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16. ABSTRACT
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All of the asphalts were of the 200-300 penetration grade and, with one exception, represented different crude sources and methods of production as found in California. The exception was a mid-continent crude source asphalt produced in a refinery in Arkansas.

Most of the asphalts were placed in 2500 ft. test sections in both the new and blanket pavements. The test sections were constructed under nearly identical procedures, and have been subjected to common climatic and traffic conditions. Paving on the project was started in October 1954 (Period 1) and completed in March 1955 (Period 2).

Complete field studies were carried on during construction, and Abson recovery tests were made on the paving mixtures. Observation and test results confirm the fact that asphalts manufactured by different methods and from different crude sources, although placed under virtually identical conditions, exhibit varying degrees of hardening during the mixing process. A comparison of Standard Thin Film test results and hardening in the mixer shows an excellent correlation.

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STATE OF CALIFORNIA
BUSINESS & TRANSPORTATION AGENCY
DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS

MATERIALS AND RESEARCH DEPARTMENT
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FINAL REPORT ON THE

ZACA-WIGMORE TEST ROAD

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February, 1969

FINAL REPORT ON THE ZACA-WIGMORE ASPHALT TEST ROAD

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SYNOPSIS

During 1954 the California Division of Highways introduced improved specifications for paving grade asphalts. In order to determine the effect of these specifications under field conditions, ten different asphalts were placed on a major construction project consisting of entirely new construction, and also an overlay over an old portland cement concrete pavement. A progress report describing the construction and early observations on service performance was reported in 1959 in ASTM, STP277.

All of the asphalts were of the 200-300 penetration grade and, with one exception, represented different crude sources and methods of production as found in California. The exception was a mid-continent crude source asphalt produced in a refinery in Arkansas.

Most of the asphalts were placed in 2500 ft. test sections in both the new and blanket pavements. The test sections were constructed under nearly identical procedures, and have been subjected to common climatic and traffic conditions. Paving on the project was started in October 1954 (Period 1) and completed in March 1955 (Period 2).

Complete field studies were carried on during construction, and Abson recovery tests were made on the paving mixtures. Observation and test results confirm the fact that asphalts manufactured by different methods and from different crude sources, although placed under virtually identical conditions, exhibit varying degrees of hardening during the mixing process. A comparison of Standard Thin Film test results and hardening in the mixer shows an excellent correlation.

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From March 1955 through April 1964 periodic inspections have been performed for rating the service record of the respective test sections. A number of sections over new and existing alignment failed within the nine year service period. Ten test sections failed between 38 months and 92 months of service life. Seven sections remained in satisfactory condition after nine years of service life, mainly in the overlay sections over the old portland cement concrete pavement.

The initial void content and the rate of change in void content during service life together with the asphalt content appear to be dominant factors in the hardening rate of the various asphalts. However, the rate of hardening under equivalent weathering, and pavement conditions is also influenced by the asphalt source.

Numerous routine and research tests have been performed on the asphalts. The best test for predicting the durability properties of the asphalt appears to be the modified Shell durability test.

INTRODUCTION

Throughout the years the Materials and Research Department has sought to develop new test methods and test limits in order to write specifications that will provide paving grade asphalts of uniform engineering properties. As a result of these studies, a trial specification was developed in 1954. In order to determine the performance of asphalts complying with the new requirements, it was decided to incorporate them in a series of test sections built as part of a state highway contract. This was done on contract 54-5VC12, on U.S. Route 101 in Santa Barbara County. The project has become known as the Zaca-Wigmore Job. The purpose of this final report is to present the findings of laboratory and field studies on the performance of the various test sections.

PROJECT DESCRIPTION

The project to compare the performance of different asphalts was constructed during 1954-1955 under contract 54-5VC12. The project has become known as the Zaca-Wigmore job because the ends of the job are located near the now abandoned Pacific Coast Railroad stations known as Zaca and Wigmore.

The contract consisted of converting six miles of an existing two lane highway into a four lane divided expressway by constructing two new lanes, and widening the existing pavement. Based on soil surveys and an anticipated Traffic Index of 9.0, the typical structural section for the new alignment consisted of 1.0 ft. imported subbase material, 0.67 ft. of Class B, cement-treated base, and 0.33 ft. asphalt concrete Type B. The existing facility consisted primarily of an old portland cement concrete pavement constructed in the early 30's which was in fair to poor condition. The reconstruction design provided a minimum of 0.5 ft. Class B, cement-treated base to be placed over the existing pavement and to be surfaced with 0.33 ft. of asphalt concrete, Type B. The existing concrete pavement was also subsealed with asphalt prior to placing the new cement-treated base. The roadway was widened to provide a geometric section similar to the new construction. The typical sections for both new and existing pavements are shown in Figure 1.

LAYOUT OF TEST SECTIONS AND SELECTION OF ASPHALTS

The test section length for each asphalt was approximately 2500 ft. with the exception of two special asphalts where the available supply prevented the laying of full length sections. Whenever possible, the test sections were placed so that asphalt from the same refinery would be used in two locations - one section on the new alignment and one section over the existing pavement.

Grade 200-300 asphalt was used on the entire project because this grade had been previously used on numerous projects in District 05.

The reasons for selection of the various asphalts are discussed in detail in reference (1). The project as finally constructed is shown in Figure 2. It contained six asphalts complying with the new tentative 1954 specification, two asphalts complying with the requirements of section 54 of the 1954 Standard Specifications and two asphalts not commercially available in California at the time, but placed in order to aid in the evaluation of new test procedures. The following table lists the asphalts by code letters and the specification designations. Paving on new alignment was performed during period 1 and 1A, while paving over the existing pavement was done during period 2.

State of California Code			Specifications
Construction Period			
1	1A	2	
A	-	A-2	Tentative 1954 Specification
-	B-1	B-2	" " "
D	-	D-2	" " "
F	-	-	" " "
G	-	G-2	" " "
H	-	H-2	" " "
C	C-1	C-2	1954 Standard Specification
E	-	E-2	" " "
-	-	I-2(5.8%)	Special
-	-	I-2(6.3%)	"
J	-	-	"

Table A shows the specification requirements for the asphalts.

CONSTRUCTION OPERATIONS

A detailed description of construction operations for the project is provided in reference (1). This report includes all field and laboratory tests on the basement soil and the various elements of the structural sections over new and existing alignment.

Construction operations were somewhat complicated by the necessity of carrying traffic through the job site, and paving was accomplished during three different time periods.

Period 1 - Oct. 14, 1954 to Nov. 3, 1954
Period 1A - Dec. 16, 1954 to Dec. 21, 1954
Period 2 - Feb. 21, 1955 to Mar. 21, 1955

The asphalts used in the paving mixture during each of these paving periods are shown in Figure 2.

Construction was completed on the entire project on March 25, 1955, and traffic was routed over all lanes on March 30, 1955.

PAVEMENT PERFORMANCE EVALUATION

From March 1955 through April 1964 periodic inspections for rating the service record of the respective test sections have been performed. Also detailed field and laboratory investigations have been carried out. The following factors have been studied.

1. Surface surveys and crack records.
2. Deflection surveys.
3. Properties of pavement cores removed at various time intervals.
4. Changes in original properties of the various asphalts during mixing and pavement service life.

SURFACE SURVEYS AND CRACK RECORDS

About one year after construction the surface of the pavement laid during periods 1 and 1A began to appear lighter in color and dry in appearance. This trend continued for about four years and then did not appear to increase materially as determined by visual observations. The lighter appearance of the surface was undoubtedly due to the nature of the aggregate. Many of the particles were light in color, and the asphalt tended to wear off the surface thus providing an appearance of dryness. Actually, final cores removed after 97 months of service life, and having this surface appearance were quite black just below the surface.

Paving performed during period 2 did not appear as dry or light as period 1 and 1A for about four years. However, after this period all sections in all periods began to appear the same in terms of dryness. The initial better surface appearance of period 2 test sections may have been caused by the slighter higher asphalt content.

"Pitting" to a varying degree occurred in the pavement placed during both periods. The most serious amount was found in the asphalt I test sections, and in this case appears to be related to the asphalt source. The very light amount that was noted in all other sections appears to be caused by varying amounts of chalk-like particles which tended to abrade easily under traffic action.

Raveling was noted in a number of test sections. The only serious form occurred in the early failures of test sections containing asphalts E, F & G.

There was no serious amount of transverse cracking in any test section except that containing asphalt E-2 which showed excessive transverse cracking up to 97 months of service life. This was most probably caused by excessive hardening of the asphalt, and appears to be a form of shrinkage cracking.

Since some of the test sections are of different length, all longitudinal cracking has been corrected to feet of cracking per 100 linear feet of lane. There was a rapid rise in longitudinal cracking in both travel and passing lanes of periods 1 and 1A paving (new alignment) within the first 28 months of service life. On the other hand, longitudinal cracking in both lanes of period 2 paving (existing alignment) was quite low up to 50 months of service life.

The longitudinal cracking in the wheel tracks was followed by the appearance of pattern cracking which invariably leads to maintenance operations. The pattern cracking of all but three of the test sections, was in a form described as "chicken-wire" or "alligator" cracking. In this type of cracking the pavement is broken into small irregular shaped blocks varying in size from 4 to 8 inches.

The early failure (38 months) of the E test section, period 1 paving, required an immediate screening seal coat. This maintenance operation occurred when approximately ten percent of the travel lane area showed "alligator" cracking. This criteria for failure has been used for the balance of the test sections, although maintenance operations involving a screening seal coat were not required in some of the other failed test sections. The reason for this was the difference in degree of "spalling" occurring along the edges of cracks in the "alligator" cracked areas. In the case of the initial failure of the asphalt E section the continued rapid increase in "spalling" required immediate maintenance action. This did not occur as rapidly in other test sections.

The amount of travel lane "alligator" type cracking during service life for all paving periods is shown in Tables

B and C. The amount of such cracking in the passing lane was very low and, therefore, this lane was not considered in the failure criteria.

An interesting finding in connection with the "alligator" type cracking in the various sections is the almost explosive increase in area after a certain period of service life, Figures 3 and 4.

The results from this test road clearly indicate that a very rapid increase in "alligator" type cracking may be expected after 10% of the lane area is reached. In other words it may be possible to predict the extent of future maintenance, and the time for required overlay construction by determining when the first rapid increase in "alligator" cracking occurs.

The following comments are presented on the development of cracking patterns during service life.

At the end of 28 months of service life all test sections over new alignment were in good condition, although there was some longitudinal cracking, mainly in the passing lane. Two short sections of "alligator" cracking had appeared in the outer wheel track of the travel lane. By the end of 53 months or 4½ years serious distress had occurred in three of the test sections while the balance of the pavement remained in quite good condition. Conditions at the end of 77 months showed an increase in "alligator" cracking in the outer wheel track and the initial appearance of such cracking in the inner wheel track. Conditions at the end of 89 and 101 months showed a small increase in the cracking pattern when compared with the 77 month cracked areas.

In the case of the pavement laid over existing alignment there was virtually no cracking of any kind through 49 months of service life. At the end of 73 months of service life the E-2 section showed an increasing amount of rather closely spaced transverse cracks and areas of large block cracks. The two I-2 sections had developed a form of large block cracking which was not apparent in adjacent sections. This cracking pattern was more prevalent in the passing lane. Neither of the I-2 sections showed any amount of "alligator" cracking. Since paving of these sections was performed during the same day as adjacent sections which did not show this form of failure, one must assume that the asphalt is responsible for the cracking pattern. The passing lane of the G section also showed the same form of cracking as the I-2 section at the end of 50 months. The travel lane was very badly cracked in the form of "alligator" cracking and did not show the large block cracking found in the passing lane.

DEFLECTION RESULTS

The average spring deflection results for all paving periods, taken in the outer wheel track of the travel lane, are shown in Table D. During the first 36 months of service life there was a gradual decrease in deflections over both new and existing alignment. Apparently consolidation of the various layers led to this decrease.

There was a definite increase in deflection readings over the new alignment shortly thereafter, and this was followed by three test section failures in which the asphalt had reached a critical penetration range. During the period from 41 to 77 months there was a slow increase with little change thereafter to the end of 9 years of service life.

Deflection results over the existing alignment have been consistently low since construction, although the results were rather high in one of the test sections during the period from 53-77 months. Thereafter, the average deflection decreased. It is difficult to explain this finding.

The average deflection results for the entire service period indicates that the test sections over the new alignment, in general, were fatigued in about the same manner since all truck traffic entering the test road travelled over its entire length.

