TRIAXIAL CLASSIFICATION OF THE SURFACE SOILS OF TEXAS AS GROUPED BY SOIL CONSERVATION SERVICE SERIES

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TEXAS HIGHWAY DEPARTMENT

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PREFACE

This report is the result of laboratory and field studies made on 710 soil series, mapped and classified by the Soil Conservation Service, U. S. Department of Agriculture in cooperation with the Texas Agricultural Experiment Station. Begun as a survey of load zoning requests by the Maintenance Operations Division, File D-18, and the Districts during the summer of 1971, it soon became evident that much additional information could be obtained from the triaxial results contained in the files of the individual Districts. With the authority of the Materials and Tests Engineer, the project was presented at the Laboratory Engineers meeting at Brownwood in February 1972, together with copies of soil maps and blank forms for use in compiling the desired information. Each District was authorized by the Finance Division, File D-3, to charge its share of the work to account I.P.E. 300. Results from all 25 Districts were tabulated by October 1972, and result in triaxial classifications for 498, or 70.1%, of the 710 soil series presented for 253 of the 254 counties of Texas. No map has yet been released by the Soil Conservation Service for DeWitt County in District 13.

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I. SUBJECT

Load zoning of highways in Texas has been conducted on a cooperative basis involving the Maintenance Operations Division, (D-18), the Materials and Tests Division, (D-9), and the Districts for some twenty years. Estimates of wheel load capacity were furnished to D-18 by D-9 and District personnel based on information, results of nearby tests, etc. in the files. Following development of the Texas Triaxial Test after World War II, it became possible to determine the triaxial classification of base, subbase, and subgrade materials. Several refinements of the test were made over the years, but are too numerous to go into detail here. All 25 District Laboratories are now equipped to run the triaxial test, and it is the results of these tests for which the original study was expanded to include.

II. PURPOSE

The purpose of this report is to show the triaxial classification, as estimated and determined by personnel of the Texas Highway Department, of soils classified and mapped by personnel of the Soil Conservation Service, U. S. Department of Agriculture. Although prior use of these maps has been conducted on a local basis, it was felt that a statewide correlation of the data would be of great value in load zoning and other areas of highway planning. The cessation of triaxial testing of subgrade soils was neither implied nor intended, but rather that it would serve as a supplement to work already completed or to that contemplated.

III. SUMMARY AND CONCLUSIONS

1. Laboratory and field studies on 710 soil series have been conducted in order to secure triaxial classifications for as many as possible. Of these 710 soils, some 46% were classified as a result of the survey of estimates and tests contained in the files of the Materials and Tests Division. This served as the basis for the appeal to the Districts for additional information contained in their files. Tabulation of that information increased the classifications to over 70%, or about 1% additional per District. Acquisition of 16 of the 17 missing Soil Conservation Service county maps has increased the available soil series classifications from 652 to 710 prior the appeal for District information. Triaxial classifications also increased from 303 to 498 as a result of additional information from the Districts. As mentioned previously, no map of DeWitt County in District 13 has as yet been released. No attempt to classify these soil series by properties other than triaxial class was made due to the vast volume of data involved. It was intended, however, to use these physical properties to identify the materials with the soil series as described on the Soil Conservation Service maps.

2. The results of this study were not surprising in that the heavy clay subgrades, with high P.I. and resultant swelling, presented the most serious problems to highway construction. Houston

Black - Houston Clay is a prime example of this type of material. Occurring in nine of the 25 Highway Department Districts, this material had a triaxial classification of 5.4 based on a total of 247 tests. Although some variation in classification between contributing laboratories was evident, it was felt that the weighted figure obtained for this material was a good one. On the other hand, there were several material sources for which very few test results were obtained. Triaxial classes for these materials are, as a result, to be used with caution. Additional testing would be most advantageous in cases where existing results are too few in number, or where a cut-and-fill type operation is used for construction of highways. Since this type of construction usually placed the best class of material from the cut portion on the bottom of the fill section, an average triaxial class for the soils involved would be of lesser value. However, it is felt that proper use of the resulting information from this study will be of great help in future long-range planning of highways in Texas.

IV. MATERIALS AND METHODS

A. Triaxial Classification of Soils.

Triaxial classifications for subgrade soils are obtained by a combination of tests published in the Manual of Testing Procedures of the Materials and Tests Division, 100-E Series. Text of Test Method Tex-117-E, parts I and II, "Triaxial Compression Test for Disturbed Soils and Base Materials" appears in the Appendix of this report. It is with this and other allied test methods that the triaxial classifications were determined for this report.

B. Location of Soil Sources.

Location of soil materials are made by station number on large-scale maps used by the project engineer during construction of the roadway. These locations are then transferred to the soil survey maps produced by the soil scientists of the Soil Conservation Service, U. S. Department of Agriculture. At present, our stock includes 42 of the detailed soil surveys on aerial photographs and 253 of the generalized county soil maps for the State. No attempt to reproduce these maps for this report was made due to the bulk of the information.

C. How Soils Are Mapped and Classified.

Soil Conservation Service scientists make these soil surveys to learn what kind of soils are in each county, where they are located, and how they can be used. They dug many holes to expose soil profiles which are the sequence of natural layers, or horizons, extending from the surface down into the parent material from which the soil was formed. Comparison of soils having similar profiles go into making up a soil series, or mapping units, as used in drawing of a generalized soil map. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Although some soils of a soil series may differ in surface texture, their major horizons are similar throughout the United States. Samples of these soils of Texas are submitted to the Soil Section of the Materials and Tests Division for determination of Atterberg limits, sieve analysis, and other tests to further study the engineering properties. Detailed information such as steepness of slopes, susceptibility to erosion, and land types can only be shown on the detailed soil surveys on aerial photographs. For this report, the generalized soil maps were found to be more suitable in locating soil series or associations. These soil associations may consist of two or three soil series in varying amounts, and are usually named for the predominant soil series.

D. How Information is Used in Load Zoning.

Requests for load zoning of highways in Texas are submitted by the Districts to File D-18 on Form 1084. This information is checked by D-18 and forwarded on to D-9 for our recommendations as to the depth for estimate, triaxial class of subgrade soil, and pavement wheel load estimate. The depth for estimate is considered as the thickness of surfacing and base material, plus an allowance of 1½" for future maintenance. Triaxial classification of the subgrade soils has been substantially simplified by the results of this report in that, once located on the Soil Conservation Service map, the soil class may be determined from the tables in the Appendix. This value may then be compared with the description and data submitted by the District on Form 1084. Knowing the estimated depth of cover and the triaxial class of the soil beneath, one can easily determine the maximum wheel load from the Flexible Pavement Chart. A sample Form 1084 is shown as Appendix II.

Table 2 gives the District, County and publication date of the U. S. Soil Conservation Service Generalized Soil Maps which have been used in compiling the data for this report.

V. RESULTS

The results of this study appear as Table I of this report. It may be seen that many of the soil series are classified triaxially by very few tests. However, it is hoped that additional tests will be made on such soils, and will appear in the future as a supplement to this report.

VI. DISCUSSION

As stated previously under the items of summary and conclusions, there were no surprising results obtained in this study. High P.I. clays, with resultant swelling tendencies, appear to present the highway engineer with the most serious problems in the design, construction and maintenance of our highway system. The simplest solution to the problem is to avoid such materials during the construction of highways and structures. Such a practice, however, is impractical from the standpoint of economics and other aspects of engineering. Proper control of moisture content both before and after compaction of the subgrade soils, together with proper compaction and density control, is perhaps the most economical method of stabilization. The second most feasible solution is to stabilize these materials with lime, cement or asphalt. Numerous research studies of these and other problems are presently underway.

Historically, the Materials and Tests Division has reported triaxial classifications that are Class 2.0, and where the rupture line on the classification chart touches the class line but nowhere goes below it, as Class 1. This is done because from the Flexible Base Design Chart the depth of better materials required is a good surface of about one inch, exclusive of other traffic data. Also, Class 1 material is Class 1 without regard to divisions of tenths as in Classes 2 through 6.5. Therefore, when any subgrade soil was reported by the Districts as Class 1 subgrade, they have been averaged as Class 2.0 rather than Class 1. It was felt that this would not adversely affect the averages since all classes would be on a decimal system. In addition, the making of specimens in the laboratory is far more controlled than in cut and fill type operations where all the variables can enter in. Few subgrade soils are that uniform unless it is in rock cuts handled as flexible base material.

In order to arrive at the "average" classification for each District's data, the sum of the classifications for any particular series was divided by the number of tests. Then to arrive at the triaxial class average in the right hand columns of Table I, the same method was used using both D-9's and the District's averages.

VII. SUGGESTED USAGE

It is probably justifiable to use the data from Table I in preparing preliminary data where little is known on the triaxial classifications of foundation soils. This is especially true where several tests from the Districts and the Materials and Tests Division have made up the final average found in the last or right hand column.

In addition, many soil series show a remarkable tendency to give very consistent test values. Others show considerable spread of triaxial values from maximum to minimum values but have quite a preponderance of values reasonably close to the final average. This is probably caused in great measure by the depth at which the sample was taken since in many cases the first few inches near the surface has been leached out and is often-times more "granular" than the second or third described horizon. In other cases, the presence of a layer of rocky or ledge material will give better results if taken and tested separately. To use the best results is questionable in cut and fill or embankment work since it is far easier to control its uniformity in laboratory specimens than in construction where a great volume of earth is moved rapidly. Where this type of soil is encountered, it is highly recommended that the use of soil constants, gradation and the like be compared before using figures on classifications less than the average. In any case, the use of soil constants and gradations can be helpful and should be used where possible.

When it is found that past soil constants tests and gradations are similar to those obtained from new locations, all within the same Soil Conservation Service soil series, then it is suggested that the number of tests could be reduced and triaxial values from Table I used with confidence. It is felt that this usage should be within the recommendations of Item 4-402.3, Materials Evaluation, Highway Design Division Operations and Procedures Manual.

ACKNOWLEDGMENTS

The sincere cooperation of all the District and Laboratory Engineers from all the Districts of our State is hereby gratefully acknowledged.

TABLE I

		District								
Soil Series	D·9 L7	1	2	3	4	5	6	7	8	9
Abilene	4 5.1								23 4.4	
Abilene-Hollister	7 4.9									
Abilene-Mansker									20 5.0	
Abilene-Mereta	6 4.4							19 4.2		
Abilene-Miles	2 4.3									
Abilene-Miles-Wichita	4 4.4									
Abilene-Roscoe	13 4.9								15 5.0	
Abilene-Wichita	10 4.5								30 5.2	
Acadia-Byars	2 5.3									
Acadia-Byars-Caddo	3 4.3									
Acuff-Portales							19 3.0			
Alluvial					1 3.4					
Alto-Nacogdoches	1 5.5									
Amarillo	25 3.8					85 3.7	33 3.0			
Amarillo-Arvana						1 3.5				
Amarillo-Arvana-Midessa	2 4.0						32 3.2			
Amarillo-Brownfield	7 3.7					26 3.7	31 3.6			
Amarillo loamy	5 3.7					27 3.6				
Amarillo-Olton	1 3.8					4 3.6				
Amarillo-Olton-Portales	1 4.0								39 4.3	
Amarillo-Portales	3 4.4					8 4.0			19 3.6	
Amarillo-Springer									5 3.7	
Amarillo-Ulysses										
Arch-Drake										
Arvana-Amarillo										
Arvana-Kimbrough-Amarillo	1 4.0									
Asa-Bastrop-Lewisville										
Austin	2 6.0									
Austin-Eddy	10 5.2	4 5.0								3 5.2
Austin-Houston	1 5.0									
Austin-Houston Black										
Axtell-Bastrop	10 4.8									1 5.3
Axtell-Irving	1 5.2									8 5.0
Axtell-Sawyer	1 5.0									
Axtell-Tabor										
Axtell-Travis										
Axtell-Wilson										
Axtell-Wrightsville										
Balmorhea-Toyah	1 4.2						15 3.9			
Bastrop-Travis	2 4.4									3 3.5
Beaumont-Edna	2 5.4									
Beaumont-Midland	3 5.5									
Bell-Axtell										
Bell-Axtell-Bastrop										
Bell-Burleson	2 5.3									
Bell-Burleson-Irving	3 5.2									7 5.2
Bell-Lewisville	8 5.3									9 5.0
Bergstrom-Norwood	3 5.2									
Bernard-Clodine										
Berthoud-Likes					3 3.4					
Berthoud-Mansker	2 4.0				3 4.3	1 4.1				
Berthoud-Mansker-Potter					1 3.3					
Berthoud-Olton										
Berthoud-Potter					8 3.8					
Berthoud-Potter-Bippus	1 4.5									
Berthoud-Potter-Mansker										
Berthoud-Potter rough										
Berthoud-Potter-Spur										
Bibb-Alluvial land										
Bibb-Iuka	3 4.7									
Bibb-Navasota	1 4.5									
Bibb-Swampland										
Bippus-Abilene						1 5.3				
Bippus-Spur	1 4.2									
Bolar-Tarrant	1 4.9									
Bonham-Crockett	2 4.8	5 5.3								
Bonham-Wilson	1 4.5	2 4.5								
Bonti-Olton-Owens	1 5.0									
Boswell-Kirvin	1 4.5									
Boswell-Sawyer	6 4.3									
Boswell-Sawyer-Bowie	1 4.0									
Boswell-Susquehanna	6 4.5									
Bowie	1 4.0									
Bowie-Axtell-Wrightsville										
Bowie-Boswell-Lakeland										
Bowie-Caddo	2 5.1									
Bowie-Caddo-Rains	6 4.5									
Bowie-Cuthbert										
Bowie-Kirvin	8 4.2									
Bowie-Kirvin-Boswell		1 4.2								
Bowie-Kirvin-Sawyer										
Bowie-Lakeland	5 4.3									
Bowie-Lakeland-Sawyer										
Bowie-Ruston	8 4.4									
Bowie-Ruston-Lakeland										
Bowie-Sawyer	16 4.3	18 4.9								
Brackett										
Brackett-Denton	2 4.5									5 4.
Brackett-Denton (shallow)										
Brackett-Hext-Pedernales										
Brackett-Tarrant	6 4.6									

10		11		12		13		14		15		16		17		18		19		20		21		22		23		24		25		Avg.	
																																27	4.5
																														7	3.3	14	4.1
																																20	5.0
																										6	4.8					31	4.4
																																2	4.3
																																4	4.4
																														2	4.0	30	4.9
																										5	5.3					45	5.1
																				16	4.6											18	4.7
																				16	4.2											19	4.2
																																19	3.0
																																1	3.4
																																1	5.5
																																143	3.6
																																1	3.5
																																34	3.2
																																64	3.7
																																32	3.6
																																5	3.6
																																40	4.3
																																30	3.8
																																5	3.7
																																1	4.0
																																2	6.0
								3	5.7	23	5.2					7	5.0															50	5.2
										7	4.9																					8	4.9
														1	4.9																	12	4.9
																8	5.4															17	5.2
														1	5.9																	2	5.5
																2	4.2															2	4.2
																																16	3.9
																																5	3.9
				10	5.0															53	5.0											65	5.0
																				120	5.0											123	5.0
						1	5.6																									1	5.6
																10	5.7															12	5.6
																																10	5.2
								4	5.9	19	4.7					12	5.5															52	5.1
																																3	5.2
				1	6.0																											1	6.0
																																3	3.4
																																6	4.2
																																1	3.3
																																8	3.8
																																1	4.5
																														2	3.2	2	3.2
																																3	4.7
																																1	4.5
																																1	5.3
																																1	4.2
																										1	4.3					2	4.6
														6	5.3																	13	5.2
																																3	4.5
																										38	4.7					39	4.7
																																1	4.5
																		12	4.6													18	4.5
																																1	4.0
4	4.4	2	3.4															2	5.1													14	4.4
																																1	4.0
2	5.0																															2	5.0
1	3.6																															1	3.6
																				17	4.3											19	4.4
		2	3.8																	6	4.7											14	4.5
14	4.1	2	3.4																													16	4.0
																		8	4.7													16	4.5
4	4.0																															5	4.0
																8	4.0															8	4.0
														19	3.6																	24	3.7
														14	3.6																	14	3.6
5	4.1																			2	5.2											15	4.4
3	3.8																															3	3.8
7	4.2																	15	4.4													56	4.5
																																7	4.6
																										1	6.0					1	6.0
										33	3.5															11	5.0					50	4.0

