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16. Abstract

All of the proposed changes to the SDHPT 1982 Standard Specifications should eventually result in lowered life cycle costs of increasingly better performing Item 340 hot-mix paving layers. It is anticipated that proposed changes 1, 2, 7, 8 and 10 would result in slight increases in bid item prices for asphalt cements and aggregates utilized in SDHPT paving contracts. However, these costs should be offset by more durable hot-mixes with reduced maintenance costs.

Adoption of proposed changes 3, 4, 5, 6 and 9 should not result in noticeable increases in bid item prices. The increased costs for these changes will come in the area of SDHPT's costs to administer and inspect the design and production of Item 340 hot-mix paving work. In the long run, changes 4, 5 and 8 should result in the increased effectiveness of SDHPT personnel to design, inspect and evaluate hot-mix materials and paving layers.

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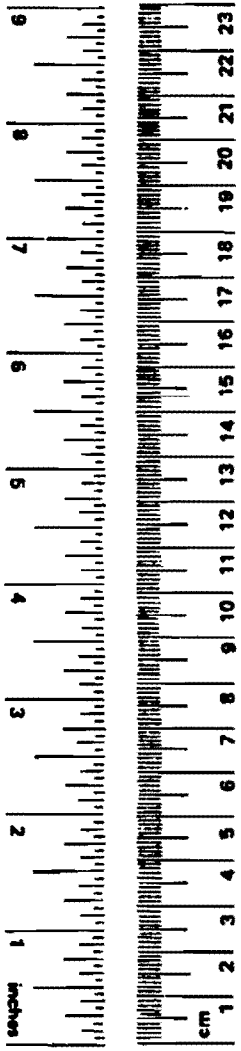
METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

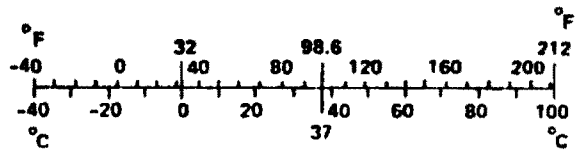
Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
	AREA			
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
	MASS (weight)			
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
	VOLUME			
tsp	teaspoons	5	millliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
	TEMPERATURE (exact)			
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C



*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.

Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
	AREA			
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
	MASS (weight)			
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
	VOLUME			
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
	TEMPERATURE (exact)			
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



RECOMMENDED CHANGES TO ITEM 340 OF THE 1982 STANDARD SPECIFICATIONS

by

Fred C. Benson

and

Bob M. Gallaway

Research Report 285-5F
Research Study Number 2-9-80-285
Asphalt Concrete Mixture Design and Specifications

Sponsored by

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The Texas A&M University System
College Station, Texas

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DISCLAIMER

The contents of this report reflect the views of the authors who are responsible for the opinions, findings and conclusions presented herein. The contents do not necessarily reflect the official views or policies of the Federal Highway Administration, or the State Department of Highways and Public Transportation. This report does not constitute a standard, specification or regulation.

RECOMMENDED CHANGES TO ITEM 340 OF THE 1982 STANDARD SPECIFICATIONS

INTRODUCTION

One of the purposes of Research Study 2-9-80-285 "Asphalt Concrete Mixture Design and Specifications" as stated in the original study proposal and subsequent renewal agreements is to recommend specification changes that would result in lowered life cycle cost and better performing hot-mix pavements constructed for the Texas State Department of Highways and Public Transportation (SDHPT). The purpose of this Report 285-5F is to make these recommendations and briefly present the arguments for their adoption.

Previous reports under Study 285 have addressed specific problem areas with the design, testing and performance of hot-mix paving layers produced under SDHPT Item 340 of the 1982 Standard Specifications (1). Report 285-1 titled "Hot-Mix Pavement Stability Performance Versus Laboratory Test Results," (2) is concerned with determining why some hot-mix paving layers have performed poorly from a rutting standpoint whereas others did well, exhibiting little or no rutting. Under this substudy, rut depths and pavement evaluations were made in the field, pavement cores were tested and evaluated, and some project records reviews were made. Results of this testing and evaluation for each of some 20 different pavement sections are compared in order to determine why the poorly performing pavements rutted while the better performers did not.

