gyratory shear test. The compressive strength of the mix is also measured in accordance with the creep and recovery compressive test.

The AAMAS program requires a combination of laboratory tests and conditioning procedures to evaluate the behavior and performance characteristics of asphalt concrete mixtures. All factors considered, tensile strain at failure, gyratory shear strength, and creep are the properties most useful for evaluating and comparing different mixtures. Resilient modulus is required, but only because of its incorporation into the AASHTO design guide. Thus, tensile strain at failure, creep, resilient modulus, and gyratory shear strength are used to ensure that the mixture, as placed, will satisfy the structural design requirements.

Initial Mixture Design Optimization Guidelines

Guidelines are provided for selecting an aggregate blend and selection of an initial asphalt content for optimizing the mixture's performance on the basis of predictions of fatigue cracking, rutting, and thermal cracking. The program ASPHALT (*4*) was found to be a good tool for selecting the "seed" asphalt content in mixture design and theoretically determining the relationship between asphalt content and air void. In addition, correlations were performed between the engineering prop-

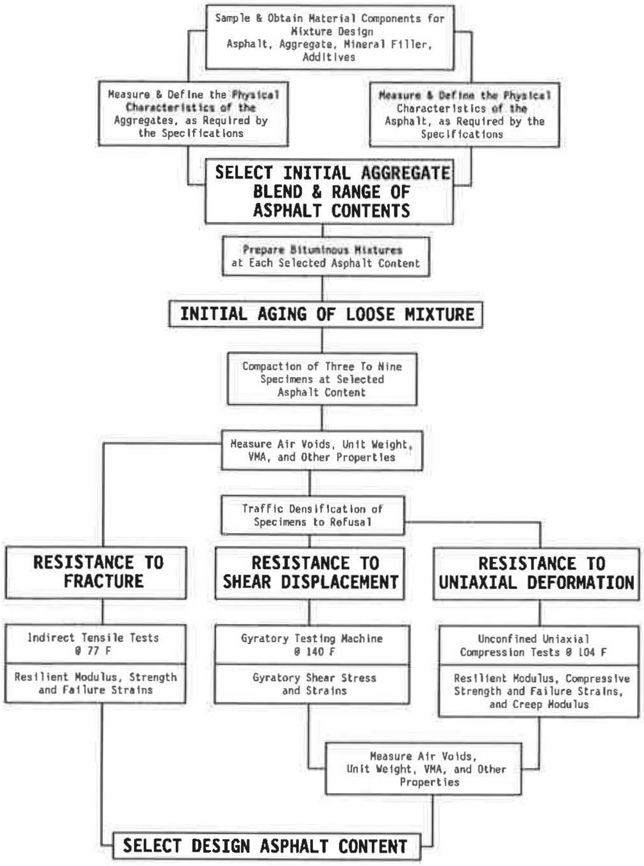


FIGURE 2 Flow chart for design of dense-graded asphalt concrete mixtures.

erties and factors normally considered during mixture design. From these analyses, it was found that the product of voids filled with asphalt (VFA) and aggregate diameter were related to work, VFA was related to tensile strain at failure, and voids in mineral aggregate (VMA) was related to indirect tensile strength. Through these correlations, an initial asphalt content and aggregate gradation are selected before any mechanical tests are performed. Using the distress functions suggested in NCHRP Project 1-26, criteria for mixture optimization and adequacy have been presented for a range of traffic and environmental conditions in the procedural manual.

Mixture Performance Evaluation

No consensus exists on the proper mathematical models to use for predicting the behavior and performance of asphalt concrete mixes. Such models are being developed by other researchers under additional NCHRP contracts. Further, the Strategic Highway Research Program (SHRP) is to conduct research work in this same area under Contracts A-005 (Performance Models and Validation of Test Results) and A-001 (Development of Performance-Based Specifications for Asphalt-Aggregate Mixtures). These research efforts, however, will not be completed until 1993. Thus, the types of performance relationship recommended by NCHRP Project 1-26 were used to evaluate the mixture's response to loads. Models are included to predict fatigue cracking, rutting, moisture damage, and low-temperature cracking.

