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STUDY OF PREMOLDED BITUMINOUS BASE PLATE FOR JOINTS

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In order to obtain a general picture of the physical characteristics of asphalt hard board for use as base plate under concrete pavement joints, hard board samples obtained from three manufacturers were subjected to a series of physical tests. The selection of physical tests was guided by three main objectives: (1) to ascertain the comparative resistance to damage while being handled on the job; (2) to estimate which materials would show least warping or distortion from weathering while lying alongside the job; and (3) to find whether concrete pavement slabs, while shrinking or expanding, would slide freely on a base plate in place under a joint, without rupturing the base plate.

The results of the physical tests indicated that the boards made by Keystone and Philip-Carey were more resistant to damage than were Meadows boards. Meadows asphalt-coated board showed the highest resistance to weathering, with the Philip-Carey material running a close second. The uncoated Meadows board and the Keystone board both showed very poor resistance to weathering. None of the materials tested showed any serious tendency to adhere to concrete cured in contact with them. Their tensile strengths were adequate, in all cases, to prevent breakage by stresses in base plates which might be expected to occur as a result of concrete pavement contraction.

Two additional Keystone asphalt hard boards, reinforced with 1/4-in. and with 1/16-in. fiberglas mesh, showed poor resistance to weathering.

MATERIALS AND METHODS

The asphalt hard boards tested in this investigation were submitted by W. R. Meadows, Inc., Keystone Asphalt Products Co., and the Philip-Carey Manufacturing Co. The two types of board submitted by Meadows were identical except that one was coated with a waterproof "catalytic" asphalt.

Both Meadows boards and that from Keystone were of core-type asphalt board composed of a homogeneous asphaltic core and lined on both faces with heavy asphalt-impregnated Kraft paper. Two additional specimens of Keystone board were reinforced with fiberglas mesh. The Philip-Carey specimen was of laminated-type asphalt board composed of five layers of heavy asphalt-impregnated Kraft paper bonded together with thin layers of asphalt.

Experimental Details

The tests designed to estimate resistance to breakage while being handled on the job, were:

1. Brittleness: This test was similar to the brittleness test described in AASHO Designation T42, except that the height from which the steel ball was dropped was 9 to 11 inches rather than the standard one foot because of the thinness of the asphalt board.

2. Adhesion Between Boards: Several boards were piled in a warm room (80-90 F.), with 50-lb. weights on each end and at the middle of the pile; these were checked after one month to determine the ease of unpiling.

3. Tensile Strength: These were run on a Scott tester at a speed of 12 in. per min. with an initial jaw separation of three inches. Standard tests for preformed joint filler (AASHO Designation T42) were employed to estimate distortion and warping from weathering, as follows: (1) accelerated weathering, (2) water absorption, and (3) distortion.

4. Liner Adhesion at 0F.: Specimens two by six inches in size were frozen at 0 F. for 24 hours after which they were examined to determine whether the liners or plies were prone to loosen at that temperature.

5. Accelerated Weathering: An Atlas Twin Arc Weatherometer using five 22-hr. cycles of sunlight, with water spray for 18 minutes every two hours. The 3-1/2- by 4-in. specimens were exposed in a horizontal position.

6. Natural Weathering: A full size board of each type was laid on the sod in an open field on March 26 and examined after periods of 37, 46 and 113 days for warping, cracking and general appearance.

A test was designed to estimate whether concrete slabs would slide on base plates in place under a joint, without breaking the base plate. The lateral force necessary to start motion of concrete blocks molded and cured on the base plate was measured by means of a spring scale and a horizontal screw jack. Then the lateral force necessary to move a concrete block premolded and placed on the base plate was measured by means of a sensitive spring scale. The latter measurement was of the force necessary to overcome static friction, while the difference between the two forces was regarded as that necessary to overcome adhesion.

From these readings, the maximum stresses likely to be encountered by a base plate under a joint were calculated. These were then compared with the known breaking strength of the base plate materials to determine whether ruptures in the base plate were likely to result from joint opening.

Tests made for general comparison of the various asphalt hard boards were:

1. Bitumen content: This was determined by extraction with trichlorethylene in a Soxhlet extractor.

2. Ash Content: The standard method of test for ash as described in AASHO Designation T111 was used for the ash determination.

3. Density: The density, calculated as pounds per cubic foot, was found according to the standard method of density determination for preformed expansion joint filler as described in AASHO Designation T42.

4. Dimensions: Full size asphalt hard board specimens were measured for maximum and minimum thickness, width, and length. Thickness was measured to the nearest 0.01 in., width to the nearest 1/8 in., and length to the nearest 1/4 in. Average plus or minus deviations obtained from several measurements of each dimension were calculated as percent deviations.

RESULTS AND DISCUSSION

The results of all the physical tests are shown in Tables 1 and 2 and Figures 1 and 2.

The brittleness test indicated that the laminated type board submitted by Philip-Carey and Keystone's core type board were about equal, and slightly less brittle than the Meadows boards.

