FINAL REPORT

INVESTIGATION OF ALTERNATIVE CURB MIXES

by

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INTRODUCTION

On October 22, 1974, the Bituminous Research Advisory Committee recommended that an investigation be undertaken to determine if asphaltic mixes not incorporating asbestos might be used satisfactorily in place of the traditional Virginia curb mix which requires asbestos for stability.

This recommendation was prompted by two considerations. First, because of the health hazards connected with breathing asbestos, it is anticipated that this material may be banned from use in asphaltic mixes; and second, some Virginia contractors have encountered problems in obtaining the small quantities of asbestos required.

This report describes the fulfillment of the recommendation above.

PURPOSE AND SCOPE

The purpose of the investigation was to design and test mixes that might satisfactorily replace the currently used asbestos curb mix.

Laboratory tests were performed on six mixes including a standard C-1 asbestos curb mix; two C-1 mixes containing 3% Portland cement and no asbestos, both of which had been used in curbs on construction projects; and three C-1 mixes with no asbestos but with other additives.

MIXES AND MATERIALS

Table 1 lists the designs for the mixes tested. Mixes #1 and #2 were placed in the Suffolk District and samples of the mixed materials were taken at the asphalt plant. The mixtures had to be reheated in order to mold laboratory test specimens.

TABLE 1

CURB MIX DESIGNS

	Mix Designation	Design or Optimum Asphalt Content-%	Aggregate: Proportion	Aggregate: Source
Field Mixes	#1 Suffolk	6.2	55% 1/2" Crushed Gravel	West Sand & Gravel Co., Inc., Richmond, Virginia
			42% #10 Crushed Gravel	West Sand & Gravel Co., Inc., Richmond, Virginia
			3% Portland Cement	—
	#2 Suffolk	7.0	35% #8's	Vulcan Materials Co., Lawrenceville, Virginia
			25 Concrete Sand	Lone Star Industries, Inc., Petersburg, Virginia
			37% #10 Screenings	Jack Quarry, Petersburg, Virginia
			3% Portland Cement	—
Laboratory Mixes	#3 Standard Asbestos Mix	7.0	40% #8 Granite	Tidewater Crushed Stone, Richmond, Virginia
			30% #10 Granite	Tidewater Crushed Stone, Richmond, Virginia
			28% Concrete Sand	Tidewater Crushed Stone, Richmond, Virginia
			2% Asbestos	—
	#4 Fly Ash Filler	6.75	40% #8 Granite	Tidewater Crushed Stone, Richmond, Virginia
			30% #10 Granite	Tidewater Crushed Stone, Richmond, Virginia
			26% Concrete Sand	Tidewater Crushed Stone, Richmond, Virginia
			4% Fly Ash	H. T. Ferron Concrete Co., Charlottesville, Virginia
	#5 Portland Cement Filler	6.75	40% #8 Granite	Tidewater Crushed Stone, Richmond, Virginia
			30% #10 Granite	Tidewater Crushed Stone, Richmond, Virginia
			25% Concrete Sand	Tidewater Crushed Stone, Richmond, Virginia
			5% Portland Cement	—
	#6 Powdered Asphalt Additive	7.0	40% #8 Granite	Tidewater Crushed Stone, Richmond, Virginia
			40% #10 Granite	Tidewater Crushed Stone, Richmond, Virginia
			20% Concrete Sand	Tidewater Crushed Stone, Richmond, Virginia
			15% Powdered Asphalt	The Asphalt Institute, College Park, Maryland

Mix #3 was a standard asbestos mix in use by the Department. It was tested to determine test values for a satisfactorily performing mix.

Mixes #4 and #5 contained fly ash and Portland cement fillers, respectively.

Fifteen percent of the asphalt cement in mix #6 was replaced by a powdered petroleum refinery asphalt having a penetration of five at 77^{o}F. Mix #6 was mixed in the lab at 325^{o}F rather than at 300^{o}F as were the other mixes.

All mixes contained AC-20 asphalt cement and conformed to the gradation specification for C-1 Virginia curb mix (see Appendix).

TESTING OF MIXES

The following types of tests were used to evaluate the mixes: (1) the Marshall stability, (2) indirect tensile strength, (3) resilient modulus, (4) creep modulus, and (5) beam stability.

Marshall Stability

Marshall stability tests were performed according to ASTM Standard Method D 1559-73.

Resilient Modulus

The resilient modulus was obtained with a Mark II resilient modulus device (Figure 1). The apparatus consists of a pneumatic load frame with a bellofram, compressed air control, strain measuring yoke, transducers, and electronic readout and controls.

The Marshall specimens were tested in indirect tension by applying a 43.1 lb. load for 0.1 sec. The horizontal strain was measured and the resilient modulus computed as:

$$M_R = \frac{P\ (\nu + 0.27)}{t\ \Delta}$$

where M_R = resilient modulus in psi

P = applied load in lbs.