Report 285-2 titled "Evaluation of Aggregate Sieving Methods for Hot-Mix Asphaltic Concrete Design and Production," (3) compares results of dry sieving versus wet sieving of combined aggregate gradations for 10 Item 340 hot-mixes. This report also presents a comparison of the results of sieving these aggregates with the SDHPT portland cement designated sieve sizes as versus the commonly used SDHPT hot-mix sizes.

Report 285-3, "Evaluation of Several Mineral Fillers for Use in Item 340 Hot-Mix Asphaltic Concrete," (4) evaluates 14 different mineral filler materials submitted by the SDHPT districts and also test methods, procedures and testing schedules. The major thrusts of this report are (1) to evaluate the specific mineral fillers submitted to determine salient characteristics and suitability for use in hot-mixes and (2) to assess, evaluate and ascertain definite testing programs and tests for future use in routinely determining mineral fillers best suited for hot-mixes.

Report 285-4 (5) titled "Statistical Quality Control Evaluation of a District 3 Hot-Mixing Paving Project," describes the application of statistical quality control parameters to evaluate the quality of hot-mix produced for a particular paving project. This material was placed on US Highways 81 and 82 in Montague County, Texas, from October 27 to November 21, 1980. The quality control parameters included the use of quality control charts to portray tests as Hveem Stability, air voids, resilient modulus, M_R, and amounts retained and passing guidelines established in a three-volume report for the Federal Highway Administration by Jack Willenbrock (6).

The proposed changes to the SDHPT 1982 Standard Specifications, therefore, are partly in response to results of testing and analyses accomplished in the above four Study 285 reports. The other changes are additionally proposed based on the judgments of the authors and other contributors to the 285 Study researc.

RECOMMENDED SPECIFICATION CHANGES

With recognition that the current 1982 Standard Specifications governing the design, production and placement of SDHPT Item 340 Hot-Mix Asphalt Concrete represents an adequate and workable document, the authors recommend the changes listed below as refinements. Discussions and arguments supporting the recommendations are presented in the following section.

1. It is proposed that two classifications of fiscosity graded asphalt cement be added under SDHPT Item 300: AC-15 and AC-30.
2. It is recommended that specification limits on asphalt cement temperature susceptibility as measured by the penetration index, PI, be established to govern selection of asphalt cements.
3. It is proposed that the use of petroleum solvents to clean hot-mix from haul truck beds should be prohibited.
4. For each master passing-retained grading presently shown for each "Type" of hot-mix asphaltic concrete in Item 340, it is recommended that an equivalent mid-point percent passing gradation, with appropriate ranges for each sieve size, be incorporated in the specifications. This would serve as an alternate to the passing-retained master gradations for use in design and construction control of hot-mix paving materials.
5. It is recommended that a new requirement be added Under Item 340.3 (2) "Paving Mixtures" and "Stability" and "Density" in which both design and production laboratory compacted hot-mix samples would be subjected to either resilient modulus testing at $32^{o}F$, $77^{o}F$ and $104^{o}F$ or indirect tensile testing at 77^{o}. Test results to determine whether the samples met certain minimum engineering strength standards that would also be established.
6. For vibrating rollers, it is proposed that the contractor be required to check the settings for amplitude and frequency at least once on each day that hot-mix is placed on the roadway. These checks should be confirmed with the Engineer.

7. For the Type "C" and Type "D" master gradations, it is proposed that the minimum amounts of materials passing and retained from the No. 10 sieve to the No. 200 sieve be increased. Therefore, these new limits are proposed as follows:

Passing No. 10 sieve, retained on No. 40 sieve	10 to 32
Passing No. 40 sieve, retained on No. 80 sieve	8 to 27
Passing No. 80 sieve, retained on No. 200 sieve	6 to 27

8. It is recommended that a water susceptibility test requirement be added in Section 340.3 (1) "Mixture Design" to check for this phenomenon during the design stages and at 3,000-ton intervals of production in the field.
9. Concerning fuel oil fired dryer drums in drum dryer plants, it is recommended that wording similar to that used for weigh batch plant aggregate dryers under Item 340 be added to the specifications to prevent residue from incompletely burned fuel from contaminating the hot-mix being produced in the drum.
10. It is recommended that the wording be added to Item 340 Section 340.6 (5) "Placing" to the effect that the placed hot-mix mat shall be free of recurring spots of segregated materials or segregated areas. These are areas that occur at regular intervals during daily laydown and are caused by deficiencies in the contractors plant and/or laydown equipment.

DISCUSSION OF RECOMMENDED CHANGES

Change 1.