LABORATORY PREPARATION AND CONDITIONING PROCEDURES

Plant-Hardening Simulation

To determine the plant-hardening simulation, the penetration and viscosity values of plant-produced material were compared to those conditioned (or aged) in the laboratory. The thin-film oven test (TFOT) at 285°F appeared to do a reasonable job of matching the asphalt cement characteristics (penetration and viscosity value) after mix production. Thus, the TFOT is used to predict the physical characteristics of the asphalt after mix production, when there is no historical data on binder aging through a mix plant.

The virgin asphalt cement is mixed with the aggregate blend and the loose mix placed in a forced-draft oven set at 275°F (or the expected mix discharge temperature from the plant) for 3 hr. After the first 1.5 hr, the mixture is removed from the oven and remixed by hand and replaced in the oven for the final 1.5 hr. The exact time the mixture is in the forced-draft oven can be determined from extraction tests of different samples aged at different times (2, 4, 8, 12, and 24 hr). The time selected is that which will age or harden the liquid asphalt to the penetration and viscosity values measured from the TFOT at 285°F or to the actual binder properties after mix production.

Mixture Compaction

Compaction was one of the critical factors studied in preparing samples for laboratory evaluation. From an evaluation and comparison of field cores and laboratory-compacted specimens, it was found that specimens compacted with the gyratory shear compactor more consistently matched the engineering properties measured on field cores. Thus, the gyratory shear compactor was the device included in the procedural manual.

Two methods of compaction are written into the procedure. One uses the U.S. Army Corps of Engineers' gyratory testing machine (GTM; ASTM D3387), and the other method uses the Texas gyratory shear compactor (ASTM D4013). The GTM is the preferred device, because angle of gyration, specimen height (an estimate of the decrease in air voids), and the mixture's resistance to compaction can be monitored with each revolution.

Moisture Conditioning

Another critical item was moisture conditioning or moisture damage evaluation. Two procedures were used to evaluate the moisture susceptibility of asphalt concrete mixtures. These were the modified Lottman procedure, or AASHTO T283, and the procedure documented in *NCHRP Report 246*, or the Lottman procedure. The Lottman procedure recommended in *NCHRP Report 246* consistently showed a more severe conditioning and testing technique. However, a version of the modified Lottman procedure was used in AAMAS, because of the concern that the procedure in *NCHRP Report 246* is too severe and unduly damages the specimens before testing. In summary, a vacuum of 26 in. of mercury is applied to the specimen for 15 min, the sample is frozen for 16 hr and placed in a 140°F water bath for 24 hr, and then it is tested. The test temperature of the procedure is 77°F, and a loading rate of 2.0 in./min is used, which are consistent with the other tests used in AAMAS. The moisture-conditioned test specimens are compacted to the air void level immediately after construction.

Environmental Aging Simulation

A long-term age-hardening simulation procedure was also developed. However, the change in physical properties of the asphalt and mixture were available for the AAMAS test sections only over a short time period. The pavements were cored twice: immediately after placement and 2 years after placement. The recommended procedure is to place compacted specimens in a forced-draft oven set at 140°F for 2 days. The specimens are then rotated, the oven's temperature is increased to 225°F, and the specimens are left in the oven for additional 5 days.

These heat-conditioned specimens are then used for measuring the resilient modulus, indirect tensile strength, strain at failure, and indirect tensile creep at 41°F. These test specimens are also compacted to the air void level immediately after construction.

Traffic Densification

Asphalt concrete mixtures densify under traffic. To simulate that densification process and its effect on the mixture's properties, specimens that had been compacted in the laboratory to an air void content similar to that of the field specimens were further compacted to a refusal density. This additional densification was accomplished using the Corps of Engineers' GTM. The initially compacted specimens are cooled to 140°F (60°C) and then compacted further in the GTM gyratory device. Initial sample height readings were obtained before the refusal densification and again after each 25 to 50 revolutions of the machine. The compaction process is stopped when the mixture's resistance reduces excessively or when there is an excessive increase in the angle of gyration.

If the Corps of Engineers' GTM is unavailable, the procedure manual suggests that the Texas gyratory shear compactor be used. With the use of this device, however, the traffic densification process continues immediately after initial compaction (i.e., the temperature is not reduced and the mold stays in the compaction machine).

