MOISTURE CONDITIONS UNDER FLEXIBLE AIRFIELD PAVEMENTS

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Synopsis

One of the major problems of designing flexible pavements is the preparation of laboratory samples to meet a future prototype condition. This requires primarily the adjustment of the laboratory-prepared samples to an anticipated maximum expected to occur at some future time, although it is recognized that factors other than moisture content will influence the future strength of the soil.

The problem of preparing samples in the laboratory to meet a future anticipated maximum moisture condition has been difficult because the moisture conditions that occur under pavements have not been known. The Corps of Engineers recognized this lack of information and in 1944 established a study of field moisture content under flexible airfield pavements. Sites were selected in New Mexico, Texas, and the Mississippi Valley which are representative of rainfall regions of less than 15 in., 15 to 35 in., and more than 35 in., respectively. Moisture readings have been made by direct sampling.

In addition to the moisture observations at the selected locations, a considerable volume of information is available on the asphalt stability test section at the Waterways Experiment Station to show the changes that occur in the subgrade over a period of time. Also, data from this test section show that a condition similar to saturation can be produced by compaction under traffic when the densification reaches the point where the voids are practically filled with water.

One of the major problems encountered by the Corps of Engineers in the CBR design procedure has been the development of laboratory procedures for preparing samples to meet a future prototype condition. Primarily, this requires the adjustment of the soil sample to a moisture content anticipated as maximum at some future time. It is recognized that other factors, such as thixotropic set, molding moisture content, method of compaction, and density changes, also will influence the future strength of a soil, but the moisture that is accumulated in many cases has a very great influence.

At present the laboratory specimens for CBR design tests are soaked for a period of 4 days prior to testing. If it could be established that the soil moisture content at a given location always would be less than that obtained in the 4-day soaking procedure, a substantial saving could be made in the thickness of base and pavement. The accumulation of moisture under pavements, therefore, is a point of vital interest.

The Corps of Engineers has long recognized this lack of positive information, and in 1944 established a study of the accumulation of moisture under airfield pavements. Sites were selected in New Mexico, Texas, and the Mississippi Valley in rainfall regions of less than 15, 15 to 35, and more than 35 in. annual precipitation. The following table lists the sites and respective rainfall regions:

Site	Nearest Town	Rainfall Region
Kirtland Air Force Base	Albuquerque, N. Mex.	Less than 15 in.
Santa Fe Municipal Airport	Santa Fe, N. Mex.	"
Clovis Air Force Base	Clovis, N. Mex.	"
Lubbock Municipal Airport	Lubbock, Texas	15 to 35 in.
Goodfellow Air Force Base	San Angelo, Texas	"
Bergstrom Air Force Base	Austin, Texas	"
Keesler Air Force Base	Biloxi, Mississippi	More than 35 in.
Memphis Municipal Airport	Memphis, Tennessee	"

The sites in each region also were selected to give a range of subgrade materials, and test locations were designated at the center of the runway, between the edge and the center, at the edge, and out on the shoulder at each site. In addition, tests were to be made on locations near an artificial crack cut in the pavement. Figure 1 is a typical plan of the test locations. Bouyoucos moisture cells were installed at the three fields in the low rainfall zone, which were the first fields tested. Moisture values obtained by direct sampling as a check showed that the moisture blocks were not giving satisfactory values and subsequently direct sampling has been used at all sites. All moisture values presented in this paper were determined by direct sampling.

Initial observations were made at the fields in New Mexico in October 1945, and subsequent samplings were accomplished in January, September, and December 1946; February and June 1947; November 1948; November 1949; and April 1950. Initial observations were made at the fields in Texas and in the Mississippi Valley in June 1947, with subsequent samplings being accomplished in November 1948, November 1949, and April 1950. In-place density and CBR values were obtained at the time of initial sampling in addition to the moisture contents, and beginning in November 1949, these values have been obtained at each sampling. The sampling was not as frequent as desired because of lack of funds. These circumstances and the relatively short period covered by the readings limit the information that can be obtained from the investigation at the present time. Tables 1 through 8 present the moisture contents, densities, CBR values, and percent saturation obtained to date, together with information on the base and subgrade materials. The data obtained at Kirtland, Santa Fe, and Clovis Fields (Tables 1, 2, and 3) in October 1945 were procured in connection with the installation of some moisture cells, and the testing program differed slightly from that of the remaining fields. Because of this difference in testing program, data are not available for some of the test locations at these three fields. Also, the data for these three fields for 1946 and 1947, which appear to be incomplete, are merely check moisture contents for a few of the moisture cells. CBR and density values were not obtained near the crack during the initial testing at any of the fields. The artificial crack at Goodfellow Air Force Base was sealed in early 1949 and has not been reopened. The crack at Bergstrom Air Force Base was sealed in 1948 and reopened in April 1949. No testing was done at either of the fields while the cracks were closed.

The sampling is performed in holes in a pattern of concentric circles around the point at which the moisture content is desired. Four holes (one in each quadrant) are tested at each sampling. Density determinations are made on the base course by the water-balloon method, and on the top of the subgrade by a drive-cylinder method. In-place CBR determinations are made on the base course and top of the subgrade following usual procedures, except that the determinations are made in 4-in. diameter holes and no surcharge weights are used. Moisture samples are obtained from the base course, top of the subgrade, and at a depth of about 18 in. from the surface of the subgrade. Atterberg limits and classification tests are performed in the laboratory on selected samples from each field.

A description of the pavement at each field and a brief résumé of the behavior and maintenance at each field are given in the following paragraphs. The location numbers referred to throughout the discussions are the standard locations shown on Figure 1. Location 1 is the center line of the pavement, location 2 near the quarter-point, location 3 near the pavement edge, location 4 in the unpaved shoulder, and locations 5 through 13 near the artificial crack.

At Kirtland Air Force Base (Table 1) the pavement consists of 2 in. of asphalt wearing course, 8.5-in. of sand-caliche base course which classifies as GM, and a sand subgrade which classifies as SM. This pavement has received considerable intermittent traffic from heavy planes and has remained in good condition since its construction.

The pavement at the Santa Fe Airport (Table 2) is composed of 2.5-in. of asphalt wearing course, 8.5-in. of caliche-gravel base course which classifies as GC, and a clay subgrade which classifies as CL. The pavement has been sealed but cracks have continued to appear. This field has received very little traffic since 1945.

The pavement at Clovis Air Force Base (Table 3) is composed of 1.5-in. of asphalt wearing course, 12 in. of caliche base course which classifies as GC, and a lean clay subgrade which classifies as CL. The wearing course was in good condition until late 1948 or early 1949 when cracks began to appear. No patching or sealing has been done since the cracking began, so the study of this field covers a series of conditions ranging from satisfactory to complete failure. The wearing course was cracked, apparently from the almost total lack of traffic since its construction, and this allowed sufficient moisture to enter the base course and subgrade to produce a failing condition in each.

The pavement at the Lubbock Municipal Airport (Table 4) consists of 1.5 in. of asphalt wearing course, and the base course consists of 7 in. of caliche which classifies as GC. The subgrade is a sand which classifies as SC. The pavement has been in fair condition during the entire period of study. This pavement has received considerable traffic from medium to heavy planes.

At Goodfellow Air Force Base (Table 5) the pavement is composed of 2 in. of asphalt wearing course, 14 in. of caliche base course which classifies as GC, and a fat clay subgrade which classifies as CH. Some cracking had occurred on the field prior to the initiation of the study but this had been sealed adequately. The entire area was sealed early in 1949, and the artificial crack was covered after only two samplings had been performed. It has not been reopened to date. This pavement has received considerable traffic from light-weight planes.

The pavement at Bergstrom Air Force Base (Table 6) is composed of 2 in. of asphalt wearing course, 9 in. of crushed stone base course which classifies as GW, 6 in. of sand subbase which classifies as SC, and a fat clay subgrade which classifies as CH. Traffic on the pavement has consisted of a few cycles of medium-weight planes and the pavement has been maintained in good condition.

The pavement at Keesler Field (Table 7) is composed of 2 in. of asphalt wearing course, 9 in. of shell base course material which classifies as GW, and a sand subgrade which classifies as SW. The pavement has been in good condition during the study. Traffic has consisted of a relatively large number of medium- to heavy-weight planes.

The municipal airport at Memphis (Table 8) is paved with 3 in. of asphalt wearing course on a clay-gravel base course 9 in. thick which classifies as GC, and a lean clay subgrade which classifies as CL. The pavement has been in fair condition during the study with some cracking occurring from time to time. Traffic has been composed of a moderate number of medium-weight planes.

While it is recognized that the observations recorded in Tables 1 through 8 have not extended as long as desired, it is believed that the following trends are indicated:

(1) Edge versus center. Gravel base courses with plastic fines, GC, and clay subgrades, CL and CH, generally showed higher values of moisture content and percent saturation at the edge than at the center. The base course at Santa Fe (Table 2) is an example. Exceptions occurred, for example the subgrade at Clovis (Table 3), but the exceptions were cases where no trend was exhibited rather than the reverse of the trend described above. The other base courses and subgrades generally do not show consistent trends, although in a number of instances, e.g., the subgrade at Kirtland (Table 1), the moisture content at the edge is lower than in the center.

(2) Pavement versus shoulder. A comparison of conditions in the shoulder (location 4) with those under the pavement shows that, regardless of rainfall or type of material, the maximum moisture content and percent saturation were generally higher under the pavement than in the shoulder. Exceptions occurred, as for example at Memphis (Table 8).

(3) Crack. It was found that the CBR in the base course and subgrade generally increased with distance from the crack, while the moisture content generally decreased, although exceptions did occur.

(4) Time effects. A study of the changes in condition with time reveals that there was a seasonal variation in moisture content in both the base and subgrade at most of the fields, except in the sand subgrade at Keesler Field (Table 7) where no appreciable changes have occurred.