F. N. Hveem (2) and Zube and Forsyth (3) have stated that the tentative maximum tolerable deflection level for 4 in. thick asphalt concrete pavement is 0.017 in. On this basis most of the test sections over new alignment had an average spring deflection reading somewhat in excess of this amount after 53 months of service life. However, the increase in average deflection results is partly caused by the increase in "alligator" cracked areas where deflections are much higher.

PROPERTIES OF PAVEMENT CORES REMOVED AT VARIOUS TIME INTERVALS

The void contents of pavement cores from the outer wheel track of the travel lane are shown in Table E. Shortly after construction there was a definite difference in void content between paving periods 1 and 2. It appears that the addition of 0.3 percent asphalt during period 2 construction permitted better compaction. The differences in void contents are also confirmed by the finding of higher stability values for period 2 cores. All test sections showed a gradual decrease in void content up to approximately 55-59 months of service life with little change thereafter.

At the end of 59 months all test sections showed about 100% relative compaction as noted in Table F.

The average grading results from the various core series are shown in Figure 5. There has been virtually no degradation during service life although a definite change was found during the mixing operation.

CHANGES IN ORIGINAL PROPERTIES OF THE VARIOUS ASPHALTS DURING MIXING AND PAVEMENT SERVICE LIFE

Original Properties of the Asphalts

Seven refineries furnished asphalt complying with the 1954 Special Provisions Specifications, Table A, and two additional sources furnished asphalt complying with the 1954 California Standard Specifications shown also in Table A. Asphalt I-2 did not have any specific requirements.

The 1954 Special Provision requirements were somewhat different from our present ones. The essential difference was that the loss on heat test without a ductility requirement was used as compared to the present thin-film test. Some of the asphalts would not meet the present requirements for the Bureau of Public Roads Thin Film test.

The test results on the original asphalts are shown in Tables G, H and I. Some of the asphalts, B-2, E, E-2, F, and G-2 were high in loss after the Bureau Thin Film test and this partly accounts for the serious drop in penetration during mixing operations with these asphalts.

On the basis of recommendations found in the report by P. C. Doyle (4), ductilities at 55F and 1 cm/min speed were performed on the residues from the Thin Film Oven tests together with ductilities under standard conditions. Three asphalts, E-2, G and I-2, Table H, show definite drops in ductility at 55F. These asphalts also show marked gains in shear susceptibility following the tentative durability test as shown in Table H. There is also a drop to very low values for the micro-ductility of the durability residue. It is interesting to note that all three of these asphalts showed varying degrees of the type of cracking encountered by Doyle (4) in his field experiments.

W. J. Halstead (5) has recently stressed the importance of asphalt ductility to pavement performance. In his summary Halstead states, "Therefore, it is most likely that the ability of the asphalt to undergo elongation is not the primary characteristic affecting durability, but rather the ductility test result is an indication of an internal phase relationship of the asphaltic constituents which in turn have an important bearing on the serviceability factors of the asphalt." This statement is confirmed by the previously stated results together with those shown in Table I. The stain numbers of asphalts G and I-2 are very high and also they have high Xylene Equivalent and high Oliensis test values. The Negative Resistance and Negative period test results indicate a definite difference in the internal phase relationships of the various asphalts used in the test road.

Change in Properties During Mixing

A complete discussion on the change in properties of the asphalts during the mixing process is provided in reference (1). The results indicate a close parallel between the Bureau Thin Film test results and hardening during mixing. The results confirm other findings on the importance of this test in providing a method for use in specification requirements for durability of paving grade asphalts during mixing with hot aggregates. Further, since this test provides a laboratory method for simulating the mixing process one may control radical changes in penetration and ductility during mixing by requirements on the residue from the test.

Change in Properties During Service Life

The change in physical properties of the various asphalts during service life are shown in Tables J and K. The hardening with age as measured by the penetration test is shown in Figures 6 and 7. The curves have the normally expected shape with a rather rapid increase in hardening during the first 16 to 20 months, and a definite decrease in hardening rate thereafter. Although the hardening rate, as measured by the penetration test tends to decrease after 20 months, there are differences between asphalts in the period from 20 to 118 months of service life. Three asphalt sections which failed within 55 months of service life have continued high rates of hardening after 20 months. Many of the asphalts used in period 2 paving show very low rates of hardening following the high initial rate. This is probably caused by the additional 0.3% asphalt used in period 2 paving mixtures compared with period 1 mixtures. The additional asphalt appears to have aided in initial compaction with a considerable lowering of void content over that found in period 1, (See Table E).

In the case of asphalt I-2, two asphalt contents, 5.8 and 6.3 percent, were used for the adjacent test sections. The change in penetration during mixing and service life is shown in Figure 8. The difference in asphalt content did not appear to be reflected in the penetration drop during mixing and the difference in asphalt content (film thickness) and percent voids, Figure 9, did not influence the rate of hardening up to approximately 11 months of service life. Immediately thereafter, there is a definite difference in the weathering rate up to approximately 18 months. Thereafter, the rates appear fairly constant although the void content of the 5.8% section is decreasing faster than the 6.3% section. It is evident that the hardening of the asphalt as measured by the penetration is influenced by a number of factors involving both the internal changes in the asphalt as well as the external factors.

Table L presents the change in the Rostler (6) analysis during mixing and up to 55-59 months of pavement service life. In a previous report (7) a rather detailed analysis of this data was presented. The analysis indicates that the changes in percentage composition of the asphaltenes, first acidaffins, and second acidaffins for any one asphalt are different from those of another asphalt. In almost all cases there is a greater change in the three noted components during the specified service period than during mixing. Also, the second acidaffins do not materially change during mixing, but exhibit definite change during service life. In summary, the results of the analysis appear to indicate that the materials in different asphalts, as represented by the Rostler Components, are not the same in relation to their rates of change during mixing and weathering in the field.

DISCUSSION

Three forms of cracking were encountered on the project. The most prevalent throughout the project was the "alligator" type cracking found in the wheel track areas of the travel lane. Little of this type cracking was found in the passing lane except in the E section. The E-2 section had very low deflections and the form of cracking was mainly transverse both in the passing and travel lanes. The I-2 sections and the passing lane of the G section displayed a form of large block cracking together with quite severe raveling and pitting. Photographs, Figures 10, and 11 of these sections appear the same as those shown for failures encountered by P. C. Doyle and described in reference (4). Of interest is the fact that this form of cracking was most prevalent in the passing lane, and was not found in adjacent sections laid on the same day.

The most serious form of failure on this project was "alligator" type cracking in the wheel tracks of the travel lane. As previously explained it was decided that when the area of "alligator" type cracking exceeded 10% of the total lane area then the section would be classified as a failure.

The design EWL was attained on this project after approximately 8 years of service life. On this basis, all the asphalts that failed in terms of the 10% failure criterion did so prior to the design life of the structural section as shown in Table M.

Prior to resurfacing the Zaca-Wigmore Project in 1964, a number of badly "alligator" cracked pavement areas were removed, and replaced with new mixture. During the removal of these areas photographs and observation were made as the large blocks of pavement were lifted from the cement treated base. At a number of locations cracks were found in the bottom of the level course with only a few of these cracks appearing at the surface, Figure 12. There was also evidence of pumping of base fines into the intimate part of the mix as determined by breaking blocks of the pavement and noting the presence of fines. Within the wheel track areas where pumping was evident, the top 1/2 inch of the CTB was quite friable or loose, while below this layer the base was in good condition. In locations where pumping was not evident the pavement had a good bond to the base even though "alligator" cracked. The surface of the CTB was somewhat variable in hardness when tested with a pick, but no cracking of the base was evident even in the wheel tracks, at any of the 21 dig-out locations covering a total of 6268' of 12' lane although all of these locations displayed very severe "alligator" cracking.

Previous examinations of the cracked faces of numerous blocks consistently indicated that the cracking occurred in the matrix of the mix. In only a very few cases were rocks broken along the fracture face although many of the larger aggregate particles were soft and could be easily broken. These observations lead to the conclusion that fatigue cracking on this project started with cracking at the bottom of the pavement. These cracks progressed through the pavement within the binder matrix. Crack propagation probably was initiated during the warm part of the season when the stiffness of the pavement was at a minimum. These findings confirm the studies of Monismith (8) which indicates that the most critical temperature for fatigue in asphalt concrete is in the range of 60-80^{o}F.

R. J. Schmidt (9) has found that the increase in "alligator" type cracking during service life as shown in Figures 3 and 4 produces a straight line when plotted on semi-log paper. This allows extrapolation of the curves to any service age. Using such a method the percentage of cracking at the end of 97 months of service life was determined and the consistency of the recovered asphalt determined from penetration and viscosity charts. The results, Table N and Figure 13, clearly indicate that the penetration of the recovered asphalt is related to the percentage of fatigue type cracking. On this specific project the results indicate that approximately thirty penetration is the critical consistency for the failure criterion adopted for the project for fatigue type cracking. The viscosity at 77^{o}F and 0.05 Sec^{-1} Shear Rate also provides a good correlation for the percentage of fatigue cracking.

The best test for predicting durability of the asphalt used on this project appears to be the Modified Shell Durability test (10). W. C. Simpson, et al, (11) found a definite correlation between the viscosity after 16 and 30 months of service life and the viscosity after the microfilm durability test. These studies are further confirmed when the comparison is made after 97 months of service life, Figure 14. The data are more scattered, but most of the asphalts used in period 1 paving have weathered faster in the road than those used in period 2.

The large block cracking and partial raveling failures found in the I-2 and G passing lane test sections appear to be caused by the development of rather high shear susceptibility during weathering. The development of this form of failure indicates the importance of attaining proper balance in the engineering properties of a paving grade asphalt as discussed in reference (1).

The entire project was resurfaced in 1964 with 3" of asphalt concrete. The present condition of this blanket is excellent.

CONCLUSIONS

1. Asphalts that were mixed under virtually identical conditions of paving showed various rates of hardening. This change in asphalt properties during mixing was predicted in a satisfactory manner with the Bureau of Public Roads Thin Film test.

2. Two main types of failure during service life were encountered on the project. The most prevalent was fatigue cracking as displayed by wheel track "alligator" type cracking. The other was a large block type cracking together with pitting and raveling. This was most prevalent in the passing lane. The amount of fatigue type cracking appears to be related to the consistency of the recovered asphalt as measured by penetration and viscosity. The other form of cracking appears to be related to the gain in shear susceptibility during weathering. This is also indicated by a marked drop in ductility during service life. This form of cracking, as found on this test project, appears to be the same as that encountered by P. C. Doyle, reference (4), on other test roads.

3. The rate of hardening of the various asphalts was quite rapid up to approximately twenty months of service life, but thereafter was reduced. These results confirm data from other test projects. The hardening rate appears to be influenced by the percentage of voids, the asphalt content and the asphalt source. The rate of weathering is influenced by the original percentage of voids and also by the rate of reduction in void content during service life. Asphalts produced from different crude sources and methods of production show various degrees of

durability under equivalent conditions of voids and asphalt content. The durability of the asphalt appears to be predicted best by the Shell Modified Microfilm Durability Test.

4. The fatigue cracking appears to be of the strain type and started in the bottom of the level course. The cracking progressed through the matrix of the mix. In some areas of the project there was evidence of base fines pumped into the intimate part of the pavement as well as along the existing crack faces. Evidence does not indicate that this pumping was a cause of fatigue cracking on the project since many areas were cracked within any specific section with no signs of pumping. Periodical surveys indicate that the fatigue cracking started at isolated places in the wheel tracks of the travel lane and progressed from these spots in opposite directions. The length of these areas might ultimately exceed two hundred feet. It is difficult to assign a reason for this cracking movement from an isolated starting point.

5. On this specific project, there was a very rapid increase in the area of fatigue cracking when the cracked area had reached ten percent of the total test section area.

