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PERFORMANCE OF SOILS UNDER TIRE LOADS

Report 3

TESTS IN CLAY THROUGH NOVEMBER 1962

by

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FOREWORD

This report concerns tests with pneumatic tires in a fat clay conducted at the U. S. Army Engineer Waterways Experiment Station (WES) as a part of the vehicle mobility research program under DA Project 1-V-0-21701-A-046, "Trafficability and Mobility Research," Task 1-V-0-21701-A-046-03, "Mobility Fundamentals and Model Studies," under the sponsorship and guidance of the Directorate of Research and Development, Headquarters, U. S. Army Materiel Command.

Acknowledgment is made to Lt. Gen. A. G. Trudeau, former Chief of Research and Development, who directed that this test program be performed; to Mr. R. C. Kerr, chairman, and Dr. Lester Goldsmith, Dr. L. C. Stuart, Dr. Robert S. Rowe, and Mr. C. J. Nuttall, members of the ad hoc committee which recommended the research program; and to Messrs. R. R. Philippe and R. F. Jackson, U. S. Army Materiel Command, and Mr. M. V. Kreipke, Office, Chief of Research and Development, who advised in the formulation of the research procedures. Personnel of the Land Locomotion Laboratory (LLL), U. S. Army Tank-Automotive Center, and of the U. S. Army Transportation Research Command (TRECOM), Fort Eustis, Virginia, maintained liaison and made valuable comments and suggestions. Messrs. C. J. Nuttall and C. W. Wilson of Wilson, Nuttall, Raimond, Engineers, Inc., served as consultants and aided in the formulation of the test program, design of the test equipment, and analysis of data.

The tests were performed by personnel of the Army Mobility Research Branch (AMRB), Mobility and Environmental Division, WES, during the period from September 1961 to November 1962. Data from certain additional tests, performed through June 1963, have been incorporated in the analysis also. The test program was under the general supervision of Messrs. W. J. Turnbull, W. G. Shockley, and S. J. Knight, and the direct supervision of Dr. D. R. Freitag and Mr. J. L. McRae. Engineers actively engaged in the study were Messrs. C. J. Powell, R. D. Wismer, A. B. Thompson, J. L. Smith, and Sp4 J. R. Wood. This report was written by Mr. Wismer, and many of the plates and figures were prepared by Sp4 Wood.

Col. Alex G. Sutton, Jr., CE, and Col. John R. Oswalt, Jr., CE, served as Directors of the WES during the course of this study and preparation of this report. Mr. J. B. Tiffany was Technical Director.

CONTENTS

SUMMARY

This report analyzes the results of 184 multiple-pass tests with a single, smooth, pneumatic tire (9.00-14, 2-PR) in a fat clay at a high degree of saturation. These tests were performed using a wide range of tire loads, tire deflections, and soil strengths. Some of the tests were conducted to study the influence of speed on performance.

Basic plots of the data (one dependent versus one independent variable with all other independent variables held constant) show the relative effect of each independent test variable on tire performance. Scatter of the pull and torque data points was found to be quite large for the early tests. An examination of the data showed that a difference in soil strength between the soil surface and the remainder of the soil mass was the probable cause of the scatter. Improvement in soil processing techniques subsequently produced more uniform soil conditions and virtually eliminated this scatter in the later tests.

A simple static analysis was found adequate to represent the forces and moments on a towed or powered pneumatic tire operating at small sinkages in a soft clay.

PERFORMANCE OF SOILS UNDER TIRE LOADS

TESTS IN CLAY THROUGH NOVEMBER 1962

PART I: INTRODUCTION

Background

1. In May 1959, the Chief of Research and Development, Department of the Army, directed the Office, Chief of Engineers, to have the U. S. Army Engineer Waterways Experiment Station (WES) proceed with the investigation outlined in the "Plan of Tests, Performance of Soils Under Tire Loads," prepared jointly by LLL, TRECOM, and WES. The broad purpose of this project is to provide results that will point the way to the selection of the proper tire size and deflection for a given load and soil condition to achieve a specified degree of mobility. The study was initiated immediately, using a system composed principally of a single-wheel dynamometer system and a series of movable soil bins. Test techniques were developed to vary the wheel slip during a run so as to allow the towed, self-propelled, and maximum pull conditions to be defined within the usable length of the soil bins. A desert sand and an alluvial clay were selected as principal test soils, and procedures were developed for filling the bins so that the soils would be in a reasonably consistent and uniform state. A series of tires with different widths, diameters, cross sections, and structural characteristics were procured for testing. The details of the test plan, techniques, and equipment employed are given in Report 1 of this series.[1*]

2. The testing program was begun with desert (Yuma) sand as the test soil. An analysis of the first-pass performance of a number of tires in the sand is presented in Report 2.[2] This analysis showed that tire width, tire deflection, load, and the strength of the soil systematically influenced the performance of the tire. Several useful numerics were developed that combined these factors.

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* Raised numbers refer to similarly numbered items in the Literature Cited following the text of this report.

Purpose

3. The tests reported herein are part of the comprehensive study of the interrelation of soft soils and pneumatic tires. The specific objectives of the tests were to:

a. Gain experience in building soft, fine-grained soil test sections and conduct tests in these sections with pneumatic tires.

b. Determine for one tire size the influence of the test soil, tire load, and deflection on the performance of the tire.

c. Study the interrelation of the moments, forces, and displacements that can be measured as a pneumatic tire travels on a yielding soil.

Scope

4. The test program consisted of conducting 184 multiple-pass tests with a single tire (9.00-14, 2-PR) in highly plastic clay. Pertinent data on the test tire are given in table 1. Load and deflection of the tire were varied over a wide range, and soil strength conditions ranged from very soft to very firm. Some tests were conducted to study the influence of speed on performance.

Definitions

5. Certain terms used in this series of reports are unique to this study, while others are considered unique to this field of research. To facilitate the analysis of the data and the communication of the test results, these terms were rigidly defined in Report 1 of this series.[1]

PART II: TEST PROCEDURES

Soil

6. A fine-grained soil has shear resistance because of interparticle attraction and friction. For a fine-grained soil of given mineralogy, interparticle attraction is solely dependent on particle spacing, while interparticle friction is dependent on effective stress and deformation. When a load is applied to a saturated, fine-grained soil, the shear resistance can increase only if the interparticle spacing decreases or the effective interparticle stresses increase. Neither of these events can occur in a saturated, fine-grained soil unless some water is expelled from the soil mass. Thus, the shear resistance of a saturated, fine-grained soil is independent of the magnitude of the applied load when said soil is loaded under conditions that do not allow drainage of the pore water. In other words, the soil-water system described behaves as a material with a zero angle of internal friction.

7. Fine-grained soils that cause serious difficulty for vehicles usually are saturated or nearly so. A moving vehicle loads the soil at any one place for only a short time, insufficient to cause significant migration of the water from the highly stressed zones under the vehicle. Thus, the strength of such a fine-grained soil is not enhanced by the vehicle load, and in fact, sensitive or highly remoldable soils may undergo strength decreases due to destruction of a favorable soil particle arrangement.

Soil processing techniques and properties of test soil

8. The soil used in this test program was an extremely nonsensitive fat clay, selected mainly because it was expected to retain its strength characteristics under load when it was saturated or nearly saturated. Laboratory testing[3] had shown this soil to behave as a load-independent material when its degree of saturation exceeded about 90 percent. Full-scale compaction studies[4,5] had shown that 90 percent saturation could be achieved by compacting the loose soil-water mixture with rubber-tired rollers. Therefore, a rubber-tired roller was adopted for use in

processing soil, and one of the criteria for adequacy of the soil test section was the attainment of a minimum of 90 percent saturation. A description of the mixing and compacting technique is contained in Report 1 of this series.

9. The degree of saturation actually achieved in the soil cars is shown by the saturation lines superimposed on the data in plate 1. Test procedures were modified after test C112 as explained in paragraphs 12-14 and the symbols in the plates distinguish between the initial tests (C7 to C112) and selected later tests through C268. Soil layers (0 to 6 in. and 6 to 12 in.) are also distinguished. With only a few exceptions, saturations between 90 and 100 percent were achieved. The overall mean was 95 percent. The stability or degree of load dependence of the soil under repeated passes of the wheel is illustrated by the data presented in plate 2. In this plate, the values obtained from several different types of soil measurements before traffic are compared with similar measurements made after traffic. (In this report, traffic denotes passes of a single wheel over the test soil.) Results from test sections with reasonably uniform initial soil-strength profiles are shown because the before-traffic and after-traffic measurements were represented by different layers in the soil cars (e.g. the zero depth in an after-traffic measurement was the surface of a rut). It is apparent that there was no consistent or significant increase or decrease with traffic in any of these soil strength-determining properties when the degree of saturation was approximately 95 percent.