Figures 2 and 3 show frequency distribution curves (in percent of total observations) of the moisture contents and degrees of saturation for the base courses and subgrades at each of the fields. The plots are grouped according to type of material and arranged in order of increasing rainfall from left to right. It will be noted that a number of the plots are bimodal (having two peaks); the base material at Kirtland, Figure 2, is an example. The occurrence of two peaks in a frequency distribution curve usually means that the data represent two separate sets of influencing conditions. In the case of Clovis, it was determined that the two peaks represented conditions "before failure" and "after failure;" therefore, separate plots have been made for this field. It is believed that bimodal curves in the other cases are related to the seasonal variations as a trend in this direction occurred, but the sampling has not been sufficiently frequent to establish this definitely.

Table 9 is a summary of the moisture content and percent saturation plotted in Figures 2 and 3. The moisture contents and percent saturation were read from the plots at the point where the curve crosses the 20-percent frequency line on the high side of the peak. As an example, the value for the percent saturation of the Santa Fe base course material at the 20-percent frequency line is 78. Where the curve crosses the 20-percent frequency line more than once on the high side of the peak, the highest moisture content or percent saturation value was used. Moisture content and percent saturation values of 80 percent of the total number of observations are less than those given by the 20-percent frequency line. The 20-percent value is considered more satisfactory than a numerical average which would be unconservative. In the subsequent discussion of the data contained in Table 9, references to moisture content and percent saturation are to the 20-percent values.

It has been found from laboratory studies that the degree of saturation obtained in the 4-day soaking period ranges from about 75 to 95 percent, depending on soil type, molding moisture content, and other variables.

It is seen from Table 9 that there is little or no direct correlation between moisture content and rainfall for any of the materials. An attempt was made to determine a correlation based on the moisture as a percentage of the plastic limit, but it was not satisfactory.

There is a general trend for the degree of saturation to vary according to rainfall. In the GC base course materials, the percentage is lowest in the low rainfall zone and highest in the high rainfall zone. The degree of saturation was within the range of the values predicted by the laboratory-soaked procedures in the medium and high rainfall zones but was near the lower limit or slightly below the laboratory range in the low rainfall zone, if the failure condition at Clovis is excepted. The GM base course material was tested only in the low rainfall zone; the degree of saturation was about the same as for the GC base course material in the low rainfall zone. The degree of saturation in the GW base material was below the laboratory range in both the medium and high rainfall zones which were the only two zones tested.

The CH subgrade was tested only in the medium rainfall zone and the degree of saturation was at the upper limit of the range of values indicated by the 4-day laboratory soaking procedure. The CL subgrade materials were tested in the low and high rainfall zones and if the failure condition at Clovis is excepted, a fair correlation with rainfall exists. The degree of saturation in the low rainfall zone was at the lower limit of or below the laboratory range, whereas in the high rainfall zone it was near the upper limit of this range. The SC, SM, and SW subgrade materials were tested in only one rainfall zone each and no correlation with rainfall could be made. It is noted that the degree of saturation varied with plasticity index since the SW material was nonplastic, the SM material had a plasticity index of 5 percent, the SC subgrade had a plasticity index of 14 percent. The degree of saturation in the SC subgrade was well within the range of the laboratory-soaked values. In the SM material which was tested in the low rainfall zone, the degree of saturation was below the laboratory range, and in the SW subgrade it was far below the range of the laboratory-soaked values even though it occurred in the high rainfall zone.

In the course of several years of study, the Waterways Experiment Station has collected a large amount of information about the soil native to the station grounds when used as a subgrade. Most of the information was collected in connection with an asphalt stability test section. This test section is described in detail in Waterways Experiment Station Technical Memorandum No. 3-254, "Investigation of the Design and Control of Asphalt Paving Mixtures," May 1948. The subgrade is a lean clay (formerly designated silty clay before the adoption of the Corps of Engineers' classification system) classified as ML to CL by the Corps of Engineers' classification. Figure 4 shows the results of the laboratory design CBR tests conducted during the design of the test section. According to the Corps of Engineers' criteria, an airfield pavement on this subgrade would be designed on the basis of samples compacted to 95 percent of modified AASHO density at optimum moisture content. These values are 108 lb. per cu. ft. and 15 percent, respectively. Samples prepared to conform to these conditions absorbed, during the 4-day soaking procedure, additional water until a moisture content of about 19.7 percent was reached. This represented a saturation of about 97 percent. The CBR of samples prepared at 108 lb. per cu. ft. and 15 percent moisture and subjected to the 4-day soaking test was about 18 percent, as indicated by either the center or right plot on Figure 4. In actual construction, however, a range of moisture and density values would occur. In the particular case of the subgrade in question, tests made in the fall of 1944 immediately after construction at 15 locations (three or more tests were made at each location) showed an average moisture content of 16.1 percent, a density of 106 lb. per cu. ft. and a percent saturation of 75. A range of about 3 percent in moisture content and about 5 lb. per cu. ft. in density occurred. The laboratory-soaked CBR value for all the combinations of moisture and density conditions at the 15 locations ranged between 10 and 20 percent, and the laboratory-soaked CBR values for the average (16.1 percent moisture and 106 lb. per cu. ft. density) was 15 percent. The value to use in design would be a matter of judgment. If the designer was familiar with the soil and sure that construction would be adequate, the average probably would be the best design value. Under less favorable circumstances, the designer might lean toward a lower figure such as the 20-percent value. The actual design of the asphalt stability test section was based on a subgrade CBR of 20 percent, because it was considered that traffic testing would be completed before the subgrade accumulated any appreciable amount of moisture and, if anything, the subgrade would tend to increase in strength as a result of the consolidating effects of traffic.

To continue with the history of the subgrade conditions, the in-place CBR of the subgrade at the 15 locations tested in the fall of 1944 was 28 percent, well above the range for the laboratory-soaked values. In the summers of 1945 and 1946, three test tracks of the test section were subjected, respectively, to 1500 coverages with a 37,000-lb. single-wheel load with a 110-psi. airplane tire, to 1500 coverages of a 60,000 -lb. dual-wheel load also equipped with airplane tires inflated to 110 psi. and 3500 coverages with a 15,000-lb. wheel load equipped with earth-mover tires inflated to 50 psi. The blocky treads on the earth-mover tires resulted in a net contact pressure of 106 psi. After this traffic moisture contents averaged 16.6 percent, the average density showed an increase of 1 lb. per cu. ft., and the CBR averaged 32 percent. The average percent saturation was 80. Between 1946 and 1949 the test section was subjected to incidental traffic of cars, trucks, and rubber-tired construction equipment. Maintenance of drainage has been questionable as the prefabricated bituminous surfacing (PBS) over the earth island between the two tracks of the test section deteriorated and it is probable that water entered the test section from the island as well as at several locations where patches around test pits failed. Also, drainage along one side of the test strip was blocked during one winter by soil piled along the shoulder. This undoubtedly resulted in ponding of water at certain locations on the subgrade. Maintenance at an airfield normally would be better; therefore, the conditions that existed in this test section are considered to represent an extreme case. In the summer of 1949 in-place CBR tests were made in connection with additional traffic which is described later. Tests were made inside the traffic lane (1949) prior to the application of traffic. Tests also were made in some locations adjacent to the traffic lane during and after the completion of traffic to obtain the "before-traffic" condition. These latter values are noted in the following table, since they might have been influenced slightly by the 12,000-lb. load on the outrigger wheels of the test cart.

Before Traffic - 1949 Tests

Section	Item No.	In-place CBR	Moisture	Density	Percent Saturation
2A-1-2	53*	8	17.1	-	-
1C-3-3	27*	10	17.3	-	-
1A-1-2	2	15	18.2	-	-
1A-3-1	7*	16	17.5	-	-
2C-1-2	35	19	18.4	105.8	85
1C-1-1	19	19	17.2	-	-
	Average	14	17.6		
1B-2-1	13*	23	16.8	-	-
4C-1-1	100	24	16.2	-	-
1A-3-3	9*	24	16.4	-	-
2A-2-2	50	26	16.5	-	-
1A-1-1	1*	32	16.4	-	-
4A-1-3	84	32	16.0	107.4	77
	Average	27	16.4		

*Adjacent to traffic lane

It can be seen that in the first six cases listed in the preceding table the moisture content has shown a definite increase, averaging 1.0 percent above the value at the end of traffic in 1946, and the CBR values are within the range of those predicted by the laboratory tests on soaked specimens. The average moisture content in the other six cases showed a slight decrease between 1946 and 1949, and the CBR values remained above the range of the laboratory tests. Density values are limited, but they are in general agreement with the values determined at the end of traffic in 1946.

The conditions cited above reflect the conditions that occur through absorption of moisture even though quantitatively the amounts were comparatively small. Even more serious conditions can develop when the absorption of moisture is accompanied by densification, as illustrated in the following paragraphs.

The additional traffic mentioned in an earlier paragraph was made with a twin-tandem whee assembly loaded to 120,000 lb. and with a single wheel loaded to 30,000 lb. In both cases the tires were inflated to 200 psi. These loads were more severe than any of the previous loads applied to the test section, as evidenced by rapid failures which developed in from 30 to 300 coverages. In addition to the CBR tests made to determine the before-traffic conditions as described above, tests also were made to determine the after-traffic conditions. The results are tabulated on the following page.

The moisture contents of the after-traffic data fall into two groups similar to the before-traffic data, with the first group showing an average of 17.5 percent, and the second group showing an average of 15.8 percent. These percentages are close to the average of the before-traffic data. The CBR values in the first group averaged 10 percent and in the second group 26 percent.

A study of the density values in the table shown indicates that a material increase in density occurred in the subgrade. At the lower moisture contents, an increase in CBR also occurred, but at the higher moisture contents, a severe reduction occurred and CBR values as low as 5 and 6 percent were measured. This behavior is illustrated in Figure 5 which is a plot of CBR versus moisture content for the tests on the subgrade. Tests made prior to the application of any traffic are shown as open circles, and tests made in the traffic path after traffic had been applied are shown as solid circles. The before-traffic conditions obtained outside the traffic path are shown as circles with X's. All points are plotted at the average moisture content for all tests at the same location. Points for tests with the 30,000-lb., single-wheel are identified by an S preceding the item number; all other points are for tests with the 120,000-lb. twin-tandem load.