TABLE I

District

Soil Series	D·9 L7		1		2		3		4		5		6		7		8		9	
Brackett-Windthorst-Stephenville	1	4.1																		
Brewster																				
Brewster (Rough)																				
Brewster stony																				
Broken lands Quinlan-Weymouth									1	4.0										
Brownfield	1	3.8																		
Brownfield-Amarillo											8	3.5								
Brownfield-Miles	1	4.2																		
Brownfield-Nimrod																				
Brownfield-Nobscot	1	4.2																		
Brownfield-Nobscot-Miles																				
Brownfield-Springer																				
Brownfield-Tivoli																	5	4.2		
Burleson-Garner																				
Burleson-Garner-Houston	1	5.5																		
Burleson-Irving																				
Burleson-Wilson	1	5.0	8	6.1																
Byars-Leaf																				
Byars-Susquehanna																				
Byrds-Tarrant																				
Byrds-Valera																				
Caddo																				
Caddo-Acadia																				
Caddo-Acadia-Rains																				
Caddo-Bibb																				
Caddo-Bowie-Rains	1	5.0																		
Caddo-Byars-Plummer	10	4.5																		
Caddo-Rains																				
Caddo-Rains-Byars	5	4.6																		
Caddo-Rains-Lufkin	10	4.6																		
Caddo-Sawyer	3	4.2																		
Cahaba-Kalmia																				
Cahaba-Klej																				
Canutio-Nickel-Vieja																				
Carey-Woodward	3	4.3															24	3.9		
Carey-Woodward-Quinlan																				
Catalpa	1	5.5																	1	4.7
Catalpa-Krum																				
Catalpa-Lewisville	7	4.6																	5	4.7
Catarina																				
Catarina-Monteola-Maverick																				
Cavot																				
Cavot-Badlands																				
Chaney-Demona																				
Chickasha	3	4.1																		
Clairemont-Yahola																				
Clareville-Raymondville	9	4.7																		
Coastal Sands																				
Cobb-Latom																				
Cobb-Miles																	30	4.0		
Conroe gravelly																				
Copita																				
Copita-Zapata																				
Crawford	8	4.8																		
Crawford-Bexar	1	4.7																		
Crawford-San Saba																				
Crawford-Tarrant	8	4.3																		
Crockett-Bonham	4	5.2																		
Crockett-Edge-Lufkin			2	6.0																
Crockett-Lufkin			3	5.2																
Crockett-Wilson	41	4.9	10	5.6	6	5.1													30	4.9
Crockett-Wilson gravelly																				
Crowley-Susquehanna																				
Crystal-Zapata																				
Cuero-Houston	2	5.5																		
Cuevitas-Delmita	1	4.6																		
Cuthbert																				
Cuthbert-Boswell																				
Cuthbert-Kirvin																				
Cuthbert-Tabor-Edge																				
Dalhart									4	3.9										
Dalhart-Mansker									2	5.1										
Dalhart-Vona	1	4.0							3	3.6										
Darnell-Owens	25	4.6			3	4.3	1	5.7												
Darnell-Owens-Byrds																				
Darnell-Pontotoc																				
Darnell-Renfrow	2	4.5															6	5.0		
Darnell-Wichita-Tillman	2	4.2																		
Delfina-Willacy	10	4.7																		
Delmita																				
Delmita-Delfina	1	4.0																		
Delmita-Nueces																				
Delmita-Zapata	4	3.8																		
Denton-San Saba	21	4.6			1	5.3													7	5.0
Denton-San Saba-Crawford	6	4.7																	12	5.0
Denton-(shallow)-Denton-San Saba	9	4.8																	7	5.0
Denton-(shallow)-Tarrant	8	4.6			7	3.9														
Denton-Tarrant	12	4.8																	4	4.8
Duffau-Bunyan																				
Duval-Delmita																				

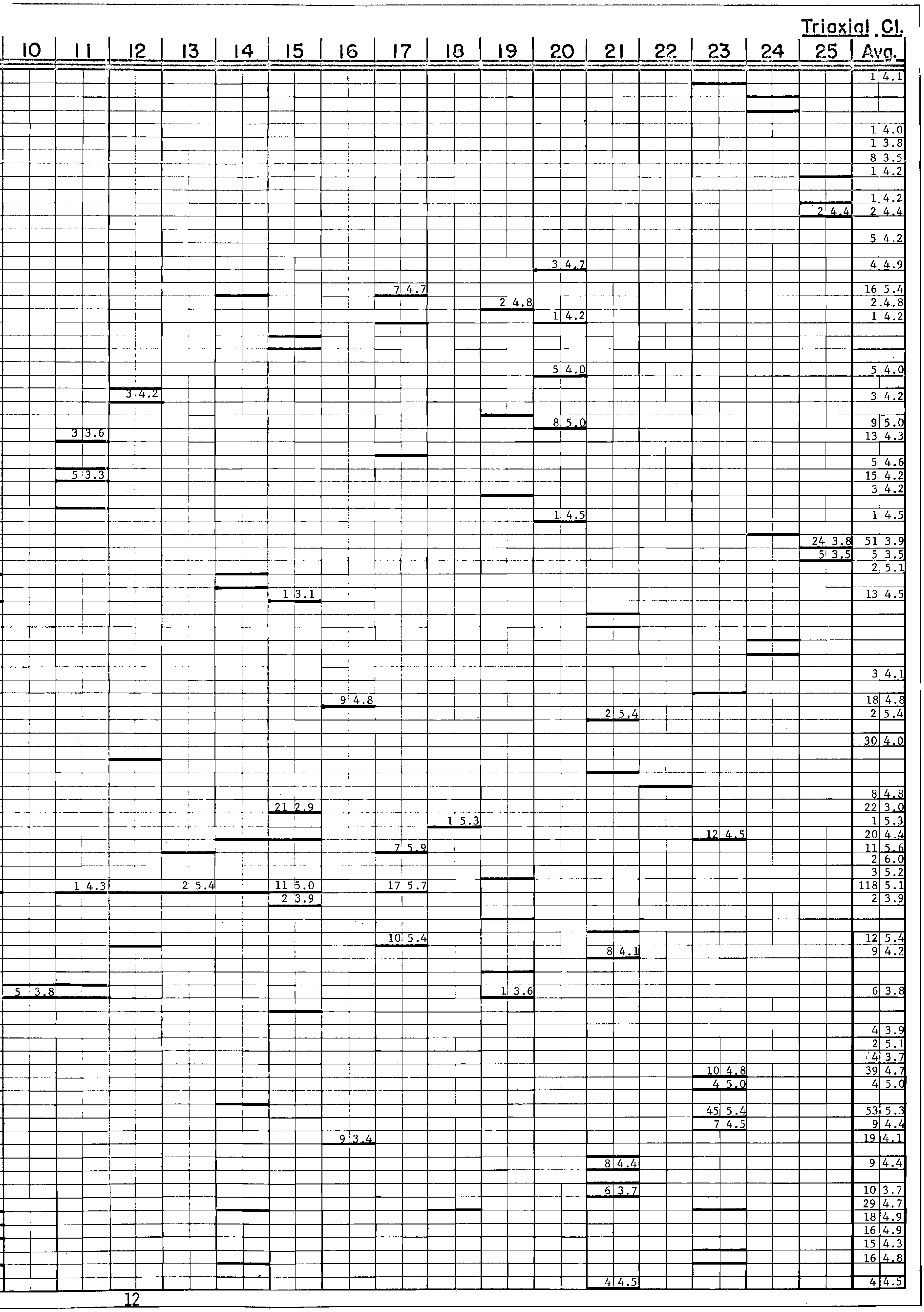

Triaxial Cl.
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
Avg.
1 4.1
1 4.0
1 3.8
8 3.5
1 4.2
1 4.2
2 4.4
2 4.4
5 4.2
3 4.7
4 4.9
7 4.7
16 5.4
2 4.8
2 4.8
1 4.2
1 4.2
5 4.0
5 4.0
3 4.2
3 4.2
8 5.0
9 5.0
3 3.6
13 4.3
5 4.6
5 3.3
15 4.2
3 4.2
1 4.5
1 4.5
24 3.8
51 3.9
5 3.5
5 3.5
2 5.1
1 3.1
13 4.5
3 4.1
9 4.8
18 4.8
2 5.4
2 5.4
30 4.0
8 4.8
21 2.9
22 3.0
1 5.3
1 5.3
12 4.5
20 4.4
7 5.9
11 5.6
2 6.0
3 5.2
1 4.3
2 5.4
11 5.0
17 5.7
118 5.1
2 3.9
2 3.9
10 5.4
12 5.4
8 4.1
9 4.2
5 3.8
1 3.6
6 3.8
4 3.9
2 5.1
4 3.7
10 4.8
39 4.7
4 5.0
4 5.0
45 5.4
53 5.3
7 4.5
9 4.4
9 3.4
19 4.1
8 4.4
9 4.4
6 3.7
10 3.7
29 4.7
18 4.9
16 4.9
15 4.3
16 4.8
4 4.5
4 4.5

TABLE I

Soil Series	D·9	L_7	District 1		2		3		4		5		6		7		8		9	
Brackett-Windthorst-Stephenville	1	4.1																		
Brewster																				
Brewster (Rough)																				
Brewster stony																				
Broken lands Quinlan-Weymouth									1	4.0										
Brownfield	1	3.8																		
Brownfield-Amarillo											8	3.5								
Brownfield-Miles	1	4.2																		
Brownfield-Nimrod																				
Brownfield-Nobscot	1	4.2																		
Brownfield-Nobscot-Miles																				
Brownfield-Springer																				
Brownfield-Tivoli																	5	4.2		
Burleson-Garner																				
Burleson-Garner-Houston	1	5.5																		
Burleson-Irving																				
Burleson-Wilson	1	5.0	8	6.1																
Byars-Leaf																				
Byars-Susquehanna																				
Byrds-Tarrant																				
Byrds-Valera																				
Caddo																				
Caddo-Acadia																				
Caddo-Acadia-Rains																				
Caddo-Bibb																				
Caddo-Bowie-Rains	1	5.0																		
Caddo-Byars-Plummer	10	4.5																		
Caddo-Rains																				
Caddo-Rains-Byars	5	4.6																		
Caddo-Rains-Lufkin	10	4.6																		
Caddo-Sawyer	3	4.2																		
Cahaba-Kalmia																				
Cahaba-Klej																				
Canutio-Nickel-Vieja																				
Carey-Woodward	3	4.3															24	3.9		
Carey-Woodward-Quinlan																				
Catalpa	1	5.5																	1	4.7
Catalpa-Krum																				
Catalpa-Lewisville	7	4.6																	5	4.7
Catarina																				
Catarina-Monteola-Maverick																				
Cavot																				
Cavot-Badlands																				
Chaney-Demona																				
Chickasha	3	4.1																		
Clairemont-Yahola																				
Clareville-Raymondville	9	4.7																		
Coastal Sands																				
Cobb-Latom																				
Cobb-Miles																	30	4.0		
Conroe gravelly																				
Copita																				
Copita-Zapata																				
Crawford	8	4.8																		
Crawford-Bexar	1	4.7																		
Crawford-San Saba																				
Crawford-Tarrant	8	4.3																		
Crockett-Bonham	4	5.2																		
Crockett-Edge-Lufkin			2	6.0																
Crockett-Lufkin			3	5.2																
Crockett-Wilson	41	4.9	10	5.6	6	5.1													30	4.9
Crockett-Wilson gravelly																				
Crowley-Susquehanna																				
Crystal-Zapata																				
Cuero-Houston	2	5.5																		
Cuevitas-Delmita	1	4.6																		
Cuthbert																				
Cuthbert-Boswell																				
Cuthbert-Kirvin																				
Cuthbert-Tabor-Edge																				
Dalhart									4	3.9										
Dalhart-Mansker									2	5.1										
Dalhart-Vona	1	4.0							3	3.6										
Darnell-Owens	25	4.6			3	4.3	1	5.7												
Darnell-Owens-Byrds																				
Darnell-Pontotoc																				
Darnell-Renfrow	2	4.5															6	5.0		
Darnell-Wichita-Tillman	2	4.2																		
Delfina-Willacy	10	4.7																		
Delmita																				
Delmita-Delfina	1	4.0																		
Delmita-Nueces																				
Delmita-Zapata	4	3.8																		
Denton-San Saba	21	4.6			1	5.3													7	5.0
Denton-San Saba-Crawford	6	4.7																	12	5.0
Denton-(shallow)-Denton-San Saba	9	4.8																	7	5.0
Denton-(shallow)-Tarrant	8	4.6			7	3.9														
Denton-Tarrant	12	4.8																	4	4.8
Duffau-Bunyan																				
Duval-Delmita																				

Triaxial Cl.

10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	Avg.
																1 4.1
																1 4.0
																1 3.8
																8 3.5
																1 4.2
																1 4.2
															2 4.4	2 4.4
																5 4.2
										3 4.7						4 4.9
							7 4.7									16 5.4
									2 4.8							2 4.8
										1 4.2						1 4.2
										5 4.0						5 4.0
		3 4.2														3 4.2
										8 5.0						9 5.0
	3 3.6															13 4.3
																5 4.6
	5 3.3															15 4.2
																3 4.2
										1 4.5						1 4.5
															24 3.8	51 3.9
															5 3.5	5 3.5
																2 5.1
					1 3.1											13 4.5
																3 4.1
						9 4.8										18 4.8
											2 5.4					2 5.4
																30 4.0
																8 4.8
					21 2.9											22 3.0
								1 5.3								1 5.3
													12 4.5			20 4.4
							7 5.9									11 5.6
																2 6.0
																3 5.2
	1 4.3		2 5.4		11 5.0		17 5.7									118 5.1
					2 3.9											2 3.9
							10 5.4									12 5.4
											8 4.1					9 4.2
5 3.8									1 3.6							6 3.8
																4 3.9
																2 5.1
																4 3.7
													10 4.8			39 4.7
													4 5.0			4 5.0
													45 5.4			53 5.3
													7 4.5			9 4.4
						9 3.4										19 4.1
											8 4.4					9 4.4
											6 3.7					10 3.7
																29 4.7
																18 4.9
																16 4.9
																15 4.3
																16 4.8
											4 4.5					4 4.5

TABLE I

Soil Series	D·9 Lz		District 1		2		3		4		5		6		7		8		9	
Duval-Nueces																				
Duval-Webb																				
Duval-Webb-Comitas	4	4.0																		
Ector	2	4.4											5	2.9	1	4.3				
Ector-Cottonwood																				
Ector-Lozier																				
Ector-Ozona																				
Ector (Rough)													29	3.2						
Ector stony	1	3.8											70	3.2						
Eddy-Ellis																			2	3.2
Edge-Kirvin	3	4.7																		
Edge-Lufkin																				
Edge-Lufkin gravelly																				
Edge-Lufkin-Tabor																				
Edge-Sawyer	4	5.1																		
Edge-Tabor	14	4.9	2	5.1																
Edge-Tabor gravelly																				
Edna	1	5.5																		
Edna-Beaumont																				
Edna-Bernard	8	5.2																		
Edna-Bernard-Waller																				
Edna-Clodine-Waller																				
Edna-Katy	10	4.6																		
Edna(saline)																				
Ellis-Crockett			3	4.7																
Engle-Brennan-Copita																				
Engle-Cuero-Houston																				
Engle-Houston	1	5.0																		
Enterprise-Tipton	2	4.3																		
Enterprise-Tivoli																				
Eufaula	1	5.5																		
Eufaula-Arenosa	2	5.4																		
Eufaula-Nueces	1	4.3																		
Eufaula-Webb-Leming																				
Eustis-Axtell																				
Eustis-Lakeland	6	4.3																		
Ferris-Heiden	3	5.2																		
Foard-Wichita	4	4.9																		
Frio	6	4.5																		
Frio-Blanco	1	4.0																		
Frio-Krum																				
Frio-Leona																				
Frio-Lewisville	1	3.5																		
Frio-Norge	2	4.4																		
Frio-Trinity																				
Frio-Uvalde	1	4.3													7	4.2				
Frio-Venus-Bosque																				
Gageby-Rockhouse																				
Galveston																				
Galveston-Medio	3	4.0																		
Galveston-Mustang																				
Galveston-Nueces	1	4.5																		
Garner	4	5.1																		
Garner-Byars-Acadia	5	5.6																		
Gila-Cavot																				
Gila-Imperial	1	3.5																		
Goliad																				
Goliad-Kimbrough	7	4.7																		
Goliad-Zapata																				
Gowen	2	4.1																		
Gowen-Iuka																				
Gowen-Ochlockonee	1	5.5																		
Gravelly rough land									1	3.8										
Gravelly-stony rough																				
Guadalupe-Trinity																				
Gypland-Reeves	2	4.0											25	3.1						
Hannahatchee																				
Harbin	2	4.5																		
Harbin-Pedernales																				
Harbin-Windthorst-Stephenville																				
Harley-Pontotoc	6	3.9																		
Harlingen-Laredo	8	5.1																		
Harlingen-Laredo-Cameron	3	5.2																		
Harmon-Cottonwood																				
Harris																				
Harris marshlands																				
Hensley-Lindy																				
Hidalgo	11	4.7																		
Hidalgo-Brennan	10	4.1																		
Hidalgo-Harlingen	8	4.8																		
Hidalgo-Raymondville																				
Hidalgo-Willacy	36	4.2																		
Hidalgo-Zapata	2	4.5																		
Hockley-Crowley																				
Hockley-Katy																				
Hockley-Kenney																				
Hollister-Abilene	1	4.7																		
Houston-Austin-Eddy	3	5.7																		

Triaxial Cl.