LABORATORY TEST PROCEDURES

Resilient Modulus Test

One of the primary test methods considered in the AAMAS study was the repeated-load resilient modulus test, because of its tie to the AASHTO design guide. ASTM D4123 (Indirect Tension Test for Resilient Modulus of Bituminous Mixtures) was the primary test procedure used. Three test temperatures are used: 41, 77, and 104°F (5, 25, and 40°C). The secondary test method for resilient modulus is a modification of ASTM D3497 (Dynamic Modulus of Asphalt Mixtures); it is used as the conditioning procedure for all uniaxial compressive type tests. The differences or modifications are that a rest period of 0.9 sec was used with a 0.1-sec load pulse and that both the instantaneous and total resilient moduli were calculated.

Indirect Tensile Strength and Failure Strain Test

The indirect tensile strength and failure strain are determined using a test method derived from ASTM D4123 (Indirect Tension Test for Resilient Modulus of Bituminous Mixtures). The actual test procedure used is published in the AAMAS final report (*1*). The test is conducted at the same three temperatures as the resilient modulus test: 41, 77, and 104°F (5, 25, and 40°C). The loading rate used at 41°F is 0.05 and 2.0 in./min (1.27 and 50.8 mm/min); a rate of 2 in./min (50.8 mm/min) is used only at 77 and 104°F (25 and 40°C). These data are used in the fatigue cracking evaluation.

Indirect Tensile Creep and Recovery Test

The indirect tensile creep and recovery test is conducted on field cores and on laboratory-compacted specimens. This test is conducted in accordance with a procedure published in the AAMAS final report. In summary, a static load of fixed magnitude is applied along the diametral axis and the horizontal displacement measured over a 60-min loading duration. After the fixed load is removed, the resilient strain is also measured over 60 min. The indirect tensile creep and recovery test is performed at a test temperature of 41°F for use in the low-temperature cracking evaluation.

Uniaxial Unconfined Compression Creep and Recovery Test

Laboratory-compacted test specimens, which are a minimum of 4 in. in diameter and 4 in. high, are tested in uniaxial compression. A static load of fixed magnitude is applied along the cylindrical axis of an asphalt concrete specimen for a set amount of time. The total axial (compressive) deformation response of the specimen is measured and used to calculate the creep compliance at particular durations of time. After the fixed load is released, the resilient deformation is also measured over a set amount of time. Although the test can be conducted with confining pressure on the specimens, all testing for the AAMAS project was completed without the use of confining pressures. For the AAMAS testing, the loading and unloading times are both 60 min and the data are used in the rutting evaluation.

The unconfined compressive strength test is also performed on a few specimens at 104°F to calculate the compressive strain at failure. This failure strain is used to set a limiting value for the allowable permanent deformation in the rutting evaluation for the mix being tested.

AAMAS MIXTURE DESIGN PROCEDURE

Selection of Mixture Components

The program ASPHALT (*4*) is used as a starting point to select a gradation and the seed asphalt content for that gradation. ASPHALT provides a theoretical relationship between asphalt content, VMA, air voids, and film thickness for a specific aggregate blend or gradation. Mixture is prepared in the laboratory at the seed asphalt content, as well as two asphalt contents above and two below this seed value.

Initial Heat Conditioning of Loose Mix

Mixture at each of the asphalt contents is aged in a forced-draft oven using the procedure previously discussed (i.e., placing a mix in the oven at 275°F for 3 hr).

Compaction

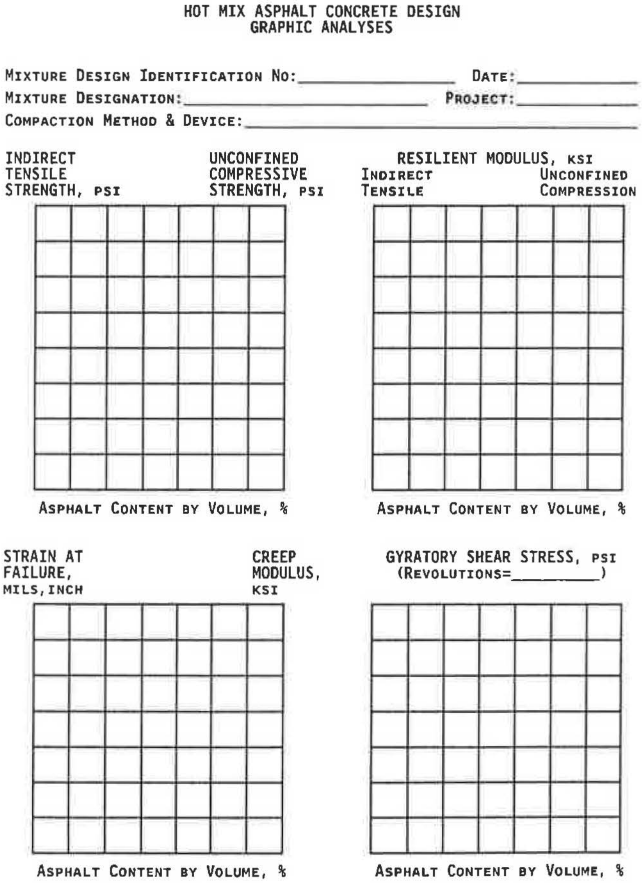
Specimens are compacted at each asphalt content using ASTM D3387, if the Corps of Engineers' GTM is available, or ASTM D4013 at a specified compactive effort. Three indirect tensile specimens per asphalt content are compacted at an air void level anticipated after construction (i.e., 6 to 8 percent), and a minimum of three uniaxial compression test specimens per asphalt content are used in the traffic densification procedure or compacted to the refusal density (i.e., no increase in density with additional compactive effort). The design air void level for the refusal density is 3 percent or greater.

