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TESTS WITH RIGID WHEELS

TESTS IN FAT CLAY, 1958

TECHNICAL REPORT NO. 3-565

Report 1

May 1961

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

U. S. Army Engineer Waterways Experiment Station, CE, Vicksburg, Miss. TESTS WITH RIGID WHEELS; TESTS IN FAT CLAY, 1958, by Mary E. Smith. May 1961, 35 pp - tables - illus. (Technical Report No. 3-565, Report 1), Subproject 8S70-05-001-03

Unclassified report

Results are presented of the first tests by the Army Mobility Research Center of a towed rigid wheel in a fairly soft soil. Speed was maintained constant. Load on the wheel was varied from test to test. Some variation in soil strength occurred along each test lane. Measurements were made of the following parameters: deviation in static load on the wheel, sinkage of wheel into the soil, motion resistance, contact pressure between the wheel face and the soil, strength (cone index) of the soil, and stresses induced within the soil mass. Various relations among the data are plotted, and expressed in mathematical terms. Measured stresses are compared with theoretical stresses.

UNCLASSIFIED

1. Clays
2. Soils--Stresses
3. Soils--Trafficability
4. Wheels, Vehicular

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May 1961

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CORPS OF ENGINEERS
Vicksburg, Mississippi

ARMY-MRC VICKSBURG, MISS.

PREFACE

This investigation of the performance of a towed rigid wheel in a fairly soft soil is the first such investigation conducted by the Army Mobility Research Center. It is part of the vehicle mobility research program under Subproject 8S70-05-001-03, "Mobility Fundamentals and Model Studies" (formerly Subproject 8-70-05-400, "Trafficability of Soils as Related to the Mobility of Military Vehicles"), authorized by the Office, Chief of Engineers. It was accomplished in the Soils Division, U. S. Army Engineer Waterways Experiment Station, during the period January-May 1958.

Personnel of the Waterways Experiment Station actively engaged in the study were Messrs. W. J. Turnbull, C. R. Foster, S. J. Knight, D. R. Freitag, A. B. Thompson, and M. D. Beasley, and Miss Mary E. Smith. This report was written by Miss Smith.

The tests were performed while Col. A. P. Rollins, Jr., CE, was Director of the Waterways Experiment Station. Present Director is Col. Edmund H. Lang, CE. Technical Director is Mr. J. B. Tiffany.

CONTENTS

SUMMARY

This report presents the results of tests conducted to study the performance of a towed rigid wheel in a fairly soft clay. The wheel was 48 in. in diameter and 6 in. wide. Five tests were conducted, each consisting of several passes of the wheel traveling at a speed of 1 fps over a test lane in which pressure cells were buried. In three of the tests the static load was 600 lb and the wheel path was offset 0, 4, and 7 in. from the line of pressure cells; in one test a 2400-lb load at 0 offset, and in the other a 1200-lb load at 7-in. offset were used. The strength of the soil varied over a fairly narrow range. Measurements were made of deviation in static load, sinkage, motion resistance, contact pressure, stresses within the soil, and soil strength (cone index).

It was found that the residual sinkage or incremental rut depth can be expressed as a function of the dynamic or total sinkage; that the total sinkage can be expressed as a function of wheel load and cone index or as a function of the wheel load and maximum contact pressure; and that the ratio of the motion resistance to the wheel load can be expressed as a function of the residual sinkage of the wheel.

The measured stresses were greater than the stresses computed by means of elastic theory by a factor ranging from about one to four. Nevertheless, measured stresses appeared reasonable.

Although the program was limited in scope, the results were encouraging; and it is recommended that this type program be continued, using rigid wheels of various sizes in softer soils in the hope that generally applicable wheel-soil relations can be developed.

TESTS WITH RIGID WHEELS

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PART I: INTRODUCTION

Purpose

1. A primary goal of the vehicle mobility research program is to determine the basic interrelations between moving wheels and tracks and the soil or snow on which they operate. The study of a rigid wheel reported herein is considered a step toward the specific objective of understanding the interactions between a pneumatic-tired wheel and the soil. In this investigation a rigid wheel was towed over a soft, fat clay area to determine whether the data obtained on wheel sinkage, contact pressure, motion resistance, load, and soil strength would reveal rational and consistent interrelations. Another purpose was to determine the magnitude and distribution of stresses induced to the soil by the wheel under various loads and at various offsets from a datum line for comparison with stress magnitude and distribution computed according to the most applicable theoretical analysis available. The analysis selected was Boussinesq's solution for stresses in an isotropic, elastic, homogeneous mass of semi-infinite extent under a static vertical load applied uniformly over a rectangular area.

Scope

2. Tests were conducted with a towed, rigid wheel, 48 in. in diameter and 6 in. in width, traveling at a constant speed of 1.0 fps on prepared areas of soft, fat clay. Wheel loads of 100, 200, and 400 lb per in. of wheel width were used. The center line of the wheel path in various tests was approximately 0, 4, or 7 in. from the datum line of the test area. Stresses in the soil were measured, and measurements were also made of the motion resistance, dynamic deviation of the load, sinkage, and dynamic contact pressure.

PART II: TEST PROGRAM

Tests Conducted

3. Five tests were conducted with the rigid wheel. The number of passes (a pass consisted of one forward trip over the test area), and the test variables, i.e. the static wheel load and the approximate offset of the center line of the wheel path from the test-area datum line in each test, are given in the following tabulation.

Test	No. of Passes	Total Load lb	Wheel Offset in.
1	4	604	0
2	3	2404	0
3	6	604	4 (west)
4	6	604	7 (west)
5	6	1196	7 (west)

Types of Data Obtained

4. Motion resistance, deviation of the load, sinkage, contact pressure of the wheel, stresses in the soil, cone index, soil moisture content, and soil density were measured during each test. The instruments and methods used for obtaining these measurements are discussed in paragraphs 17-24.

Test Cart

5. A rectangular test cart (see fig. 1), 13 ft wide by 8 ft long, was used to support the test wheel and to permit the measuring of the vertical load and motion resistance. The test cart consisted of three nested frames (A, B, and C) held within an outrigger frame. The outrigger frame was mounted on rigid wheels which traveled on rails (located outside the test area) and which were driven by sprocket and chain systems (see fig. 2). The sprocket and chain systems were powered by a variable-speed motor.

6. Frame A, the outermost of the nested frames, was free to move vertically (see figs. 3 and 4) and was restricted horizontally by roller

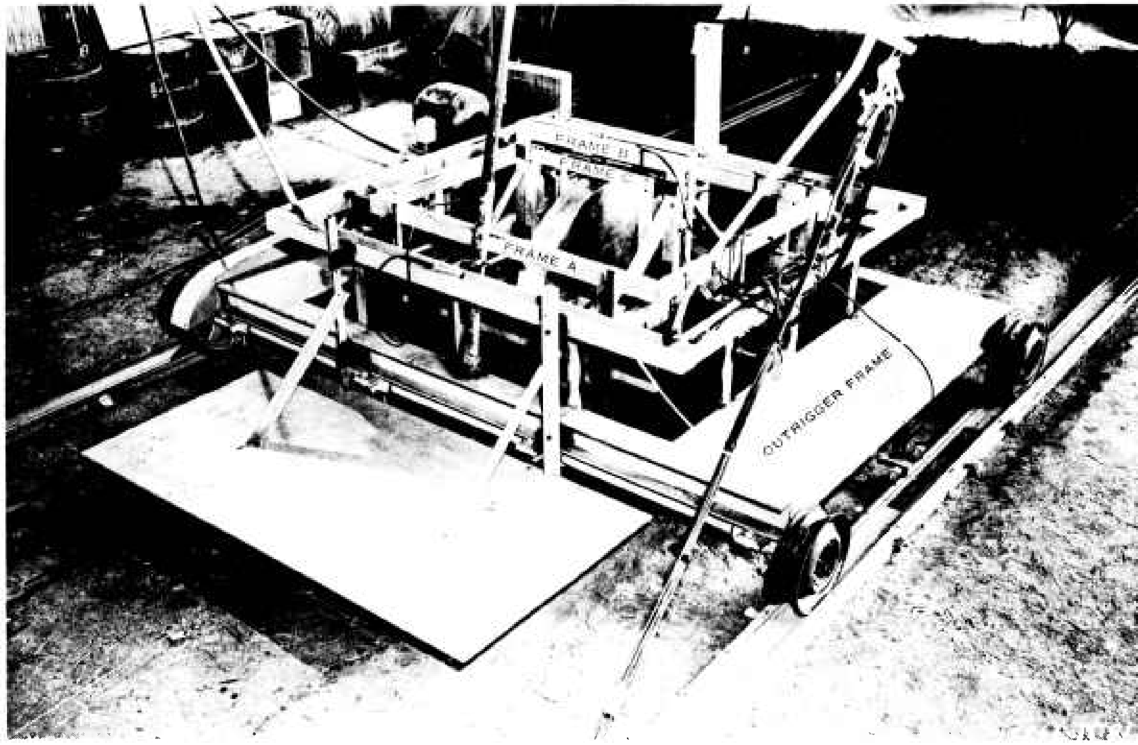


Fig. 1. Test cart

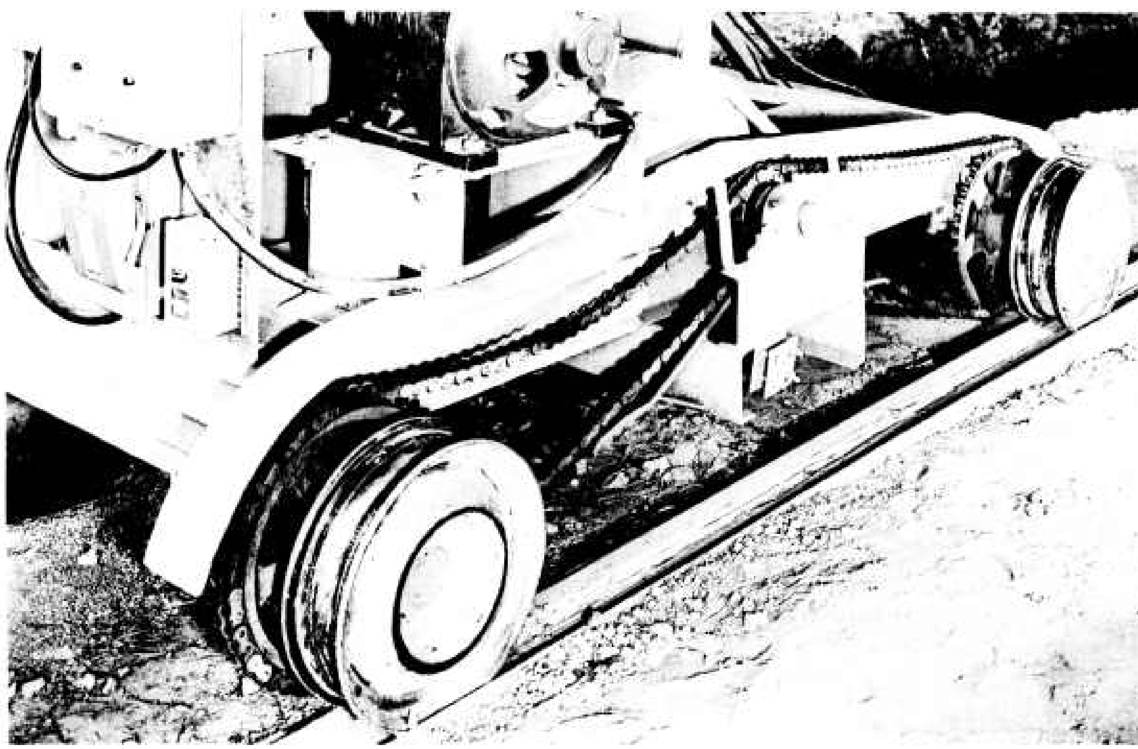


Fig. 2. Drive system of test cart

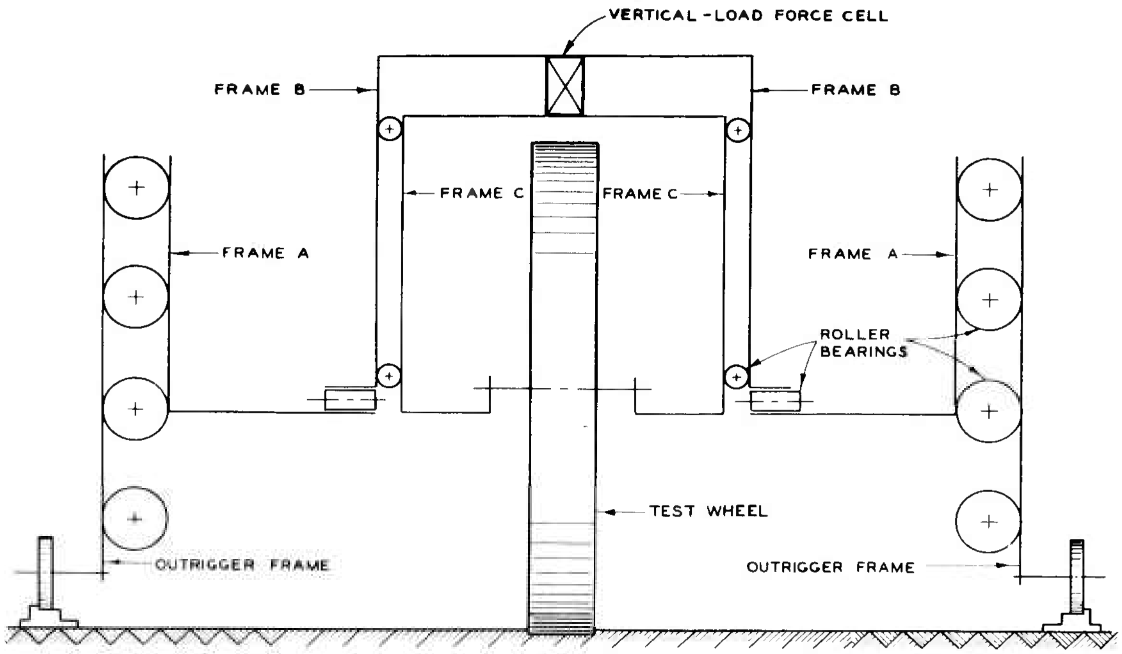


Fig. 3. Schematic representation of test cart (end view)

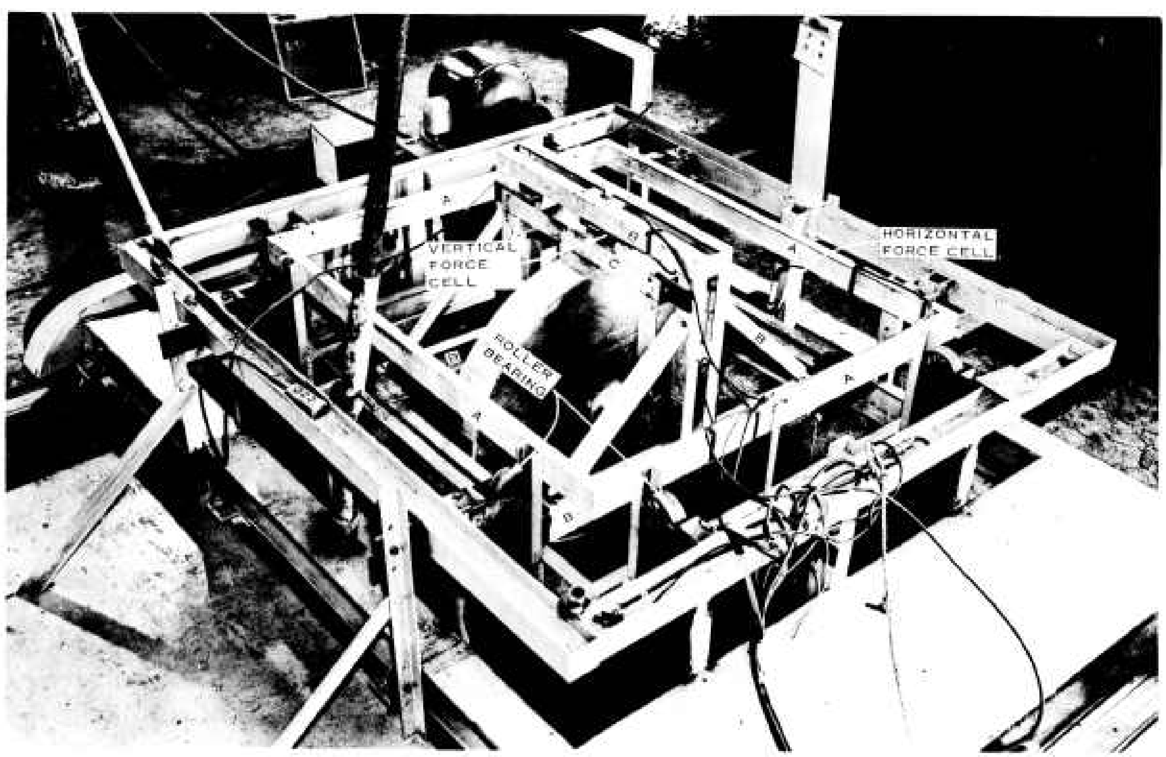


Fig. 4. Location of force cells on test cart

bearings attached to the outrigger frame. Relative to frame A, frame B could not move vertically but was free to move horizontally. The horizontal movement of frame B was restrained in the direction of travel by a force cell (see fig. 4 and paragraph 19) which measured, in compression, the motion resistance of the test wheel. Relative to frame B, the innermost frame (frame C) could not move horizontally but was free to move vertically except as restrained by the force cell (see figs. 3 and 4 and paragraph 19). This cell measured, in compression, the externally applied vertical load. The output of the force cell under the externally applied static load was established as a zero on the recording chart, and any deviation from this zero during a test was recorded as deviation from the original static wheel load. The axle of the test wheel was attached to frame C.

Test Wheel

7. The test wheel was constructed of two circular aluminum plates 47-1/2 in. in diameter. The inside edges of a rectangular aluminum plate (1/4 in. thick, 6 in. wide, and equal in length to the perimeter of the circular plates) were welded to the outside edges of the circular plates, thus forming a wheel 48 in. in diameter and 6 in. wide. Axle supports (6-1/2-in. outside diameter and 1-15/16-in. inside diameter) were welded on each side of the wheel at its center. The axle was placed through the center of the wheel, and its extremities were mounted in bearing blocks attached to frame C.

8. An access opening was made in the side of the wheel to mount the force cell (see paragraph 20) in the face of the wheel. The wires from the force cell passed through a hole bored in the axle and on to the recording instrument. This cell measured the contact pressure at the wheel-soil interface.

9. The normal load (604 lb) of the test wheel on the soil consisted of the weights of the inner frames and the test wheel. When loads higher than the normal were desired, dead weights were added to frame A.

Test Soil

10. The soil used in this test program was a river-deposited fat

clay (locally termed "buckshot"), classified as CH under the Unified Soil Classification System. Gradation and classification data are given in plate 1.

Test Areas

11. A test area located under shelter on the Waterways Experiment Station reservation was used in this study. The test area as originally constructed was designated test area 1; the center portion of it was subsequently reconstructed and designated test area 2. They are described in the following paragraphs.

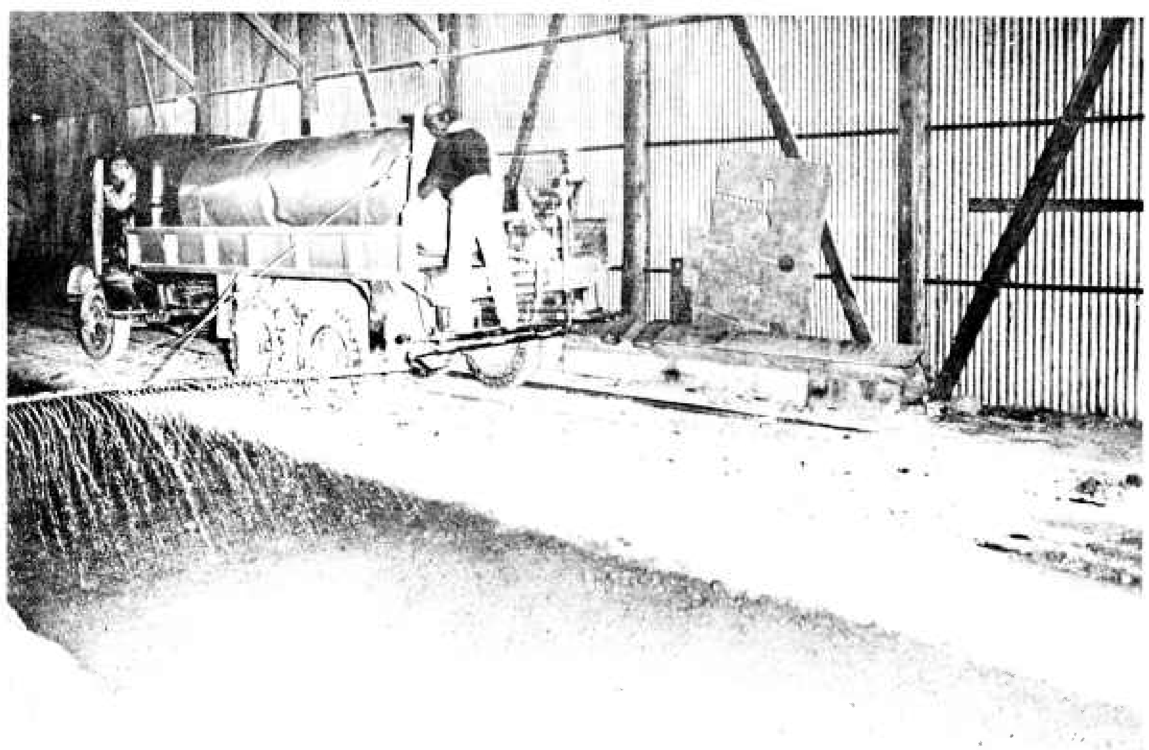
Area 1

12. Test area 1, 110 ft long and 9 ft wide, was excavated to 4 ft below the surrounding elevation and backfilled (manually) with the fat clay in 3-in. lifts (see fig. 5a). Before the soil was placed in the excavated area, it was broken down with a pulvimixer and air-dried to a uniform low moisture content. Each lift of soil was placed in the air-dried state, and then wetted with a predetermined amount of water (see fig. 5b). After 12 to 16 hours had been allowed for the water to penetrate the soil, the lift was compacted with an M29C weasel. Following the placing and compacting of the final lift, the surface was smoothed and leveled by hand.

13. The test area was divided into three sections. Section 1 (at the north end of the area) was 30 ft long (sta 0+00 to sta 0+30) and was used for the approach of the test cart. Section 2, the center section in which the pressure cells were installed, was 50 ft long (sta 0+30 to sta 0+80). Section 3 (at the south end of the area) was 30 ft long (sta 0+80 to sta 0+110) and was used for the departure of the test cart. A datum line was established along the length of the test area. Fig. 6 shows the area just prior to test 1.

14. Since only a very shallow rut was created by the four passes of the wheel in test 1, the test area was considered suitable for further testing. Therefore, test 2 was conducted on the area after scarifying the soil surface slightly in the area of the rut, refilling the rut, and rolling the surface with a steel-wheel roller.

a. Placing a lift of soil



b. Adding water to a lift of soil

Fig. [illegible]. Construction of test area

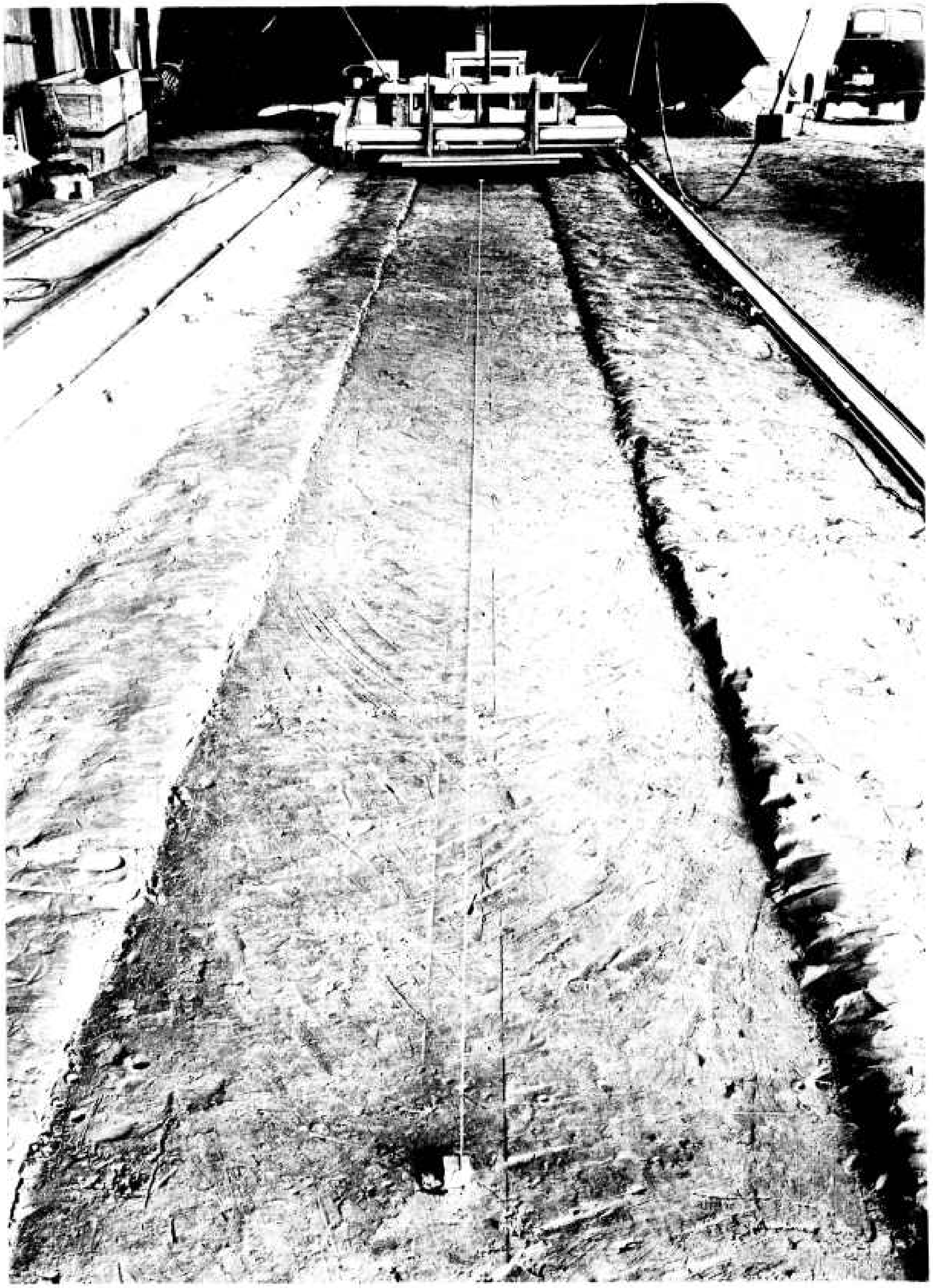


Fig. 6. Test area 1, before test 1

Area 2

15. After the completion of test 2, during which a 2-in. rut (approximate) was created, the test area was no longer considered suitable for further testing. Therefore, it was necessary to construct a new area. Test area 2 was constructed by removing a strip of soil (80 ft long, 2-1/2 ft wide, and 1 ft deep) from the center of sections 2 and 3 of test area 1. The excavation was backfilled with the fat clay by the same process used in construction of test area 1, except that each lift of soil was compacted with a smooth-wheel roller towed by the test cart (see fig. 7).