After Traffic - 1949 Tests

Section	Item No.	CBR	Moisture	Density	Percent Saturation
1A-2-1	4	5	18.2	-	-
2A-1-2	53*	6	17.6	109.3	90
2A-2-1	49*	7	17.9	110.6	94
2A-2-2	50*	7	17.1	109.6	88
1C-3-3	27	10	17.8	-	-
1C-3-2	26	12	17.4	111.5	94
1A-3-1	7	12	17.4	-	-
2A-3-2	47*	14	17.0	111.8	93
1B-2-1	13	19	17.0	-	-
	Average	10	17.5		
1A-3-3	9*	19	16.3	113.0	92
1A-3-3	9	20	16.0	-	-
1A-1-1	1	30	15.8	-	-
21A-3-1	204	35	14.7	-	-
	Average	26	15.8		

* Single wheel

Fairly good correlation of CBR and moisture occurs for both the before- and after-traffic data. A dashed curve is shown representing the best average curve for the before-traffic data, and a solid curve is shown for the after-traffic data. In drawing the curve for the before-traffic data, the tests made outside the traffic lane have been used to some extent, even though the data were influenced slightly by the outrigger wheels. Also shown on the plate are two curves representing laboratory test data which were taken from Figure 4. The portions of the curves beyond a moisture content of about 17.2 percent are extrapolated.

The table below summarizes the history of the subgrade conditions in the asphalt-stability-test section. The values for percent saturation in the 1949 measurements are based on the over-all average density and the indicated moisture content.

Conditions	CBR	Moisture	Density	Percent Sat.
Laboratory design, as-molded condition	40	15.0	108	74
Laboratory design, after soaking	18	19.7	108	97
After construction, 1944	28	16.1	106	75
After traffic, 1946	32	16.6	107	80
Before traffic, 1949, where moisture increased	14	17.6	107	84
Before traffic, 1949, where no moisture increase occurred	27	16.4	107	79
After traffic, 1949, where moisture increased	10	17.5	111	93
After traffic, 1949, where no moisture increase occurred	26	15.8	111	84

It is believed that the CBR-moisture relationships exhibited in this test section are entirely valid, and the following postulation is offered as explanation. The traffic with the 110-psi. tires in 1945 and 1946 caused an increase in CBR values from the as-constructed value of 28 percent to 32 percent. As previously described, the PBS blanket on the center island had deteriorated, the patches around old test pits and failed areas had opened up, and subgrade drainage had been restricted one winter thus allowing access and retention of water. This resulted in an average increase of about 1.0 percent in moisture content, which in turn resulted in a decrease of the CBR to 14 percent, which was about the design value based on laboratory-soaked specimens. During application of traffic with the high-pressure tires, the subgrade consolidated, and stresses were set up in the pore spaces in those areas with the higher moisture contents thus producing a lowering of the CBR value to an average of 10 percent (percent saturation of 93). Where the moisture contents were lower no stresses were set up in the pore spaces and the CBR remained about the same, averaging 26 percent (percent saturation of 84).

Conclusions

The data obtained to date from the locations included in the field moisture studies indicate the following trends in the relationship of the prototype to the soaked laboratory specimen:

(1) The percent saturation of plastic subgrades and base courses with plastic fines tends to vary with rainfall, the lowest values occurring in the low rainfall zone. Non-plastic materials or materials with low plasticity were not tested in enough zones to establish a trend.

(2) The degree of saturation of GC, GM, CH, CL, SC, and SM materials was within the range of values obtained by the 4-day laboratory soaking procedure in the high and medium rainfall zones but tended to be below the laboratory range in the low rainfall zone.

(3) The GW and SW materials showed degrees of saturation which were well below the laboratory-soaked range in both the medium and high rainfall zones (only zones tested).

(4) The degree of saturation and the CBR values that developed in the asphalt-stability-test section, in those sections which absorbed additional moisture, approximated those predicted by the 4-day soaking procedures.

(5) Where absorption of moisture is accompanied by densification from traffic producing high degrees of saturation, CBR values can occur which are well below those predicted by tests on samples subjected to the 4-day soaking test.

(6) From the results of the observations of moisture conditions at locations included in the field moisture studies and from the study of the test section at the Waterways Experiment Station, it is concluded that the moisture conditions and the resulting CBR values obtained to date generally have been slightly to moderately more favorable than those based on samples subjected to the 4-day soaking procedures. This does not take into consideration possible detrimental effects due to consolidation by traffic.

(7) Additional study is needed to predict with complete reliability where the conditions will be more favorable or less favorable than indicated by the laboratory-soaked value.

TABLE 1

KIRTLAND AIR FORCE BASE
SUMMARY OF TEST DATA

Material	Classification	LL	PL	PI	Sp. G.
Base	GM	18	14	4	2.61
Subgrade	SM	22	17	5	2.65

			October 1945				15 Jan 46	23 Sept 46	31 Dec 46	28 Feb 47	27 May 47	20 Nov 48	2 November 1949				16 April 1950			
Location	Course	Depth from Surface - In.	CBR	Dry Density Lb/Cu Ft	Moisture Content	Per Cent Saturation	Moisture Content	Moisture Content	Moisture Content	Moisture Content	Moisture Content	Moisture Content	CBR	Dry Density Lb/Cu Ft	Moisture Content	Per Cent Saturation	CBR	Dry Density Lb/Cu Ft	Moisture Content	Per Cent Saturation
1	Base	3	43	130.9	6.7	72	6.2	6.2	6.2	8.4	3.2	2.8	115	148.1	3.1	79	152	138.9	3.1	47
	Subgrade	11	28	116.6	11.0	68	9.6	10.5	10.6	11.1	9.6	8.6	48	-	8.8	-	53	122.6	9.3	68
	Subgrade	29	5	101.1	9.1	46	8.7	9.1	9.4	10.1	9.5	7.5	-	-	8.7	-	-	-	8.1	-
2	Base	3			3.7						3.2	2.7	108	144.3	3.9	80	155	143.7	2.2	44
	Subgrade	11			8.9						8.0	7.1	66	-	6.1	-	52	-	8.1	-
	Subgrade	29			6.9						8.5	7.4	-	-	8.1	-	-	-	7.6	-
3	Base	3	109	138.7	3.6	54					2.9	2.5	63	139.0	3.2	49	77	138.4	2.7	40
	Subgrade	11	11	113.6	7.2	42					9.2	6.8	61	-	6.2	-	50	-	7.5	-
	Subgrade	29	3	105.3	6.5	30					8.4	8.6	-	-	8.3	-	-	-	8.3	-
4	Subgrade	3	32	104.8	3.9	18		5.6	5.2	5.0	3.2	3.2	-	-	3.1	-			4.1	
	Subgrade	13	18	99.8	4.8	20		4.8	7.8	4.2	5.8	3.3	43	101.3	5.0	21			3.1	
	Subgrade	29	14	97.2	5.1	20		4.8	4.9	5.2	5.4	4.4	-	-	3.7	-			4.3	
5	Base	3			3.9		4.3	4.7			4.6	4.5	60	139.3	4.7	72	36	142.3	4.4	80
	Subgrade	13			7.0		8.8	9.7			9.8	9.0	30	108.7	9.4	49	33	-	10.8	-
	Subgrade	29			7.3		6.1	7.5			10.8	7.1	-	-	5.5	-	-	-	6.7	-
6	Base	3			3.4				9.5	3.7	3.8	4.4	28	126.6	3.9	35	41	137.7	5.4	77
	Subgrade	13			7.9				10.0	10.5	8.0	7.3	63	120.8	8.4	63	39	118.3	10.7	74
	Subgrade	29			6.9				9.8	10.1	9.6	7.5	-	-	6.8	-	-	-	9.2	-
7	Base	3			3.0						3.4	4.1	80	135.6	3.1	36	38	134.9	5.0	64
	Subgrade	13			8.2						8.8	7.9	43	115.4	8.3	53	27	120.8	11.3	84
	Subgrade	29			6.9						8.4	4.8	-	-	7.8	-	-	-	5.6	-
8	Base	3			3.0		4.3	4.7			4.7	5.0	43	141.4	5.1	89	26	147.5	6.1	-
	Subgrade	13			8.1		8.8	9.7			10.8	10.2	26	-	11.6	-	34	119.3	11.3	80
	Subgrade	29			6.2		6.1	7.5			11.8	15.4	-	-	9.7	-	-	-	7.3	-
9	Base	3			3.0				9.5	3.7	4.4	4.8	66	152.0	4.4	-	43	138.2	4.3	63
	Subgrade	13			8.1				10.0	10.5	10.2	9.0	36	120.4	9.9	60	34	119.0	9.8	69
	Subgrade	29			6.2				9.8	10.1	9.8	9.7	-	-	10.0	-	-	-	10.8	-
10	Base	3			3.0						4.6	4.5	106	153.6	4.5	-	74	137.8	5.4	77
	Subgrade	13			8.1						10.4	8.7	51	118.5	8.2	57	30	121.1	11.6	87
	Subgrade	29			6.2						8.7	8.0	-	-	8.9	-	-	-	8.4	-

TABLE 2

SANTA FE MUNICIPAL AIRPORT
SUMMARY OF TEST DATA

Material	Classification	LL	PL	PI	Sp. G.
Base	GC	29	17	12	2.63
Subgrade	CL	43	24	19	2.67