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TABLE A

SPECIFICATIONS FOR PAVING ASPHALTS

Specification Designation	1954 Standard Specifications		1954 Special Provision Specifications	
	AASHO Test Method	Specification Requirements	AASHO Test Method	Specification Requirements
Flash point, Cleveland open cup, deg. Fahr, minimum	T48	350	-	-
Flash point, Pensky-Martens closed flash tester, deg. Fahr, minimum	-	-	T73	400
Penetration of original samples, 77F	T49	200-300	T49	200-300
Loss on heating, 5 hr. at 325F, per cent maximum	T47	3.0	T47	1.0
Penetration after loss on heating, per cent of original minimum	T49	60	T49	75
Original ductility at 77F, cm, minimum	T51	100	-	-
Penetration Ratio: $\frac{\text{Pen 39.2F-200g-1 min}}{\text{Pen 77F-100g-5 sec}}$	-	-	T49	25 min
Furol Viscosity at 275F, sec.	-	-	-	40-125
Solubility in CS_2, minimum percent	T44	99.5	-	-
Solubility in CCl_4, minimum percent	T45	99	T45	99
Xylene equivalent, maximum percent	Sect. 6 Chap. II Calif. Std. Specs.	35	T102	30

TABLE B

"Alligator" Cracking in Travel Lane of Asphalt Test Sections
Laid on New Alignment

Asphalt	Pave. Per.	"Alligator" Cracking in Travel Lane: March 1957 28 Mo. Area Sq.Ft.	%*	November 1958 48 Mo. Area Sq.Ft.	%	April 1959 53 Mo. Area Sq.Ft.	%	April 1960 65 Mo. Area Sq.Ft.	%	June 1962 91 Mo. Area Sq.Ft.	%	April 1963 101 Mo. Area Sq.Ft.	%
A	1	0	0	94	0.4	240	0.9	430	1.6	3825	15	4610	18
C	"	0	0	140	1.0	200	1.4	540	3.7	1800	12	2378	16
D	"	120	0.4	450	1.5	765	2.7	510	1.8	4730	17	6207	22
E	"	110	0.4	8565	25	-	-	-	-	-	-	-	-
F	"	70	0.1	260	0.4	3952	6.4	-	-	-	-	-	-
G	"	0	0	250	1.1	2210	9.4	-	-	-	-	-	-
H	"	0	0	0	0	0	0	24	0.1	1570	7.6	5497	26
J	"	0	0	0	0	0	0	0	0	0	0	0	0
B-1	1A	70	0.2	50	0.2	120	0.4	230	0.8	653	2.2	639	2.2
C-1	"	0	0	30	0.2	70	0.5	130	0.9	290	2.0	210	1.5

$$*\% = \frac{\text{"Alligator" Cracking Area}}{\text{Test Section Lane Area}} \times 100$$

TABLE C

"Alligator" Cracking in Travel Lane of Asphalt
Test Sections Laid Over
Existing Alignment

Asphalt	Pave. Per.	"Alligator" Cracking in Travel Lane											
		March 1957 24 Mo.		November 1958 44 Mo.		April 1959 49 Mo.		April 1960 61 Mo.		June 1962 87 Mo.		April 1963 97 Mo.	
		Area Sq.Ft.	%*	Area Sq.Ft.	%	Area Sq.Ft.	%	Area Sq.Ft.	%	Area Sq.Ft.	%	Area Sq.Ft.	%
A-2	2	0	0	0	0	0	0	0	0	325	1.2	280	1.0
B-2	"	0	0	0	0	0	0	80	0.3	2359	9.9	2719	11
C-2	"	0	0	0	0	0	0	120	0.4	258	0.9	444	1.5
D-2	"	0	0	0	0	130	0.4	190	0.6	815	2.7	845	2.8
E-2	"	40	0.2	50	0.2	50	0.2	100	0.4	270	0.9	620	2.2
G-2	"	0	0	0	0	80	0.2	540	1.5	5833	16	7135	20
H-2	"	0	0	0	0	0	0	0	0	24	0.1	415	1.3

$$*\% = \frac{\text{"Alligator" Cracking Area}}{\text{Test Section Lane Area}} \times 100$$

TABLE D

Average Deflection Readings in 0.001 In. With 15,000 Lb.
Axle Load, for Asphalt Test Sections
Period 1 and 1A Paving Over New Alignment
Period 2 Paving Over Existing Alignment

Asphalt	Pave. Per.	Average Deflection, Outer Wheel Track-Travel Lane										Ave.
		April 1955	May 1956	March 1957	April 1958	April 1959	April 1960	April 1961	March 1962	April 1963	April 1964	
Age		5 Mo.	18 Mo.	28 Mo.	41 Mo.	53 Mo.	65 Mo.	77 Mo.	88 Mo.	101 Mo.	113 Mo.	
A	1	17	11	11	19	18	20	25	21	21	20	17
C	1	11	18	8	13	15	18	25	26	-	23	15
D	1	12	10	11	19	17	21	25	23	18	20	16
E	1	11	12	12	19	19	-	-	23	25	20	16
F	1	12	9	10	16	15	-	-	17	16	16	13
G	1	10	8	7	15	15	-	-	19	27	22	14
H	1	16	11	12	23	23	26	31	24	27	28	21
J	1	10	10	11	14	14	16	19	14	15	13	13
Average		12	11	10	17	17	20	25	21	21	20	-
Age		4 Mo.	17 Mo.	27 Mo.	40 Mo.	52 Mo.	64 Mo.	76 Mo.	87 Mo.	100 Mo.	112 Mo.	-
B-1	1A	19	12	13	19	19	20	24	18	17	18	17
C-1	1A	18	11	12	16	16	13	18	14	13	14	14
Average		19	12	13	17	18	17	21	16	15	16	-
Age		1 Mo.	14 Mo.	24 Mo.	-	49 Mo.	61 Mo.	73 Mo.	84 Mo.	97 Mo.	109 Mo.	-
A-2	2	15	5	5	-	10	10	8	8	6	5	8
B-2	2	12	6	4	-	10	12	9	7	8	7	9
C-2	2	12	8	6	-	10	11	9	10	8	8	9
D-2	2	11	9	6	-	9	10	10	7	6	5	8
E-2	2	11	4	5	-	5	6	8	6	4	4	6
G-2	2	15	8	9	-	12	12	12	13	11	11	12
H-2	2	10	6	6	-	6	7	8	4	2	-	6
I-2,5.8%	2	15	7	7	-	11	11	13	9	5	7	10
I-2,6.3%	2	20	6	8	-	18	17	18	13	9	8	13
Average		14	7	6	-	10	11	11	9	7	7	-

TABLE E

Void Content of Pavement Cores Removed
at Various Times From the Outer Wheel Track
of the Travel Lane

Asphalt	Pave. Per.	Void Content - %				
Age		5 Mo.	20 Mo.	35 Mo.	59 Mo.	91 Mo.
A	1	12.7	9.9	5.9	6.3	7.6
C	1	10.2	8.1	7.0	6.8	6.8
D	1	14.4	-	9.7	6.3	5.9
E	1	11.8	10.6	10.2	Failed	
F	1	12.2	9.5	8.6	"	
G	1	11.4	10.4	9.1	"	
H	1	9.7	8.0	8.5	6.8	6.8
J	1	10.8	10.8	10.2	8.9	8.9
Average		11.6	9.6	8.6	7.0	7.2
Age		4 Mo.	19 Mo.	33 Mo.	57 Mo.	90 Mo.
B-1	1A	11.4	9.9	5.1	4.1	5.6
C-1	1A	10.2	10.6	8.2	3.4	5.6
Average		10.8	10.2	6.6	3.8	5.6
Age		8 Mo.	16 Mo.	31 Mo.	55 Mo.	87 Mo.
A-2	2	4.3	5.3	3.5	2.1	1.2
B-2	2	6.4	-	-	5.1	5.2
C-2	2	4.0	4.8	4.3	3.8	4.6
D-2	2	7.7	8.8	7.2	2.9	2.2
E-2	2	5.8	6.6	6.2	4.6	6.8
G-2	2	7.1	8.0	6.4	4.6	5.6
H-2	2	4.5	5.0	3.8	2.6	2.2
I-2,5.8%	2	6.0	7.1	5.8	4.3	3.4
I-2,6.3%	2	4.4	4.7	3.6	2.9	2.6
Average		5.6	6.3	5.1	3.7	3.8

Note - Paving Period 1 & 1A is over new alignment
Paving Period 2 is over existing alignment

TABLE F

Percent Relative Compaction of Pavement Cores Removed at Various Times From the Outer Wheel Track of the Travel Lane

Asphalt	Pave. Per.	Percent Relative Compaction*				
Age		5 Mo.	20 Mo.	35 Mo.	59 Mo.	91 Mo.
A	1	95	100	103	102	101
C	1	98	100	101	101	101
D	1	93	-	98	101	102
E	1	97	99	99	Failed	
F	1	97	100	101	"	
G	1	97	98	100	"	
H	1	98	100	100	101	101
J	1	98	98	99	101	101
Average		97	99	100	101	101
Age		4 Mo.	19 Mo.	33 Mo.	57 Mo.	90 Mo.
B-1	1A	95	97	102	103	102
C-1	1A	98	97	100	105	103
Average		97	97	101	104	103
Age		8 Mo.	16 Mo.	31 Mo.	55 Mo.	87 Mo.
A-2	2	102	101	103	104	105
B-2	2	99	-	-	100	100
C-2	2	102	101	102	102	102
D-2	2	97	96	97	102	103
E-2	2	100	99	99	101	99
G-2	2	98	97	99	101	100
H-2	2	100	100	101	102	103
I-2,5.8%	2	100	98	100	101	102
I-2,6.3%	2	100	100	101	101	102
Average		100	99	100	102	102

Note - Paving Period 1 & 1A is over new alignment
Paving Period 2 is over existing alignment

*California Division of Highways Materials Manual, Vol. I, Test Method 304.

TABLE G

Physical Properties of Paving Grade Asphalts

Asphalt	Spec.	Pav. Period	COC Flash	PMCT Flash	Orig. Pen.	Pen. Ratio	Visc. 275 F	X.E.	Duct. 77 F	S.P.	Sol. CCl_4	Stand. Loss % Loss	Stand. Loss % Orig.	BPR Thin Film % Loss	BPR Thin Film % Orig.
A	Spec. Prov.	1	505	450	222	26	61	10-15	100+	100	99.9	0.14	92.8	0.65	56.3
A-2	"	2	500	435	217	25	60	10-15	100+	97	99.9	0.20	88.5	0.70	52.5
B-1	"	1A	470	405	269	31	78	25-30	92	97	99.9	0.38	91.8	1.35	41.2
B-2	"	2	430	410	221	33	110	25-30	100+	103	99.9	0.37	84.2	2.10	36.2
C	1954 Std. Spec.	1	480	430	252	24	60	10-15	100+	98	99.9	0.36	89.3	0.75	50.0
C-1		1A	480	430	240	26	64	15-20	100+	93	99.9	0.18	90.0	0.80	49.6
C-2		2	475	395	242	26	65	15-20	100+	98	99.9	0.21	89.7	1.10	42.6
D	Spec Prov.	1	480	350	243	31	61	15-20	100+	98	99.8	0.27	92.2	1.40	48.5
D-2		2	485	420	220	28	60	10-15	100+	100	99.8	0.32	89.6	0.85	50.9
E	1954 Std. Spec.	1	390	325	231	43	117	30-35	100+	99	99.9	0.98	81.0	4.45	27.7
E-2		2	350	290	235	43	125	25-30	100+	100	99.8	1.79	62.5	5.65	18.7
F	Spec. Prov.	1	435	390	225	33	102	25-30	100+	102	99.9	0.47	84.8	2.25	34.7
G	"	1	470	410	242	37	93	30-35	100+	101	99.8	0.28	89.2	1.60	35.1
G-2	"	2	450	400	219	36	103	30-35	100+	101	99.9	0.43	88.1	2.20	39.7
H	"	1	485	430	227	29	73	25-30	100+	101	99.9	0.26	90.4	0.70	48.5
H-2	"	2	480	415	211	29	73	25-30	100+	100	99.9	0.29	83.5	1.05	45.1
I-2	No Spec.	2	470	440	204	35	65	35-40	100+	102	99.9	0.25	81.5	1.00	39.5
J	Spec. Prov.	1	600	465	245	32	119	25-30	100+	101	99.9	0.11	92.0	0.35	52.3