ν = Poisson's ratio (assumed 0.3)

t = thickness of specimen in in.

Δ = horizontal strain in in./in.

This test is nondestructive, so the same specimens were used for the resilient modulus test, creep modulus test and indirect tensile strength test.

Creep Modulus

The Mark II resilient modulus device was also used for the creep test. The only differences between the resilient modulus test and the creep modulus test were in the magnitude and duration of the load application. For the creep modulus, a 19.4 lb. load was applied for 300 seconds and the horizontal strain recorded.

Indirect Tensile Test

The apparatus for the indirect tensile test (Figure 2) consists of a loading frame with 0.5" wide loading strips and a proving ring with an electronic readout. In this investigation the load was recorded with a 1508A Honeywell recorder. Horizontal strain was also recorded but was not used in the analysis.

The load was applied with a Soiltest Versa Testa at a 2"/min. vertical deformation rate, and failure was characterized by a vertical splitting of the specimen. The maximum (failure) load was used to compute the indirect tensile strength as:

$$S_T = 0.156 \frac{P_{Fail}}{h}$$

where S_T = indirect tensile strength in psi

P_{Fail} = vertical load at failure in lb.

h = height of specimen in in.

Beam Tests

Beams (3.25" x 3.5" x 15") were made from each of the mixes described in Table 1 and also from a gravel-sand mix which was thought to have a low stability. The beams were placed on their side in a 140°F oven and observed for signs of instability. None of the beams collapsed, therefore, the results were inconclusive.

APPLICABILITY OF TEST RESULTS

The resilient modulus simulates the modulus of the material under moving traffic and probably is not applicable for testing curb mixes except cases simulating tires bumping the curb.

The indirect tensile test uses an intermediate loading rate and may indicate good and bad curb mixes by high and low values respectively.

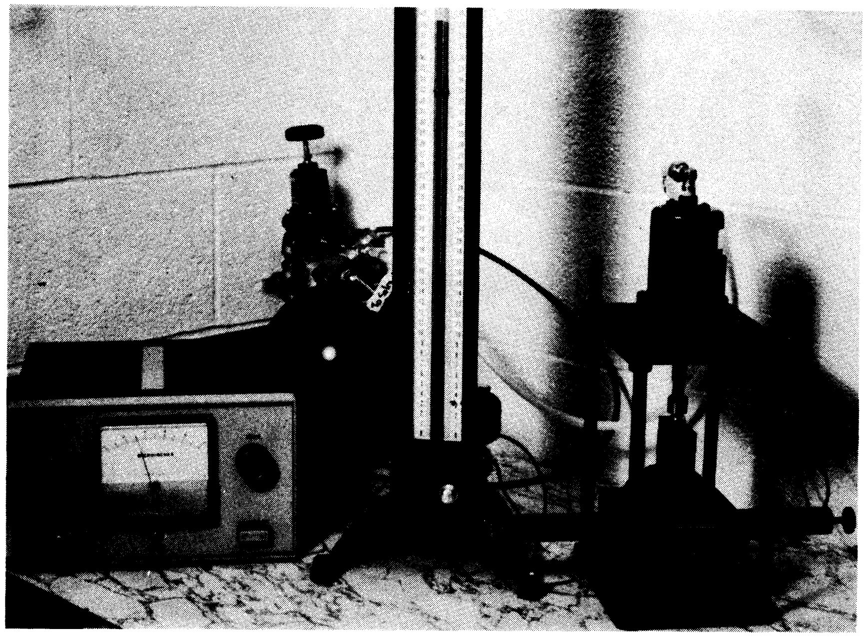

Figure 1. Resilient Modulus Device.