10. The effectiveness of the soil-processing techniques in producing a load-independent soil condition over the desired range of strengths is further shown by the typical results of unconsolidated-undrained triaxial tests in plate 3. Three levels of strength that span the full range of test conditions are represented. The cone indexes, taken near the points in the test soil from which the triaxial samples were extracted, are recorded within each Mohr circle, with the exception of the high-strength condition for which only a soil-car average was available. It should be noted that the existence of an apparent friction angle is questionable for the low- and medium-strength soils. These data agree very well with results of previous tests on laboratory-prepared samples.[3] It is believed

that the techniques used in preparing the soil test sections for this study provided soil conditions that were essentially load independent.

Uniformity of soil

11. Variation limits. When testing was begun, it was not known how uniform the test sections should be to provide consistent test results, nor precisely what degree of uniformity could be achieved with the processing techniques at hand. Somewhat arbitrarily, therefore, it was established that the goal of soil processing was to limit moisture content variation to ±1 percent and dry density to ±1 pcf and to obtain a cone index profile that did not show any marked change in cone index with depth (average slope of the cone index versus depth curve less than 1.5). In addition, the acceptable variation in cone index between any two of the three cone penetrations performed in the test lane at any depth within the 0- to 6-in. layers was generally limited to 20 percent of the 0- to 6-in. average cone index of the three penetrations. A summary of the soil data obtained for the tests is given in table 2.

12. Limits exceeded. An example of the soil measurements that were obtained in some of the early tests is shown in plate 4. It can be seen that certain variations exceeded the limits proposed. Two features in particular were objectionable: the occurrence of surface soil water contents that diverged from the mean, and a marked soil-strength gradient. Both features tended to reduce the probability that a simple average of strength measurements made in the soil test section reflected the conditions that actually influenced the tire behavior in a test. Consequently, in later tests greater effort was expended to obtain more uniform soil conditions and especially to reduce the extent to which the surface characteristics were different from those of the rest of the soil mass.

13. Improvements in techniques. Prior to test C113, soil cars were sprinkled with water at the end of each day. With the start of test C113, watering of the cars was reduced to a maximum of twice a week and was done then only if the surface of the clay appeared to be dry. The clay was not wetted within 24 hr of the beginning of a test. In addition, just prior to a wheel test, the top 1/2 in. of the soil was trimmed off with a blade attached to the soil-processing truck.

14. Because of the improvement in test controls, more reliability

was placed on the traction results of the clay tests after C112. For this reason, the wheel tests from C7 through C112 will be referred to as the "initial" tests and denoted by open symbols on the data analysis plots, while those after C112 will be referred to as the "later" tests and will be denoted by closed symbols on the data plots. However, even in the later tests, inexplicable deviations from the general trend of results were encountered.

Effect of nonuniformity of soil

15. As a working hypothesis, it is considered that the force required to tow a wheel results primarily from energy losses expended in deforming a soft soil. Thus, in a soft soil, towed force is dependent more on the mass properties of the soil than on the surface properties. This hypothesis is in accord with current concepts of rolling friction.[6] On the other hand, the traction that a powered wheel develops, especially a smooth, pneumatic-tired wheel, appears to depend significantly upon surface conditions. Thus, if the soil strength near the surface is different from that within the mass, the performance of a powered wheel probably will be influenced more by surface properties than by mass properties.

16. To illustrate the relative importance of surface and mass soil properties, certain first-pass data from two tests using the 9.00-14, 2-PR tire with an 890-lb load and 35 percent deflection were assembled:

	Test C34	Test C119
Moisture content (0- to 1/4-in.), %	--	34
Moisture content (0- to 1-in.), %	41	38
Moisture content (0- to 6-in.), %	39	40
Cone index (surface)	32	40
Cone index (0- to 6-in.)	42	39
Towed force, lb	47	52
Pull at 20% slip, lb	128	446

17. The moisture content and cone index data obtained in the 0- to 6-in. layer were about the same in the two tests. The towed forces likewise were nearly identical. However, there was a big

difference in pulls achieved at 20 percent slip. The moisture content data for test C34 showed that oversprinkling of the soil surface had caused a significant increase in moisture in the 0- to 1-in. layer. Corresponding data for test C119, one of the first in which surface sprinkling had been reduced, showed the moisture content in the 0- to 1-in. layer to be significantly lower than that in the 0- to 6-in. layer. The low moisture content in the top 1/4 in. should also be noted. The cone indexes corroborate the moisture content data. Therefore, the causes for the marked difference in the pull at 20 percent slip and the close agreement of the towed force measurements seem clear.

18. While these data represent rather extreme examples, they nevertheless indicate that surface conditions must be recognized in the analysis of the pull data. Examination of the data for approximately the first 100 tests indicated that a surface soil effect on traction was clearly present in the tests. The effect was predominantly a lowering of the torque and pull values because of the excessive wetness of the surface, but in some instances, there was an increase in traction because of dry surface soil. The preparation techniques instituted for the later tests lessened, but apparently did not completely eliminate, the problem of maintaining consistent soil properties throughout the soil mass.

Measurement of Soil Strength with the Cone Penetrometer

Effect of shaft drag

19. Cone penetrometer tests were performed at three evenly spaced points in the test lane before traffic and at specified intervals during traffic. Cone index is computed as the unit pressure on the base of the cone but is not regarded as shear strength or bearing capacity, per se. One of the several advantages of the cone penetrometer is its ability to make measurements at various depths below the surface. In making measurements in soft clay prior to the first tire tests, it was found that the cone indexes increased with depth, whereas from the concepts outlined in paragraphs 6-10 there should have been no appreciable change in soil strength. The increase in cone index apparently occurred because the soft soil closed in on the penetrometer shaft and thereby added to the

penetration resistance. The resulting shaft drag was dependent on the relative diameters of the cone and the shaft, the surface area of the shaft in contact with the soil, and the cohesive strength of the soil (for a soil-to-soil failure along the shaft) or the adhesive strength of the soil (for a metal-to-soil failure along the shaft).

20. The penetrometer used for these pretest measurements had a cone with a 1/2-sq-in. base area (about 0.8 in. in diameter) mounted on a 5/8-in.-diameter shaft. The influence of different relative shaft-cone sizes was studied by making several cone penetrometer tests in both low- and high-strength clay using different sizes of cones and shafts. The cone and shaft dimensions of the different penetrometers employed were as follows:

Cone Base Area sq in.	Shaft Diameter in.	Cone Radius in.	Shaft Radius in.	Soil-Shaft Clearance in.
1/2	5/8	0.399	0.312	0.087
1/2	3/8	0.399	0.188	0.211
1	5/8	0.565	0.312	0.253

Typical examples of the cone index profiles obtained in two soil-strength conditions with these penetrometers are presented in plate 5. It is apparent from these profiles that shaft drag occurred only on the 1/2-sq-in. cone with the 5/8-in.-diameter shaft and that the drag was more pronounced in the lower strength condition. It appears that the clay around the penetrometer hole moved inward radially an amount greater than the soil-shaft clearance of the 5/8-in.-diameter shaft, but less than that of the 3/8-in.-diameter shaft.

Effect of cone size

21. In tests C7 to C123 it was found expedient to use the 1-sq-in. cone with the 5/8-in.-diameter shaft to eliminate shaft drag as well as to guard against the possibility of obtaining erroneous readings due to shaft bending. However, later in the testing program, it was found possible to avoid both shaft drag and bending with the 1/2-sq-in. cone with the 3/8-in.-diameter shaft. Consequently, starting with test C124, the 1/2-sq-in. cone with the 3/8-in.-diameter shaft was adopted as the standard penetrometer for clay tests because of the mass of field data that has been

acquired over the past years with this particular cone size.

22. The two sizes of cones used did not give exactly the same evaluation of a soil condition. From the previously mentioned comparative penetrometer tests, it was found that the 1-sq-in. cone yielded cone indexes that were approximately 95 percent as high as those determined by the 1/2-sq-in. cone. Thus, the clay test data for the 9.00-14, 2-PR tire include cone indexes determined by two different cone sizes exhibiting no shaft drag but with a definite effect of cone size. The relation between the two sets of cone indexes is not perfectly linear; however, the effect of a 5 percent difference was so small that the cone indexes determined by the two different cone sizes have been considered equal in this report.

Programed-Slip Compared to Constant-Slip and Towed Test Data

23. The tests performed in the study were mainly of the programed-slip type.[1] The programed-slip technique, which allows the test wheel to go through a broad range of slips in a single pass, permits information to be gathered in one test that would otherwise require six or seven constant-slip and towed tests. However, if data from the programed-slip tests are to be accepted, they must be shown to be the same as for the equivalent constant-slip and towed tests.