The addition of two classifications of viscosity graded asphalt cement, AC-15 and AC-30, is recommended under SDHPT Specification Item 300, "Asphalts, Oils and Emulsions." This modification would allow the designer of Item 340 paving materials increased flexibility in dealing with roadways with more exacting demands from traffic loading and service temperature.

For example, in north and west, Texas, the designer has a choice of using either AC-10 or AC-20. The roadway to be designated for may require a "harder" asphalt cement for adequate stability and strength for prevention of rutting and shoving than an AC-10 could supply. Yet an AC-20 may pose too much potential for aging and thermal cracking. Thus the AC-15 would allow the use of a mid-path route to achieve stability with a reduced risk of cracking.

In southeast Texas, for heavily trafficked and loaded roadways, the designer is allowed the use of AC-20 or AC-40 asphalt cement under the present 1982 Standard Specifications. For traffic and temperature demands, the AC-20 may be unsuitably "soft," whereas the AC-40 may be too "hard" and prone to age. Thus again the designer would have a mid-point viscosity asphalt cement (by use of the AC-30) with which to achieve the desired design and construction of the hot-mix paving layer.

Change 2.

At the present time there exist certain asphalt cements that are highly temperature susceptible (i.e. viscosities decrease considerably more than desired with increasing temperature). These asphalts often

cause considerable problems during the construction phases of the hot-mix layers, with the phenomena of pavement tenderness, instability and low densities from construction compaction being present.

The proposed change to the specification would put a limit on the temperature susceptibility as measured by one or more presently existing tests. For example, the Penetration Index, PI, test could be used to establish a limiting value for temperature susceptibility that would be acceptable. As calculated by the PI test equation, asphalt cements with PI's of -2 have been found to be highly temperature susceptible whereas those with a PI of +2 have not. The limit on temperature susceptible as measured by PI could be set at say -1.5 or some other value so determined as to preclude or require refinery modification of the least number of asphalt cements currently being used in the state. Yet, this number would also be set as close as possible to 0.0 to reduce the number of temperature related problems with asphalt cements in the field. The limit on temperature susceptibility as measured by PI or other test(s) would also serve to allow the refinery to make modifying changes in crude oil sources that might pose future problems for asphalt cements used in paving.

Change 3.

Often times hot-mix haul truck beds are cleaned with petroleum liquids such as diesel fuel to remove chunks of hardened hot-mix that tend to accumulate. As a result, these cleaning liquids are often left in small puddles on the floor of the truck bed. It is also quite probable that some of the residue material is still present when trucks are again loaded with hot-mix at the plant for delivery to the roadway site.

The proposed change to the specifications of prohibiting the use of petroleum fluids for cleaning would help ensure that residual puddles of these liquids are not present for absorption into newly produced hot-mix. It is believed that eliminating the practice described above will help alleviate problems of hot-mix instability, shoving, rutting and even raveling in the field.

Change 4.

This change would allow SDHPT designers in the districts a choice of using either the presently specified "pass-retained" master hot-mix aggregate gradation listing or the proposed "percent passing" gradation listings for design and production control of hot-mixes. It is believed that the new alternate gradation listings would be easier to work with for new engineers and technicians entering the system. Also, their usage would allow more understanding and insight into what is happening during (1) the use of passing-retained gradations and (2) the evaluation of problems and changes in aggregate gradings.

Change 5.

Under this proposed change, certain reasonable minimum requirements of strength for resilient modulus, M_R, or indirect tensile test results would be set for laboratory compacted samples of hot-mix paving mixtures to meet during design and construction. These would be in addition to the present stability requirements. This change would allow the opportunity to assess and maintain the engineering strength properties of hot-mix paving materials.

With the present practice of using only Hveem stability testing to determine whether laboratory molded samples meet specification requirements, little is known of the ability of hot-mix paving materials to meet tensile stress which are exerted in the field at different ambient temperatures. It is expected that the use of M_R testing during design and construction would help identify hot-mixes more prone to damage such as from the extremes of shoving and rutting to thermal and fatigue cracking. Also, use of the testing during construction should be useful to spot either long or short term deterioration trends in the quality of hot-mix.

Initial requirements for M_R or indirect tension test results of gyratory compacted hot-mix samples could be changed, probably in an upward direction, as more is learned about producing better quality, higher strength hot-mixes as a result of this new testing. This proposed change could be initiated in the form of pilot programs in one or two districts to determine problems involved and implementation needs on a state-wide basis.