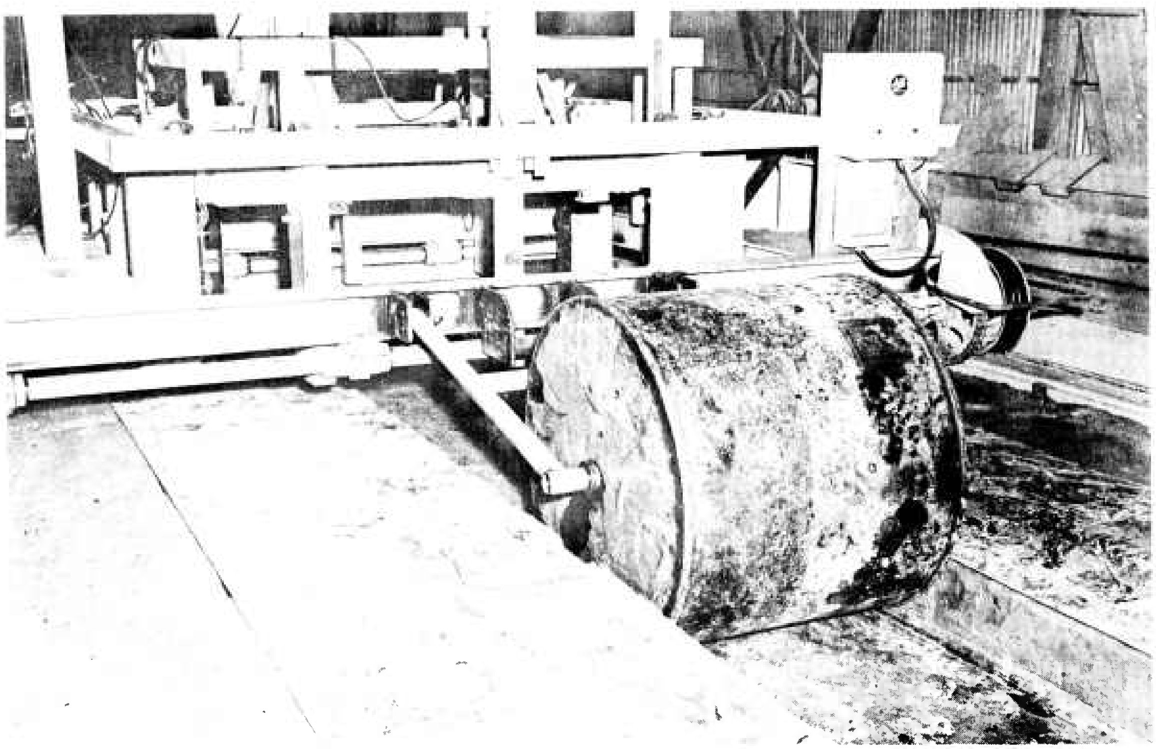


Fig. 7. Smooth-wheel roller attached to test cart

Following the construction of the test area, the surface of the soil was hand-graded to obtain a smooth, level surface. As in the case of test area 1, test area 2 was divided into three sections and a datum line was established along the length of the test area.

16. It was found possible to conduct tests 3, 4, and 5 on area 2 with minor reprocessing between tests similar to that described in paragraph 14.

Instrumentation

Soil data instruments

17. The cone indexes were taken with the WES cone penetrometer, and soil samples for determining moisture content and density were taken with the WES trafficability sampler. Descriptions of these instruments and the techniques for their use are presented in Waterways Experiment Station Technical Memorandum 3-240, Trafficability of Soils, Fourteenth Supplement, A Summary of Trafficability Studies Through 1955.

Sinkage measuring instruments

18. When a wheel passes over a soft soil, it sinks into the soil because it deforms or depresses the soil. When the wheel has passed, the soil behind it will recover part of the total deformation (total sinkage, Z_t) by rebounding. The sinkage recovered is termed elastic sinkage, Z_e. The net sinkage of the wheel is called residual sinkage, Z_r. The residual sinkage measurements were obtained by means of a surveyor's level. Total sinkage was to have been measured by means of a continuously recording potentiometer sensing vertical movements. However, due to a series of unfortunate malfunctions, no reliable direct measurements of total sinkage were obtained from this device.

Force cells

19. Test cart. The force cells used for measuring horizontal (motion resistance) and vertical (deviation from load) forces on the test wheel were manufactured by the Baldwin-Lima-Hamilton Corporation. Basically, this type of cell (see fig. 8a) consists of a central measuring column with strain gages bonded to selected surfaces. A force applied to the measuring column produces a deflection (strain) in proportion to the force. The attached strain gages translate the motion into a directly related electrical signal. A hermetically sealed case around the measuring column protects it from adverse atmospheric or mechanical environments. Continuous records of the horizontal and vertical forces were obtained from these cells.

20. Test wheel. A small force cell, rather than a diaphragm-type pressure cell, was used to measure the contact pressure because the 0.3-sq-in.-circular contact surface of the force cell is more durable than

Fig. 8. Force cells

the thin, easily damaged diaphragms of most pressure cells. The force cell used (see fig. 8b) was commercially manufactured by Statham Laboratories. The basic principle of this type of cell is similar to that of a Baldwin force cell in that strain gages give an output proportional to the applied force.

Pressure cells

21. The EP cell (see fig. 9), an earth pressure cell developed by WES, contains a mercury-filled fluid chamber with diaphragm, and a full Wheatstone bridge circuit consisting of four SR-4 electrical-resistance strain gages hermetically sealed within the cell. Detailed information concerning the EP cell can be found in Waterways Experiment Station Technical Report 3-545, Stresses Under Moving Vehicles, Wheeled Vehicles (M135), Lean and Fat Clay, 1957.

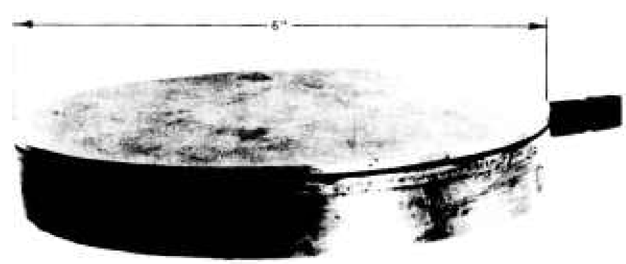


Fig. 9. WES earth pressure cell

22. The CEC pressure cell (see fig. 10) is a small, hermetically

sealed, single-diaphragm cell manufactured by the Consolidated Electrodynamics Corporation of Pasadena, California. Detailed information concerning the CEC cell can be found in the report referenced in the preceding paragraph.

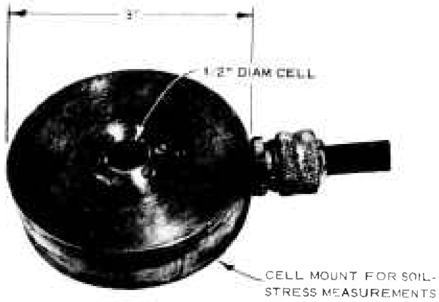


Fig. 10. CEC cell

23. Twelve pressure cells were used in each test to measure stresses in the soils. The location and other pertinent information for each cell are given in the following tabulation.

	Pressure Cell			
			Location	
Test	No.	Capacity psi	Station	Approx Depth in.
1, 2, 3, 4, and 5	EP 97	50	0+33	9
1, 2, 3, 4, and 5	EP 109	50	0+36	9
1, 2, 3, 4, and 5	EP 91	50	0+39	9
1 and 2	CEC 637	150	0+42	9
3, 4, and 5	CEC 7640	25	0+42	9
1 and 2	CEC 643	100	0+45	9
3, 4, and 5	CEC 7544	25	0+45	9
1 and 2	CEC 645	150	0+48	9
3, 4, and 5	CEC 8534	25	0+48	9
1, 2, 3, 4, and 5	EP 61	50	0+51	12
1, 2, 3, 4, and 5	EP 51	50	0+54	12
1, 2, 3, 4, and 5	EP 102	50	0+57	12
1 and 2	CEC 639	100	0+60	12
3, 4, and 5	CEC 14560	15	0+60	12
1 and 2	CEC 618	100	0+63	12
3, 4, and 5	CEC 12172	15	0+63	12
1 and 2	CEC 369	100	0+66	12
3, 4, and 5	CEC 7837	15	0+66	12

Amplifiers and recorders

24. The electrical signals produced by the pressure cells and force cells were transmitted to a carrier amplifier, a Type 1-118 manufactured by Consolidated Electrodynamics Corporation, or a Brush 520. The amplified electrical signals were recorded by a direct-recording oscillograph, Model 602 manufactured by Midwestern Instruments of Tulsa, Oklahoma, or a Brush multichannel recorder.

Test Procedures

Installation of cells

25. The pressure cells were installed in the test areas after completion of construction. A hole approximately 7 in. in diameter (1 in. greater than the EP cell and 4 in. greater than the CEC cell diameter) was dug to the desired depth (9 or 12 in.); the cell was placed in a horizontal position in the hole (the location and elevation of each cell were measured carefully) with the cable exiting through a trench leading from the side of the hole; then the soil was replaced. In replacing the soil every effort was made to duplicate the consistency of the surrounding undisturbed soil.

26. The pressure cells were spaced on 3-ft centers along the datum line of the test area. The general location of each of the cells is given in paragraph 23; the specific location of each cell in each test is recorded in tables 9-13.

Traffic application

27. Traffic was applied with the test cart traveling in a north-to-south direction at a constant speed of 1.0 fps.

28. Tests 1 and 2. For tests 1 and 2, the test wheel was on the center of the axle of the test cart. With this arrangement the center line of the wheel path coincided with the datum line of the test area. In test 2, half the 1800 lb added to produce the 2404-lb load was on the east and half on the west side of frame A.

29. Test 3. For test 3, the test wheel was on the center of the axle of the test cart, but the datum line of test area 2 was established so that it would be 4 in. to the east of the center line of the wheel path. This was done to obtain the 4-in. offset of the load from the center of the cells.

30. Test 4. For test 4, the test wheel was moved 3 in. to the west of its position in test 3. This arrangement made the center line of the wheel path 7 in. from the datum line of the test area (line of centers of the cells). Since test 4 was conducted with no additional load, offsetting the test wheel unbalanced frame C of the test cart. The effect of this imbalance on the test results was not determined but at most was believed minor.

31. Test 5. For test 5, the test wheel was in the same position as in test 4; only the load was changed. Dead weights were added to the east (247 lb) and west (345 lb) sides of frame A to attain a test load of 1196 lb. Although frames A and C were unbalanced, the bearings are believed to have compensated for this imbalance. However, no special measurements were made to determine if this was actually the case.

Soil measurements

32. Moisture content, density, and cone index were determined before and after traffic and at various intervals during a test. In the beginning of the test program, cone index measurements were made near each cell after each pass, and at least four moisture content and density measurements were made along the wheel path after each pass. As the program progressed, fewer soil measurements were made to minimize the possibility that the numerous holes in the soil from these measurements might interfere with the transmission of stress through the soil to the cells. The moisture content and density, and the cone index measurements are listed in tables 1 and 2, respectively.

Wheel-path profiles

33. A profile of the undisturbed test surface was obtained from elevations taken at 1-ft intervals by means of a surveyor's level and rod. Elevations of the wheel-path surface were measured after each pass in a similar manner. These elevations were used to obtain the residual sinkage of the wheel for each pass and the cumulative residual sinkage. The residual sinkage measured at each station (between sta 0+30 and 0+81) along the test area is given in tables 4-8. The cumulative residual sinkage measured over the pressure cells is recorded in tables 9-13.

Cell movement

34. During the course of a test, the location of a cell was determined by systematic probing with a thin wire. This permitted the during-traffic movements of a cell to be estimated. Because of the disturbance to the soil caused by the probing, less and less probing was done as the test program progressed. However, enough probing was done to determine that no cell movement was occurring in tests 3, 4, and 5; this was verified by the position of the cells when they were uncovered at the end of this test program.

Residual stress

35. Although the residual stress of each cell, the air temperature, and the barometric pressure were measured, the recorded stresses were not corrected by these measurements. Instead, the maximum stress was measured from the lowest to the highest points on the oscillograph charts of the stresses. Since the positions of the recording pens were not changed during a test, this method of obtaining the maximum stresses accounted for any change that might have occurred in the cell caused by changes in residual stress, temperature, or barometric pressure.

PART III: DISCUSSION OF TEST RESULTS

Soil

Soil structure

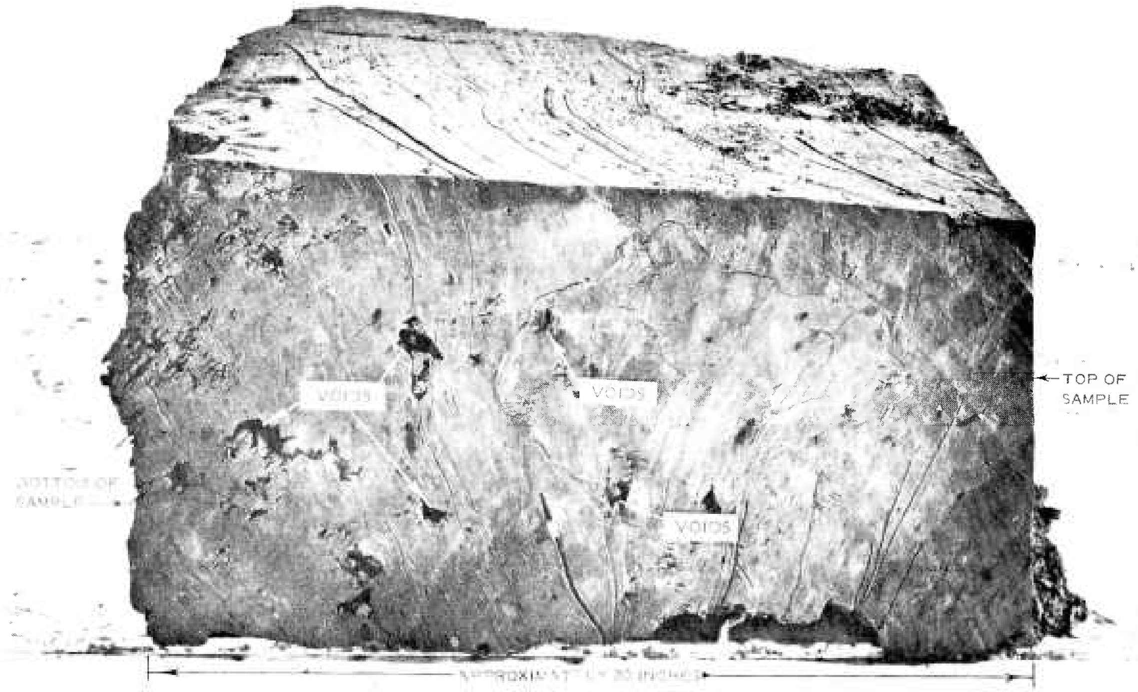
36. Although every effort was made to construct uniform test areas, some irregularities in the soil were present. These irregularities limited the analysis of the data and should be kept in mind when examining them.

37. A photograph of an undisturbed sample of the top 20 in. of soil (taken from the central part of test area 2 after test 5 was completed) considered typical of the test areas is shown in fig. 11a. Note the numerous voids, particularly in the bottom half.

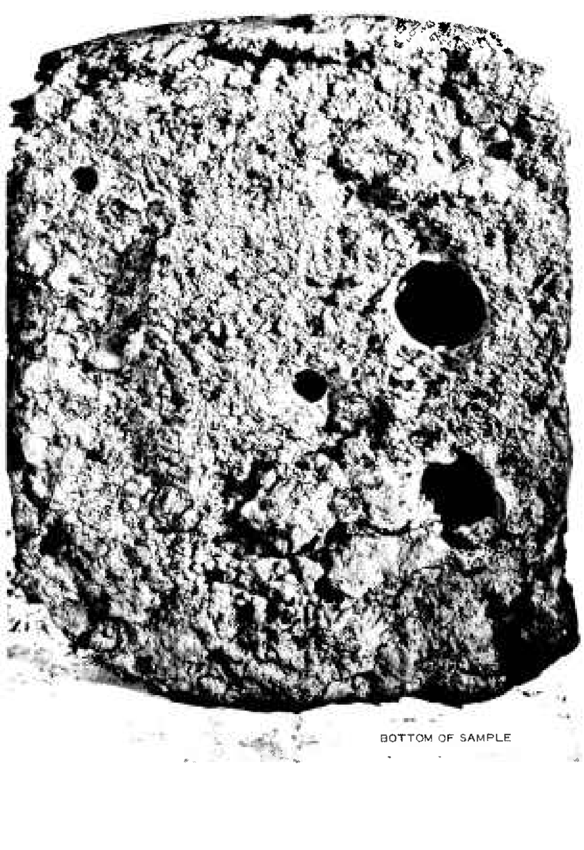
38. A bottom view (fig. 11b) of the same soil sample shows holes made by the penetrometer and the sampler. Although attempts were made to fill the holes left by the sampler, they were not completely successful (see fig. 12). The holes made by the sampler and penetrometer were never directly over a cell; but since they were always quite close to a cell, it is possible that they influenced the transmission of stress to the cell.

Moisture content and density

39. Test area 1. The moisture content and density measured at different points in a specific layer of soil (see table 1) along test area 1 (where tests 1 and 2 were conducted) varied by approximately ±2 per cent and ±2 lb per cu ft, respectively, from the average moisture content and density of that layer at a given time. The average moisture content of the 6- to 12-in. layer was approximately 2 to 6 per cent greater than that of the other three layers (0- to 6-in., 12- to 18-in., and 18- to 24-in.). The moisture contents of the 0- to 6-in. and 12- to 18-in. layers were usually within 2 per cent of each other. Although the 18- to 24-in. layer was drier than the other layers immediately after construction, it gained moisture during the testing period and was comparable in moisture content to the 0- to 6-in. and 12- to 18-in. layers by the end of testing on that area. The soil in the area near sta 0+60 had a higher (1 to 6 per cent) moisture content in the 6- to 12-in. layer than in any other part of the area. This condition was probably responsible for the appreciable movement of cell CEC 639 which had been installed at the 12-in. depth at sta 0+60.



a. Cross section



b. Bottom view

Fig. 11. Undisturbed sample of soil taken from test area 2 after completion of test 5

Fig. 12. Sections of the soil sample shown in fig. 11

Fig. 13. Uncovered cell CEC 639 (at sta 0+60) after completion of test 2

Fig. 13 shows the position of this cell when it was uncovered after testing on the area had been completed. It had originally been placed in a horizontal position.

40. Test area 2. The moisture contents and densities of the soil of test area 2 (used for tests 3-5) were similar to those of the 0- to 6-in., 12- to 18-in., and 18- to 24-in. layers of test area 1. The soil in any location of test area 2 was not appreciably different in moisture content and density from the soil in other locations, except for the 0- to 12-in. layer between sta 0+33 and 0+42 (where the moisture content was approximately 2 to 4 per cent higher and the density 2 to 6 lb per cu ft lower).

Cone index measurements

41. Cone indexes measured at 3-in. vertical increments before and after traffic on areas 1 and 2 are plotted in plates 2, 3, 4, and 5, respectively. These plots show that the test sections were not uniform in regard to cone index either before or after traffic. Although some of the cone indexes on an area are shown as being at the same station, individual points cannot be compared directly because the measurements could have been as much as a foot apart (see fig. 14).

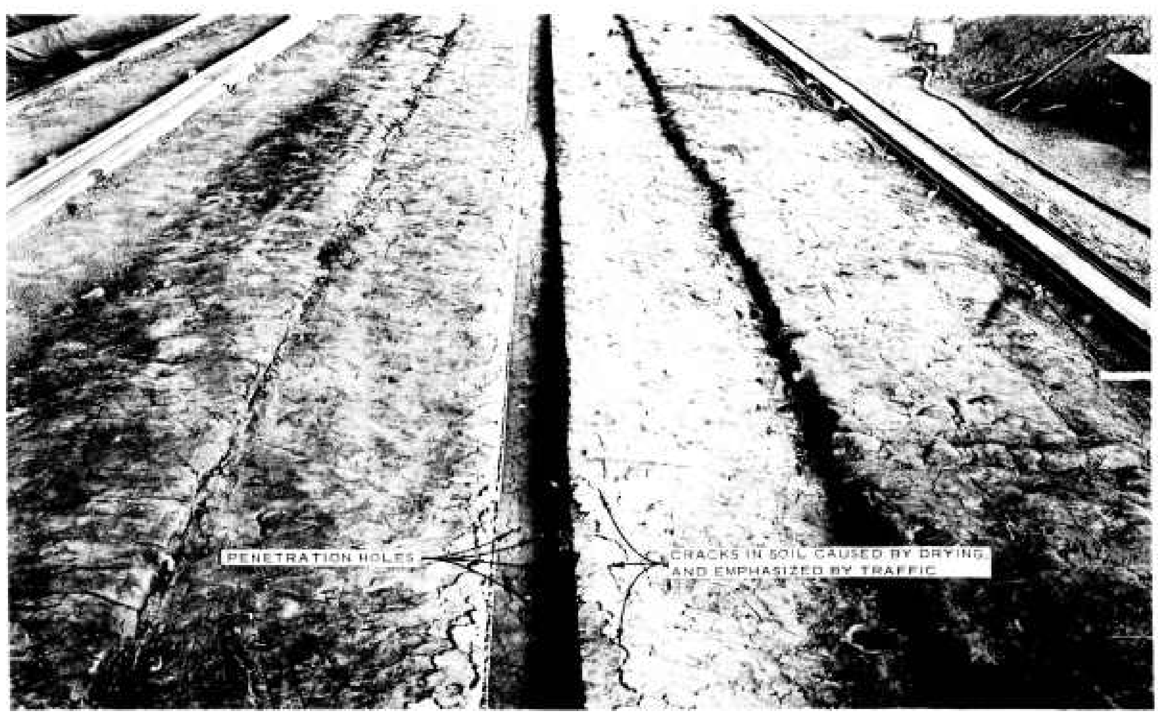


Fig. 14. After traffic on test area 2

42. The surface cone indexes measured after traffic on area 1 were decidedly higher than those measured before traffic (compare plates 2 and 3). Some of this increase was probably due to drying of the soil, which resulted in a crusty and cracked surface. The cracks were evident in the immediate vicinity of the wheel path (see fig. 14). The average depth to which drying occurred was not precisely determined but appeared to be about 1/2 in.; some cracks appeared to be about 3 in. deep. This surface condition may have influenced the various measurements (particularly contact pressure) made in test 2.

43. The soil strength also varied along the length of the test areas (see table 2). To illustrate this variation, the average cone indexes of the top 12-in. layer (before and after traffic) of the two areas are plotted in plate 6. Note the difference in the patterns of soil strength in the two areas; the strength of the soil in the middle of the center section of area 1 was lower than that near the ends of the center section of the area, whereas the reverse was found in area 2. No attempt has been made in this report to determine the effect of soil strength on stress transmissions.

Wheel Load

44. The actual load on the test wheel was not continuously determined because of instrumentation limitations; but the deviation from the known applied static load was measured. Because of instrumentation failure, the deviation from the applied load was not recorded for test 1 and the second pass of test 2. However, the corrected load is listed by stations in tables 5, 6, 7, and 8 for passes 1 and 3 of test 2, and for tests 3, 4, and 5, respectively. With only few exceptions, the load remained fairly constant in tests 3, 4, and 5. It was usually a little less than the original load in tests 3 and 5, and a little more than the original load in test 4. On the other hand, although the variation in load from station to station during either the first or third pass of test 2 was in most cases not very significant, the difference in loads for the two passes was significant.

45. The varying loads are believed to have been caused primarily by

inadequate roller bearings, since replacement of the bearings after the test program has resulted in more consistent loads. Some variation could have been caused by deceleration and acceleration of the wheel as it ascended or descended slight rises, but since the profile of the ruts was fairly level, these variations are not considered significant.

Wheel-path Alignment

46. Because the test wheel was slightly warped, the wheel-path alignment varied a maximum of 0.4 in. in one revolution of the wheel. This variation was included in the horizontal distance to the cell in tests 3, 4, and 5. It was not measured during tests 1 and 2 but was likely of little consequence in those tests because the pressure cells were placed along the center line of the wheel path.

Relations Among Test Data

47. Plots of the various test data (cone index, maximum contact pressure, residual sinkage, and motion resistance) obtained during a pass of the wheel indicated general direct or inverse relations. Plate 7 shows a set of typical data plots. The similarity of shape between the two curves of the upper plot (cone index and contact pressure) and between the two lower curves (sinkage and motion resistance) is apparent, as is the general inverse relation between the upper pair and the lower pair of curves.

48. It will be noted that whereas sinkage measurements were made at every station and motion resistance measurements were made continuously, cone index and contact pressure data were collected less frequently. As mentioned earlier, the number of cone index measurements was restricted because too many penetrometer holes would probably have introduced an undesirable condition in the soil mass. Since it was considered important to know the strength of the soil in which the pressure cells were located, cone indexes were measured in their vicinity, sometimes on one side of the cell, sometimes on the other, but never directly over the cell or too close to the cell, for obvious reasons. Only one force cell for measuring contact pressure was used in this test program, and it

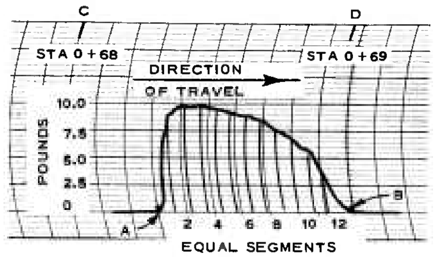
registered every 12.57 ft, the circumference of the wheel.

49. In order to provide sufficient data with which to develop relations among the several parameters, certain assumptions regarding the magnitude of data not actually measured at the desired spot had to be made. These assumptions are explained in subsequent paragraphs. The relations developed are necessarily influenced to some extent by the errors involved in the assumptions. Also, it will be noted that in most instances the derived equations have been obtained from simple cross plots of the pertinent test variables. As a result, many of the equations recorded are not in a dimensionally balanced form.

Residual sinkage and total sinkage

50. As stated in paragraph 18, it was considered likely that some of the total sinkage of the load wheel would be the result of recoverable deformation of the soil (elastic sinkage). Residual sinkage was measured immediately after the passage of the wheel, but because of malfunctioning of the device intended to determine the total sinkage of the wheel, no other direct measurements of sinkage were obtained. To get this information, total sinkage was approximated from measured data on residual sinkage and contact arc of the force cell. It was assumed that the force cell registered immediately upon its contact with the soil and continued its registration until it was removed from the soil at the elevation represented by the residual sinkage. It was further assumed that no wheel slip occurred. Fig. 15 shows a typical trace for the force cell, and by example (pass 6 of test 5) shows how the contact arc and angle were computed. In fig. 16 are given the equations for computing total sinkage (and elastic sinkage) from residual sinkage and contact angles. Because residual sinkage was not always measured at the exact location desired, a value was interpolated from measured values at the two adjacent stations. The interpolated residual sinkages and the computed total and elastic sinkages are presented in table 3.

51. The relation of residual sinkage to total sinkage on the first pass appeared to differ from the relation of residual sinkage to total sinkage on subsequent passes. For this reason, separate plots of these data are shown in plates 8 and 9, respectively. A straight line on each of these logarithmic plots seems to represent the data very well. The equations of these lines are:



TRACE MADE BY FORCE CELL
ON PASS 6 OF TEST 5

CD = 48.8 MM REPRESENTS 12 IN. HORIZONTAL TRAVEL BY THE WHEEL

$$\text{CONTACT LENGTH} = \frac{AB}{CD} \cdot 12 = \frac{33\text{ MM}}{48.8\text{ MM}} \cdot 12\text{ IN.} = 8.1148\text{ IN.}$$

$$\text{CONTACT ARC OR } \alpha + \beta = \frac{(8.1148)(360)}{2\pi(24)} = 19^{\circ}22.36'$$

$$\frac{\alpha+\beta}{2} = 9^{\circ}41.18', \quad Z_r = 0.21\text{ IN.}, \quad D = 48\text{ IN.}$$

$$\text{SIN}\frac{\alpha-\beta}{2} = \frac{Z_r}{D \cdot \text{SIN}\frac{\alpha+\beta}{2}} = \frac{0.21}{(48)(0.16825)} = 0.02600$$

$$\frac{\alpha-\beta}{2} = 1^{\circ}29.38'$$

$$\frac{\alpha+\beta}{2} = 9^{\circ}41.18'$$

$$\alpha = 11^{\circ}10.56', \quad \beta = 8^{\circ}11.80'$$

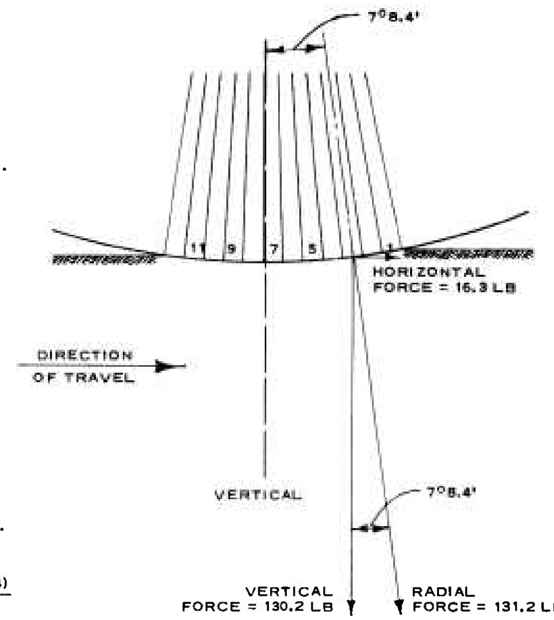
WIDTH OF WHEEL = 6 IN.