10		11		12		13		14		15		16		17		18		19		20		21		22		23		24		25		Avg.	
																						11	4.4									11	4.4
										63	3.5													3	4.4							70	3.6
																																8	3.5
																												7	3.2			36	3.2
																																71	3.2
																3	6.0															5	4.9
																																3	4.7
														3	4.3																	3	4.3
														4	4.1																	8	4.6
						2	5.6			4	5.2			67	4.5	9	5.0															98	4.7
						4	5.9																									4	5.9
				2	4.5																											3	4.8
				7	5.0																											7	5.0
				12	5.5	12	5.2																									32	5.3
				8	4.0																											8	4.0
				25	4.0																											25	4.0
				4	4.1	21	5.1					4	4.0																			39	4.8
				6	4.4																											6	4.4
																																3	4.7
						4	5.5																									4	5.5
																																1	5.0
																																2	4.3
																														6	3.3	6	3.3
										16	4.0																					17	4.1
																																2	5.4
										13	3.5																					14	3.6
		2	3.9																													8	4.2
																																3	5.2
																																4	4.9
										29	4.5															5	4.3					40	4.5
										2	4.8													1	4.9							4	4.6
										6	5.2																					7	5.0
																																2	4.4
																										2	5.0					10	4.4
						1	3.4																									1	3.4
																																3	4.0
												4	4.1																			5	4.2
																																4	5.1
																				28	4.2											33	4.4
																												2	5.0			3	4.5
												26	4.1																			33	4.2
																																2	4.1
														3	5.2																	3	5.2
														1	3.8																	2	4.7
																																1	3.8
																																27	3.2
																																2	4.5
																																6	3.9
																						6	5.1									14	5.1
																						107	5.3									110	5.3
																				7	5.6											7	5.6
																				2	4.5											2	4.5
																						14	5.0									25	4.9
																						10	3.8									20	4.0
																						15	4.5									23	4.6
																						136	4.6									172	4.5
																																2	4.5
				9	3.7															2	4.2											11	3.8
																														3	5.0	4	4.9
																																3	5.7

TABLE I

District

Soil Series	D·9 L7		1		2		3		4		5		6		7		8		9	
Houston Black-Austin	2	5.8	8	5.3																
Houston Black-Burleson																				
Houston Black-Denton-Purves					2	3.8														
Houston Black-Heiden																				
Houston Black-Houston	61	5.4	13	5.7	11	5.2													16	5.3
Houston Black-Houston-Austin	4	5.4	3	4.8															19	5.3
Houston Black-Houston-Ellis	2	5.2																		
Houston Black-Hunt			3	5.9																
Houston Black-Knippa-Lewisville	2	4.9																		
Houston Black-Wilson																				
Houston-Bonham																				
Houston-Burleson	3	5.0																		
Houston-Crockett	2	5.5																		
Houston-Houston Black																				
Houston-Sumter	7	5.6																	10	5.3
Houston-Wilson-Crockett	2	5.5																		
Hunt-Burleson	3	5.8																		
Hunt-Houston Black																				
Hunt-Sumter-Houston	3	5.1																		
Independence-Huckabee																				
Irving-Burleson	1	6.0																		
Irving-Burleson-Lewisville																				
Irving-Vanoss			1	3.4																
Iuka-Bibb	4	4.6																		
Ivanhoe-Irving	3	5.1																		
Jiminez-Quemado	1	5.0																		
Kalmia-Cahaba																				
Katy-Edna																				
Katy-Hockley																				
Katy-Kenney																				
Katy-Waller																				
Kaufman																				
Kaufman-Gowen	1	5.5	1	4.0																
Kaufman-Navasota	2	5.0																		
Kaufman-Trinity																				
Kavett-Tarrant																				
Kavett-Valera-Tarrant	2	4.5																		
Kenney-Hockley																				
Kimbrough-Arvana											2	3.5								
Kimbrough-Engle	1	5.0																		
Kimbrough-Slaughter													25	2.9						
Kimbrough-Stegall	5	3.9											83	3.1						
Kirkland-Renfrow	6	4.4																		
Kirvin-Boswell																				
Kirvin-Bowie	2	4.6	2	4.6																
Kirvin-Bowie-Cuthbert	1	4.2																		
Kirvin-Bowie-Ruston	1	5.5																		
Kirvin-Bowie-Tabor	1	4.8			6	4.5														
Kirvin-Cuthbert	3	4.1																		
Kirvin-Cuthbert-Sawyer	5	4.5																		
Kirvin-Lakeland	2	4.3																		
Kirvin-Tabor-Bowie					15	4.1														
Klej-Cahaba-Myatt																				
Klej-Myatt																				
Knippa-Frio	1	4.5													3	4.0				
Knippa-Uvalde																				
LaCasa																				
LaCasa-Ector																				
LaCasa-Harmon																				
Lake Charles-Bernard	7	5.2																		
Lakeland																				
Lakeland-Bowie	4	4.6	1	4.3																
Lakeland-Byars																				
Lakeland-Cuthbert	9	4.7																		
Lakeland-Cuthbert-Bowie	1	4.5																		
Lakeland-Eustis	4	4.3																		
Lakeland-Eustis-Bowie																				
Lakeland-Ruston	3	5.5																		
Lakeland-Sawyer	2	4.3																	2	3.8
Lakeland-Tabor-Luverne	3	4.3																		
Laredo-Harlingen																				
Lee-Kimbrough																				
Leming-Miguel																				
Leming-Miguel-Nueces																				
Leona																				
Leona-Sinton	1	5.0																		
Leona-Zavala																				
Lewisville																				
Lewisville-Patrick																				
Likes-Lincoln																				
Likes-Springer-Tivoli									5	3.6										
Likes-Tivoli									4	3.6										
Lincoln																				
Lincoln-Yahola																				
Lomalta																				
Lomalta-Coastal marshland																				
Lomalta-Harlingen	1	5.0																		
Lomalta-Point Isabel																				

Triaxial Cl.

10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	Avg.
								5 5.2								15 5.3
								4 5.3								4 5.3
																2 3.8
		1 5.0	2 5.0	10 5.8	76 5.2		33 5.9	24 5.5								247 5.4
								3 5.4								29 5.3
																2 5.2
																3 5.9
					76 5.1											78 5.1
	1 4.8															4 5.0
			5 5.0													7 5.1
			1 4.9													1 4.9
																17 5.4
			2 5.4													4 5.5
								6 5.9								9 5.9
																3 5.1
							10 5.2									11 5.3
																1 3.4
2 4.2																6 4.5
																3 5.1
																1 5.0
									9 4.2							9 4.2
			2 4.3													2 4.3
		1 2.8														1 2.8
			2 4.3													2 4.3
		3 4.9														3 4.9
							1 5.9	1 5.9								4 5.3
																2 5.0
													1 4.2			1 4.2
																2 4.5
																2 3.5
																1 5.0
																25 2.9
																88 3.1
																6 4.4
12 3.8																16 4.0
12 4.6																13 4.6
										4 4.4						5 4.6
																7 4.5
	1 3.5															4 4.0
																5 4.5
																2 4.3
																15 4.1
										10 4.3						10 4.3
																4 4.1
															8 4.1	8 4.1
															4 3.9	4 3.9
		68 5.2	35 5.2													110 5.2
							1 4.2									1 4.2
4 4.3	1 4.0								2 4.1							12 4.3
							22 3.7									31 4.0
																1 4.5
10 3.8																14 3.9
										5 4.3						8 4.8
																4 4.1
					1 4.1		15 4.0									19 4.1
												1 4.8				1 4.8
					10 3.9											10 3.9
						8 5.2										9 5.2
					1 5.0											1 5.0
				2 6.0												2 6.0
																5 3.6
																4 3.6
											9 5.6					10 5.5

TABLE I

Soil Series	D·9 L7	District								
		1	2	3	4	5	6	7	8	9
Lozier-Gaddis										
Lucien-Vernon	1 5.0									
Lufkin-Edge	4 5.6									
Lufkin-Susquehanna										
Lufkin-Tabor-Edge										
Luverne-Tabor-Lakeland	2 4.7									
Mainstay-Brewster-Liv										
Maloterre-Purves-Dugout			3 4.7							
Mansker-Berthoud s.l.	2 4.5					6 3.7				
Mansker-Berthoud f.s.l.	1 4.0				4 4.4					
Mansker-Berthoud-Potter					6 4.3					
Mansker-Bippus	1 4.2				4 4.4					
Mansker-Miles										
Mansker-Potter	3 3.9				3 4.7		1 4.2		5 4.3	
Marsh										
Maverick	3 4.3									
Maverick-Montell	1 4.5									
Maverick-Montell-Catarina	5 4.3									
Maverick-Montell-Zapata										
Maverick-Zapata	1 5.5									
McAllen-Brennan	2 4.6									
McAllen-Copita	1 4.5									
McAllen-Zapata										
Medio-Delfina										
Medio-Miguel	5 4.8									
Medio-Tiocana										
Menard-Brackett-Duffau										
Mereta										
Mereta-Potter	2 4.0							22 3.7		
Mereta-Valera	5 4.3									
Midland-Beaumont										
Midland-Crowley-Harris										
Midland-Crowley-Hockley	3 5.3									
Midland-Crowley-Waller	1 4.2									
Miguel-Leming	3 4.5									
Miguel-Medio										
Miguel-Orelia	1 5.0									
Miguel-San Antonio	1 3.9									
Miguel-Willacy	2 5.2									
Miles	3 4.1									
Miles-Abilene										
Miles-Berthoud										
Miles-Brownfield										
Miles-Enterprise	2 4.0									
Miles-Mansker					11 3.7					
Miles-Olton					1 3.4					
Miles-Potter-Uvalde								2 3.5		
Miles-Springer	7 4.4				1 3.9				2 4.1	
Miles-Tipton	2 4.1									
Miles-Wichita	4 4.3									
Miller-Norwood	3 5.0									
Miller-Norwood-Pledger										
Miller-Norwood-Yahola	1 5.5									
Miller-Pledger	2 4.5									
Miller-Yahola										
Miller-Yahola-Trinity										
Minco-Brazos	1 4.0									
Minco-Teller	1 4.5									
Minco-Wilson		3 4.8								
Montell-Maverick	1 4.5									
Montell-Uvalde										
Monteola	3 5.0									
Monteola-Dant	6 4.7									
Monteola-Engle										
Monteola-Kimbrough	1 4.5									
Monteola-Tordia-Zapata	6 4.8									
Morey-Crowley-Waller										
Musquiz										
Musquiz-Santo Tomas										
Myatt-Ruston-Susquehanna										
Maverick-Catarina-Montell										
Nacogdoches-Alto										
Nacogdoches-Bub	7 4.4									
Nacogdoches-Magnolia	2 4.4									
Nacogdoches-Magnolia-Bub										
Navasota	1 5.7									
Navasota-Bibb										
Navasota-Ochlockonee										
Navasota-Swampland										
Nimrod-Pedernales-Windthorst	1 5.0									
Nimrod-Selden										
Nimrod-Windthorst	8 4.3									
Nimrod-Windthorst-Stephenville	1 4.5								8 4.7	
Nobscot-Brownfield										
Norfolk	1 4.2									
Norwood-Miller	3 4.4									
Norwood-Wichita								10 4.0		
Norwood-Yahola	1 4.5									
Nueces										
Nueces-Medio										
Nueces-Serita										

Triaxial Cl.

10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	Avg.
																1 5.0
							2 6.2									6 5.8
							21 4.3									21 4.3
			2 4.1				3 4.3									7 4.4
																3 4.7
																8 3.9
																5 4.3
																6 4.3
																5 4.4
															4 3.4	4 3.4
																12 4.3
											1 4.7					4 4.4
																1 4.5
												11 5.1				16 4.9
											38 5.5					38 5.5
																1 5.5
											4 4.3					6 4.4
																1 4.5
											17 3.8					17 3.8
											1 4.8					6 4.8
													9 4.6			9 4.6
													8 4.3			32 3.9
													21 4.8			26 4.7
										1 5.3						1 5.3
										27 5.1						30 5.1
										58 4.5						59 4.5
						1 3.4										4 4.2
						5 3.6										5 3.6
					3 5.3											4 5.2
																1 3.9
						6 3.8										8 4.2
															5 4.2	8 4.2
															5 3.8	5 3.8
																2 4.0
															2 3.8	13 3.7
																1 3.4
																2 3.5
															20 3.7	30 3.9
																2 4.1
															6 3.5	10 3.8
		1 3.8					3 5.3									7 5.0
		6 5.5														6 5.5
																1 5.5
																2 4.5
			4 4.5													4 4.5
																1 4.0
																1 4.5
																3 4.8
																1 4.5
																3 5.0
					7 4.4	2 4.2										15 4.5
																1 4.5
					2 4.5	6 5.1										14 4.9
												13 4.4				13 4.4
	2 2.9															2 2.9
18 4.6	1 4.1						1 6.2									27 4.6
	3 3.8						3 5.9									8 4.7
10 4.5																10 4.5
							1 5.9									2 5.8
										2 4.6						2 4.6
													2 4.0			3 4.3
													22 5.0			30 4.8
																9 4.7
																1 4.2
																3 4.4
																10 4.0
																1 4.5
											3 4.6					3 4.6
											10 4.6					10 4.6

TABLE I

Soil Series	D·9 L7		District																	
			1		2		3		4		5		6		7		8		9	
Nueces-Willacy	1	4.0																		
Ochlockonee-Bibb-Navasota																				
Olton											1	4.9								
Olton-Amarillo	5	3.7									51	3.8								
Olton-Berthoud									4	3.8										
Olton-Pullman									2	4.2	3	4.2								
Olton-Winters															5	4.0				
Orelia-Banquete	4	5.4																		
Orelia-Miguel	2	5.2																		
Orelia-Monteola-Tordia	3	4.9																		
Owens-Kirkland	2	4.4																		
Owens-Renfrow-Darnell	1	5.0																		
Owens-Tarrant																				
Owens-Windthorst-Darnell	1	4.3																		
Ozona-Uvalde																				
Pajarito									2	3.4										
Pecos-Arno	5	4.3											15	3.3						
Pedernales																				
Pedernales-Pontotoc																				
Pinal gravelly																				
Pinal-Reagan	2	4.0											74	3.2						
Pinal-Verhalen													40	3.6						
Pinal-Zapata																				
Plummer-Caddo																				
Portales											2	3.6								
Portales-Arch	1	3.8									2	3.6	34	2.9						
Portales-Berthoud-Drake																				
Portales-Drake																				
Portales-Mansker	1	4.0							6	4.5	1	4.8								
Portales-Pullman											3	4.0								
Portland-Yahola																				
Potter-Berthoud	1	4.5																		
Potter-Berthoud (rough)											5	3.9								
Potter-Bippus																				
Potter-Mansker	8	4.2							5	4.3			29	2.9			4	4.0		
Potter rough																				
Potter stony land																				
Potter-Vernon															3	3.8				
Pratt-Dalhart									1	4.6										
Puerta-Madrone-Loghouse																				
Pullman	21	4.4							38	4.7	73	4.4								
Pullman-Richfield	5	4.0							9	4.2										
Pullman-Ulysses																				
Pullman-Zita	3	4.5							3	4.5										
Quay-Montoya-Vernon																				
Quay-Vernon-Montoya																				
Quinlan (rough)																				
Quinlan-Woodward																	2	4.3		
Rains-Caddo																				
Reagan	8	4.1											77	3.4	1	4.5				
Reagan-Frio													6	3.3						
Reagan-Krum	1	3.8											88	3.3						
Reagan-Pinal																				
Reagan-Reeves															1	3.4				
Reagan-Sanderson																				
Reagan-Upton																				
Reagan-Verhalen	1	3.7											28	3.2						
Redona-Reagan-Verhalen																				
Reeves	12	4.1											22	3.0						
Reeves-Gypsum Land																				
Reeves-Pinal																				
Reeves-Toyah																				
Renfrow	11	4.4			9	4.4	1	3.8												
Renfrow-Chickasha	1	4.0																		
Renfrow-Chickasha-Kirkland	7	4.2					1	3.7												
Renfrow-Darnell	2	4.7																		
Renfrow-Kirkland	16	4.8			1	5.1	1	4.2												
Renfrow-Owens	5	5.1															16	5.4		
Richfield-Mansker									5	5.0										
Richfield-Ulysses	2	4.4							7	4.6										
Rio Grande-Camargo	1	5.0																		
Rio Grande-Matamoros																				
Roebuck-Pledger (saline)	1	5.5																		
Rough Broken land																				
Rowena-Mereta	2	4.5													45	4.0				
Rowena-Tabosa															1	4.3				
Runge-Engle	5	4.6																		
Runge-Miguel	1	5.0																		
Runge-Sarnosa	9	5.0																		
Sabine-Coastal land																				
Sabine-Galveston																				
Sabine-Hockley																				
San Antonio-Clareville																				
San Antonio-Clareville-Monteola	1	4.7																		
San Antonio-Miguel	1	3.8																		
Sanderson-Reagan													18	3.1						
San Saba-Crawford	8	5.2																	9	5.1

Trioxial Cl.

10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	Avg.
																1 4.0
		1 4.0														1 4.0
													2 3.9			3 4.2
																56 3.8
																4 3.8
															2 4.7	7 4.3
																5 4.0
																4 5.4
						12 4.0										14 4.2
						7 4.8										10 4.8
																2 4.4
																1 5.0
													1 3.1			1 3.1
																1 4.3
																2 3.4
																20 3.6
														3 3.3		3 3.3
																76 3.2
																40 3.6
											2 3.6					2 3.6
																2 3.6
																38 3.0
																8 4.5
																3 4.0
																1 4.5
															1 4.8	6 4.1
																46 3.4
																3 3.8
																1 4.6
															5 4.5	137 4.5
																14 4.1
																6 4.5
															3 4.0	5 4.1
										4 5.3						4 5.3
														1 4.4		87 3.5
																6 3.3
																89 3.3
														8 3.4		8 3.4
																1 3.4
														9 3.5		38 3.3
														2 3.9		2 3.9
																34 3.4
													10 4.8			31 4.5
																1 4.0
																8 4.1
																2 4.7
													27 4.9			45 4.9
													27 5.4			48 5.4
																5 5.0
																9 4.6
											2 3.6					3 4.1
																1 5.5
																47 4.0
																1 4.3
						2 3.7										7 4.3
																1 5.0
						16 4.5										25 4.7
					8 5.1											9 5.1
					2 5.1											3 4.7
																18 3.1
																17 5.2

TABLE I.

