AD-756 296

CONDITION SURVEYS OF PAVEMENTS SUBJECTED TO CHANNELIZED TRAFFIC, REPORT 2, MARCH AIR FORCE BASE, RIVERSIDE, CALIFORNIA

Army Engineer Waterways Experiment Station
Vicksburg, Mississippi

June 1958

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CONDITION SURVEYS OF PAVEMENTS SUBJECTED TO CHANNELIZED TRAFFIC MARCH AIR FORCE BASE RIVERSIDE, CALIFORNIA

MISCELLANEOUS PAPER NO. 4-213

Report 2

June 1958

U. S. Army Engineer Waterways Experiment Station
CORPS OF ENGINEERS
Vicksburg, Mississippi

ARMY, MRC VICKSBURG MISS

Preface

This report presents the results of a condition survey performed on taxiway 3 at March AFB, Riverside, California, in June 1955 in accordance with addendum 3 to Instructions and Outline, "Condition Surveys for Existing Pavements." This report is one of a series of reports entitled Condition Surveys of Pavements Subjected to Channelized Traffic, prepared in connection with research studies of flexible pavements.

This survey is a continuation of a condition survey conducted by the U. S. Army Engineer District, Los Angeles, CE, in June 1954 on taxiway 3 (designated as taxiway 11 at the time of the Los Angeles survey). The data obtained by the Los Angeles District were presented in the report, Flexible Pavement Failures, Taxiway 11, March Air Force Base, Riverside, California, dated September 1954, and are incorporated in this report. The work by the Los Angeles District was under the general supervision of Mr. E. G. Knight.

The field work for this survey at March AFB was accomplished by a Waterways Experiment Station field party during June 1955. The party was composed of Messrs. P. J. Vedros and C. L. Rone, soils and pavement engineers; and Messrs. R. A. Andress, L. L. Steen, and W. J. Harper, soils technicians. This report was prepared by Mr. Vedros. The investigation was performed under the general supervision of Messrs. W. J. Turnbull, C. R. Foster, O. B. Ray, and J. F. Redus (formerly of WES).

Acknowledgment is made to the officers and men of March AFB and to the personnel of the Los Angeles District who assisted in the field studies.

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Contents

CONDITION SURVEYS OF PAVEMENTS SUBJECTED TO CHANNELIZED TRAFFIC

MARCH AIR FORCE BASE, RIVERSIDE, CALIFORNIA

Introduction

Purpose of investigation

1. This report presents the results of field and laboratory investigations conducted to obtain data regarding pavement conditions on taxiway 3 (designated taxiway 11 prior to 1955) at March Air Force Base. These investigations were made in connection with a series of investigations of the effects of channelized traffic on various flexible pavement elements. March AFB was included in this series because the pavements there had been subjected to channelized traffic and taxiway 3 had shown signs of distress along the channelized traffic lane.

Description of site, climate, and facilities

2. March AFB is located on a slightly undulating alluvial plain about six miles southeast of Riverside, California (see vicinity map, plate 1). This plain is broken by occasional outcroppings of small areas of eroded igneous rocks. The nearest highlands, the Box Springs Mountains, whose peaks reach an elevation of 3000 ft, are less than four miles north of the base. The western half of the base is covered with residual soil except for a few small areas where granitic bedrock is exposed. The soil type is described as a brown micaceous soil varying from a reddish to grayish brown, low in humus, and containing small angular particles of quartz and granite which render it more or less gritty. The surface and near-surface deposits that cover the eastern half of the base are the uppermost layers of a vast body of old alluvium which was derived chiefly from granitic rocks of mountains to the north and east. Elevation of the field is approximately 1500 ft above mean sea level. The water table is about 160 to 190 ft below the ground surface. The climate in this area is semiarid, with long, hot summers, and short, cool winters. Over a 34-yr period, monthly maximum and minimum temperatures of 118 F and 21 F have been recorded. The average annual rainfall is about 11.5 in. with the rainy season occurring in the winter.

3. Pavement facilities at the base in June 1955 consisted of two runways, parking aprons, warm-up aprons, and connecting taxiways (plate 1) surfaced with both flexible and rigid pavements.

Construction and drainage

4. The original pavements at March AFB were constructed prior to 1940 under the supervision of the Quartermaster Corps, and subsequent construction was designed and supervised by the Los Angeles District, CE. The history of this construction has been presented in previous reports (see paragraph 7) and is not discussed here. An extensive paving program was undertaken in 1951. Runway 2, warm-up apron 2, taxiway 3, southeast end of taxiway 2, and a large apron northeast of taxiway 1 were constructed of flexible pavement (plate 1). Taxiway 2, which was originally 9-6-9 portland cement concrete, was overlaid with about 5 in. of asphaltic concrete. A long parking apron parallel to runway 1 (adjacent to the existing concrete apron) and a warm-up apron northeast of the northwest end of runway 1 were constructed of 13-11-13 portland cement concrete. The new flexible pavement consisted of 4 in. of asphaltic concrete (2-1/2-in. binder and 1-1/2-in. surface), 7 in. of dry-bound macadam base course (1-1/2-in. maximum size crushed granite), 6 in. of pit-run gravel (3-in. maximum size, uncrushed), and 14 in. (except 11 in. on interior of runway) of disintegrated granite over a 6-in. compacted layer of subgrade. Taxiway 3 was repaired in 1954 with a leveling course where needed in the channelized areas and a surfacing of 4 in. of asphaltic concrete. At the time of this survey, a leveling course was being placed on the southeastern end of runway 2 with a 2-in. asphaltic-concrete overlay, and a 3000-ft extension to the southeast end of runway 2 with connecting taxiway was also being constructed. The design of the pavement was the same as that used on taxiway 3 (1951 construction) except deeper subgrade compaction was required.

5. Drainage installations were inspected and seemed to be functioning properly. No complaints of structural trouble or settlement of backfill were reported.

Traffic history

6. The traffic history prior to 1953 has been presented in previous reports (paragraph 7). The first B-47's were delivered to March AFB in February 1953, and by July 1953 B-47 traffic on taxiway 3 had reached the

present load intensity. The type, average gross weight, and number of aircraft utilizing taxiway 3 during March, April, and May 1954 were as follows:

Type of Aircraft	Average Gross Weight, lb	Total Number Movements
B-47	165,000	1785
KC-97	155,000)	
B-50	158,000)	743
B-29	128,000)	
C-124	150,000)	

The number of other aircraft utilizing taxiway 3 is unknown; however, it can be assumed that taxiway 3 was used by approximately 200 to 300 aircraft with gross weights varying from 8900 to 70,000 lb. From these data it is estimated that approximately 5000 coverages of B-47 and 1000 coverages of KC-97, B-50, etc., had been applied to taxiway 3 during the 18-month period, February 1953 to July 1954. Runway 2 and taxiway 3 were to be reopened to traffic within a week after the completion of this survey. Runway 1 was the only active runway at the time of this survey.

Previous studies

7. The first pavement investigation at March AFB was reported by the U. S. Army Engineer District, Los Angeles, CE, in Airfield Pavement Evaluation, March Field, Riverside, California, dated June 1944. Evaluations of facilities built or reconstructed since 1944 were published in Airfield Pavement Evaluation, Addendum No. 1, March Field, Riverside, California, dated October 1947. The pavements at March AFB were inspected by a representative of the WES in May 1954 and results of this inspection are on file at the WES. Failures on taxiway 3 were investigated by the Los Angeles District, and the results were reported in Flexible Pavement Failures, Taxiway No. 3, March Air Force Base, Riverside, California, dated September 1954.

Description of Survey

Condition of pavements

8. The Los Angeles District stated in the 1954 failure report that depressions on taxiway 3 were first noted about 1 April 1954 by March AFB personnel. The areas affected were small in extent and not over 1 in. in

depth. In the WES inspection report of May 1954, the depressions on taxiway 3 were stated to be very pronounced and to consist of grooves confined to the center 10 ft of the taxiway. The depressed areas were of variable lengths, and cracking was confined to the edges of the grooves. The taxiway pavement was overlaid in December 1954; and at the time of this investigation (June 1955), the taxiway pavement generally appeared to be in satisfactory condition. In one area on the taxiway cracking had just started, apparently as a result of slippage of the overlay on the original pavement. Runway 2 was being heater-planed and overlaid at the time of these tests. It was reported that about 3500 ft of pavement on the southeast end of the runway was rough and uneven. The work consisted of planing the uneven areas of the runway and then placing an asphaltic-concrete leveling course varying in thickness from 3/4 to 1-1/2 in. An asphaltic-concrete overlay approximately 2 in. thick was then placed in the center 100 ft of the runway. The overlay pavement was soft, and not well compacted, and appeared to be rich in asphalt content. On taxiway 2, cracks from the underlying portland cement concrete pavement had progressed up through the overlay and movement of the underlying broken pavement was evident. The pavement on all other facilities appeared to be in a satisfactory condition.

Test locations

9. The Los Angeles District performed tests in two trenches on taxiway 3. Field testing and sampling in connection with the WES investigation were performed in three test pits so located on taxiway 3 as to supplement the Los Angeles District tests, and in one test pit located in the southeast end of runway 2. Locations of all test pits are shown in plate 1 and are listed below with reasons for their selection.

Testing Agency	Test Hole No.	Location	Reason for Selection
LAD	Trench 1	Taxiway 3, Sta 29+39.5	Considerable deformation. Trench extends across area traveled by B-47 planes and into untraveled area.

(Continued)

Testing Agency	Test Hole No.	Location	Reason for Selection
LAD	Trench 2	Taxiway 3, Sta 30+78.5	Area of very slight distress. Trench extends across area where channelized traffic of B-47 planes has occurred.
WES	Pit 1	Taxiway 3, Sta 29+31 on center line	In area of considerable deformation in channelized B-47 traffic lane and 8 ft from trench 1, to supplement data from trench 1.
WES	Pit 2	Taxiway 3, Sta 29+31, 11 ft northwest of center line	Outside of channelized traffic lane and opposite pit 1 for comparison.
WES	Pit 3	Runway 2, 152 ft from southeast end of runway and 4 ft northeast of center line	In lane of B-47 travel on runway where small deformation of pavement has occurred.
WES	Pit 4	Taxiway 3, Sta 12+29 on center line	In channelized B-47 traffic lane where pavement deformation has occurred.

As indicated in the above table, testing was performed in areas where channelized traffic occurred and outside the areas of channelized traffic so that pavement behavior under different traffic conditions could be studied. The LAD tests were performed on the original taxiway pavement which consisted of about 4 in. of asphaltic concrete. WES test pits 1 and 4 were in areas where a leveling course had been placed prior to the overlay, while test pits 2 and 3 were in areas that had not required a leveling course but had been overlaid with only about 2 in. of asphaltic concrete. WES testing extended into the subsoil layer to a somewhat greater depth than the LAD test trenches. Data from test pit 3 were not intended for comparison of test results but were an attempt to determine the cause of the pavement depression that had occurred in the southeastern portion of runway 2. The deformation that had occurred on the taxiway is indicated on the pavement cross sections, plates 2 and 3.

In-place testing and sampling

10. In-place testing and sampling performed by both LAD and the WES are described on the following page.

a. LAD. In-place density and moisture content were determined on the surface of the base course materials. In-place CBR, density, and moisture content were determined on the surface of subbases 1 and 2, 6 in. below the surface of subbase 2, on the surface of the compacted subgrade, and 6 in. below the surface of the subgrade.

b. WES. The only test performed on the base course was a moisture content determination at test pit 1. The surfaces of subbases 1 and 2, the surface of the compacted subgrade, and the subgrade at depths of 0.5, 1, and 2 ft were tested for in-place CBR, density, and moisture content.

11. Disturbed samples of the base, subbases, and subgrade materials were taken by the LAD and WES for laboratory testing. Core samples of the pavement were also obtained from each test trench and test pit for laboratory testing. Detailed results of the pavement tests are summarized in table 1, logs of test pits are shown in plate 4, and profiles of test trenches 1 and 2 in plate 5.

Laboratory testing

12. Pavement. The cored specimens were separated along the interfaces between the various courses and tested for unit weight, Marshall stability, and flow; and the voids relationships were determined. Extraction and gradation tests were also performed on most of these specimens. Specific gravity tests were conducted on representative samples of the asphalt and aggregates. Representative chunk samples of the asphaltic-concrete overlay and surface and binder courses were reheated and compacted using 50 and 75 blows on each side of the specimen. These recompacted samples were tested for unit weight, stability, and flow, and voids relationships were computed. The LAD also performed similar tests on pavement samples obtained in the 1954 investigation. Results of the 1954 and 1955 pavement tests are given in table 1. Gradation of the pavement aggregates is shown in plates 6 and 7.

13. Base course. No laboratory tests were performed on the base course material by either the LAD or the WES.

14. Subbases 1 and 2 and subgrade. The subbase materials were nonplastic, and the subgrade materials varied from a slightly plastic sandy clay to a nonplastic silty sand. Results of Atterberg limits tests are shown in table 2. Gradation tests were conducted by the LAD and WES on the subbase and subgrade materials, and the results are shown in plates

8, 9, and 10. A complete series of laboratory CBR tests was conducted by the LAD on most of the subbase and subgrade materials encountered and supplementary tests were performed by WES as needed. The results of these tests are shown in plates 11 through 17 and are summarized in table 2.