24. Eighteen towed wheel and 27 constant-slip tests were performed with the 9.00-14, 2-PR smooth tire, representing essentially the complete range of loads, deflections, and soil strengths considered. The data are listed in tables 3 and 4, respectively. The towed wheel tests are identified by the letter T in table 3. Relevant pull data from these tests were compared with data determined at the towed (table 3) and 20 percent slip (table 5) points of equivalent programed-slip tests in plate 6. Since corresponding data for identical soil strengths were seldom available, towed force and pull at 20 percent slip for the programed-slip tests were obtained from faired curves relating these measurements and the independent test variables (plates 7 and 8). The resulting comparisons (plate 6) show some scatter about the 1:1 line, but appear to be commensurate with that experienced in the basic tests. As indicated in fig. a

of plate 6, one constant-slip test (C94, table 4) produced negative pull (-14 lb), while the faired line on plate 8 from programed-slip tests indicated a positive pull (+40 lb). However, if the 0- to 6-in. cone index of test C94 were 18 instead of the recorded 19, the corresponding pull at 20 percent slip from the faired curve would be -20 lb, thus yielding a good correlation with the pull measured in the constant-slip test. It was concluded that programed-slip tests furnish essentially the same values of pull at the towed and 20 percent slip points as the constant-slip and towed tests.

PART III: ANALYSIS OF WHEEL PERFORMANCE

Towed Wheel

Towed force

25. The force required to tow a wheel through the soil under the specified test conditions is considered to be the primary criterion of towed-wheel performance. The relations of towed force for a 9.00-14, 2-PR tire in clay to soil strength, load, and tire deflection are summarized in plate 7. It can be seen that towed force varied with changes in these independent parameters in an orderly fashion. The towed force increased as soil strength decreased, as tire deflection decreased, and as load increased. The scatter present in the various plots in plate 7 is not considered unreasonable. The maximum variation in towed force between two supposedly identical tests at high strengths was 15 lb, assuming all other measurements to be exact. At low strengths, the variation appears quite large, but here the relation was extremely sensitive to small differences in soil strength and a variation of only one or two cone index units could account for much of the observed scatter. Since all the data were for a single tire, no information was obtained on the influence of the overall tire dimensions on performance. The only factors evaluated were load, soil strength, and tire deflection; and the range of these was limited.

26. Load. The effect of load (W) on performance was studied by comparing the ratio of towed forces (P_T) obtained at two different loads (at one soil strength and tire deflection) with the ratio of the two loads. For example, if the towed force was 170 lb at an 890-lb load and under the same test conditions was 22 lb at 340-lb load, the load ratio is 890/340 = 2.6, and the towed force ratio is 170/22 = 7.7. Several such comparisons were made using data representing performance at 25 and 40 cone index from the faired curves in plate 7. These cone indexes were chosen because the curves of plate 7 usually were best established in those regions and because the towed forces were comparatively high. No towed force less than 6 lb was considered because a few pounds change could cause a large change in the towed force ratio. These comparisons

are shown in plate 9, and the data are listed below. The curve drawn suggests that towed force varies as a power of the load. For the data shown, the relation appears to fall about the line $\frac{P_{T_1}}{P_{T_2}} = K\left(\frac{W_1}{W_2}\right)^2$.

Load and Towed Force (Faired Values)

Deflection %	W_1	W_2	P_{T_1}	P_{T_2}	$\frac{W_1}{W_2}$	$\frac{P_{T_1}}{P_{T_2}}$
		25 Cone Index				
15	890	670	170	95	1.33	1.79
15	890	455	170	40	1.95	4.25
15	890	340	170	22	2.62	7.73
15	890	225	170	10	3.96	1.70
15	670	455	95	40	1.47	2.38
15	670	340	95	22	1.97	4.33
15	670	225	95	10	2.98	9.50
15	455	340	40	22	1.34	1.82
15	455	225	40	10	2.02	4.00
15	340	225	22	10	1.51	2.20
25	1330	890	305	128	1.50	2.36
25	1330	670	305	73	1.99	4.18
25	1330	455	305	33	2.92	9.25
25	890	670	128	73	1.33	1.75
25	890	455	128	33	1.95	3.88
25	670	455	73	33	1.47	2.21
35	1020	890	109	78	1.15	1.40
35	1020	720	109	46	1.41	2.37
35	1020	455	109	18	2.24	6.05
35	890	720	78	46	1.24	1.69
35	890	455	78	18	1.95	4.33
35	720	455	46	18	1.58	2.55
		40 Cone Index				
15	890	670	100	45	1.33	2.22
15	890	455	100	16	1.95	6.25
15	670	455	45	16	1.47	2.82
25	890	670	50	28	1.33	1.78
25	890	455	50	12	1.95	4.17
25	670	455	28	12	1.47	2.33
35	1020	890	58	45	1.15	1.29
35	1020	720	58	25	1.42	2.32
35	1020	455	58	12	2.25	4.38
35	890	720	45	25	1.24	1.80
35	890	455	45	12	1.95	3.76
35	720	455	25	12	1.58	2.08

27. Soil strength and deflection. In principle, a similar analysis could be made of the effect of soil strength and tire deflection on performance. However, since some of the curves are quite flat over much of the range of cone index and since the influence of tire deflection on towed force is not well defined by these preliminary data, this analysis will be deferred until additional data can be obtained.

Sinkage

28. No special equation has yet been developed to determine the sinkage, i.e. the maximum penetration of any point on the test tire into the clay, although it is possible that the expression used in the tests on sand* may be applicable. For the clay reported herein, sinkage was computed as the depth of penetration of a point on the tire surface directly beneath the axle, a value which is relatively easy to obtain from the oscillograph record. Since the maximum penetration of a deflected tire occurs a few degrees behind the axle, the sinkage computed in this manner is somewhat less than the maximum sinkage.[2] However, examination of the detailed sinkage data showed that the error occasioned by use of the simplified method seldom exceeded 1/4 in. and was that large only when the sinkage was relatively large.

29. The relation of sinkage of towed wheels to the primary test parameters for the 9.00-14, 2-PR tire in clay is shown in plate 10. The similarity between these curves and those representing towed force relations (plate 7) is apparent. This similarity leads, quite naturally, to a direct correlation of sinkage and towed force. Plate 11 shows a grouping of all test data obtained by plotting the ratio of towed force to load against the towed sinkage. It is of some interest to note that it was necessary to use the force/load ratio to obtain a single curve. This makes the plot dimensionless, since the other factor, diameter, was

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* $$z = \frac{2H\,(\delta_{MH} + H)^2}{H^2 + (\delta_{MH} + H)^2}$$

where z is sinkage, H is the hub movement, and δ_{MH} is the maximum center-line deflection of the tire on an unyielding surface.[2]

constant. When the towed force alone was plotted, the data tended to separate on the basis of the load employed. It is thought that this resulted from the different requirement of units when plotted in a dimensional form (i.e. sinkage in inches and towed force in pounds). While considerable scatter still was evident, the relation was considered to be essentially correct since no special trends were noted. It is possible that much of the variation experienced arose from the sinkage approximation, and, at small sinkages, from energy losses in the tire deflection, resilient soil deflections, slip, and other factors unaccounted for in the analysis.

Powered Wheel

Powered-wheel force systems

30. A representation of the forces acting on a powered wheel is shown in fig. 1. The load on the wheel is represented by the force W acting vertically downward through the axle. With the direction of travel from left to right as shown, the input torque, M, acts clockwise

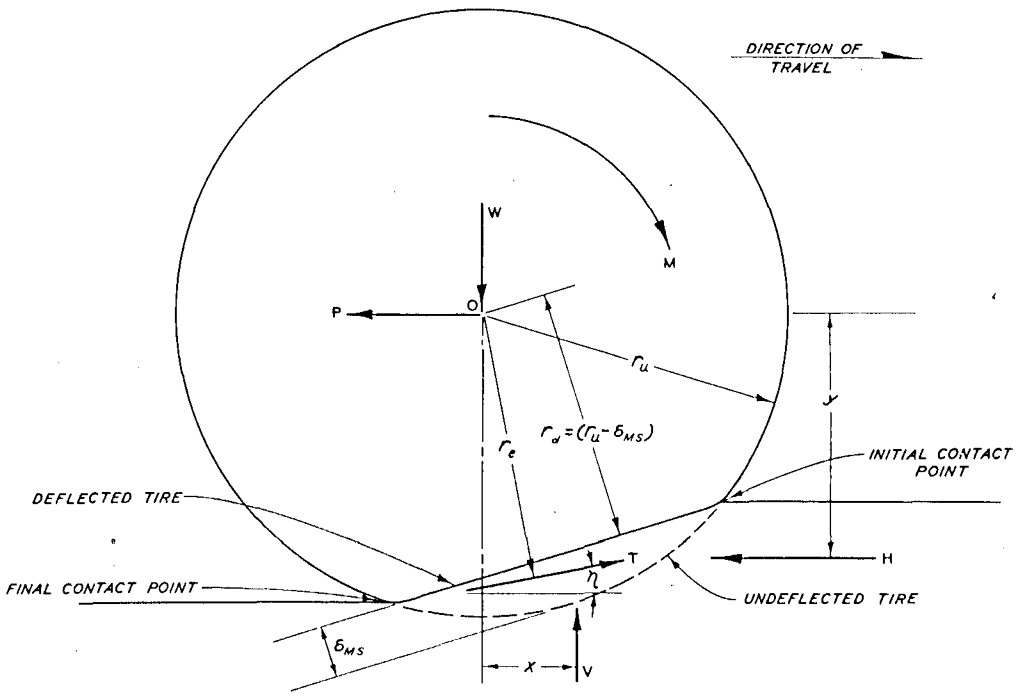

Fig. 1. Theoretical force system

with respect to the axle, O. The output pull is represented by the force P acting horizontally through the axle in the direction opposite to travel. The soil reactions are represented by the forces H, V, and T. The horizontal force, H, and the vertical force, V, are considered to be the components of the resultant of the forces acting normal to the wheel surface. The force T is the traction resulting from soil shear stresses.