TABLE H

Durability Test Results

Asph.	Pave. Per	BPR Thin Film Test				California Rolling Thin* Film Test				Durability Test* 24 Hrs.-210°F, 20y Film		
		Loss %	% Orig. Pen.	Stand. Duct. 77F 5cm/min	Stand. Duct. 55F 1cm/min	Loss %	% Orig. Pen.	Stand. Duct. 77F 5cm/min	Stand. Duct. 55F 1cm/min	Viscosity 77F - M.P. SR=0.05sec^{-1}	Shear Index	Micro Duct. 77F
A	1	0.65	56	100+	100+	0.09	63	100+	100+	6.0	0.00	88
A-2	2	0.70	53	100+	100+	0.17	61	100+	100+	5.0	0.00	61
B-1	1A	1.4	41	100+	100+	0.05	59	100+	100+	12	0.22	13
B-2	2	2.10	36	100+	68	0.83	51	100+	100+	37	0.31	5
C	1	0.75	50	100+	100+	0.23	53	100+	100+	14	0.09	52
C-1	1A	0.80	50	100+	100+	0.32	68	100+	100+	16	0.09	59
C-2	2	1.1	43	100+	100+	0.36	58	100+	100+	15	0.06	52
D	1	1.4	49	100+	100+	0.45	66	100+	100+	6.4	0.07	61
D-2	2	0.85	51	100+	100+	0.44	63	100+	100+	4.8	0.00	80
E	1	4.5	28	100+	100+	2.8	36	100+	88	460	0.31	0
E-2	2	5.7	19	100+	38	3.3	30	100+	100+	276	0.37	0
F	1	2.3	35	100+	100+	0.94	48	100+	100+	56	0.29	5
G	1	1.6	35	100+	54	0.43	36	100+	29	25	0.49	2
G-2	2	2.2	40	100+	100+	0.78	44	100+	100+	82	0.31	2
H	1	0.70	49	100+	100+	0.40	56	100+	100+	19	0.13	15
H-2	2	1.1	45	100+	100+	0.40	58	100+	100+	22	0.07	29
I-2	2	1.0	40	81	33	0.29	50	100+	66	26	0.41	3
J	1	0.35	52	100+	100+	0.06	63	100+	100+	2.7	0.18	39

*See Reference 10

TABLE I

Properties of Paving Grade Asphalts

Asphalt	Pave. Per.	Test						
		Heptane Xylene Equiv.	Oliensis Spot-0hrs.	Oliensis Spot-24hrs.	Xylene Equivalent Skelly Solvent	Hexane Resistance	Negative Period Hrs.	Stain No.
A	1	10-15	Neg.	Neg.	-	21	1704	7
A-2	2	10-15	Neg.	Neg.	-	24	840	9
B-1	1A	25-30	Neg.	Pos.	0-2	-	-	10
B-2	2	25-30	Neg.	Pos.	0-2	-	-	11
C	1	10-15	Neg.	Neg.	-	24	2040	8
C-1	1A	10-15	Neg.	Neg.	-	21	744	7
C-2	2	15-20	Neg.	Neg.	-	15	1032	9
D	1	15-20	Neg.	Neg.	-	12	288	7
D-2	2	10-15	Neg.	Neg.	-	26	480	10
E	1	30-35	Neg.	Pos.	0-2	-	-	8
E-2	2	30-35	Neg.	Pos.	2-4	-	-	10
F	1	25-30	Neg.	Pos.	0-2	-	-	9
G	1	30-35	Pos.	Pos.	5-7	-	-	16
G-2	2	30-35	Neg.	Neg.	-	6	48	11
H	1	25-30	Neg.	Neg.	-	14	288	7
H-2	2	25-30	Neg.	Neg.	-	10	168	8
I-2	2	35-40	Pos.	Pos.	2-4	-	-	15
J	1	25-30	Neg.	Neg.	-	29	1872	6

TABLE J

Change in Physical Properties of Asphalts
During Mixing and Pavement Service Life
All Cores From Outer Wheel Track of Travel Lane
Period 1 and 1A Paving Over New Alignment

Asphalt	Pave. Per.	Test	Age - Months									
			Orig.	Mix	5	13	20	35	55	59	91	118
A	1	Penetration, 77°F	224	164	131	84	48	44	-	22	25	20
		Softening Point	100	106	109	116	124	125	-	137	136	142
		Ductility, 77°F	100+	-	-	-	-	100+	-	100+	100+	100+
C	1	Penetration, 77°F	255	154	131	83	46	44	-	34	27	-
		Softening Point	98	104	111	116	121	125	-	129	133	-
		Ductility, 77°F	100+	-	-	-	-	100+	-	100+	100+	-
D	1	Penetration, 77°F	248	184	151	93	59	52	-	31	27	27
		Softening Point	98	103	104	113	116	125	-	127	133	137
		Ductility, 77°F	100+	-	-	-	-	100+	-	100+	100+	100+
E	1	Penetration, 77°F	228	98	93	38	20	17	10(45)	-	-	-
		Softening Point	99	119	121	138	148	151	161	-	-	-
		Ductility, 77°F	100+	-	100+	100+	-	16	5	-	-	-
F	1	Penetration, 77°F	212	112	93	57	42	38	27	-	-	-
		Softening Point	102	117	120	127	135	130	143	-	-	-
		Ductility, 77°F	100+	-	100+	100+	100+	21	(46)	-	-	-
G	1	Penetration, 77°F	233	105	86	47	39	33	23	-	-	-
		Softening Point	101	119	124	136	134	140	154	-	-	-
		Ductility, 77°F	100+	-	82	-	7	12	8	-	-	-
H	1	Penetration, 77°F	223	159	109	61	40	31	30	24	25	24
		Softening Point	101	105	112	124	126	126	131	136	138	145
		Ductility, 77°F	100+	-	-	-	-	100+	100+	100+	100+	100+
J	1	Penetration, 77°F	239	187	154	96	59	(70)	53	47	42	34
		Softening Point	101	104	109	116	126	121	126	128	133	140
		Ductility, 77°F	100+	-	-	-	-	100+	100+	100+	100+	67
Age - Months			Orig.	Mix	4	11	19	34	-	58	90	117
B-1	1A	Penetration, 77°F	259	147	149	107	102	81	-	74	79	70
		Softening Point	97	110	112	117	117	124	-	121	121	131
		Ductility, 77°F	100+	-	-	-	-	-	-	100+	100+	100+
C-1	1A	Penetration, 77°F	269	151	135	98	44	-	-	46	36	-
		Softening Point	93	107	109	113	126	-	-	125	129	-
		Ductility, 77°F	100+	-	-	-	-	-	-	100+	100+	-

TABLE J

Change in Physical Properties of Asphalt
During Mixing and Pavement Service Life
All Cores From Outer Wheel Track of Travel Lane
Period 2 Paving Over Existing Alignment

Asphalt	Pave. Per.	Test	Age - Months							
			Orig.	Mix	8	16	31	55	87	97
A-2	2	Pentration, 77°F	217	188	147	62	-	-	-	53
		Softening Point	97	101	107	114	-	-	-	121
		Ductility, 77°F	100+	-	-	-	-	-	100+	100+
B-2	2	Penetration, 77°F	220	145	54	50	40	41	36	33
		Softening Point	103	112	129	130	131	133	142	141
		Ductility, 77°F	100+	-	-	-	95	100+	100+	100+
C-2	2	Penetration, 77°F	249	183	90	59	50	49	43	45
		Softening Point	98	104	115	119	128	122	127	127
		Ductility, 77°F	100+	-	-	-	100+	-	100+	100+
D-2	2	Penetration, 77°F	226	211	120	75	56	58	43	54
		Softening Point	100	100	109	115	118	122	128	120
		Ductility, 77°F	100+	-	-	100+	-	-	100+	100+
E-2	2	Penetration, 77°F	248	130	53	37	32	28	26	23
		Softening Point	100	114	137	135	145	143	151	151
		Ductility, 77°F	100+	-	100+	100+	71	39	-	35
G-2	2	Penetration, 77°F	220	158	64	53	36	24	20	24
		Softening Point	101	109	130	130	140	143	154	145
		Ductility, 77°F	100+	-	100+	100+	96	100+	11	-
H-2	2	Penetration, 77°F	211	161	94	65	56	(31)	48	58
		Softening Point	100	105	119	120	127	129	124	123
		Ductility, 77°F	100+	-	-	-	-	100+	-	100+
I-2 5.8%	2	Penetration, 77°F	201	131	60	45	30	33	31	27
		Softening Point	102	111	126	129	136	140	143	155
		Ductility, 77°F	100+	-	95	-	-	58	16	6
I-2 6.3%	2	Penetration, 77°F	203	132	71	55	51	54	45	48
		Softening Point	102	110	125	128	129	130	135	133
		Ductility, 77°F	100+	-	100+	-	96	80	33	51

TABLE K

Change in Viscosity and Shear Susceptibility
During Pavement Service Life
All Cores From Outer Wheel Track of Travel Lane

Asphalt	Pave. Per.	Test	Orig.	Mix.	5	13	20	35	55	59	91	118
A	1	Visc,M.P.,77F.SR=.05Sec^{-1}	0.17	-	0.8	3.1	4.2	6.8	-	21	32	34
		Shear Index	0.03	-	0.04	0.10	0.03	0.05	-	0.06	0.10	0.13
C	1	Visc,M.P.,77F.SR=.05Sec^{-1}	0.13	-	1.2	3.5	3.3	9.7	-	8.5	18	-
		Shear Index	0.03	-	0.09	0.09	0.03	0.08	-	0.04	0.06	-
D	1	Visc,M.P.,77F.SR=.05Sec^{-1}	0.12	-	0.6	1.7	2.7	-	-	9.8	19	18
		Shear Index	0.04	-	0.03	0.08	0.03	-	-	0.03	0.09	0.07
E	1	Visc,M.P.,77F.SR=.05Sec^{-1}	0.16	-	3.6	20	-	254	-	-	-	-
		Shear Index	0.05	-	0.15	0.19	-	0.31	-	-	-	-
F	1	"	0.19	-	2.7	8.8	11	19	23	-	-	-
		"	0.07	-	0.16	0.18	0.18	0.21	0.22	-	-	-
G	1	"	0.19	-	5.6	12	15	26	31	-	-	-
		"	0.12	-	0.21	0.22	0.25	0.34	0.37	-	-	-
H	1	"	0.17	-	1.2	4.7	8.2	6.8	11	19	30	38
		"	0.03	-	0.07	0.11	0.09	0.11	0.10	0.07	0.14	0.18
J	1	"	0.13	-	0.8	2.4	3.4	-	5.5	5.8	9.3	11.9
		"	0.09	-	0.10	0.07	0.06	-	0.11	0.19	0.20	0.27
Age - Months			Orig.	Mix.	4	11	19	34	-	58	90	117
B-1	1A	Visc,M.P.,77F.SR=.05Sec^{-1}	0.13	-	0.7	2.2	1.8	1.5	-	2.3	2.0	2.6
		Shear Index	0.03	-	0.08	0.13	0.14	0.19	-	0.10	0.14	0.15
C-1	1A	"	0.15	-	1.0	1.7	6.8	-	-	11	10	-
		"	0.09	-	0.02	0.04	0.02	-	-	0.04	0.07	-
Age - Months			Orig.	Mix.	8	-	16	31	55	-	87	97
A-2	2	Visc,M.P.,77F.SR=.05Sec^{-1}	0.17	-	0.9	-	2.8	-	-	-	-	-
		Shear Index	0.00	-	0.08	-	0.03	-	-	-	-	-
B-2	2	"	0.19	-	3.5	-	9.5	17	7.7	-	18	16
		"	0.11	-	0.16	-	0.17	0.17	0.16	-	0.19	0.18
C-2	2	"	0.13	-	2.0	-	2.8	4.5	3.7	-	6.1	5.7
		"	0.08	-	0.06	-	0.04	0.00	0.07	-	0.05	0.03
D-2	2	"	0.14	-	1.0	-	1.6	5.7	4.3	-	-	-
		"	0.04	-	0.03	-	0.06	0.03	0.02	-	-	-
E-2	2	"	0.16	-	10	-	18	37	17	-	38	51
		"	0.09	-	0.14	-	0.19	0.25	0.16	-	0.22	0.26

TABLE K

Change in Viscosity and Shear Susceptibility
During Pavement Service Life
All Cores From Outer Wheel Track of Travel Lane

Asphalt	Pave. Per.	Test	Orig.	Mix.	8	-	16	31	55	-	87	97
G-2	2	Visc, M.P., 77F, SR=.05Sec^{-1}	0.21	-	4.5	-	6.2	5.3	26	-	48	32
		Shear Index	0.06	-	0.13	-	0.18	0.25	0.16	-	0.26	0.28
H-2	2	"	0.20	-	1.9	-	3.3	3.9	10	-	4.4	3.4
		"	0.02	-	0.08	-	0.12	0.08	0.03	-	0.07	0.08
I-2 5.8%	2	"	0.26	-	5.7	-	7.7	21	14	-	17	26
		"	0.08	-	0.19	-	0.17	0.32	0.28	-	0.27	0.35
I-2 6.3%	2	"	0.26	-	3.8	-	6.4	8.9	5.6	-	8.6	8.0
		"	0.08	-	0.17	-	0.23	0.22	0.23	-	0.28	0.22