			20 October 1945				24 May 46	26 Sept 46	6 Jan 47	5 March 47	14 May 47	24 May 47	19 Nov 48	30 October 1949				12 April 1950			
Location	Course	Depth from Surface - In.	CBR	Dry Density Lb/Cu Ft	Moisture Content	Per Cent Saturation	Moisture Content	Moisture Content	Moisture Content	Moisture Content	Moisture Content	Moisture Content	Moisture Content	CBR	Dry Density Lb/Cu Ft	Moisture Content	Per Cent Saturation	CBR	Dry Density Lb/Cu Ft	Moisture Content	Per Cent Saturation
1	Base	4			5.0							4.2	4.1	80	115.4	4.0	25	158	138.1	3.4	48
	Subgrade	13			10.3							13.1	11.4	20	102.9	15.7	67	29	108.7	13.1	65
	Subgrade	29			13.0							12.6	13.9	-	-	11.3	-	-	-	15.8	-
2	Base	4	91	133.2	3.5	40	4.4					3.4	4.6	68	125.2	5.4	46	49	133.3	4.6	53
	Subgrade	13	28	86.9	14.5	42	11.0					10.8	13.5	19	94.8	16.5	59	26	96.4	15.8	59
	Subgrade	29	7	93.3	10.1	34	12.1					14.2	16.4	-	-	21.4	-	-	-	20.2	-
3	Base	4	38	128.6	3.9	37	4.2					4.6	5.1	27	137.5	6.9	92	24	136.0	5.8	73
	Subgrade	13	5	86.6	16.4	47	15.8					14.4	17.5	21	91.1	19.2	60	13	90.9	20.6	65
	Subgrade	29	4	84.8	14.2	39	15.4					13.6	13.2	-	-	20.6	-	-	-	20.7	-
4	Subgrade	4	5	87.8	15.4	46	18.2	21.8	12.4	15.6	17.3	17.4	-	-		12.8		-	-	11.2	-
	Subgrade	13	12	77.0	11.6	27	17.3	18.7	9.2	16.3	15.2	18.0	11.9	9		12.8		6	90.5	16.5	53
	Subgrade	29	29	91.5	7.8	26	16.3	14.0	10.7	13.4	12.1	17.2	13.3	-		14.8		-	-	16.3	-
5	Base	4			5.5							7.3	8.6	13	131.3	7.6	79	7	138.5	9.0	125
	Subgrade	13			14.0							20.5	16.8	2	109.6	16.0	83	5	109.5	17.2	85
	Subgrade	29			14.0							18.4	18.0	-	-	20.3	-	-	-	18.5	-
6	Base	4			3.8			5.8	6.5	7.0	7.1	6.8	8.7	9	127.3	7.6	68	9	128.5	8.1	75
	Subgrade	13			14.8			15.0	15.3	14.9	15.4	18.7	19.1	9	111.2	18.9	100	7	103.5	22.2	98
	Subgrade	29			14.4			15.8	14.7	14.9	16.0	18.3	18.8	-	-	24.9	-	-	-	23.1	-
7	Base	4			6.4							6.7	7.5	14	135.3	7.2	88	9	132.0	7.7	84
	Subgrade	13			14.1							13.9	14.8	8	119.9	14.7	100	8	113.2	17.1	98
	Subgrade	29			15.6							16.4	9.2	-	-	26.8	-	-	-	18.3	-
8	Base	4			5.5							7.4	8.3	11	130.6	8.2	83	3	136.1	8.2	100
	Subgrade	13			14.0							16.3	17.0	8	116.4	16.6	100	8	107.6	19.0	94
	Subgrade	29			14.0							18.2	15.6	-	-	17.9	-	-	-	18.2	-
9	Base	4			3.8			5.8	6.5	7.0	7.1	6.6	9.2	6	120.3	7.3	52	10	136.2	6.8	85
	Subgrade	13			14.8			15.0	15.3	14.9	15.4	15.4	16.4	7	116.5	16.2	100	8	-	21.2	-
	Subgrade	29			14.4			15.8	14.7	14.9	16.0	17.5	15.2	-	-	19.2	-	-	-	18.7	-
10	Base	4			6.4							7.5	7.7	8	130.2	7.4	74	7	127.4	7.8	70
	Subgrade	13			14.1							15.8	15.9	13	117.0	17.4	100	11	109.0	16.3	83
	Subgrade	29			15.6							16.4	20.3	-	-	19.0	-	-	-	19.9	-

TABLE 3

CLOVIS AIR FORCE BASE

SUMMARY OF TEST DATA

Material	Classification	LL	PL	PI	SP. G.
Base	GC	24	17	7	2.63
Subgrade	CL	29	13	16	2.65

Location	Course	Depth from Surface - In.	25 October 1945 CBR	25 October 1945 Dry Density Lb/Cu Ft	25 October 1945 Moisture Content	25 October 1945 Per Cent Saturation	25 Jan 46 Moisture Content	23 May 46 Moisture Content	3 Jan 47 Moisture Content	4 March 47 Moisture Content	13 May 47 Moisture Content	1 June 47 Moisture Content	28 Nov 48 Moisture Content	8 November 1949 CBR	8 November 1949 Dry Density Lb/Cu Ft	8 November 1949 Moisture Content	8 November 1949 Per Cent Saturation	8 April 1950 CBR	8 April 1950 Dry Density Lb/Cu Ft	8 April 1950 Moisture Content	8 April 1950 Per Cent Saturation
1	Base	3	42	117.5	10.4	69		9.8	10.5	11.9	13.2	8.6	10.8	24	120.0	12.1	86	32	123.9	10.6	87
	Subgrade	15	24	125.6	9.0	75		12.1	9.1	10.1	9.4	11.0	10.5	13	122.1	13.6	100	11	116.2	13.2	82
	Subgrade	32	6	99.5	9.6	38		10.5	11.9	10.2	11.2	12.2	11.3	-	-	12.8	-	-	-	12.7	-
2	Base	3			9.3		8.4					8.4	12.2	10	111.4	15.2	85	27	124.2	12.4	100
	Subgrade	15			12.2		12.0					12.7	11.4	9	118.7	13.0	88	14	117.2	13.5	87
	Subgrade	32			9.7		9.4					8.9	9.9	-	-	11.5	-	-	-	10.6	-
3	Base	3	96	120.5	8.5	68		12.3	10.9	14.2	15.6	11.2	12.0	8	117.5	15.5	100	18	110.3	13.4	72
	Subgrade	15	10	119.8	10.5	74		11.4	11.7	11.4	12.6	12.4	12.3	27	118.2	12.6	84	17	117.8	12.9	85
	Subgrade	32	2	101.7	7.9	33		8.5	10.2	8.8	11.9	9.6	9.8	-	-	12.0	-	-	-	11.7	-
4	Subgrade	3			11.4		13.4					12.1	7.9	-	-	12.2	-	-	-	6.8	-
	Subgrade	15			13.8		12.3					14.3	11.7	9	104.5	13.7	63	7	101.0	11.0	46
	Subgrade	32			10.9		11.7					14.5	12.1	-	-	13.1	-	-	-	11.1	-
5	Base	4			7.9							13.6	16.9	5	87.7	14.9	45	14	108.4	15.8	81
	Subgrade	16			11.7							14.6	13.3	13	121.2	14.5	100	13	118.6	13.5	93
	Subgrade	34			10.5							10.6	12.4	-	-	10.7	-	-	-	11.3	-
6	Base	4			9.5							12.6	15.0	4	117.6	16.9	100	7	119.9	16.1	-
	Subgrade	16			12.8							14.7	13.1	7	114.2	14.4	87	11	117.4	13.1	87
	Subgrade	34			10.0							10.2	11.9	-	-	11.0	-	-	-	11.2	-
7	Base	4			7.5							12.5	14.9	6	109.6	18.6	99	9	117.2	15.4	100
	Subgrade	16			11.0							13.3	13.9	8	117.4	13.4	89	16	119.5	13.4	96
	Subgrade	34			9.0							10.3	11.0	-	-	11.3	-	-	-	11.3	-
8	Base	4			7.9							13.5	13.9	4	106.7	16.3	79	12	115.2	15.2	94
	Subgrade	16			11.7							14.7	13.9	14	119.7	14.2	100	10	-	13.6	-
	Subgrade	34			10.5							10.7	10.8	-	-	12.4	-	-	-	-	-
9	Base	4			9.5							12.4	16.5	3	113.5	15.5	92	8	112.4	14.8	84
	Subgrade	16			12.8							14.1	13.7	16	-	14.0	-	12	121.0	13.9	100
	Subgrade	34			10.0							10.6	11.1	-	-	12.7	-	-	-	12.5	-
10	Base	4			7.5							13.6	16.6	2	124.4	15.6		6	115.4	16.6	100
	Subgrade	16			11.0							13.8	13.8	18	123.8	14.0		10	119.7	14.2	100
	Subgrade	34			9.0							10.0	10.7	-	-	12.1		-	-	11.6	-

TABLE 4

LUBBOCK MUNICIPAL AIRPORT
SUMMARY OF TEST DATA

Material	Classification	LL	PL	PI	Sp. G.
Base	GC	38	31	7	2.62
Subgrade	SC	27	13	14	2.66