Analysis of Data

General

15. The 1954 investigation by the LAD indicated that the deformation that occurred on taxiway 3 was a result of compression of the subsoil layers. The 1954 testing extended to a depth of only 40 in. beneath the pavement surface or to a 6-in. depth in the subgrade. As stated previously, the WES investigation was intended to supplement the LAD investigation, and testing was to be extended into the subsoil layers. As the investigations are comparable, results from the 1954 tests are also used in this analysis. Prior to the 1955 tests, taxiway 3 had been patched and overlaid as described in paragraph 4; therefore, cross sections made in 1954 are presented in plates 2 and 3 to show the extent of the settlement that had occurred in the pavement surface. The profiles of test trenches 1 and 2 are shown in plate 5. Fig. 1 shows the type materials and magnitude of

Fig. 1. Test trench; bottom string and wood blocks indicate deformation of subgrade surface

settlement of the individual layers. The 1954 report and the 1955 tests indicated that densification of the subsoil caused the distress; therefore, this analysis discusses primarily the compaction of the subsoil. Also included is a brief analysis of the paving mixes. Other data procured are reported herein but are not analyzed.

Pavements

16. The following table from the 1954 report of the Los Angeles District shows the relationship between the design criteria, the job-mix formula, and the average test results actually obtained during construction of the binder and surface courses.

	AC, %	Voids Filled, %	Voids Total Mix, %	Stability lb	Flow 1/100 in.
		Surface Course			
Design criteria	-	75-88	4-6	1000+	16-
Job mix	6.5	80	4.0	2500+	10
Actually obtained	6.2	89	1.9	2446	10
		Binder Course			
Design criteria	-	65-72	5-7	1000+	16-
Job mix	5.2	74	4.2	1000+	11
Actually obtained	5.2	83	2.4	2645	8

17. The aggregate used in both the binder and surface courses was a crushed granite. The gradations of the extracted aggregates from the 1954 and 1955 tests are shown in plates 6 and 7. Studies at WES (unpublished) have indicated that the density of recompacted specimens closely approximates that determined at the construction-control laboratory. In order to study the degree of compaction developed under traffic, the 75-blow recompacted density is used as a reference value. The only recompacted density values available were those determined on samples from the traveled lane (TP-1) in the 1955 tests, but these are believed to be reasonably representative of all the test locations. Average in-place density in percentage of recompacted density, asphalt content, and voids in the total mix are presented in the following table for surface and binder courses.

	Recompacted Density lb/cu ft	In-place Density, % 75-blow Recompaction	Asphalt Content %	Voids Total Mix %
		Surface Course		
Job mix	-	-	6.5	4.0
Construction control	-	-	6.2	1.9
Untraveled areas (1954 cond survey)	150.3*	99	6.4	2.0
Traveled areas (1954 cond survey)	150.3*	97	6.3	4.0
Untraveled areas (1955 cond survey)	150.3*	99	6.2	3.8
Traveled areas (1955 cond survey)	150.3	99	6.5	3.5
		Binder Course		
Job mix	-	-	5.2	4.2
Construction control	-	-	5.2	2.4
Untraveled areas (1954 cond survey)	151.6*	99	5.2	2.7
Traveled areas (1954 cond survey)	151.6*	100	5.3	1.8
Untraveled areas (1955 cond survey)	151.6*	99	5.9	2.7
Traveled areas (1955 cond survey)	151.6	101	4.9	3.0

* Assumed recompacted density values.

A comparison of densities in the traveled and untraveled areas indicates an average of 98% of recompacted density in the surface course in the traveled area and 99% in the untraveled. In the binder course an average density of slightly more than 100% of recompacted density is shown in the traveled area and 99% in the untraveled. No densification of the surface course and only slight densification of the binder course are indicated. The voids in the total mix were generally above the minimum allowable of 3 per cent (1955 criteria) for the surface course, but were less than the minimum allowable of 5 per cent for the binder course. No evidence of distress was noted in the surface or binder course.

18. Data in table 1 indicate that the penetration of the asphalt in the surface course in 1955 was about 50, while that in the binder course was about 25. It is presumed (values are not available) that the material originally had penetration values between 85 and 100. Softening points of 132 F and 141 F were found for the asphalt in the surface and binder courses, respectively.

19. Cores taken from the pavement in 1955 indicated that the apparent slippage described in paragraph 8 was partly due to lack of bond between the overlay and original surface course. The data in table 1 show that the stability in the overlay in the untraveled area was 250 lb, the degree of compaction 92%, and the voids in the total mix 11.9%. In the traveled area the stability had increased to over 400 lb and the compaction to 95%, and the voids had decreased to about 9.5%. The data available on the leveling course were from the traveled area only and showed an average stability of about 700 lb and voids in the total mix of a little over 12%. These data indicate that traffic will tend to increase the strength of both the leveling and overlay courses; however, it is doubtful that the bond between layers will be improved.

Densification

20. In this analysis it is assumed initially that the density obtained during construction was about the same inside and outside the tracking lane. The plot of in-place density versus depth in plate 18 shows that below depths of about 32 in. at trench 1 and 40 in. at trench 2 considerable densification is indicated to have occurred in the tracking lane over that outside the tracking lane. From 40 in. to about 60 in. the density outside the tracking lane averaged about 81 per cent of modified AASHO maximum density; that inside the tracking lanes averaged about 86 per cent. Below 60 in. the data indicated about the same density inside and outside the tracking lanes. Assuming that the density of the material between 40 and 60 in. has increased about 5 percentage points, an inch of deformation would be expected. Actually, the deformation amounts to nearly 4 in. This has three possible explanations: (1) the original assumption of equal construction densities is in error and the tracking lane was less dense than the untraveled area, (2) the densification extended to considerably more than 60 in., or (3) a combination of (1) and (2).

21. It was stated that during construction the subsoil was rather dry (see reports mentioned in paragraph 7). It is seen in plates 15, 16, and 17 that the optimum moisture content for the 10- or 12-blow compaction efforts for the subgrade materials ranges from 10 to 13 per cent. In-place moisture contents in the uncompacted subgrade ranged from 5.9 to 15.6 per cent. As stated in the LAD failure report of 1954, it appears that at least a portion of the deformation is explained by the fact that the dry subsoil gathered appreciable moisture after it was covered by subsequent construction and was then capable of accepting more compaction from the imposed traffic.

Significant Facts and Conclusions

22. No measurable change in thickness occurred in the pavement, base course, and subbase layers; therefore, the compaction at the time of this investigation appears adequate for these materials for the imposed traffic.

23. The densification which accounted for an appreciable portion of the settlement occurred at depths below 40 in.

24. As the moisture content of the subsoil increased toward optimum after construction the material densified under B-47 airplane loadings.

25. Design studies should include moisture, density, and CBR data in the subsoil to a depth where the design wheel load will have little effect.

Table 1

Results of Pavement Tests, March AFB

LOCATION		DESCRIPTION				QUALITY					ASPHALT					AGGREGATE						REMARKS
FACILITY	PIT NO.	TYPE AND CONDITION	COURSE	THICKNESS INCHES	TYPE OF SAMPLE	UNIT WT LB PER CU FT	STABILITY LB	FLOW 1/100 IN.	PER CENT VOIDS TOTAL MIX	PER CENT VOIDS FILLED WITH ASPHALT	PER CENT	SP GR COMPUTED	DUCTILITY CM	PEN. MM	SOFT POINT °F	SP GR +#10	SP GR -#10	GRADATION PER CENT PASSING 3/4	#10	#40	#200	
					1954 Tests by Los Angeles District																	
Taxiway 3		Untraveled	Surface	---	Core	150.3	3340	12	1.5	91.0	6.3	1.007						100	53	33	10.7	
					Recomp - 75 blows	-----	3510	11	---	----	---	-----						---	--	--	----	
			Binder	---	Core	151.9	2800	14	1.3	91.2	5.6	1.007						91	38	22	5.3	
					Recomp - 75 blows	-----	4030	11	---	----	---	-----						---	--	--	----	
		Untraveled	Surface	---	Core	147.1	2000	11	3.2	82.6	6.5	1.007						100	51	32	9.4	
					Recomp - 75 blows	-----	3760	11	---	----	---	-----						---	--	--	----	
			Binder	---	Core	150.2	2270	10	3.3	78.4	5.0	1.007						87	32	19	4.5	
					Recomp - 75 blows	-----	3110	9	---	----	---	-----						---	--	--	----	
		Traveled	Surface	---	Core	146.8	2200	11	3.7	79.9	6.3	1.007						100	49	29	8.6	
					Recomp - 75 blows	-----	3750	11	---	----	---	-----						---	--	--	----	
			Binder	---	Core	151.3	2880	16	1.9	87.4	5.5	1.007						90	35	22	7.1	
					Recomp - 75 blows	-----	3690	15	---	----	---	-----						---	--	--	----	
		Traveled	Surface	---	Core	146.1	2200	10	4.3	77.0	6.2	1.007						100	47	30	9.4	
					Recomp - 75 blows	-----	4000	10	---	----	---	-----						---	--	--	----	
			Binder	---	Core	152.8	2840	12	1.6	88.4	5.0	1.007						82	30	19	6.3	
					Recomp - 75 blows	-----	3250	14	---	----	---	-----						---	--	--	----	
	TP 2	Untraveled	Surface	---	Core	151.1	2950	12	6.8	95.1	6.4	1.007						100	49	31	10.5	
					Recomp - 75 blows	-----	3430	13	---	----	---	-----						---	--	--	----	
			Binder	---	Core	150.8	2260	16	2.7	82.2	5.2	1.007						95	34	21	6.5	
					Recomp - 75 blows	-----	3630	13	---	----	---	-----						---	--	--	----	
		Untraveled	Surface	---	Core	150.3	3460	10	1.5	91.0	6.3	1.007						100	51	31	10.9	
					Recomp - 75 blows	-----	4950	12	---	----	---	-----						---	--	--	----	
			Binder	---	Core	152.1	3140	17	2.2	84.4	4.9	1.007						81	34	22	6.9	
					Recomp - 75 blows	-----	3200	14	---	----	---	-----						---	--	--	----	
	TP 1	Untraveled	Surface	---	Core	149.6	3250	11	1.8	89.3	6.3	1.007						100	48	30	9.2	
					Recomp - 75 blows	-----	5280	11	---	----	---	-----						---	--	--	----	
			Binder	---	Core	151.7	3720	12	1.9	87.1	5.3	1.007						97	38	25	8.0	
					Recomp - 75 blows	-----	3620	12	---	----	---	-----						---	--	--	----	
		Untraveled	Surface	---	Core	146.4	3210	10	3.3	82.7	6.8	1.007						100	50	30	9.6	
					Recomp - 75 blows	-----	6240	10	---	----	---	-----						---	--	--	----	
			Binder	---	Core	148.0	1310	13	4.8	71.1	5.0	1.007						89	35	22	6.9	
					Recomp - 75 blows	-----	4020	13	---	----	---	-----						---	--	--	----	
					1955 Tests by Waterways Experiment Station																	
Taxiway 3	TP 1	Traveled	Overlay	2-3/4	Core	137.6	490	16	10.1	53.9	5.5							100	51.3	27.3	5.7	
					Recompaction																	
					50 blows/end	144.9	1911	12	5.3	70.4	5.6	1.030	20	51	---	2.667	2.671	100	53.0	25.7	6.2	
					75 blows/end	145.3	2073	14	5.0	71.8												
			Leveling	7/8	Core	137.2	806	12	12.0	48.1	5.2							100	52.8	23.4	7.4	Test results from overlay used to compute voids
			Surface	1-7/16	Core	148.0	2253	15	3.5	80.9	6.5							100	45.9	30.0	10.9	
					Recompaction																	
					50 blows/end	149.6	3196	18	2.7	84.3	6.3	1.044	107	49	132	2.726	2.698	98.1	44.6	28.6	10.6	One-inch max aggregate
					75 blows/end	150.3	3490	21	2.3	86.3												
			Binder	2-7/8	Core	153.1	2231	18	2.6	81.9	5.0							91.1	33.5	21.3	6.8	One-inch max aggregate
					Recompaction																	
					50 blows/end	150.6	3546	16	4.5	71.2	4.8	1.043	150+	24	141	2.731	2.701	93.3	33.8	21.2	6.8	One-inch max aggregate
					75 blows/end	151.6	4179	16	3.8	74.7												

Summary of Test Results Pavement
WES Form No. 775
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(1 of 2 sheets)

Table 1 (Continued)

LOCATION		DESCRIPTION				QUALITY					ASPHALT					AGGREGATE						REMARKS
FACILITY	PIT NO.	TYPE AND CONDITION	COURSE	THICKNESS INCHES	TYPE OF SAMPLE	UNIT WT LB PER CU FT	STABILITY LB	FLOW 1/100 IN.	PER CENT VOIDS TOTAL MIX	PER CENT VOIDS FILLED WITH ASPHALT	PER CENT	SP GR COMPUTED	DUCTILITY CM	PEN. MM	SOFT POINT OF	SP GR +#10	SP GR -#10	GRADATION PER CENT PASSING 3/4	#10	#40	#200	
						195[illegible] Tests by Waterways Experiment Station (Continued)																
Taxiway 3 (Continued)	TP 2	Untraveled	Overlay	2-15/16	Core	133.8	250	17	11.9	51.6	6.1							100	50.9	26.4	5.0	
			Surface	1-9/16	Core	148.1	1695	16	3.8	78.8	6.2							100	51.2	31.7	8.7	
			Binder	2-5/16	Core	150.8	1368	21	2.7	83.5	5.9							94.4	38.1	24.4	6.9	One-inch max aggregate
Runway 2	TP 3	Traveled	Overlay	1-7/8	Core	134.2	295	12	11.1	55.1	6.5							100	60.6	25.9	5.2	
			Surface	1-3/8	Core	150.3	2862	14	2.3	86.3	6.3							100	50.6	30.3	9.6	
			Binder	2-3/16	Core	153.5	1979	20	3.7	72.4	4.1							92.2	27.9	18.0	6.2	One-inch max aggregate
Taxiway 3	TP 4	Traveled	Overlay	2-1/16	Core	138.7	417	15	8.8	59.4	6.0							100	49.7	25.1	4.6	
			Leveling	1-1/2	Core	133.5	629	12	12.7	47.7	5.6							100	60.1	24.8	4.9	
			Surface	1-7/8	Core	147.5	1929	20	----	----	---							100	48.2	31.3	12.3	Asphalt data erratic
			Binder	2-1/8	Core	152.2	1657	23	3.4	76.7	4.8							86.1	35.4	22.4	7.6	

Note: Notes apply only to Waterways Experiment Station test data.
The aggregate is described as crushed granite. Absorption tests are tabulated below:

	Absorption - Per Cent		
	+ No. 10	- No. 10	Weighted Average
Overlay	1.05	0.75	0.89
Surface	0.79	2.46	1.54
Binder	0.89	1.07	0.95

In the overlay of pits 1 and 2 and the binder of pit 1, a number of samples were too thick for stability tests. These layers were measured and weighed in air and in water for density determinations, and then were sawed to fit the breaking head. The samples were reweighed and it was ascertained that there had been little change in density. The thickness and density of the original samples were used in computing average values.