Soil Series	D·9 L7	District 1	2	3	4	5	6	7	8	9
San Saba-Denton	16 4.8		8 5.2							
San Saba-Denton-Crawford										
Sarnosa-Dant	2 5.0									
Sarnosa-Runge	1 5.5									
Sarnosa-Zapata	1 5.0									
Sawyer-Axtell										
Sawyer-Bowie										
Sawyer-Cuthbert										
Sawyer-Edge	2 5.7									
Sawyer-Edge-Lufkin	7 4.2	11 4.3								
Sawyer-Edge-Tabor										
Sawyer-Kalmia	1 4.5									
Sawyer-Kirvin	4 4.3									
Sawyer-Kirvin-Cuthbert	3 4.3									
Sawyer-Lakeland	1 5.5									
Sawyer-Lakeland-Bowie										
Sawyer-Lakeland-Ruston	11 4.5									
Sawyer-Susquehanna	8 4.6									
Serita-Falfurrias										
Simona-Potter						1 3.4				
Sinton	1 5.5									
Speck-Tarrant										
Springer	6 4.1						88 3.2			
Springer-Gomez							9 3.4			
Springer-Miles	1 4.7									
Springer-Miles-Nobscot										
Springer-Otero										
Spur										
Spur-Norwood	1 5.0									
Spur-Potter										
Spur-Yahola										
Stamford										
Stamford-Vernon	2 5.3								9 5.0	
Stegall-Arvana										
Stephenville-Darnell										
Stephenville-May										
Stephenville-Nimrod	8 4.2		1 4.7	1 4.7						
Stephenville-Windthorst										
Stidham-Webb-Miguel	1 5.5									
Stony rough land					5 4.0					
Susquehanna-Boswell	25 4.6									
Susquehanna-Bowie-Sawyer	3 4.7									
Susquehanna-Byars	5 4.8									
Susquehanna-Houston										
Susquehanna-Lufkin	14 4.5	6 4.8								
Susquehanna-Sawyer	15 5.0	7 4.2								
Tabor-Axtell	1 3.9									
Tabor-Crockett	1 3.6									
Tabor-Edge	2 4.3									
Tabor-Edge gravelly										
Tabor-Edge-Lakeland										
Tabor-Edge-Ruston	2 5.2									
Tabor-Lakeland										
Tabor-Lufkin										
Tarrant	3 4.8							13 4.3		
Tarrant-Brackett	40 4.6									3 4.7
Tarrant-Brackett stony										
Tarrant-Byrds										
Tarrant-Crawford	9 4.6		1 6.0							
Tarrant-Denton	7 4.7		7 5.2							
Tarrant-Denton stony										
Tarrant-Ector										
Tarrant-Kavett										
Tarrant Rough stony land										
Tarrant stony	7 4.5							11 3.8	21 5.6	
Tarrant stony-Valera										
Tarrant-Tobosa-Owens	1 5.0									
Tarrant-Valera	4 4.4							6 3.9		
Teller-Minco	1 4.0									
Teller-Vanoss										
Tillman-Foard	3 4.8									
Tillman-Foard-Hollister	9 5.2								42 4.8	
Tillman-Stamford										
Tillman-Vernon	6 4.8			1 4.2						
Tillman-Wichita-Vernon										
Tipton-Enterprise										
Tipton-Yahola-Altus										
Tishomingo										
Tishomingo gravel	1 3.6									
Tishomingo gravelly rough										
Tishomingo-Katemcy										
Tishomingo-Pontotoc	1 4.0									
Tivoli										
Tivoli-Brownfield	3 4.0					1 3.5	25 4.2			
Tivoli-Dalhart										
Tivoli-Likes										
Tivoli-Nueces										
Tivoli-Pratt					24 3.7					
Tivoli-Springer										
Tobosa										
Tobosa-Mereta-Tarrant	5 4.5									

Triaxial Cl.

	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	Avg.
																	24 4.9
									8 5.5								8 5.5
							9 4.2					4 4.7					15 4.4
																	1 5.5
												6 4.0					7 4.1
	1 3.4																1 3.4
																	2 5.7
																	18 4.3
								4 3.9									4 3.9
																	1 4.5
								13 4.2									17 4.2
																	3 4.3
			18 4.1					11 3.9									30 4.1
											3 4.3						3 4.3
																	11 4.5
	5 4.6	2 3.5															15 4.5
																	1 3.4
																	1 5.5
																	94 3.3
																	9 3.4
																6 3.7	7 3.8
															5 4.0		5 4.0
																	1 5.0
																	11 5.1
														1 3.1			1 3.1
																	10 4.3
														9 4.4			9 4.4
						26 4.6											27 4.6
																	5 4.0
		1 3.9															26 4.6
																	3 4.7
																	5 4.8
		7 3.5															27 4.3
	20 4.2	1 3.9						45 4.6									88 4.5
							1 3.9										2 3.9
						33 3.5											34 3.5
				10 4.4													12 4.4
																	2 5.2
								18 5.3									18 5.3
																	16 4.4
7						44 4.0								25 4.3			112 4.3
						5 2.8								20 5.1			35 4.7
																	14 5.0
						13 2.8											52 4.4
														9 4.6			10 4.6
														4 3.8			14 4.0
																	1 4.0
																	3 4.8
																12 4.6	63 4.8
																19 4.1	26 4.3
																	1 3.6
																	1 4.0
																	29 4.2
																	24 3.7
														53 4.8			58 4.8

TABLE I

Soil Series	D·9 L7	District 1	2	3	4	5	6	7	8	9
Tobosa-Ozona								5 4.2		
Tobosa-Valera										
Toyah										
Travessilla-Spade (Rough)										
Travis-Bastrop	1 4.5									3 3.5
Treadway-Miller	1 4.0									
Trinity	2 5.0									
Trinity-Catalpa	5 5.0									7 4.9
Trinity-Frio	2 4.5		5 4.7							
Trinity-Gowen										
Trinity-Kaufman	2 5.8									
Trinity-Norge	2 4.5									
Trinity-Zavala	1 4.3									
Truce-Bonti-Owens										
Ulysses-Mansker					3 4.1					
Ulysses-Pullman					3 4.4					
Upton										
Upton-Lozier-Reagan							16 2.6			
Uvalde-Copita										
Uvalde-Frio										
Uvalde-Knippa	3 4.3									
Uvalde-Knippa-Montell										
Uvalde-Krum										
Uvalde-Mereta	1 5.0									
Uvalde-Montell	4 4.3									
Uvalde-Trinity	1 4.5									
Uvalde-Zapata										
Valera	1 5.0									
Valera-Byrds										
Valera-Crawford										
Valera-Hensley	4 4.7									
Valera-Tarrant										
Verhalen-Reagan							27 3.4			
Vernon	5 4.8									
Vernon-Owens	5 4.7									
Vernon-Rough									6 4.7	
Vernon-Tillman								3 3.5		
Vernon-Tobosa										
Vernon-Weymouth	5 4.8									
Vernon-Weymouth-Rough	1 4.5					6 4.8				
Vernon-Wichita										
Victoria-Clareville	3 5.0									
Victoria-Orelia	23 5.2									
Volco-Brewster-Ector										
Vona-Berthoud					2 3.9					
Valera-Tabosa								3 4.9		
Webb-Crystal	2 4.0									
Webb-Duval	3 4.1									
Webb-Miguel	3 4.3									
Webb-Wilco	2 4.9									
Weymouth-Cottonwood										
Weymouth-Miles	1 4.7									
Wichita-Abilene										
Wichita-Miles										
Wichita-Vernon						3 5.4				
Wichita-Weymouth									3 4.3	
Wichita-Weymouth-Miles										
Wilco-Miguel	6 4.7									
Willacy	19 4.1									
Willacy-Delfina										
Willacy-Orelia	7 4.7									
Wilson-Burleson	21 5.2	3 5.5								20 4.9
Wilson-Burleson-Lewisville										
Wilson-Crockett	6 5.0	3 4.5								30 4.9
Wilson-Crockett gravelly										
Wilson-Houston										
Wilson-Hunt-Burleson	4 5.6	7 5.6								
Windthorst-Duffau			1 5.0							
Windthorst-Nimrod	6 4.3									
Windthorst-Stephenville	11 4.2		24 3.6							
Winters	1 5.0									
Winters-Olton-Latom								12 3.9		
Woodward-Quinlan										
Woodward-Quinlan-Rough										
Wrightsville-Hortman										
Wrightsville-Leaf										
Wrightsville-Teller		1 6.2								
Yahola-Miller	1 5.6									
Yahola-Norwood										
Zapata-Delmita										
Zapata-Goliad	3 4.9									
Zapata gravelly										
Zapata-Pinal-Uvalde										
Zapata-Quemado										
Zapata-Uvalde										

Triaxial Cl.

10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	Avg.
																5 4.2
																4 3.8
																1 4.0
																2 5.0
			1 5.3					12 5.7								25 5.3
					5 3.7											12 4.3
																2 5.8
													12 5.2			14 5.1
																1 4.3
																3 4.1
																3 4.4
																16 2.6
																3 4.3
												2 4.6				2 4.6
																1 5.0
												7 4.4				11 4.4
																1 4.5
													7 4.9			8 4.9
					1 3.1											1 3.1
																4 4.7
																27 3.4
															4 4.1	9 4.5
																5 4.7
																6 4.7
																3 3.5
															1 3.0	6 4.5
																7 4.8
						3 4.6										6 4.8
						69 5.2										92 5.2
														4 3.0		4 3.0
																2 3.9
																3 4.9
												4 4.7				6 4.5
												1 3.1				4 3.9
					46 4.8											49 4.8
																2 4.9
															1 4.4	1 4.4
															1 3.0	2 3.9
																3 5.4
															4 3.6	7 3.9
					8 4.8	1 3.6										15 4.7
											38 4.3					57 4.2
						5 5.1										12 4.9
							7 5.3	2 4.6								53 5.1
12 5.5								16 5.4								67 5.1
			4 5.6													4 5.6
																11 5.6
																1 5.0
																6 4.3
																35 3.8
													13 4.8			14 4.8
																12 3.9
															3 3.6	3 3.6
									2 4.7							2 4.7
									1 4.6							1 4.6
																1 6.2
																1 5.6
						1 4.2					2 4.1					6 4.5
					12 3.8											12 3.8
											2 3.2					2 3.2

TABLE 2.

U.S. SOIL CONSERVATION SERVICE GENERALIZED SOIL MAP DATE

Dist.	1		2		3		4	
	Delta	Sep 61	*Erath	Feb 66	Archer	Aug 62	Armstrong	Aug 63
	Fannin	Aug 61	Hood	Jul 60	Baylor	Aug 63	Carson	Jun 60
	Franklin	Aug 60	Jack	Aug 62	Clay	Aug 62	Dallam	Aug 63
	Grayson	1962	Johnson	Aug 63	Cooke	Jul 62	Deaf Smith	Jul 63
	Hopkins	Sep 61	Palo Pinto	Jul 60	Montague	Aug 62	Gray	Dec 62
	Hunt	Aug 61	Parker	Aug 63	Throckmorton	Dec 63	Hansford	Aug 63
	Lamar	Aug 61	Somervell	Jul 60	Wichita	Aug 62	Hartley	Aug 63
	Rains	Sep 61	Tarrant	Aug 63	Wilbarger	Jun 60	Hemphill	Mar 65
	Red River	Aug 60	Wise	Aug 62	Young	Aug 62	Hutchinson	Dec 63
							Lipscomb	Aug 63
							Moore	Dec 63
							Ochiltree	Aug 63
							Oldham	Dec 63
							Potter	Dec 60
							Randall	Aug 60
							Roberts	Jul 63
							Sherman	Aug 63

Dist.	5		6		7		8	
	Bailey	Aug 60	Andrews	Aug 63	Coke	Jan 65	Borden	Dec 63
	Castro	Aug 63	Crane	Aug 63	Concho	Aug 63	Callahan	Aug 63
	Cochran	Aug 60	Ector	Sep 63	Crockett	Aug 60	Fisher	Jul 60
	Crosby	Aug 63	Loving	Aug 63	Glasscock	Jan 66	Haskell	Aug 60
	Dawson	Jul 62	Martin	Dec.65	Irion	Dec 65	Howard	Nov 63
	Floyd	Sep 63	Midland	Dec 65	Kimble	Aug 63	Jones	Dec 63
	Gaines	Dec 63	Pecos	Aug 63	Menard	Dec 62	Kent	Dec 63
	Garza	Dec 63	Reeves	Aug 63	Reagan	Dec 65	Mitchell	Nov 63
	Hale	Aug 60	Terrell	Dec 65	Runnels	Jun 60	Nolan	Dec 63
	Hockley	May 64	Upton	Dec 65	Schleicher	Dec 62	Scurry	Dec 63
	Lamb	Jul 62	Ward	Dec 63	Sterling	Jan 65	Shackleford	Aug 63
	Lynn	Jul 62	Winkler	Aug 63	Sutton	Dec 62	Stonewall	Dec 63
	Lubbock	Aug 60			Tom Green	Jan 65	Taylor	Dec 63
	Parmer	Aug 63						
	Swisher	Aug 63						
	Terry	Jul 62						
	Yoakum	Jul 62						

Dist.	9		10		11		12	
	Bell	Aug 60	Anderson	Sep 63	Angelina	Aug 63	Austin	Aug 61
	Bosque	Jul 60	Cherokee	Aug 60	Houston	Sep 63	Brazoria	Aug 63
	Coryell	Aug 63	Gregg	Jul 62	Nacogdoches	Jun 60	Fort Bend	Jul 62
	Falls	Aug 61	Henderson	Sep 63	Polk	Aug 62	Galveston	Nov 62
	Hamilton	Aug 63	Rusk	Jul 62	Sabine	Aug 63	Harris	Sep 62
	Hill	Aug 61	Smith	Aug 62	San Augustine	Aug 63	Matagorda	Sep 60
	Limestone	Aug 61	Wood	Sep 61	San Jacinto	Sep 62	Montgomery	Sep 62
	McLennan	Aug 61	Van Zandt	Sep 63	Shelby	Aug 62	Waller	Sep 62
					Trinity	Aug 62		

* Maps on hand; but of poor quality

TABLE 2.

U.S. SOIL CONSERVATION SERVICE GENERALIZED SOIL MAP DATE

Page Two

Dist.	13		14		15		16	
	Calhoun	Jul 61	Bastrop	Jul 61	Atascosa	Jan 65	Aransas	Jul 66
	Colorado	Jul 61	Blanco	Aug 63	Bandera	Aug 60	Bee	Jan 65
	**DeWitt		Burnet	Aug 63	Bexar	Nov 64	Goliad	Jan 65
	Fayette	Jun 60	Caldwell	Aug 61	Comal	Aug 61	Jim Wells	Jan 65
	Gonzales	Jul 60	Gillespie	Aug 60	Frio	Jan 65	Karnes	Jun 69
	Jackson	Jul 61	Hays	Aug 61	Guadalupe	Aug 61	Kleberg	Dec 63
	Lavaca	Jul 61	Lee	Aug 60	Kendall	Aug 63	Live Oak	Jun 69
	Victoria	Jul 61	Llano	Aug 60	Kerr	Aug 63	Nueces	Jun 63
	Wharton	Sep 62	Mason	undated	LaSalle	Jan 65	Refugio	Jan 65
			*Travis	Oct 69	McMullen	Jan 65	San Patricio	Jul 61
			Williamson	Aug 61	Medina	Jan 65		
					Wilson	Jun 69		

Dist.	17		18		19		20	
	Brazos	Aug 61	Collin	Aug 61	Bowie	Jul 60	Chambers	Sep 62
	Burleson	Jun 60	Dallas	Aug 61	Camp	Aug 60	Hardin	Sep 62
	Freestone	Aug 62	Denton	Aug 62	Cass	Jul 62	Jasper	Aug 63
	Grimes	Sep 62	Ellis	Aug 61	Harrison	Jul 62	Jefferson	Aug 62
	Leon	Sep 62	Kaufman	Aug 61	Marion	Jul 62	Liberty	Aug 62
	Madison	Jul 62	Navarro	Aug 60	Morris	Aug 60	Newton	Aug 63
	Milam	Aug 61	Rockwall	Aug 61	Panola	Jul 62	Orange	Aug 62
	Robertson	Jul 61			Titus	Aug 60	Tyler	Sep 62
	Walker	Sep 62			Upshur	Jul 62		
	Washington	Aug 61						

Dist.	21		22		23		24	
	Brooks	Aug 63	Dimmit	Jan 65	Brown	Jan 69	Brewster	Nov 65
	Cameron	Aug 60	Edwards	Aug 63	Coleman	Aug 63	Culberson	Jan 64
	Duval	Jun 69	Kinney	Aug 61	Comanche	Aug 63	El Paso	Aug 63
	Hidalgo	Aug 63	Maverick	Jan 65	Eastland	Aug 63	Hudspeth	Aug 63
	Jim Hogg	Aug 63	Real	Aug 63	Lampasas	Aug 63	Jeff Davis	undated
	Kenedy	Aug 60	Uvalde	Aug 61	McCulloch	Aug 63	Presidio	Jan 66
	Starr	Dec 65	Val Verde	Jul 62	Mills	Aug 63		
	Webb	Jun 60	Zavala	Jan 65	San Saba	Jun 61		
	Willacy	Aug 63			Stephens	Aug 63		
	Zapata	Aug 60						

Dist.	25	
	Briscoe	Aug 63
	Childress	Aug 63
	Collingsworth	Jan 65
	Cottle	Aug 63
	Dickens	Aug 63
	Donley	Sep 63
	Foard	Jun 60
	Hall	Feb 63
	Hardeman	Jun 60
	King	Dec 63
	Knox	Aug 63
	Motley	Aug 63
	Wheeler	Dec 63

** No map available

APPENDIX I

Test Method Tex-117-E
Rev: January 1, 1972

Texas Highway Department

Materials and Tests Division

TRIAXIAL COMPRESSION TESTS FOR DISTURBED SOILS AND BASE MATERIALS

Scope

This method of procedure provides for the determination of the shearing resistance, water absorption and expansion of soils or soil aggregate mixtures. The test consists of applying an axial load to cylindrical specimens of definite dimensions, supported by various known lateral pressures until failure occurs. The test method is applied in Part I to laboratory compacted specimens of disturbed soil or material containing aggregate with the largest size particle passing the 1-3/4 inch sieve. Part II describes an accelerated procedure which has been carefully correlated with the standard method of Part I. It is intended to use the accelerated method to control the quality of material during construction.