Note - Period 1 & 1A over new alignment
Period 2 over existing alignment

TABLE L

Change in Rostler Analysis During Mixing and Pavement Service Life

Asphalt	Paving Period	Age Mo.	Rostler Analysis				
			Asph.	N.B.	A_1	A_2	P
A	1	Orig.	11.3	37.2	14.2	22.2	15.1
		Mix.	20.0	32.7	13.4	21.9	12.2
		59	21.1	34.5	11.3	18.4	14.8
C	1	Orig.	11.5	40.4	13.6	20.6	13.9
		Mix.	16.2	37.6	11.6	20.6	14.1
		59	22.0	37.1	9.7	16.4	14.9
D	1	Orig.	10.5	36.0	16.1	23.2	14.2
		Mix.	14.8	35.8	13.0	21.9	14.5
		59	21.9	33.2	12.6	18.4	13.9
E	1	Orig.	28.8	28.3	21.8	12.3	8.7
		Mix.	34.6	24.6	20.1	13.5	7.2
		55	-	-	-	-	-
F	1	Orig.	26.5	27.5	20.6	14.6	11.2
		Mix.	29.9	24.8	18.9	15.7	10.8
		55	36.9	26.3	13.6	13.2	9.9
G	1	Orig.	28.1	22.6	18.5	15.2	15.6
		Mix.	33.1	20.7	17.0	15.2	14.0
		55	37.2	19.7	13.7	14.9	14.3
H	1	Orig.	17.1	36.2	17.4	17.2	12.2
		Mix.	23.0	31.7	16.9	17.3	11.1
		59	27.5	33.0	10.9	15.7	12.8
J	1	Orig.	17.7	15.7	23.1	32.6	11.0
		Mix.	21.4	14.7	20.1	32.9	10.7
		59	-	-	-	-	-
B-1	1A	Orig.	22.0	27.9	19.7	16.9	13.5
		Mix.	25.9	27.8	16.6	17.2	12.5
		58	28.4	28.0	16.3	15.4	11.9
C-1	1A	Orig.	13.2	39.5	14.2	19.3	13.7
		Mix.	21.6	33.7	12.5	19.0	13.2
		58	24.0	38.2	9.4	15.9	12.5
A-2	2	Orig	11.2	36.2	14.7	23.9	13.9
		Mix.	13.2	35.8	13.3	23.7	14.1
		55	-	-	-	-	-
B-2	2	Orig.	26.5	26.0	21.8	15.1	10.6
		Mix.	31.2	24.9	19.9	15.3	8.7
		55	34.3	24.7	17.4	13.6	10.1
C-2	2	Orig.	13.1	39.8	10.9	23.4	12.8
		Mix.	17.0	37.9	12.5	19.9	12.7
		55	21.1	37.5	10.2	16.6	14.7
D-2	2	Orig.	9.9	36.0	18.0	22.3	13.8
		Mix.	13.6	34.8	13.7	23.6	14.3
		55	22.5	34.2	10.9	17.5	14.9

TABLE L

Change in Rostler Analysis During Mixing and Pavement Service Life

Asphalt	Paving Period	Age Mo.	Rostler Analysis				
			Asph.	N.B.	A_1	A_2	P
E-2	2	Orig. Mix. 55	29.9 33.7 38.5	27.3 24.7 25.0	21.3 20.2 17.9	13.2 13.1 11.3	8.3 8.2 7.2
G-2	2	Orig. Mix. 55	26.1 29.2 36.2	26.5 25.0 24.2	19.7 18.0 13.7	16.0 16.2 14.1	11.7 11.4 11.8
H-2	2	Orig. Mix. 55	18.1 21.9 21.6	36.3 33.9 35.7	16.2 15.9 16.0	16.7 18.0 14.5	12.7 10.3 12.2
I-2 5.8%	2	Orig. Mix. 55	22.4 26.3 30.5	22.5 19.7 21.4	12.2 10.9 10.5	21.1 21.5 18.1	21.8 21.5 19.7
I-2 6.3%	2	Orig. Mix. 55	22.4 25.9 26.7	22.5 19.9 20.3	12.2 11.4 12.4	21.1 20.8 18.5	21.8 21.9 22.3

Note - Asph. = Asphaltenes

N.B. = Nitrogen Bases

A_1 = First Acidaffins

A_2 = Second Acidaffins

P = Paraffins

Note - Period 1 & 1A = Paving over new alignment
Period 2 = Paving over existing alignment

TABLE M

Service Life of Various Asphalts

Asphalt	Paving Period	Service * Life - Mos.
E	1	38
G	1	53
F	1	56
D	1	77
G-2	2	80
C	1	84
A	1	85
B-2	2	87
H	1	92
J	1	113+
C-1	1A	113+
B-1	1A	113+
D-2	2	113+
C-2	2	113+
A-2	2	113+
H-2	2	113+

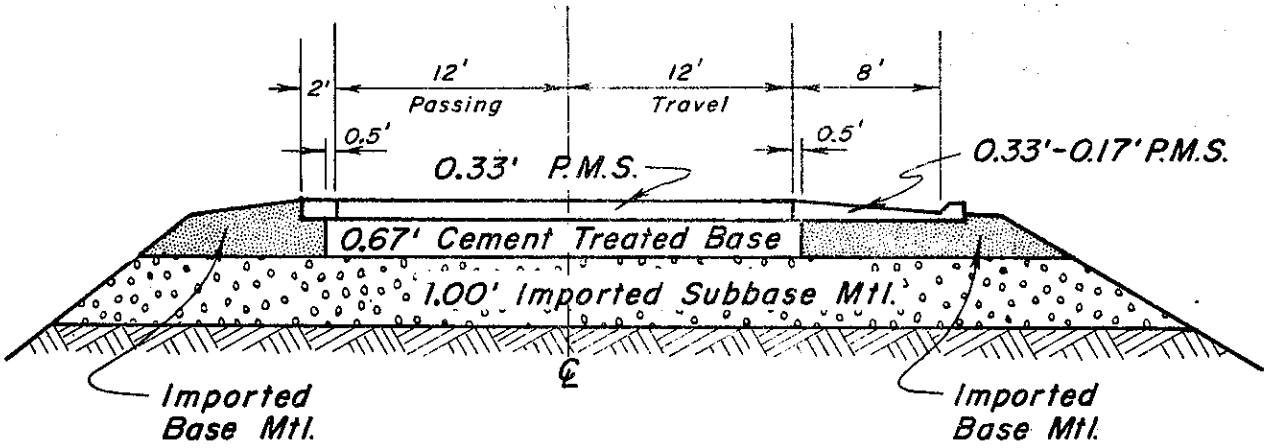
*Service Life - When 10% of Travel Lane Area Shows "Alligator" Cracking.

TABLE N

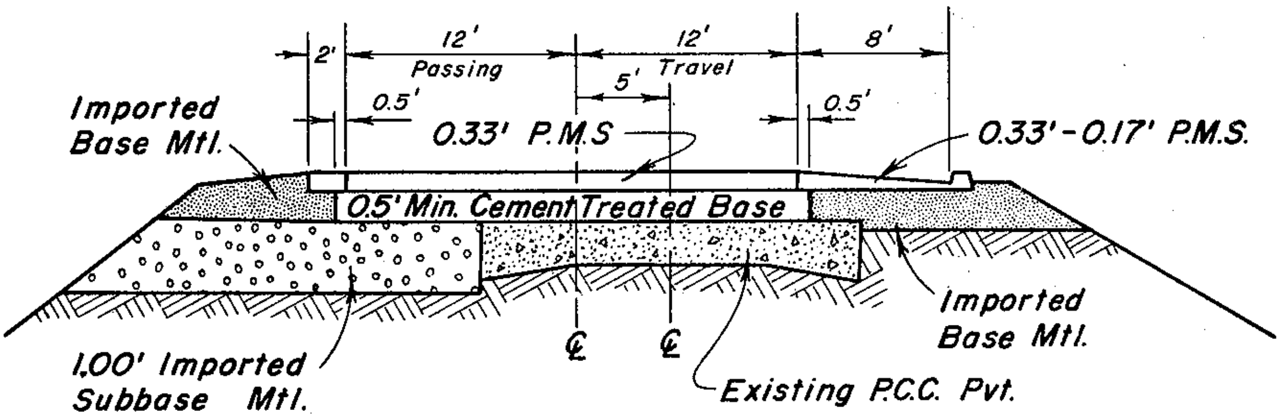
Comparison of Consistency of Recovered Asphalts and Percentage of "Alligator" Cracking After 97 Months of Service Life

Asphalt	Pave. Per.	% "Alligator" Cracking Tr. Lane	Pen. 77°F	Visc. 77°F S.R.=.05Sec^{-1}
A	1	19	24	33
C	1	17	25	20
D	1	19	29	22
E	1	100	4	-
F	1	100	17	33
G	1	100	11	50
H	1	15	25	32
J	1	0	40	10
B-1	1A	2.2	76	2
C-1	1B	1.7	38	14
B-2	2	11	33	18
C-2	2	1.5	43	6
D-2	2	2.9	47	6
G-2	2	26	22	55
H-2	2	1.4	53	5
I-2 5.8%	2	-	29	23
I-2 6.3%	2	-	46	10

Figure 1



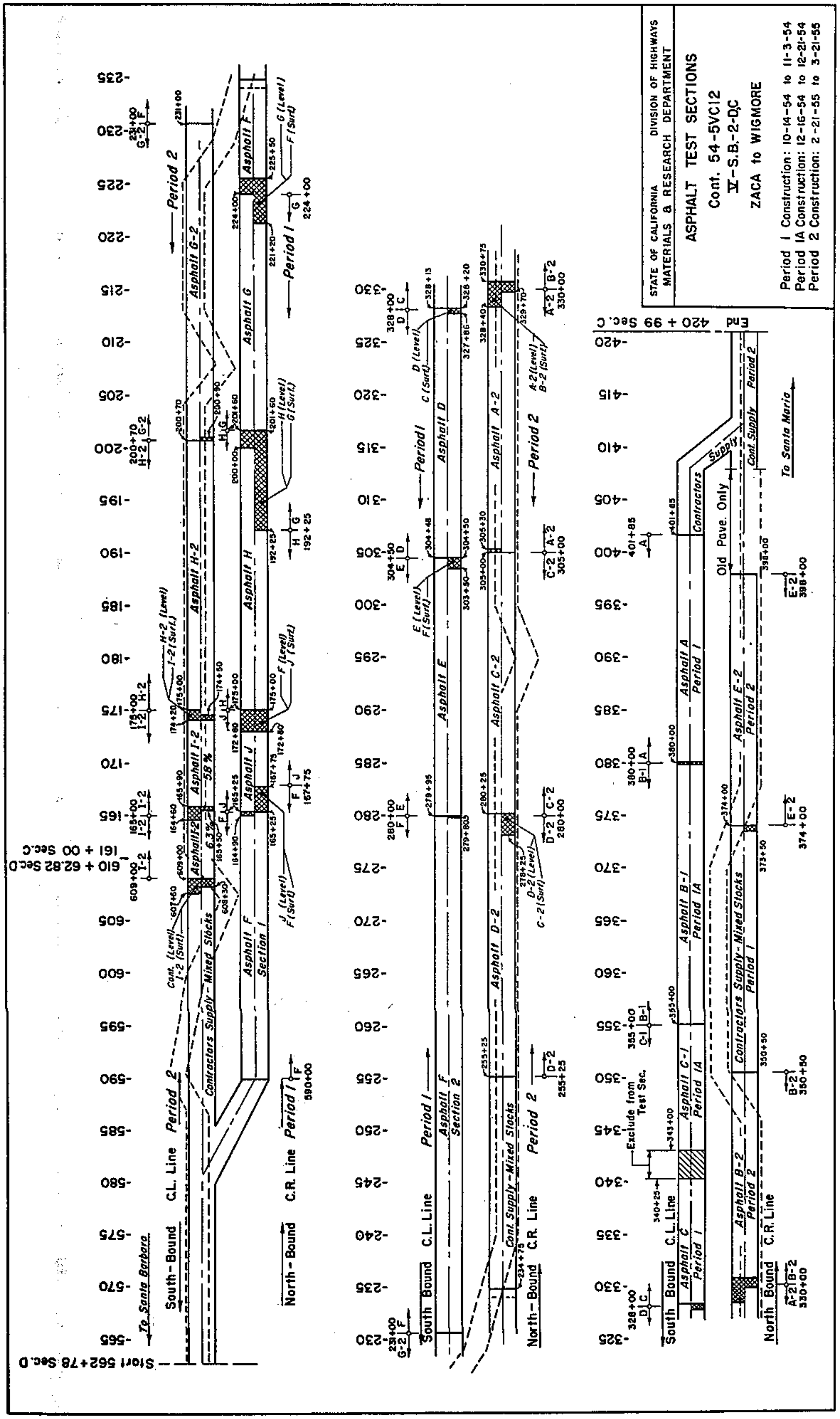
TYPICAL STRUCTURAL SECTION
NEW ALIGNMENT