Location	Course	Depth from Surface - In.	4 June 1947 CBR	4 June 1947 Dry Density Lb/Cu Ft	4 June 1947 Moisture Content	4 June 1947 Per Cent Saturation	24 November 1948 Moisture Content	12 November 1949 CBR	12 November 1949 Dry Density Lb/Cu Ft	12 November 1949 Moisture Content	12 November 1949 Per Cent Saturation	5 April 1950 CBR	5 April 1950 Dry Density Lb/Cu Ft	5 April 1950 Moisture Content	5 April 1950 Per Cent Saturation
1	Base	2	58	107.2	12.1	60	11.9	54	113.3	10.7	64	31	117.6	12.9	86
	Subgrade	8	17	111.7	13.2	72	11.1	18	115.5	11.6	70	21	115.9	11.9	78
	Subgrade	27	-	92.0	12.0	40	12.7	-	-	11.7	-	-	-	12.1	-
2	Base	2	64	108.0	13.5	69	12.6	51	115.9	11.3	72	33	119.3	11.1	78
	Subgrade	8	27	121.2	11.8	85	11.4	22	107.5	12.1	59	18	119.8	13.2	91
	Subgrade	27	-	94.8	12.5	45	12.0	-	-	12.6	-	-	-	12.1	-
3	Base	2	48	112.6	12.2	71	14.4	26	126.4	13.1	-	25	122.1	12.8	69
	Subgrade	8	20	119.8	13.2	68	12.4	17	114.5	11.8	71	11	118.8	13.8	93
	Subgrade	27	-	96.2	14.8	55	13.5	-	-	14.6	-	-	-	15.2	-
4	Subgrade	2		107.5	13.5	66	4.9	-	-	8.1	-	-		5.3	
	Subgrade	8		98.6	11.6	46	7.7	19	103.6	9.9	44	37		7.2	
	Subgrade	27		100.9	13.4	55	9.2	-	-	12.8	-	-		10.6	
5	Base	2			16.1		14.8	36	118.7	13.3	92	17	119.4	11.3	81
	Subgrade	8			11.9		11.6	19	-	12.3	-	17	112.3	12.8	72
	Subgrade	27			12.5		13.2	-	-	13.6	-	-	-	12.9	-
6	Base	2			12.8		15.1	60	135.5	9.1	-	32	105.3	13.2	62
	Subgrade	8			11.6		11.9	23	110.4	13.3	70	26	114.9	13.8	83
	Subgrade	27			12.2		-	-	-	13.7	-	-	-	14.1	-
7	Base	2			16.4		15.5	33	120.8	11.5	62	31	108.3	11.4	59
	Subgrade	8			11.9		11.8	32	110.3	11.8	62	21	109.2	13.5	69
	Subgrade	27			11.8		12.2	-	-	13.5	-	-	-	14.6	-
8	Base	2			14.6		12.0	46	111.2	13.3	74	57	115.6	12.1	77
	Subgrade	8			13.4		10.8	30	115.8	13.6	84	22	112.5	14.4	77
	Subgrade	27			15.0		14.0	-	-	13.8	-	-	-	15.2	-
9	Base	2			13.4		13.5	78	134.7	8.9		30	125.8	12.4	
	Subgrade	8			10.9		10.4	23	-	11.9		16	-	13.4	
	Subgrade	27			15.2		13.3	-	-	14.1		-	-	15.8	
10	Base	2			13.2		13.7	77	103.6	11.3	51	60	109.4	11.5	61
	Subgrade	8			12.1		11.2	35	119.4	12.0	82	19	-	12.5	-
	Subgrade	27			13.0		13.6	-	-	14.6	-	-	-	14.9	-
11	Base	2			12.1		12.2	50	114.8	10.3	65	52	109.2	10.1	53
	Subgrade	8			9.1		10.3	42	-	10.2	-	33	121.7	12.0	87
	Subgrade	27			13.4		12.0	-	-	13.3	-	-	-	12.0	-
12	Base	2			13.1		10.4	54	120.5	10.0	54	58		-	
	Subgrade	8			10.9		9.7	37	115.6	10.4	64	40		10.8	
	Subgrade	27			13.1		12.3	-	-	13.2	-	-		12.4	
13	Base	2			11.4		10.6	35	111.0	10.4	44	34	115.7	9.6	61
	Subgrade	8			8.7		10.8	18	117.5	11.4	73	24	-	11.1	-
	Subgrade	27			7.6		12.6	-	-	13.4	-	-	-	13.7	-

TABLE 5

GOODFELLOW AIR FORCE BASE
SUMMARY OF TEST DATA

Material	Classification	LL	PL	PI	Sp. G.
Base	GC	28	18	10	2.67
Subgrade	CH	51	21	30	2.69

Location	Course	Depth from Surface - In.	12 June 1947 CBR	12 June 1947 Dry Density Lb/Cu Ft	12 June 1947 Moisture Content	12 June 1947 Per Cent Saturation	24 November 1948 Moisture Content	16 November 1949 CBR	16 November 1949 Dry Density Lb/Cu Ft	16 November 1949 Moisture Content	16 November 1949 Per Cent Saturation	1 April 1950 CBR	1 April 1950 Dry Density Lb/Cu Ft	1 April 1950 Moisture Content	1 April 1950 Per Cent Saturation
1	Base	3	48	122.6	10.6	79	9.6	39	117.0	11.3	72	18	117.0	10.7	68
	Subgrade	17	21	100.3	22.9	81	20.4	19	104.3	22.6	99	14	-	22.8	-
	Subgrade	33	-	83.0	21.2	56	19.0	-	-	20.6	-	-	-	20.3	-
2	Base	3	54	122.6	11.9	89	10.9	42	125.7	12.1	100	25	114.4	11.7	69
	Subgrade	17	22	104.0	23.3	100	21.2	17	104.2	22.5	99	12	-	23.4	-
	Subgrade	33	-	88.7	20.7	62	20.2	-	-	20.7	-	-	-	21.7	-
3	Base	3	36	118.0	13.9	90	11.7	34	123.0	13.2	100	25	111.0	12.9	69
	Subgrade	17	25	100.6	22.6	90	21.6	17	102.2	24.1	100	15	-	24.3	-
	Subgrade	33	-	89.6	21.8	67	21.1	-	-	21.8	-	-	-	21.3	-
4	Subgrade	3		87.6	17.9	53	-	-		22.3		-		12.1	
	Subgrade	17		95.0	20.6	72	15.0	5		25.6		10		14.9	
	Subgrade	33		84.8	19.1	52	15.4	-		17.5		-		17.2	
5	Base	3			10.5		11.9								
	Subgrade	17			20.0		18.5								
	Subgrade	33			16.8		15.1								
6	Base	3			10.2		11.1								
	Subgrade	17			18.0		-								
	Subgrade	33			16.0		15.9								
7	Base	3			10.3		11.3								
	Subgrade	17			21.6		17.6								
	Subgrade	33			15.5		18.1								
8	Base	3			10.7		10.7								
	Subgrade	17			21.0		18.4								
	Subgrade	33			18.6		-								
9	Base	3			11.7		11.3								
	Subgrade	17			19.2		12.5								
	Subgrade	33			18.6		11.1								
10	Base	3			12.9		11.1								
	Subgrade	17			19.4		17.9								
	Subgrade	33			18.1		15.0								
11	Base	3			9.8		10.8								
	Subgrade	17			19.6		17.5								
	Subgrade	33			16.7		17.0								
12	Base	3			9.3		10.1								
	Subgrade	17			17.9		17.9								
	Subgrade	33			15.0		15.2								
13	Base	3			10.1		9.9								
	Subgrade	17			18.5		17.2								
	Subgrade	33			14.8		16.6								

NOTE: Crack sealed in early 1949 and never reopened.

TABLE 6

BERGSTROM AIR FORCE BASE
SUMMARY OF TEST DATA

Material	Classification	LL	PL	PI	Sp. G.
Base	GW	16	15	1	2.67
Subbase	SC	21	14	7	2.70
Subgrade	CH	50	23	27	2.73

			16 June 1947				28 November 1948	19 April 1949	19 November 1949				29 April 1950			
Location	Course	Depth from Surface - In.	CBR	Dry Density Lb/Cu Ft	Moisture Content	Per Cent Saturation	Moisture Content	Moisture Content	CBR	Dry Density Lb/Cu Ft	Moisture Content	Per Cent Saturation	CBR	Dry Density Lb/Cu Ft	Moisture Content	Per Cent Saturation
1	Base	3	100	134	4.2	47	3.9	5.0	128	140.0	5.2	73	83	136.3	4.9	60
	Subbase	12	26	111	9.1	48	8.2	9.7	48	-	8.8	-	-	-	-	-
	Subgrade	18	10	100	22.8	88	19.2	19.9	-	-	-	-	22	-	20.7	-
	Subgrade	34	-	125	15.7	-	14.3	14.4	-	-	16.8	-	-	-	12.5	-
2	Base	3	100	133	3.0	32	2.9	5.2	146	135.7	4.2	50	104	131.8	4.1	42
	Subbase	12	29	116	8.8	53	8.6	13.7	42	-	9.4	-	-	-	-	-
	Subgrade	18	19	109	19.5	96	23.6	25.7	-	-	-	-	26	-	32.0	-
	Subgrade	34	-	101	28.3	-	25.2	26.4	-	-	25.4	-	-	-	27.8	-
3	Base	3	100	142	5.8	91	5.1	6.5	92	128.1	6.3	57	56	127.0	5.5	47
	Subbase	12	20	113	12.5	69	10.0	12.9	30	109.3	11.1	55	-	-	-	-
	Subgrade	18	12	103	22.6	94	20.0	22.2	-	-	-	-	20	-	24.7	-
	Subgrade	34	-	106	22.9	99	17.6	23.4	-	-	21.9	-	-	-	22.6	-
4	Subgrade	3			16.9		24.3	24.2	-		19.9		-	-	14.2	-
	Subgrade	12			10.1		25.0	23.1	-				-	-	-	-
	Subgrade	18			14.7		14.1	21.7	5		21.3		5	98.5	20.7	77
	Subgrade	34			16.2		11.2	17.8	-		17.2		-	-	18.4	-
5	Base	3			5.4				130	129.1	6.0	56	120	136.6	5.6	69
	Subbase	12			9.0				27	117.0	9.6	58	-	-	-	-
	Subgrade	18			22.3				-	-	-	-	26	-	21.6	-
	Subgrade	34			18.6				-	-	18.5	-	-	-	18.9	-
6	Base	3			5.7				105	140.1	5.7	82	100	134.1	5.8	65
	Subbase	12			8.9				20	-	9.3	-	27	114.2	10.8	60
	Subgrade	18			23.4				-	-	-	-	-	-	-	-
	Subgrade	34			15.9				-	-	15.7	-	-	-	17.6	-
7	Base	3			5.4				93	144.9	5.6	100	51	129.0	5.4	50
	Subbase	12			9.7				28	116.9	9.6	58	28	115.5	11.1	64
	Subgrade	18			25.4				-	-	-	-	-	-	-	-
	Subgrade	34			17.2				-	-	18.3	-	-	-	19.1	-
8	Base	3			5.6				105	129.8	7.0	67	64	130.1	5.4	52
	Subbase	12			9.0				28	121.5	10.1	69	-	-	-	-
	Subgrade	18			21.3				-	-	-	-	27	-	21.3	-
	Subgrade	34			20.2				-	-	17.1	-	-	-	18.9	-
9	Base	3			5.4				135	131.1	6.3	63	95	135.5	5.8	68
	Subbase	12			9.2				30	112.6	8.9	48	-	-	-	-
	Subgrade	18			22.4				-	-	-	-	33	-	20.4	-
	Subgrade	34			16.0				-	-	19.3	-	-	-	18.1	-
10	Base	3			5.1				122	137.5	5.9	76	53	127.5	5.4	48
	Subbase	12			10.3				39	-	9.8	-	31	114.2	10.0	56
	Subgrade	18			21.4				-	-	-	-	-	-	-	-
	Subgrade	34			16.3				-	-	19.0	-	-	-	15.0	-
11	Base	3			5.2								65	134.9	6.4	74
	Subbase	12			10.0								12	118.9	12.2	77
	Subgrade	18			22.6								-	-	-	-
	Subgrade	34			18.7								-	-	18.8	-
12	Base	3			5.2								71	136.8	5.6	70
	Subbase	12			10.5								20	114.4	12.0	68
	Subgrade	18			22.3								-	-	-	-
	Subgrade	34			16.9								-	-	18.8	-
13	Base	3			5.9								149	140.0	5.6	80
	Subbase	12			10.0								18	115.6	11.2	65
	Subgrade	18			24.6								-	-	-	-
	Subgrade	34			19.7								-	-	18.2	-