Change 6.

The proper operation of vibratory rollers in compacting hot-mix pavements is vital on a day to day basis. A roller allowed to stray from the proper setting of frequency and amplitude can do thousands of dollars in a single day by improper compaction of a new hot-mix paving layer and/or damage to an underlying layer.

This proposed specification change would draw daily attention to maintaining the proper control settings on vibratory roller by requiring daily documentation that the settings were correct. This change would also emphasize the importance being placed on this one aspect of pavement construction.

Change 7.

Under this proposed change to the 1982 Standard Specifications, increased minimum amounts of material would be required as passing and retained in the three sieve brackets from the No. 10 sieve to the No. 200 sieve. The proposed increases in the minimum amounts of material retained for the three brackets in descending order are four, four and three percent, respectively.

The major purpose for this change is to avoid or further alleviate situations in which little or no material is found in aggregate gradation from the No. 10 to the No. 40 or No. 80 sieve, and an excess of material is therefore provided from the No. 40 or No. 80 sieve to the No. 200 sieve. The excess creates a grading hump above a dense grading line in the percent passing grading curve around the No. 30 sieve, which situation has been found to be correlated with many hot-mixes that have proven to be tender during construction and often for extended periods for time after construction.

The change is therefore proposed to lessen the possibility of additions of large percentages of fine materials from the No. 40 or No. 80 sieves to the No. 200 sieve in a hot-mix design gradation. This change should thus lessen the chances for hot-mixes to exhibit compaction and performance problems associated with tenderness. It is anticipated

that the change would help ensure the design and production of hot-mixes that can be compacted more satisfactorily and will exhibit less tendency to rut and shove under traffic at high service temperatures.

Change 8.

This recommended change is intended to reveal the majority of water susceptible hot-mix materials before these are placed and subsequently show distress. It is intended that the testing to be used to detect susceptibility that would involve either or both the boiling test and the one-cyle Lottman water test (7). Once a particular design with its unique materials has been checked in the laboratory and has been judged to be nonstripping, it could be placed in the field and would require testing at 3,000-ton production or other reasonable intervals.

It is believed that this proposed required testing for water susceptibility in the design stage and subsequent check testing in the field would save the SDHPT many maintenance problems on the roadway, including the need in many instances to completely remove deteriorated hot-mix layers. The laboratory costs for administering hot-mix designs would increase as a result, and contractors would need to submit materials for designs earlier to allow time for possible redesign. Some cost increases would occur in bid prices for hot-mix when it becomes apparent that additives and/or upgraded aggregate materials will have to be used in certain cases to assure quality materials. However, ultimate savings in maintenance expenditures would probably exceed both the administrative and contract costs.

Change 9.

This specification change is recommended to guard against improper operation of the drum-dryer resulting in deleterious coating of aggregates with residue from drum-dryer burner fuel. It would be expressed basically in the same wording as in Item 340 (1) "Weigh-batch Type" under the "Dryer" subsection.

Change 10.

This proposed specification addition will place more responsibility upon the contractor to modify equipment and/or production procedures in

order to eliminate spots of segregated hot-mix that recur in definite spacings or patterns in the mat during a day's production. In certain instances, it is probable that somewhat significant modifications would be required in contractor plant, or laydown equipment to preclude recurring segregation problems.

Overall, some slight increases in bid prices for hot-mixes could be expected for this until plants and equipment are modified. Some maintenance savings should result in the long term when the amount of segregated hot-mix is reduced.

CLOSING REMARKS

All of the proposed changes to the SDHPT 1982 Standard Specifications should eventually result in lowered cycle costs of increasingly better performing Item 340 hot-mix paving layers. It is anticipated that proposed changes 1, 2, 7, 8 and 10 would result in slight increases in bid item prices for asphalt cements and aggregates utilized in SDHPT paving contracts. However, these costs should be offset by more durable hot-mixes with reduced maintenance costs.

Adoption of proposed changes 3, 4, 5, 6 and 9 should not result in noticeable increases in bid item prices. The increase costs for these changes will come in the area of SDHPT's costs to administer and inspect the design and production of Item 340 hot-mix paving work. In the long run, changes 4, 5 and 8 should result in the increased effectiveness of SDHPT personnel to design, inspect and evaluate hot-mix materials and paving layers.

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