Definitions

1. Triaxial Test: A test in which force is applied in three mutually perpendicular directions.

2. Axial Load: This force is the sum of the applied load and dead load which includes the weight of the top porous stone, metal block and bell housing and applied along the vertical axis of the test specimen.

3. Lateral Pressure: The force supplied by air in the cell and is applied in a radial or horizontal direction.

4. Unit Stress: This term is defined as the axial load divided by the end area of the cylindrical specimen.

5. Strain: Strain is unit deformation and equal to deformation of specimen divided by the original height often expressed as a percentage.

6. Mohr's Diagram: A graphical construction used in analyzing data from tests on bodies acted on by combined forces in static equilibrium which shows more information as to physical properties of the material than other methods in common use.

7. Mohr's circle of failure: A stress circle constructed from principal stresses acting on the specimen at failure.

8. Mohr's envelope of failure: The envelope of failure is the common tangent to a series of failure circles constructed from different pairs of principal stresses required to fail the material. The envelope is generally curved, its curvature depending on the factors related to the characteristics of the material.

Apparatus

1. Apparatus used in Test Methods Tex-101-E and Tex-113-E
2. Axial Cells, lightweight stainless steel cylinders; 6-3/4 inches inside diameter and 12 inches in height, fitted with standard air valve and tubular rubber membrane 6 inches in diameter (Figure 1).
3. Aspirator or other vacuum pump
4. Air Compressor
5. Damp room or moist cabinet equipped with shelves and regulated air pressure.
6. Screw jack press and assembly (Figure 3)
7. Pressure regulator, gauges and valves
8. Micrometer dial gauge, calibrated in 0.001 inch, with support to measure deflection of specimen.
9. Dial housing and loading block to transmit load to cylindrical specimen
10. Calibrated proving rings according to A.S.T.M. Designation E 4-57T.
11. Circumference measuring device, special made metal tape measure (Figure 5).
12. Lead weights for surcharge loads
13. Rectangular stainless steel pans 9" x 16" x 2 1/4 inches deep equipped with porous plates

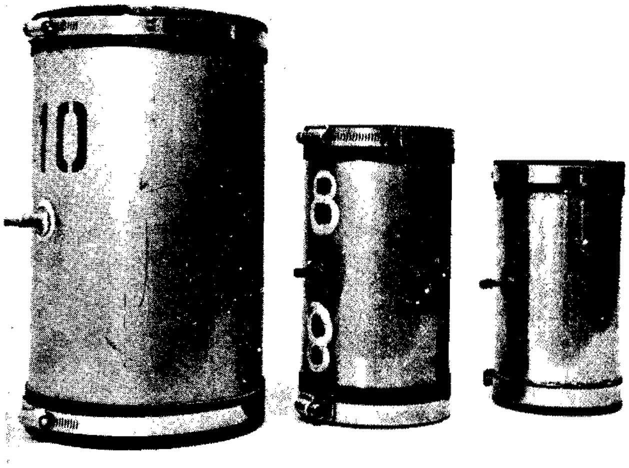


Figure 1
Axial Cells of Various Sizes

Figure 2
Capillary Wetting of Triaxial Specimens

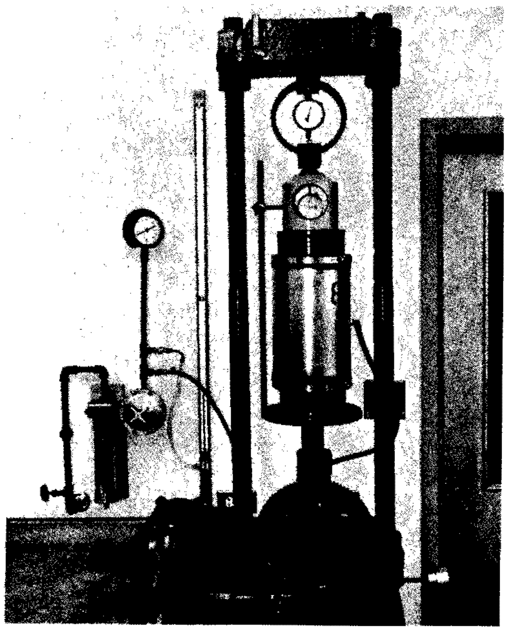


Figure 3
Press Assembly with Specimen in Place

Test Record Forms

Record test data on Form No. 1062, Figure 10, M/D and Triaxial Test Work Sheets, Figure 9, and Triaxial Compression Test Capillary Wetting Data, Figure 8. After test and calculations are completed, summarize results on Triaxial Test Summary Sheet, Figure 15.

Preparation of Sample

Prepare approximately 200 pounds of material according to the procedure given in Part II of Test Method Tex-101-E. See general notes.

PART I

STANDARD TRIAXIAL COMPRESSION TEST

Procedure

A. Determining Moisture-Density Relations

Determine the optimum moisture and maximum density as outlined in Test Method Tex-113-E, using the compactive effort specified for the type of material being tested.

B. Compaction of Test Specimens

1. Follow steps 1 through 12 under procedure of Test Method Tex-113-E and mold at optimum moisture a total of seven specimens, including the specimen from the peak of the M-D Curve for all materials containing aggregates. (Base and subbase materials). For fine grain soils or those containing small amounts of aggregates mold a total of six specimens at optimum moisture and density conditions. These specimens should be six inches in diameter and 8 inches in height to the nearest 1/4 pound of dry material. These test specimens should be wet, mixed, molded and finished as nearly identical as possible. Identify each test specimen by laboratory number and specimen number.

2. Immediately after extruding the specimen from the mold, enclose the specimen in a triaxial cell, with top and bottom porous stones in place and allow all the specimens to set undistrubed at room temperature until the entire set of test specimens has been molded. Record data on M-D and Triaxial Work Sheet shown in figure 9.

Notes

When a different compactive effort is desired, a complete new M-D Curve and test specimens must be molded.

C. Curing Test Specimens

After the entire test set has been completed remove the triaxial cells and dry cure the specimens according to the type of material. To avoid excessive cracking which will damage the specimen the dry curing is accomplished as follows:

1. For flexible base materials and select granular soils with little or no tendency to shrink, place specimens in the oven air dryer and remove 1/3 to 1/2 of the molding moisture content at a temperature of 140° F. (This will require about 3 to 6 hours depending on the material, the optimum moisture content and the load of other wet material in the oven.) Allow the specimens to return to room temperature before preparation for and subjection to capillarity.

2. Very plastic clay subgrade soils subject to large volume change crack badly while shrinking. Air dry these soils at room temperature inspecting the specimens frequently by looking at the sides of the specimens and raising the top porous stones to examine the extent of cracking at the top edges of the specimens. When these cracks have formed to a depth of approximately 1/4 inch, replace the triaxial cell and prepare the specimens for capillary wetting.

3. For moderately active soils that might crack badly if placed in air dryer for full curing time, dry at 140°F and check frequently for the appearance of shrinkage cracks. If cracks appear, examine the extent of cracking as described under step 2, and allow some air drying at room temperature during the cooling period before enclosing specimens in cells.

D. Subjecting Test Specimens to Capillary Absorption

1. The specimens are now ready to be prepared for capillary wetting. Do not change the porous stones or otherwise remove them until the specimens have been tested. Weigh each specimen and its accompanying stones and record weight. Cut a piece of filter paper 10 in. by 20 in. in size, fold to 5 in. by 20 in. make several cuts with scissors (Jack-o-lantern fashion). These cuts will prevent any restriction by the paper. Wrap the filter paper around the specimen and stones, allowing the bottom of the paper to be near the bottom of the bottom porous stone, and fasten with a piece of cellophane tape. Replace cell by applying a partial vacuum to the cell, deflating the rubber membrane, then place the cell over the specimen and release the vacuum.

2. Transfer the specimens to the damp room and place them into the rectangular pans provided for capillary wetting shown in picture of damp room, Figure 2. Adjust the water level on the lower porous stones to a distance of approximately 1/2 inch below the bottom of the specimens. Add water later to the pans, as necessary, to maintain this level. Note schematic arrangement, Figure 4.

3. Connect each cell to the air manifold and open valve to apply a constant lateral pressure of 1 p.s.i. Maintain this constant pressure throughout the period of absorption.

4. Next, place a suitable vertical surcharge load (which will depend upon the proposed use or location of the material in the roadway) on the top porous stone. For flexible base use 1/2 pound per square inch and for subgrade soils use 1 pound per square inch of end area of the specimen. Consider the weight of the top porous stone as part of the surcharge weight, Figure 4.

5. Subject all flexible base materials and soils with plasticity index of 15 or less to capillary absorption for 10 days. Use a period of time in days equal to the plasticity index of the material for subgrade soils with PI above 15. Keep the specimens in the damp room, equipped with spray system, during the period of capillary absorption.

E. Preparing Specimens for Testing

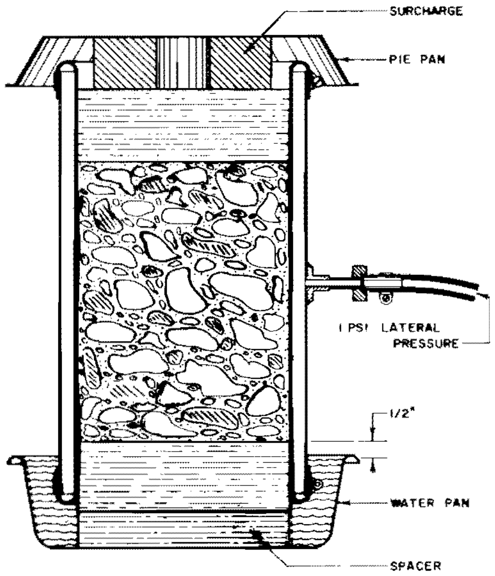


Figure 4
Schematic Arrangement for Capillary Wetting

1. Disconnect air hose from cell, remove surcharge weight and return specimens to laboratory for testing. Use a vacuum and deflate the rubber membrane to aid in removing the cell from specimens and discard filter paper. If any appreciable material clings to paper, carefully press it back into the available holes along the side of the specimen.

2. Weigh the specimens and record as total weight after capillary absorption. Note that the wet weight of stones are obtained after the specimens are tested. Record on Figure 8.

3. Measure the circumference of each specimen by means of the metal measuring tape. Measure the height of the specimen including the stones, and enter on data sheet as height over stones. Also record the height of each stone (Figures 5 and 6).

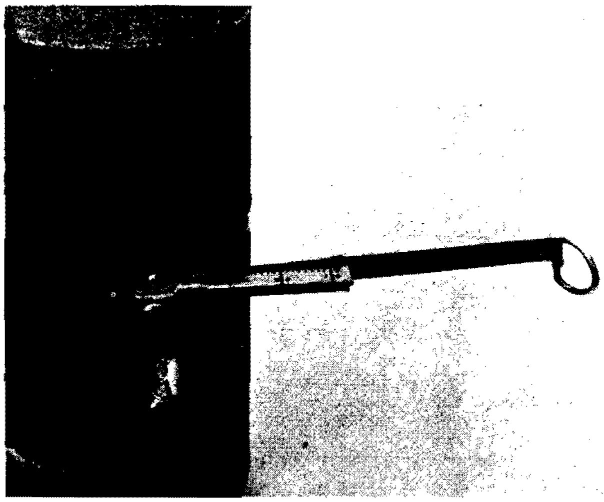


Figure 5
Circumference Measuring Device

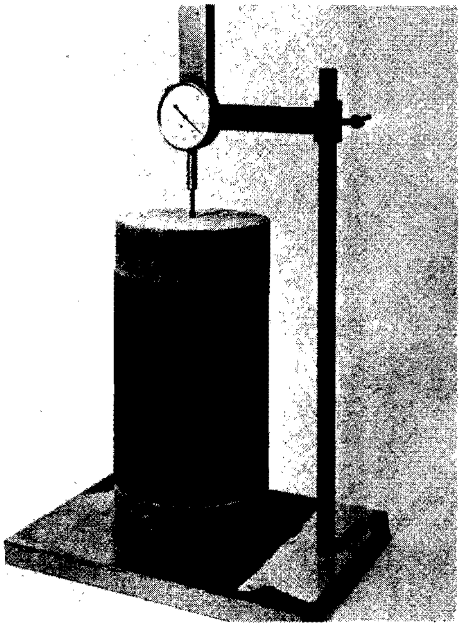


Figure 6
Measuring Overall Height of Specimen and Stones

4. Replace the axial cell on the specimen, release the vacuum, and the specimen is ready to be tested. The cell need not be placed on the specimen to be tested at zero lateral pressure if tested immediately after preparation. It is important to keep the proper identification on the specimens at all times because weights, measurements, test values and calculations are determined for each individual specimen.

F. Testing Specimens

In brief, the specimens are tested in compression while being subjected to their assigned constant lateral pressure. The motorized press is geared to travel at the rate of 0.135 inches per minute plus or minus 0.015 inches per minute. Simultaneous readings of load and deformation are taken at intervals of 0.01 inch deformation until specimen fails, Figure 7.

1. Disengage the worm gear drive and crank the press down far enough to have room to place specimen, metal loading blocks and the special bell dial housing in the press.

2. Center the specimen with upper and lower metal loading blocks in place in the press. Adjust the deformation gauge in such a manner that it will be down against the center of the top spacer block and also compressed for almost the length of travel of the stem. The gauge must be placed in this position since the specimen moves away from the gauge during the compression. Set the dial of the strain gauge to read zero.

3. Next, set the bell housing over the strain gauge and adjust so that it does not touch the gauge or its mounting. At this point it should be noted that the compressive stress will necessarily be applied along a vertical line through the center of the ball that is mounted in the top of the bell housing. Since it is desirable to apply the compressive force along the vertical axis of the test specimen, shift the bell housing laterally to bring the ball directly over the axis of the specimen. Raise the press by means of the motor, align and seat the ball on the bell housing into the socket in the proving ring. Then apply just enough pressure to obtain a perceptible reading on the proving ring gauge. Read the strain gauge and record as deformation under dead load.