The overlay on the cores from pits 3 and 4 was in poor condition for testing. It appeared from several cores that the overlay had been placed in two layers. Attempts to separate the layers were not always successful and damage resulted to some of the specimens. Both sections were measured and tested when possible, but any damaged or disintegrated part was discarded.

The leveling course was not apparent in the chunk samples used for recompaction and recovery tests. Therefore the test results from the overlay were used to compute voids data for the leveling course.

Table 2

SUMMARY OF TEST RESULTS

Subbase and Subgrade, March AFB

Field In-Place

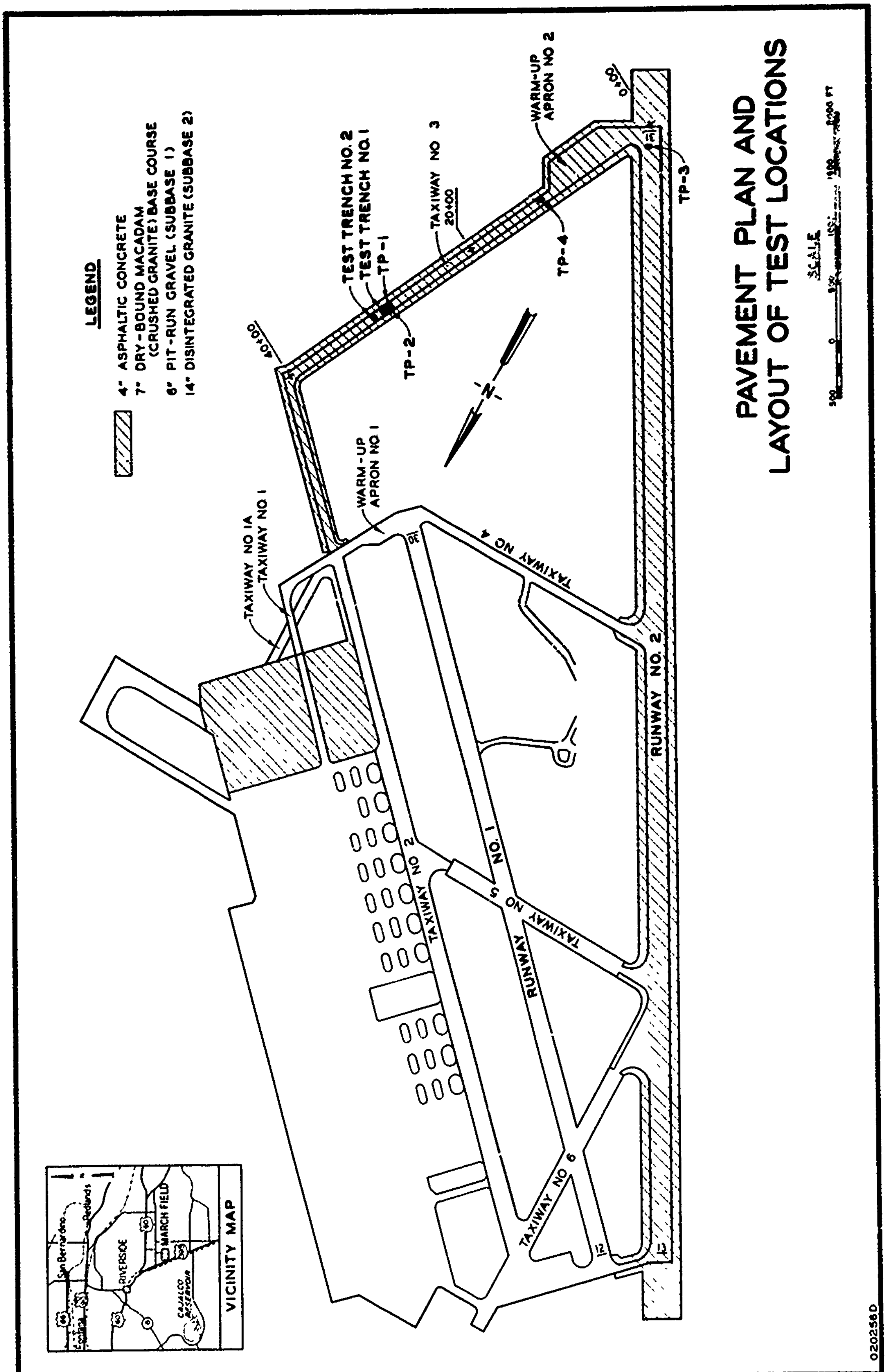
Location: Facility	Trench or Pit No.	Description: Condition	Depth from Sfc In.	Sp Gr	LL	PI	Dept of Army Unified	% Mod AASHO Dens	Moisture Per Cent	% Sat.	Density Lb per Cu Ft	CBR Unsoaked in Place (IU)	CBR Undist Soaked (US)
Taxiway 3	Tr 1	Traveled	11.75	2.68	NP	NP	SM	99	5.8	56	132.5	57	
	1	Untraveled	11.75		NP	NP	SM	99	5.3	55	132.5	60	
	2	Traveled	11.50		NP	NP	GW-GM	99	5.5	53	134.5	77	
	2	Lightly traveled	11.50		NP	NP	GW-GM	99	4.4	48	134.0	68	
Taxiway 3	Tr 1	Traveled	17.75	2.75	24	0	SM	94	6.4	60	128.3	32	
	1	Traveled	24.0		--	--		--	9.1	91	-----	20	
	1	Untraveled	17.75		--	--	SM	95	6.6	55	130.3	34	
	1	Untraveled	24.0		--	--		--	12.6	74	-----	18	
	2	Traveled	17.0		--	NP	SM	93	6.2	50	128.0	37	
	2	Traveled	23.0		--	--		--	6.3	52	-----	15	
	2	Lightly traveled	17.0		--	NP	SM	91	5.9	58.2	123.5	15	
	2	Lightly traveled	23.0		--	NP	SM	--	5.3	52.3	-----	15	
Taxiway 3	Tr 1	Traveled	31.25	2.68	23	10	CL	89	11.7	71	117.0	23	
	1	Traveled	35.50					81	13.7	71	110.5	11	
	1	Untraveled	31.50		23	9	CL	87	12.9	71	112.5	23	
	1	Untraveled	35.50					83	13.9	68	108.5	5	
	2	Traveled	30.0		21	6	ML	85	12.0	69	114.0	77	
	2	Traveled	35.50					74	13.6	54	99.5	9	
	2	Lightly traveled	30.0		21	4	ML	83	10.6	73	120.0	25	
	2	Lightly traveled	35.50					71	13.4	50	97.0	30	
Taxiway 3	TP 1	Traveled	15.0	2.70	NP	NP	SM	94	6.2	64	125.4	78	
	2	Lightly traveled	17.5	2.70	NP	NP	SM	93	6.0	59	132.6	65	
Runway 2	3	Traveled	15.5	2.70	NP	NP	[illegible]	95	3.5	35	132.6	93	
Taxiway 3	4	Traveled	17.5	2.70	NP	NP	SP	98	5.0	47	130.0	103	
Taxiway 3	TP 1	Traveled	23.0	2.77	NP	NP	SM	98	6.4	54	130.5	34	
	2	Lightly traveled	20.0	2.77	NP	NP	SM	101	4.9	48	135.1	31	
Runway 2	3	Traveled	21.5	2.77	NP	NP	SM	100	4.6	44	134.1	45	
Taxiway 3	4	Traveled	22.0	2.77	NP	NP	SM	104	6.3	73	139.7	56	
Taxiway 3	TP 1	Traveled	35.0	2.70	25	12	CL	87	13.2	70	111.9	15	
			41.0					92	14.4	65	105.6	--	
			53.0					75	13.9	55	100.5	--	
			[illegible]					77	14.9	57	99.4	--	
	2	Lightly traveled	34.0	(2.70)	--	--	CL	93	11.2	72	119.1	26	
			40.0					79	15.5	65	102.2	--	
			52.0					75	15.0	55	96.9	--	
			64.0					79	13.5	56	102.3	--	
Runway 2	3	Traveled	32.0	(2.70)	NP	NP	ML	100	8.0	72	129.7	35	
			38.0		NP	NP		91	7.6	47	117.8	--	
			50.0		NP	NP		90	5.9	36	115.6	--	
			62.0		NP	NP		82	7.5	34	106.3	--	
Taxiway 3	4	Traveled	35.0	(2.70)	--	--	CL	92	10.5	67	118.9	18	
			41.0					86	11.0	56	110.5	--	
			53.0					83	9.9	47	107.8	--	
			70.0					80	7.5	32	103.1	--	

Laboratory

Material	Mod AASHO Comp: Optimum Moisture Per Cent	Mod AASHO Comp: % Sat.	Mod AASHO Comp: Maximum Density Lb per Cu Ft	Soaked CBR: Molding Moisture Per Cent	Soaked CBR: % Sat.	Soaked CBR: Molding Density Lb per Cu Ft	Soaked CBR: % Mod AASHO Dens.	Soaked CBR: Soaked Moisture Per Cent	Soaked CBR: % Sat.	Soaked CBR: Soaked Density Lb per Cu Ft	Soaked CBR: % Mod AASHO Dens.	Soaked CBR: CBR (RS)	Unsoaked CBR: Molding Moisture Per Cent	Unsoaked CBR: % Sat.	Unsoaked CBR: Molding Density Lb per Cu Ft	Unsoaked CBR: % Mod AASHO Dens.	Unsoaked CBR: CBR (RU)	Remarks
1954 TESTS BY LOS ANGELES DISTRICT																		
Subbase No. 1	6.4		134.6					6.4				150	5.4		133.5		120	
Subbase No. 2	6.6		136.0									80+						
Subgrade	7.5		132.5															
	8.1		130.0															
	7.1		134.0															
	7.0		136.0															
1955 TESTS BY WATERWAYS EXPERIMENT STATION																		
Subbase No. 1	--	--	-----	6.0	69	133.2		8.8	87	133.1		98	---	--	-----	---	---	
Subbase No. 2	7.1	67	133.8	---	--	-----	---	---	--	-----	---	---	7.1	67	133.8	100	77	
Subgrade	9.5	83	128.9	9.5	85	130.6	101	10.5	63	130.8	101	62	9.5	83	128.9	100	54	

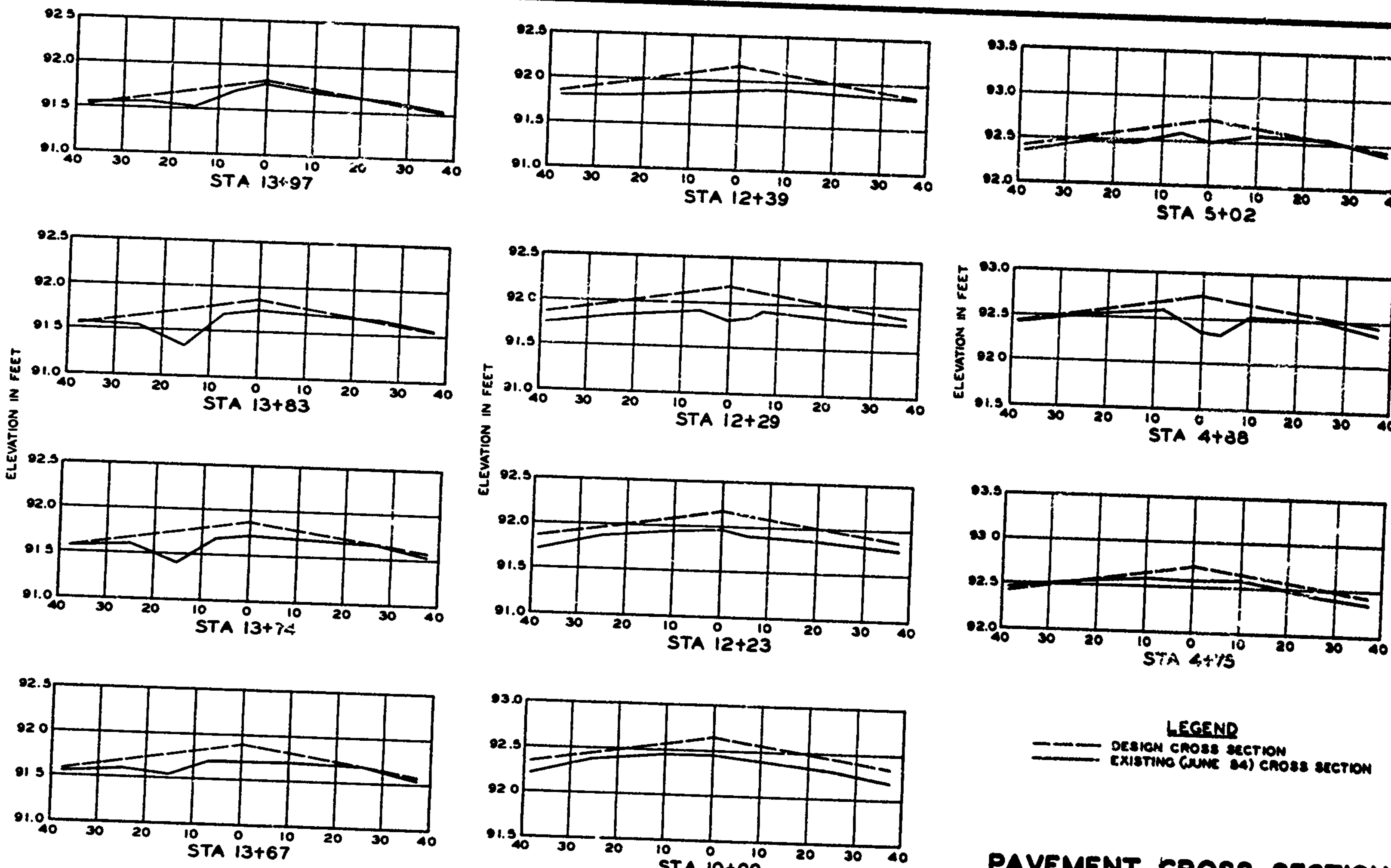
Note: Figures in parentheses assumed.

