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BENDING STRENGTH OF ASPHALTIC CONCRETE

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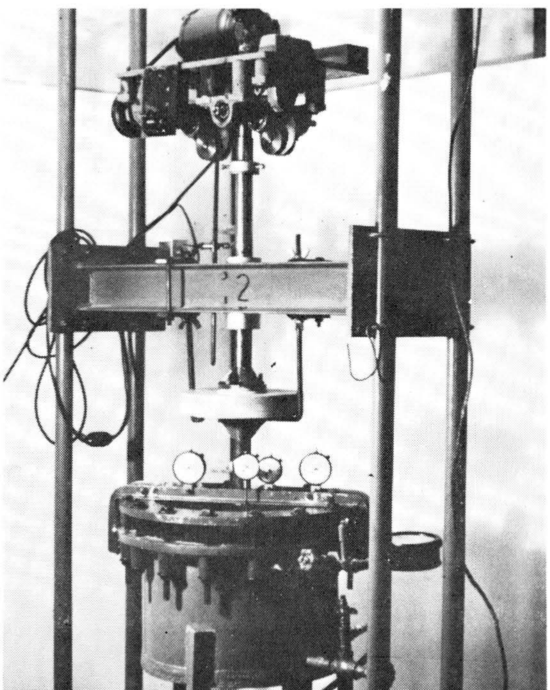

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Bending Strength of Asphaltic Concrete

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Research is being conducted by a number of states with the objective of refining or modifying the pavement performance equations developed by the engineers of the AASHO Road Test. These studies are essential for translating the general findings of the AASHO group in Ottawa, Illinois for usage throughout the nation. The particular concern of this report is to relate the bending strength of asphaltic concrete to the viscosity of the asphalt in the mixture, and to compare the bending strength under a static load to that under a repetitive load. The final objective of the study is to describe the contribution of the asphaltic concrete surface to the performance of flexible pavement systems.

One aggregate blend was mixed with three grades of asphalts (50/60, 85/100, and 120/150 penetration) from two different sources at asphalt contents of five, six, and seven percent. Table 1 presents the values and range of asphalt viscosity covered within the study.

The primary bending strength tests used were the cohesiometer (static bending) and the "deflectometer," a repeated flexure test developed at TTI. The cohesiometer equipment was modified to include a load and deflection recorder which was required for the analysis of failure of a specimen. Tests were performed with the modified cohesiometer at temperatures of 77 and 140° F.

The repeated flexure tests were performed on specimens approximately 18 inches in diameter on the deflectometer pictured on the cover. These tests were made on laboratory and field specimens at a temperature of 77° F.

Mixtures were characterized with respect to their cohesiometer strength by the parameter, A_0, representing the strength of

TABLE 1
Viscosity of Asphalts Recovered from Deflectometer Specimens

Source	Penetration Grade	Viscosity, Poise 77° F	140° F
	50-60	7.50×10^6	6,250
H	85-100	1.80×10^6	2,440
	120-150	0.87×10^6	1,580
	50-60	28.5×10^6	21,300
T	85-100	10.5×10^6	6,240
	120-150	2.90×10^6	3,555

TABLE 2
Coefficients for Stress-Repetition Relationship On Deflectometer
$\text{Log } S = \text{Log } I - b \text{ Log } N$

Asphalt							
Source	Grade & Viscosity 77° F. Poise	Content, %	b	Number of Observations	Coefficient of Determination r^2	I* psi	I_0** psi
		5	0.1479	3	.8889	1006	1757
	120-150	6	0.1934	6	.9953	1360	1379
	0.45×10^6	7	0.1192	4	.9243	517	1140
		5	0.1808	6	.9978	1367	1569
T	85-100	6	0.1700	6	.9967	1123	1446
	1.30×10^6	7	0.2686	5	.9990	2574	1233
		5					2285
	50-60	5	0.2318	6	.9799	2504	1676
	2.95×10^6	7	0.2072	4	.9732	2184	1869
		Average	0.1899				
	120-150 0.30×10^6	6	0.2031	4	.9388	1369	1252
		5	0.1714	6	.9942	1358	1760
H	85-100	6	0.1896	5	.9940	1317	1388
	0.54×10^6	7	0.2109	6	.9358	1571	1364
	50-60	6	0.2356	5	.9895	2806	1740
	1.74×10^6						
		Average	0.2021				
	GRAND AVERAGE		0.1946				