4. Connect the air line to the axial cell and apply lateral pressure to the specimen. The usual lateral pressures used for a series of tests are 0, 3, 5, 10, 15, and 20 p.s.i. In cases where the load or stress is high (175 - 180 p.s.i.) for the specimen tested at 15 p.s.i. lateral pressure, use 7 p.s.i. instead of 20 p.s.i. for the last specimen. The lateral pressure applied by the air will tend to change the initial reading of the strain gauge. As the air pressure is adjusted, start the motor momentarily to compress the specimen until the deformation gauge reads the same as recorded in step 3. Read the proving ring gauge and enter in load column opposite the initial deformation reading. (Figure 10)

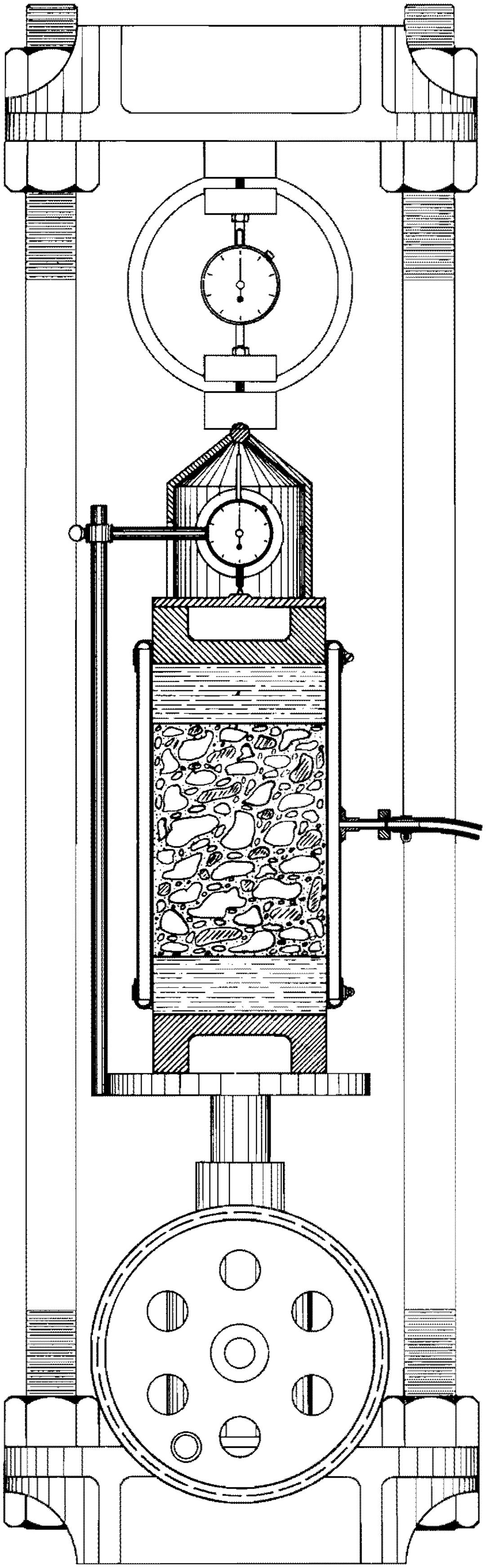


Figure 7a

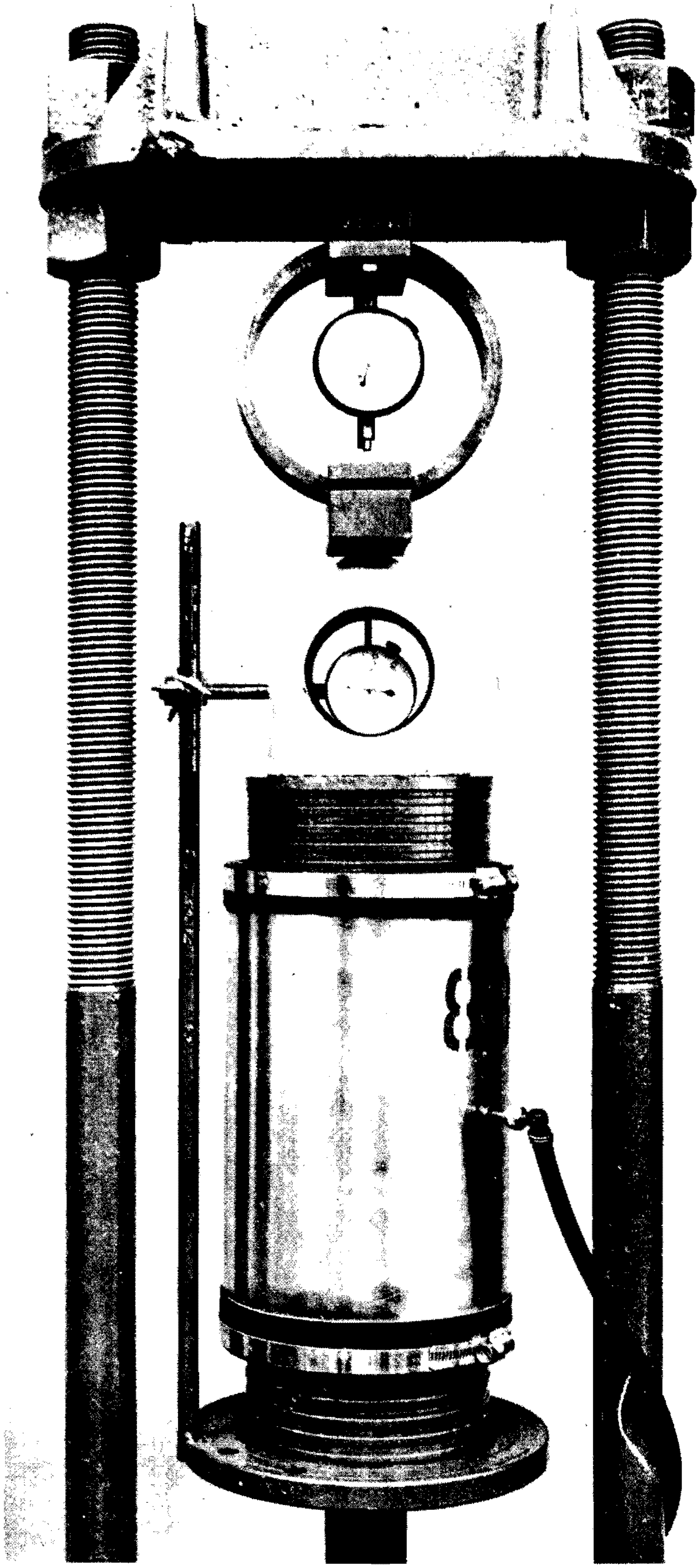


Figure 7b

Press Assembly for Triaxial Test

5. The test is ready to be started. Turn on the motor and read the proving ring dial at each .01 inch deformation of the specimen. Continue readings until 60 readings have been taken unless failure occurs earlier. Failure is reached when the proving ring dial readings remain constant or decrease with further increments of deformation. In testing specimens with aggregates, the slipping and shearing of aggregates will cause temporary decreases in proving ring readings. The test should be continued until true failure is reached. After 60 readings the cross sectional area of the specimen has increased so that the subsequent small increase in load readings is little more than the increase in tension of the membrane acting as lateral pressure.

6. All of the above procedure applies to the unconfined specimen except that no air or axial cell is used. For materials which contain a large amount of aggregate, compact and test two specimens at zero lateral pressure. Use average of test results unless large rocks appear to have created point bearing; in this case use highest value.

G. Obtaining Dry Weight of Specimens and Stones

1. The specimen and stones are removed from the cell over a flat tared drying pan. Use a spatula to clean the material from the inside of cell and stones. Break up the specimen taking care to lose none of the material and place the identification tag in the tray.

2. Dry the material to constant weight at a temperature of 230°F and determine the dry weight.

3. The damp stones are weighed, dried at 140°F and the dry weight obtained. This weight completes the test procedure.

Calculations

1. Volume of compacted specimen = volume per inch of mold x height of specimen.

2. Calculate dry density of specimen as follows:

$$\text{Dry density} = \frac{\text{Dry weight of specimen in pounds}}{\text{Volume of specimen in cu. ft.}}$$

3. Molding moisture =

$$\frac{\text{Weight of specimen wet - weight of specimen dry}}{\text{Weight of specimen dry}} \times 100$$

4. Calculate the percentage of volumetric swell by the expression:

$$V_S = \frac{V_A - V_M}{V_M} \times 100$$

Where:

V_S = Percentage volumetric swell

V_A = Volume of specimen after capillary absorption

V_M = Volume of specimen as molded

5. Calculate the moisture before and after capillarity as follows:

Where:

M_C = Percent moisture in specimen after capillarity
M_B = Percent moisture in specimen before capillarity

$$M_C = \frac{W_A - W_B - W_D}{W_D} \times 100$$

$$M_B = \frac{W_C - W_S - W_D}{W_D} \times 100$$

W_A = Wet weight of specimen and stones after absorption
W_B = Wet weight of stones
W_C = Weight of specimen and stones before capillarity
W_D = Correct oven-dry weight of specimen
W_S = Dry weight of stones

6. Calculate the values of stress and strain for each individual specimen from the following relations:

$$S = \frac{d}{h} \times 100$$

Where:

S = Percent strain
d = Total vertical deformation at the given instant, measured in inches by strain gauge.
h = The height of the specimen in inches, measured after specimen is removed from capillarity.

$$p = \frac{P}{A}\left(1 - \frac{S}{100}\right)$$

Where:

p = The corrected vertical unit stress in pounds per square inch

A correction is necessary because the area of the cross-section increases as the specimen is reduced in height. The assumption is made that the specimen deforms at constant volume.

TRIAXIAL COMPRESSION TEST CAPILLARY WETTING DATA

LAB. NO. ____________

Sample No.												
Cell No.												
Lbs. of Added Surcharge												
Date Molded												
Date in Air Dryer												
Date in Capillarity												
Date out Capillarity												
Heighth in Capillarity												
Heighth out Capillarity												
Weight after Air Dry												
Dry Weight Stones												
Dry Weight Sample												
Weight Moisture in Sample												
% Moisture to Capillarity												
Weight after Capillarity												
Wet Weight Stones												
Wet Weight Sample												
Dry Weight Sample												
Weight Moisture in Sample												
% Moisture after Capillarity												
Remarks:												

Figure 8

M/D & TRIAXIAL WORK SHEET

LAB NO.____________

____% HYGRO ALLOWED

Date Molded												
Sample No.												
Compactive Effort												
Total % Water												
Pounds Material												
Pounds Water Desired												
Pounds Hygroscopic Water												
Pounds Water Added												
Tare Weight of Jar												
Weight Jar and Water												
Mold No.												
Wet Wt. Specimen & Mold												
Tare Weight Mold												
Wet Weight Specimen												
Height of Mold												
Dial Reference												
Dial Reading												
Height Specimen												
Vol. per Linear Inch												
Vol. of Specimen												
Wet Density Specimen												
Dry Weight Pan & Specimen												
Tare Weight Pan												
Dry Weight Material												
Weight Water												
Percent Water on Total												
Dry Density												
Guestimated Dry Density												

Figure 9

FORM 1062

TRIAXIAL TEST DATA SHEET

Lab. No.______ Area______ Circumference______ Ht. / Stones______
Specimen No.______ 1 / A______ Avg. Dia.______ Stones______ & ______
Lat. Pressure______ * ______ / A______ Strain Rate = .15"/min. New Height______
Date Molded______ ______ ft. lbs./cu. in. Compaction
Date Tested______ Initial Vol.______ Final Vol.______ % Vol. Swell______
No. Days in Cap.______
* Ring Factor______
Dead Load______ Lbs.
DL / A______ Psi

$$\text{Strain} = \frac{.01}{\text{New Ht.}} = \frac{.01}{\_\_\_\_\_\_} = \_\_\_\_\_\_$$

Deformation	Load	Uncorr'd. Stress	1−Strain	% Strain	Corrected Stress	Deformation	Load	Uncorr'd. Stress	1−Strain	% Strain	Corrected Stress
.01						.31					
.02						.32					
.03						.33					
.04						.34					
.05						.35					
.06						.36					
.07						.37					
.08						.38					
.09						.39					
.10						.40					
.11						.41					
.12						.42					
.13						.43					
.14						.44					
.15						.45					
.16						.46					
.17						.47					
.18						.48					
.19						.49					
.20						.50					
.21						.51					
.22						.52					
.23						.53					
.24						.54					
.25						.55					
.26						.56					
.27						.57					
.28						.58					
.29						.59					
.30						.60					

Figure 10

P = The total vertical load on the specimen at any given deformation expressed in pounds. It is the sum of the applied load measured by the proving ring plus the dead weight of the upper stone, loading block and dial housing.

A = The end area of cylindrical specimen expressed in square inches at the beginning of test.

Graphs and Diagrams

1. Plot the moisture-density curve shown in Figure 8 of Test Method Tex-113-E.

2. Plot the stress-strain diagram as shown in Figure 12 when requested.

3. The Mohr's diagram of stress (Figure 13) is constructed upon coordinate axes in which ordinates represent shear stress and abscissas represent normal stress, both expressed as pounds per square inch to the same scale.

L = Minor principal stress which is the constant lateral pressure applied to the specimen during an individual test.

V = The major principal stress which is the ultimate compressive strength or the highest value of p determined at the given lateral pressure.

Each individual test will be shown by one stress circle drawn as follows:

Plot L and V on the base line of normal stress. Locate the center of each circle a distance of (V + L)/2 from the origin and construct a semi-circle with its radius equal to (V - L)/2 intersecting the base line at V and L. Repeat these steps for each specimen tested at different lateral pressures to provide enough stress circles to define the failure envelope on the Mohr's diagram.

Draw the failure envelope tangent to all of the stress circles. Since it is practically impossible to avoid compacting an occasional specimen that is not identical with the other specimens in the same set, disregard any stress circle that is obviously out of line when drawing the tangent line.

Classification of Material

Transfer the envelope of failure on to the chart for classification of subgrade and flexible base materials (Figure 14) and classify the material to the nearest one-tenth of a class. When the envelope of failure falls between class limits, select the critical point or weakest condition on the failure envelope. Measure the vertical distance down from a boundary line to the point to obtain the exact classification (3.7) as shown in Figure 14.

Reporting Test Results

Report the soil constants, grading and Texas Ball Machine Value for the aggregate on Form 476-A. Summarize test results on Triaxial Test Summary Sheet, Figure 15, and strength classification plotted as given in Figure 14.

PART II

ACCELERATED METHOD FOR TRIAXIAL COMPRESSION OF SOILS

This accelerated procedure is based on a correlation with the standard method for Triaxial Compression Test, Part I., performed on a large number of different types of soils. Generally it is intended to use the accelerated test to control the quality of base materials of group (d) during stockpiling and in such cases roadway samples will not necessarily be considered to be representative.

Procedure

1. Prepare all materials in accordance with Test Method Tex-101-E, Part II.

2. Determine the optimum moisture and maximum density as outlined in Test Method Tex-113-E with the following addition that materials having a P.I. of 20 or above and containing aggregate; wet the portion passing the No. 10 sieve and retained on the No. 20 sieve with the aggregate.

3. Group the soils into five general types of materials and treat as follows:

a. Fine granular materials with plasticity index less than 5
b. Non-swelling soils with plasticity index of 5 through 11.
c. Swelling subgrade soils, plasticity index of 12 or more.
d. Flexible base and subbase materials with considerable amounts of aggregate.
e. Combination soil types

Group (a)

Fine Granular Materials with Plasticity Index Less Than 5

5

1. Mold 6 specimens 6 inches in diameter and 8 inches in height at the optimum moisture and density, using the same compactive effort that was specified in Test Method Tex-113-E.

2. Cover the specimen (with stones in place) with a triaxial cell immediately after removing from mold

and allow to set over night undisturbed at room temperature. Do not dry cure or subject specimens to capillary absorption.

3. Test the specimens at the usual lateral pressures.

4. Calculate unit stress, plot diagrams and classify material.

Group (b)

Non-Swelling Soils with Plasticity Index of 5 thru 11

1. Compact a set of 6 identical specimens at the optimum moisture and density condition.

2. Use filter paper, lead surcharge weights and air pressure for lateral support and subject the specimens to capillary absorption over night as described in Section D of Part I.

3. The next morning, remove filter paper and test the specimens at the usual lateral pressure shown above. Calculate unit stress, plot diagrams and classify material.

Group (c)

Swelling Subgrade Soils, Plasticity Index of 12 or More.

1. Obtain the plasticity index and hygroscopic moisture of these soils in advance of molding specimens.

2. Determine the optimum moisture and dry density of the materials as outlined in Test Method Tex-113-E, using the compactive effort specified in Test Method Tex-113-E under Compactive Effort

3. Calculate the molding moisture to use as follows: Percent Molding Moisture = (1.4 x optimum moisture) - 2.2

4. Obtain the desired molding density from the following expression:

$$\text{Molded Dry Density} = \frac{\text{Optimum dry density (step 2)}}{1 + \frac{\text{percent volumetric swell}}{100}}$$

To determine the percent volumetric swell to be expected, use average condition in chart shown in Figure 11 or soil pressure Slide Rule. If Slide Rule is available, use A_2 Scale, an infinite thickness of layer and the plasticity index of the soil. It is important to modify the percent volumetric swell by multiplying by percent soil binder divided by 100 to obtain the percent volumetric swell to be expected.

5. Use the moisture content (step 3), vary the compactive effort (usually 25 blows per layer will suffice on most materials) until the desired density (step 4) is obtained and mold a set of six specimens. Where this moisture content is too great to permit the desired density, then reduce the molding water slightly (usually about 1%) and continue molding. The specimens, being in capillarity over night, will pick up this moisture that was left out.

6. When the six specimens have been molded, they are put to capillary absorption (as in Part I) over night. Test at the usual lateral pressures and classify.

Group (d)

Flexible Base and Subbase Materials With Aggregate

1. When classification is required, weigh out enough material to mold 6 or more specimens, in individual pans, keeping the portion passing the No. 10 sieve separate. Sprinkle all the soaking water on the + No. 10 aggregate portion in the mixing pan and allow to soak for four or more hours. The soaking water is the optimum moisture as determined in Tex-113-E except, where the flat top curve exists, then the soaking water should be the amount of the left or dry end of the flat portion.