WES Form No. 774 Rev July 1952



PAVEMENT PLAN AND
LAYOUT OF TEST LOCATIONS
SCALE
LEGEND
4" ASPHALTIC CONCRETE
7" DRY-BOUND MACADAM (CRUSHED GRANITE) BASE COURSE
6" PIT-RUN GRAVEL (SUBBASE 1)
14" DISINTEGRATED GRANITE (SUBBASE 2)
TEST TRENCH NO. 2
TEST TRENCH NO. 1
TP-1
TP-2
TP-3
TP-4
TAXIWAY NO 3
20+00
40+00
0+00
WARM-UP APRON NO 2
WARM-UP APRON NO. 1
TAXIWAY NO 1A
TAXIWAY NO. 1
TAXIWAY NO 4
TAXIWAY NO 2
TAXIWAY NO 5
TAXIWAY NO 6
RUNWAY NO. 1
RUNWAY NO. 2
N
VICINITY MAP
RIVERSIDE
MARCH FIELD
020256D

PLATE I



NOTE NO AS-BUILT CROSS SECTIONS WERE MADE.

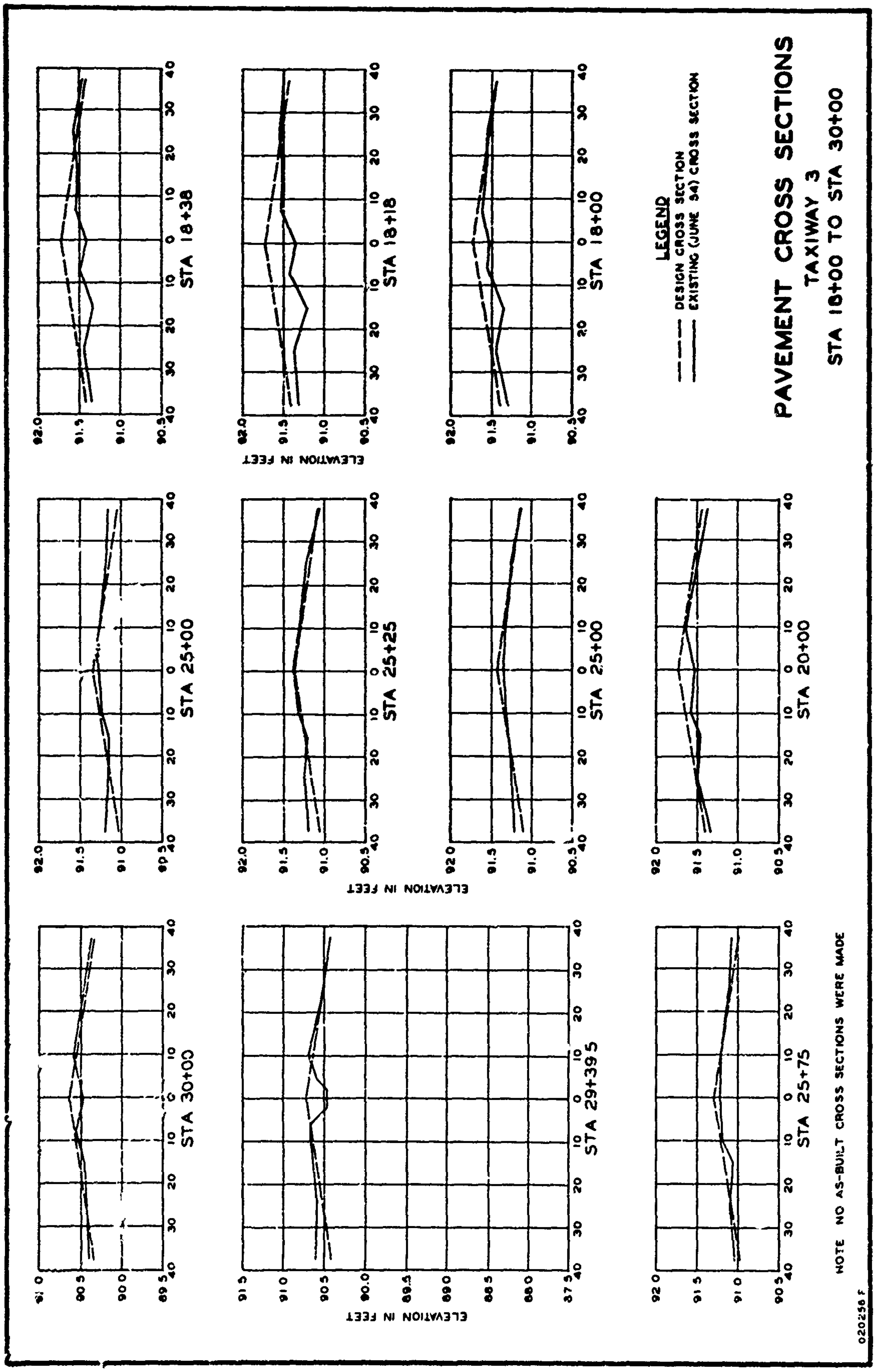
020256 E

PAVEMENT CROSS SECTIONS

TAXIWAY 3

STA 4+75 TO STA 13+97

PLATE 2


PAVEMENT CROSS SECTIONS
TAXIWAY 3
STA 18+00 TO STA 30+00
LEGEND
DESIGN CROSS SECTION
EXISTING (JUNE 54) CROSS SECTION
STA 18+38
STA 18+18
STA 18+00
STA 25+00
STA 25+25
STA 25+00
STA 20+00
STA 30+00
STA 29+39.5
STA 25+75
ELEVATION IN FEET
NOTE NO AS-BUILT CROSS SECTIONS WERE MADE
020256 F

17

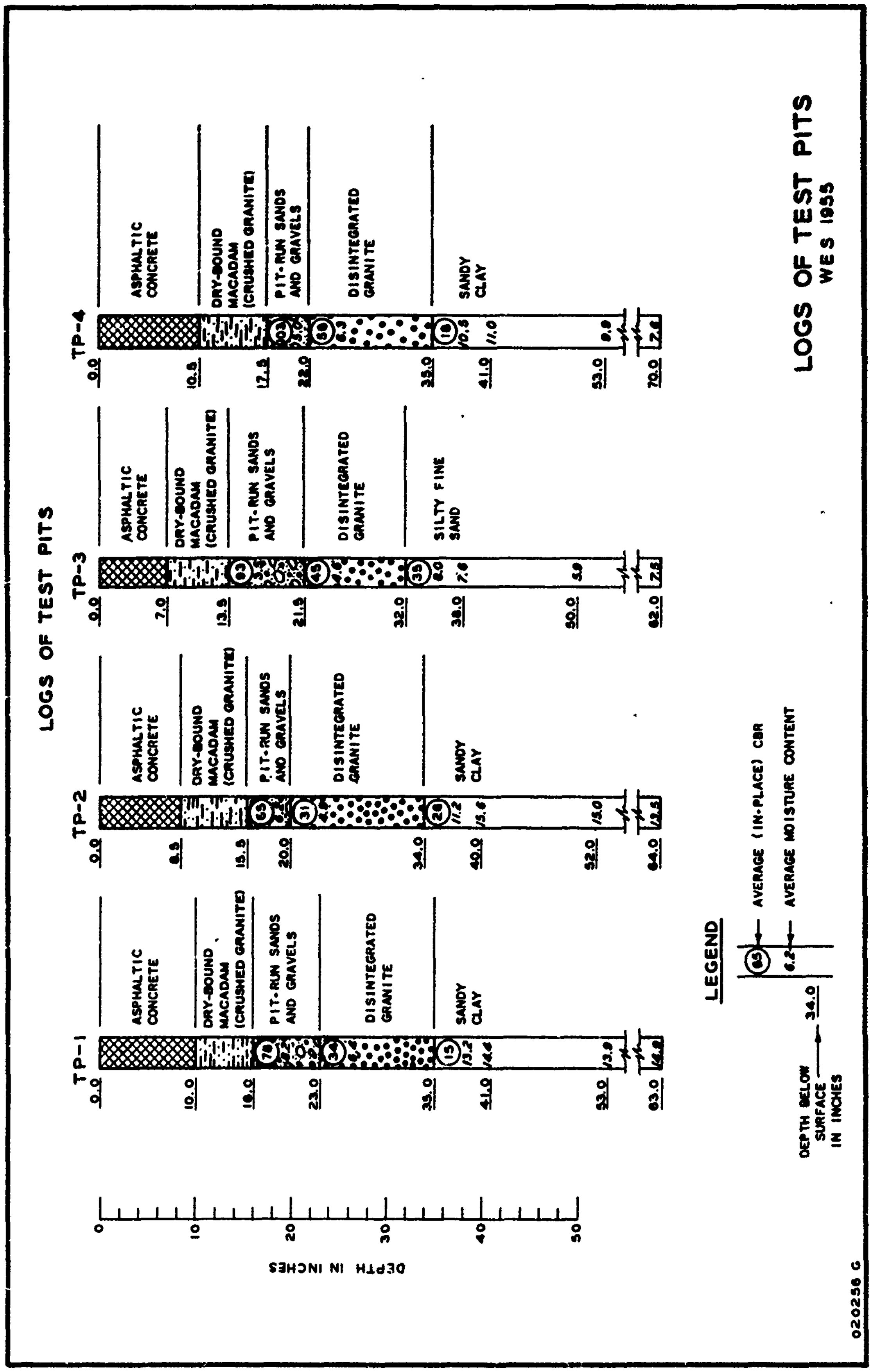
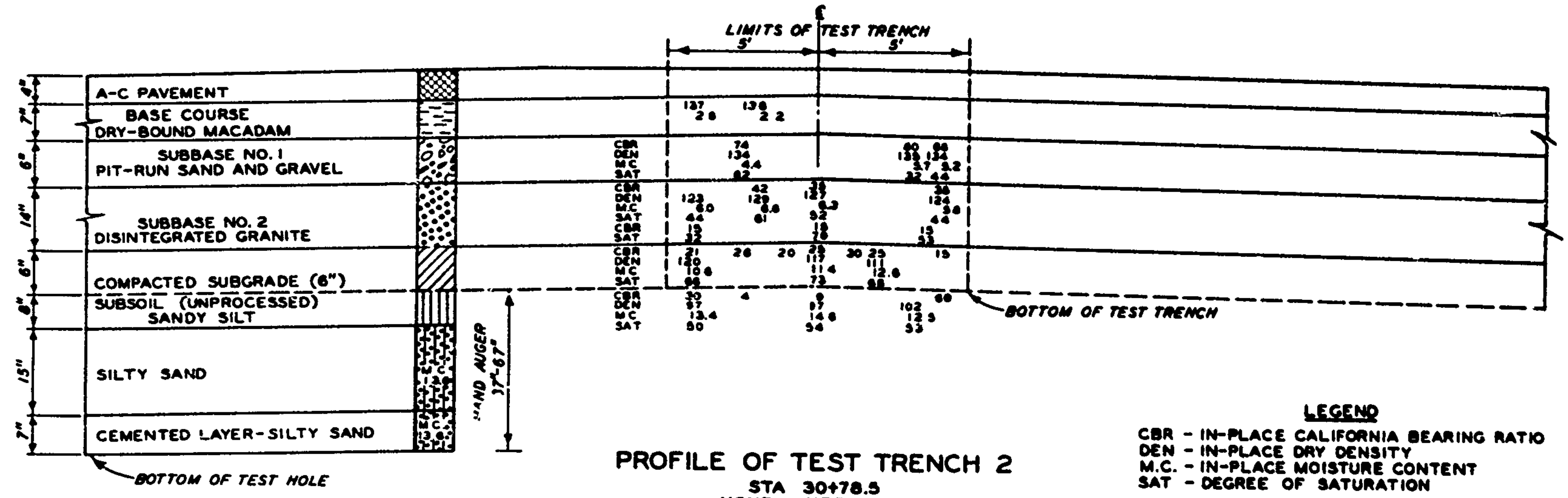