31. Static equilibrium. To be in static equilibrium, the forces acting on the powered wheel must satisfy the following equations.

Sum of the horizontal forces must equal zero:

$$\Sigma F_H = -P - H + T \cos \eta = 0$$

or

$$T = \frac{P + H}{\cos \eta} \tag{1}$$

Sum of the vertical forces must equal zero:

$$\Sigma F_V = V + T \sin \eta - W = 0$$

or

$$T = \frac{W - V}{\sin \eta} \tag{2}$$

Sum of the moments must equal zero:

$$\Sigma M_O = M + Hy - Vx - Tr_e = 0$$

or

$$T = \frac{M + Hy - Vx}{r_e} \tag{3}$$

32. The forces P and W are measured by the test apparatus, and their lines of action are known. The moment, M, is also known from the test measurements. However, the magnitude and the line of action of the soil reactions, H, V, and T, are not known from the data measured during a normal test. Special tests in which measurements are made of

soil stresses are being conducted, but the results are incomplete. However, these data indicate that, with good approximation, it can be assumed that the resultant of H and V passes through the axle center line; thus, it can be stated that the moments due to H and V are equal in magnitude but opposite in sign and, therefore, cancel each other. Equation 3 then becomes:

$$T = \frac{M}{r_e} \tag{3a}$$

33. The line of action of the resultant shear force (T) would be parallel to a line drawn between the initial and the final points of tire-soil contact if it is assumed that the same shear force per unit of area exists at all points on the tire-soil interface. However, the tire-soil interface is not a straight line as shown, and the shear stress is not uniform but increases generally with depth. The actual resultant shear, therefore, is not parallel to the straight line but probably makes a smaller angle (η) with the horizontal. The effective moment arm, r_e , is probably not greatly different from the deflected radius of the tire, r_d , especially at small sinkages. At small sinkages, the angle η probably approaches zero, as well. If it is assumed that $\eta = 0$ and $r_d = r_e$, equation 3a becomes

$$T = \frac{M}{r_d} \tag{3b}$$

Then, combining this with equation 1 and, for simplicity, letting the deflected radius be the undeflected radius, r_u , minus the maximum in-soil deflection, δ_{MS} , at the particular dynamic condition to be considered, the equation becomes

$$\frac{M}{r_u - \delta_{MS}} = P + H \tag{4}$$

This approximation, depicted in fig. 2, is considered to be reasonably valid for small sinkages, and it has been used to assist in the analysis of powered-wheel traction.

34. Self-propelled point. At the self-propelled point, all the

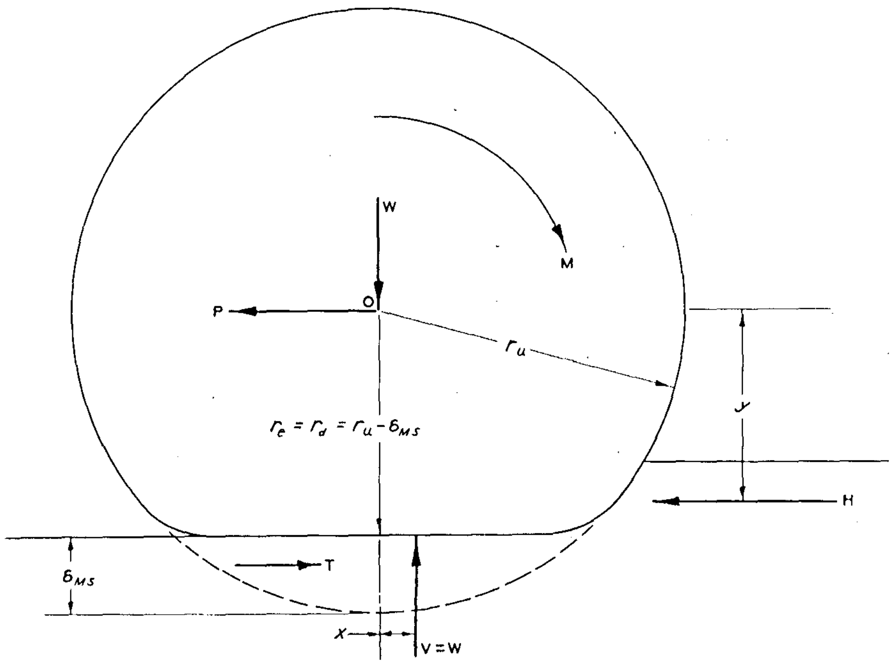

Fig. 2. Simplified force system.
Assume $r_e = r_u - \delta_{MS}$ and $\eta = 0$

tractive effort that a wheel develops is expended in overcoming motion resistance, i.e. P = 0. If, in addition to the assumptions stated in the previous paragraphs, the towed force is considered to approximate the motion resistance at the self-propelled point, i.e. $P_T = H_{sp}$, equation 4 becomes

$$P_T = \frac{M_{sp}}{(r_u - \delta_{MS})_{sp}} \tag{5}$$

where M_{sp} is the torque at the self-propelled point. This added approximation probably will be reasonably good for tests in which the sinkage is about the same at both the towed point and the self-propelled point.

35. Test data for the self-propelled condition are given in table 6. The relation of towed force to the ratio of torque at the self-propelled point and deflected radius is evaluated in plate 12. The correlation is quite good as demonstrated by the close agreement between the data points and the line representing 1:1 relation. The scatter is well within the probable experimental error. The sinkage at the self-propelled point in all tests used in the plot was 1.5 in. or less.

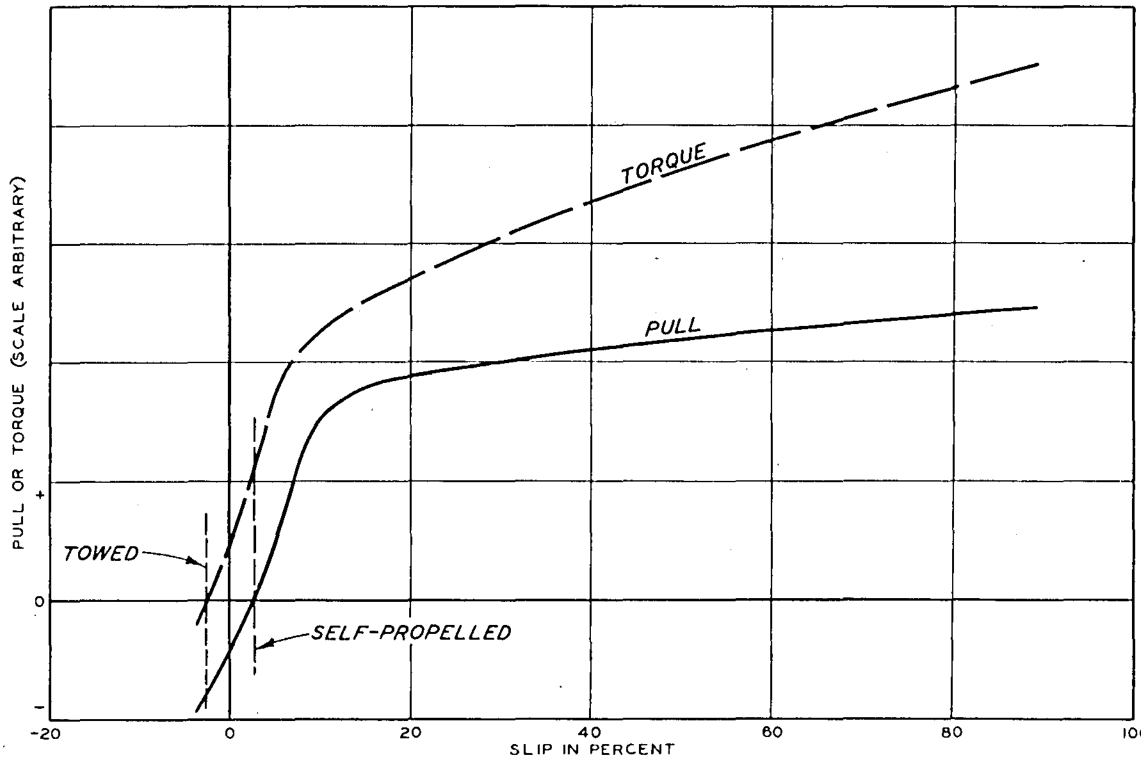

Fig. 3. Typical pull-slip and torque-slip curves, fat clay

Pull at 20 percent slip

36. On a typical pull-slip curve for a pneumatic tire operating in clay (fig. 3), the pull does not reach a definite maximum except possibly at a very high slip. Thus, it was necessary to choose a particular dynamic condition in the positive pull region in order that pulls could be compared. A specific slip condition was chosen because the same velocities, both absolute and relative (between tire and soil), then exist in each test. Several specific slip points (20, 40, and sometimes 60 and 80 percent) were evaluated in each test. In the analyses, primary consideration was given to the 20 percent slip condition (table 5) because this slip is large enough to develop 80 and 90 percent of the extrapolated pull at 100 percent slip and yet small enough for the wheel to operate at a reasonably high efficiency.