2. When desired in testing base and sub base materials with aggregates, the following procedure may be used where strengths are required. Begin the M-D curve as outlined in Test Method Tex-113-E and mold at least 2 specimens on the dry side of optimum moisture with the second specimen being slightly below optimum moisture. Weigh out the plus No. 10 portion of 9 specimens in individual pans and sprinkle the water as determined to be just below optimum moisture on each specimen then stir so as to wet the aggregates thoroughly. As each pan is wet, weigh the contents to obtain the weight of pan + soil + water and record. Cover with a lid or suitable cover and stir contents every hour (or 3 times). Continue molding the M-D curve until optimum moisture and density are determined. The difference between optimum moisture and the water the specimens were sprinkled with must be added to the + 10 material in the pans. If in the event the specimens have been wet with only slightly more than optimum, they may be dried back at room temperature, by stirring, to the desired weight.

3. Replace any evaporated water, add in the material passing No. 10 sieve, mix and compact. Materials which can be compacted to the desired density without the addition of more water, should be molded at optimum moistures ± 0.1%. Many materials require the addition of small amounts of additional moisture to obtain the desired density. If needed,

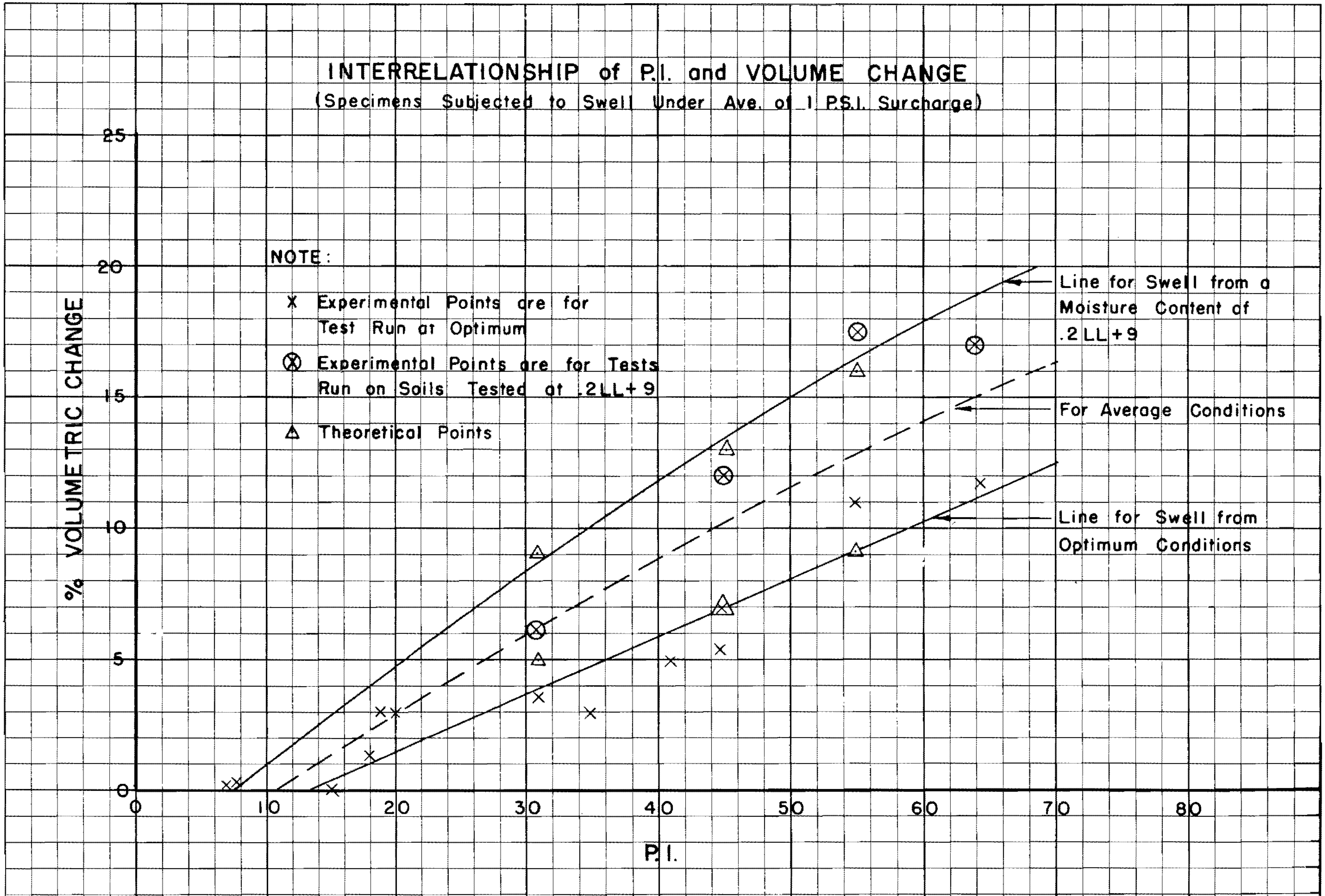

INTERRELATIONSHIP of P.I. and VOLUME CHANGE
(Specimens Subjected to Swell Under Ave. of 1 P.S.I. Surcharge)
% VOLUMETRIC CHANGE
25
20
15
10
5
0
P.I.
0
10
20
30
40
50
60
70
80
NOTE:
X Experimental Points are for Test Run at Optimum
⊗ Experimental Points are for Tests Run on Soils Tested at .2LL+9
△ Theoretical Points
Line for Swell from a Moisture Content of .2LL+9
For Average Conditions
Line for Swell from Optimum Conditions

Figure 11

add in the required amounts of additional water (by trial and error method) until the desired density is obtained and compact a set of 8 specimens using 13.26 Ft. Lbs. Per Cu. In. effort. The intent of this technique is to use the minimum amount of moisture equal to or above optimum moisture that will produce a set of accelerated test specimens whose average density is within 1/2 lb. per Cu. Ft. of the maximum density of the original moisture density curve. It should be noted that excessive densities can sometimes be obtained in the accelerated set but these are almost always very wet specimens and their resultant strengths can be misleading.

4. Subject specimens to overnight capillarity.

5. Test and if required classify in accordance with Part I. If strengths at zero and 15 lb. lateral pressures are specified, test 5 specimens at zero lateral confinement and 3 at 15 lb. lateral confinement and average the three highest values for each state of confinement for the control values.

Note: When strengths at zero and 15 psi lateral pressures are specified, it is permitted to run correlation tests on a given source of material.

The correlation shall be as follows: As soon as three satisfactory accelerated test specimens have been molded in accordance with paragraph two above, two of them will be tested at zero lateral pressure and the results averaged as one test. The third specimen will be tested at 15 psi lateral pressure. If these specimens pass it is safe to assume the set to be tested the next day will pass.

Group (e)

Combination Soil Types

This group includes all materials with enough soil binder to separate the aggregate particles or overfill the voids of the compacted specimen. For example, if the material is a clay gravel with high plasticity index, treat the material as a swelling soil, and allow the + No. 20 material to soak 4 hours as do aggregate materials. It should be noted that the total swelling is figured only for that part passing the No. 40 sieve. Other combinations must be recognized and tested in the proper group. Subject all specimens to overnight capillarity, test and classify.

Notes:

Testing aggregate materials under Part II when classification is required, test 2 specimens at 0 psi and the others at 3, 5, 10 and 15 psi. Average the result of the zero lateral pressure tests as one value. Fine grain soils are classified using lateral pressures of 0, 3, 5, 10, 15 and 20 psi.

Reporting Test Results

The reports and forms are the same as given in Part I of this procedure.

Interpretation of Results:

After materials have been classified in accordance with Part I or II and cohesiometer values for stabilized layers and surfacing have been determined, the following steps should be followed for the thickness design:

1. Obtain from the Planning Survey Division the average of the ten heaviest daily wheel loads. Wheel load maps for most roads on the primary system are available from this Division. If traffic is anticipated to have over 50 percent tandem axles, multiply this wheel load by 1.3.

2. Enter wheel load, determined above, on wheel load depth chart (Figure 16) and find where it intersects Triaxial strength class, and read depth from left side of chart.

3. Enter above depth on ordinate of Figure 17 and follow across page until intersection of cohesiometer value selected (see below) for use is reached, then project to abscissa to read reduction in depth due to bridging effects.

Standard cohesiometer values (corrected to represent values from 3 inch height specimens) are used with Figure 17 regardless of thickness of stabilized layer except where asphaltic mixtures are used. The modification of cohesiometer values for 3 inch high specimens for application to other thicknesses of asphaltic mixtures is obtained by the following formula:

$$C_m = \frac{C \times t^2}{9}$$

Where:

C_m = Modified cohesiometer value

C = Standard cohesiometer value for a 3 inch height specimen

t = Proposed thickness of Bituminous Mixtures in inches.

Notes:

For a 6 inch or greater layer thickness, use a value of 6 in. in the formula for t.

When adjacent layers of stabilization and asphaltic concrete are used, the cohesiometer value to be used with Figure 17 should be equal to the sum of the standard cohesiometer value for the stabilized layer and the modified cohesiometer value of the asphaltic concrete. When two adjacent layers of stabilization are used, or if a layer of untreated flexible base material exists between asphaltic concrete and a stabilized layer only the greater of the two cohesiometer values should be used in Figure 17. Considerable caution and good engineering judgement should be used in selecting cohesiometer values for use in reduction of base depths. This is especially true in cases where hot mix-cold lay asphaltic concrete is bid as an alternate to hot mix asphaltic concrete laid hot. In the case of stabilized bases, subbases and subgrades, average values rather than highest values should be selected for use in Figure 17.

4. Either the number of applications of wheel loads in excess of 8000 pounds or the data to determine the 18 Kip Single Axle Load Equivalencies is available through the Highway Planning Survey Division.

The load frequency design factor can be obtained from the tabulation in Fig. 18 for either set of data, preferably from the 18 Kip single axle load equivalent data. The depth obtained in Step 3 is then multiplied by this factor.

General Notes

Wetted stabilized materials taken from the roadway during construction should be quartered to approximate specimen size batches and molded. This material should not be prepared in accordance with Test Method Tex-101-E. Where M-D curves are desired, material drier than the roadway mix can be produced by stirring the material or by drying back under a fan while stirring the mix.

Figure 19 presents data which was interpreted from good engineering practice supplemented by utilizing the AASHO Road Test data and is a suggested method for determining the thickness of surface courses.

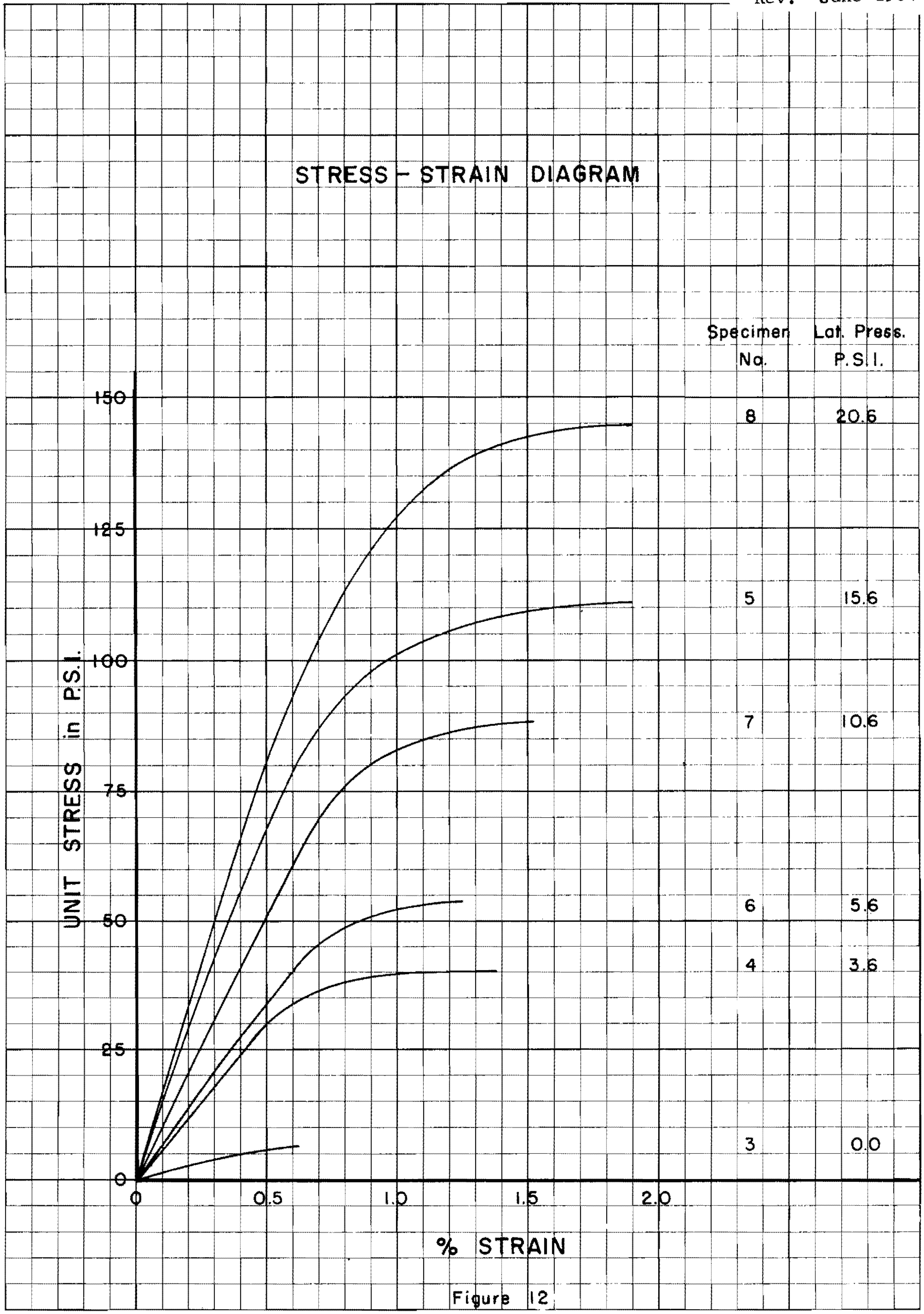

STRESS - STRAIN DIAGRAM
Specimen No.
Lat. Press. P.S.I.
8
20.6
5
15.6
7
10.6
6
5.6
4
3.6
3
0.0
UNIT STRESS in P.S.I.
150
125
100
75
50
25
0
0
0.5
1.0
1.5
2.0
% STRAIN

Figure 12

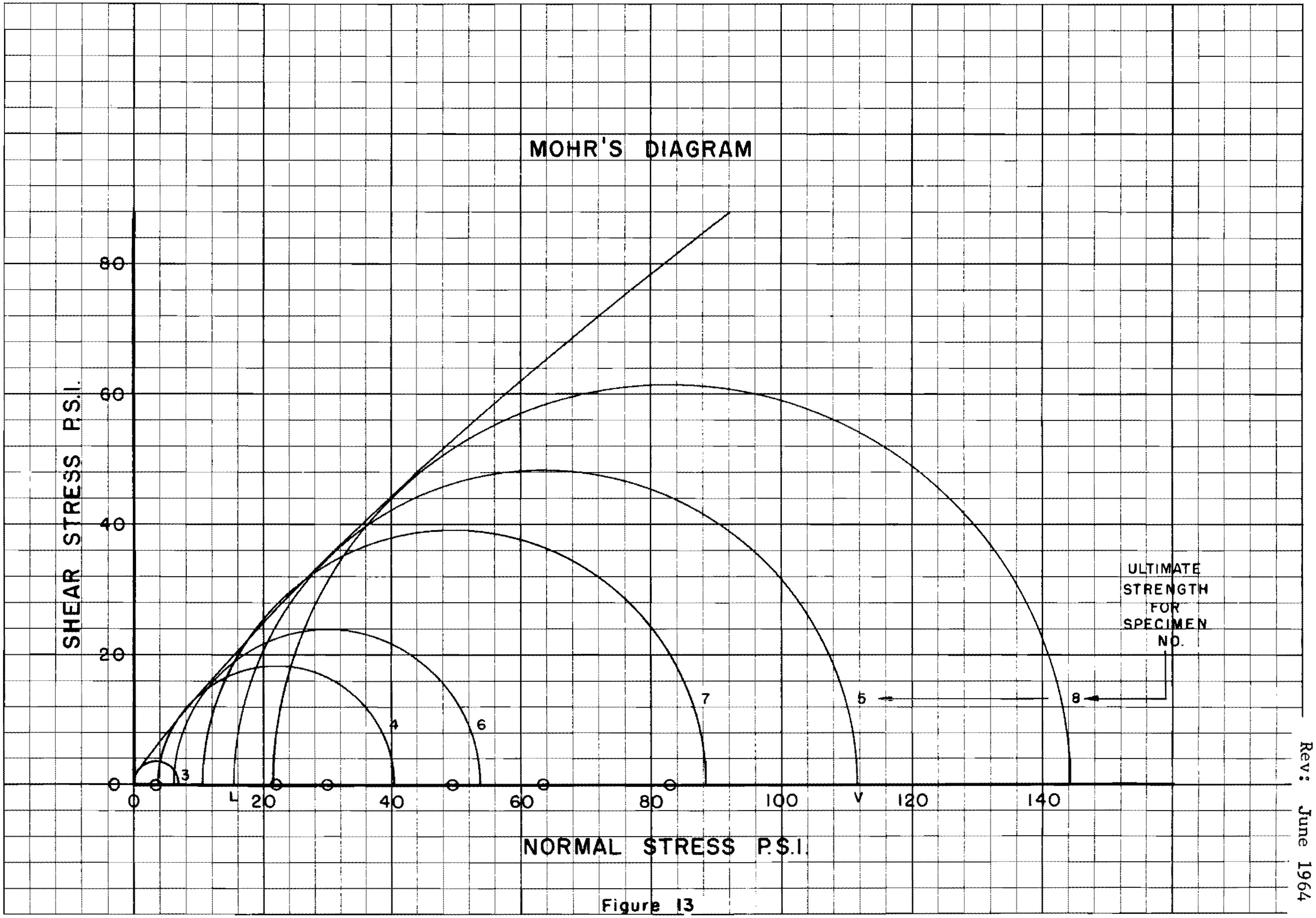

MOHR'S DIAGRAM
SHEAR STRESS P.S.I.
80
60
40
20
0
NORMAL STRESS P.S.I.
0
20
40
60
80
100
120
140
L
V
3
4
6
7
5
8
ULTIMATE STRENGTH FOR SPECIMEN NO.