CONTACT AREA FOR EACH EQUAL SEGMENT

$$= \frac{(8.1148)(6)}{12} = 4.0574\text{ SQ IN.}$$

AREA OF FORCE CELL = 0.3 SQ IN.

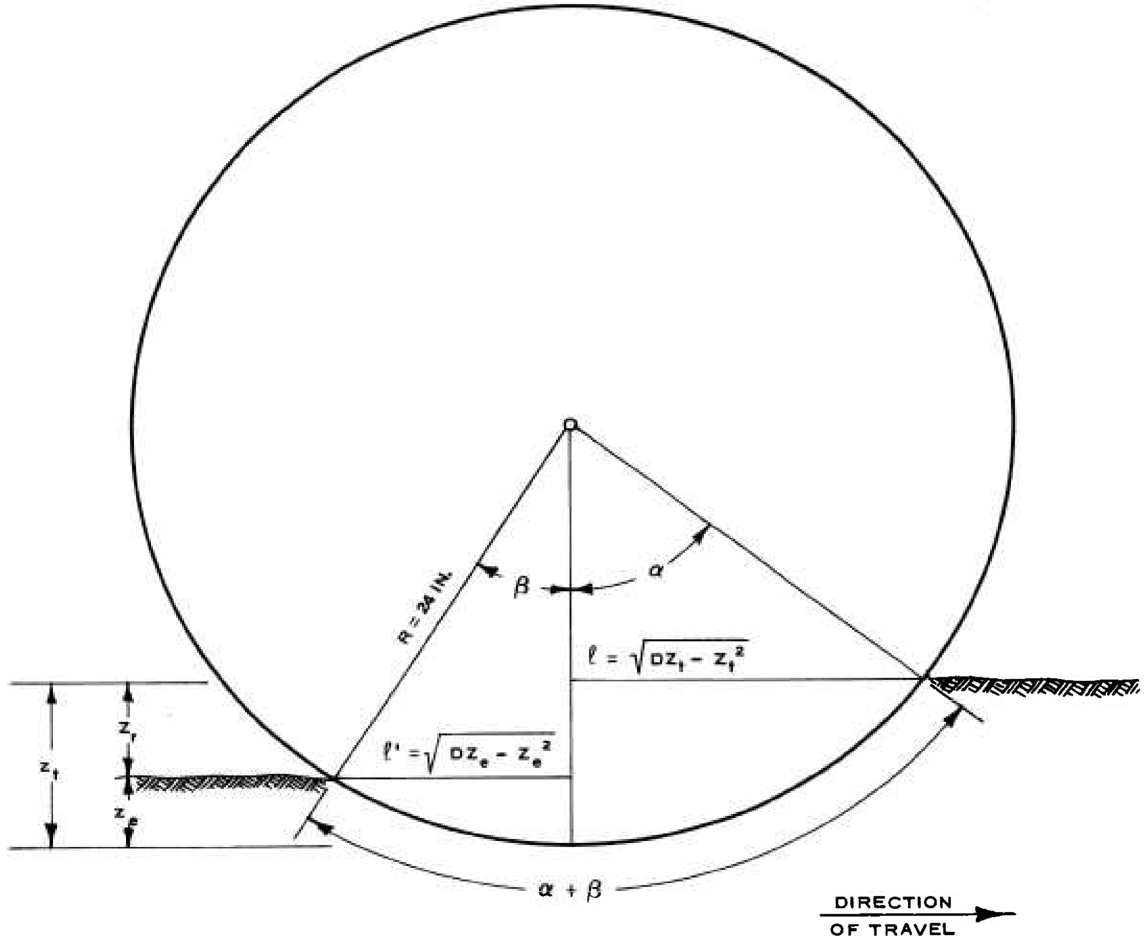
$$\text{SEGMENTAL RADIAL FORCE} = \frac{(\text{AVERAGE FORCE})(4.0574)}{0.3}$$



EQUAL SEGMENT NO.	AVERAGE FORCE LB	SEGMENTAL RADIAL FORCE LB	CENTRAL ANGLE BETWEEN MID-POINT OF THE EQUAL SEGMENT AND THE VERTICAL	SINE OF ANGLE	COSINE OF ANGLE	FORCE, LB	
						HORIZONTAL	VERTICAL
1	4.25	57.48	10°22.1'	0.17998	0.98367	10.35	56.54
2	9.35	126.46	8°45.3'	0.15221	0.98835	19.25	124.99
3	9.70	131.19	7°8.4'	0.12430	0.99224	16.31	130.17
4	9.60	129.84	5°31.6'	0.09631	0.99535	12.50	129.24
5	9.40	127.13	3°54.7'	0.06822	0.99767	8.67	126.83
6	9.10	123.07	2°17.8'	0.04007	0.99919	4.93	122.97
7	8.65	116.98	0°41.0'	0.01193	0.99993	1.40	116.97
8	7.95	107.52	−0°55.9'	−0.01626	0.99987	−1.75	107.51
9	7.05	95.35	−2°32.8'	−0.04443	0.99901	−4.24	95.26
10	6.10	82.50	−4°9.6'	−0.07254	0.99737	−5.98	82.28
11	4.55	61.94	−5°46.5'	−0.10062	0.99492	−6.19	61.23
12	1.65	22.32	−7°23.3'	−0.12860	0.99170	−2.87	22.13
						52.38	1176.12

NOTE: MEASURED LOAD AT STA 0+68 AND 0+69 WAS 1214 AND 1233 LB, RESPECTIVELY.
MEASURED MOTION RESISTANCE AT STA 0+68 AND 0+69 WAS 66 AND 63 LB, RESPECTIVELY.

Fig. 15. Typical trace made by force cell, and example of how the contact arc and angle were computed



$$\cos\beta = \frac{R - Z_e}{R}\,; \quad \cos\alpha = \frac{R - Z_t}{R}$$

$$\cos\beta - \cos\alpha = \frac{Z_t - Z_e}{R} = \frac{Z_r}{R} = \frac{2\,Z_r}{D}$$

SINCE $\cos\beta - \cos\alpha = -2\,\sin\frac{\beta+\alpha}{2} \cdot \sin\frac{\beta-\alpha}{2}$

THEN, $\sin\frac{\alpha+\beta}{2} \cdot \sin\frac{\alpha-\beta}{2} = \frac{Z_r}{D}$

OR, $\sin\frac{\alpha-\beta}{2} = \frac{Z_r}{D\,\sin\frac{\alpha+\beta}{2}}$

α AND β ARE FOUND BY $\frac{\alpha+\beta}{2} + \frac{\alpha-\beta}{2} = \alpha\,; \quad \frac{\alpha+\beta}{2} - \frac{\alpha-\beta}{2} = \beta$

THEN, $Z_t = R - R\cos\alpha$

$Z_e = R - R\cos\beta$

Fig. 16. Equations for computing total and elastic sinkages

$$Z_r = 0.75\ Z_t^{1.15} \qquad \text{(sinkages from first pass)}$$

$$Z_r = 0.70\ Z_t^{1.5} \qquad \text{(sinkages from subsequent passes)}$$

Although the plotted points indicate a good possibility that the residual and total sinkages are related, it should be pointed out that total sinkage was obtained indirectly. In future tests, both residual and total sinkages should be measured directly for a wider range of wheel sinkages in order that the relation of residual and total sinkages can be clarified.

52. According to the derived equations, when Z_t is equal to 6.8 in. on the first pass, Z_r also is equal to 6.8 in.; and if Z_t becomes greater than 6.8 in., Z_r becomes greater than Z_t. Since the residual sinkage can never be greater than the total sinkage, the relation of the two sinkages probably changes to become $Z_r = Z_t$ at some value of total sinkage greater than the total sinkage experienced in this test program and less than the limiting value of the equation, 6.8 in. Similarly, the value of total sinkage on subsequent passes, at which the relation of the two sinkages changes, lies between the upper limit of the total sinkages experienced in these tests and the limiting value of the equation for subsequent passes, 2.04 in.

Motion resistance and residual sinkage

53. Although a study of the relation of motion resistance to any one of the three sinkages (total, residual, or elastic) could have been made, residual sinkage was used because it is deemed to be most indicative of the energy lost in deforming the soil. It has the further advantage that it was measured directly. If the relation of motion resistance to total or elastic sinkage is required, it can be derived from demonstrated relations of total and elastic sinkage to residual sinkage.

54. The relation of motion resistance (MR) to residual sinkage (Z_r) was derived from the data measured in the area from sta 0+48 to 0+57, which was the most uniform 10 ft of the test area (see plate 6). All the data for all the passes (excluding the first-pass measurements which were treated separately) were averaged to minimize the effect of any errors in the measurements. This was considered reasonable as the data for passes

other than the first are quite similar. The average motion resistance divided by the average load is plotted against the average increment of residual sinkage in plate 10. Each plotted point represents one test. Because the three points for the tests conducted with a 600-lb load were so scattered, the data for all three were again averaged and plotted as one point. This point and the points for the 1200- and 2400-lb loads form a straight line on logarithmic paper (see plate 10). The equation of this line is

$$\frac{MR}{W} = 0.144\ Z_r^{0.5}$$

55. The measurements from the first pass of each test were averaged as before, and are plotted in plate 11. The equation of the line representing these measurements is

$$\frac{MR}{W} = 0.076\ Z_r^{0.5}$$

The dashed line in plate 11 represents the data plotted in plate 10. It can be seen that the two lines have the same slope (0.5) and that an abscissa value on the dashed line at a given ordinate value is approximately one-fourth that on the solid line. This indicates that when the ratio of motion resistance to load for subsequent passes was the same as that for the first pass, the residual sinkage was approximately one-fourth as great. Possibly future tests will determine whether this phenomenon was peculiar to the conditions of this test program or if it can be expected generally for a rigid wheel traveling on soft soil.

Load and contact pressure

56. To test the reliability of the contact pressure measurements (made by the force cell in the face of the wheel), the traces of the force cell were studied to determine whether it had measured the total load. Each trace was studied in the following manner (see fig. 15).

a. Equally spaced points were marked on the zero line of the trace and projected to the trace.

b. The average force on each trace segment was determined.

c. The average force on each trace segment was divided by the area of the force cell (0.3 sq in.) and the result multiplied by the area of the wheel face represented by a trace segment to obtain the total radial force on that segment.

d. Each segmental radial force was resolved into its horizontal and vertical components.

e. The horizontal components were added and the vertical components were added.

57. Since a study of this nature is laborious, only the traces made by the force cell when it contacted the soil in the vicinity of a single station (sta 0+68) were studied. Of the 25 traces studied, 18 showed the computed total vertical force to be within ±10 per cent of the measured load. Therefore, the force cell was considered to have given a fair approximation of the test load, and, consequently, of the pressures at the wheel-soil interface.

58. The segmental vertical forces and radial forces derived from the example in fig. 15 were converted to pressures and are drawn to scale in fig. 17. The maximum vertical pressure obtained in this manner was 32.1

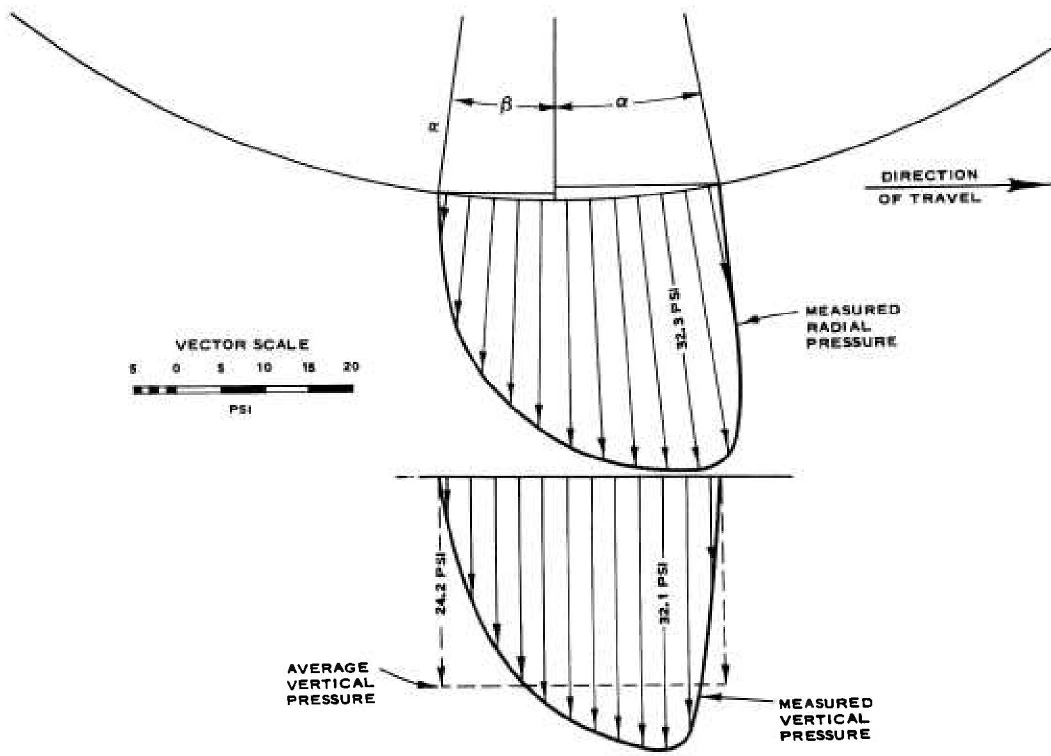


Fig. 17. Typical contact pressure diagram, test 5, pass 6, sta 0+68 to 0+69

psi, and the average was 24.2 psi. An average vertical pressure can also be determined by dividing the total load, $\frac{1214 + 1233}{2} = 1223.5$ (table 10, pass 6, test 5, sta 0+68 and 0+69), by the total projected contact area as is shown in the following computations using the measurement and notations in fig. 15.

If $Z_r = 0.21$ in., then from $Z_r = 0.70\ Z_t^{1.5}$ (see paragraph 51), $Z_t = 0.448$. From $Z_t = Z_r + Z_e$, $Z_e = 0.238$ in.

Average vertical pressure $(CP_{avg}) = \frac{W}{b(\ell + \ell')}$ (see fig. 16)

By substitution

$$CP_{avg} = \frac{W}{b\left(\sqrt{DZ_t - Z_t^2} + \sqrt{DZ_e - Ze^2}\right)}$$

or

$$CP_{avg} = \frac{1223.5}{6\left[\sqrt{48(0.448) - (0.448)^2} + \sqrt{48(0.238) - (0.238)^2}\right]} = 25.5$$

59. The ratio of maximum radial pressure (see table 3) to average contact pressure determined in the latter manner is $\frac{CP_{max}}{CP_{avg}} = \frac{32.3}{25.5} = 1.27$ in this particular example. This value fairly well characterizes the other traces also.

Maximum contact pressure and total sinkage

60. For a given wheel load, the contact pressure between the wheel face and the soil depends upon the contact area. Since the width of the wheel is constant, the contact area is a function of the contact length, which, in turn, is a function of the total sinkage. The total sinkage, however, depends upon the strength (cone index) of the soil. It was considered of interest, therefore, to develop the relation between maximum contact pressure and total sinkage.

61. To study the relation of total sinkage to maximum contact pressures for the different and varying wheel loads, the total sinkage was plotted against the ratio of wheel load to maximum contact pressure.

Sinkage and contact pressure are listed in table 3; loads at the proper stations are interpolated from tables 4-8. The plotted data (see plate 12) suggest a straight-line relation between the logarithms of the two variables, as a first approximation. The equation of the line that seems to fit the data best is $Z_t = 0.0011\left(\frac{W}{CP_{max}}\right)^{1.65}$. Some of the scatter of the plotted points can be attributed to the difficulties encountered in measuring the small sinkages and to the crusty surface-soil on which test 2 was conducted.

<u>Cone index and total sinkage</u>

62. As stated in paragraph 60, the total sinkage depends upon the strength (cone index) of the soil. Thus, it was also considered of interest to develop the relation between cone index and total sinkage. The cone indexes in the 0- to 12-in. layer are listed in table 2; the total sinkages were computed from the residual sinkages listed in tables 4-8. However, cone indexes were only measured in the vicinity of pressure cell locations and no record was kept of the exact location of the measurement. In order to derive the relation between total sinkage and cone index, the appropriate total sinkage values were taken to be the average of the total sinkages derived from the residual sinkages measured at the cell location and at stations immediately adjacent to the cell location. For example, on the first pass of test 3, an average cone index of 49 in the 0- to 12-in. layer was measured near the pressure cell at sta 0+33 (see table 2). From table 6 it can be seen that the residual sinkage at sta 0+33 was 0.20 in., and at sta 0+32 and 0+34, it was 0.27 and 0.25 in., respectively. The total sinkages (0.317, 0.412, and 0.387 in., respectively) were computed (from the equation $Z_r = 0.75\ Z_t^{1.15}$) and averaged to obtain the total sinkage of 0.372 in. which was taken to correspond to the cone index of 49. The total sinkages computed from residual sinkages from subsequent passes were computed from the equation $Z_r = 0.70\ Z_t^{1.5}$. To compensate for the different wheel loads (see tables 4-8), the total sinkage was plotted against the ratio of the wheel load to the corresponding cone index (see plate 13). Although the plotted points are scattered, they indicate a straight-line relation between the logarithms of the two variables. The equation of the straight line that appears to fit the data best is

$Z_t = 0.0048 \left(\frac{W}{CI}\right)^{1.65}$. Although simplifying assumptions had to be made in order that this relation could be approximated, the relation between cone index and total sinkage, as stated above, is considered reasonable.

Cone index and maximum contact pressure

63. Since both cone index and maximum contact pressure were related to total sinkage, a simultaneous solution of the equations representing these relations (see paragraphs 61 and 62) provided the following relation of cone index to maximum contact pressure: $\frac{CI}{CP_{max}} = 2.44$. If the relation of cone index to average contact pressure (CP_{avg}) is desired, it can be obtained by substituting 1.27 CP_{avg} (see paragraph 59) for CP_{max} in the above equation to obtain $\frac{CI}{CP_{avg}} = 3.10$.

Comparison of cone index-contact pressure ratio with theoretical bearing capacity

64. The cone penetrometer and the wheel may be considered as footings for purposes of discussion; and their respective strength units, cone index and average contact pressure, considered as units of bearing capacity. According to the theory of bearing capacity of footings,* the ratio of cone index to contact pressure should be a constant other than 1 because the bearing capacity was measured by footings of different shapes and at different depths. The theoretical value of the constant can be estimated from the bearing capacity equations for footings on a purely cohesive soil.* For a circular footing (the cone penetrometer) at depths more than about two diameters (about 1.5 in. in this case), a unit bearing capacity (q_{ci}) as much as 9.7 times the cohesion of the soil could be expected. The wheel, which can be considered a rectangular footing on the basis of projected area, would be expected to develop a unit bearing capacity (q_w) no less than 5.1 times the soil cohesion (the theoretical relation for an infinitely long, loaded strip at the surface of the soil). Thus, theoretically the constant expressing the ratio $\frac{q_{ci}}{q_w} = \frac{9.7}{5.1}$ should be no larger than

* G. G. Meyerhof, "The ultimate bearing capacity of foundations," Geotechnique, vol II, No. 4 (December 1951).

1.9, considerably less than the value 3.10 derived from the experimental data (see paragraph 63).

65. Recent laboratory tests at the Waterways Experiment Station relating cone index to triaxial test results have shown that the cone index is actually about 12.5 times the soil cohesion when the apparent angle of friction of the compacted test soil is zero. On this basis, the constant in question could be as large as $\frac{12.5}{5.1} = 2.45$. This value is still less than the ratio of cone index to average contact pressure (3.10), but it is close to the ratio of cone index to the maximum contact pressure (2.44). However, in view of the limitations of the test data, with respect to both uniformity and range, this is not believed to be an adequate basis for concluding that maximum contact pressure is the more valid criterion of the support required for the soil. It does suggest, however, that the various test measurements and the interrelations developed from them are reasonably correct.

Pressure Cell Measurements

66. The maximum stresses measured by the pressure cells during the five tests are listed in tables 9-13 along with load, sinkage, and cell location data. Examination of these data shows that for the most part the measured stresses increased with each additional pass. This tendency can be attributed, at least in part, to the fact that as the ruts deepened, the load came nearer to the cells. In some instances, however, the stresses measured by a cell merely fluctuated irregularly or even decreased. This type of behavior occurred in test 2 in the case of cells buried at depths of about 9 in. or less. It is noteworthy also that these stresses were, in general terms, the highest stresses measured during the program.

67. To provide a basis for estimating whether the measured stresses were reasonable, a theoretical computation of stresses was made for the cell position-load condition that existed on the last pass of each test. It should be noted that all the pressure cells were oriented to measure vertical stresses and consequently all comparisons shown are made only in terms of vertical stresses. Computations were made using the Boussinesq solution for the stresses in an isotropic, elastic, homogeneous mass of

semi-infinite extent due to a vertical load applied uniformly over a rectangular area. The width of the rectangle was the width of the wheel and the length of the rectangle was the (computed) length of the chord, $\ell + \ell'$ (see fig. 16), that supported the load. These measured and computed stresses, along with other pertinent information, are recorded in table 14.

68. Generally, the measured stresses were greater than the computed stresses by a factor ranging from a little more than one to about four. Further, the ratio of the measured and computed stresses appeared to vary with the cell location. To study the manner in which the stress ratio (and ultimately that of the measured stresses) varied with the cell location, average values for depth, offset, and stress ratio were determined for similarly located cells. These average values are tabulated below.

Test	Average Depth of Cell, in.	Average Offset of Cell, in.	Average Ratio of Measured to Computed Stress
1	8.8	0.0	1.7
	11.8	0.0	1.4
2	6.7	0.0	1.7
	9.5	0.0	2.1
3	8.4	4.2	2.6
	11.6	4.1	1.5
4	8.8	7.4	2.6
	11.8	7.4	1.9
5	7.6	7.4	3.2
	11.3	7.4	1.8

The average depth of the cell is plotted against the average stress ratio for the three offsets (0.0, 4.2, and 7.4 in.) and the average offset is also plotted against the average stress ratio for the two depths (approximately 9 and 12 in.) in plate 14. Although the trend of these data is not definitive, it indicates that the ratio of the measured to the computed stress is a function of the cell location. Furthermore, it indicates that the measured stresses follow a pattern other than that of the stresses computed from elastic theory. The data from tests 1, 3, and 4, all of which were conducted with the 600-lb load, provide sufficient information for a direct comparison of computed and measured stress patterns in a portion of the stress field (plate 15). For the region for which data are available, this comparison shows that the stress induced in the soil is greater than that predicted by means of elastic theory. If the measured stresses are correct, this implies that in other regions, probably near the point of load application and at greater offsets, actual stresses must be less than the computed stresses since a static balance of forces must be achieved. No data are available to substantiate this implication.

69. It is evident from the foregoing analysis that elastic theory does not provide a validation of the pressure cell measurements. However, since the test soil only crudely approximates the homogeneous, isotropic, elastic mass assumed as a basis for computing stresses, lack of agreement is not surprising. The fact that the stress measurements appear to form a consistent pattern and are of a reasonable magnitude suggests that they, at least qualitatively, reflect the true stress state of the yielding soil mass. Much more detailed studies will be required before more definitive conclusions can be drawn.

PART IV: CONCLUSIONS AND RECOMMENDATIONS

Conclusions

70. The following conclusions are believed warranted based on the results of this test program:

a. The residual sinkage (Z_r) can be expressed as a function of the total sinkage (Z_t) of the wheel for the range of sinkage experienced in these tests. (First pass, $Z_r = 0.75\ Z_t^{1.15}$; subsequent passes, $Z_r = 0.70\ Z_t^{1.5}$.)

b. The ratio of the motion resistance to the wheel load can be expressed as a function of the residual sinkage of the wheel. (First pass, $\frac{MR}{W} = 0.076\ Z_r^{0.5}$; subsequent passes, $\frac{MR}{W} = 0.144\ Z_r^{0.5}$.)

c. When the ratio of the motion resistance to the load for subsequent passes is the same as that for the first pass, the residual sinkage of the wheel is approximately one-fourth as great.

d. The total sinkage of the wheel can be expressed as a function of the wheel load and the maximum contact pressure.

$$\left[Z_t = 0.0011 \left(\frac{W}{CP_{max}} \right)^{1.65} \right]$$

e. The total sinkage of the wheel can be expressed as a function of the wheel load and the cone index of the soil.

$$\left[Z_t = 0.0048 \left(\frac{W}{CI} \right)^{1.65} \right]$$

f. Within the limitations of the pressure cells and the variation in test conditions, the pressure cells gave reasonable, quantitative results.

g. The distribution of stresses induced in the test soil was different from that to be expected in an elastic medium.

Recommendations

71. It is recommended that:

a. Tests be performed in a clay whose strength is low enough to allow large wheel sinkages, using the same wheel used in this program.

b. Tests be performed with rigid wheels of various diameters and widths in soils of low strength.

c. Accuracy and frequency of test measurements be increased by any feasible means, including the following:

   (1) Record exact points at which cone indexes are measured and soil samples extracted; fill cone penetrometer and sampler holes with soil similar to that of the test area.

   (2) Install additional force cells on the center of the wheel face and across the wheel face.

   (3) Measure total and residual sinkages continuously.

   (4) Determine exact location at which a force cell in the wheel face lies on a vertical diameter during the time of its contact with the soil.