37. The pull at 20 percent slip (P_{20}) developed by the 9.00-14, 2-PR tire operating in fat clay is shown in relation to percent deflection, load, and soil strength in plate 8. The faired curves in this and all succeeding plots depicting pull give primary consideration to the later test results.

This plate shows that the pull at 20 percent slip increased with increasing soil strength (cone index) and increasing deflection, and that these increases were nonuniform. The effect of load on pull was not as clearly defined and appeared to vary with both soil strength and tire deflection.

38. Effect of soil strength. The rate of change of pull with respect to soil strength varied from very large at the lower cone indexes to very small at the higher cone indexes for all loads and all deflections (plate 8). The largest rate of change was in the low cone index region for 35 percent deflection condition. The data suggested two critical soil strengths in relation to pull development, one at 20 and the other at 60 cone index. Below 20 cone index, the decrease in pull per unit decrease in cone index was rapid. In fact, all test conditions for which the soil strength was 15 cone index or less and surface contact pressure was in excess of 7 psi failed to produce positive pull. Above 60 cone index, there was little increase in the pull at 20 percent slip, regardless of load-deflection condition. In the 20 to 60 cone index range, there was a general increase in pull development with increasing cone index, but the rate at which the pull increased varied with load, deflection, and cone index. Thus, a separate relation between cone index and pull at 20 percent slip was required for each load-deflection condition.

39. Effect of deflection. The effect of percent deflection on pull at 20 percent slip is shown for a typical test load (455 lb) in plate 8d. In the very soft soil, deflection had little influence, but in firm soil, the greatest pull was achieved with the greatest deflection. Since the combination of firm soil and high deflection resulted in a relatively large contact area, the results suggest that a large contact area (and therefore low pressure) enhances performance. However, the increase in pull was not linear with increasing deflection but apparently increased at a decreasing rate. Thus, there is probably a limit to the benefit gained by increasing percent deflection.

40. Effect of load. Pull does not appear to be a direct function of load as it is of soil strength and deflection. For the 35 percent deflection condition, for example, the effect of the load on pull was erratic

between 20 and 60 cone index. However, for a given soil strength and tire deflection, the pull/load ratio appears to have a fairly regular inverse relation with load (plate 13).

Torque at 20 percent slip

41. Using torque as a measure of tractive effort, a relation of tractive effort to load can also be shown (plate 14). The 1020-lb load at 35 percent deflection (see plate 14c) may be an exception to the relation, although it seems more likely that these data are not valid. The 1020-lb load data were not considered reliable because of the small number of tests performed at this load in the initial phase of testing. Except for this, plus a few scattered tests at other loads, the tractive effort-load relation can be explained in terms of the dependence of tractive effort on soil shear stress and soil shear area. Since the clay can be considered a purely cohesive soil within the soil strength range tested, the soil shear stress was independent of load; but the soil shear area was dependent upon tire deflection and wheel sinkage--both of which were dependent upon load. Thus, tractive effort, which is considered to be the product of contact area times unit stress, must also be dependent upon load.

Sinkage at 20 percent slip

42. A direct relation between sinkage at 20 percent slip and load for a constant deflection-strength condition is observed in plate 15 for all deflections and strengths with the exception of the 1020-lb load at 35 percent deflection (plate 15c). It does not seem likely that the 1020-lb load actually produced lower sinkages at 20 percent slip than did the 890-lb load. Because of the doubtful reliability of the 1020-lb load data as discussed in the preceding paragraph, these data should be disregarded until further tests can be made.

Analysis of forces at 20 percent slip

43. Returning to the force system of a powered wheel as shown in figs. 1 and 2, rearranging equation 4 for the 20 percent slip condition results in the following equation if sinkage is small ($\eta \approx 0$):

$$P_{20} = \frac{M_{20}}{(r_u - \delta_{MS})_{20}} - H_{20} \qquad (6)$$

If the motion resistance at 20 percent slip (H_{20}) is assumed equal to the towed force (equation 5) for the particular tire-soil condition considered, equation 6 reduces to

$$P_{20} = \frac{M_{20}}{(r_u - \delta_{MS})_{20}} - P_T$$

or

$$P_{20} = \frac{M_{20}}{(r_u - \delta_{MS})_{20}} - \frac{M_{sp}}{(r_u - \delta_{MS})_{sp}} \qquad (6a)$$

This is a nonconservative assumption because the motion resistance at 20 percent slip can be expected to be larger than the towed force because of the larger sinkage likely at the 20 percent slip condition. Before observing the relation of equation 6a to the test data, it is advisable to review the inherent assumptions: (a) the resultant normal force on the tire passes through the axle center line, (b) $r_e = r_u - \delta_{MS}$, (c) angle $\eta = 0$, and (d) $H_{20} = P_T = H_{sp}$.

44. The relation between the measured pull at 20 percent slip for the 9.00-14, 2-PR tire operating in clay and the pull at 20 percent slip calculated by equation 6a is shown graphically in plate 16a. The correlation is quite good. It should be noted, however, that the directly measured pull values are generally lower than the values computed from measured torque, tire radius, and tire deflection. This is attributed mainly to the fact that the computed quantity, $\frac{M_{sp}}{(r_u - \delta_{MS})_{sp}}$, i.e. motion resistance at the self-propelled point, is probably smaller than the actual motion resistance when the wheel is slipping at 20 percent, because in the latter condition, sinkage is greater. When a more nearly correct motion resistance is used, the scatter about the 1:1 line is reduced considerably. This is illustrated in plate 16b. To obtain the plot shown, the equation

$$P_{20} = \frac{M_{20}}{(r_u - \delta_{MS})_{20}} - \frac{M_{sp}}{(r_u - \delta_{MS})_{sp}}$$

was rewritten as

$$P_{20} = \frac{M_{20}}{(r_u - \delta_{MS})_{20}} - P_{T_{z20}}$$

in which P_T at the sinkage actually incurred at 20 percent slip was substituted for the term $\frac{M_{sp}}{(r_u - \delta_{MS})_{sp}}$. Proper P_T values were determined by the equation $P_T = W(0.015 + 0.123z)$ from plate 11. In this form, the equation might be considered to be total traction output = total traction input. The improved relation lends credence to the simple analysis presented of the powered-wheel system, at least for light pulls and low sinkages. Note that points occur on both sides of the 1:1 line in plate 16b up to about 400 lb, but thereafter the pulls calculated by dividing measured torque by an effective radius are all higher than those measured more directly.

Effect of Speed on Performance

45. Studies have shown that the effective shear strength of a cohesive soil increases as the rate of strain increases.[7] Therefore, it was reasonable to expect that the torque, pull, towed force, and sinkage recorded in a wheel test would be affected by the rate of travel of the wheel. A few tests, including towed, constant-slip, and programed-slip, were run to gain some appreciation of the extent of the influence of the speed (table 7). Towed tests have an advantage in that inertial forces in the carriage system are negligible (although they can be important at rapid accelerations). Furthermore, this type of test provides an opportunity to average results over a longer distance and to dissipate transient oscillations that can occur at high speeds. Powered tests, both constant- and programed-slip, could not be run as fast as towed tests because the torque input requirements exceeded the available system output.

46. The results of the variable-speed towed tests are presented graphically in plate 17. Although only three towed speeds were used, a

reasonable range of test conditions was represented by judicious selection of loads, deflections, and soil strengths. It is apparent from plate 17 that sinkage (fig. a) and towed force (fig. b) decreased with increasing speed and that the greatest change occurred within the speed range 0 to 6 fps. These results suggest that at higher speeds less energy is expended in deforming the soil.

47. One test condition (455-lb load, 15 percent tire deflection, and a cone index that averaged 36) was selected for powered-wheel speed tests, and the results of pull and torque measurements at 20 percent slip, shown in plate 18, corroborate both shear studies[7] and results of towed wheel tests. Torque (fig. a) and pull (fig. b) measurements indicated increases in performance with increases in speed. Apparently, sinkage (fig. c) decreased, but not to the degree noted in towed-wheel tests.