TABLE 7

KEESLER AIR FORCE BASE
SUMMARY OF TEST DATA

Material	Classification	LL	PL	PI	Sp. G.
Base	GW	Nonplastic			2.73
Subgrade	SW	Nonplastic			2.65

			23 June 1947				8 November 1948	12 December 1949				4 March 1950			
Location	Course	Depth from Surface - In.	CBR	Dry Density Lb/Cu Ft	Moisture Content	Per Cent Saturation	Moisture Content	CBR	Dry Density Lb/Cu Ft	Moisture Content	Per Cent Saturation	CBR	Dry Density Lb/Cu Ft	Moisture Content	Per Cent Saturation
1	Base	3	53	136	5.7	63	5.4	25	120.8	5.7	38	41	-	5.6	-
	Subgrade	12	36	109	4.2	22	4.1	45	-	4.4	-	50	107.4	4.2	21
	Subgrade	30	-	97	3.4	13	3.2	-	-	3.4	-	-	-	4.8	-
2	Base	3	38	127	5.5	45	4.9	19	114.8	5.4	31	35	-	5.3	-
	Subgrade	12	44	107	3.8	19	3.6	43	-	3.5	-	50	104.0	3.3	15
	Subgrade	30	-	98	4.3	17	4.5	-	-	3.6	-	-	-	3.4	-
3	Base	3	67	134	5.5	57	4.9	40	129.2	5.3	46	65	-	5.1	-
	Subgrade	12	26	105	4.5	21	3.2	32	-	4.0	-	22	104.2	3.2	14
	Subgrade	30	-	98	3.5	13	2.9	-	-	3.3	-	-	-	3.2	-
4	Subgrade	3		106	4.9	23	5.9	-		5.0		-		5.2	
	Subgrade	12		104	3.9	18	5.0	33		2.4		6		4.6	
	Subgrade	30		100	5.1	21	3.3	-		3.2		-		4.7	
5	Base	3			5.5		6.1	42	127.3	6.1	50	36	-	5.0	-
	Subgrade	12			6.4		6.0	28	-	5.5	-	46	105.8	6.3	30
	Subgrade	30			5.7		5.5	-	-	5.2	-	-	-	4.9	-
6	Base	3			5.8		5.1	53	134.6	6.3	77	41	-	5.9	-
	Subgrade	12			5.1		4.8	50	-	5.1	-	50	102.0	8.5	36
	Subgrade	30			5.6		5.3	-	-	5.2	-	-	-	5.4	-
7	Base	3			6.2		4.9	60	134.4	5.6	59	30		5.1	
	Subgrade	12			5.6		6.0	39	-	4.8	-	60		6.7	
	Subgrade	30			5.5		5.3	-	-	6.3	-	-		5.3	
8	Base	3			5.2		5.8	47	131.8	6.3	60	49		6.1	
	Subgrade	12			7.1		5.3	53	-	6.8	-	25		12.3	
	Subgrade	30			5.4		8.6	-	-	5.4	-	-		5.0	
9	Base	3			5.3		5.6	76	129.6	6.5	58	30	-	4.7	-
	Subgrade	12			6.8		6.2	35	-	6.3	-	38	101.2	7.4	31
	Subgrade	30			5.5		5.2	-	-	6.3	-	-	-	5.2	-
10	Base	3			4.9		4.9	66	138.0	6.5	77	38		5.7	
	Subgrade	12			6.4		5.7	43	-	6.0	-	44		6.5	
	Subgrade	30			5.3		5.4	-	-	5.0	-	-		4.9	
11	Base	3			5.2		5.4	63	134.4	6.4	68	30	-	5.9	-
	Subgrade	12			-		8.1	51	-	9.0	-	31	97.3	11.3	44
	Subgrade	30			5.3		4.7	-	-	5.5	-	-	-	6.3	-
12	Base	3			6.2		5.9	45	122.5	6.4	45	26	-	5.3	-
	Subgrade	12			4.5		7.5	45	-	9.4	-	56	106.3	8.1	39
	Subgrade	30			5.3		4.3	-	-	7.0	-	-	-	8.6	-
13	Base	3			5.1		5.4	38	123.8	6.0	44	39	-	5.1	-
	Subgrade	12			5.3		6.6	67	-	7.9	-	63	109.2	5.4	28
	Subgrade	30			5.6		4.4	-	-	4.9	-	-	-	4.5	-

TABLE 8

MEMPHIS MUNICIPAL AIRPORT
SUMMARY OF TEST DATA

Material	Classification	LL	PL	PI	Sp. G.
Base	GC	24	11	13	2.65
Subgrade	CL	43	24	19	2.70

Location	Course	Depth from Surface - In.	29 June 1947 CBR	29 June 1947 Dry Density Lb/Cu Ft	29 June 1947 Moisture Content	29 June 1947 Per Cent Saturation	13 December 1948 Moisture Content	1 December 1949 CBR	1 December 1949 Dry Density Lb/Cu Ft	1 December 1949 Moisture Content	1 December 1949 Per Cent Saturation	11 March 1950 CBR	11 March 1950 Dry Density Lb/Cu Ft	11 March 1950 Moisture Content	11 March 1950 Per Cent Saturation
1	Base	4	75	135	7.4	89	8.8	26	117.0	7.2	46	30	119.7	7.4	52
	Subgrade	13	18	102	16.2	70	19.5	28	107.9	17.2	83	26	108.7	16.0	79
	Subgrade	30	-	98	23.2	86	22.7	-	-	23.0	-	-	-	23.1	-
2	Base	4	60	148	4.9	95	6.5	67	153.8	5.4		93	-	4.5	-
	Subgrade	13	77	102	18.5	79	16.7	17	-	20.0		18	110.1	18.0	92
	Subgrade	30	-	96	22.6	81	25.6	-	-	26.1		-	-	27.0	-
3	Base	4	46	153	5.5	-	6.0	57	143.2	5.8	100	95	-	5.2	-
	Subgrade	13	20	103	20.1	85	20.3	12	104.2	20.9	92	18	104.0	21.2	92
	Subgrade	30	-	87	22.5	65	25.9	-	-	26.6	-	-	-	26.7	-
4	Subgrade	4		93	22.2	74	22.6	-	-	22.5	-	-	-	22.5	-
	Subgrade	13		85	25.6	70	27.2	13	101.3	20.5	84	10	97.0	21.9	80
	Subgrade	30		93	25.4	84	27.8	-	-	22.6	-	-	-	29.3	-
5	Base	4			6.4		7.9	36	132.2	6.2	67	27	147.0	4.9	100
	Subgrade	13			17.3		18.0	13	-	18.4	-	8	95.4	22.5	79
	Subgrade	30			20.9		21.5	-	-	21.3	-	-	-	25.1	-
6	Base	4			5.1		7.1	46	127.9	5.2	48	70	144.9	3.1	60
	Subgrade	13			18.8		19.1	13	101.0	19.1	77	10	98.3	20.5	78
	Subgrade	30			22.0		23.3	-	-	22.2	-	-	-	23.4	-
7	Base	4			4.9		6.9	55	135.1	4.5	54	66	-	4.0	-
	Subgrade	13			18.4		17.1	10	104.5	18.7	82	4	94.5	21.4	74
	Subgrade	30			21.1		21.8	-	-	21.9	-	-	-	24.2	-
8	Base	4			4.9		8.3	67	135.4	5.0	61	45	-	5.6	-
	Subgrade	13			17.5		19.0	11	-	20.7	-	7	98.8	20.4	80
	Subgrade	30			20.8		22.0	-	-	22.0	-	-	-	24.9	-
9	Base	4			5.3		6.4	76	137.5	4.4	59	49	-	5.0	-
	Subgrade	13			17.9		24.0	12	-	19.3	-	12	102.2	21.7	90
	Subgrade	30			21.5		24.3	-	-	22.1	-	-	-	22.2	-
10	Base	4			4.5		6.1	39	137.8	5.0	68	69		5.3	
	Subgrade	13			19.0		20.0	14	-	20.1	-	14		27.7	
	Subgrade	30			21.1		25.0	-	-	21.9	-	-		21.9	
11	Base	4			4.8		7.0	82	155.8	4.9		22	-	5.0	-
	Subgrade	13			17.9		23.2	6	-	24.3		11	101.1	19.6	80
	Subgrade	30			23.2		26.1	-	-	24.6		-	-	22.4	-
12	Base	4			4.7		6.1	42	134.4	4.7	55	35	-	5.4	-
	Subgrade	13			18.7		29.6	10	101.6	22.0	90	16	98.4	20.4	78
	Subgrade	30			21.2		-	-	-	22.8	-	-	-	22.2	-
13	Base	4			4.6		5.9	50	137.8	5.2	71	16	136.1	4.0	50
	Subgrade	13			19.7		22.9	8	100.5	22.6	90	13	97.6	20.8	77
	Subgrade	30			83.3		24.6	-	-	22.5	-	-	-	21.8	-