TYPICAL STRUCTURAL SECTION
OVER EXISTING PAVEMENT

CONT. 54-5VC12
Road V-SB-2-D,C
Zaca - Wigmore
Asphalt Test Road

Figure 2


STATE OF CALIFORNIA DIVISION OF HIGHWAYS
MATERIALS & RESEARCH DEPARTMENT
ASPHALT TEST SECTIONS
Cont. 54-5VC12
V-S.B.-2-D,C
ZACA to WIGMORE
Period 1 Construction: 10-14-54 to 11-3-54
Period 1A Construction: 12-16-54 to 12-21-54
Period 2 Construction: 2-21-55 to 3-21-55
To Santa Barbara
To Santa Maria
Start 562+78 Sec. D
End 420 + 99 Sec. C
South-Bound
North-Bound
C.L. Line
C.R. Line

"ALLIGATOR" TYPE CRACKING IN THE TRAVEL LANE DURING SERVICE LIFE

NEW ALIGNMENT

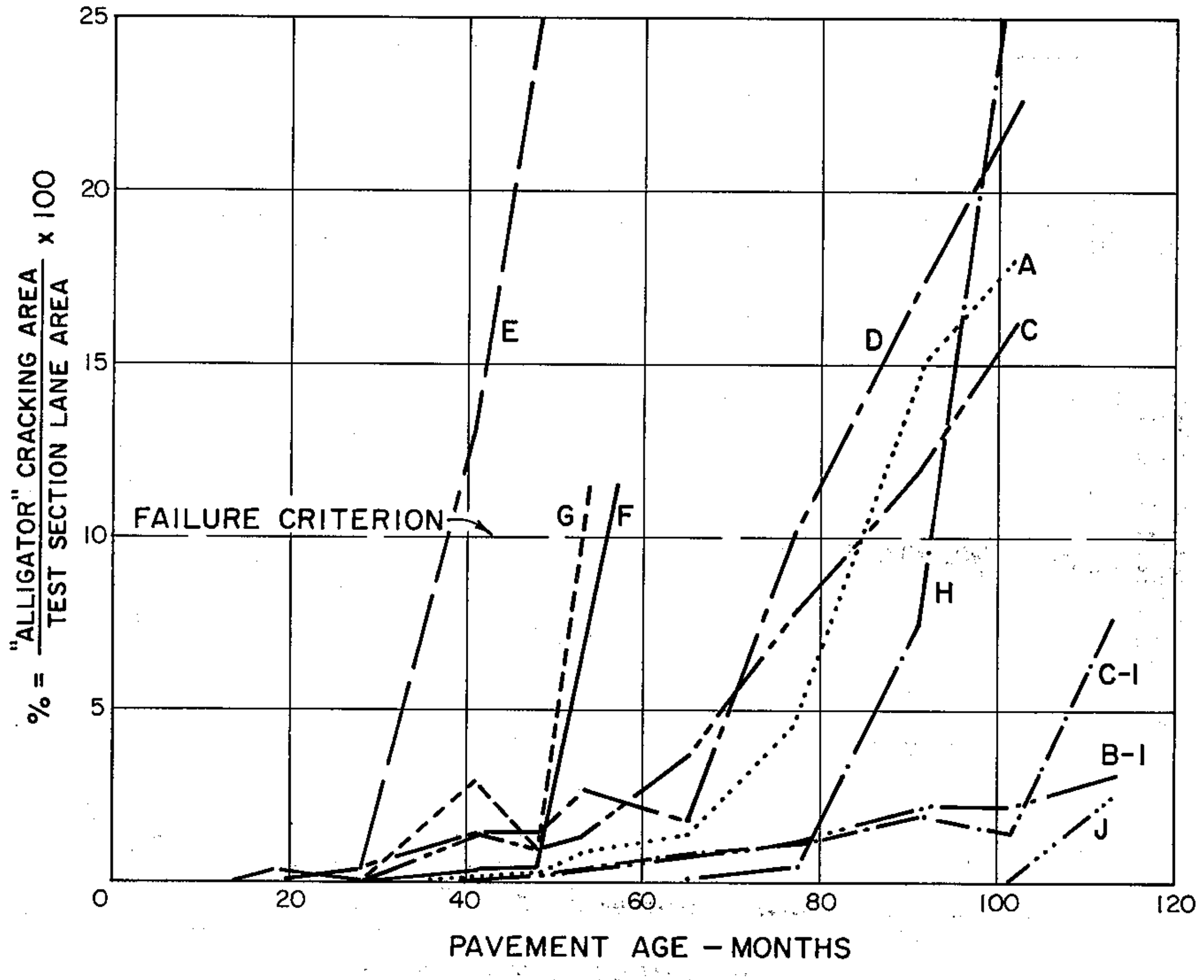
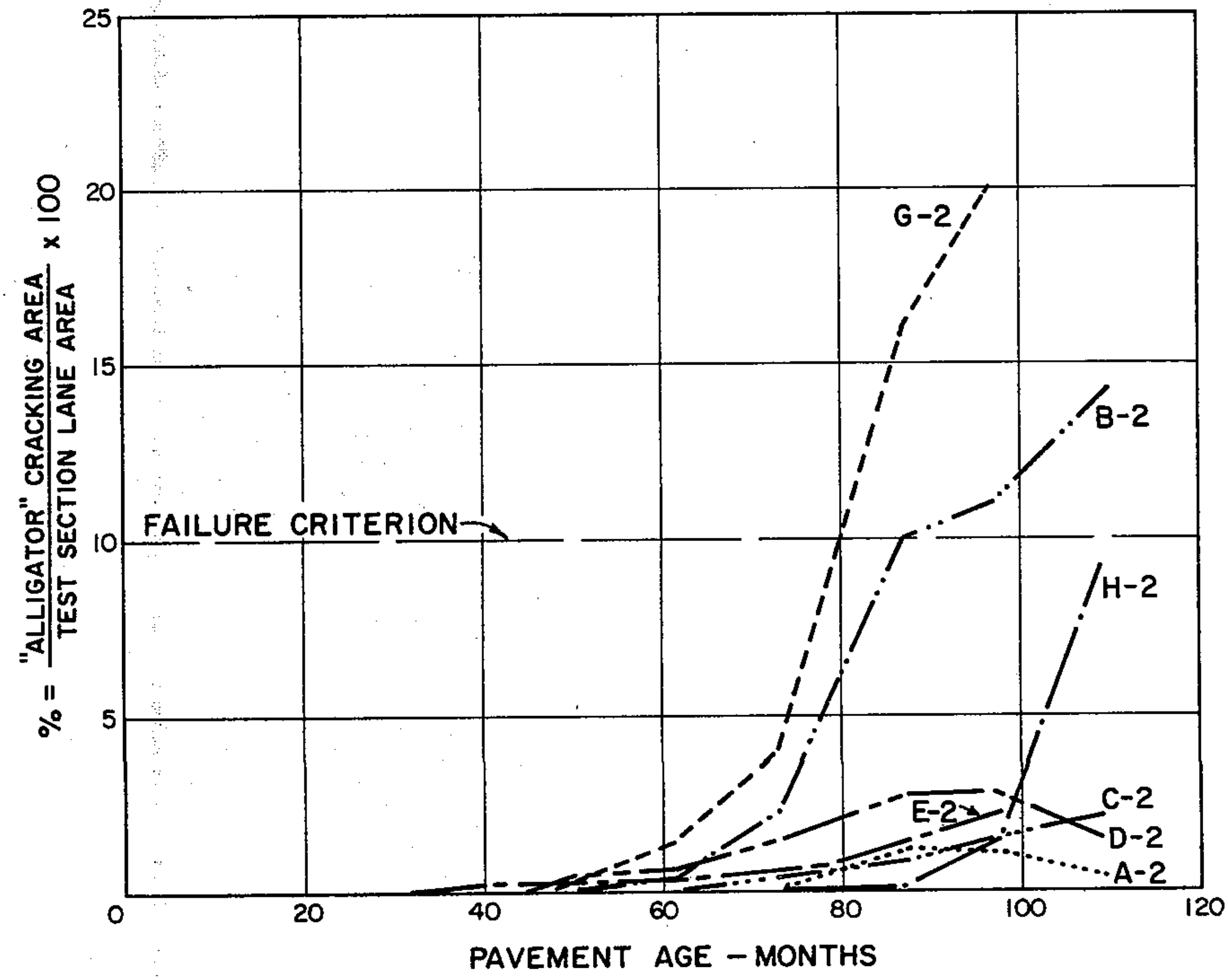


Figure 4

"ALLIGATOR" TYPE CRACKING IN THE TRAVEL LANE DURING SERVICE LIFE

EXISTING ALIGNMENT



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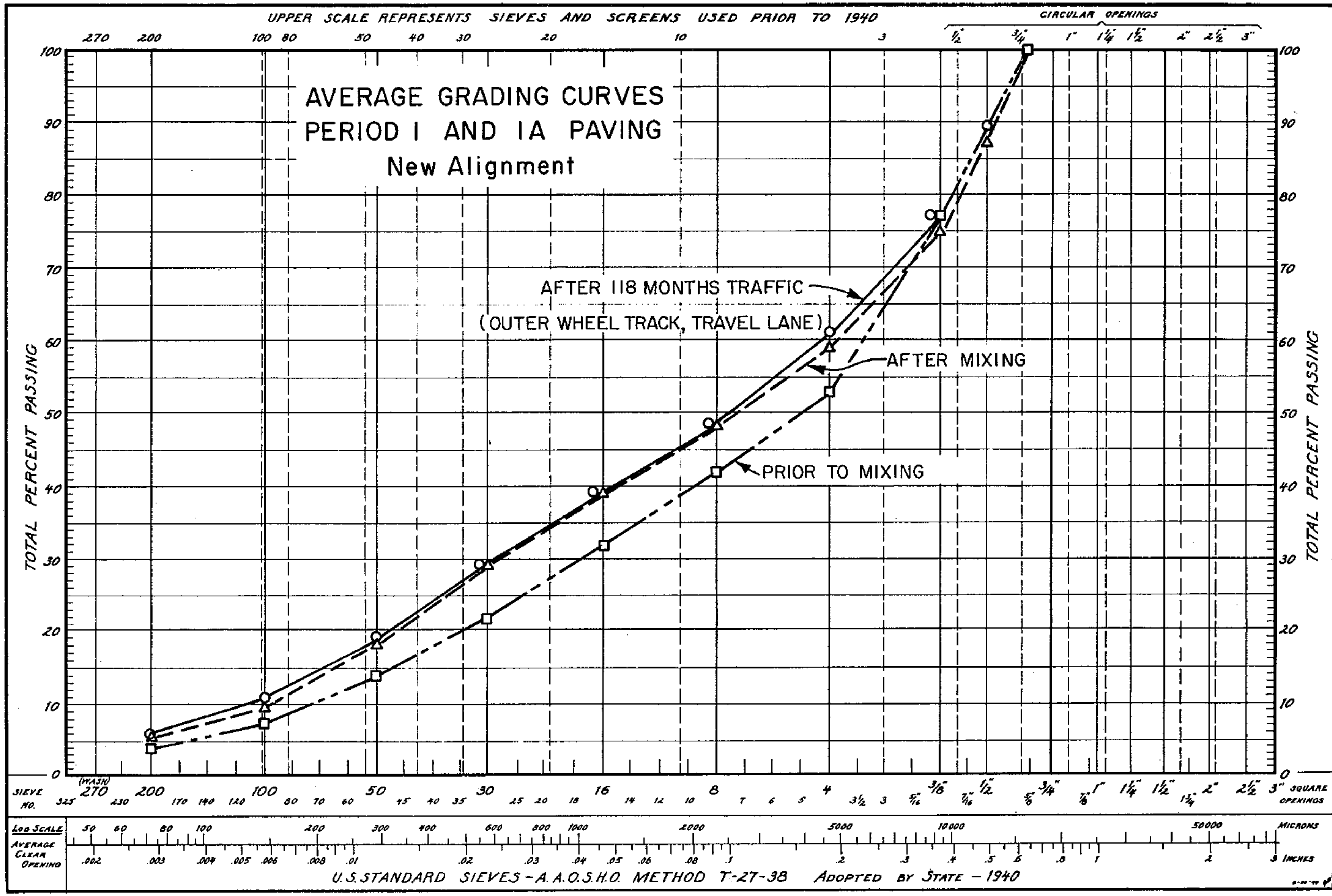
MATERIALS AND RESEARCH DEPARTMENT