Mixture Testing

Three specimens at each asphalt content are initially tested for resistance to fracture (Figure 2). Indirect tensile resilient moduli and strength tests are performed on the same sample to define the initial allowable range of asphalt contents to meet the design criteria for resistance to fracture.

Gyratory shear tests are run with the GTM during the traffic densification procedure to ensure that minimum design requirements for shear are met (i.e., resistance to shear). For mix design, a minimum shear value of 54 is used in the procedure.

Uniaxial compression creep and recovery tests are performed on specimens compacted to the refusal density. The uniaxial compression creep and recovery test is used to ensure that the design value will satisfy the deformation criteria (i.e., resistance to deformation). The minimum creep modulus value used for design is dependent on the pavement structure. Figures 3 and 4 are included in the procedural manual for presenting the mixture design data.



HOT MIX ASPHALT CONCRETE DESIGN
GRAPHIC ANALYSES

MIXTURE DESIGN IDENTIFICATION NO:______________ DATE:____________
MIXTURE DESIGNATION:______________________________ PROJECT:____________
COMPACTION METHOD & DEVICE:____

FIGURE 3 AAMAS graphical presentation of mixture design data for engineering properties.

Allowable Range of Asphalt Contents

The allowable range of asphalt contents for the specific aggregate gradation is defined as being those values that are within the minimum and maximum limits as established by the fatigue, shear, and deformation criteria. Figure 5 is a graphical summary of the mixture design test for selecting the design asphalt content and an allowable tolerance. These criteria include a minimum creep modulus for different structures, minimum gyratory shear strength, and minimum tensile strain at failure for fatigue. Figure 6 illustrates the minimum fatigue criteria.

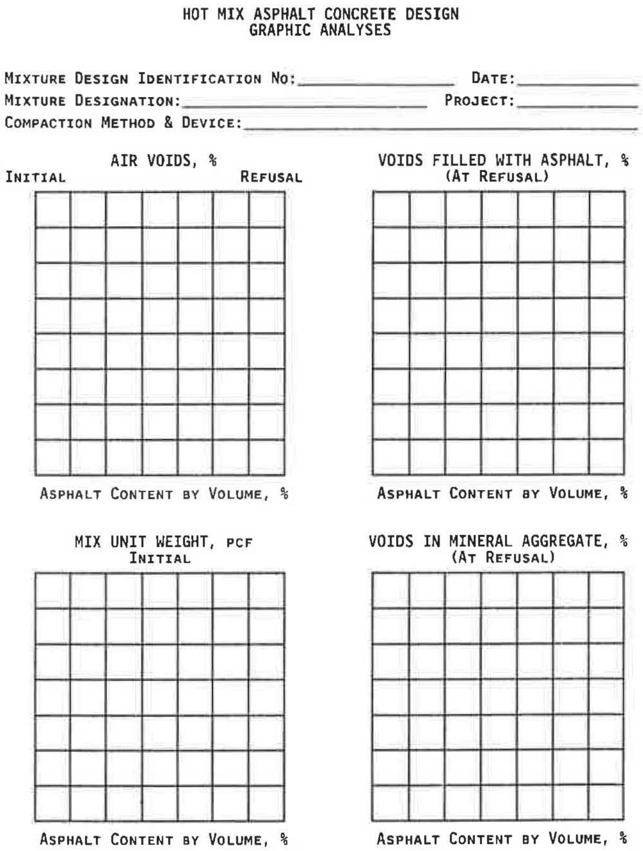
AAMAS MIXTURE EVALUATION

Initial Heat Conditioning of Loose Mix

The mixture is aged in a forced-draft oven using the procedure previously discussed (i.e., placing the mixture in the oven at 275°F for 3 hr).