Effects of Repetitive Traffic

48. The ultimate requirement of the test program will involve extrapolation of single-wheel performance to multiwheel (vehicle) performance. Thus, it is of interest to examine the results obtained on each pass with the intent of evaluating the degree to which the performance data on any one pass, particularly the first, are indicative of multiple-pass performance. In examining the results of these tests, it should be borne in mind that there was little or no strength change in the test soil as a result of traffic. Therefore, the trends indicated cannot be related directly to performance in soils that either increase or decrease in strength under traffic loadings.

49. The effect of repeated passes of the test wheel is shown in a general way by the data plotted in plate 19. It is apparent from this plate that multiple passes had relatively little effect on the magnitude of the tire-soil performance parameters shown, except for cumulative sinkage, for either the high- (cone index ~50) or low-strength (cone index ~20) condition. It should be noted, however, that although the cumulative sinkage increased with each pass of the tire, the incremental sinkage was approximately constant, particularly during the second through fifth passes. Thus, a significant increase in motion resistance would not be

expected and, in fact, was not evident, as shown by the relatively constant magnitude of pull and towed force for the different passes. Results of a constant-slip test of 20 passes are presented in plate 20, and serve to substantiate and extend the observations made for the programed-slip tests.

50. The effect of multiple passes on pull at 20 percent slip, torque at 20 percent slip, and towed force for this tire operating in clay is shown in a different manner in plate 21. In this plate, the first-pass value of the different parameters is compared with the arithmetic means of the parameters for all the passes, which is termed the test average. It is apparent from this plate that the first-pass and test-average values of pull, torque, and towed force were equal within the limits of experimental error.

51. The similarity of first-pass and test-average values suggests the possibility of using test-average tire performance values in parameter-by-parameter analyses to improve the reliability of developed relations because of the possibility of soil-bed nonuniformity yielding an unrepresentative first-pass result. Also, the constant magnitude of pull, torque, and towed force, respectively, on all passes may make it possible to multiply the respective test-average values by the number of wheels on a particular vehicle to predict vehicle performance. Sinkage, of course, is not expected to follow a similar trend, since the sinkage on the first pass usually is somewhat greater than on subsequent passes.

PART IV: CONCLUSIONS AND RECOMMENDATIONS

Conclusions

52. From the information presented in this report, the following conclusions were drawn:

a. The basic concept of using wet clay at a high degree of saturation as a load-independent test soil is valid and useful (paragraphs 9, 10).

b. Variation in soil strength between the soil surface and the remainder of the soil mass at the time of test can drastically affect powered-wheel performance, but does not seriously influence towed-wheel performance (paragraphs 16, 17).

c. The towed force determined at the towed point of a programed-slip test and that determined by a purely towed test are equal within the limits of experiment error (paragraph 24).

d. For a towed wheel, increasing test speed reduces towed force and towed sinkage, the largest changes occurring in the 0- to 6-fps speed range (paragraph 46).

e. For a powered wheel, increasing speed increases torque and pull at 20 percent slip and apparently decreases sinkage slightly (paragraph 47).

f. Towed force, pull, or torque, respectively, measured on the various passes of a single test do not change appreciably (paragraphs 48-50).

g. Soil strength, load, and tire deflection affect towed force, pull, and sinkage in an orderly manner (paragraphs 25-27).

h. A simple system to represent the forces and moments on towed or powered pneumatic tires operating in a soft clay at small sinkages is adequate as a basis for examining the relations among the test variables (paragraphs 35, 44).

Recommendations

53. On the basis of the discussion and the analyses presented in this report and the conclusions therefrom, it is recommended that:

a. The clay-testing phase of the current program on the performance of soils under tire loads be continued, and that tires of other sizes be included as soon as possible.

b. The parameter-by-parameter analysis of clay behavior under tire traffic be continued, and a numeric analysis be initiated.

c. The simple force system continue to be examined, evaluated, and modified in light of new test data and better understanding of tire-soil relations.

d. The revised test controls on clay saturation and surface strength be continued, and all test controls be reexamined constantly in order to improve test quality.

e. Evaluation of the equivalence of test data obtained at similar dynamic states and test conditions produced by towed, constant-slip, and programed-slip tests be continued as the test schedule permits.

f. A detailed evaluation of the effect of speed on powered-wheel performance in clay be accomplished.

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Table 1

Summary of Tire Data

9.00-14, 2-PR Smooth Tires

			Unloaded Dimensions			Loaded Dimensions - Hard Surface					Contact Print Data			
Load lb	Deflection %	Inflation Pressure psi	Section Width in.	Section Height in.	Diameter in.	Section Width in.	Section Height in.	Deflection in.	Rolling Radius ft	Rolling Circumference ft	Print Width in.	Print Length in.	Contact Area sq in.	Contact Pressure psi
Armstrong Serial No. 8A-1503, Tests C7 Through C112*														
225	15	9.4	8.48	5.75	26.79	8.62	4.89	0.86	1.045	6.95	4.59	7.00	26.07	8.63
340	15	14.1	8.50	5.81	27.09	8.69	4.94	0.87	1.056	6.95	4.58	7.02	26.18	12.99
455	15	17.6	8.68	5.84	27.15	8.91	4.94	0.90	1.056	7.02	4.63	7.34	27.62	16.47
670	15	30.1	8.76	6.04	27.55	8.92	5.13	0.91	1.072	7.13	4.20	7.00	23.43	28.60
890	15	40.2	8.82	6.16	27.79	8.99	5.24	0.92	1.081	7.17	4.20	7.12	24.20	36.78
290	25	5.9	8.52	5.67	26.81	8.82	4.25	1.42	0.999	6.74	5.86	8.90	43.13	6.72
455	25	9.4	8.48	5.75	26.97	8.85	4.31	1.44	1.004	6.76	6.20	9.20	47.40	9.60
670	25	14.1	8.50	5.81	27.09	8.87	4.36	1.45	1.008	6.82	5.90	9.63	47.27	14.17
890	25	17.6	8.68	5.84	27.15	9.00	4.38	1.46	1.010	6.85	6.00	9.78	48.41	18.38
1330	25	30.1	8.76	6.04	27.55	9.10	4.53	1.51	1.022	6.98	5.69	9.71	45.85	29.01
225	35	2.4	8.70	5.15	25.77	9.40	3.35	1.80	0.924	6.36	8.20	12.00	83.22	2.70
455	35	5.6	8.50	5.65	26.77	9.20	3.67	1.98	0.950	6.53	7.30	11.80	71.58	6.36
720	35	9.4	8.48	5.75	26.97	9.23	3.74	2.01	0.956	6.57	7.40	12.00	74.55	9.66
890	35	12.5	8.49	5.79	27.05	9.15	3.76	2.03	0.958	6.61	7.19	11.80	71.24	12.49
1020	35	14.1	8.50	5.81	27.09	9.20	3.78	2.03	0.960	6.62	7.21	11.80	71.28	14.31
Armstrong Serial No. 9A-1503, Tests C115 Through C152														
340	15	14.1	8.51	5.88	27.23	8.78	5.00	0.88	1.065	6.98	4.28	7.07	24.25	14.02
455	15	20.0	8.57	6.00	27.47	8.80	5.10	0.90	1.070	7.05	4.18	7.28	24.39	18.66
890	15	41.6	8.80	6.30	28.07	8.86	5.36	0.94	1.091	7.23	4.00	7.14	22.97	38.80
1300	15	59.0	8.93	6.42	28.31	9.13	5.46	0.96	1.100	7.33	3.75	7.08	21.02	61.80
455	25	9.3	8.50	5.80	27.07	8.99	4.35	1.45	1.007	6.78	5.70	9.40	44.16	10.30
890	25	20.0	8.57	6.00	27.47	8.98	4.50	1.50	1.020	6.94	5.40	9.40	42.05	21.20
455	35	5.5	8.49	5.64	26.75	9.33	3.67	1.97	0.950	6.55	7.25	11.80	71.55	6.36
890	35	12.3	8.51	5.86	27.19	9.33	3.81	2.05	0.962	6.65	7.00	11.68	67.57	13.17

* This tire was accidently destroyed on April 2, 1962.