The boards tested showed very little tendency to adhere to each other after being piled together under heavy weight for a prolonged period, thus minimizing any danger of breakage in unpiling the boards.

The AASHO accelerated weathering test proved to be a poor measure of resistance to weathering. The Meadows uncoated board and the Keystone board both passed the AASHO accelerated test but warped badly after outdoor exposure to weather, as can be seen in Figure 1. On the other hand, the Meadows coated board and the Philip-Carey board both failed the accelerated weathering test but showed no warping after exposure to natural weather.

Weatherometer exposure showed the same order in weathering resistance as did natural weathering. The results of the weatherometer tests can be seen in Figure 2.. Weatherometer exposure also caused serious warping of the two Keystone specimens with fiberglas reinforcement.

Although the Meadows board showed relatively high heat distortion (1/4 in.) it had a very low water absorption., which probably accounted for its excellent resistance to natural weathering. The Philip-Carey board had a very high water absorption but, due to its laminated type structure, a low heat distortion (1/16 in.); it also showed very good resistance to natural weathering. It would appear from examination of the data regarding these properties that high resistance to weathering is somewhat dependent on either low water absorption or low heat distortion.

Presented below are results of the tests for static friction and concrete-to-base-plate adhesion as well as the calculations involved.

The maximum lateral force necessary to start motion of a concrete block molded and cured on base plate (pull to overcome adhesion plus static friction):

84 lb.

The maximum lateral force necessary to start motion of a concrete block premolded and then placed on base plate (pull to overcome friction):

5.25 lb.

The difference equals the force necessary to break adhesion:

$$84 - 5.25 = 78.75 \text{ lb.}$$

The area of block adhered to base plate was 3- by 8-1/4-in. =

24.75 sq. in.

so

$$78.75/24.75 = 3.2 \text{ psi.}$$

which is the unit lateral force necessary to break adhesion.

The block was three inches high, so the maximum lateral force for a block nine inches high would be:

$$3 \times 5.25$$

and

$$3 \times 5.25/24.75 = 0.64 \text{ psi.}$$

would be the maximum lateral unit force necessary to overcome static friction.

The maximum lateral unit force necessary to overcome both adhesion and friction would be for a nine-inch thick concrete slab:

$$3.2 + 0.64 = 3.84 \text{ psi.}$$

The area of a base plate, in situ, in contact with a pavement slab end would be for a 11-in. by 11-ft. base plate:

$$5.5 \times 132 = 726 \text{ sq. in.}$$

so

$$726 \times 3.84 = 2788 \text{ lb.}$$

would be the maximum total tension produced in the base plate.

The maximum total tension in a strip of base plate one inch wide would be

$$2969/132 = 21.1 \text{ lb. per in. of width}$$

The tensions necessary to break one-inch strips of various base plates in lb. per in. of width are shown in the Table, and by comparison with the above figure of 21.1 lb. per in., it can be seen that breakage of a base plate in situ should not occur as a result of joint opening.

None of the boards tested deviated seriously from their specified dimensions. Most of the deviations were plus deviations which would not interfere with the boards' utility; any minus deviations were practically negligible.

CONCLUSIONS

It is concluded from the results of this investigation that specifications for asphalt hard board to be used as base plate under concrete pavement joints should include maximum limits on the following properties:

1. Brittleness (AASHO Designation T42 - Modified)

2. Adhesion between piled-up boards

3. Delamination at 0 F.

4. Warping after repeated wet and dry cycles in a standard weatherometer to accelerate the effects of natural weathering.

Figure 1. Samples after 113-day natural weathering test.