LOGS OF TEST PITS
TP-1
TP-2
TP-3
TP-4
ASPHALTIC CONCRETE
DRY-BOUND MACADAM (CRUSHED GRANITE)
PIT-RUN SANDS AND GRAVELS
DISINTEGRATED GRANITE
SANDY CLAY
SILTY FINE SAND
DEPTH IN INCHES
LEGEND
AVERAGE (IN-PLACE) CBR
AVERAGE MOISTURE CONTENT
DEPTH BELOW SURFACE IN INCHES
LOGS OF TEST PITS
WES 1955
020256 G

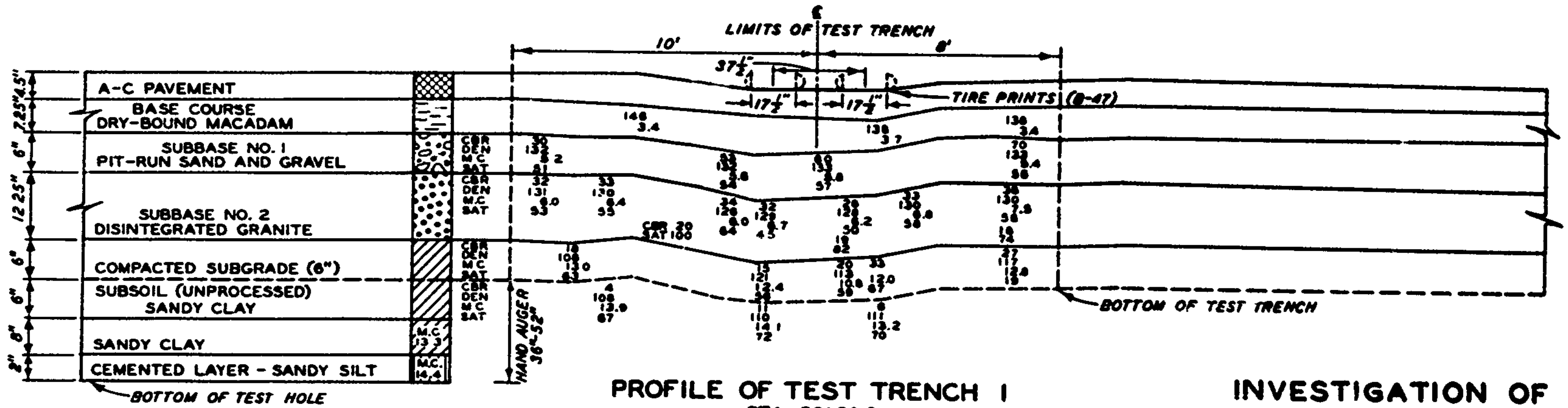
PLATE 4



PROFILE OF TEST TRENCH 2
STA 30+78.5
NONFAILURE AREA

LEGEND

CBR - IN-PLACE CALIFORNIA BEARING RATIO
DEN - IN-PLACE DRY DENSITY
M.C. - IN-PLACE MOISTURE CONTENT
SAT - DEGREE OF SATURATION