Table 1

Moisture Content and Density Measurements

	Moisture Content, %				Density, lb/cu ft			
Station	0- to 6-in. Depth	6- to 12-in. Depth	12- to 18-in. Depth	18- to 24-in. Depth	0- to 6-in. Depth	6- to 12-in. Depth	12- to 18-in. Depth	18- to 24-in. Depth
Test 1								
Before Pass 1								
0+33	33.4	33.4	31.0	34.7	86.5	86.4	86.1	83.8
0+42	35.5	34.8	33.0	27.6	83.2	84.5	87.6	92.3
0+51	30.1	32.5	30.3	28.1	83.1	87.3	89.9	85.9
0+60	33.1	39.8	35.6	34.6	87.5	78.8	84.2	85.8
0+69	31.5	37.6	34.0	26.5	86.2	81.3	84.9	93.0
0+78	34.4	35.4	32.9	26.2	84.0	83.5	86.6	89.1
Avg	33.0	35.6	32.8	29.6	85.1	83.6	86.6	88.3
After Pass 1								
0+33	32.0	35.4	28.5	31.5	87.8	84.0	86.5	88.8
0+51	33.3	38.5	32.8	31.4	82.8	80.6	87.2	88.6
0+69	32.2	34.2	34.5	28.0	87.1	84.7	86.5	90.1
0+78	35.5	36.1	34.1	28.6	83.5	81.5	84.9	89.6
Avg	33.2	36.0	32.5	29.9	85.3	82.7	86.3	89.3
After Pass 2								
0+33	30.5	32.8	28.5	32.4	86.7	86.5	85.1	84.3
0+51	31.9	35.8	32.3	30.7	88.0	82.5	88.1	87.3
0+69	32.0	34.3	33.6	29.0	87.1	84.7	86.5	90.1
0+78	36.0	35.2	29.9	30.8	84.2	84.3	90.4	--
Avg	32.6	34.5	31.1	30.7	86.5	84.5	87.5	87.2
After Pass 3								
0+33	31.0	33.3	29.6	29.9	88.3	86.2	86.2	86.7
0+51	32.5	36.5	33.8	29.9	86.4	82.2	86.1	89.0
0+69	32.9	34.9	32.8	29.2	87.1	84.2	86.3	88.8
0+78	29.7	36.9	32.0	30.6	88.8	80.2	86.9	88.3
Avg	31.5	35.4	32.0	29.2	87.6	83.2	86.4	88.2
After Pass 4								
0+33	29.5	32.9	29.0	31.0	86.6	86.2	89.2	89.9
0+51	32.0	36.0	32.2	29.6	88.0	82.9	87.4	87.8
0+69	33.7	33.4	33.1	29.9	87.4	85.3	87.0	85.2
0+78	34.0	38.0	35.4	32.1	84.5	80.5	84.9	87.4
Avg	32.3	35.1	32.4	30.6	86.6	83.7	87.1	87.6
Test 2								
Before Pass 1								
0+36	31.2	34.9	33.3	34.0	88.8	84.1	86.6	--
0+48	33.9	36.9	32.3	29.6	87.4	83.2	88.4	85.0
0+60	36.1	38.0	33.1	31.6	84.3	81.4	87.3	--
0+72	33.6	36.4	32.8	33.0	85.9	83.4	88.1	--
Avg	33.7	36.6	32.9	32.0	86.6	83.0	87.6	--
After Pass 1								
0+36	30.7	34.7	31.6	31.6	90.2	85.2	86.3	89.2
0+48	31.5	31.7	35.0	31.3	88.8	88.8	85.2	89.7
0+60	34.1	37.3	33.2	31.2	85.8	80.2	85.4	85.4
0+72	31.8	35.0	31.3	31.4	88.7	84.7	87.6	--
Avg	32.0	34.7	32.8	31.4	88.4	84.7	86.1	88.1
After Pass 2								
0+36	32.5	33.0	31.7	31.0	88.7	86.5	87.4	86.6
0+48	32.8	34.7	33.2	33.2	86.6	83.7	86.4	87.5
0+60	33.2	39.0	34.6	33.2	87.8	80.0	86.0	86.8
0+72	33.0	36.2	32.3	33.4	87.6	84.1	85.0	86.2
Avg	32.9	35.7	33.0	32.7	87.7	83.6	86.2	86.8
After Pass 3								
0+36	30.7	32.7	32.8	26.0	90.1	87.8	86.5	--
0+48	31.4	33.5	30.7	30.4	89.5	--	89.4	89.8
0+60	31.3	34.8	30.8	31.4	89.4	85.1	89.6	87.0
0+72	33.2	35.5	31.0	--	87.1	84.2	--	--
Avg	31.6	34.1	31.3	29.3	89.0	85.7	88.5	88.4

(Continued)

Table 1 (Concluded)

Station	Moisture Content, % 0- to 6-in. Depth	6- to 12-in. Depth	12- to 18-in. Depth	18- to 24-in. Depth	Density, lb/cu ft 0- to 6-in. Depth	6- to 12-in. Depth	12- to 18-in. Depth	18- to 24-in. Depth
				Test 3				
				Before Pass 1				
0+48	33.6	32.9	31.3	31.9	86.6	87.5	87.3	--
0+60	33.5	34.2	31.2	33.5	85.6	85.4	88.1	88.1
0+75	34.8	33.4	32.6	32.4	85.3	86.1	85.0	--
Avg	34.0	33.5	31.7	32.6	85.8	86.3	86.8	--
				After Pass 1				
0+36	35.3	37.2	32.9	34.0	84.3	81.4	87.2	84.3
0+54	32.5	33.6	32.4	32.2	87.9	86.8	81.6	88.5
0+66	32.6	31.8	31.8	34.1	87.1	88.9	85.9	86.1
Avg	33.5	34.2	32.4	33.4	86.4	85.7	84.9	86.3
				After Pass 3				
0+42	33.3	35.5	32.3	31.6	85.5	--	87.4	86.6
0+51	30.9	31.4	31.2	30.1	89.8	89.0	86.7	89.1
0+72	32.8	32.7	32.1	30.9	86.2	--	88.1	90.1
Avg	32.3	33.2	31.9	30.9	87.2	--	87.4	88.6
				After Pass 6				
0+39	35.5	35.9	--	--	81.9	83.5	--	--
0+57	31.8	34.6	--	--	88.5	85.0	--	--
Avg	33.6	35.2	--	--	85.2	84.2	--	--
				Test 4				
				Before Pass 1				
0+36	33.4	36.1	34.7	30.3	86.3	82.3	73.4	--
0+54	31.8	32.8	29.8	33.8	88.5	87.9	88.6	--
0+72	33.2	33.0	32.6	--	87.2	85.6	--	--
Avg	32.8	34.0	32.4	32.0	87.3	85.3	81.0	--
				After Pass 1				
0+42	31.3	34.6	30.7	--	88.5	83.7	89.1	--
0+57	31.4	32.3	30.9	--	87.2	88.4	88.7	--
0+75	32.7	32.4	31.0	--	87.4	87.1	--	--
Avg	31.8	33.1	30.9	--	87.7	86.4	88.9	--
				After Pass 4				
0+33	36.2	36.9	32.9	--	83.8	82.1	83.4	--
0+48	34.0	32.0	30.6	--	86.5	88.4	91.2	--
0+66	33.1	32.5	32.6	--	87.5	87.8	87.5	--
Avg	34.4	33.8	32.0	--	85.9	86.1	87.4	--
				After Pass 6				
0+39	34.5	36.5	32.9	--	86.1	81.9	86.6	--
0+51	32.4	32.2	28.5	--	88.8	88.9	90.3	--
0+63	33.6	32.7	32.9	--	87.0	87.7	87.5	--
Avg	33.5	33.8	31.4	--	87.3	86.2	88.1	--
				Test 5				
				Before Pass 1				
0+45	33.0	32.4	32.1	--	88.1	89.0	87.6	--
0+57	31.6	35.0	28.5	--	89.9	85.7	93.0	--
0+72	32.3	33.9	31.5	--	88.6	86.5	89.7	--
Avg	32.3	33.8	30.7	--	88.9	87.1	90.1	--
				After Pass 1				
0+39	34.6	34.1	--	--	85.8	86.2	--	--
0+51	32.0	31.7	--	--	90.3	89.1	--	--
0+75	32.0	33.6	--	--	88.8	87.2	--	--
Avg	32.9	33.1	--	--	88.3	87.5	--	--
				After Pass 3				
0+33	33.8	33.5	--	--	86.4	87.2	--	--
0+54	31.2	32.3	--	--	90.4	89.2	--	--
Avg	32.5	32.9	--	--	88.4	88.2	--	--
				After Pass 5				
0+42	35.1	35.3	--	--	85.5	84.4	--	--
0+60	33.2	35.7	--	--	87.8	83.8	--	--
0+69	33.7	33.3	--	--	87.2	85.8	--	--
Avg	34.0	34.8	--	--	86.8	84.7	--	--
				After Pass 6				
0+36	36.2	37.5	--	--	84.6	81.9	--	--
0+48	34.4	34.3	--	--	86.4	86.5	--	--
0+63	33.4	32.7	--	--	87.4	88.4	--	--
Avg	34.7	34.8	--	--	86.1	85.6	--	--

Table 2

Cone Index Measurements

Station	Cone Index: Depth, in. 0	3	6	9	12	15	18	24	Layer, in. 0-6	0-12	0-18
Test 1											
Before Pass 1											
0+33	58	72	72	89	156	121	150	118	67	89	103
0+36	66	79	69	69	105	115	122	140	71	78	89
0+39	58	62	81	81	76	114	122	145	67	72	85
0+42	47	56	64	60	109	145	159	159	56	67	89
0+45	59	59	62	66	110	127	156	137	60	71	91
0+48	51	54	68	62	88	136	157	132	58	65	88
0+51	55	65	68	70	69	130	106	119	63	65	80
0+54	51	62	61	74	74	109	111	122	58	64	77
0+57	61	61	62	65	62	109	126	136	61	62	78
0+60	55	59	61	52	56	101	125	130	58	57	73
0+63	56	77	75	67	75	110	137	136	69	70	85
0+66	78	91	75	70	85	103	125	144	81	80	90
0+69	79	90	78	70	75	104	129	139	82	78	89
0+72	76	78	74	66	70	133	133	111	76	73	90
0+75	58	56	71	71	81	132	158	167	62	67	90
0+78	64	58	63	75	70	135	140	140	62	66	86
Avg	61	67	69	69	85	120	135	136	66	70	86
After Pass 1											
0+33	87	87	85	87	152	108	127	90	86	100	105
0+36	75	85	75	77	112	135	130	192	78	85	98
0+39	65	62	70	67	75	102	130	105	66	68	82
0+42	57	55	62	78	105	130	150	142	58	71	91
0+45	58	60	62	65	95	142	162	172	60	68	92
0+48	62	65	72	62	102	145	120	112	66	73	90
0+51	62	60	73	60	80	117	133	150	65	67	84
0+54	62	70	65	65	70	117	120	137	66	66	81
0+57	57	62	60	60	77	100	135	140	60	63	79
0+60	60	62	62	47	60	97	122	135	61	58	73
0+63	67	75	70	70	75	105	117	135	71	71	83
0+66	97	82	100	50	65	120	135	105	93	79	93
0+69	81	77	79	70	82	118	146	146	79	78	93
0+72	88	67	75	85	77	155	142	108	77	78	98
0+75	72	57	70	62	67	127	127	130	66	66	83
0+78	92	62	72	65	75	122	137	117	75	73	89
Avg	71	68	72	67	86	121	133	132	70	73	88
After Pass 2											
0+33	80	90	80	85	165	100	105	75	83	100	101
0+36	100	100	90	80	110	110	100	85	97	96	99
0+39	80	95	100	95	90	125	105	80	92	92	99
0+42	60	55	70	55	75	155	150	120	62	63	89
0+45	75	85	65	65	100	125	135	125	75	78	93
0+48	60	65	55	40	85	165	160	160	60	61	90
0+51	60	65	60	65	70	150	165	180	62	64	91
0+54	55	60	70	55	55	65	70	115	62	59	61
0+57	45	70	70	75	55	110	140	160	62	63	81
0+60	55	85	80	60	55	120	130	145	73	67	84
0+63	65	70	70	50	55	95	115	90	68	62	74
0+66	95	80	80	75	80	110	100	115	85	82	89
0+69	80	70	68	55	78	95	125	128	73	70	82
0+72	55	55	60	65	80	150	160	145	57	63	89
0+75	55	55	80	75	95	115	160	180	63	72	91
0+78	90	65	60	60	105	130	105	105	72	76	88
Avg	69	73	72	66	85	120	127	126	72	73	87
After Pass 3											
0+33	95	100	95	85	120	135	105	115	97	99	105
0+36	95	85	95	90	105	120	130	165	92	94	103
0+39	80	65	70	85	80	120	190	160	72	76	99
0+42	55	50	70	60	125	135	120	120	58	72	88
0+45	60	50	65	50	115	160	180	150	58	68	97
0+48	65	65	65	60	95	140	155	125	65	70	92
0+51	45	60	80	60	80	180	180	145	62	65	98
0+54	55	60	60	60	50	120	160	155	58	57	81
0+57	60	60	65	45	60	120	150	165	62	58	80
0+60	55	75	85	60	65	135	150	170	72	68	89
0+63	85	95	60	70	85	100	105	90	80	79	86
0+66	95	105	90	65	80	120	120	120	97	87	96
0+69	75	80	80	80	95	100	125	145	78	82	91
0+72	75	45	65	60	60	105	110	120	62	61	74
0+75	60	50	70	75	85	135	145	150	60	68	89
0+78	80	60	65	55	75	140	120	125	68	67	85
Avg	71	69	74	66	86	129	140	139	71	73	91

(Continued)

Table 2 (Continued)

Station	Cone Index: Depth, in. 0	3	6	9	12	15	18	24	Layer, in. 0-6	0-12	0-18
Test 1 (Continued)											
After Pass 4											
0+33	85	95	115	100	90	135	155	125	98	97	111
0+36	90	90	90	65	80	115	125	115	90	83	94
0+39	65	65	60	60	80	125	150	155	63	66	86
0+42	60	70	70	100	140	155	135	130	67	88	104
0+45	55	45	60	65	95	105	125	125	53	64	79
0+48	70	75	70	65	105	115	125	140	72	77	89
0+51	60	70	80	50	55	135	145	125	70	63	85
0+54	55	60	65	50	70	100	140	200	60	60	77
0+57	55	50	50	50	65	95	90	90	52	54	65
0+60	70	90	100	75	75	100	90	95	87	82	86
0+63	80	85	65	45	65	115	145	155	77	68	86
0+66	100	75	50	60	60	80	75	115	75	69	71
0+69	80	70	65	65	80	105	115	100	72	72	83
0+72	85	80	80	85	80	155	140	125	82	82	101
0+75	55	70	65	70	75	120	115	120	63	67	81
0+78	95	65	55	65	80	85	95	120	72	72	77
Avg	72	72	71	67	81	115	123	127	72	73	86
Test 2											
Before Pass 1											
0+33	75	80	82	85	98	155	145	172	79	84	103
0+36	95	102	98	95	120	155	148	150	98	102	116
0+39	88	75	82	105	102	110	145	152	82	90	101
0+42	75	70	82	85	145	140	145	155	76	91	106
0+45	80	80	68	75	100	182	225	235	76	81	116
0+48	85	78	92	62	110	172	170	225	85	85	110
0+51	100	102	75	85	105	148	160	230	92	93	111
0+54	88	100	80	88	85	130	145	160	89	88	102
0+57	90	88	75	80	68	128	145	158	84	80	96
0+60	85	90	70	78	60	120	115	120	82	77	88
0+63	68	90	72	65	75	120	135	185	77	72	89
0+66	115	110	90	62	80	95	100	127	105	91	93
0+69	110	95	80	72	115	130	135	150	95	94	105
0+72	88	82	68	82	95	130	138	145	79	83	98
0+75	70	75	55	62	75	118	145	140	67	67	86
0+78	98	72	65	85	90	110	122	140	78	82	92
Avg	88	87	77	79	95	134	145	165	84	85	101
After Pass 1											
0+33	75	70	80	80	120	135	145	120	75	85	101
0+36	110	105	100	70	120	125	125	155	105	101	108
0+39	85	85	90	90	120	160	155	130	87	94	112
0+42	80	75	80	105	150	175	180	185	78	98	121
0+45	75	65	70	120	175	200	200	180	70	101	129
0+48	100	80	85	120	165	130	150	155	88	110	119
0+51	80	85	80	85	115	80	100	175	82	89	89
0+54	80	80	75	100	125	160	160	200	78	92	111
0+57	70	65	70	80	100	115	100	140	68	77	86
0+60	120	90	80	60	100	95	115	100	97	90	94
0+63	115	85	80	65	95	135	135	135	93	88	101
0+66	80	85	80	80	90	115	100	100	82	83	90
0+69	125	95	85	95	105	150	165	175	102	101	117
0+72	85	90	115	80	95	130	125	130	97	93	103
0+75	60	65	95	65	95	180	160	150	73	76	103
0+78	135	100	105	100	105	115	125	130	113	109	112
Avg	92	82	86	87	117	138	140	148	87	93	106
After Pass 2											
0+33	125	90	110	125	175	160	170	120	108	125	136
0+36	150	130	110	110	125	105	105	120	130	125	119
0+39	125	80	90	85	130	140	120	135	98	102	110
0+42	90	80	80	85	110	150	160	165	83	89	108
0+45	80	80	85	115	155	170	165	210	82	103	121
0+48	135	90	80	140	140	120	140	120	102	117	121
0+51	140	100	90	80	130	160	140	188	110	108	120
0+54	80	75	80	80	85	135	130	155	78	80	95
0+57	85	85	70	130	130	130	140	185	80	100	110
0+60	130	100	80	60	130	130	130	150	103	100	109
0+63	125	100	80	80	105	125	140	130	102	98	108
0+66	200	130	120	100	160	165	140	150	150	142	145
0+69	160	100	80	100	160	180	200	170	113	120	140
0+72	140	80	100	80	110	160	165	180	107	102	119
0+75	100	80	90	85	80	110	140	160	90	87	98
0+78	145	100	65	75	90	155	150	160	103	95	111
Avg	126	194	88	96	126	143	146	156	102	106	117

(Continued)

Table 2 (Continued)

Station	Cone Index										
	Depth, in.								Layer, in.		
	0	3	6	9	12	15	18	24	0-6	0-12	0-18
					Test 2 (Continued)						
					After Pass 3						
0+33	110	90	100	85	145	100	85	125	100	106	102
0+36	135	90	95	120	150	125	165	130	107	118	126
0+39	90	75	85	95	115	155	200	185	83	92	116
0+42	75	75	100	125	130	125	125	140	83	101	108
0+45	60	70	65	85	135	120	125	165	65	83	94
0+48	120	100	80	85	80	75	70	135	100	93	87
0+51	80	85	75	95	105	145	120	180	80	88	101
0+54	100	80	80	75	85	135	200	180	87	84	108
0+57	95	75	70	85	105	115	140	160	80	86	98
0+60	135	95	80	90	95	120	135	120	103	99	107
0+63	135	90	65	85	120	135	160	160	97	99	113
0+66	260	65	100	80	115	105	180	130	142	124	129
0+69	150	100	70	80	80	65	70	120	107	96	88
0+72	120	85	85	145	140	130	130	130	97	115	119
0+75	100	80	80	65	65	65	70	145	87	78	75
0+78	140	70	70	120	130	100	120	120	93	106	107
Avg	119	83	81	95	112	113	131	145	94	98	105
					Test 3						
					Before Pass 1						
0+33	35	40	48	48	75	92	140	102	41	49	68
0+39	47	52	42	50	65	92	128	112	47	51	68
0+45	48	72	45	62	67	110	115	110	55	59	74
0+51	58	82	80	68	90	112	92	108	73	76	83
0+57	62	85	55	80	115	98	105	105	67	79	86
0+63	50	65	55	102	105	100	110	128	57	75	84
0+72	45	55	50	80	88	112	105	122	50	64	76
0+78	40	58	55	92	80	102	110	102	51	65	77
Avg	48	64	54	73	86	102	113	111	55	65	77
					After Pass 1						
0+36	50	50	35	52	65	92	100	102	45	50	63
0+42	48	50	48	52	68	85	108	115	49	53	66
0+48	58	60	50	100	90	100	102	115	56	72	80
0+54	62	60	68	68	82	90	90	105	63	68	74
0+60	85	60	58	75	88	100	108	110	68	73	82
0+66	50	58	55	95	92	110	105	125	54	70	81
0+75	55	62	50	78	95	135	110	140	56	68	84
Avg	58	57	52	74	83	102	103	116	56	65	76
					After Pass 3						
0+33	39	45	42	60	75	107	100	107	42	52	67
0+39	50	48	48	58	75	105	98	108	49	56	69
0+45	65	65	58	70	98	98	110	110	63	71	81
0+51	72	90	82	102	122	115	108	102	81	94	99
0+57	78	70	70	100	125	100	95	105	73	89	91
0+63	78	68	62	102	115	115	122	152	69	85	95
0+72	68	60	55	90	122	138	120	118	61	79	93
0+78	62	65	58	75	95	130	118	118	62	71	86
Avg	64	64	59	82	103	114	109	115	62	75	85
					After Pass 6						
0+33	52	48	42	45	70	102	128	120	47	51	70
0+39	50	52	42	58	70	88	88	95	48	54	64
0+45	60	60	52	70	85	105	110	102	57	65	77
0+51	72	78	75	95	152	112	110	112	75	94	99
0+57	75	70	60	85	145	100	108	128	68	87	92
0+63	70	62	62	102	102	105	115	125	65	80	88
0+72	68	60	55	88	98	128	128	115	61	74	89
0+78	60	60	60	88	92	128	110	122	60	72	85
Avg	63	61	56	79	102	108	112	115	60	72	83
					Test 4						
					Before Pass 1						
0+36	50	65	45	48	58	80	88	105	53	53	62
0+45	65	60	50	42	45	50	55	90	58	52	52
0+54	75	85	75	70	105	120	120	135	78	82	93
0+63	72	75	72	110	95	110	108	115	73	85	92
0+69	70	65	50	100	95	125	140	148	62	76	92
0+78	75	60	62	80	95	118	122	112	66	74	87
Avg	68	68	59	75	82	100	106	118	65	70	80

(Continued)

Table 2 (Concluded)

Station	Cone Index: Depth, in. 0	3	6	9	12	15	18	24	Layer, in. 0-6	0-12	0-18
Test 4 (Continued)											
After Pass 1											
0+33	58	58	55	55	68	90	132	142	57	59	74
0+42	58	52	50	48	62	90	118	155	53	54	68
0+51	75	78	110	98	115	130	135	135	88	95	106
0+60	80	65	62	62	98	120	130	145	69	73	88
0+66	70	65	78	75	125	138	155	160	71	83	101
0+72	65	70	52	95	118	102	102	70	62	80	86
Avg	68	65	68	72	98	112	129	134	67	74	87
After Pass 4											
0+39	48	55	42	50	75	128	115	105	48	54	73
0+48	42	55	52	80	85	105	110	108	50	63	76
0+57	70	72	90	110	128	105	112	125	77	94	98
0+66	55	62	72	100	102	112	128	145	63	78	90
0+75	60	65	58	82	112	150	148	150	61	75	96
Avg	55	62	63	84	100	120	123	127	60	73	87
After Pass 6											
0+33	52	58	50	72	90	100	110	102	53	64	76
0+45	70	68	60	98	100	132	130	120	66	79	94
0+57	78	75	65	108	160	142	125	128	73	97	108
0+60	65	62	60	90	100	112	108	122	62	75	85
0+66	70	62	65	98	150	125	130	125	66	89	100
0+78	72	68	62	80	98	108	120	115	67	76	87
Avg	68	66	60	91	116	120	120	119	65	80	92
Test 5											
Before Pass 1											
0+36	35	50	45	50	70	85	95	115	43	50	61
0+45	50	70	60	65	80	85	105	100	60	65	74
0+51	65	90	80	90	110	110	85	80	78	87	90
0+57	55	95	80	130	140	115	140	125	77	100	108
0+72	55	60	65	115	130	120	130	120	60	85	96
0+78	45	65	60	85	95	100	100	125	57	70	79
Avg	51	72	65	89	104	102	109	111	62	76	85
After Pass 1											
0+33	50	50	55	60	65	80	125	105	52	56	69
0+42	55	55	60	60	85	100	90	95	57	63	72
0+48	55	60	60	85	95	110	105	100	58	71	81
0+60	60	70	70	80	100	125	140	115	67	76	92
0+69	60	65	55	95	85	125	120	130	60	72	86
Avg	56	60	60	76	86	108	116	109	59	68	80
After Pass 3											
0+39	40	55	50	60	75	125	105	115	48	56	73
0+45	55	65	60	100	85	100	100	100	60	73	81
0+54	65	75	70	80	125	110	115	135	70	83	91
0+63	50	70	65	110	105	100	130	150	62	80	90
0+75	65	65	65	80	95	85	85	125	65	74	77
Avg	55	66	62	86	97	104	107	125	61	73	82
After Pass 5											
0+36	50	50	40	70	120	120	100	95	47	66	79
0+48	60	65	65	85	150	100	115	110	63	85	91
0+57	60	75	120	120	90	115	120	140	85	93	100
0+66	60	70	65	90	110	130	140	165	65	79	95
0+78	55	70	80	85	100	115	105	130	68	78	87
Avg	57	66	74	90	114	116	116	128	66	80	90
After Pass 6											
0+39	45	60	60	70	90	110	110	115	55	65	78
0+42	65	65	60	80	115	125	120	110	63	77	90
0+51	105	80	90	100	130	120	145	130	92	101	110
0+60	75	75	70	120	140	115	120	115	73	96	102
0+69	65	70	70	95	120	130	140	125	68	84	99
0+72	75	80	70	75	90	110	90	125	75	78	84
Avg	72	72	70	90	114	118	121	120	71	84	94

Table 3

Computed Sinkages and Measured Maximum Contact Pressure

Station	Interpolated Z_r* in.	Computed Z_t** in.	Computed Z_e† in.	Maximum Contact Pressure†† psi
Test 1, Pass 1				
0+30.0	0.08	0.118	0.038	26.2
0+42.6	0.12	0.213	0.093	20.7
0+55.1	0.18	0.237	0.057	39.9
0+67.6	0.10	0.134	0.034	41.5
0+80.1	0.24	0.252	0.012	17.5
Test 1, Pass 2				
0+30.1	0.02	0.092	0.072	30.4
0+42.7	0.03	0.168	0.138	22.9
0+55.2	0.07	0.167	0.097	33.9
0+67.8	0.09	0.123	0.033	30.3
0+80.3	0.11	0.149	0.039	22.3
Test 1, Pass 3				
0+54.6	0.08	0.176	0.096	33.2
0+67.1	0.04	0.083	0.043	40.3
0+79.7	0.04	0.099	0.059	30.6
Test 1, Pass 4				
0+29.7	0.03	0.071	0.041	35.2
0+42.2	0.04	0.150	0.110	34.9
0+54.6	0.04	0.145	0.105	32.4
0+67.1	0.03	0.076	0.046	41.1
0+79.7	0.05	0.113	0.063	39.5
Test 2, Pass 1				
0+30.5	0.82	1.043	0.223	46.0
0+43.1	1.02	1.258	0.238	31.0
0+55.7	0.99	1.305	0.315	32.0
0+68.4	0.80	0.913	0.113	56.7
0+81.1	1.00	1.287	0.287	33.7
Test 2, Pass 2				
0+30.1	0.55	0.852	0.302	56.7
0+42.7	0.73	1.017	0.287	38.7
0+55.4	0.81	1.158	0.348	35.7
0+68.1	0.54	0.759	0.219	58.0
0+80.8	0.60	0.822	0.222	34.7
Test 2, Pass 3				
0+30.3	0.56	0.873	0.313	40.7
0+42.8	0.78	1.106	0.326	47.7
0+55.4	0.70	1.086	0.386	46.3
0+68.1	0.48	0.685	0.205	39.3
0+80.6	0.83	1.073	0.243	48.0
Test 3, Pass 1				
0+30.6	0.48	0.581	0.101	24.3
0+43.2	0.23	0.343	0.113	20.4
0+55.8	0.11	---	---	2.9
0+68.4	0.17	0.225	0.055	18.4
0+81.1	0.29	0.337	0.047	16.3
Test 3, Pass 2				
0+30.6	0.11	0.306	0.196	22.1
0+43.2	0.11	0.239	0.129	16.7
0+55.8	0.03	0.157	0.127	42.5
0+68.3	0.06	0.215	0.155	22.1
0+80.8	0.06	0.230	0.170	19.7
Test 3, Pass 3				
0+30.5	0.11	0.342	0.232	22.5
0+43.1	0.12	0.275	0.155	24.1
0+55.8	0.03	0.162	0.132	37.4
0+68.4	0.09	0.229	0.139	27.2
0+81.1	0.10	0.278	0.178	19.6
Test 3, Pass 4				
0+30.7	0.09	0.309	0.219	23.9
0+43.2	0.08	0.237	0.157	23.5
0+55.8	0.02	0.140	0.120	35.7
0+68.3	0.03	0.197	0.167	27.1
0+80.9	0.10	0.243	0.143	22.1
Test 3, Pass 5				
0+30.6	0.07	0.317	0.247	21.8
0+43.2	0.08	0.249	0.169	23.3
0+55.8	0.05	0.170	0.120	31.4
0+68.3	0.08	0.222	0.142	24.1
0+80.9	0.05	0.247	0.197	20.5

(Continued)

Note: The station listed is a calculated point at which the force cell was directly beneath the axle of the test wheel.

* Residual sinkage.

** Total sinkage.

† Elastic sinkage.

†† The highest stress in psi measured by the force cell in the face of the wheel.