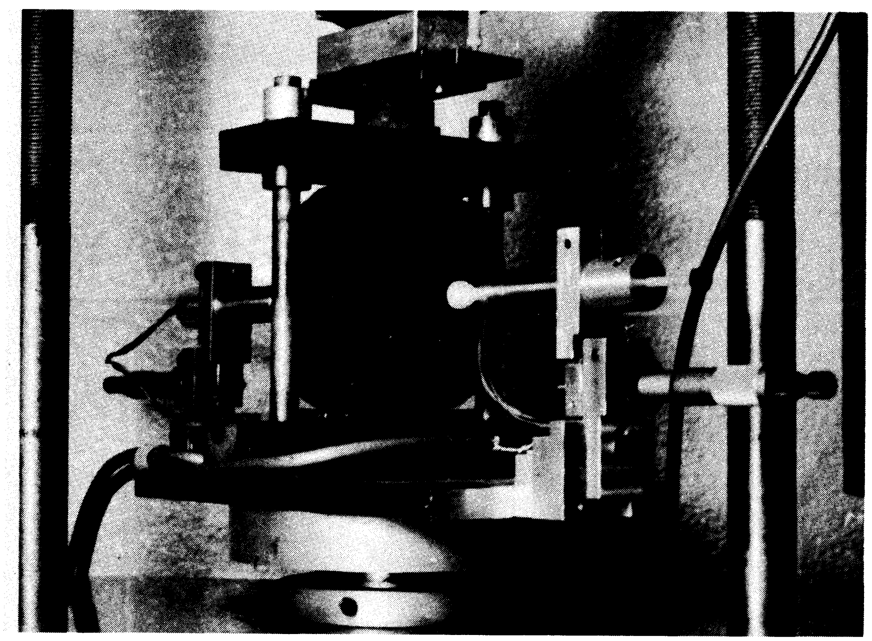

Figure 2. Indirect Tensile Test.

The stability test is performed at 140°F, a temperature at which the strength of a curb mix is critical (hot weather); therefore, it logically would be a good indicator of good and bad curb mixes.

The creep modulus test is probably the best of the five test methods for gaging the acceptability of curb mixes. Unstable curb mixes usually fail over long periods which are simulated by the long loading time in the creep test. A high modulus indicates a good mix.

RESULTS

Table 2 lists the test results. As can be seen, mixes #1, #2, #3, and #6 had the highest values for the four test methods.

The field mixes from Suffolk, (mixes #1 and #2) containing 3% Portland cement had very high test values. Mix #5, which contained 5% Portland cement and was made in the lab, had very low test values. The disagreement was probably caused by asphalt hardening that resulted from the reheating. Asphalt will be recovered and tested from mixes #1, #2, and #5 at a later date to determine if reheating caused the apparent difference in test results.

Since no design requirements are used for determining an acceptable curb mix, the test results for the asbestos mix were used as a guide in the selection of suitable curb mixes. Mixes #1, #2, and #6 gave test results similar to those from the asbestos mix (#3) and therefore would be considered acceptable; however, mixes #1 and #2 should probably be eliminated until the disagreement in results mentioned above is resolved. Therefore, mix #6 containing powdered asphalt is the only mix with properties similar to those of the asbestos mix.

The Asphalt Institute has indicated (by correspondence) that similar results have been obtained with the addition of either powdered asphalt or Gilsonite to curb mixes.

Gilsonite, a bituminous substance with properties similar to those of powdered asphalt, is commercially available in bulk or 50 lb. bags. The price is approximately $100/ton FOB Colorado. Therefore, assuming shipping costs are $50/ton and 10% Gilsonite is required, it is estimated to cost less than $1.50/ton more than regular plant mix. The Gilsonite curb mix will be evaluated and reported on in the near future.

CONCLUSIONS

1. The powdered asphalt curb mix possessed characteristics similar to those of the asbestos mix, and therefore it should perform satisfactorily.

2. The field mixes from Suffolk were comparable to the asbestos mix; however, additional tests are needed to determine the effect of reheating.

TABLE 2

TEST RESULTS

Mix Description	Stability, lbs.	Indirect Tensile Strength, Psi	Resilient Modulus, Psi	Creep Modulus, Psi
#1 Suffolk	2115	222	462,000	18,900
#2 Suffolk	1930	221	312,000	21,200
#3 Standard Asbestos Mix	1920	159	331,000	10,400
#4 Fly Ash Filler	1700	124	172,000	2,910
#5 Portland Cement Filler	1900	140	158,000	1,790
#6 Powdered Asphalt Additive	2350	160	287,000	10,700

3. Powdered asphalt or a comparable additive (Gilsonite) should add less than $1.50/ton to the cost of a regular mix.

RECOMMENDATIONS

Tentatively, it is recommended that a Gilsonite asphalt mix be substituted for the asbestos curb mix in situations where high stability is necessary.

APPENDIX

Specifications for Virginia C-1 Mix

Sec. 212.24 Type C-1 Bituminous Concrete (Curb Mix) shall consist of a blend of No. 78 crushed aggregate, No. 10 aggregate, Grading A fine aggregate, and one to three percent of finely divided asbestos fiber combined with asphalt cement, viscosity grade AC-20 unless otherwise specified, and shall conform to the following:

Percent by Weight Passing Square Mesh Sieves

Inches		U. S. Standard					Percent
1/2	3/8	No. 4	No. 8	No. 30	No. 50	No. 200	Asphalt
100	90-100	65-80	45-65	25-40	13-23	6-10	6.0 - 9.0

Asbestos fiber shall meet the general requirements of Canadian Chrysotile Asbestos and shall be Grade 7M06 by Quebec's Standard Screen Tests. The asbestos shall be protected from the weather. The use of wet or damp asbestos will not be permitted.

The contractor shall not commence production of the mix until the results of the Marshall design, performed by the Department, are known and the job-mix formula has been approved.

A dry mixing time of not less than 15 seconds will be required.