Compaction

After initial heat conditioning, eight sets of three specimens are compacted. Eighteen specimens are compacted to be used



HOT MIX ASPHALT CONCRETE DESIGN
GRAPHIC ANALYSES

MIXTURE DESIGN IDENTIFICATION NO:____________ DATE:__________
MIXTURE DESIGNATION:__________________ PROJECT:__________
COMPACTION METHOD & DEVICE:__________________________

FIGURE 4 AAMAS graphical presentation of mixture design data for compaction properties.

for indirect tensile testing and six specimens to be used for uniaxial compression type testing. All specimens are compacted using the GTM because of its ability to monitor changes in mixture behavior with a reduction in air voids. If the GTM is unavailable, the specimens can be compacted using the Texas gyratory shear compactor.

All specimens are initially compacted to the air void level specified immediately after construction. Of the 18 specimens compacted for indirect tensile testing, 9 are unconditioned, 6 are conditioned by the accelerated aging technique, and 3 are moisture-conditioned. The six uniaxial compression specimens are all unconditioned and used in the traffic densification procedure.

Grouping by Air Voids

Before conditioning and testing, all specimens are grouped in sets of three by air voids. The intent is to have both the average air voids and standard deviation of air voids between the different sample sets as close as possible.

Moisture Conditioning

Three specimens are moisture-conditioned in accordance with a modification of AASHTO T283, with the exception that the test procedure is at 77°F and a loading rate of 2 in./min is used.

Accelerated Aging

Six indirect tensile specimens are used for accelerated aging for the low-temperature cracking evaluation. These specimens

	ASPHALT CONTENT BY TOTAL VOLUME, %						
ENGINEERING PROPERTIES							
Total Resilient Modulus (Layer Coefficients)							
Tensile Strain at Failure and Total Resilient Modulus							
Gyratory Shear Stress and Shear Index							
Creep Modulus							
COMPACTION PROPERTIES							
Aggregate Unit Weight							
Final Air Voids, %							
VMA (Porosity), %							
VFA (Degree of Saturation), %							
Allowable Range of the Design Asphalt Content							
	ASPHALT CONTENT BY TOTAL WEIGHT, %						

FIGURE 5 Worksheet for summarizing test results and selecting design asphalt content and tolerance.