Table 3 (Concluded)

Station	Interpolated Z_r in.	Computed Z_t in.	Computed Z_e in.	Maximum Contact Pressure psi
		Test 3, Pass 6		
0+30.6	0.08	0.304	0.224	21.6
0+43.2	0.09	0.244	0.154	17.0
0+55.7	0.02	0.140	0.120	28.9
0+68.3	0.03	0.226	0.196	26.2
0+80.8	0.06	0.245	0.185	19.4
		Test 4, Pass 1		
0+30.6	0.09	0.186	0.096	22.4
0+43.1	0.09	0.198	0.108	20.4
0+55.7	0.05	0.144	0.094	28.6
0+68.2	0.10	0.188	0.088	30.9
0+80.8	0.12	0.245	0.125	21.2
		Test 4, Pass 2		
0+30.6	0.09	0.222	0.132	20.9
0+43.1	0.09	0.219	0.129	19.1
0+55.7	0.02	0.154	0.134	25.9
0+68.2	0.02	0.141	0.121	26.9
0+80.8	0.08	0.232	0.152	19.2
		Test 4, Pass 3		
0+30.6	0.09	0.228	0.138	18.2
0+43.2	0.09	0.226	0.136	21.8
0+55.7	0.05	0.169	0.119	28.9
0+68.2	0.07	0.188	0.118	29.4
0+80.8	0.05	0.227	0.177	20.1
		Test 4, Pass 4		
0+30.6	0.05	0.200	0.150	19.9
0+43.2	0.06	0.224	0.164	20.4
0+55.7	0.02	0.172	0.152	28.7
0+68.3	0.04	0.187	0.147	28.9
0+80.8	0.05	0.229	0.179	19.4
		Test 4, Pass 5		
0+30.6	0.00	---	---	20.4
0+43.2	0.02	---	---	21.0
0+55.7	0.00	---	---	28.0
0+68.2	0.01	---	---	26.5
0+80.8	0.02	---	---	22.4
		Test 4, Pass 6		
0+30.6	0.09	0.246	0.156	17.5
0+43.2	0.07	0.245	0.175	22.1
0+55.8	0.01	0.170	0.160	31.5
0+68.3	0.05	0.207	0.157	30.3
0+80.8	0.06	0.226	0.166	23.3

Station	Interpolated Z_r in.	Computed Z_t in.	Computed Z_e in.	Maximum Contact Pressure psi
		Test 5, Pass 1		
0+30.8	0.25	0.478	0.228	26.0
0+43.3	0.32	0.512	0.192	27.3
0+55.9	0.14	0.311	0.171	34.6
0+68.5	0.24	0.396	0.156	35.0
0+81.1	0.32	0.522	0.202	25.6
		Test 5, Pass 2		
0+30.8	0.29	0.568	0.278	24.5
0+43.4	0.30	0.539	0.239	28.2
0+56.1	0.15	0.338	0.188	34.7
0+68.7	0.20	0.423	0.223	30.8
0+81.2	0.24	0.494	0.254	30.1
		Test 5, Pass 3		
0+30.8	0.30	0.613	0.313	28.4
0+43.3	0.29	0.534	0.244	28.2
0+56.0	0.13	0.353	0.223	36.2
0+68.6	0.21	0.416	0.206	33.5
0+81.1	0.26	0.506	0.246	29.2
		Test 5, Pass 4		
0+30.8	0.33	0.653	0.323	25.3
0+43.3	0.33	0.559	0.229	26.2
0+56.0	0.15	0.379	0.229	32.3
0+68.5	0.21	0.449	0.239	31.4
0+81.1	0.26	0.504	0.244	28.6
		Test 5, Pass 5		
0+30.8	0.33	0.616	0.286	27.2
0+43.4	0.22	0.452	0.232	29.6
0+56.0	0.11	0.335	0.225	36.4
0+68.5	0.17	0.381	0.211	33.8
0+81.1	0.27	0.494	0.224	31.1
		Test 5, Pass 6		
0+30.9	0.34	0.603	0.263	25.8
0+43.4	0.28	0.510	0.230	28.9
0+56.1	0.13	0.343	0.213	35.4
0+68.6	0.21	0.455	0.245	32.3
0+81.1	0.23	0.516	0.286	30.6

Table 4

Motion Resistance and Sinkage Measurements, Test 1

Station	Motion Resistance, lb, for Pass No. 1	2	3	4	Residual Sinkage, in., for Pass No. 1	2	3	4
0+30	2	9	--	8	0.08	0.01	0.02	0.03
0+32	6	14	--	13	0.20	0.05	0.05	0.07
0+33	4	9	--	9	0.14	0.03	0.04	0.03
0+34	7	13	--	13	0.19	0.09	0.03	0.03
0+35	-	6	--	4	0.18	0.07	0.05	0.03
0+36	5	11	8	8	0.10	0.04	0.02	0.07
0+37	2	9	--	5	0.18	0.06	0.07	0.02
0+38	0	2	--	0	0.21	0.08	0.07	0.04
0+39	0	3	--	0	0.14	0.04	0.03	0.04
0+40	1	3	--	2	0.18	0.06	0.07	0.01
0+41	0	2	--	3	0.15	0.04	0.07	0.04
0+42	2	8	--	11	0.11	0.04	0.05	0.04
0+43	0	8	0	3	0.12	0.03	0.04	0.04
0+44	3	12	9	12	0.12	0.07	0.07	0.07
0+45	4	13	8	12	0.19	0.06	0.05	0.04
0+46	8	21	18	26	0.18	0.09	0.05	0.02
0+47	6	14	13	15	0.13	0.07	0.08	0.02
0+48	4	5	7	9	0.20	0.07	0.05	0.04
0+49	3	3	12	13	0.23	0.10	0.06	0.02
0+50	1	0	-4	0	0.16	0.08	0.06	0.02
0+51	0	3	2	6	0.12	0.07	0.05	0.06
0+52	0	1	1	-3	0.18	0.05	0.11	0.02
0+53	1	5	4	7	0.16	0.05	0.11	0.02
0+54	0	3	0	8	0.15	0.06	0.04	0.03
0+55	4	9	7	17	0.18	0.08	0.10	0.05
0+56	8	21	31	29	0.14	0.04	0.10	0.10
0+57	6	14	14	14	0.10	0.06	0.06	0.06
0+58	1	2	0	5	0.15	0.08	0.05	0.01
0+59	2	5	2	8	0.25	0.13	0.09	0.05
0+60	3	12	12	16	0.22	0.09	0.06	0.06
0+61	3	7	-4	4	0.16	0.06	0.09	0.04
0+62	2	6	1	4	0.15	0.06	0.11	0.04
0+63	1	5	-7	-3	0.14	0.06	0.06	0.03
0+64	2	6	5	10	0.17	0.06	0.07	0.06
0+65	0	6	2	7	0.16	0.05	0.07	0.05

(Continued)

Note: Load measurements were not recorded because of instrumentation difficulties. The static load was 604 lb.

Table 4 (Concluded)

Station	Motion Resistance, lb, for Pass No.				Residual Sinkage, in., for Pass No.			
	1	2	3	4	1	2	3	4
0+66	4	9	5	8	0.18	0.04	0.03	0.03
0+67	4	9	15	19	0.12	0.07	0.04	0.03
0+68	2	7	14	15	0.08	0.10	0.03	0.02
0+69	1	4	0	6	0.16	0.04	0.03	0.03
0+70	3	8	-3	7	0.10	0.06	0.05	0.03
0+71	4	19	10	14	0.17	0.07	0.06	0.06
0+72	6	16	11	13	0.08	0.04	0.05	0.04
0+73	2	8	3	5	0.09	0.05	0.07	0.05
0+74	7	9	7	9	0.15	0.08	0.07	0.05
0+75	5	9	0	5	0.11	0.05	0.04	0.04
0+76	3	4	8	14	0.14	0.07	0.04	0.04
0+77	2	5	3	9	0.19	0.14	0.06	0.05
0+78	2	6	9	12	0.13	0.05	0.03	0.03
0+79	1	6	-7	-2	0.19	0.08	0.03	0.08
0+80	4	12	7	10	0.25	0.11	0.05	0.04
0+81	2	11	13	8	0.16	0.10	0.09	0.03

Table 5

Load, Motion Resistance, and Sinkage Measurements, Test 2

Station	Load, lb, for Pass No.			Motion Resistance, lb, for Pass No.			Residual Sinkage, in., for Pass No.		
	1	2*	3	1	2	3**	1	2	3
0+30	2393	--	2431	173	206	324	0.81	0.55	0.56
0+32	2396	--	2425	187	203	327	0.89	0.59	0.51
0+33	2390	--	2418	182	204	326	0.91	0.60	0.51
0+34	2339	--	2429	188	209	338	0.94	0.62	0.46
0+35	2439	--	2404	177	203	319	0.78	0.72	0.55
0+36	2372	--	2445	181	203	332	0.81	0.71	0.55
0+37	2382	--	2456	171	199	313	0.89	0.65	0.56
0+38	2369	--	2663	180	201	314	0.87	0.68	0.60
0+39	2380	--	2519	185	194	300	0.94	0.66	0.66
0+40	2393	--	2560	192	189	298	1.10	0.68	0.67
0+41	2309	--	2616	193	187	307	1.05	0.70	0.79
0+42	2320	--	2499	197	189	309	0.96	0.75	0.77
0+43	2404	--	2591	193	188	297	1.02	0.72	0.78
0+44	2388	--	2579	197	189	304	1.02	0.73	0.79
0+45	2322	--	2573	202	192	307	1.07	0.73	0.75
0+46	2384	--	2576	201	192	318	1.08	0.74	0.75
0+47	2385	--	2583	192	189	313	0.92	1.01	0.77
0+48	2430	--	2528	196	193	319	1.09	0.79	0.79
0+49	2504	--	2484	195	199	322	0.96	0.84	0.75
0+50	2421	--	2482	189	196	310	0.96	0.90	0.69
0+51	2435	--	2544	193	196	315	1.07	0.85	0.77
0+52	2332	--	2520	192	199	318	1.12	0.82	0.76
0+53	2316	--	2485	191	198	322	0.99	0.94	0.75
0+54	2355	--	2523	191	194	319	1.05	0.86	0.71
0+55	2357	--	2593	192	184	309	0.99	0.78	0.68
0+56	2319	--	2643	196	183	303	0.99	0.85	0.73
0+57	2320	--	2663	195	184	303	1.13	0.84	0.77
0+58	2326	--	2647	194	183	306	1.10	0.80	0.80
0+59	2284	--	2659	197	182	312	0.87	1.03	0.85
0+60	2341	--	2629	202	179	321	1.25	0.86	0.85
0+61	2388	--	2543	192	184	321	1.11	0.90	0.91
0+62	2344	--	2483	190	184	329	0.95	0.91	0.90
0+63	2352	--	2459	194	189	329	1.05	0.84	0.78
0+64	2333	--	2465	194	197	329	0.88	0.81	0.67
0+65	2345	--	2405	187	198	332	0.73	0.70	0.60

(Continued)

* The channel for recording load was inactive during the second pass.

** On the third pass the recording pen for motion resistance went off the chart (210 lb) before the load wheel reached sta 0+30. Pen was reset but readings thereafter are not considered reliable.

Table 5 (Concluded)

Station	Load, lb, for Pass No. 1	2	3	Motion Resistance, lb, for Pass No. 1	2	3	Residual Sinkage, in., for Pass No. 1	2	3
0+66	2312	--	2437	187	202	339	0.87	0.54	0.47
0+67	2310	--	2435	187	198	335	0.72	0.58	0.43
0+68	2318	--	2412	189	198	324	0.79	0.53	0.48
0+69	2337	--	2483	188	204	321	0.81	0.62	0.46
0+70	2328	--	2526	189	200	314	1.01	0.53	0.45
0+71	2312	--	2543	196	205	328	0.90	0.63	0.51
0+72	2347	--	2546	200	206	334	0.92	0.55	0.61
0+73	2351	--	2517	197	193	319	1.10	0.47	0.67
0+74	2388	--	2505	205	187	321	1.00	0.40	0.63
0+75	2387	--	2526	203	182	330	1.13	0.45	0.81
0+76	2312	--	2551	205	179	329	1.19	0.36	0.85
0+77	2313	--	2553	205	179	349	1.17	0.44	0.91
0+78	2392	--	2478	202	189	346	1.16	0.50	0.87
0+79	2367	--	2452	198	189	342	1.12	0.50	0.80
0+80	2384	--	2471	200	191	339	1.15	0.51	0.78
0+81	2387	--	2559	194	188	321	0.98	0.63	0.86

Table 6

Load, Motion Resistance, and Sinkage Measurements, Test 3

Sta	Load, lb, for Pass No.						Motion Resistance, lb, for Pass No.						Residual Sinkage, in., for Pass No.					
	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
0+30	576	593	595	588	588	587	27	24	29	35	35	32	0.78	0.07	0.08	0.06	0.01	0.08
0+32	584	595	595	583	587	587	51	46	41	45	44	39	0.27	0.10	0.12	0.11	0.12	0.10
0+33	582	594	596	588	586	586	39	36	36	44	43	40	0.20	0.12	0.16	0.11	0.11	0.10
0+34	572	592	591	581	579	578	35	31	33	33	34	34	0.25	0.11	0.15	0.05	0.09	0.08
0+35	585	595	591	582	582	584	35	31	31	33	32	32	0.15	0.12	0.12	0.09	0.09	0.08
0+36	590	599	595	595	595	599	37	37	43	44	43	40	0.19	0.11	0.09	0.12	0.11	0.09
0+37	588	596	596	587	593	595	34	21	25	28	30	27	0.25	0.13	0.13	0.11	0.13	0.09
0+38	584	598	599	597	597	588	39	32	34	41	39	34	0.18	0.12	0.12	0.09	0.11	0.07
0+39	587	598	603	602	602	602	31	31	33	39	39	37	0.18	0.11	0.09	0.12	0.12	0.08
0+40	592	602	603	598	602	601	36	28	35	41	38	39	0.14	0.08	0.10	0.06	0.10	0.07
0+41	588	598	603	601	601	594	26	21	26	38	36	35	--	--	--	--	--	--
0+42	585	603	602	598	591	592	30	25	29	23	19	20	0.22	0.05	0.13	0.01	0.10	0.07
0+43	587	597	602	595	589	594	35	23	29	31	32	30	0.25	0.10	0.12	0.09	0.08	0.09
0+44	584	606	605	601	601	597	46	38	39	46	45	44	0.17	0.13	0.12	0.06	0.08	0.10
0+45	586	598	600	597	599	600	36	27	31	34	37	34	0.13	0.07	0.09	0.02	0.09	0.06
0+46	581	600	600	598	596	593	34	29	29	34	32	30	0.13	0.07	0.09	0.04	0.10	0.04
0+47	586	604	599	596	598	593	36	29	32	35	31	33	0.19	0.09	0.10	0.07	0.10	0.05
0+48	580	601	598	598	598	594	36	29	33	35	33	33	0.15	0.07	0.07	0.05	0.05	0.06
0+49	583	604	602	604	601	598	34	26	29	33	33	32	0.14	0.07	0.06	0.04	0.04	0.05
0+50	583	605	604	600	600	598	29	23	27	33	30	29	0.19	0.02	0.06	0.00	0.02	0.03
0+51	586	604	604	598	603	602	23	18	21	26	22	22	--	--	--	--	--	--
0+52	587	604	601	599	601	597	24	17	18	21	18	19	0.10	0.03	0.04	0.02	0.03	0.00
0+53	594	606	604	600	604	601	27	23	22	24	22	22	0.14	0.03	0.02	0.03	0.04	0.03
0+54	597	607	598	600	602	595	27	16	19	21	20	20	0.16	0.00	0.06	0.02	0.07	0.03
0+55	591	604	601	600	601	599	25	21	19	25	19	20	0.09	0.01	0.08	0.01	0.03	0.04
0+56	598	602	597	600	600	597	27	24	22	29	24	24	0.11	0.03	0.02	0.02	0.05	0.01
0+57	596	602	599	601	601	597	26	20	24	27	23	23	0.13	0.07	0.07	0.00	0.04	0.03
0+58	597	602	600	602	604	600	34	29	33	37	35	33	0.08	0.02	0.02	0.04	0.04	0.01
0+59	592	604	613	597	602	592	21	19	16	21	17	15	0.12	0.05	0.10	0.00	0.08	0.00
0+60	595	604	597	600	601	599	29	24	27	29	26	26	0.12	0.06	0.04	0.03	0.05	0.12
0+61	599	603	597	601	601	599	28	21	22	26	25	24	0.13	0.03	0.09	0.04	0.05	0.01
0+62	584	604	592	601	595	595	17	12	18	18	14	14	0.09	0.06	0.05	0.02	0.04	0.02
0+63	591	600	602	601	597	600	24	22	24	23	22	21	0.13	0.08	0.06	0.03	0.04	0.01
0+64	598	604	602	601	601	601	24	21	25	25	23	20	0.12	0.06	0.04	0.04	0.03	0.02
0+65	597	601	592	598	594	595	13	9	15	16	14	14	0.15	0.10	0.05	0.04	0.06	0.01
0+66	599	604	598	598	597	597	27	20	22	23	21	20	0.12	0.03	0.07	0.04	0.04	0.04
0+67	594	604	588	597	594	597	22	18	22	19	18	20	0.16	0.07	0.07	0.05	0.09	0.01
0+68	594	604	593	594	590	592	29	23	29	29	28	29	0.15	0.05	0.08	0.02	0.07	0.03
0+69	586	599	586	588	585	591	28	19	24	23	20	22	0.20	0.07	0.10	0.05	0.10	0.02
0+70	579	590	582	583	584	591	34	29	32	41	43	40	0.17	0.07	0.08	0.06	0.07	0.05
0+71	593	599	588	587	589	591	37	37	41	31	30	32	--	--	--	--	--	--
0+72	594	604	586	590	595	592	34	--	37	37	37	37	0.10	0.02	0.08	0.05	0.06	0.01
0+73	598	604	592	597	596	595	29	19	24	26	23	24	0.29	0.04	0.08	0.01	0.08	0.01
0+74	598	604	595	596	598	593	31	26	32	31	29	26	0.15	0.02	0.08	0.05	0.05	0.04
0+75	596	604	594	595	590	595	29	23	28	29	30	28	0.28	0.10	0.07	0.03	0.10	0.06
0+76	596	600	590	587	587	591	25	17	23	22	17	19	0.19	0.04	0.14	0.02	0.10	0.02
0+77	595	600	594	595	599	601	21	33	34	44	35	36	0.31	0.09	0.10	0.04	0.07	0.00
0+78	599	603	595	600	598	594	27	27	29	33	30	29	0.10	0.02	0.08	0.01	0.00	0.09
0+79	591	597	590	592	591	592	11	14	14	12	9	11	0.21	0.09	0.03	0.00	0.09	0.03
0+80	589	595	585	586	586	590	28	22	25	26	20	20	0.18	0.05	0.13	0.05	0.09	0.02
0+81	589	595	590	593	590	593	39	39	39	42	39	36	0.29	0.06	0.10	0.10	0.05	0.07

Table 7

Load, Motion Resistance, and Sinkage Measurements, Test 4

Sta	Load, lb, for Pass No.						Motion Resistance, lb, for Pass No.						Residual Sinkage, in., for Pass No.					
	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
0+30	602	613	613	599	610	600	20	23	21	20	19	29	0.10	0.08	0.07	0.04	0.00	0.08
0+32	604	609	609	593	606	603	42	41	37	36	39	30	0.10	0.07	0.13	0.08	0.00	0.13
0+33	605	610	610	599	607	600	34	37	30	31	32	32	0.14	0.09	0.07	0.07	0.03	0.10
0+34	609	609	610	601	609	600	34	30	28	25	28	28	0.10	0.09	0.08	0.05	0.03	0.08
0+35	607	613	611	599	608	604	33	30	27	23	24	23	0.15	0.09	0.07	0.08	0.02	0.10
0+36	606	617	610	599	609	608	25	23	24	20	22	22	0.11	0.11	0.10	0.08	0.04	0.10
0+37	607	616	610	600	612	608	25	23	21	19	18	20	0.15	0.11	0.13	0.04	0.03	0.10
0+38	607	610	610	600	609	604	27	28	27	24	23	23	0.17	0.11	0.12	0.08	0.02	0.09
0+39	602	607	605	593	603	594	24	24	24	20	21	23	0.15	0.10	0.10	0.08	0.01	0.07
0+40	604	604	605	597	600	596	30	30	25	20	20	21	0.12	0.09	0.11	0.04	0.00	0.06
0+41	598	604	602	598	600	595	25	28	20	22	22	21	0.10	0.02	0.07	0.00	0.01	0.09
0+42	604	612	612	604	608	609	17	14	9	6	4	8	0.11	0.01	0.08	0.08	0.00	0.07
0+43	607	613	599	605	610	607	30	27	21	17	15	13	0.09	0.09	0.10	0.06	0.01	0.07
0+44	601	608	602	600	603	599	38	32	27	24	24	22	0.09	0.07	0.05	0.06	0.04	0.07
0+45	606	610	608	599	603	602	22	23	20	17	20	18	0.10	0.04	0.07	0.00	0.02	0.06
0+46	607	612	612	604	610	609	24	23	20	20	16	16	0.08	0.04	0.06	0.04	0.00	0.04
0+47	604	610	609	600	606	601	30	28	29	25	26	24	0.09	0.04	0.07	0.04	0.00	0.03
0+48	604	610	610	602	609	608	28	25	20	19	21	19	0.10	0.07	0.08	0.03	0.00	0.06
0+49	601	607	601	600	605	600	28	25	23	23	21	21	0.09	0.05	0.06	0.03	0.00	0.06
0+50	600	607	601	595	600	600	22	17	16	15	16	16	0.06	0.02	0.05	0.02	0.00	0.01
0+51	600	609	603	596	607	598	17	18	10	10	9	10	0.03	0.02	0.02	0.01	0.00	0.02
0+52	602	609	609	601	604	608	19	17	10	8	8	10	0.06	0.03	0.07	0.00	0.00	0.02
0+53	599	607	601	596	603	601	18	20	15	10	13	10	0.05	0.03	0.05	0.03	0.00	0.03
0+54	607	611	600	599	606	607	16	20	14	11	10	10	0.08	0.01	0.01	0.00	0.00	0.00
0+55	607	615	610	601	611	614	15	16	10	9	12	12	0.04	0.01	0.06	0.00	0.00	0.03
0+56	609	613	611	603	612	613	19	20	16	12	14	14	0.06	0.03	0.04	0.03	0.00	0.01
0+57	608	609	608	600	608	609	23	20	20	15	18	14	0.04	0.04	0.05	0.00	0.00	0.00
0+58	606	610	606	599	606	607	27	25	23	20	17	16	0.06	0.02	0.00	0.06	0.00	0.00
0+59	607	611	607	600	609	612	19	20	12	8	14	11	0.05	0.00	0.08	0.01	0.00	0.05
0+60	606	611	605	596	609	608	26	26	20	17	17	13	0.06	0.03	0.04	0.03	0.00	0.05
0+61	607	610	607	599	609	607	15	22	13	10	10	10	0.04	0.05	0.05	0.03	0.00	0.05
0+62	608	616	609	599	613	613	14	15	11	6	8	6	0.10	0.05	0.05	0.02	0.01	0.02
0+63	605	609	607	598	608	607	24	20	15	10	12	11	0.08	0.05	0.02	0.05	0.00	0.03
0+64	602	613	607	600	611	610	18	16	13	10	10	10	0.08	0.03	0.02	0.07	0.00	0.03
0+65	605	615	609	602	609	608	16	15	14	8	12	12	0.05	0.03	0.07	0.00	0.00	0.02
0+66	602	609	608	600	612	607	20	22	21	15	17	16	0.04	0.02	0.05	0.05	0.00	0.01
0+67	607	617	609	601	613	610	18	20	18	12	14	11	0.09	0.06	0.06	0.05	0.00	0.02
0+68	607	616	607	606	614	612	20	24	18	13	10	17	0.10	0.01	0.07	0.03	0.01	0.06
0+69	608	619	611	608	617	612	25	20	20	15	14	16	0.08	0.07	0.05	0.06	0.00	0.03
0+70	608	617	609	608	617	615	35	36	33	30	26	27	0.11	0.06	0.08	0.04	0.00	0.05
0+71	608	621	612	608	617	613	24	20	20	24	24	23	0.11	0.08	0.05	0.05	0.00	0.05
0+72	608	613	607	607	614	612	32	30	30	29	24	28	0.07	0.02	0.06	0.03	0.00	0.03
0+73	606	616	608	603	612	610	28	25	23	20	18	19	0.08	0.03	0.07	0.05	0.00	0.02
0+74	606	615	608	604	611	610	23	25	18	17	21	20	0.10	0.02	0.01	0.00	0.00	0.02
0+75	604	615	606	603	609	609	25	22	15	13	12	13	0.10	0.02	0.06	0.04	0.00	0.01
0+76	607	618	608	607	613	610	20	20	16	14	11	13	0.12	0.06	0.07	0.02	0.00	0.06
0+77	602	609	601	600	609	603	27	30	20	20	15	12	0.10	0.07	0.05	0.05	0.01	0.04
0+78	600	608	600	600	607	601	20	20	20	17	16	14	0.10	0.05	0.06	0.01	0.00	0.07
0+79	608	618	607	606	611	612	19	20	17	15	13	13	0.10	0.09	0.03	0.08	0.00	0.05
0+80	624	624	622	618	618	617	20	20	18	14	14	13	0.12	0.08	0.05	0.05	0.00	0.07
0+81	640	634	636	632	631	631	36	30	32	28	27	27	0.12	0.08	0.05	0.05	0.02	0.06

Table 8

Load, Motion Resistance, and Sinkage Measurements, Test 5

Sta	Load, lb, for Pass No.						Motion Resistance, lb, for Pass No.						Residual Sinkage, in., for Pass No.					
	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
0+30	1200	1192	1202	1194	1200	1211	52	80	76	83	77	83	0.19	0.22	0.30	0.30	0.24	0.34
0+32	1187	1205	1193	1202	1268	1335	61	93	85	87	82	78	0.35	0.37	0.41	0.36	0.27	0.30
0+33	1189	1190	1192	1203	1188	1228	61	95	92	98	92	90	0.28	0.33	0.39	0.40	0.32	0.36
0+34	1192	1191	1205	1198	1200	1200	58	91	90	94	90	96	0.29	0.30	0.36	0.37	0.30	0.38
0+35	1193	1194	1209	1202	1207	1316	52	84	77	79	74	80	0.38	0.32	0.38	0.38	0.34	0.33
0+36	1192	1203	1207	1228	1306	1342	54	88	82	86	72	72	0.37	0.39	0.46	0.43	0.31	0.27
0+37	1198	1204	1202	1246	1278	1335	48	83	82	89	77	80	0.36	0.39	0.44	0.43	0.31	0.31
0+38	1199	1204	1199	1273	1258	1349	57	89	88	95	85	85	0.41	0.37	0.47	0.37	0.35	0.31
0+39	1191	1190	1187	1211	1191	1265	48	83	86	93	89	89	0.35	0.38	0.43	0.35	0.39	0.33
0+40	1187	1187	----	1201	1203	----	53	91	--	103	--	--	0.29	0.32	0.32	0.34	0.33	0.32
0+41	1179	1185	1202	1198	1195	1204	49	81	88	94	86	90	0.26	0.24	0.35	0.35	0.26	0.32
0+42	1199	1200	1220	1211	1204	1224	45	72	75	79	71	84	0.33	0.27	0.34	0.34	0.29	0.28
0+43	1203	1200	1211	1204	1207	1237	49	82	82	86	82	90	0.35	0.31	0.30	0.34	0.27	0.29
0+44	1190	1187	1200	1192	1182	1194	52	87	89	97	89	102	0.26	0.28	0.26	0.30	0.13	0.26
0+45	1189	1189	1189	1194	1199	1194	49	82	81	89	84	90	0.19	0.20	0.20	0.21	0.15	0.23
0+46	1205	1207	1205	1212	1210	1212	45	72	70	73	65	70	0.27	0.22	0.25	0.20	0.18	0.21
0+47	1199	1201	1204	1212	1214	1218	52	82	78	82	75	79	0.26	0.21	0.24	0.23	0.23	0.26
0+48	1201	1205	1210	1223	1218	1222	48	79	78	84	79	84	0.28	0.23	0.25	0.26	0.25	0.23
0+49	1193	1190	1192	1201	1202	1201	47	79	81	89	88	98	0.22	0.21	0.20	0.16	0.17	0.20
0+50	1179	1185	1185	1192	1191	1205	45	77	78	81	80	91	0.10	0.03	0.18	0.13	0.14	0.12
0+51	1179	1178	1183	1191	1186	1202	30	63	61	65	61	68	0.09	0.09	0.10	0.12	0.10	0.12
0+52	1192	1190	1194	1201	1200	1211	25	54	51	53	47	52	0.17	0.11	0.13	0.15	0.14	0.14
0+53	1190	1193	1191	1193	1192	1214	24	54	52	58	50	61	0.17	0.06	0.17	0.19	0.11	0.14
0+54	1190	1191	1193	1195	1190	1209	27	58	54	62	54	64	0.12	0.10	0.13	0.17	0.08	0.13
0+55	1195	1192	1195	1202	1196	1209	26	53	50	55	48	58	0.17	0.10	0.13	0.15	0.11	0.12
0+56	1202	1202	1195	1207	1201	1216	36	62	59	63	58	67	0.14	0.15	0.13	0.15	0.11	0.13
0+57	1193	1199	1190	1205	1191	1204	23	56	60	61	60	69	0.11	0.10	0.14	0.15	0.08	0.14
0+58	1193	1196	1192	1199	1192	1208	42	53	62	54	56	64	0.09	0.15	0.13	0.16	0.09	0.12
0+59	----	1204	1190	1207	1196	1208	--	69	52	46	44	52	0.27	0.12	0.16	0.14	0.12	0.16
0+60	1190	1194	1188	1204	1192	1195	53	61	64	61	63	70	0.19	0.19	0.16	0.16	0.07	0.18
0+61	1193	1199	1191	1202	1196	1203	36	51	58	55	50	64	0.16	0.15	0.15	0.14	0.08	0.19
0+62	1200	1204	1205	1215	1201	1208	32	46	52	53	51	56	0.16	0.16	0.12	0.17	0.10	0.13
0+63	1197	1204	1200	1211	1201	1205	39	54	60	58	56	62	0.15	0.15	0.16	0.17	0.13	0.15
0+64	1198	1196	1204	1212	1198	1205	43	56	64	62	60	66	0.15	0.17	0.18	0.20	0.13	0.17
0+65	1201	1199	1203	1212	1196	1201	40	52	60	57	58	67	0.20	0.16	0.14	0.18	0.15	0.13
0+66	1197	1196	1200	1211	1196	1204	50	62	68	65	61	67	0.18	0.18	0.18	0.19	0.15	0.18
0+67	1198	1201	1207	1216	1200	1212	44	58	64	61	57	65	0.20	0.17	0.22	0.21	0.16	0.19
0+68	1205	1211	1205	1212	1202	1214	42	58	62	61	56	66	0.20	0.19	0.17	0.21	0.16	0.19
0+69	1210	1215	1200	1210	1201	1233	41	57	60	56	53	63	0.28	0.21	0.24	0.21	0.18	0.22
0+70	1205	1218	1202	1211	1201	1246	61	71	75	69	74	81	0.31	0.20	0.27	0.22	0.21	0.22
0+71	1201	1205	1192	1200	1190	1196	58	72	75	74	76	87	0.22	0.20	0.22	0.26	0.17	0.23
0+72	1201	1209	1195	1203	1188	1203	54	69	74	76	75	84	0.21	0.15	0.17	0.21	0.18	0.21
0+73	1200	1203	1200	1200	1192	1207	48	63	65	63	60	74	0.13	0.19	0.20	0.20	0.17	0.20
0+74	1194	1201	1200	1201	1192	1211	49	67	67	65	63	73	0.23	0.17	0.20	0.23	0.17	0.28
0+75	1193	1202	1188	1201	1196	1225	43	58	60	56	64	76	0.29	0.16	0.25	0.20	0.20	0.22
0+76	1199	1205	1191	1203	1196	1262	48	61	64	59	63	74	0.31	0.19	0.24	0.24	0.21	0.21
0+77	1192	1189	1187	1199	1189	1205	48	64	72	71	71	82	0.28	0.20	0.21	0.21	0.18	0.20
0+78	1199	1191	1187	1196	1189	1200	52	67	75	76	70	81	0.25	0.18	0.18	0.23	0.18	0.18
0+79	1198	1196	1196	1209	1200	1209	52	63	67	67	64	73	0.29	0.21	0.20	0.25	0.20	0.26
0+80	1203	1209	1203	1209	1206	1225	50	66	68	66	63	73	0.32	0.21	0.24	0.26	0.23	0.23
0+81	1200	1204	1196	1206	1196	1224	62	78	81	77	78	83	0.32	0.25	0.26	0.26	0.28	0.23