TABLE 9

SUMMARY OF MOISTURE CONTENTS AND DEGREES OF SATURATION

Material	Name of Field	Rainfall Zone	Moisture Content	Percent Saturation
		Base Course		
Clay gravel, GC	Santa Fe	Low	4.8	78
	Clovis (before failure)	Low	9.8	68
	Clovis (after failure)	Low	15.1	98
	Lubbock	Medium	13.2	71
	Goodfellow	Medium	12.5	98
	Memphis	High	8.1	98
Silty gravel, GM	Kirtland	Low	3.8	79
Sand gravel, GW	Bergstrom	Medium	5.3	65
	Keesler	High	5.7	61
		Subgrade		
Fat clay, CH	Bergstrom	Medium	25.0	97
	Goodfellow	Medium	24.1	99
Lean clay, CL	Santa Fe	Low	16.8	65
	Clovis (before failure)	Low	12.5	75
	Clovis (after failure)	Low	13.5	91
	Memphis	High	20.8	91
Clayey sand, SC	Lubbock	Medium	13.5	92
Silty sand, SM	Kirtland	Low	10.8	67
Sand, SW	Keesler	High	4.5	22

NOTE: Eighty percent of the observations of moisture content and percent saturation were less than the values shown in these columns.

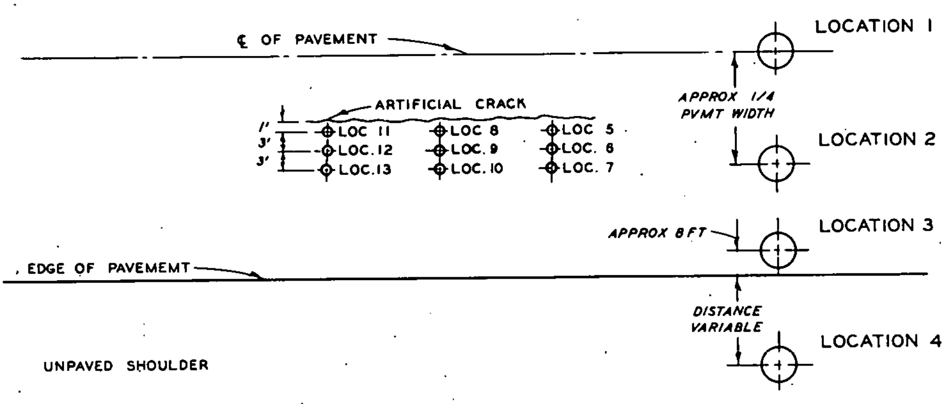


Figure 1. Key to Testing Locations. Not to Scale.

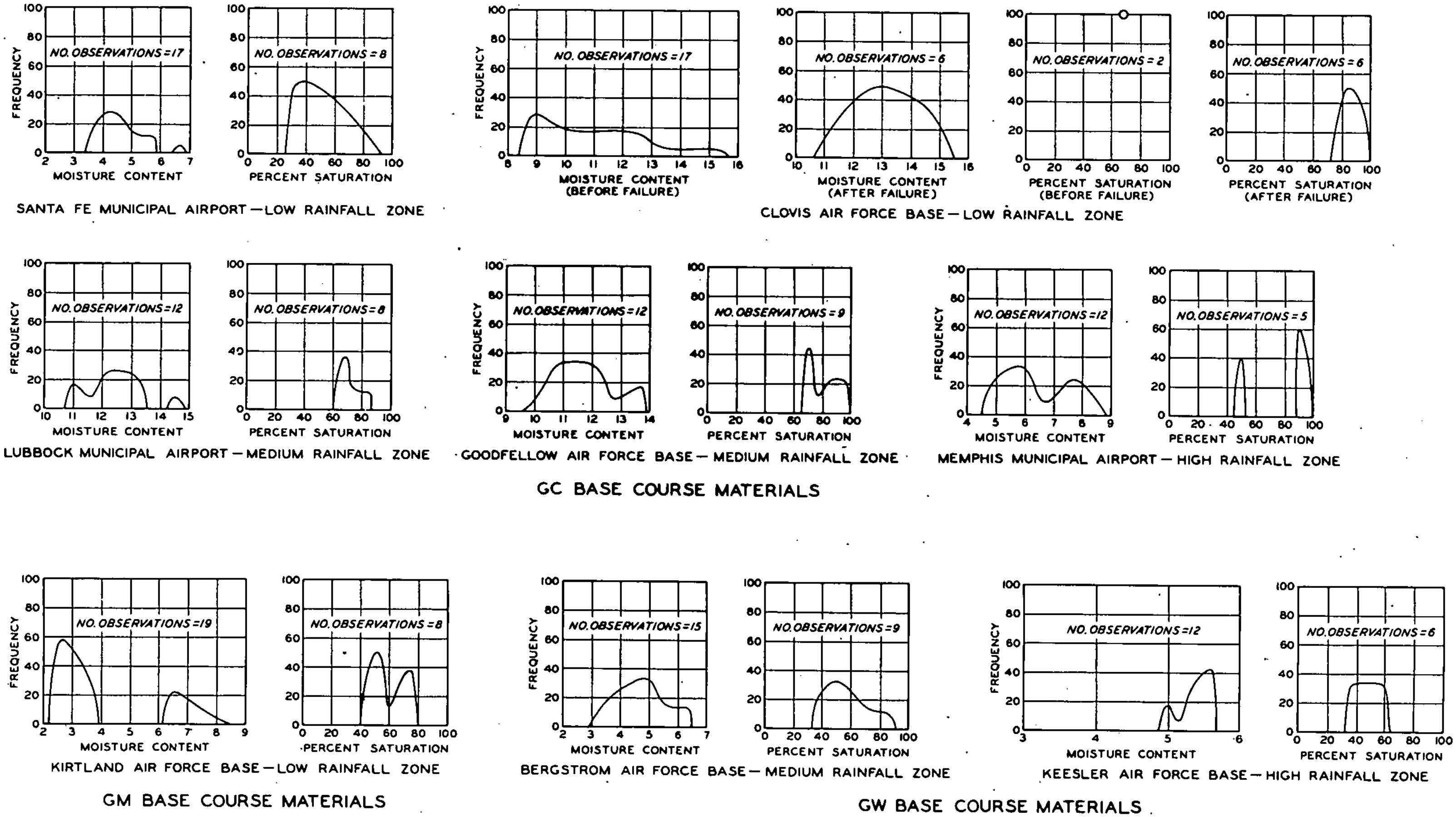


Figure 2. Frequency Distribution. Moisture Contents and Percents Saturation Base Course Materials.