Table 2

Summary of Soil Data

Test	Pass*	Moisture Content % of Dry Weight: 0- to 1/4-in. Layer	0- to 1-in. Layer	0- to 6-in. Layer	6- to 12-in. Layer	Dry Density pcf: 0- to 6-in. Layer	6- to 12-in. Layer	Cone Index: 0- to 6-in. Layer	6- to 12-in. Layer
C7	1			45.9	45.9	72.2	72.4	18	21
	2							18	24
	3							17	23
	4							14	26
	5							16	25
	A			46.2	42.3	71.8	76.2	16	29
C8	1			45.9	46.5	72.5	72.4	17	23
	2							15	--
	A			46.7	40.0	71.7	77.7	16	--
C9	1			45.8	45.8	72.5	72.7	15	20
	2							15	23
	3							15	20
	4							14	24
	5							16	--
	A			45.4	39.0	73.4	79.9	15	--
C10	1			44.6	45.0	71.8	69.0	17	25
	2							16	--
	A			45.4	41.4	73.3	70.8	17	--
C11	1			46.0	46.3	73.2	71.4	17	21
	2							15	21
	3							15	23
	4							15	23
	5							15	--
	A			45.6	42.5	73.4	76.1	16	--
C12	1			45.9	45.9	71.3	73.0	18	20
	2							17	--
	3							16	--
	4							15	--
	A			46.9	40.9	71.2	79.1	18	--
C13	1			45.4	45.3	73.2	74.0	16	21
	2							16	24
	3							15	21
	4							17	29
	5							17	23
	A			46.0	41.9	72.3	77.4	15	22
C14	1			45.9	46.4	71.4	74.8	18	20
	2							16	24
	3							17	--
	A			46.2	43.6			17	--
C15	1			44.6	42.7	73.3	72.0	18	22
	2							16	23
	3							17	23
	4							18	--
	5							17	--
	A			45.2	43.4	73.3	75.2	18	--
C16	1			44.6	45.0	73.8	74.7	19	--
	2							17	--
	3							17	--
	4							17	--
	5							18	--
	A			44.8	43.8	73.0	74.8	16	--
C17	1			45.8	45.2	72.6	74.8	19	25
	2							19	23
	3							18	23
	4							18	--
	5							19	--
	A			45.6	44.4	72.8	75.5	16	17
C18	1			45.4	42.1	73.3	77.4	20	25
	2							18	--
	3							18	--
	4							18	19
	A			46.1	44.7	72.9	74.1	17	--
C19	1		48.1	50.9	47.3	69.5	72.4	16	22
	2							18	21
	3							16	22
	4							13	20
	5							15	22
	A		45.9	48.8	46.8	71.0	72.4	16	22
C20	1		49.4	48.8	47.3	69.8	71.0	19	24
	2							16	23
	3							18	19
	4							15	22
	5							17	22
	A		47.3	48.0	47.8	71.8	72.1	19	24
C21	1		49.4	47.1	48.1	74.7	71.8	16	20
	2							13	20
	A		45.2	47.6	46.3	72.1	73.6	17	21
C22	1		47.7	48.0	47.2	71.8	72.8	19	24
	2							17	22
	3							15	17
	4							17	24
	5							15	19
	A		47.7	48.8	48.2	70.2	69.4	16	19
C23	1		47.3	47.7	47.5	71.5	70.9	18	23
	A		47.7	48.0	49.1	72.2	70.8	18	22
C24	1		47.7	47.9	48.5	71.2	70.6	19	26
	2							16	20
	3							17	20
	A		47.7	47.2	48.0	72.8	70.5	17	20
C25	1		47.1	47.1	47.3	72.4	71.5	19	18
	2							17	20
	3							17	20
	4							17	19
	5							16	19
	A		46.6	46.1	46.7	74.0	72.1	18	20
C26	1		46.5	47.6	47.4	73.0	72.2	18	21
	2							18	22
	3							18	22
	4							17	20
	5							17	21
	A		45.8	47.4	46.9	72.7	71.0	18	22
C27	1		45.1	45.1	46.1	73.4	72.0	19	21
	2							19	22
	3							17	20
	4							17	19
	5							18	20
	A		46.2	46.9	47.4	72.7	27.4	18	23
C28	1		39.8	39.1	38.8	79.3	78.6	41	47
	2							38	44
	3							39	46
	4							39	48
	5							39	42
	A		39.1	38.5	38.6	80.0	79.7	40	45
C29	1		40.7	39.9	38.9	78.3	81.2	41	46
	2							36	46
	3							39	43
	4							36	44
	5							39	48
	A		40.0	39.1	39.2	79.5	79.1	38	46
C30	1		47.2	47.7	47.8	72.3	72.4	19	21
	2							18	23
	3							17	22
	4							17	21
	5							17	23
	A		46.7	47.4	48.6	72.3	71.5	17	22
C31	1		47.8	46.9	47.6	73.6	72.1	19	21
	2							19	20
	3							17	21
	A		46.9	47.0	48.4	72.4	70.4	18	22
C32	1		46.6	48.0	47.7	72.1	71.1	19	21
	2							18	20
	3							17	20
	4							18	20
	5							18	20
	A		46.7	48.0	47.6	72.5	70.3	19	21
C33	1		47.2	47.2	48.0	73.8	71.6	18	21
	2							19	21
	3							18	20
	4							17	19
	A		46.3	47.6	48.9	72.1	70.2	17	23
C34	1		40.8	38.9	38.9	80.7	80.9	42	51
	2							40	48
	3							40	45
	4							40	46
	A		40.6	38.9	38.8	81.1	80.4	40	48
C36	1		46.3	46.5	47.9	74.1	71.0	18	19
	2							18	19
	3							16	19
	4							17	18
	5							16	21
	A		46.5	47.0	47.3	72.9	70.9	16	22
C37	1		47.0	47.0	47.7	73.0	71.4	18	20
	2							17	21
	A		45.5	47.3	48.0	72.8	72.5	17	22

(Continued)

* Measurements were taken before passage of the wheel for the pass indicated. A indicates measurements taken after all passes were completed or after the pass indicated.

Table 2 (Continued)

Test	Pass	Moisture Content % of Dry Weight: 0- to 1/4-in. Layer	0- to 1-in. Layer	0- to 6-in. Layer	6- to 12-in. Layer	Dry Density pcf: 0- to 6-in. Layer	6- to 12-in. Layer	Cone Index: 0- to 6-in. Layer	6- to 12-in. Layer
C38	1		39.4	39.0	38.9	79.6	82.1	43	46
	2							38	44
	3							40	46
	4							42	45
	5							42	49
	A		40.4	39.9	39.9	79.4	81.4	42	47
C39	1		41.0	40.1	39.9	79.7	79.1	44	50
	2							39	49
	3							41	47
	4							40	45
	5							42	53
	A		40.1	39.8	39.5	79.4	81.2	41	50
C40	1		39.0	39.4	39.2	78.6	81.3	44	50
	2							43	53
	3							42	50
	4							42	51
	A5		39.1	39.2	38.9	79.8	81.8	44	53
C41	1		40.4	39.5	39.3	79.9	80.0	45	48
	2							42	51
	3							42	50
	4							46	56
	A		40.2	40.0	39.1	80.0	80.0	43	51
C42	1		34.8	34.1	33.8	86.2	86.0	82	83
	2							82	86
	3							80	83
	4							76	84
	5							82	88
	A		34.2	34.0	34.7	84.0	85.0	81	82
C43	1		34.9	34.0	34.3	86.4	85.9	78	83
	2							75	86
	A		34.9	35.0	34.7	85.8	84.4	80	84
C44	1		39.2	38.4	38.6	81.3	79.5	42	45
	2							41	42
	3							40	45
	4							43	46
	5							41	48
	A		39.1	38.8	38.6	80.7	80.3	40	48
C45	1		39.8	38.9	38.3	78.3	77.4	42	46
	2							41	53
	3							38	44
	4							40	49
	5							40	45
	A		39.9	39.7	39.2	80.7	80.5	40	49
C46	1		35.0	34.4	--	85.4	--	80	82
	2							77	81
	3							72	76
	4							77	81
	5							74	72
	A		34.3	34.4	--	85.9	--	75	83
C47	1		34.0	33.7	--	85.5	--	75	80
	2							70	78
	3							70	75
	4							73	80
	5							72	76
	A		34.3	33.8	--	90.1	--	69	76
C48	1		39.4	39.0	39.2	80.9	81.3	38	46
	2							41	49
	3							41	43
	4							41	48
	5							41	50
	A		39.3	39.3	39.5	78.8	79.4	42	50
C50	1		33.6	33.6	--	87.9	--	77	80
	2							77	90
	3							79	86
	A		--	--	--	--	--	78	91
C51	1		34.5	33.7	--	87.4	--	79	83
	2							74	83
	3							83	83
	4							79	88
	A		33.3	35.4	--	88.7	--	81	87
C52	1		39.5	38.9	39.2	81.3	80.0	42	50
	2							38	45
	3							41	48
	4							41	45
	A		39.6	39.4	39.7	80.7	79.2	39	40
C53	1		39.5	39.4	39.9	80.2	79.5	42	44
	2							43	48
	3							40	39
	A		39.2	39.4	39.1	80.6	80.7	36	42
C54	1		47.1	46.3	47.0	73.3	72.0	20	25
	2							23	26
	3							22	25
	4							23	24
	5							22	23
	A		46.1	46.0	46.8	73.7	72.7	21	23
C55	1		45.2	45.8	46.9	73.6	72.2	24	24
	2							23	23
	A		44.7	45.8	46.0	73.7	73.9	23	27
C56	1		45.8	45.5	43.7	74.3	76.0	25	29
	2							24	32
	3							24	31
	4							24	32
	5							24	30
	A		46.5	44.9	43.9	74.5	73.7	24	31
C57	1		43.9	44.2	44.5	76.2	76.2	26	31
	2							25	32
	3							24	32
	4							24	31
	5							23	31
	A		44.9	44.4	43.5	74.6	75.5	27	32
C58	1		45.2	45.3	43.6	74.4	75.4	24	30
	2							22	30
	3							23	32
	4							22	33
	5							23	34
	A		46.4	44.5	43.2	74.5	76.3	23	33
C59	1		45.9	45.0	43.2	74.7	75.5	25	30
	2							25	30
	3							24	31
	4							23	29
	5							24	29
	A		45.3	45.5	44.3	73.9	74.5	22	29
C60	1		45.8	44.8	43.9	74.7	75.6	24	32
	2							23	32
	3							25	31
	4							24	30
	5							25	32
	A		45.0	44.3	43.0	75.1	75.7	26	29
C61	1		46.4	46.0	47.1	73.1	71.7	23	25
	2							26	26
	3							25	26
	4							23	26
	5							25	26
	A		45.2	46.7	46.4	72.7	72.6	23	25
C62	1		46.9	45.4	46.3	74.8	74.0	25	26
	2							23	23
	3							21	24
	4							23	25
	5							21	23
	A		46.0	46.5	47.4	73.1	70.5	21	23
C63	1		44.3	44.6	43.0	75.5	76.8	24	29
	2							24	32
	3							23	31
	4							24	29
	5							25	33
	A		42.5	44.8	43.6	75.0	75.7	25	29
C64	1		44.8	44.7	43.1	74.0	75.8	25	31
	2							24	31
	3							23	30
	4							22	28
	5							24	29
	A		44.4	44.1	43.3	75.2	75.6	25	31
C65	1		46.4	46.0	46.6	74.3	73.3	24	25
	2							23	24
	3							21	25
	A		47.0	46.3	45.8	73.5	74.3	21	26
C66	1		43.7	45.0	46.0	74.9	73.5	25	25
	2							23	24
	A		43.7	43.8	46.8	74.6	71.2	23	27
C67	1		44.2	44.8	43.5	74.9	76.1	23	30
	2							22	32
	3							22	29
	4							23	30
	5							22	30
	A		43.6	44.9	43.2	73.6	76.1	22	32
C68	1		43.5	44.0	43.2	74.4	75.9	24	31
	2							24	32
	3							24	28
	4							24	29
	5							24	31
	A		43.9	43.9	43.0	75.6	75.7	24	27
C69	1		45.5	45.7	46.3	74.4	72.8	23	22
	2							24	23
	3							24	24
	4							23	24
	5							22	24
	A		45.6	45.0	46.3	74.6	72.7	21	23