*Intercept of stress axis for 1 repetition for individual values of b.
**Average intercept of stress axis for 1 repetition assuming $b = 0.1946$.

a specimen four inches wide and one inch in thickness. A similar parameter, obtained with the deflectometer, was I_0, which is the value of stress that can be resisted for one application only.

For the deflectometer test, the relationship between bending stress, S, and number of repetitions, N, to cause failure was represented as $\log S = \log I - b \log N$, where I is a constant for a mix. The results of regressing log S on log N for each mixture are shown in Table 2. The values of r^2 were high but there was some variability between mixtures in the values of the slope $- b$. As indicated in the table the variability in slope was assumed to be of a random nature and an average value (— .1946) was used to calculate I_0 for the different mixtures. The parameter, I_0, is considered to be a better estimate of strength than I.

For the laboratory prepared specimens, data obtained were analyzed for correlation between strength and viscosity of the recovered asphalt; these results are presented in Table 3. The cohesiometer strength A_0 correlated well with asphalt viscosity and the slope may have been affected by asphalt content but differences were small.

The correlation study for I_0 with asphalt viscosity is not as conclusive as the one for A_0; however, this may be due to the more limited amount of data.

An objective of the study was to determine if a relationship exists between the static bending strength (A_0) of asphaltic concrete and its resistance to repeated bending. In this study the

TABLE 3

Results of Correlation Study of Cohesiometer Value, A_0, and Deflectometer Number, I_0, With Recovered Asphalt Viscosity, η_r

Mixture	Test Temperature °F	b	Number Of Observations	Coefficient of Determination r^2
	$\log A_0 = \text{constant} + b \log \eta_r$			
T — 5%	77 & 140	0.2685	5	0.9951
T — 6%	77 & 140	0.2455	6	0.9965
T — 7%	77 & 140	0.2426	6	0.9968
H — 6%	77 & 140	0.2569	6	0.9895
	$\log I_0 = \text{constant} + b \log \eta_r$			
T — 5%	77	0.1057	3	0.4046
T — 6%	77	0.0830	3	0.8748
T — 7%	77	0.2092	3	0.8135
H — 6%	77	0.1535	3	0.9992

repeated bending strength was characterized by I_0 since it was assumed that all of the mixtures had essentially the same slope in logarithmic plots of stress versus repetitions to failure. The relationship between log A_0 and log I_0 was represented by the equation, $\log I_0 = C_0 + C_1 \log A_0$, where C_0 and C_1 are constants. A regression analysis of data from laboratory specimens yielded an r^2 value of 0.7028 and a slope of 0.6326 representing the effect of A_0. The same study was made of data obtained from specimens taken from pavements throughout Texas. The analysis of results from testing approximately twenty such pavement surfaces yielded a smaller r^2 value (0.6041) but very nearly the same slope (0.6375) obtained from the laboratory specimens. Thus, if the deflectometer test is accepted as representing field stressing conditions, then the modified cohesiometer test must also be accepted as representing field stressing conditions, at least to the degree indicated by the values of r^2 obtained.

In summary, it may be said that:

(1) The data indicate the strong influence of asphalt viscosity on bending strength.

(2) Bending strengths determined from the modified cohesiometer were fairly well correlated with those determined from the deflectometer. The slope, $d(\log I_0)/d(\log A_0)$ was 0.6

(3) The results warrant investigation of the hypothesis that the resistance to cracking of asphaltic concrete can be predicted if asphalt viscosity and the modified cohesiometer value are known.