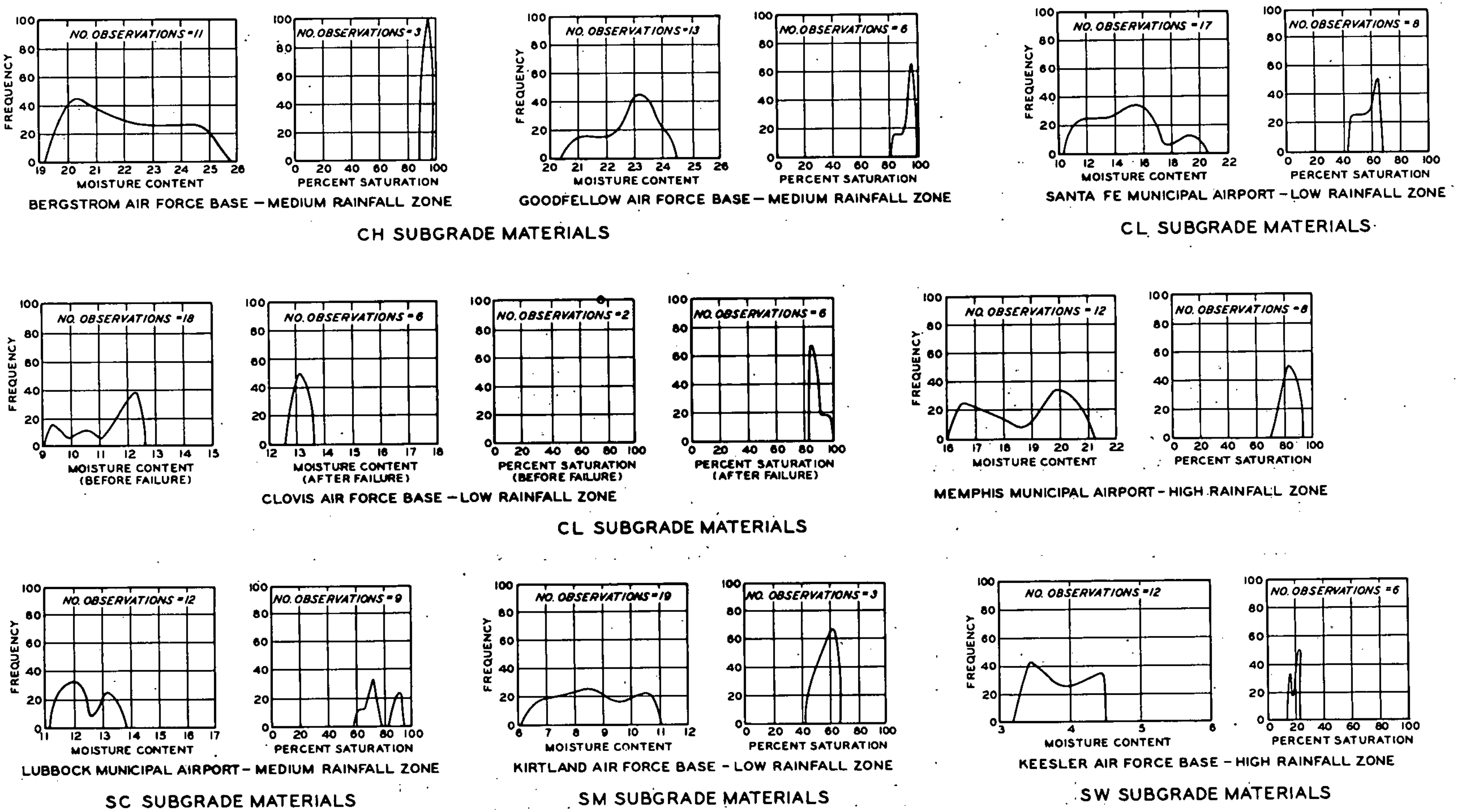
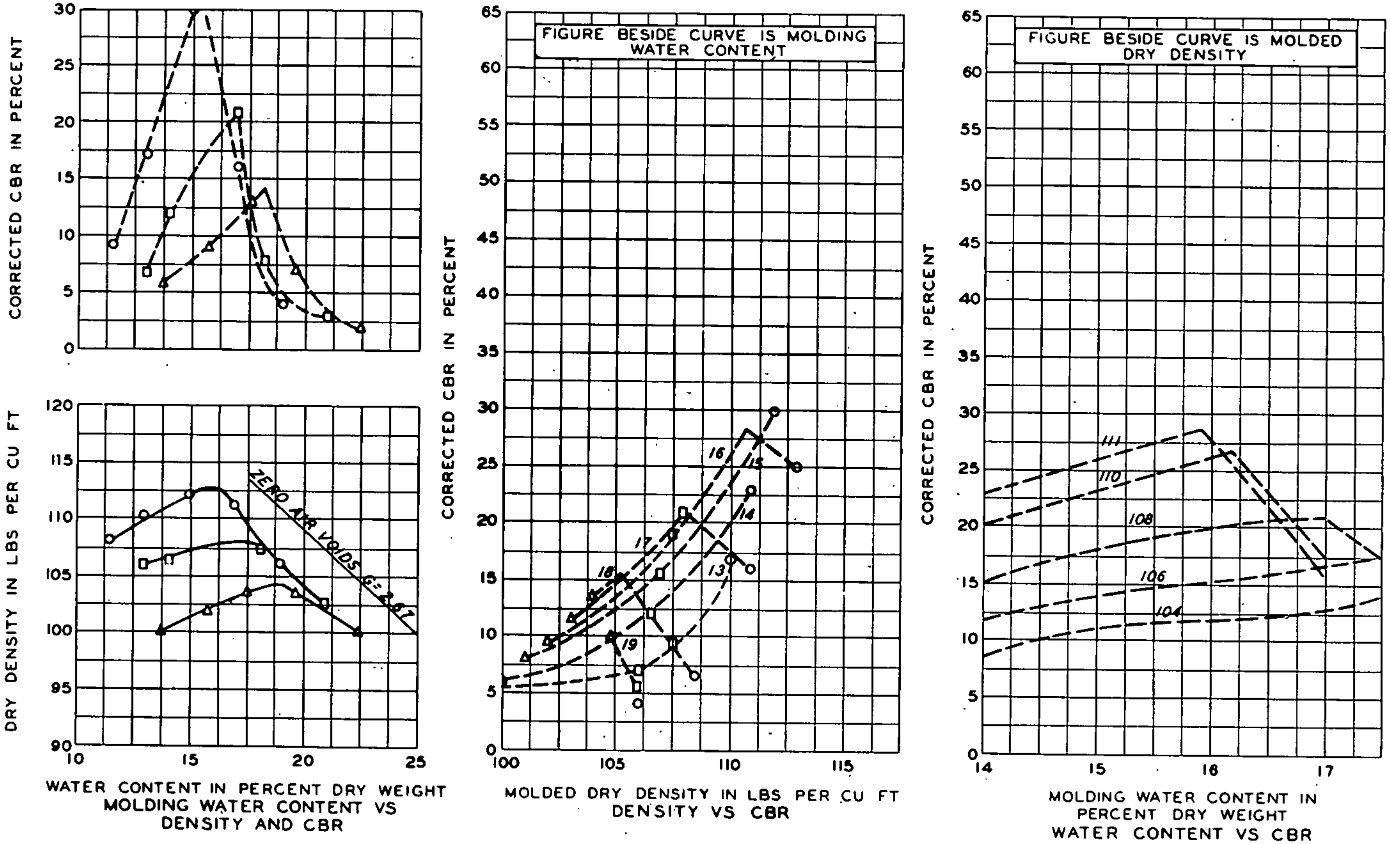


Figure 3. Frequency Distribution. Moisture Contents and Percents Saturation Subgrade Materials.



NOTE: SPECIMENS SOAKED FROM TOP AND BOTTOM. SURCHARGE 30 LBS SOAKING AND PENETRATION.

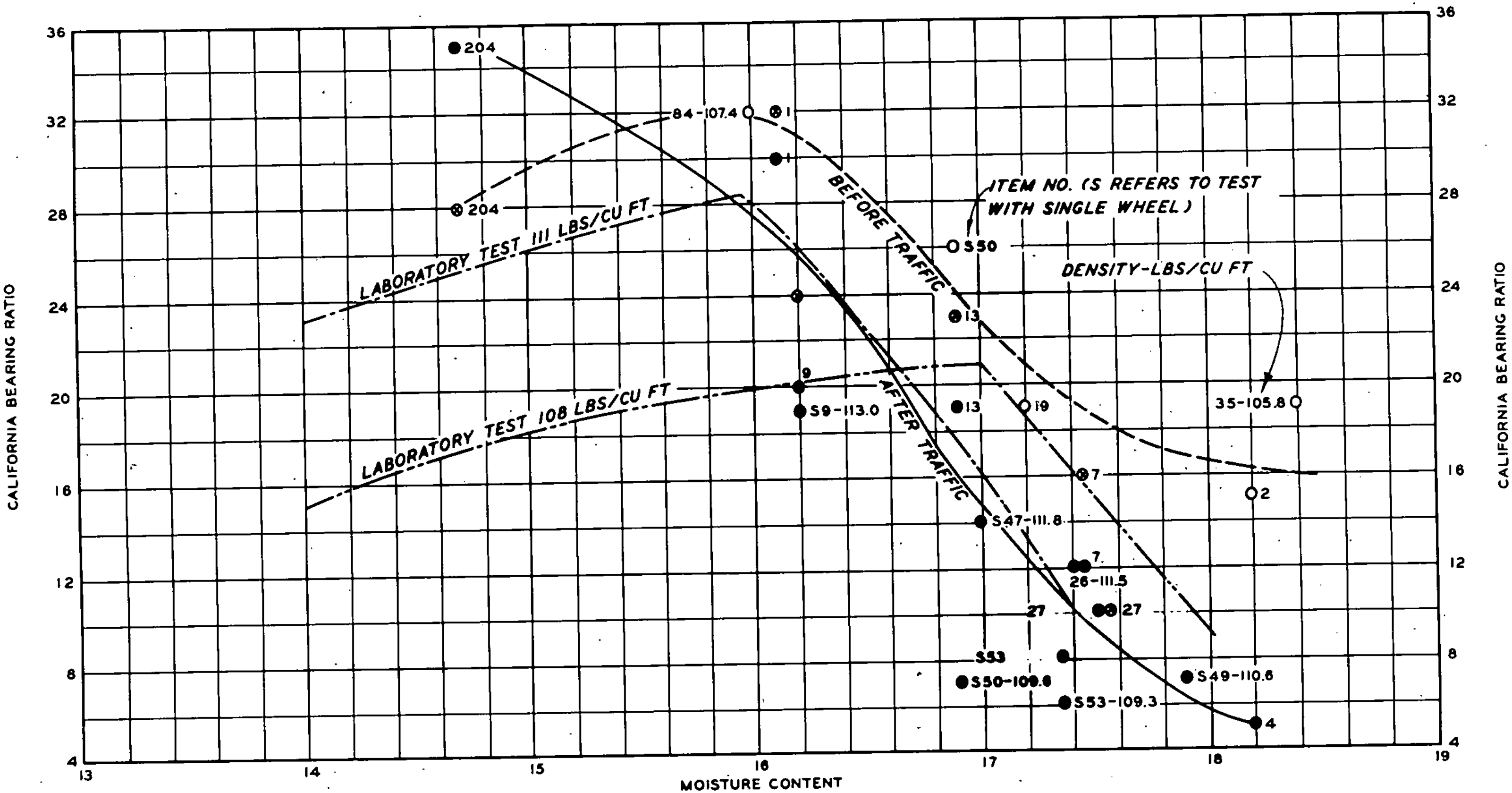
SPECIMENS SHOWED NO SWELL DURING SOAKING.

ALL SPECIMENS COMPACTED WITH 10 LB HAMMER, 5 LAYERS, 18 INCH DROP.

LEGEND

O 55 BLOWS PER LAYER
□ 26 BLOWS PER LAYER
Δ 12 BLOWS PER LAYER

Figure 4. Design CBR Tests Subgrade.



LEGEND

- ○ BEFORE TRAFFIC
- ⊗ DURING TRAFFIC-OUTSIDE OF TRAFFIC PATH
- ● DURING TRAFFIC WITH TIRES INFLATED TO 200 PSI-WITHIN TRAFFIC PATH

NOTE : FIELD TESTS WERE IN-PLACE TESTS

Figure 5. Effect of Traffic on Subgrade CBR-Moisture Relationships.