Figure 13

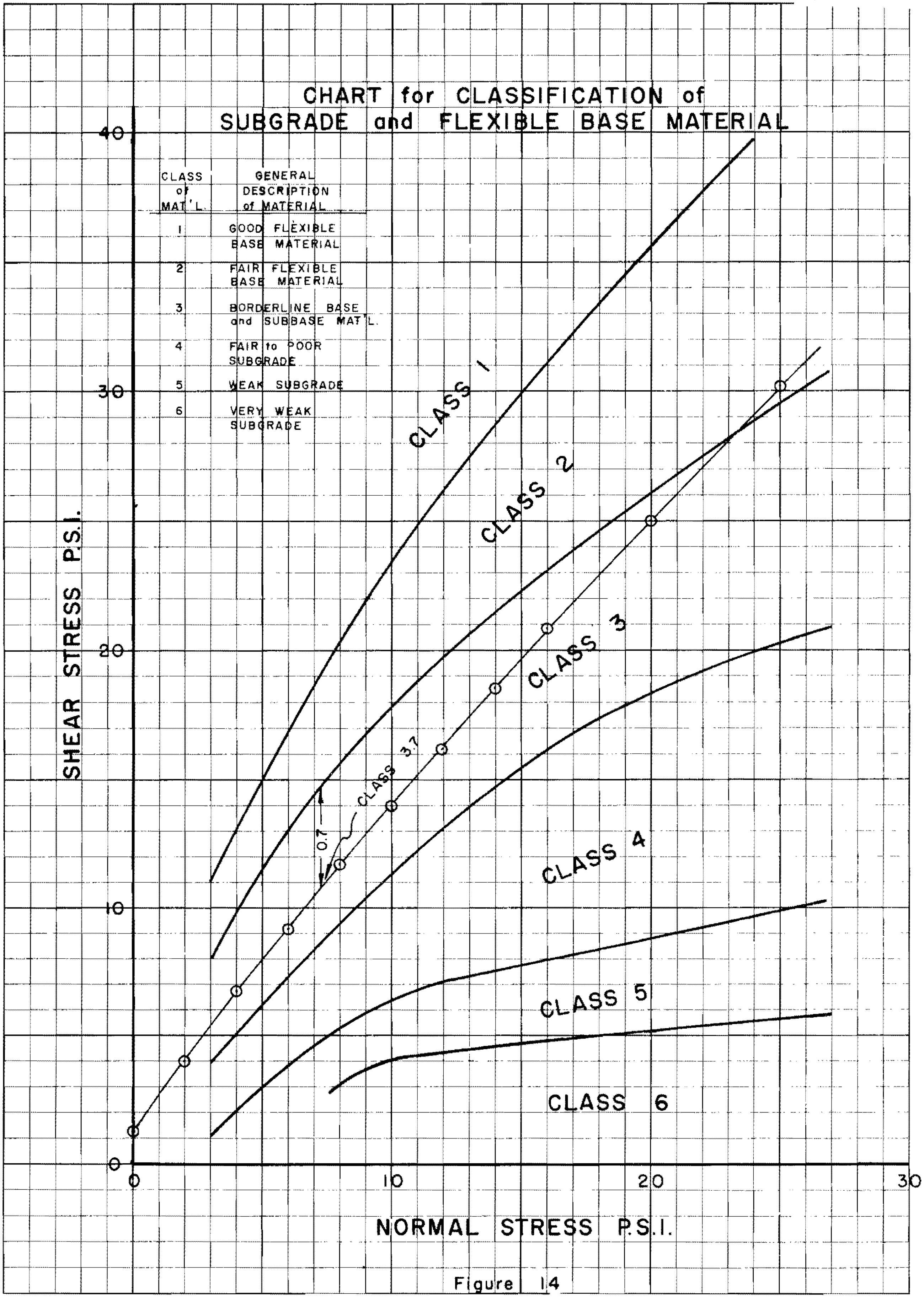


CHART for CLASSIFICATION of
SUBGRADE and FLEXIBLE BASE MATERIAL
CLASS of MAT'L.
GENERAL DESCRIPTION of MATERIAL
1 GOOD FLEXIBLE BASE MATERIAL
2 FAIR FLEXIBLE BASE MATERIAL
3 BORDERLINE BASE and SUBBASE MAT'L.
4 FAIR to POOR SUBGRADE
5 WEAK SUBGRADE
6 VERY WEAK SUBGRADE
CLASS 1
CLASS 2
CLASS 3
CLASS 3.7
0.7
CLASS 4
CLASS 5
CLASS 6
SHEAR STRESS P.S.I.
NORMAL STRESS P.S.I.
0
10
20
30
40

Figure 14

TRIAXIAL TEST SUMMARY SHEET

TABLE NO. ____

Lab No. ____________ County ____________ Highway ________ Project ________

Material ______________________________ Identification ______________

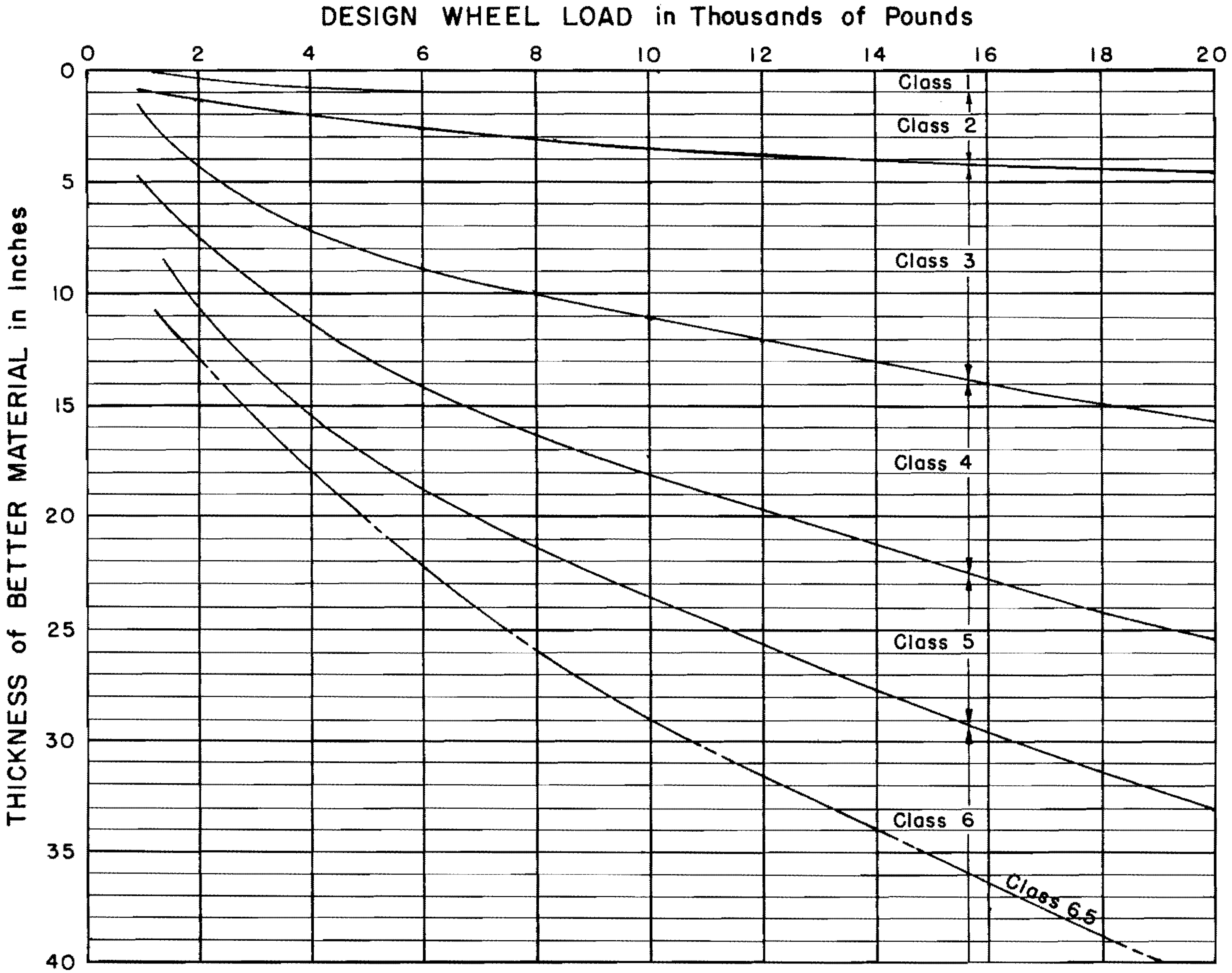
Description ____

____

Opt. Moist. ________ Opt. Dry Density ________ at Comp. Effort ________ ft.-lbs./cu. in.

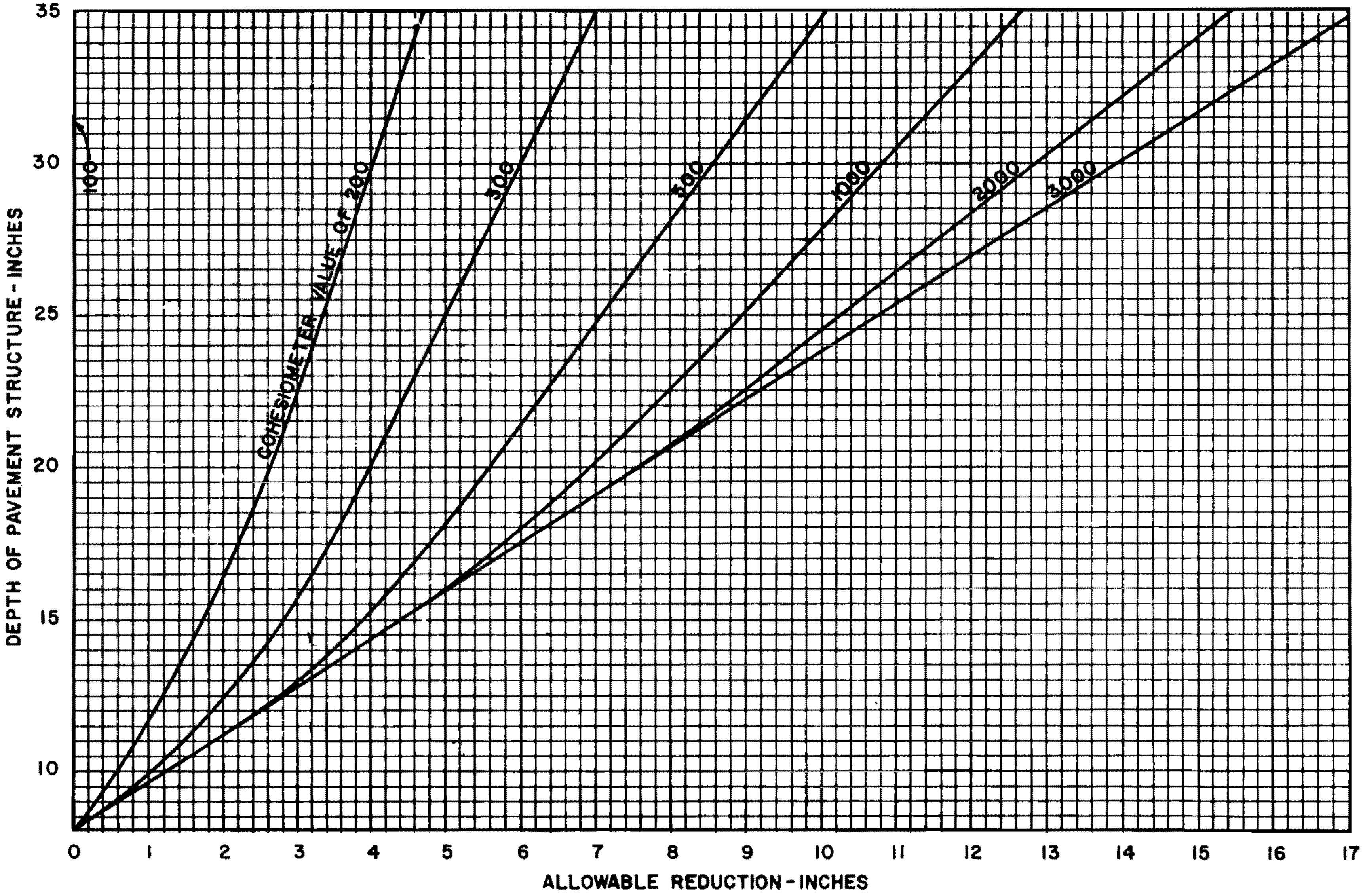
Molding Data			Curing Data			Testing Data			
				Water Content					
Specimen No.	Water Percent Dry Weight	Dry Density Lbs./Cu.Ft.	Capillary Moisture Time Days	After Drying Percent Dry Weight	After Capillary Absorption % Dry Wt.	Applied Lateral Pressure PSI	Ultimate Compressive Strength PSI	Percent Strain at Ultimate	Percent Volumetric Swell

Figure 15



FLEXIBLE BASE DESIGN CHART

Figure 16



THICKNESS REDUCTION CHART FOR STABILIZED LAYERS

Figure 17

CRITERIA FOR OBTAINING THE LOAD-FREQUENCY DESIGN FACTOR

Number of Applications of Wheel Loads in Excess of 8000 Pounds		Total Equivalent 18 Kip Single Axle Load Applications	Load Frequency
Total Estimated During Design Life	Approximate Daily Applications for a 25 Year Design Life		Design Factor*
10,000	1	14,000	0.65
18,000	2	25,000	0.70
30,000	3	38,000	0.75
56,000	6	61,000	0.80
100,000	11	100,000	0.85
175,000	19	150,000	0.90
300,000	33	250,000	0.95
550,000	60	400,000	1.00
1,000,000	110	600,000	1.05
1,700,000	186	1,000,000	1.10
3,000,000	330	1,500,000	1.15
5,200,000	570	2,500,000	1.20
10,000,000	1100	4,000,000	1.25
30,000,000	3300	10,000,000	1.35

*A load-frequency design factor less than 1.0 shall not be used for the design of the main lanes of a controlled access highway.

Figure 18

SUGGESTED THICKNESSES OF SURFACE COURSES
INCHES

Total Equivalent 18 Kip Single Axle Load Applications	When Tests Show Materials to be Specifications Grades* of Base Materials Item 248		
	Grade 1	Grade 2	Grade 3**
14,000	ST	ST	ST
25,000	ST	ST	ST
38,000	ST	ST	ST
61,000	ST	ST	1-1/2
100,000	ST	1-1/2	2
150,000	ST	1-3/4	2-1/2
250,000	1-1/4	2	3
400,000	1-1/2	2-1/4	3-1/2
600,000	1-3/4	2-1/2	4
1,000,000	2	3	4-1/2
1,500,000	2-1/2	3-1/2	5
2,500,000	3	4	5-1/2
4,000,000	3-1/2	4-1/2	6
10,000,000	4-1/2	5-1/2	7

Not recommended for use except where availability of better base materials is very expensive.

* It is assumed that the material in question is no better than the grade shown.
** Exclusive of Cohesionless Materials.

Notes: ST denotes surface treatments.
Stage construction of surfacing permitted if traffic studies indicate slow development of axle load equivalencies.

Figure 19

APPENDIX II

APPENDIX II

Form 1084R Rev. 2-69

Date November 3, 1972

RECOMMENDED CHANGE IN ROAD LOAD ZONING

Highway No. F.M. 3149 County McLennan District 9

Control and Section 3234-1 Length, Miles 7.54

Limits Jct. F.M. 1858 to Jct. F.M. 2311

Current Load Restrictions None

Minute Order Number

Recommended Load Zoning 58,420 lbs. gross

Remarks

Will this Load Zoning affect haul roads for scheduled Highway construction projects? No ~~Yes~~

(If "Yes", Explain:)

Engineering Data:

Pavement Type One course surface treatment Pavement Width 20'

Crown Width 30' Base Type and Thickness (Bosque) Flex Base (Gravel) 8"

Description of Subgrade Soil From approx. ½ mi. W. of I.H. 35 to F.M. 1858: (1) Axtell and Irving Sandy loams

Triaxial Classification of Subgrade Soil (1) Class 4.0 (2) Class 5.2

Avg. 10 Heaviest Daily Wheel Load Traffic (V.P.D.)

Completed (Date) July 1972 Present Condition New

(2) From ½ mi. W. of I.H. 35, East to F.M. 2311:
Wilson and Burleson clays