SEMI-LOG CHART FOR GRADING CURVES



Form T-216

Figure 5

Figure 6

HARDENING OF 200-300 PAVING GRADE ASPHALT

ZACA-WIGMORE PROJECT

PERIOD I AND IA PAVING

ALL CORES FROM OUTER WHEEL TRACK OF TRAVEL LANE

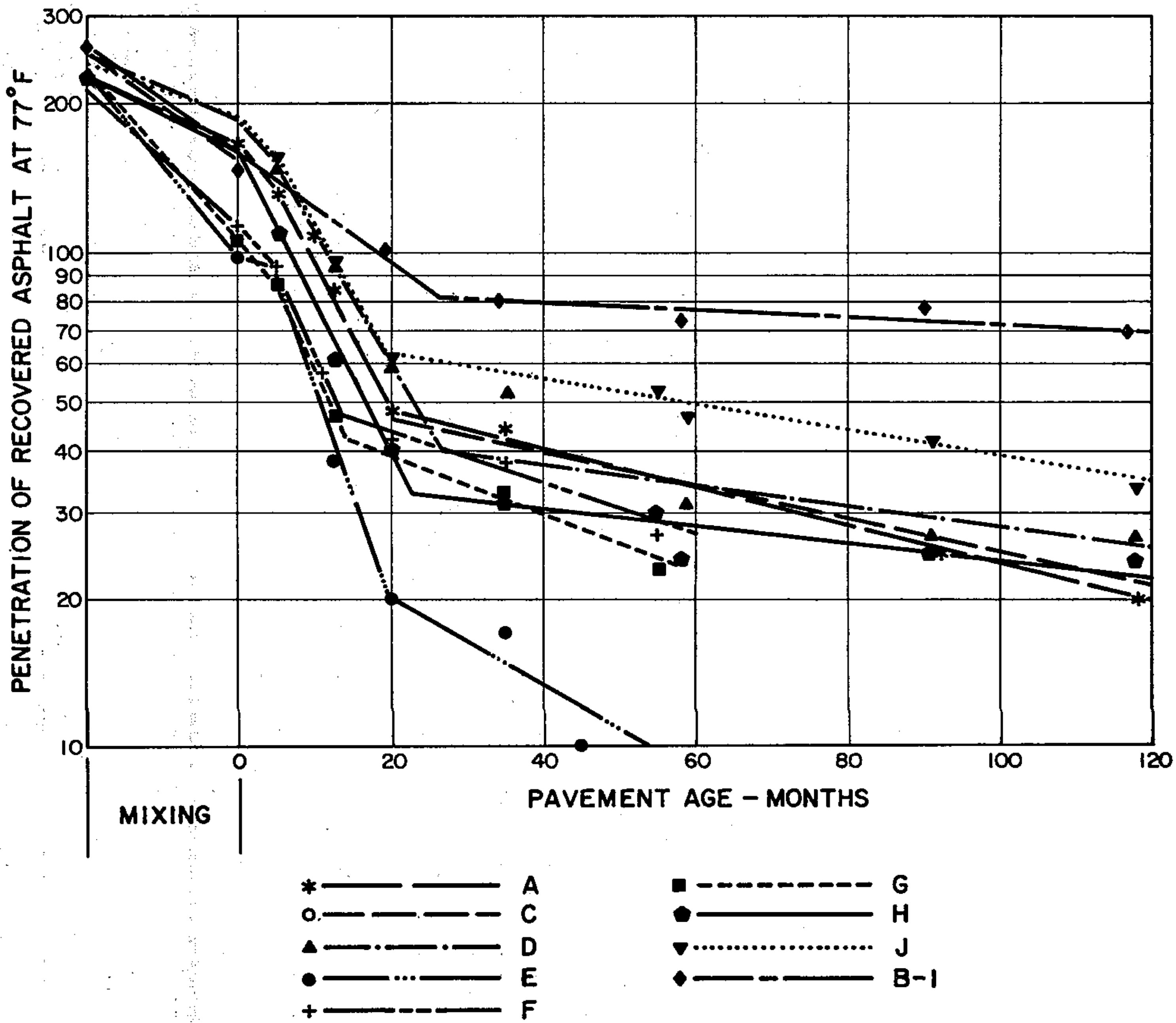


Figure 7

HARDENING OF 200-300 PAVING GRADE ASPHALT

ZACA-WIGMORE PROJECT
PERIOD 2 PAVING

ALL CORES FROM OUTER WHEEL TRACK OF TRAVEL LANE

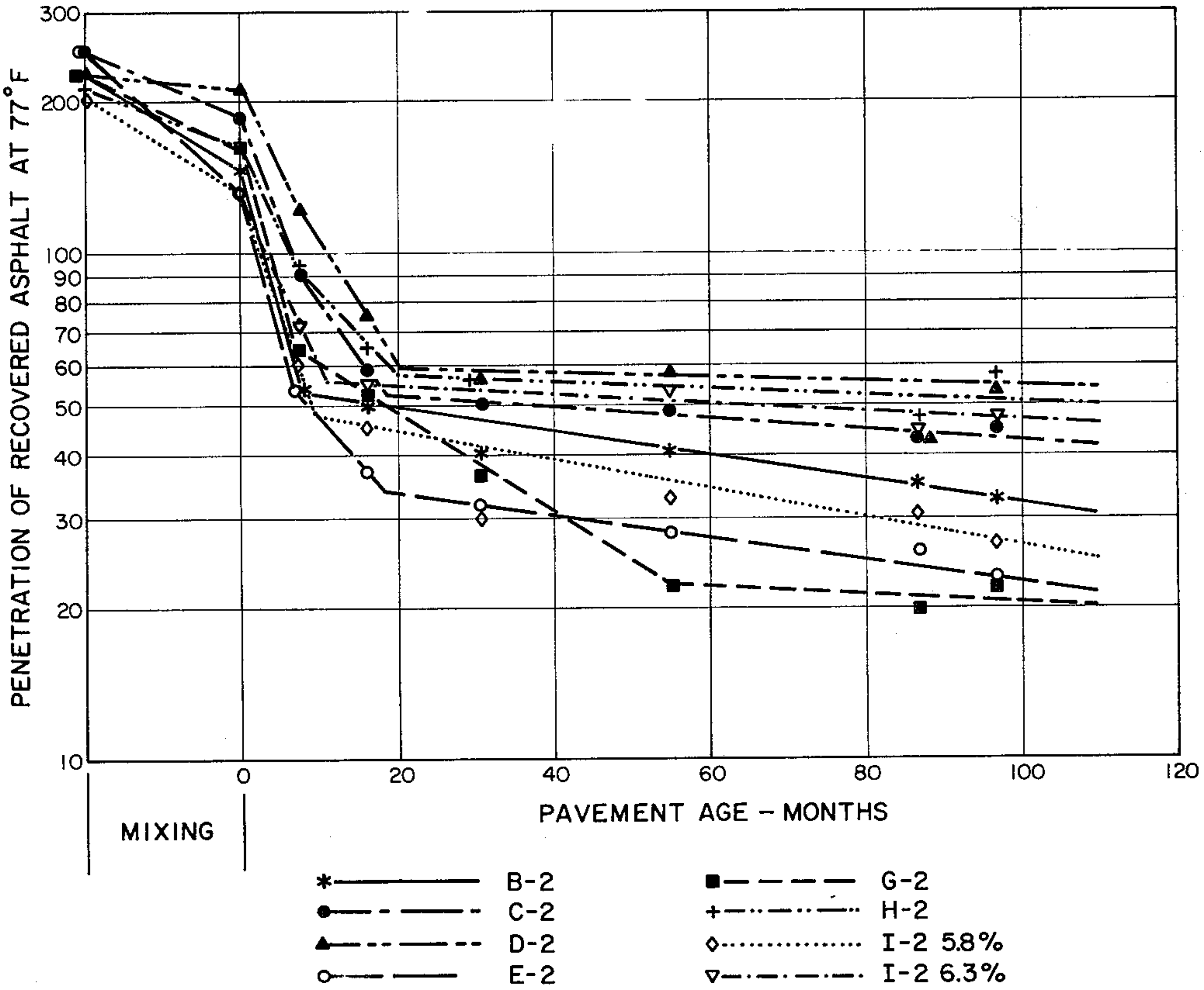
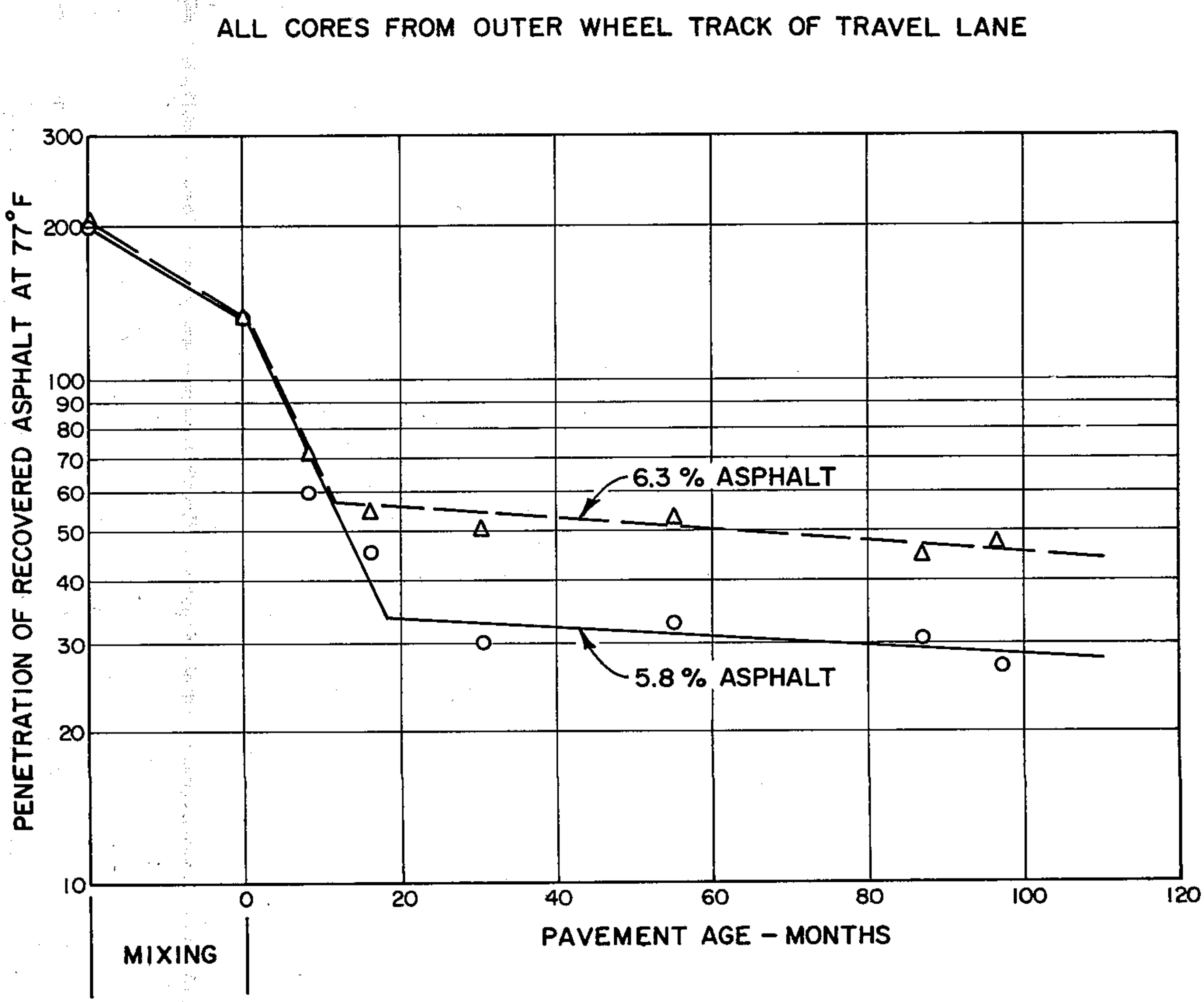