Table 9

Maximum Stresses Induced in Soil by Rigid Wheel, Test 1

Static Load = 604 lb

Cell		Pass No.	Cumulative Residual Sinkage,* in.	Vertical Distance to Cell,** in.	Maximum Stress,† psi
No.	Station				
EP 97	0+33	1	0.14	9.0	3.2
		2	0.17	9.0	3.8
		3	0.21	8.9	4.0
		4	0.24	8.9	3.5
EP 109	0+36	1	0.10	8.9	3.3
		2	0.14	8.9	3.9
		3	0.16	8.9	3.6
		4	0.23	8.8	3.8
EP 91	0+39	1	0.14	9.0	2.9
		2	0.18	8.9	3.4
		3	0.21	8.9	5.0
		4	0.25	8.8	5.2
CEC 637	0+42	1	0.11	9.1	0.9
		2	0.15	9.0	2.4
		3	0.20	9.0	1.4
		4	0.24	8.9	2.4
CEC 643	0+45	1	0.19	8.8	1.2
		2	0.25	8.8	---
		3	0.30	8.7	---
		4	0.34	8.7	6.0
CEC 645	0+48	1	0.20	8.9	4.9
		2	0.27	8.8	6.4
		3	0.32	8.8	10.4
		4	0.36	8.7	11.7
EP 61	0+51	1	0.12	11.9	1.2
		2	0.19	11.8	1.4
		3	0.24	11.8	1.5
		4	0.30	11.7	1.6
EP 51	0+54	1	0.15	11.9	---
		2	0.21	11.8	1.4
		3	0.25	11.8	2.6
		4	0.28	11.8	2.6
EP 102	0+57	1	0.10	11.9	0.8
		2	0.16	11.9	2.2
		3	0.22	11.8	2.0
		4	0.28	11.8	2.4
CEC 639	0+60	1	0.22	11.8	2.6
		2	0.31	11.8	3.2
		3	0.37	11.7	2.7
		4	0.43	11.6	3.4
CEC 618	0+63	1	0.14	11.9	3.2
		2	0.20	11.8	3.8
		3	0.26	11.7	4.1
		4	0.29	11.7	3.9
CEC 369	0+66	1	0.18	12.0	1.6
		2	0.22	11.9	1.8
		3	0.25	11.9	1.8
		4	0.28	11.9	1.8

Note: Horizontal distance from center line of wheel path to center of cell was 0.
Deviation of wheel from center line was not measured.
No cell movement.
Deviation in load was not measured.

* Accumulation of residual sinkage from pass to pass, often called total rut depth.

** Vertical distance from center of cell to center line of wheel path.

† Highest stress measured by a cell as wheel passed over it.

Table 10

Maximum Stresses Induced in Soil by Rigid Wheel, Test 2

Static Load = 2404 lb

Cell No.	Cell Sta	Pass No.	Load lb	Cumulative Residual Sinkage* in.	Total Vertical Cell Movement** in.	Vertical Distance to Cell* in.	Maximum Stress* psi	Other Total Cell Movement
EP 97	0+33	1	2386	0.91	0.07	8.2	28.9	None
		2	----	1.51	0.10	7.6	22.1	None
		3	2386	2.02	0.05	7.0	24.6	None
EP 109	0+36	1	2368	0.81	0.00	8.0	25.5	None
		2	----	1.52	0.14	7.5	22.6	None
		3	2359	2.07	0.15	6.9	23.9	None
EP 91	0+39	1	2376	0.99	0.00	7.9	23.0	None
		2	----	1.65	0.20	7.5	20.6	None
		3	2285	2.31	0.17	6.8	22.1	None
CEC 637	0+42	1	2484	0.96	-0.02	7.9	15.6	None
		2	----	1.71	0.00	7.2	9.8	None
		3	2205	2.48	0.02	6.4	24.9	0.38 in. E and 0.12 in. N
CEC 643	0+45	1	2482	1.07	0.20	7.9	32.7	None
		2	----	1.80	0.19	7.1	32.8	None
		3	2231	2.55	0.27	6.5	30.7	0.25 in. E
CEC 645	0+48	1	2374	1.09	0.16	7.9	35.8	None
		2	----	1.88	0.21	7.1	25.9	None
		3	2276	2.67	0.28	6.4	28.7	0.38 in. E
EP 61	0+51	1	2369	1.07	0.00	10.7	12.3	None
		2	----	1.92	0.10	10.0	17.9	None
		3	2260	2.69	0.09	9.2	18.0	None
EP 51	0+54	1	2351	1.05	0.00	10.8	13.4	None
		2	----	1.91	0.11	10.0	17.0	None
		3	2282	2.62	0.10	9.3	22.7	0.12 in. E
EP 102	0+57	1	2484	1.13	0.00	10.8	14.6	None
		2	----	1.97	0.09	10.0	14.0	None
		3	2141	2.74	0.08	9.3	17.2	None
CEC 639	0+60	1	2463	1.25	0.02	10.7	6.0	None
		2	----	2.11	0.64	10.4	16.0	1.00 in. E, 0.50 in. S, and 36° tilt S
		3	2175	2.96	0.21	9.2	15.4	0.75 in. E, 0.25 in. S, and 52° tilt S
CEC 618	0+63	1	2348	1.05	0.06	10.8	15.4	None
		2	----	1.89	0.16	10.1	27.3	0.88 in. E, 0.62 in. N
		3	2345	2.67	0.13	9.3	28.4	0.31 in. E, 0.12 in. N
CEC 369	0+66	1	2308	0.87	0.00	11.1	8.8	None
		2	----	1.41	0.07	10.7	15.4	None
		9	2367	1.88	0.06	10.2	16.0	0.25 in. E, 0.19 in. S

Note: Horizontal distance from center line of wheel path to center of cell was 0. Deviation of wheel from center line was not measured.

* See Table 9.

** The total vertical movement of a cell in a downward direction is represented by a positive number of inches and the total vertical movement of a cell in an upward direction is represented by a negative number of inches.

Table 11

Maximum Stresses Induced in Soil by Rigid Wheel, Test 3

Static Load = 604 lb

Cell No.	Cell Sta	Pass No.	Load lb	Cumulative Residual Sinkage* in.	Distance to Cell, in. Vertical*	Distance to Cell, in. Horizontal**	Maximum Stress* psi
EP 97	0+33	1	582	0.20	8.9	4.0	3.4
		2	594	0.32	8.8	4.0	4.8
		3	596	0.48	8.6	4.0	5.7
		4	588	0.59	8.5	4.0	5.7
		5	586	0.70	8.4	4.0	6.1
		6	586	0.80	8.3	4.0	6.0
EP 109	0+36	1	590	0.19	8.9	4.1	3.8
		2	599	0.30	8.8	4.1	4.4
		3	595	0.39	8.7	4.1	5.1
		4	595	0.51	8.5	4.1	5.1
		5	595	0.62	8.4	4.1	5.4
		6	599	0.71	8.3	4.1	5.2
EP 91	0+39	1	587	0.18	8.9	4.2	3.1
		2	598	0.29	8.8	4.2	3.3
		3	603	0.38	8.7	4.2	3.7
		4	602	0.50	8.6	4.2	4.1
		5	602	0.62	8.4	4.2	4.4
		6	602	0.70	8.4	4.2	4.3
CEC 7640	0+42	1	585	0.22	8.8	4.4	2.4
		2	603	0.27	8.8	4.4	2.7
		3	602	0.40	8.6	4.4	3.1
		4	598	0.41	8.6	4.4	3.4
		5	591	0.51	8.5	4.4	3.6
		6	592	0.58	8.4	4.4	3.8
CEC 7544	0+45	1	586	0.13	8.9	4.2	4.6
		2	598	0.20	8.8	4.2	3.5
		3	600	0.29	8.7	4.2	3.5
		4	597	0.31	8.7	4.2	4.6
		5	599	0.40	8.6	4.2	4.2
		6	600	0.46	8.6	4.2	3.9
CEC 8534	0+48	1	580	0.15	8.8	4.0	4.4
		2	601	0.22	8.7	4.0	4.8
		3	598	0.29	8.7	4.0	5.6
		4	598	0.34	8.6	4.0	4.9
		5	598	0.39	8.6	4.0	5.2
		6	594	0.45	8.5	4.0	5.2

(Continued)

Note: No cell movement.

* See Table 9.

** The horizontal distance in inches from the center of the cell to the center line of the wheel path.

Table 11 (Concluded)

Cell No.	Cell Sta	Pass No.	Load lb	Cumulative Residual Sinkage in.	Distance to Cell, in. Vertical	Distance to Cell, in. Horizontal	Maximum Stress psi
EP 61	0+51	1	586	0.13	11.8	4.2	2.4
		2	604	0.15	11.8	4.2	1.2
		3	604	0.19	11.8	4.2	1.2
		4	598	0.20	11.8	4.2	1.9
		5	603	0.23	11.7	4.2	1.5
		6	602	0.27	11.7	4.2	1.4
EP 51	0+54	1	597	0.16	11.8	4.2	2.5
		2	607	0.16	11.8	4.2	2.2
		3	598	0.22	11.7	4.2	2.5
		4	600	0.24	11.7	4.2	2.7
		5	602	0.31	11.6	4.2	2.6
		6	595	0.34	11.6	4.2	---
EP 102	0+57	1	596	0.13	11.9	4.0	2.2
		2	602	0.20	11.9	4.0	1.5
		3	599	0.27	11.8	4.0	1.5
		4	601	0.27	11.8	4.0	1.7
		5	601	0.31	11.8	4.0	1.7
		6	597	0.34	11.7	4.0	---
CEC 14560	0+60	1	595	0.12	11.8	4.0	3.8
		2	604	0.18	11.7	4.0	3.4
		3	597	0.22	11.6	4.0	3.8
		4	600	0.25	11.6	4.0	4.1
		5	601	0.30	11.6	4.0	4.4
		6	599	0.32	11.6	4.0	---
CEC 12172	0+63	1	591	0.13	11.9	4.0	0.4
		2	600	0.21	11.8	4.0	0.4
		3	602	0.27	11.8	4.0	0.4
		4	601	0.30	11.8	4.0	0.5
		5	597	0.34	11.7	4.0	0.4
		6	600	0.35	11.7	4.0	---
CEC 7837	0+66	1	599	0.12	11.7	4.0	0.2
		2	604	0.15	11.7	4.0	0.2
		3	598	0.22	11.6	4.0	0.4
		4	598	0.26	11.6	4.0	0.4
		5	597	0.30	11.5	4.0	0.4
		6	597	0.34	11.5	4.0	---

Table 12

Maximum Stresses Induced in Soil by Rigid Wheel, Test 4

Static Load = 604 lb

Cell No.	Cell Sta	Pass No.	Load lb	Cumulative Residual Sinkage* in.	Distance to Cell, in. Vertical*	Distance to Cell, in. Horizontal**	Maximum Stress* psi
EP 97	0+33	1	605	0.14	9.2	7.2	3.2
		2	610	0.23	9.1	7.2	2.7
		3	610	0.30	9.0	7.2	2.6
		4	599	0.37	8.9	7.2	2.7
		5	607	0.40	8.9	7.2	2.4
		6	600	0.50	8.8	7.2	2.3
EP 109	0+36	1	606	0.11	9.3	7.5	2.9
		2	617	0.22	9.2	7.5	2.6
		3	610	0.32	9.1	7.5	2.4
		4	599	0.40	9.0	7.5	2.4
		5	609	0.44	9.0	7.5	2.2
		6	608	0.54	8.9	7.5	2.1
EP 91	0+39	1	602	0.15	9.2	7.6	2.5
		2	607	0.25	9.1	7.6	1.9
		3	605	0.35	9.0	7.6	1.9
		4	595	0.43	8.9	7.6	1.7
		5	603	0.44	8.9	7.6	1.5
		6	594	0.51	8.8	7.6	1.4
CEC 7640	0+42	1	604	0.11	9.1	7.6	2.0
		2	612	0.12	9.1	7.6	2.0
		3	612	0.20	9.0	7.6	1.7
		4	604	0.28	8.9	7.6	1.6
		5	608	0.28	8.9	7.6	1.6
		6	609	0.35	8.8	7.6	1.6
CEC 7544	0+45	1	606	0.10	9.0	7.3	0.7
		2	610	0.14	8.9	7.3	0.7
		3	608	0.21	8.9	7.3	0.6
		4	599	0.21	8.9	7.3	0.6
		5	603	0.23	8.8	7.3	0.5
		6	602	0.27	8.8	7.3	0.5
CEC 8534	0+48	1	606	0.10	9.0	7.4	2.1
		2	610	0.17	8.9	7.4	2.2
		3	610	0.25	8.8	7.4	1.9
		4	602	0.28	8.8	7.4	1.7
		5	609	0.28	8.8	7.4	1.7
		6	608	0.34	8.7	7.4	1.5

(Continued)

Note: No cell movement.
* See Table 9.
** See Table 11.

Table 12 (Concluded)

Cell No.	Cell Sta	Pass No.	Load lb	Cumulative Residual Sinkage in.	Distance to Cell, in. Vertical	Distance to Cell, in. Horizontal	Maximum Stress psi
EP 61	0+51	1	600	0.03	11.9	7.5	1.0
		2	609	0.05	11.9	7.5	0.7
		3	603	0.07	11.9	7.5	0.9
		4	596	0.08	11.9	7.5	0.7
		5	607	0.08	11.9	7.5	0.7
		6	598	0.10	11.8	7.5	0.7
EP 51	0+54	1	607	0.08	11.8	7.5	1.8
		2	611	0.09	11.8	7.5	0.9
		3	600	0.10	11.8	7.5	0.9
		4	599	0.10	11.8	7.5	1.3
		5	606	0.10	11.8	7.5	0.8
		6	607	0.10	11.8	7.5	1.3
EP 102	0+57	1	609	0.04	12.0	7.4	1.1
		2	609	0.08	12.0	7.4	0.8
		3	608	0.13	11.9	7.4	1.0
		4	600	0.13	11.9	7.4	0.9
		5	608	0.13	11.9	7.4	0.8
		6	609	0.13	11.9	7.4	0.8
CEC 14560	0+60	1	606	0.06	11.8	7.2	1.8
		2	611	0.09	11.8	7.2	1.8
		3	605	0.13	11.8	7.2	1.6
		4	596	0.16	11.7	7.2	1.5
		5	609	0.16	11.7	7.2	1.5
		6	608	0.21	11.7	7.2	1.5
CEC 12172	0+63	1	605	0.08	11.9	7.4	0.8
		2	609	0.13	11.9	7.4	0.6
		3	607	0.15	11.8	7.4	0.6
		4	598	0.20	11.8	7.4	0.6
		5	608	0.20	11.8	7.4	0.6
		6	607	0.23	11.8	7.4	0.6
CEC 7837	0+66	1	602	0.04	11.9	7.5	1.5
		2	609	0.06	11.9	7.5	1.6
		3	608	0.11	11.8	7.5	1.4
		4	600	0.16	11.8	7.5	1.3
		5	612	0.16	11.8	7.5	1.2
		6	607	0.17	11.8	7.5	1.2

Table 13

Maximum Stresses Induced in Soil by Rigid Wheel, Test 5

Static Load = 1196 lb

Cell No.	Cell Sta	Pass No.	Load lb	Cumulative Residual Sinkage* in.	Distance to Cell, in. Vertical*	Distance to Cell, in. Horizontal**	Maximum Stress* psi
EP 97	0+33	1	1189	0.28	9.2	7.2	4.4
		2	1190	0.61	8.9	7.2	4.6
		3	1192	1.00	8.5	7.2	4.6
		4	1203	1.40	8.1	7.2	4.7
		5	1188	1.72	7.8	7.2	4.7
		6	1228	2.08	7.4	7.2	4.6
EP 109	0+36	1	1192	0.37	9.3	7.5	3.9
		2	1203	0.76	8.9	7.5	3.9
		3	1207	1.22	8.4	7.5	4.0
		4	1228	1.65	8.0	7.5	4.2
		5	1306	1.96	7.7	7.5	4.0
		6	1342	2.23	7.4	7.5	4.1
EP 91	0+39	1	1191	0.35	9.2	7.6	2.9
		2	1190	0.73	8.8	7.6	3.0
		3	1187	1.16	8.4	7.6	3.3
		4	1211	1.51	8.0	7.6	3.4
		5	1191	1.90	7.6	7.6	3.1
		6	1265	2.23	7.3	7.6	3.3
CEC 7640	0+42	1	1199	0.33	9.1	7.6	3.0
		2	1200	0.60	8.9	7.6	2.9
		3	1220	0.94	8.5	7.6	2.6
		4	1211	1.28	8.2	7.6	2.7
		5	1204	1.57	7.9	7.6	2.9
		6	1224	1.85	7.6	7.6	3.0
CEC 7544	0+45	1	1189	0.19	9.1	7.3	1.5
		2	1189	0.39	8.9	7.3	1.3
		3	1189	0.59	8.7	7.3	1.4
		4	1194	0.80	8.4	7.3	1.8
		5	1199	0.95	8.3	7.3	1.6
		6	1194	1.18	8.1	7.3	1.7
CEC 8534	0+48	1	1201	0.28	9.1	7.4	3.3
		2	1205	0.51	8.8	7.4	3.7
		3	1210	0.76	8.6	7.4	3.6
		4	1223	1.02	8.3	7.4	3.6
		5	1218	1.27	8.1	7.4	3.8
		6	1222	1.50	7.8	7.4	4.2

(Continued)

Note: No cell movement.
* See Table 9.
** See Table 11.

Table 13 (Concluded)

Cell No.	Cell Sta	Pass No.	Load lb	Cumulative Residual Sinkage in.	Distance to Cell, in. Vertical	Distance to Cell, in. Horizontal	Maximum Stress psi
EP 61	0+51	1	1179	0.09	12.1	7.5	1.4
		2	1178	0.18	12.0	7.5	1.2
		3	1183	0.28	11.9	7.5	1.2
		4	1191	0.40	11.8	7.5	1.4
		5	1186	0.50	11.7	7.5	1.3
		6	1202	0.62	11.5	7.5	1.3
EP 51	0+54	1	1190	0.12	11.9	7.5	1.6
		2	1191	0.22	11.8	7.5	1.6
		3	1193	0.35	11.7	7.5	1.6
		4	1195	0.52	11.5	7.5	1.6
		5	1190	0.60	11.4	7.5	1.5
		6	1209	0.73	11.3	7.5	1.2
EP 102	0+57	1	1193	0.11	12.1	7.4	1.9
		2	1199	0.21	12.0	7.4	1.8
		3	1190	0.35	11.8	7.4	1.7
		4	1205	0.50	11.7	7.4	1.7
		5	1191	0.58	11.6	7.4	1.8
		6	1204	0.72	11.5	7.4	1.8
CEC 14560	0+60	1	1190	0.19	11.9	7.2	4.0
		2	1194	0.38	11.7	7.2	3.7
		3	1188	0.54	11.5	7.2	3.4
		4	1204	0.70	11.4	7.2	4.0
		5	1192	0.77	11.3	7.2	3.1
		6	1195	0.95	11.1	7.2	3.2
CEC 12172	0+63	1	1197	0.15	12.0	7.4	1.2
		2	1204	0.30	11.8	7.4	1.1
		3	1200	0.46	11.7	7.4	1.0
		4	1211	0.63	11.5	7.4	1.0
		5	1201	0.76	11.4	7.4	1.0
		6	1205	0.91	11.2	7.4	1.1
CEC 7837	0+66	1	1197	0.18	12.0	7.5	2.6
		2	1196	0.36	11.8	7.5	1.1
		3	1200	0.54	11.6	7.5	2.4
		4	1211	0.73	11.4	7.5	2.3
		5	1196	0.88	11.3	7.5	2.0
		6	1204	1.06	11.1	7.5	2.2

Table 14

Comparison of Computed and Measured Stresses

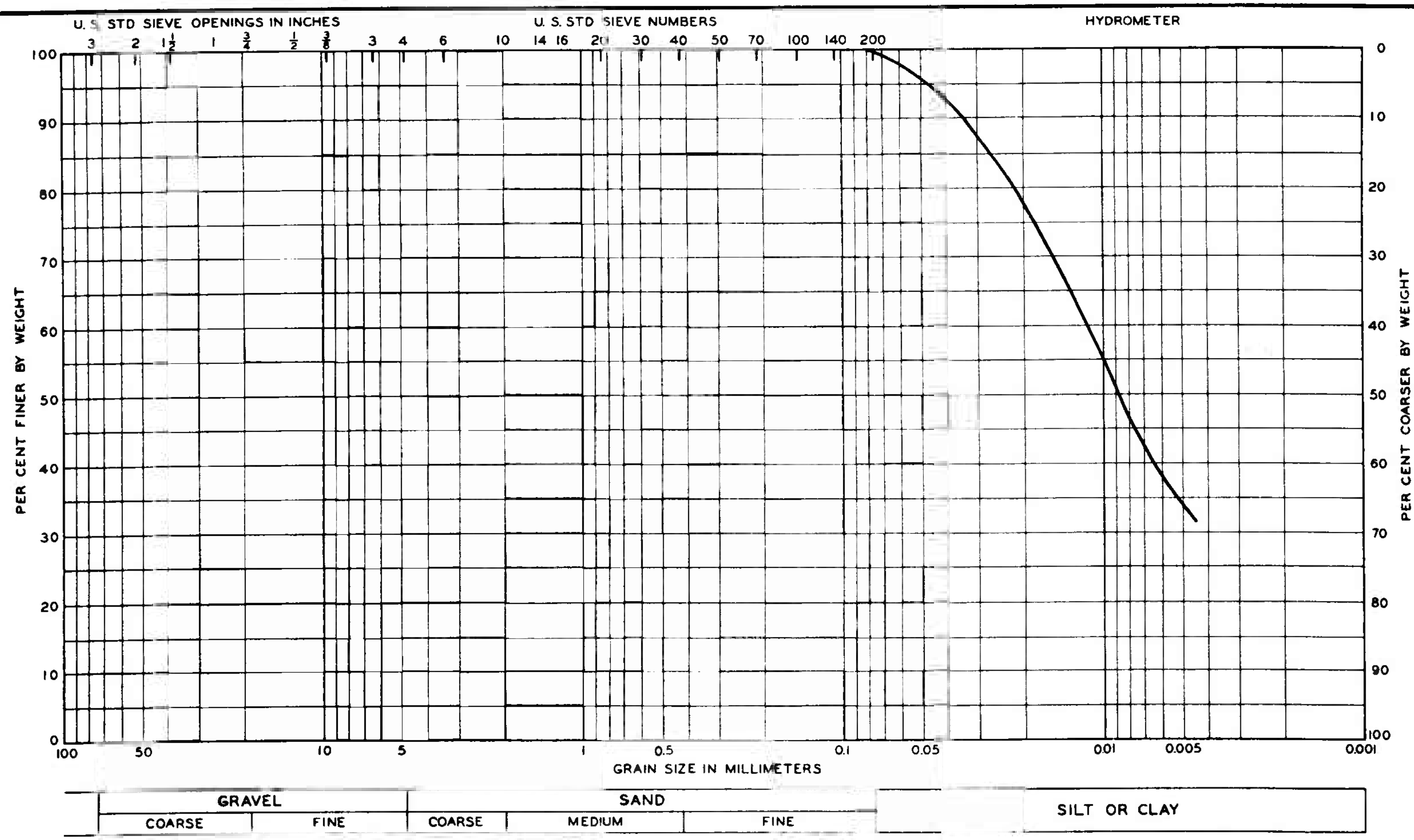
Test	Cell No. and Type	Residual Sinkage in.	Distance to Cell in. Vertical	Distance to Cell in. Horizontal	Maximum Stress, psi Measured	Maximum Stress, psi Computed	Stress Ratio (Measured/Computed)
1	EP 97	0.03	8.9		3.5	3.1	1.1
	EP 109	0.07	8.8		3.8	3.1	1.2
	EP 91	0.04	8.8		5.2	3.2	1.6
	CEC 637	0.04	8.9		2.4	3.1	0.8
	CEC 643	0.04	8.7		6.0	3.2	1.9
	CEC 645	0.04	8.7		11.7	3.2	3.7
	EP 61	0.06	11.7		1.6	1.9	0.8
	EP 51	0.03	11.8		2.6	1.9	1.4
	EP 102	0.06	11.8		2.4	1.9	1.3
	CEC 639	0.06	11.6		3.4	1.9	1.8
	CEC 618	0.03	11.7		3.9	1.9	2.1
	CEC 369	0.03	11.9		1.8	1.9	0.9
2	EP 97	0.51	7.0		24.6	14.8	1.7
	EP 109	0.55	6.9		23.9	15.0	1.6
	EP 91	0.66	6.8		22.1	15.0	1.5
	CEC 637	0.77	6.4		24.9	15.9	1.6
	CEC 643	0.75	6.5		30.7	15.6	2.0
	CEC 645	0.79	6.4		28.7	15.8	1.8
	EP 61	0.77	9.2		18.0	9.8	1.8
	EP 51	0.71	9.3		22.7	9.7	2.3
	EP 102	0.77	9.3		17.2	9.7	1.8
	CEC 618	0.78	9.3		28.4	9.7	2.9
	CEC 369	0.47	10.2		16.0	8.7	1.8
3	EP 97	0.10	8.3	4.0	6.0	1.9	3.2
	EP 109	0.09	8.3	4.1	5.2	1.9	2.7
	EP 91	0.08	8.4	4.2	4.3	1.8	2.4
	CEC 7640	0.07	8.4	4.4	3.8	1.7	2.2
	CEC 7544	0.06	8.6	4.2	3.9	1.8	2.2
	CEC 8534	0.06	8.5	4.1	5.2	1.9	2.7
	EP 61	0.04	11.7	4.2	1.4	1.2	1.2
	EP 51*	0.07	11.6	4.2	2.6	1.2	2.2
	EP 102*	0.04	11.8	4.1	1.7	1.3	1.3
	CEC 14560*	0.05	11.6	4.0	4.4	1.3	3.4
	CEC 12172*	0.04	11.7	4.0	0.4	1.3	0.3
	CEC 7837*	0.04	11.5	4.1	0.4	1.3	0.3

(Continued)

* Data from fifth pass.