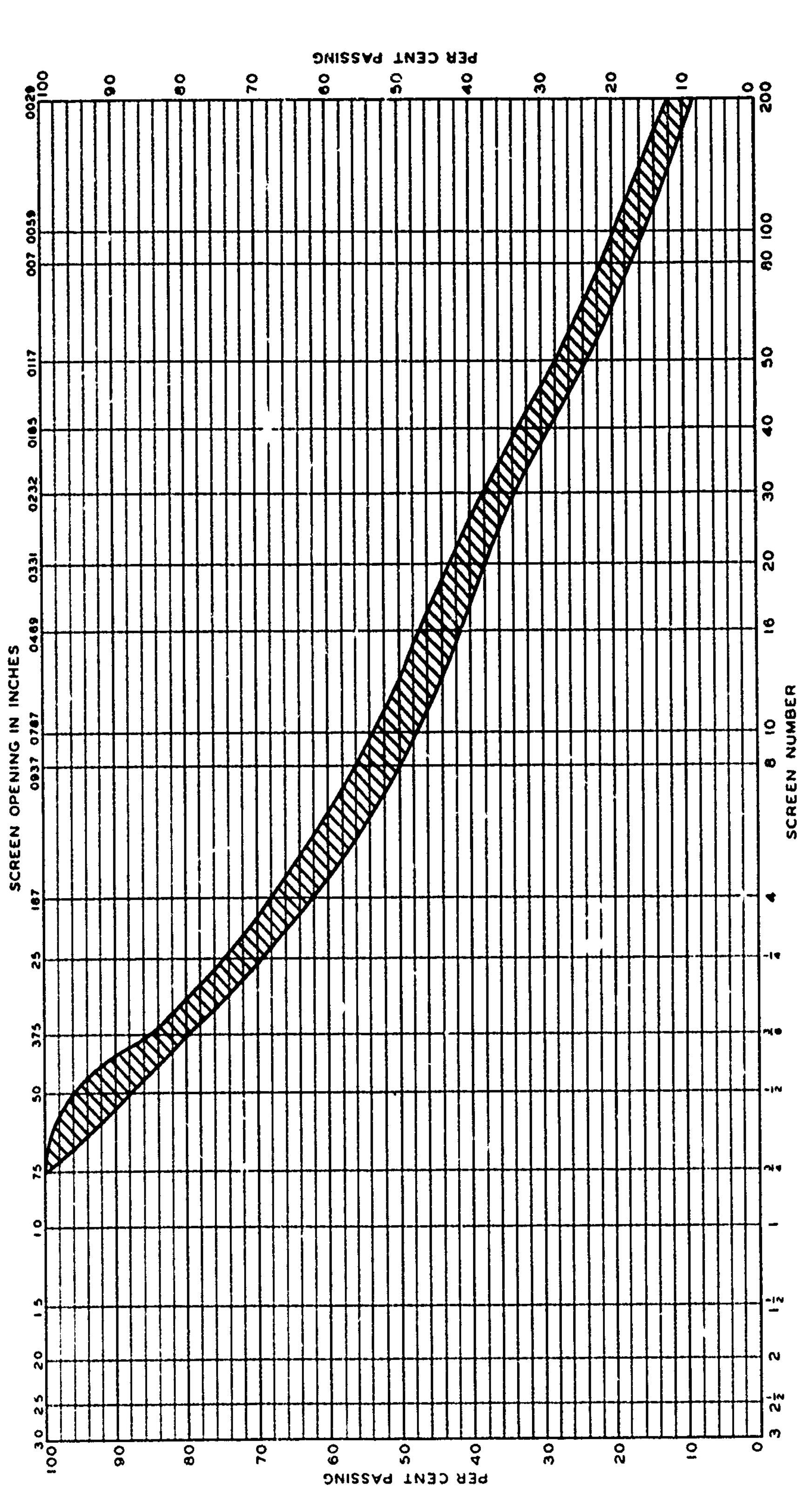


PROFILE OF TEST TRENCH 1
STA 29+39.5
THROUGH FAILED AREA

INVESTIGATION OF PAVEMENT FAILURES
TAXIWAY 11

JUNE 1954

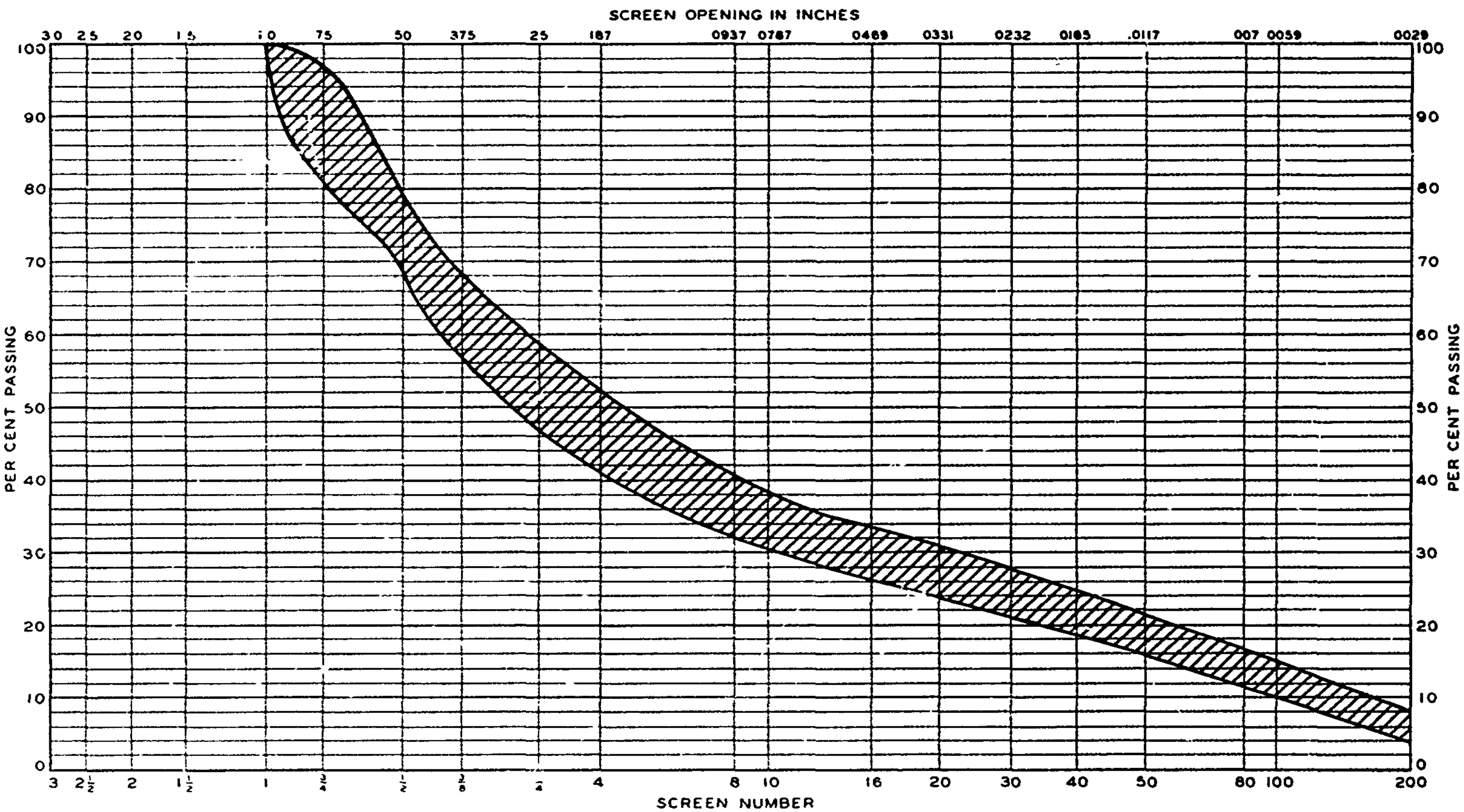
020256 H



RANGE OF GRADATIONS OF
SURFACE COURSE AGGREGATES

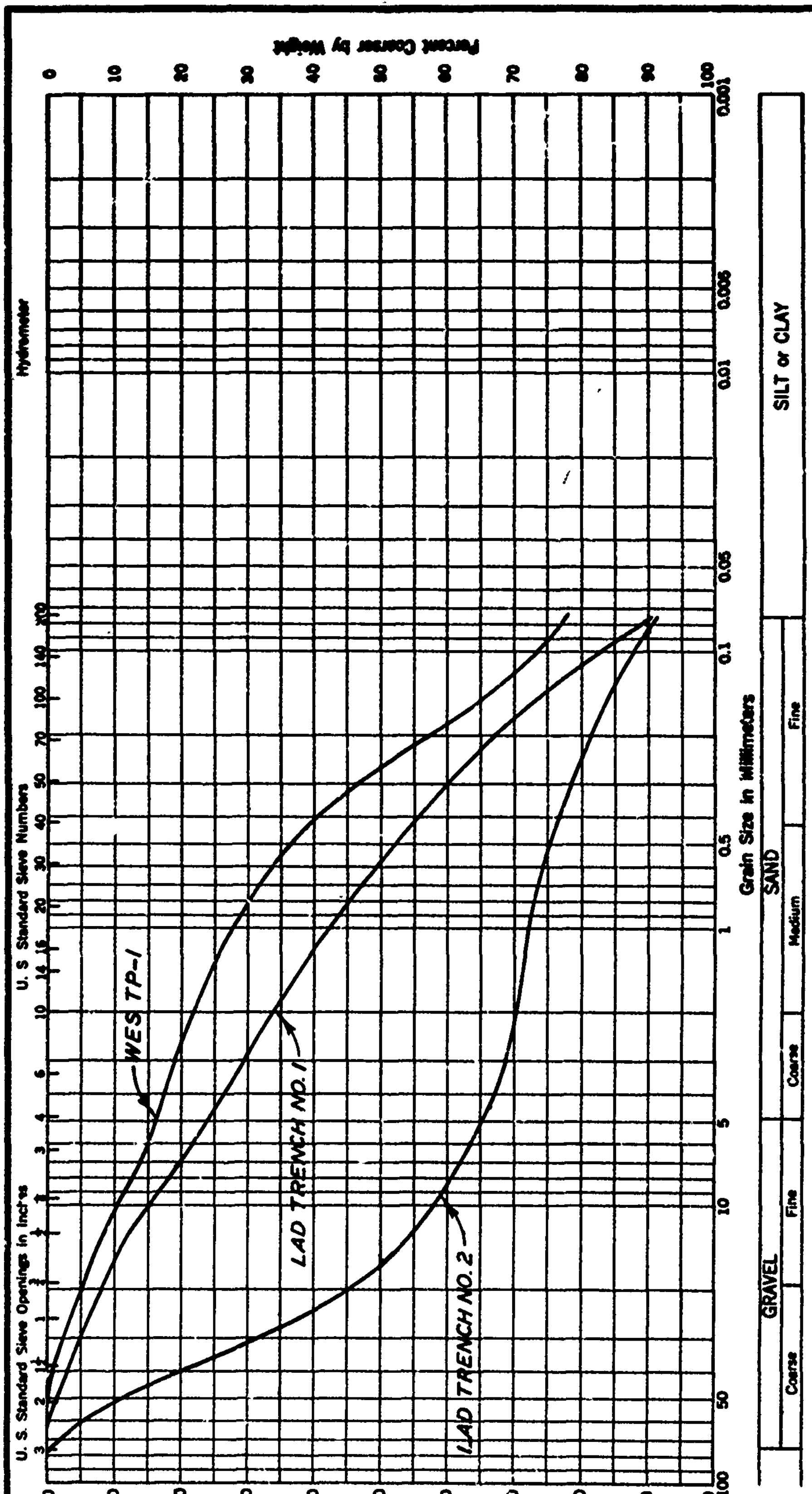
020256 J

PLATE 6



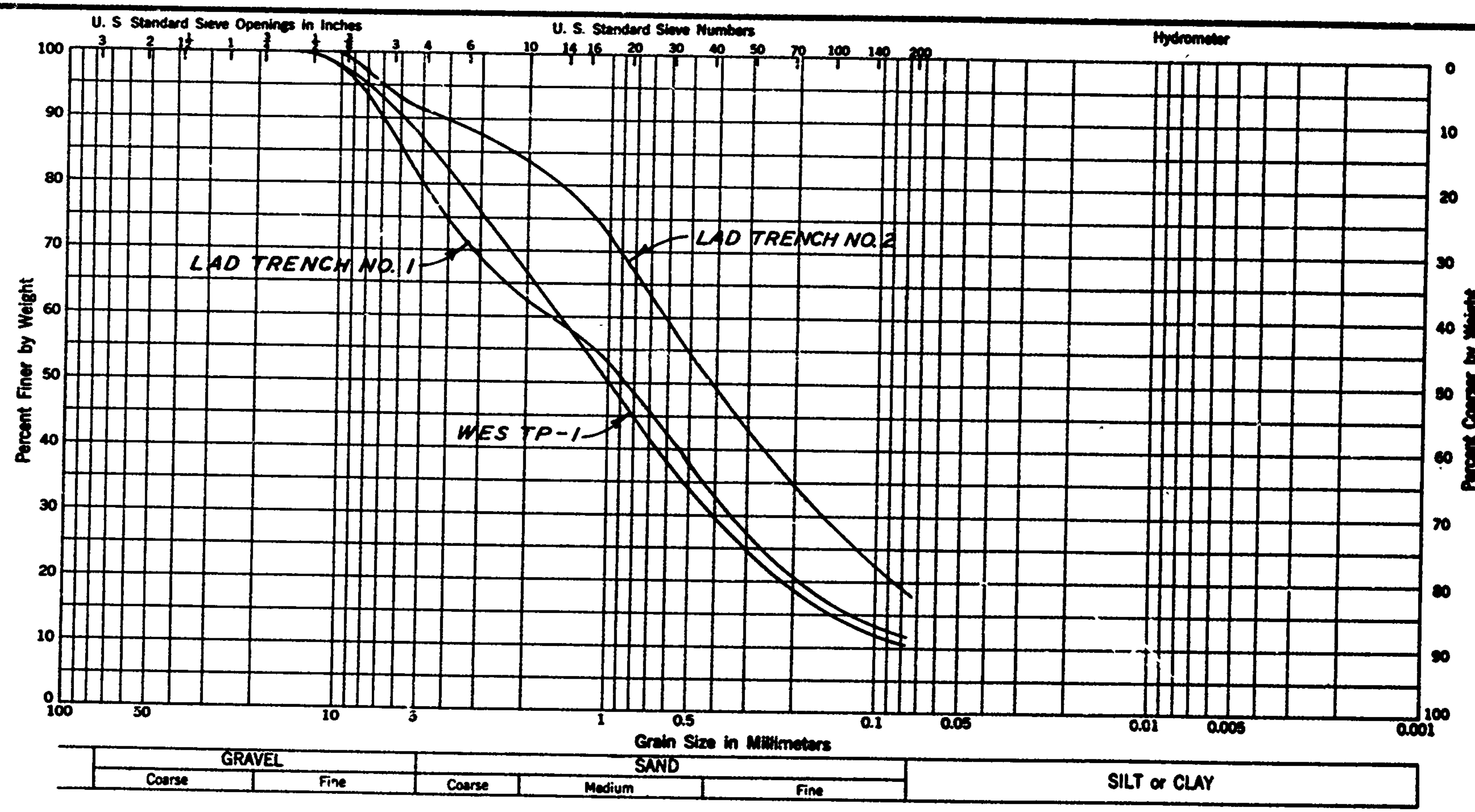
RANGE OF GRADATIONS OF
BINDER COURSE AGGREGATES

020256 K



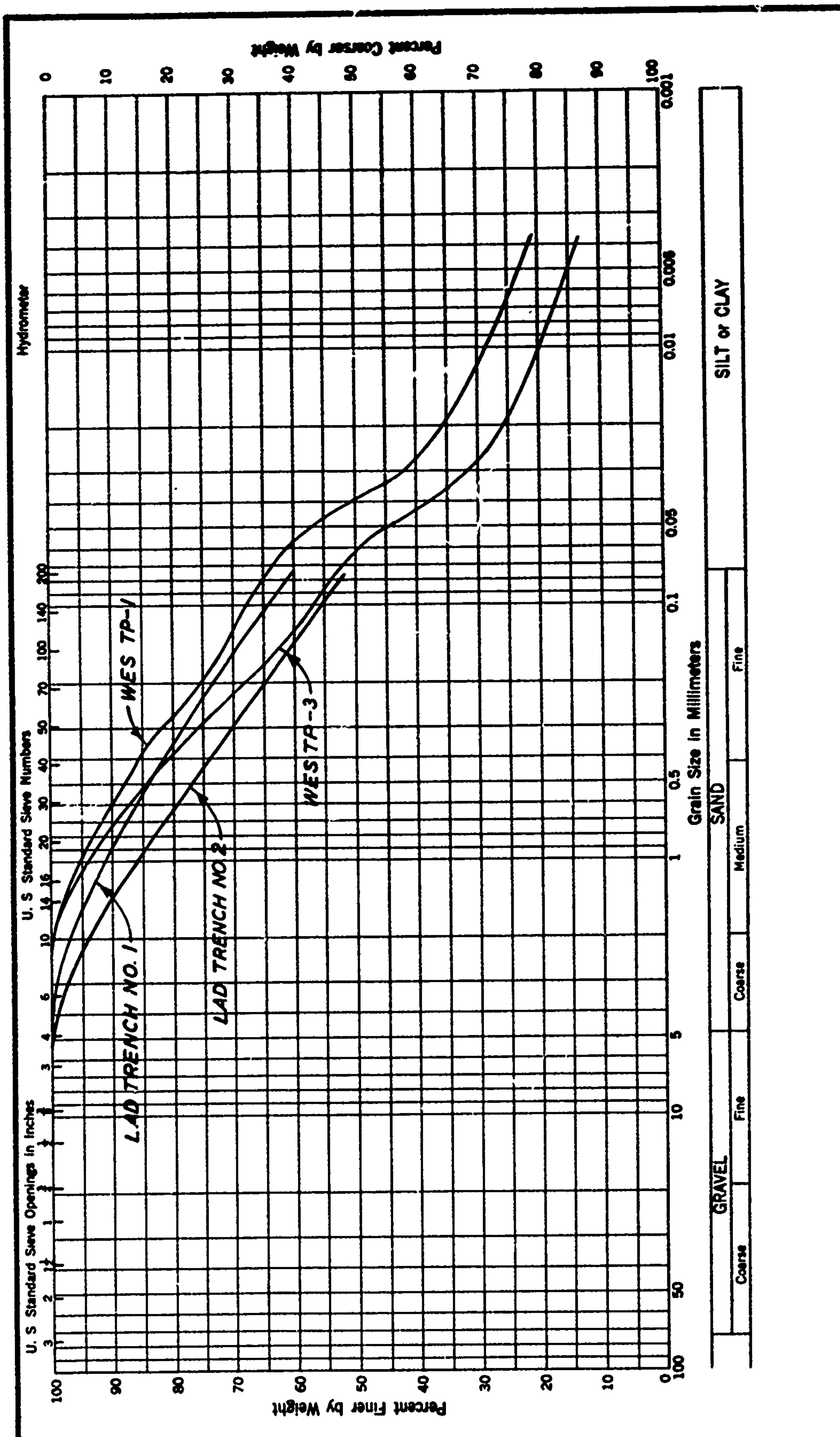
GRADATIONS OF TYPICAL SUBBASE NO. 1 MATERIALS

020256 L



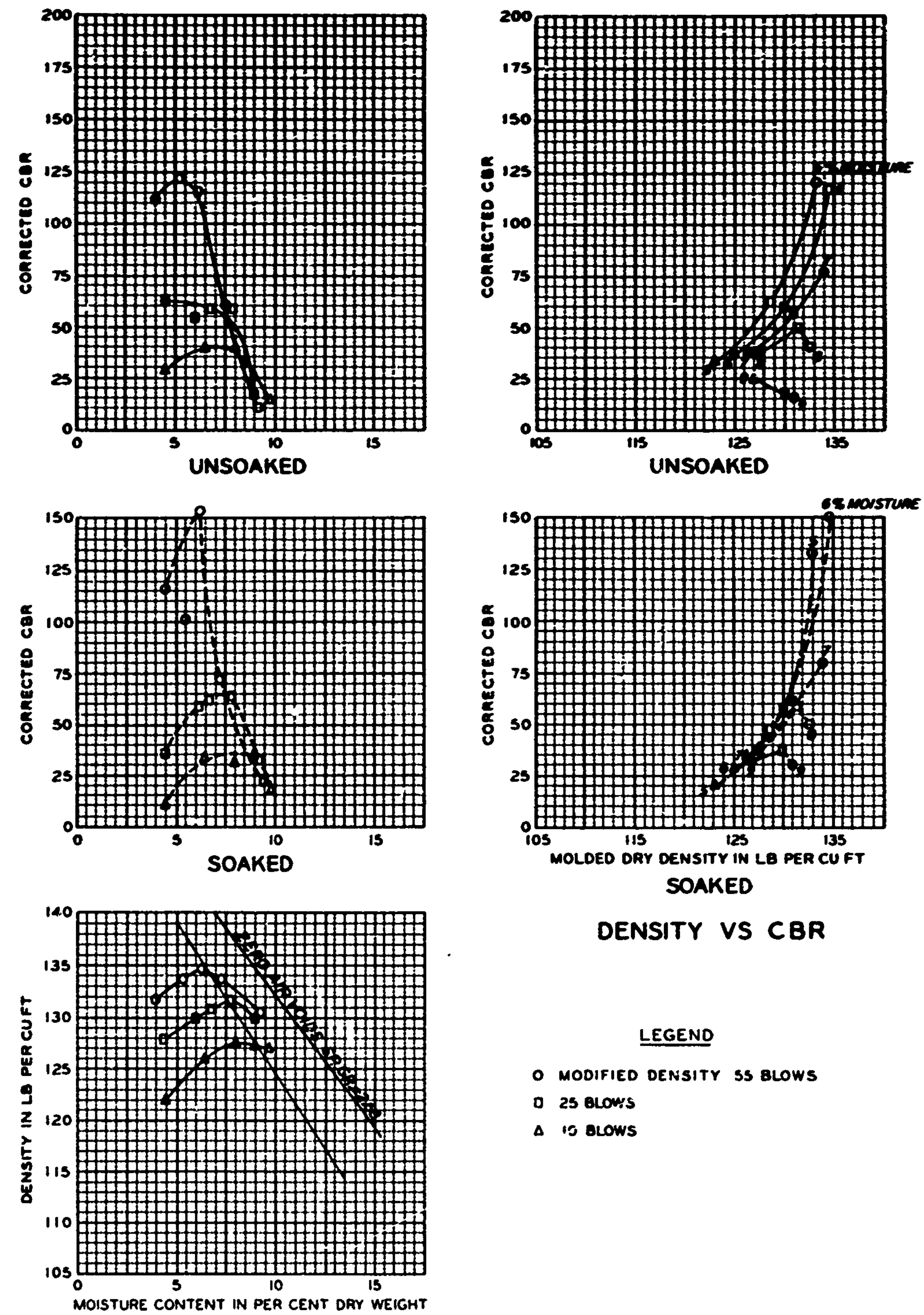
020256 M

GRADATIONS OF TYPICAL SUBBASE NO. 2 MATERIALS



GRADATIONS OF TYPICAL SUBGRADE MATERIALS

020256 N



MOLDING MOISTURE CONTENT VS DENSITY AND CBR

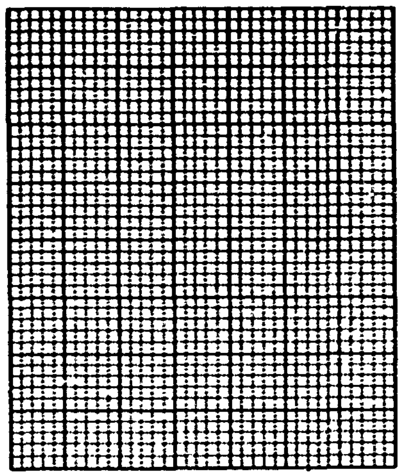
DENSITY VS CBR

LABORATORY CBR TEST LAD

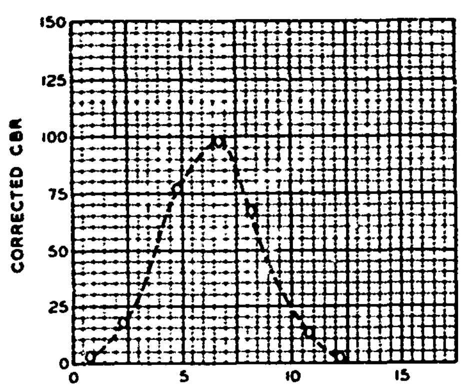
SUBBASE NO. 1 - SM

TT-1

020256P



UNSOAKED



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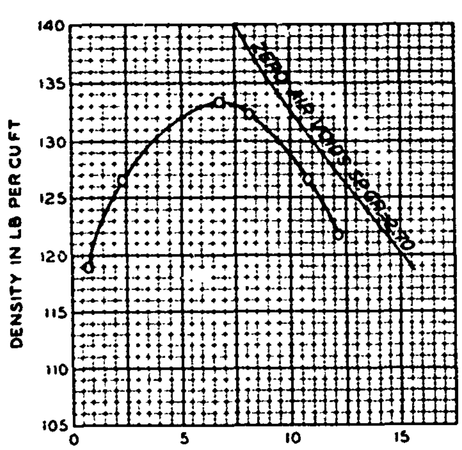
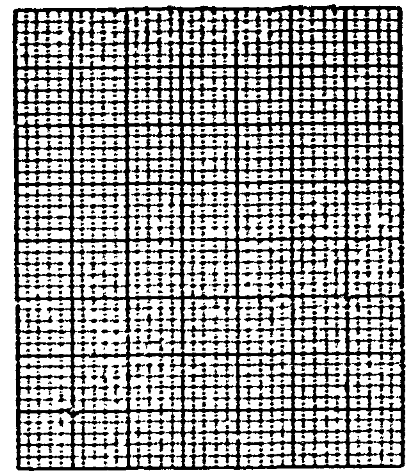