Figure 8

CHANGE IN PENETRATION DURING MIXING AND SERVICE LIFE
ASPHALT I-2, PERIOD 2 PAVING



CHANGE IN VOID CONTENT DURING SERVICE LIFE FOR TEST SECTIONS CONTAINING 5.8 % AND 6.3 % OF I-2 ASPHALT

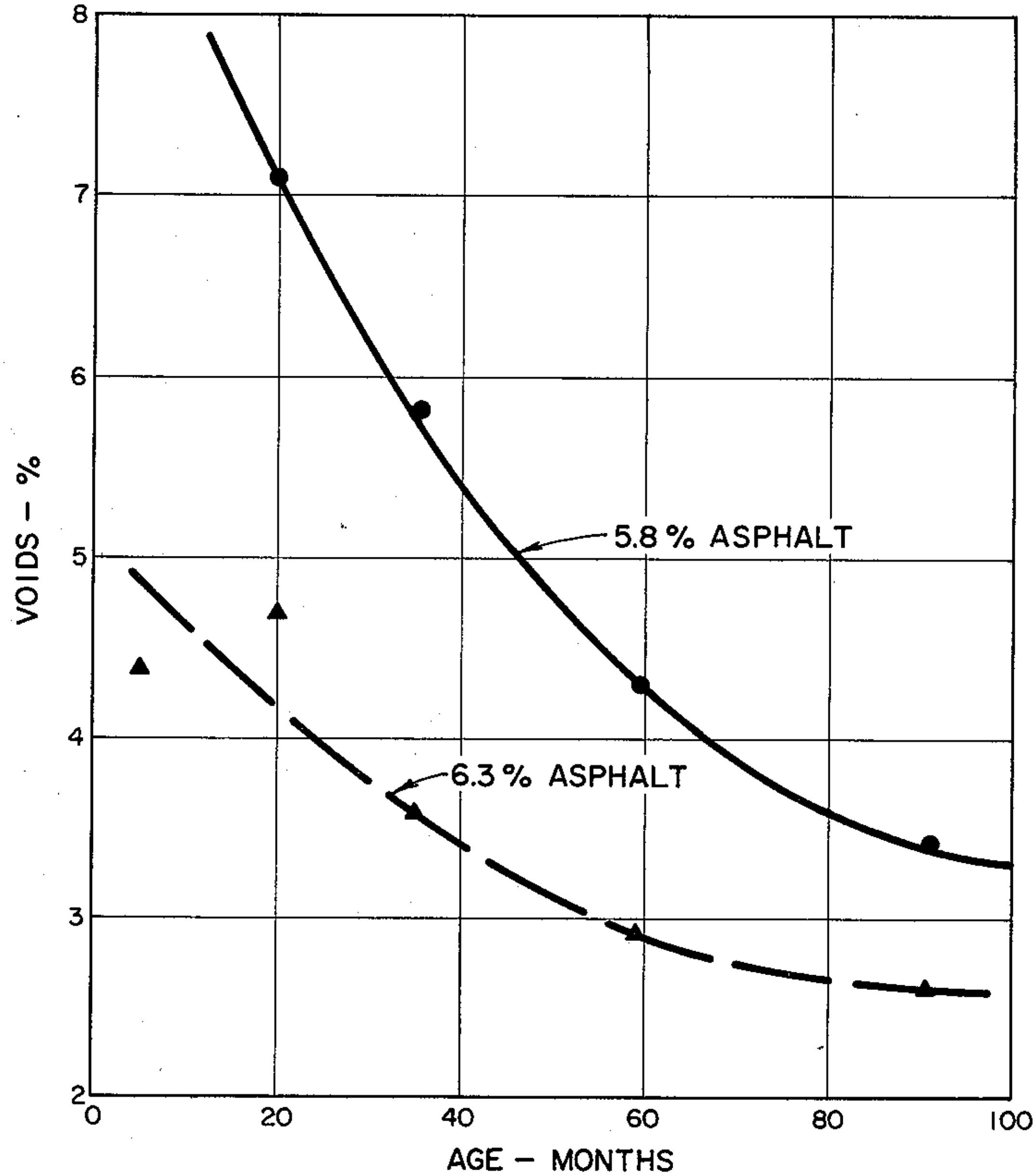


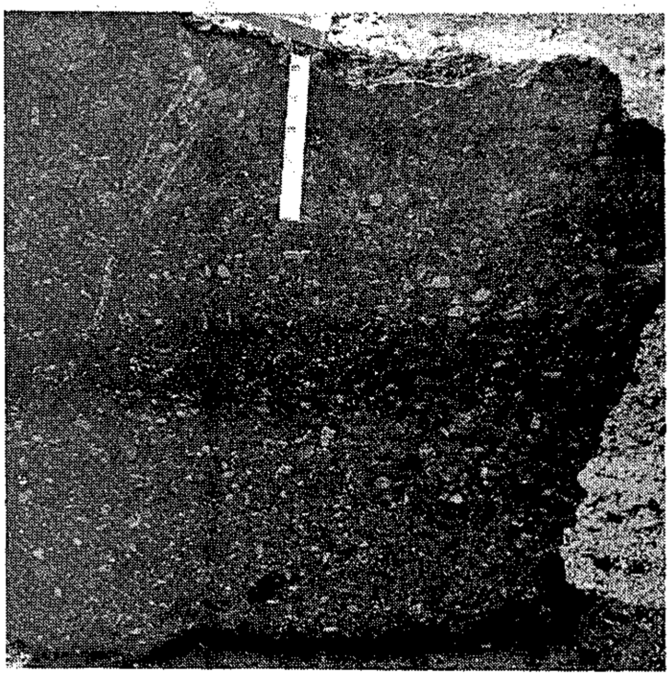
FIGURE 10

Pavement Condition of Asphalt I Test Section After
82 Months of Service Life

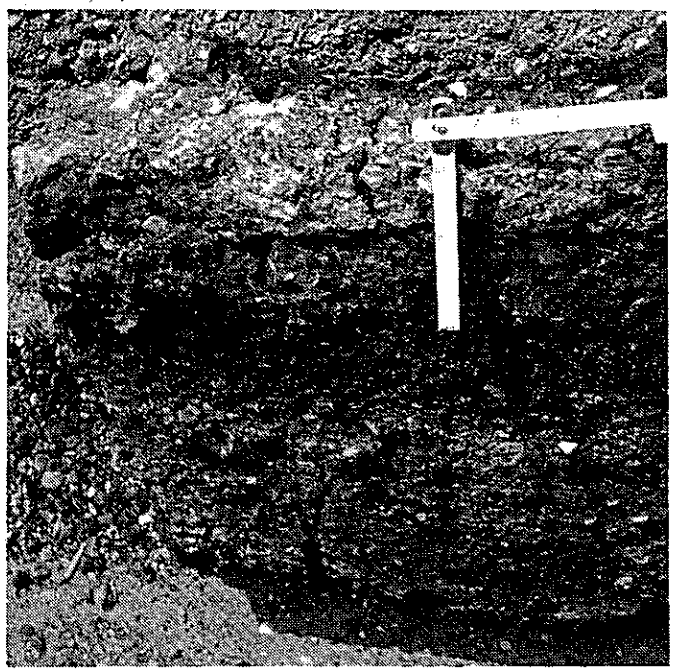
FIGURE 11

Pavement Condition of Passing Lane of Asphalt G Test Section
After 55 Months of Service Life

Figure 12



Top of Pavement



Bottom of Pavement

Cracking Pattern of Top and Bottom
of Pavement After 9 Years
of Service Life

Figure 13

COMPARISON OF CONSISTENCY OF RECOVERED ASPHALTS AND PERCENTAGE OF "ALLIGATOR" TYPE CRACKING AFTER 97 MONTHS OF SERVICE LIFE

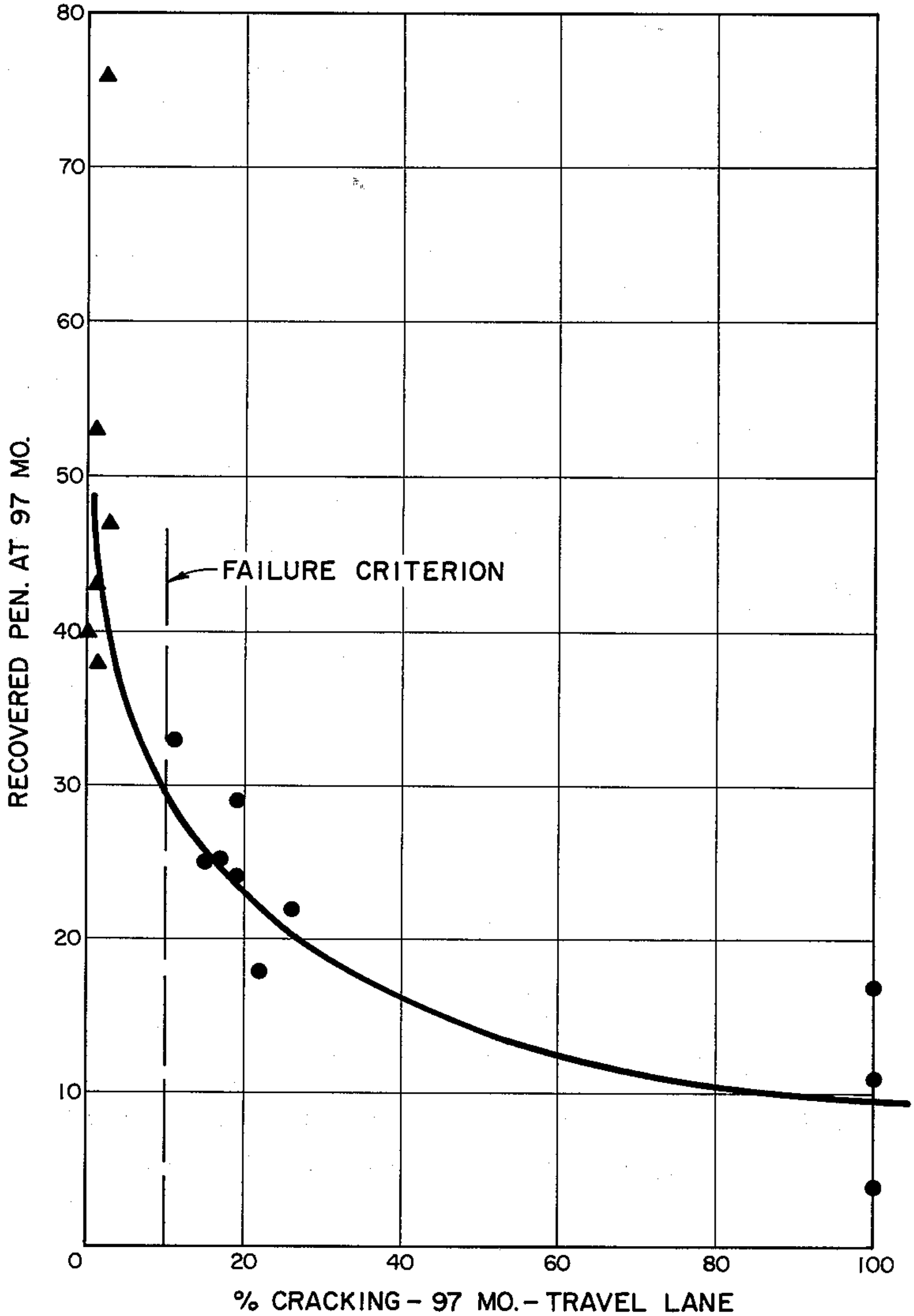


Figure 14

COMPARISON OF VISCOSITY AFTER 97 MONTHS OF SERVICE LIFE WITH VISCOSITY AFTER THE MICROFILM DURABILITY TEST