Table 14 (Concluded)

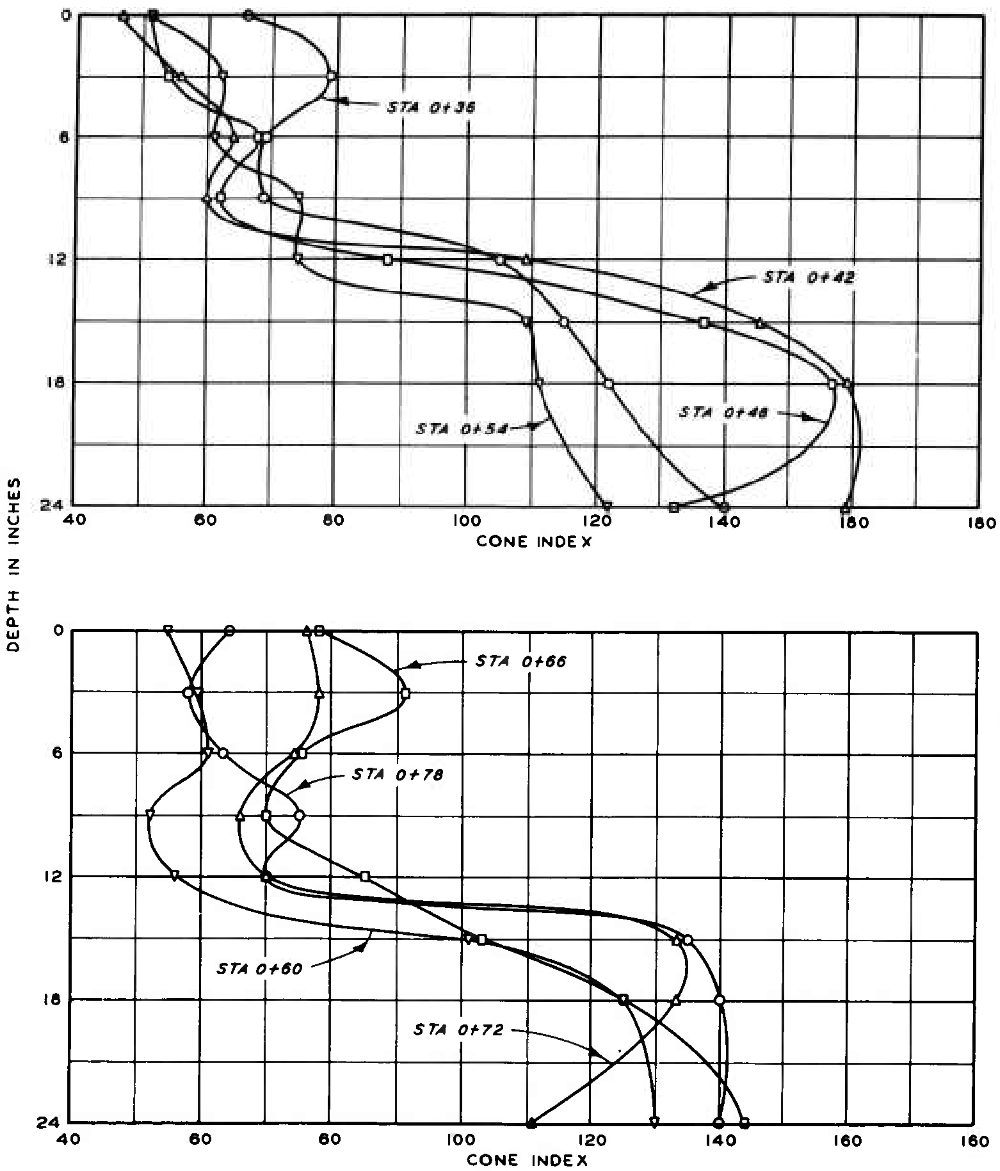
Test	Cell No. and Type	Residual Sinkage in.	Distance to Cell in. Vertical	Distance to Cell in. Horizontal	Maximum Stress, psi Measured	Maximum Stress, psi Computed	Stress Ratio (Measured / Computed)
4	EP 97	0.10	8.8	7.2	2.3	0.6	3.8
	EP 109	0.10	8.9	7.5	2.1	0.6	3.5
	EP 91	0.07	8.8	7.6	1.4	0.6	2.3
	CEC 7640	0.07	8.8	7.6	1.6	0.6	2.7
	CEC 7544	0.04	8.8	7.3	0.5	0.6	0.8
	CEC 8534	0.06	8.7	7.4	1.5	0.6	2.5
	EP 61	0.02	11.8	7.5	0.7	0.5	1.4
	EP 51	0.00	11.8	7.5	1.3	0.5	2.6
	EP 102	0.00	11.9	7.4	0.8	0.5	1.6
	CEC 14560	0.05	11.7	7.2	1.5	0.6	2.5
	CEC 12172	0.03	11.8	7.4	0.6	0.6	1.0
	CEC 7837	0.01	11.8	7.5	1.2	0.5	2.4
5	EP 97	0.36	7.4	7.2	4.6	1.1	4.2
	EP 109	0.27	7.4	7.5	4.1	1.1	3.7
	EP 91	0.33	7.3	7.6	3.3	1.0	3.3
	CEC 7640	0.28	7.6	7.6	3.0	1.0	3.0
	CEC 7544	0.23	8.1	7.3	1.7	1.2	1.4
	CEC 8534	0.23	7.8	7.4	4.2	1.1	3.8
	EP 61	0.12	11.5	7.5	1.3	1.0	1.3
	EP 51	0.13	11.3	7.5	1.2	1.0	1.2
	EP 102	0.14	11.5	7.4	1.8	1.0	1.8
	CEC 14560	0.18	11.1	7.2	3.2	1.1	2.9
	CEC 12172	0.15	11.2	7.4	1.1	1.0	1.1
	CEC 7837	0.18	11.1	7.5	2.2	1.0	2.2



NUMBER	DEPTH	NATURAL MOISTURE	L.L.	P.L.	P.I.	CLASSIFICATION
			60	21	39	FAT CLAY (CH)

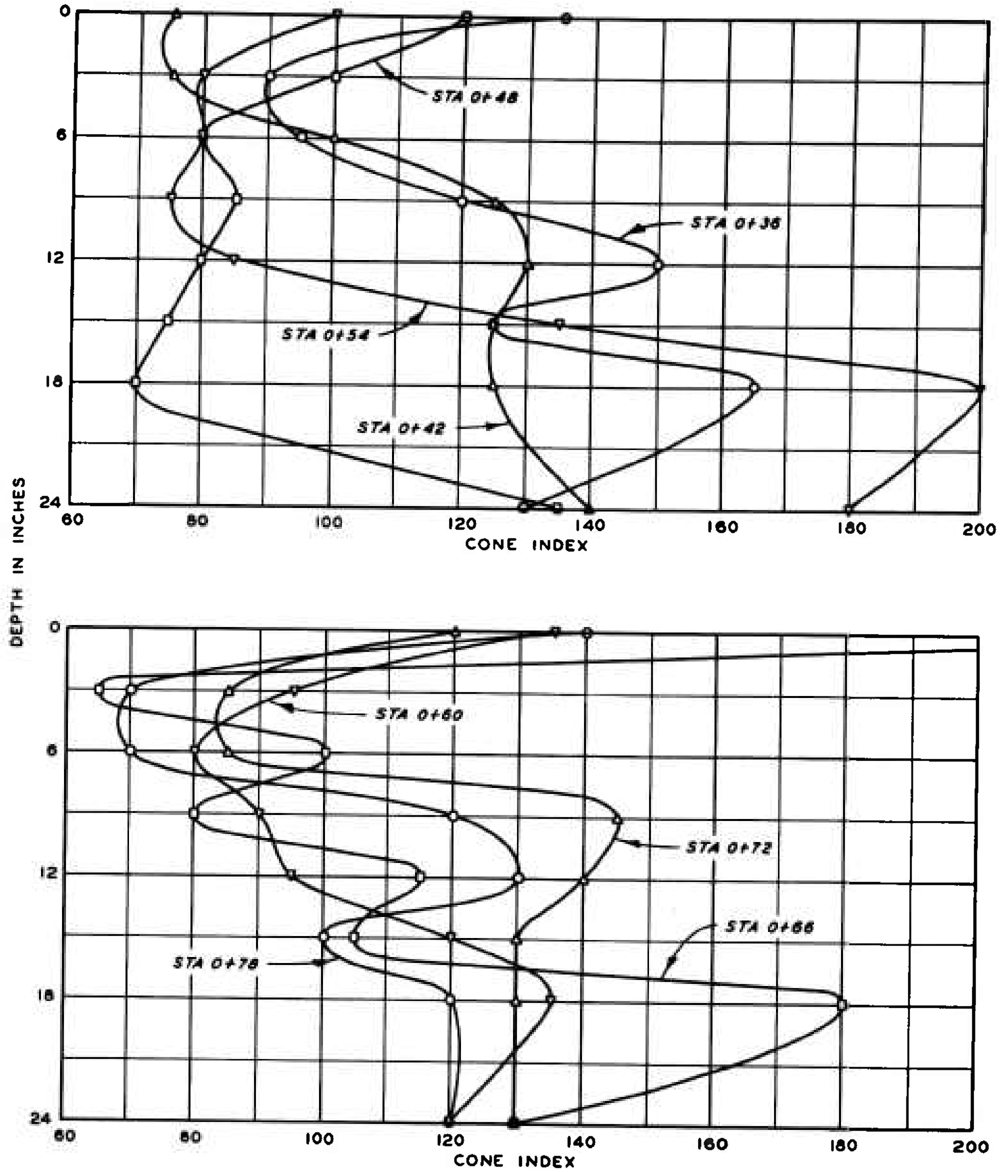
SOIL CLASSIFICATION DATA

PLATE I



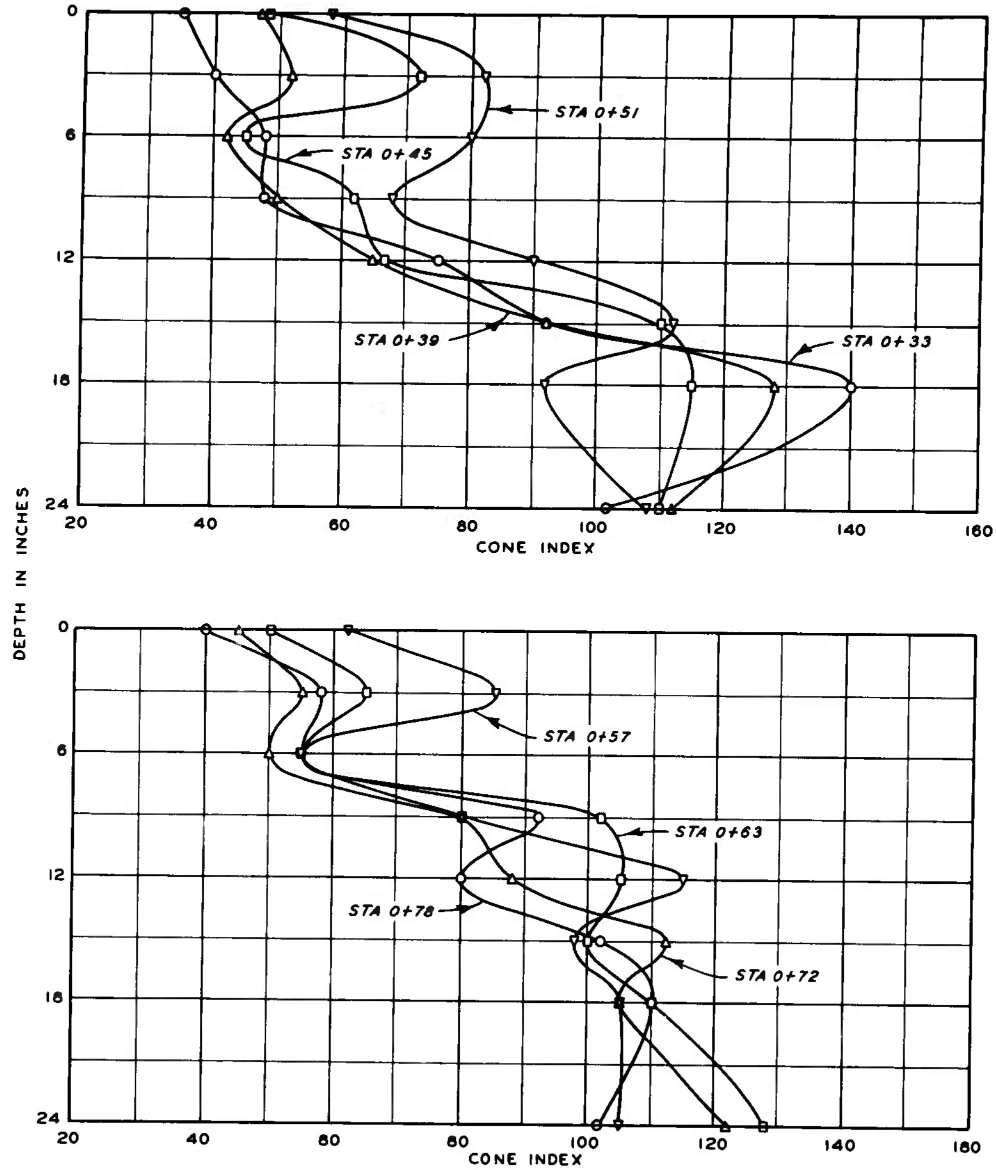
VARIATION OF CONE INDEX WITH DEPTH AND STATION

BEFORE TRAFFIC ON AREA 1
(BEFORE PASS 1 OF TEST 1)



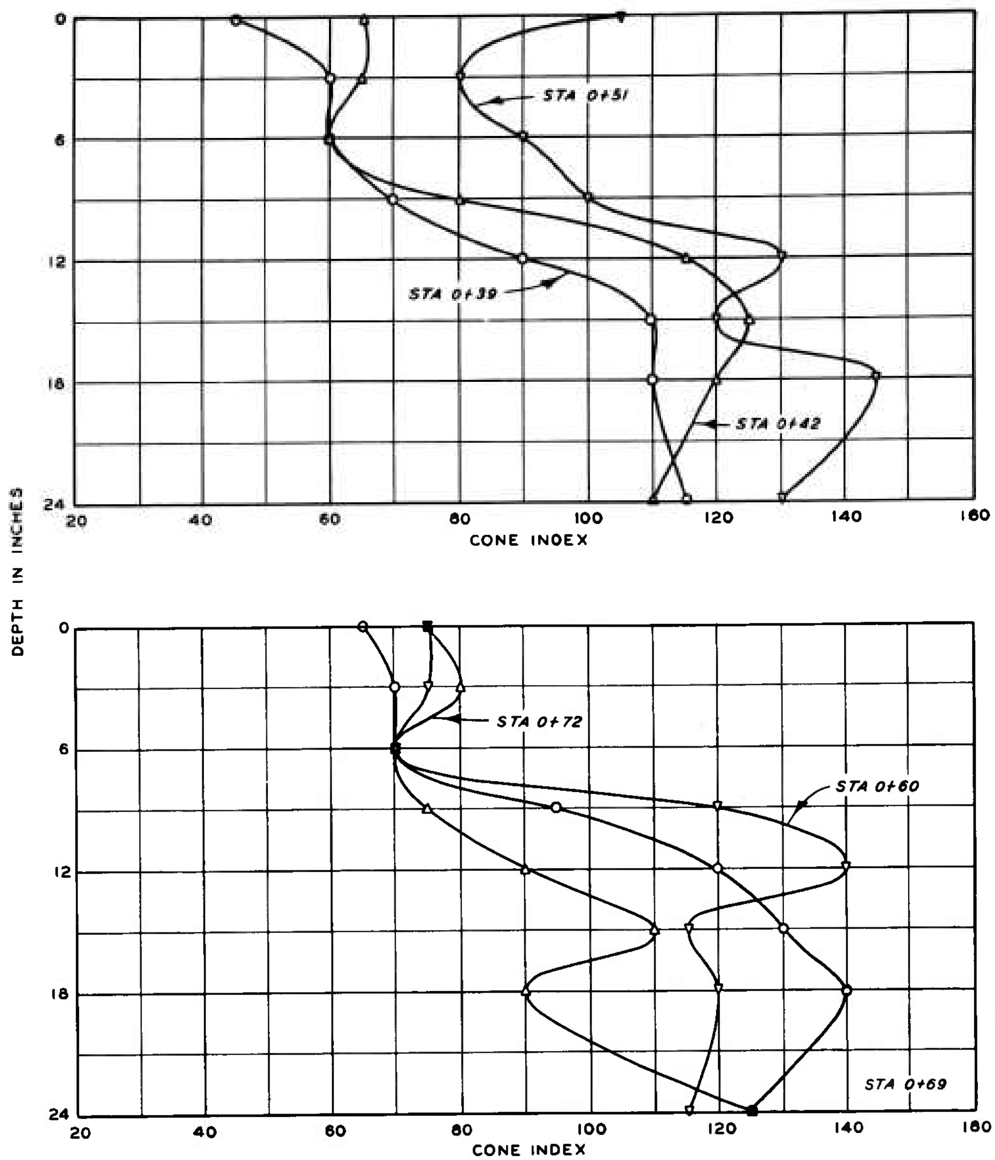
VARIATION OF CONE INDEX WITH DEPTH AND STATION

AFTER TRAFFIC ON AREA I
(AFTER PASS 3 OF TEST 2)



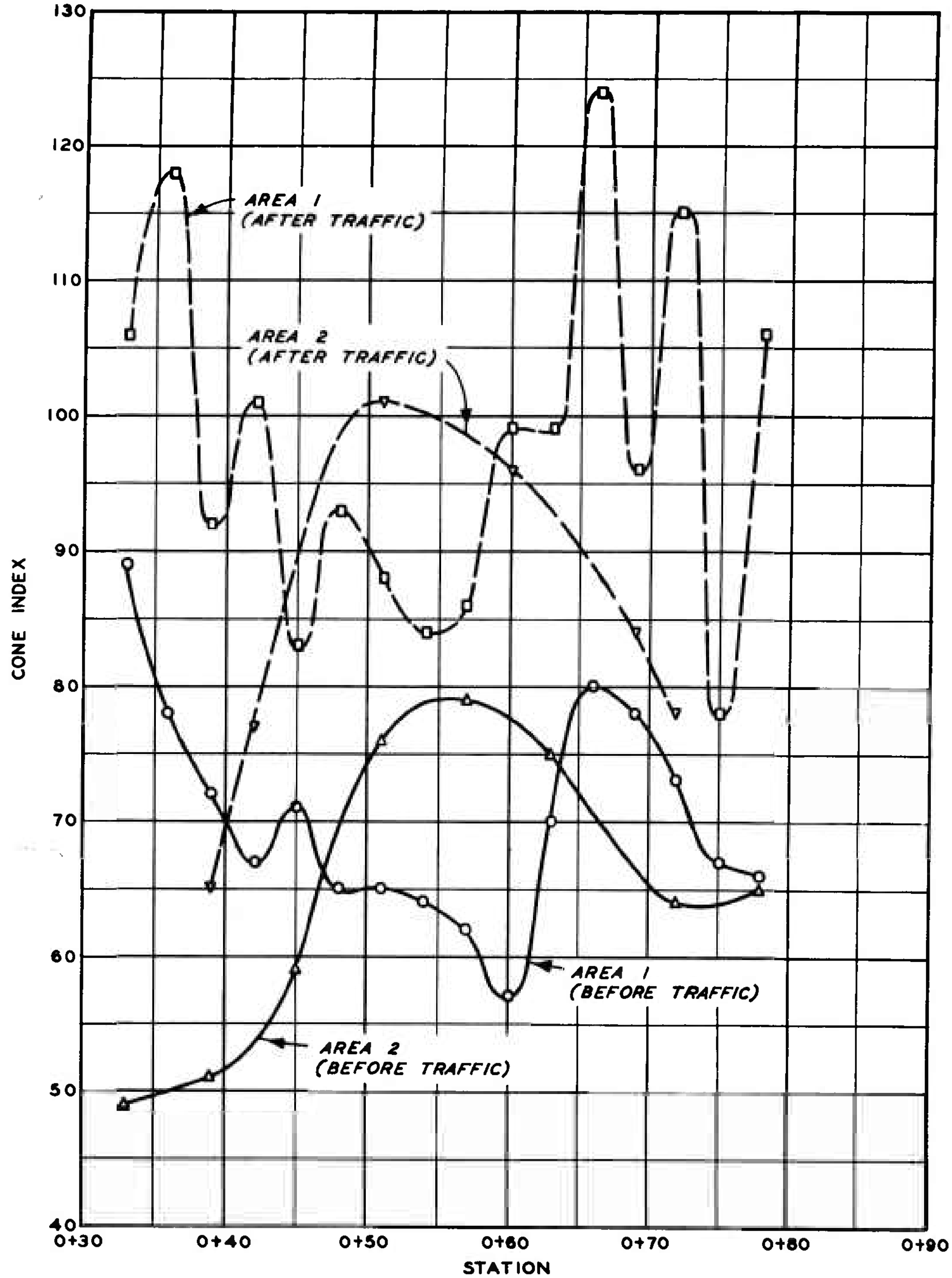
VARIATION OF CONE INDEX
WITH DEPTH AND STATION

BEFORE TRAFFIC ON AREA 2
(BEFORE PASS 1 OF TEST 3)

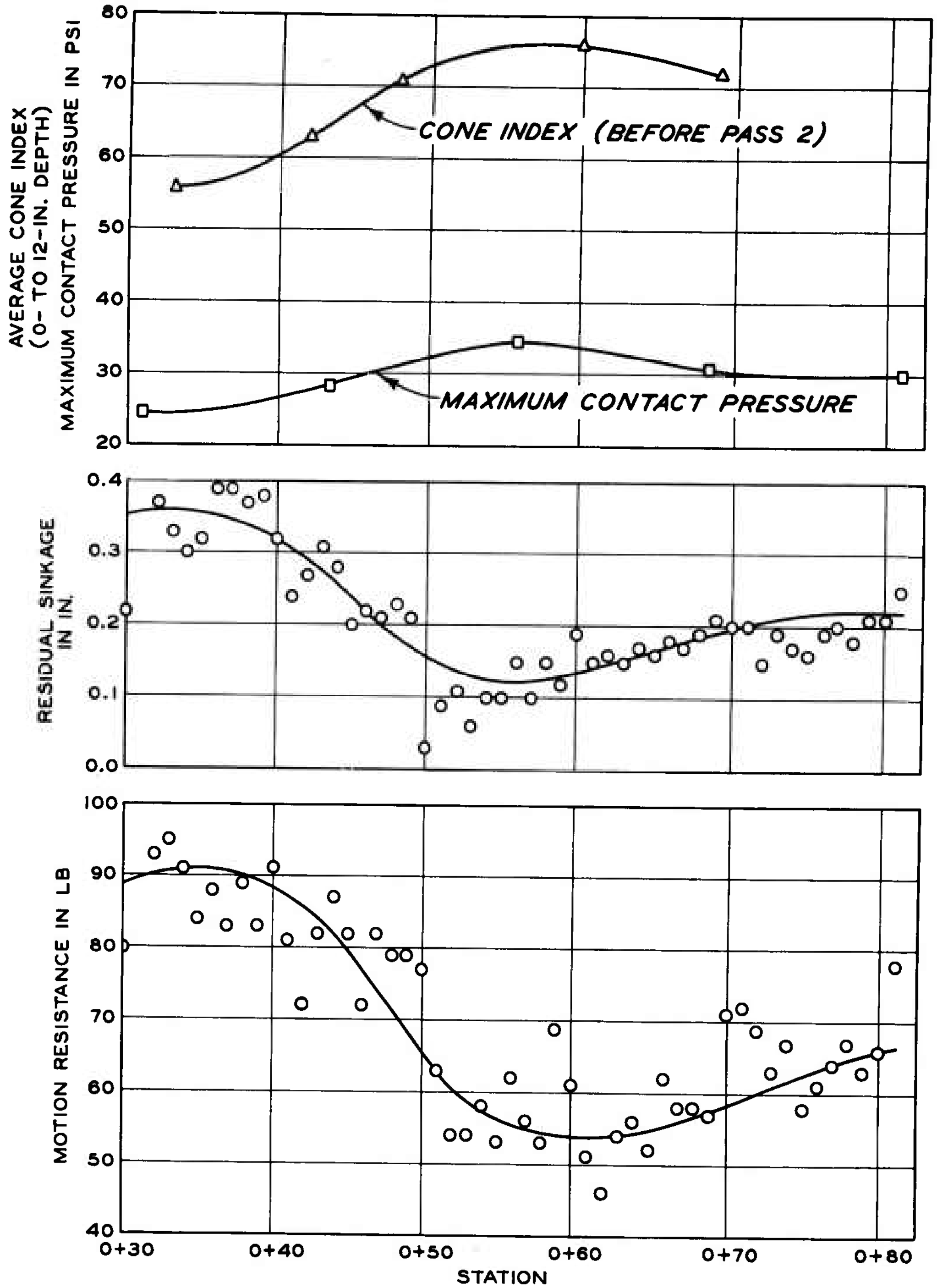


VARIATION OF CONE INDEX WITH DEPTH AND STATION

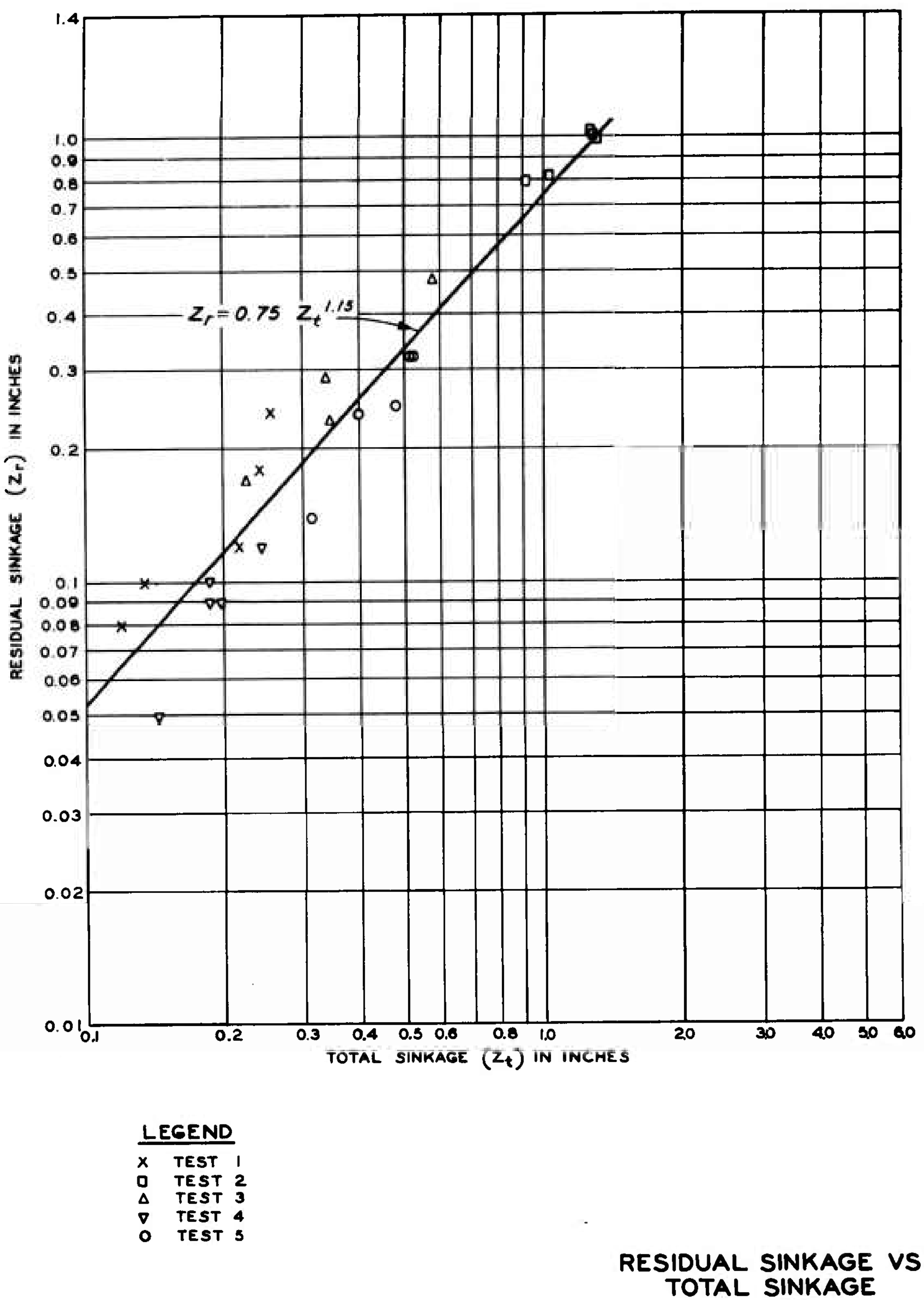
AFTER TRAFFIC ON AREA 2
(AFTER PASS 6 OF TEST 5)