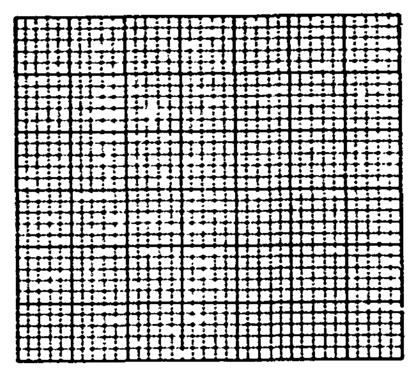


MOLDING MOISTURE CONTENT VS DENSITY AND CBR



UNSOAKED



SOAKED

DENSITY VS CBR

LEGEND

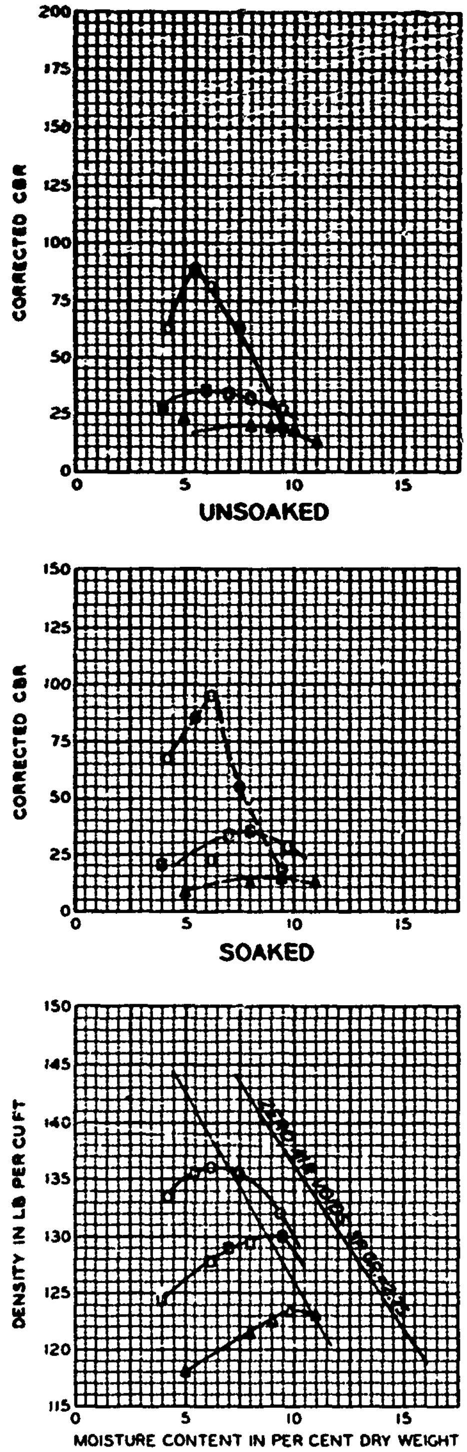
O MODIFIED DENSITY 55 BLOWS

LABORATORY CBR TEST WES

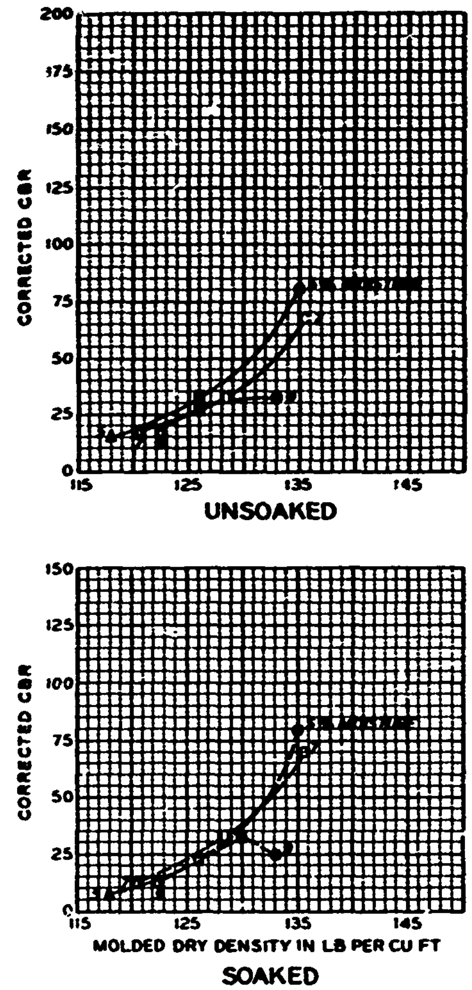
SUBBASE NO. 1 - SM

TP-1

020256Q



MOLDING MOISTURE CONTENT VS DENSITY AND CBR



DENSITY VS CBR

LEGEND

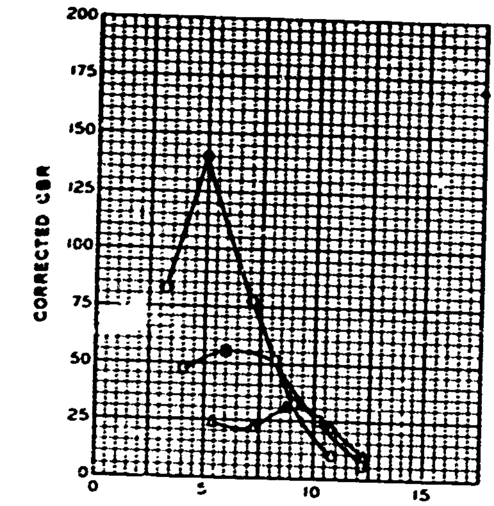
- O MODIFIED DENSITY 55 BLOWS
- □ 25 BLOWS
- Δ 10 BLOWS

LABORATORY CBR TEST LAD

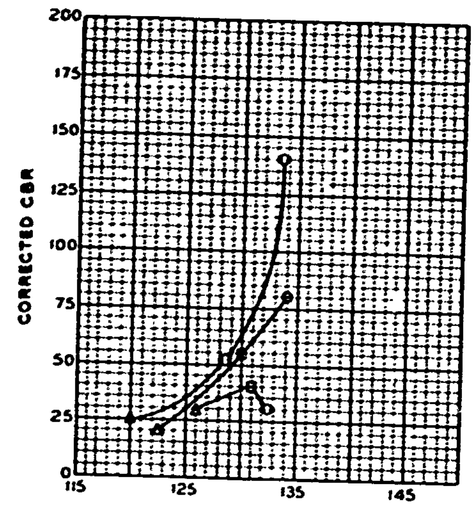
SUBBASE NO. 2 - SM

TT-2

020256R



UNSOAKED



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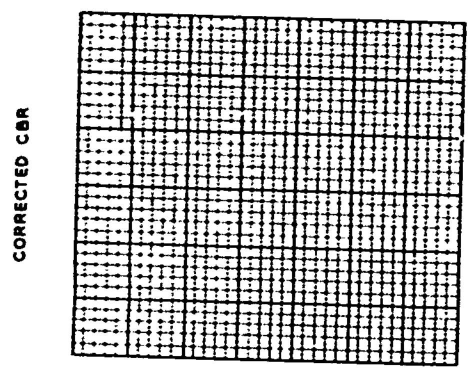
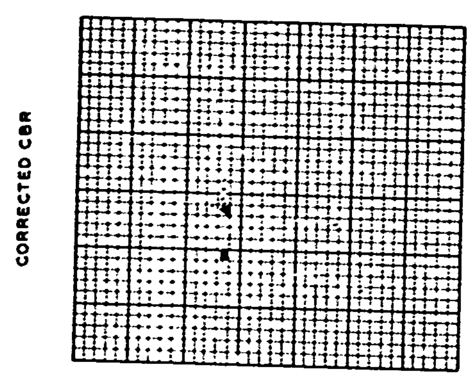


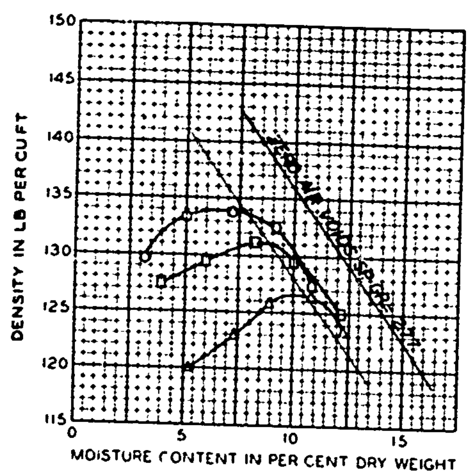
SOAKED



MOLDED DRY DENSITY IN LB PER CU FT

SOAKED

DENSITY VS CBR



MOLDING MOISTURE CONTENT VS DENSITY AND CBR

LEGEND

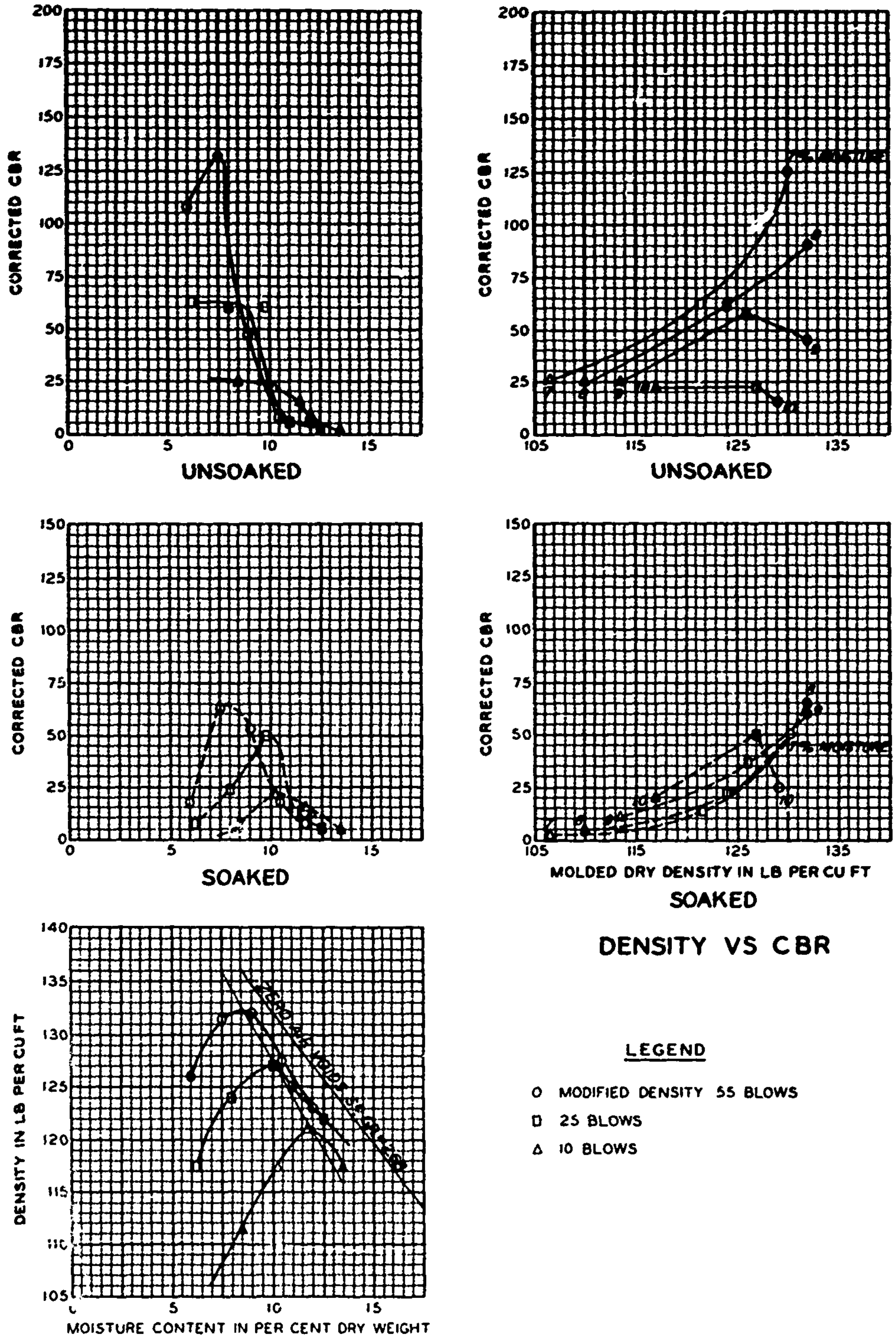
- O MODIFIED DENSITY 55 BLOWS
- □ 26 BLOWS
- Δ 12 BLOWS