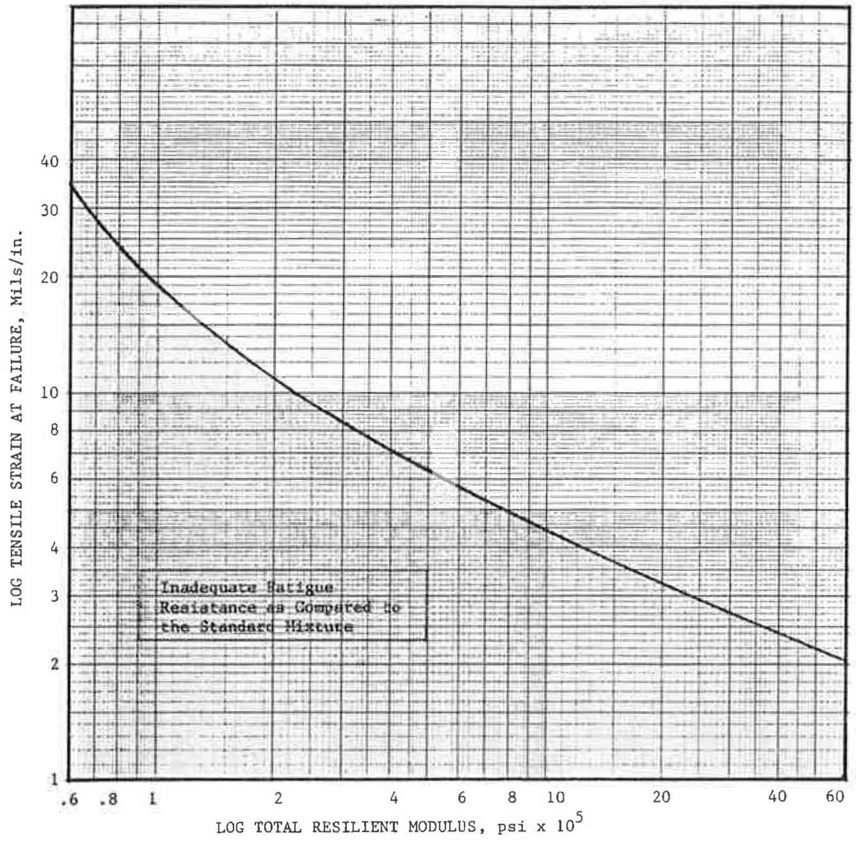


FIGURE 6 Minimum tensile strains at failure required for mixture as function of total resilient modulus as measured by indirect tensile testing techniques.

are aged using the procedure previously discussed (i.e., placing the specimens in a forced-draft oven at 140°F for 2 days, then elevating the oven's temperature to 225°F for an additional 5 days of aging).

Traffic Densification

The six uniaxial compression specimens previously compacted are all used in the traffic densification process. The temperature of these specimens is reduced to 140°F. The specimens are then placed in the GTM, and additional compactive effort is applied to achieve the refusal density of the mix. The gyratory shear stress and sample height are monitored with a number of gyrations during this densification process.

If the GTM is unavailable, specimens are compacted using the Texas gyratory shear compactor to the refusal density or air void content during initial compaction. In other words, the six specimens are compacted to the refusal density for uniaxial compression testing at the initial compaction temperature.

Mixture Testing

The repeated-load indirect tensile resilient modulus test is performed on all unconditioned and conditioned specimens (18 specimens). The indirect tensile strength and failure strains are measured on all unconditioned and moisture-conditioned specimens, and one set of accelerated age specimens (15 specimens). The indirect tensile creep and recovery test is performed on the second set of accelerated age specimens (three specimens). These tests are performed on the specimens as previously discussed and used to predict fatigue and low-temperature cracking.

The uniaxial compression specimens are used to predict rutting and distortion type failures from the uniaxial compressive resilient modulus, unconfined compressive strength and failure strain, and compression creep and recovery tests. The repeated-load uniaxial compression resilient modulus is measured on all traffic-densified specimens at 104°F (six specimens). The unconfined compressive strength is measured on one set of traffic-densified specimens and the compressive creep and recovery measured on the other set of specimens.

Mixture Performance Evaluation

For the fatigue cracking evaluation, the total resilient modulus and tensile strain at failure are used for mixture evaluation. These two values are measured on the unconditioned specimens are 41, 77, and 104°F. These values can be used to generate a fatigue cracking curve or can be compared to the results for a "standard" mixture, as graphically illustrated in Figure 6.

For thermal cracking, the test results from the indirect tensile strength and creep and recovery tests on the accelerated age specimens are used to define the critical temperature change at which cracking can be expected to occur. The creep and recovery tests results are used to evaluate and determine the creep modulus at the lower testing temperature.

For the moisture damage evaluation of the mixture, the tensile strength ratio, the resilient modulus ratio, and the tensile strain at failure ratio are used to evaluate the mixes' susceptibility to moisture damage.

For rutting evaluation, three tests are performed on the traffic-densified specimens. These are the repeated-load resilient modulus, the unconfined compressive strength, and the compressive creep and recovery tests. The uniaxial compression creep and recovery test is used to evaluate the rutting potential of each mixture, as shown by an example in Figure 7. It can also be used to estimate the expected level of rutting to occur in the pavement for each of the asphalt concrete layers. The unconfined compressive strength and resilient moduli are used to set limiting criteria for the mix under specific loading conditions for the pavement and environment.

IMPLEMENTATION

It should be recognized and understood that implementing the AAMAS concepts and methodology will not be a quick process because most of these tests and evaluation procedures are unfamiliar to some SHA personnel. Therefore, it becomes very important that each agency take a systematic approach in reviewing the AAMAS concept when considering its implementation.

It is obvious that many of those tests previously discussed are not adaptable or practical for the use of field control of mixtures. However, other fundamental properties of the mixture are adaptable to field control. These are the indirect tensile strength and unconfined compressive strength. There are relationships, which are mixture-dependent, between strength properties and those used in AAMAS to evaluate mixture performance.