AVERAGE CONE INDEXES OF TEST AREAS 1 AND 2 0- TO 12-IN. DEPTH

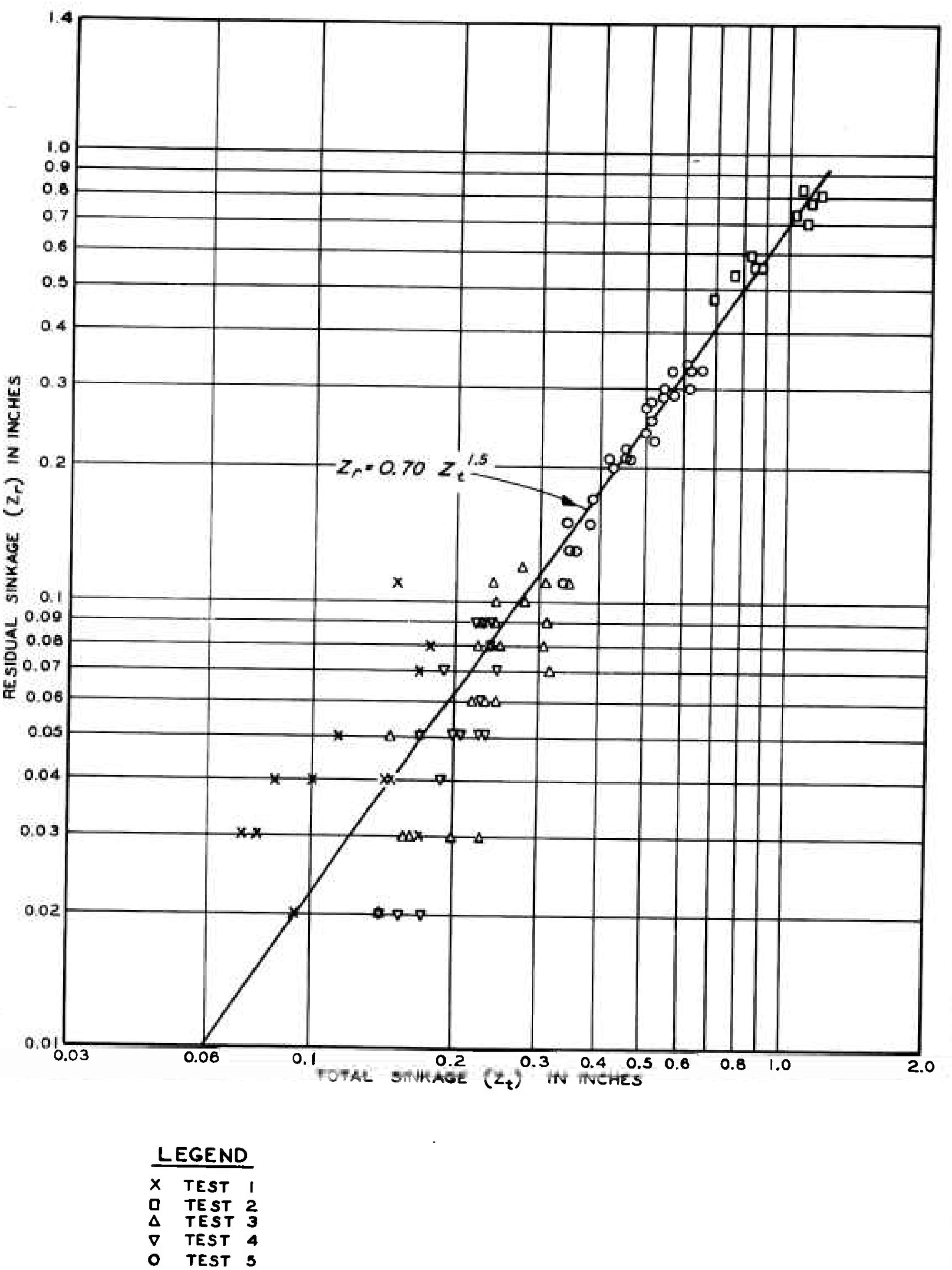


TEST MEASUREMENTS
TEST 5 PASS 2

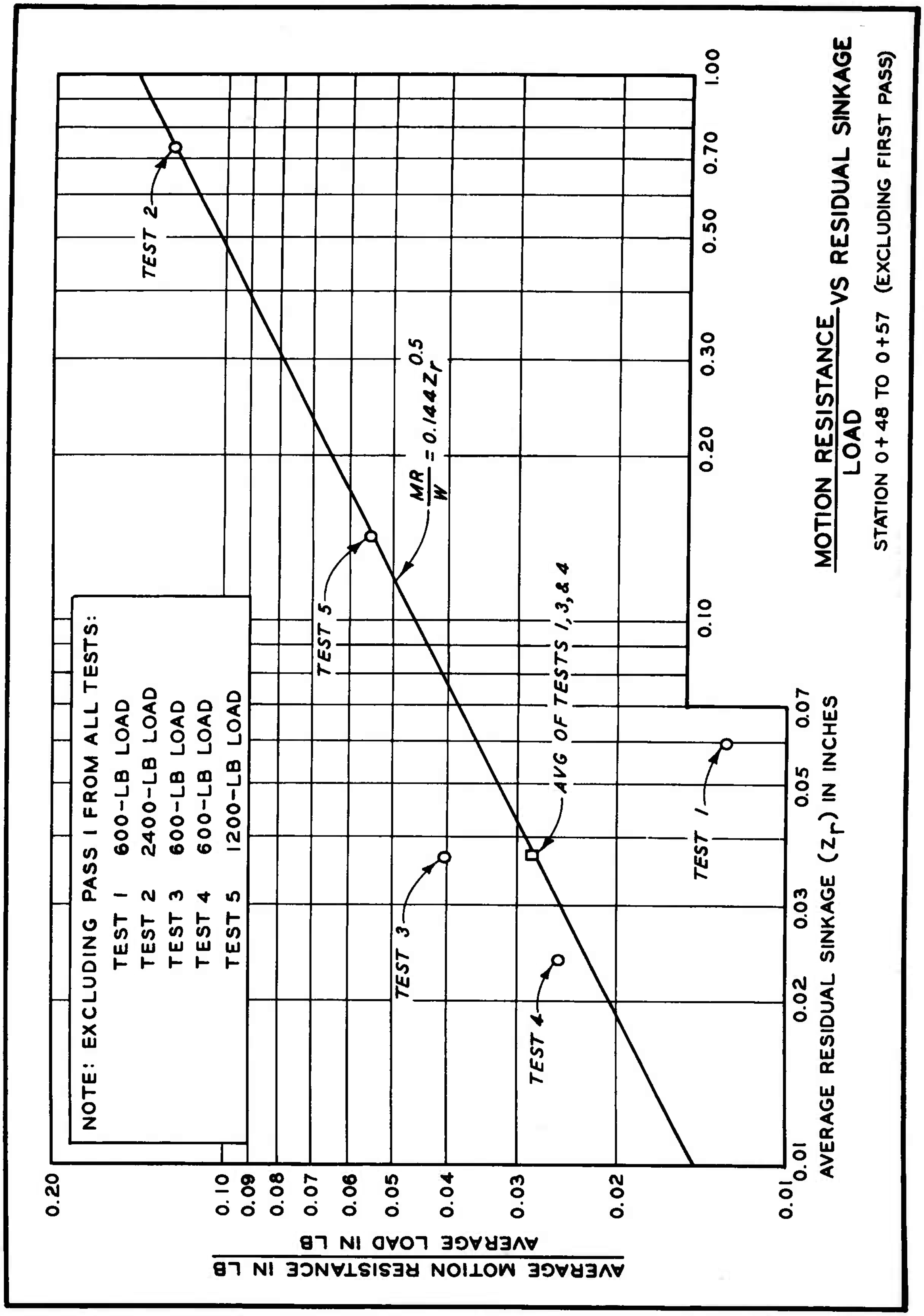


RESIDUAL SINKAGE VS TOTAL SINKAGE
(FIRST- PASS DATA)

PLATE 8



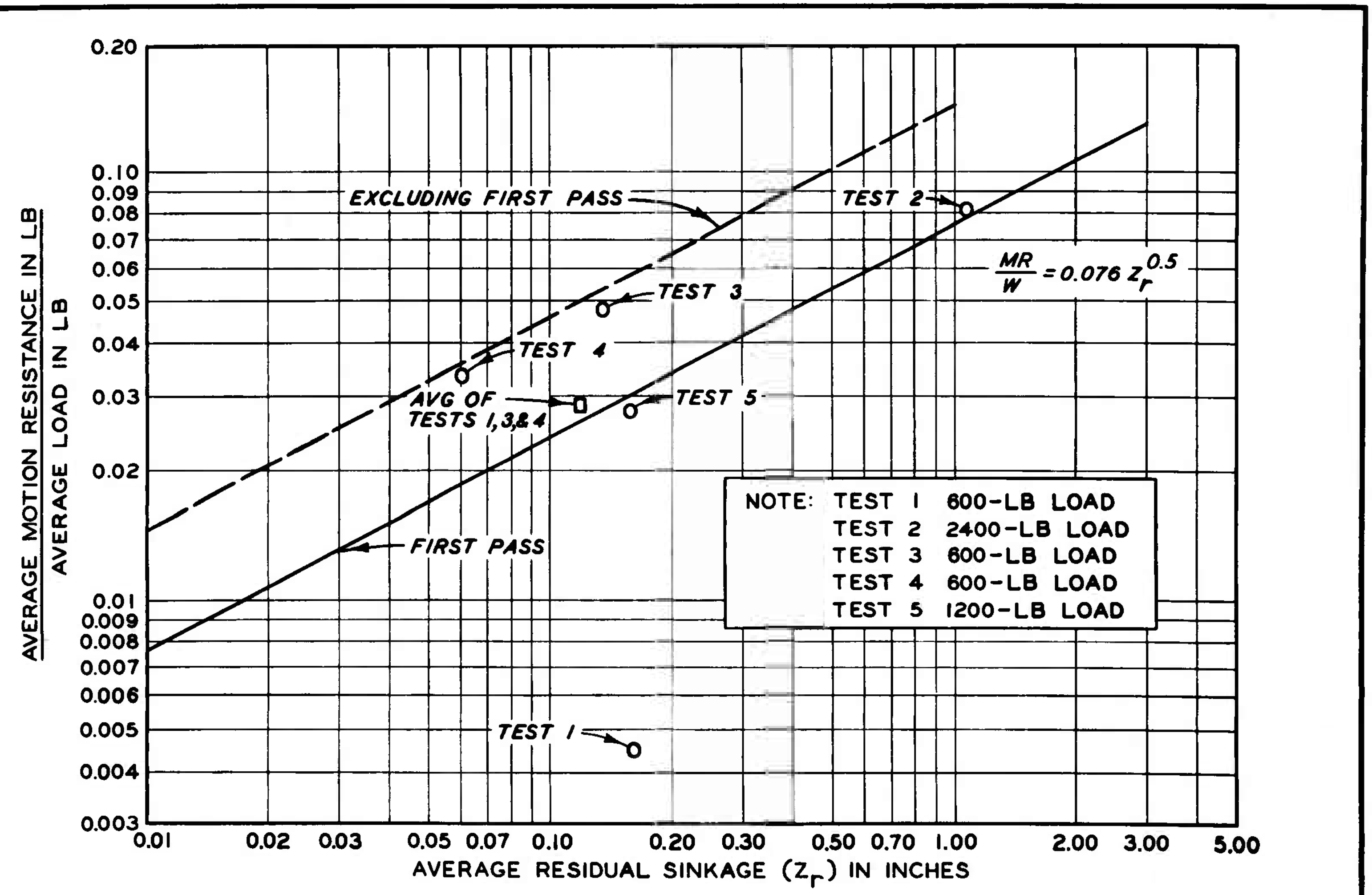
RESIDUAL SINKAGE VS TOTAL SINKAGE
(EXCLUDING FIRST-PASS DATA)



MOTION RESISTANCE / LOAD VS RESIDUAL SINKAGE

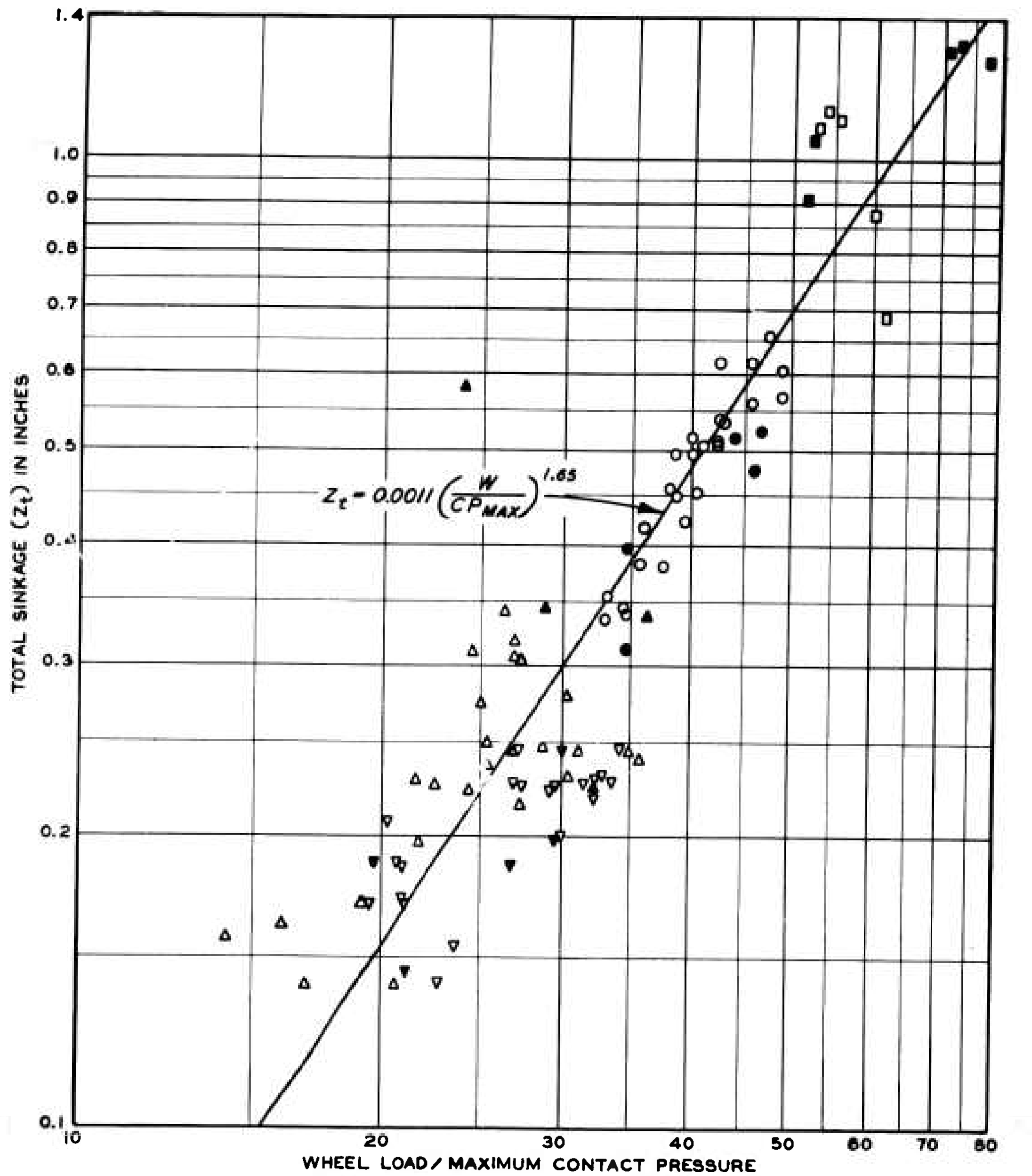
STATION 0+48 TO 0+57 (EXCLUDING FIRST PASS)

PLATE 10



$\frac{\text{MOTION RESISTANCE}}{\text{LOAD}}$ VS RESIDUAL SINKAGE

STATION 0+48 TO 0+57 (FIRST PASS)



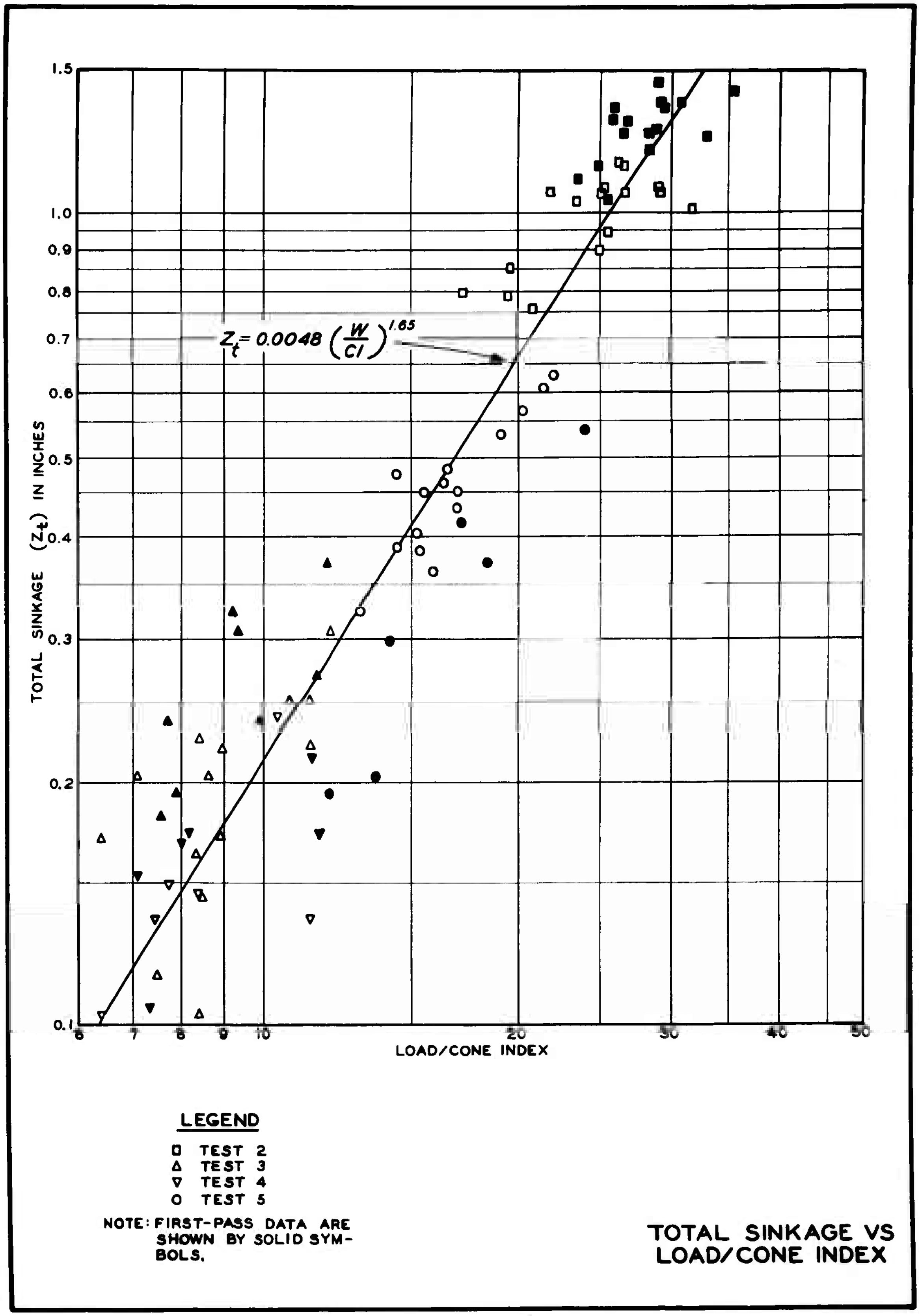
LEGEND

□ TEST 2
△ TEST 3
▽ TEST 4
○ TEST 5

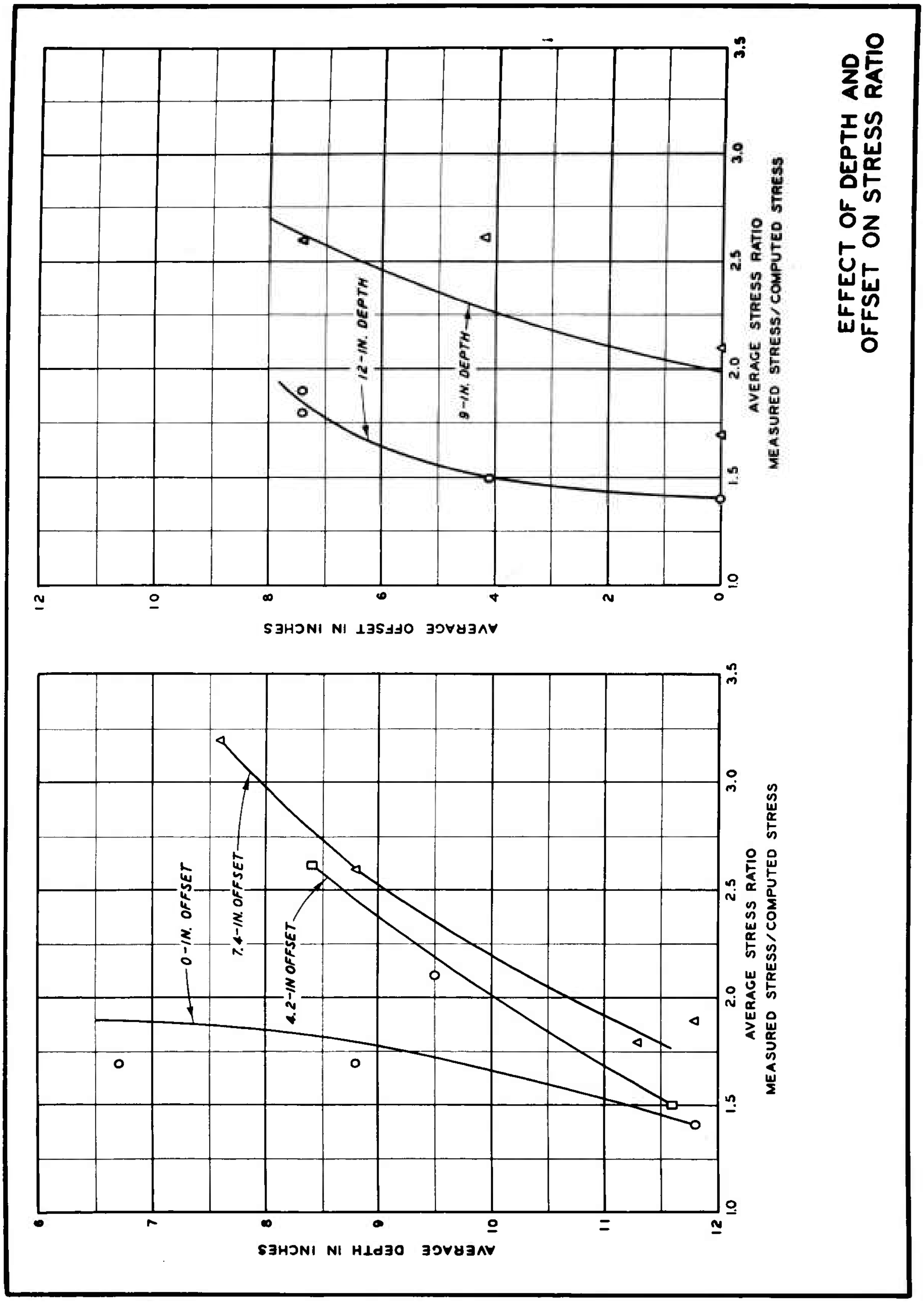
NOTE: FIRST-PASS DATA ARE SHOWN BY SOLID SYMBOLS.

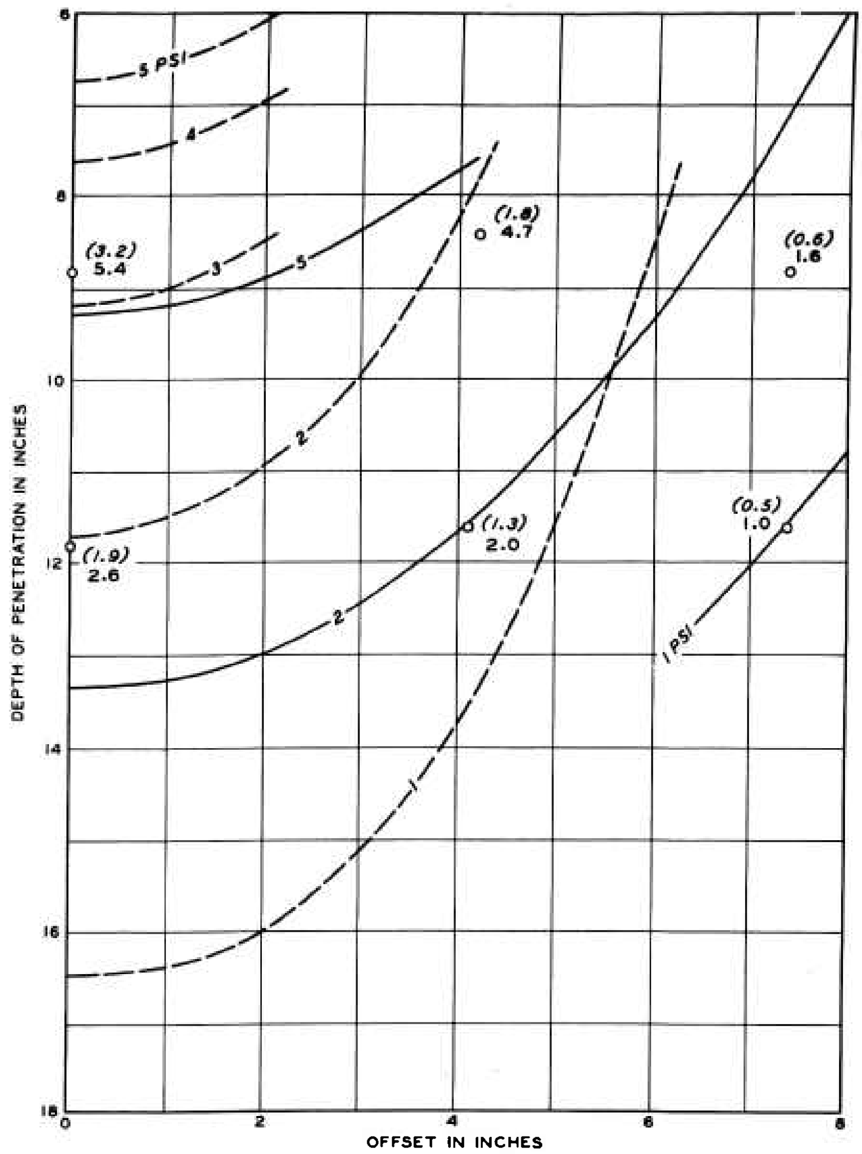
TOTAL SINKAGE VS WHEEL LOAD/MAXIMUM CONTACT PRESSURE

PLATE 12



TOTAL SINKAGE VS LOAD/CONE INDEX


EFFECT OF DEPTH AND
OFFSET ON STRESS RATIO
AVERAGE OFFSET IN INCHES
0
2
4
6
8
10
12
1.0
1.5
2.0
2.5
3.0
3.5
AVERAGE STRESS RATIO
MEASURED STRESS/COMPUTED STRESS
12-IN. DEPTH
9-IN. DEPTH
AVERAGE DEPTH IN INCHES
6
7
8
9
10
11
12
1.0
1.5
2.0
2.5
3.0
3.5
AVERAGE STRESS RATIO
MEASURED STRESS/COMPUTED STRESS
0-IN. OFFSET
7.4-IN. OFFSET
4.2-IN OFFSET



LEGEND

— — — COMPUTED STRESS
——— AVG MEASURED STRESS

NOTE: VERTICAL NUMBER BY POINT IS AVG MEASURED STRESS IN PSI.
NUMBER IN PARENTHESES IS COMPUTED STRESS IN PSI.

DISTRIBUTION OF VERTICAL PRESSURES IN THE SOIL
600-LB LOAD