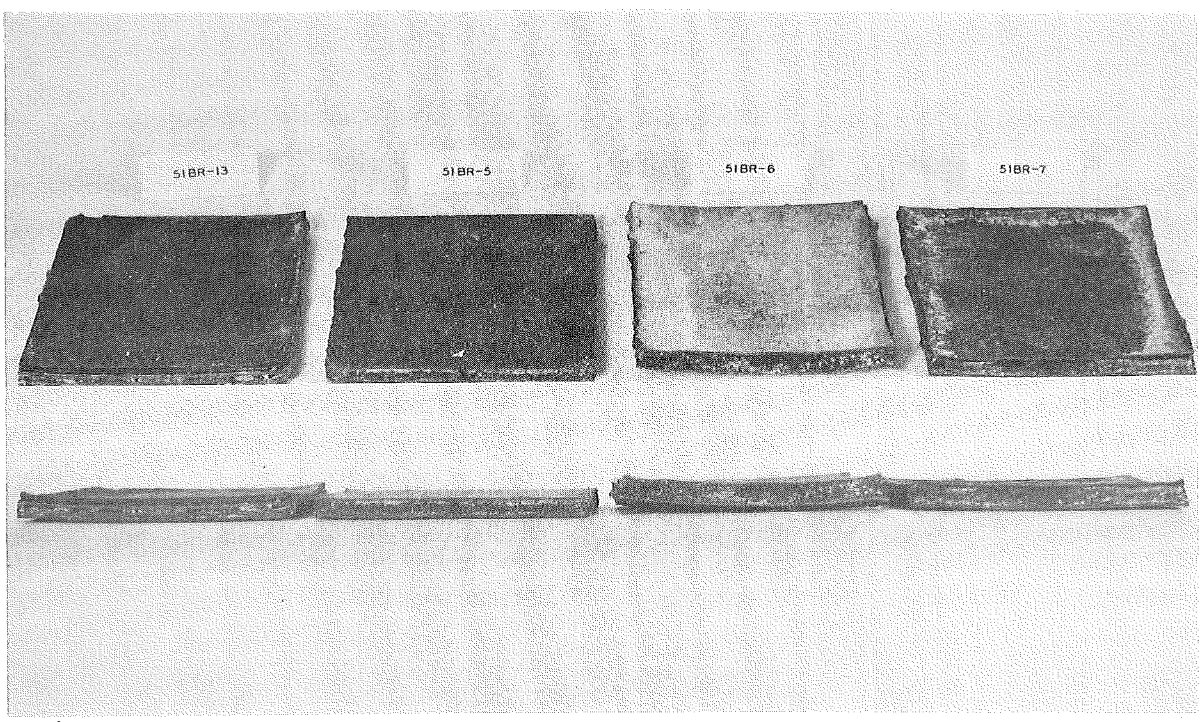

Figure 2. Samples after 90 cycles in the weatherometer.

TABLE 1

PHYSICAL PROPERTIES OF ASPHALT HARD BOARDS SUBMITTED BY VARIOUS PRODUCERS FOR USE AS BASE PLATES FOR CONCRETE PAVEMENT JOINTS

	51 BR-13	51 BR-5	51 BR-6	51 BR-7
Producer	Philip-Carey	Meadows	Meadows	Keystone
Type	Laminated	Core-Coated	Core-Plain	Core-Plain
Brittleness: (AASHO)				
11 in. Drop	Failed	Failed	Failed	Failed
10 in. Drop	No Failure	Failed	Failed	No Failure
9 in. Drop	No Failure	No Failure	No Failure	No Failure
Adhesion Between Piled Boards	Very Slight	Very Slight	Very Slight	Very Slight
Accelerated Weathering (AASHO)	Failed	Coating Failed	No Failure	No Failure
Accelerated Weathering Atlas Weatherometer	Very Slightly Warped	No Change	Severely Warped	Moderately Warped
Water Absorption (percent)	4.2	0.89	2.8	2.6
Natural Weathering:				
after 37 days	No Change	No Change	Moderately Warped & Faded	Slightly Warped & Cracked
after 46 days	No Change	No Change	Severely Warped & Faded	Moderately Warped & Cracked
after 113 days	Shrinkage of Outer Piles, No Warping	No Change	Severely Warped & Faded	Moderately Warped & Cracked
Distortion (in.) (AASHO)	1/16	1/4	5/16	1/8
Liner Adhesion at 0 F.	No Separation	No Separation	No Separation	No Separation
Bitumen Content (percent)	61.3	67.2	65.6	56.5
Ash Content (percent)	28.7	38.5	37.7	46.6
Density (lb. per cu. ft.)	73.0	72.2	73.7	79.2
Dimensions, (percent deviation):				
Thickness (0.25 in.)	+3 -0	+4 -0	+0 -8	+0 -4
Width (11 in.)	+5 -0	+8 -0	+7 -0	+5 -0
Length (11 ft.)	+0 -0	+0 -0	+0 -0	+0 (8 ft.) -0
Maximum Lateral Force Necessary to Start Motion of 3- x 3- x 8-1/4-in. Concrete Block Precured & Placed on Base Plate (lb.)	4	5	5.25	4.25
Maximum Lateral Force Necessary to Start Motion of 3- x 3- x 8-1/4-in. Concrete Block Cured on Base Plate (lb.)	84	81	48	52
Tensile Strength Cross Grain lbs. per in. width				
Wet (soaked 24 hrs. in H_2O)	161	147	95	115
Dry	203	164	144	162

TABLE 2

PHYSICAL PROPERTIES OF 1/4-IN. KAPCO ASPHALT HARD BOARD FOR USE AS BASE PLATE

	52 BR-36	52 BR-37
Producer	Keystone	Keystone
Type	Core-Plain	Core-Plain
Reinforcement	1/4-in. Fiberglas Mesh	1/16-in. Fiberglas Mesh
Accelerated Weathering-Atlas Twin Arc Weatherometer		
Top side up	Badly Warped	Badly Warped
Bottom side up	" "	" "
Tensile Strength Cross Grain lbs. per in. width		
Wet (soaked 24 hrs. in H_2O)	50	68
Dry	64	145