The evaluation and implementation of the AAMAS concepts for the design and control of asphalt concrete mixtures still requires that many questions be answered about the policies of different agencies. A few of these are listed as follows:

- Are the AAMAS tests practical or adaptable for field control variables? For example, what length of time is required to run the test and analyze the results? Many contractors can place 2,000 to 3,000 tons of asphalt concrete a day. It would be highly advantageous that the results of quality control and acceptance tests be obtained within a short time period. Additionally, some of the more sophisticated tests may require that the expertise of field and laboratory personnel be upgraded from present levels, both for the contractor and for SHA personnel.
- Can the AAMAS concepts be readily implemented where different organizations are responsible for mix design? For example, some SHAs require that contractors or consultants conduct the mixture designs; others are responsible for mix design themselves. In some cases, this may prevent smaller contractors from competing on smaller projects, because they do not have the financial backing to purchase the equipment.
- Is the AAMAS compaction, conditioning, and testing equipment practical for the field control of mixtures? If one device is used in the laboratory for mixture design and another device used in the field, equivalency factors become extremely important. Most equivalency factors are mixture-dependent, which can result in confusion between the field and laboratory, similar to what exists to date with the empirical-based methods.
- Will AAMAS be cost-effective for those SHAs that control and accept mixtures based on specifications geared toward method as opposed to end product?

With these few questions, implementation and acceptance of the AAMAS concepts will not be simple. There should be at least four steps in the implementation process: (a) familiarization with AAMAS, (b) training, (c) education, and (d) field pilot studies. The familiarization with AAMAS is simply an understanding of the concepts and methodology employed by AAMAS. This is a relatively short part of the implementation process.

The second step of the implementation process is training. It is the more detailed in terms of how to run the tests and interpret the test results. Training is important to ensure that the tests are performed in accordance with the procedure and that the output of the tests is being interpreted properly.

The third part of the implementation is education. This is probably the most important step toward full-scale implementation of AAMAS. Basically, the education part is to evaluate, on a trial basis, mixes for high-volume roadways. The objective is to allow the user to become confident in using AAMAS, understanding the properties measured and sensitivity of those properties to pavement performance, and establishing typical properties for their local materials. This part of the implementation process is also the more time-intensive, because it involves most of the learning curve.

The final step of the implementation is conducting mix designs and analyzing those mixes for actual projects. This step is the one that leads to defining the time requirements that are required to perform the tests on a routine basis and to establish day-to-day operational procedures in a working laboratory.

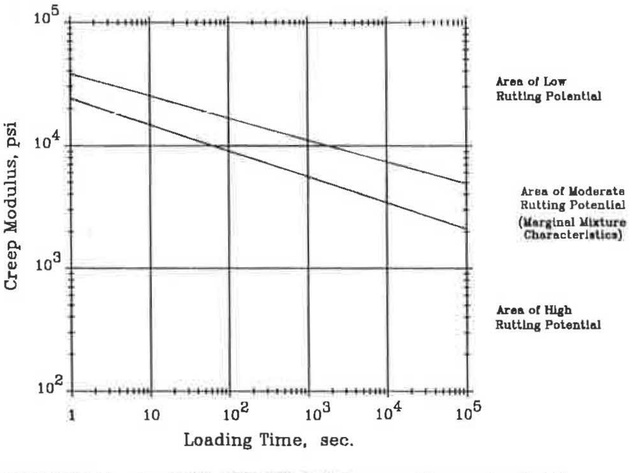


FIGURE 7 Asphalt concrete mixture rutting potential for surface layers of asphalt concrete pavements.

SUMMARY

In conclusion, the development of an AAMAS, as initiated through NCHRP Project 9-6(1), is a very important element of a multimillion-dollar research effort involving SHRP, FHWA, and the asphalt pavement industry, an effort that will ultimately result in improved performance of asphalt concrete pavements. Premature and costly pavement failures can be drastically reduced by (a) designing structures that more realistically consider traffic loadings, climate, and material conditions; (b) selecting asphalt, aggregates, and additives or modifiers consistent with the structural design; (c) producing new or modified asphalt binders that provide the desired characteristics for minimizing distress; and (d) developing and using performance-related specifications for control of construction.

ACKNOWLEDGMENTS

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