LABORATORY CBR TEST WES

SUBBASE NO. 2 - SM

TP-1

020256S



DENSITY VS CBR

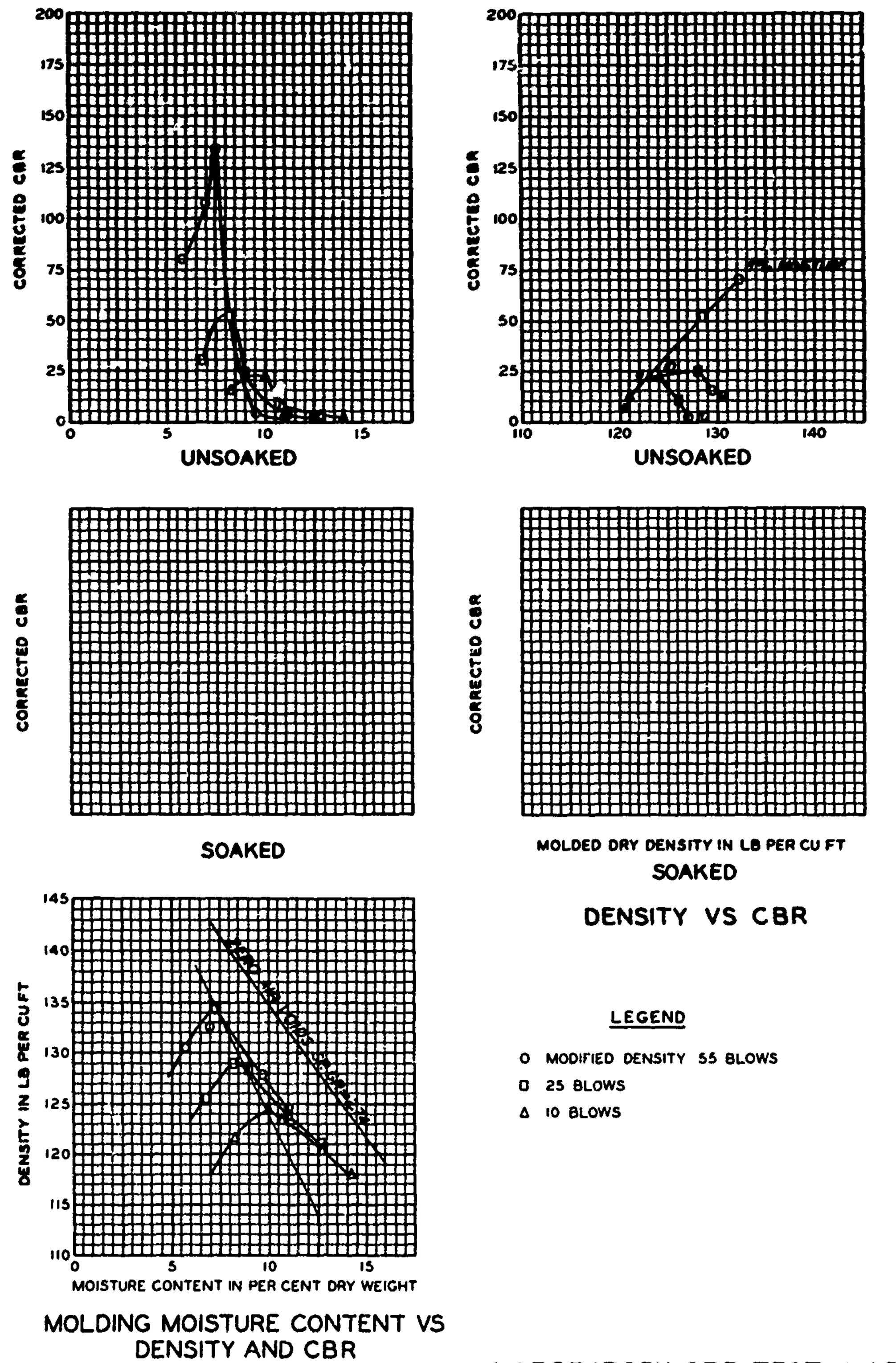
MOLDING MOISTURE CONTENT VS DENSITY AND CBR

LABORATORY CBR TEST LAD

SUBGRADE - CL

TT-1

020256T

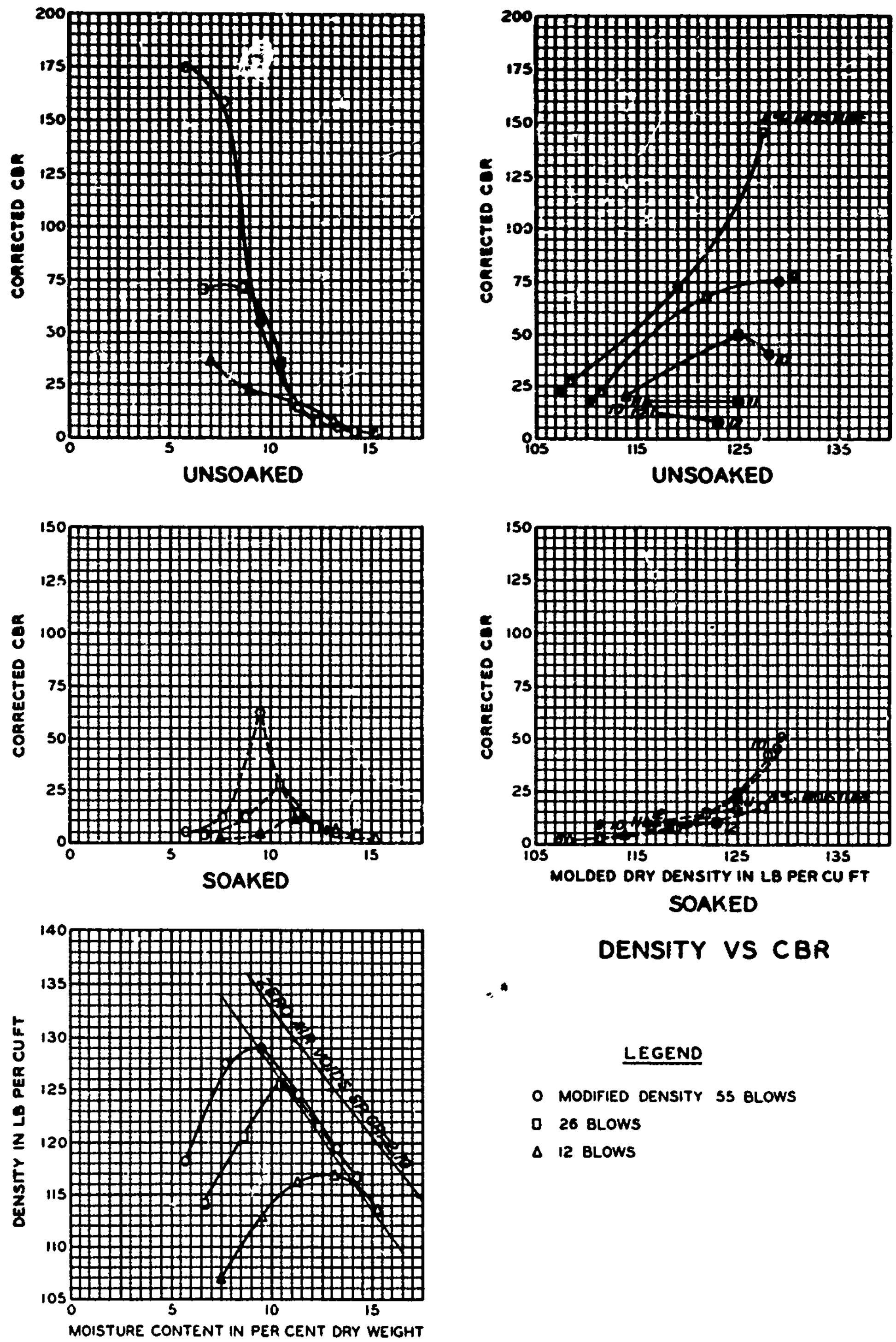


LABORATORY CBR TEST LAD

SUBGRADE - ML

DESIGN TEST HOLE 16 (1951)

020256 U



MOLDING MOISTURE CONTENT VS DENSITY AND CBR

LABORATORY CBR TEST WES

SUBGRADE - CL

TP-1

?20256 V

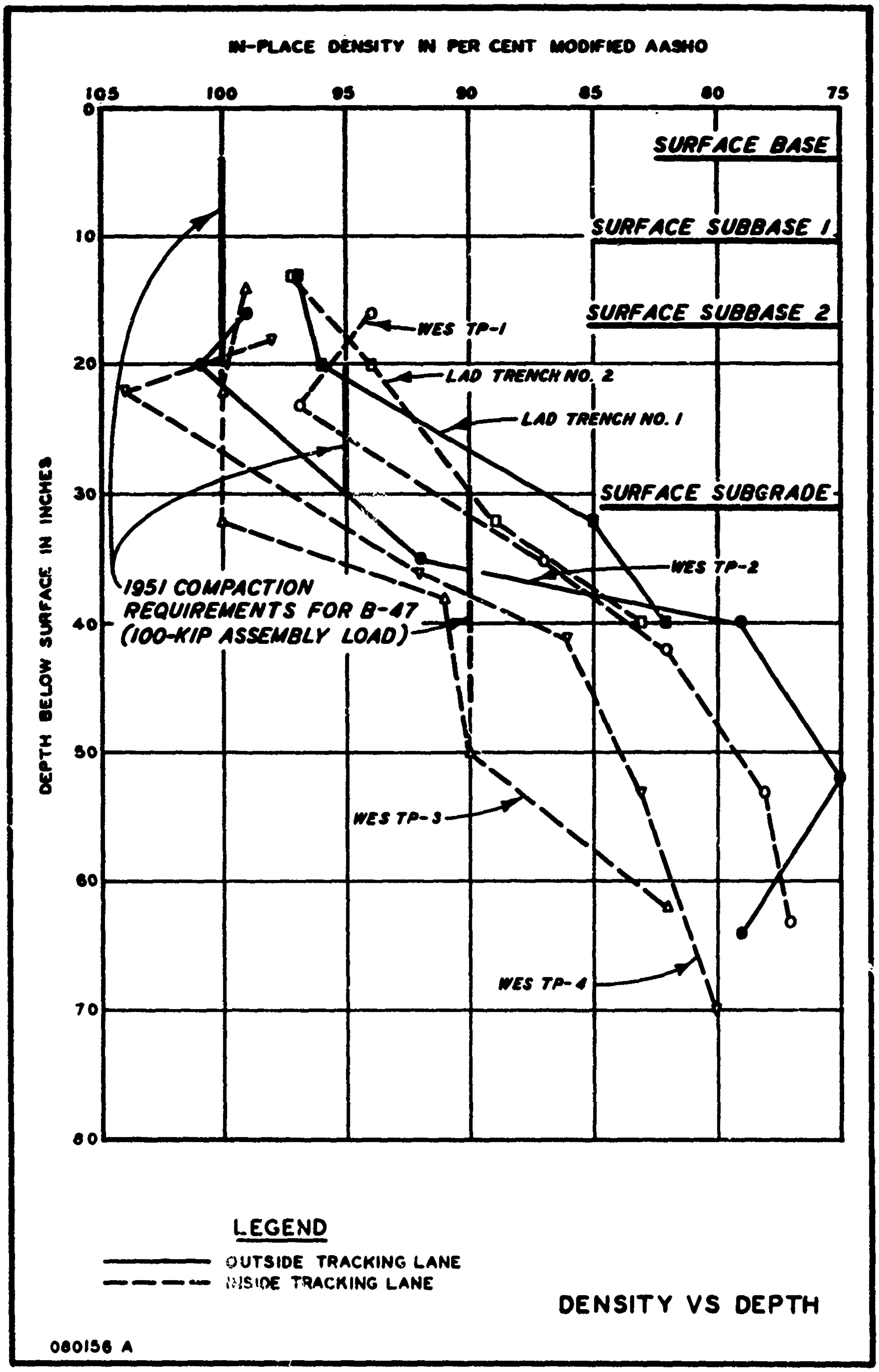

IN-PLACE DENSITY IN PER CENT MODIFIED AASHO
105
100
95
90
85
80
75
0
10
20
30
40
50
60
70
80
DEPTH BELOW SURFACE IN INCHES
SURFACE BASE
SURFACE SUBBASE 1
SURFACE SUBBASE 2
SURFACE SUBGRADE
WES TP-1
LAD TRENCH NO. 2
LAD TRENCH NO. 1
WES TP-2
1951 COMPACTION REQUIREMENTS FOR B-47 (100-KIP ASSEMBLY LOAD)
WES TP-3
WES TP-4
LEGEND
OUTSIDE TRACKING LANE
INSIDE TRACKING LANE
DENSITY VS DEPTH
080156 A

PLATE 18