(Continued)

Table 2 (Continued)

Test	Pass	Moisture Content % of Dry Weight 0- to 1/4-in. Layer	0- to 1-in. Layer	0- to 6-in. Layer	6- to 12-in. Layer	Dry Density pcf 0- to 6-in. Layer	6- to 12-in. Layer	Cone Index 0- to 6-in. Layer	6- to 12-in. Layer
C70	1		45.8	45.4	46.3	74.9	73.9	22	22
	2							21	22
	3							21	24
	4							22	22
	5							22	22
	A		44.0	45.3	47.1	75.2	73.2	20	22
C71	1		43.9	44.2	43.2	74.2	75.8	25	26
	2							25	31
	3							24	30
	4							26	29
	5							23	29
	A		42.3	43.7	43.2	76.7	77.4	24	31
C72	1		43.1	43.2	42.9	76.9	76.7	27	29
	2							26	30
	3							24	28
	A		44.3	44.1	42.5	76.0	75.2	25	28
C73	1		45.6	45.4	46.6	74.3	73.0	25	25
	2							26	25
	3							26	26
	A		44.2	45.9	46.9	74.5	72.5	24	29
C74	1		46.2	45.4	46.6	73.5	73.3	26	26
	2							24	26
	3							24	28
	4							23	26
	5							23	28
	A		45.1	45.4	45.1	75.2	74.5	24	27
C75	1		44.6	43.6	43.3	77.0	76.4	29	29
	2							27	34
	3							26	36
	4							27	38
	5							27	37
	A		43.2	43.7	43.1	76.8	76.7	27	38
C76	1		44.3	42.9	43.3	77.2	75.8	28	33
	2							28	33
	3							27	33
	4							25	30
	5							26	32
	A		44.6	43.5	43.7	77.1	76.8	27	32
C77	1		45.9	45.2	46.7	74.3	72.4	26	26
	2							24	26
	3							25	26
	4							25	25
	5							24	28
	A		45.7	45.5	46.5	74.9	73.4	23	28
C78	1		44.8	45.3	46.3	75.2	73.1	27	30
	2							26	27
	3							27	28
	4							26	26
	5							26	27
	A		46.1	44.9	48.0	75.7	73.4	26	28
C79	1		41.9	42.4	42.3	76.2	76.8	31	37
	2							29	39
	3							28	38
	4							29	35
	5							28	36
	A		42.5	43.1	42.6	77.6	77.5	29	38
C80	1		41.8	43.1	42.7	76.0	75.3	31	35
	2							32	39
	3							32	37
	4							29	33
	5							29	33
	A		41.4	42.3	42.2	78.3	77.4	29	35
C81	1		43.3	41.1	40.0	78.8	79.5	41	48
	2							40	48
	3							41	49
	4							39	48
	5							40	48
	A		42.3	41.1	40.9	77.5	79.5	40	50
C82	1		42.3	41.2	40.2	79.0	76.9	44	49
	2							42	52
	3							40	51
	4							43	48
	5							41	51
	A		41.8	40.5	39.3	79.1	81.0	42	48
C85	1		47.7	47.4	45.7	73.0	73.5	20	27
	2							19	28
	3							20	29
	4							19	28
	5							21	29
	A		48.2	47.6	45.7	72.4	71.6	21	32
C86	1		48.6	47.2	46.1	73.0	73.1	21	29
	2							21	28
	3							23	29
	A		48.9	46.5	45.7	73.1	73.8	21	26
C87	1		42.0	40.5	39.7	78.6	80.0	40	48
	2							38	44
	3							38	46
	4							38	48
	5							40	52
	A		42.3	40.9	40.5	78.7	78.9	40	50
C88	1		42.2	40.3	40.3	80.5	79.6	42	52
	2							42	52
	3							44	54
	4							44	48
	5							42	50
	A		42.0	40.5	39.8	80.0	78.3	42	52
C89	1		47.1	47.2	45.2	72.8	73.7	21	29
	2							20	29
	3							21	29
	4							23	28
	A		46.8	46.0	44.8	74.0	74.4	23	29
C90	1		47.5	46.7	44.3	72.5	72.8	20	27
	2							20	31
	3							21	30
	A		46.6	47.0	45.2	73.5	73.0	21	30
C91	1		40.4	39.9	39.7	80.3	81.6	41	51
	2							39	46
	3							39	46
	4							39	48
	5							39	47
	A		39.8	40.3	39.8	79.2	79.6	37	45
C92	1		40.3	39.9	38.8	80.2	81.3	41	49
	2							41	47
	3							41	50
	4							40	47
	5							39	49
	A		40.3	39.9	39.4	79.6	80.4	36	42
C94	1		48.6	48.3	48.6	71.2	71.0	19	22
	2							17	19
	3							17	21
	4							16	22
	5							16	22
	A		48.2	47.5	48.2	72.0	70.1	17	24
C95	1		37.5	38.2	38.9	81.7	80.6	50	51
	2							48	49
	3							46	47
	4							48	50
	5							47	51
	A		38.3	38.3	39.3	81.4	80.4	45	48
C96	1		38.8	38.4	39.2	80.9	79.8	48	52
	2							48	52
	A		38.5	38.6	39.4	81.1	79.6	48	55
C97	1		48.6	46.4	45.5	73.6	73.6	24	27
	2							23	28
	3							23	26
	4							22	28
	5							21	25
	A		47.0	46.2	45.6	73.0	73.6	22	28
C98	1		47.8	46.5	44.6	74.5	75.7	22	30
	2							22	31
	3							21	28
	4							22	30
	5							21	31
	A		47.5	46.6	44.7	74.2	75.7	21	28
C99	1		38.3	38.4	39.9	80.6	78.5	46	49
	2							46	53
	3							45	52
	4							45	51
	5							45	55
	A		38.2	38.8	40.2	80.9	77.4	44	56
C100	1		39.2	38.6	39.8	80.4	79.2	47	53
	2							47	59
	3							48	59
	4							45	52
	5							45	56
	A		38.7	38.7	40.2	80.6	78.9	46	56
C102	1		47.8	46.1	45.2	73.7	74.2	22	27
	2							23	25
	3							22	28
	A		47.2	45.8	45.2	73.8	73.6	22	26
C106	1		38.9	35.0	--	87.2	--	74	86
	2							64	85
	3							67	88
	4							70	80
	5							73	89
	A		37.1	35.6	--	86.4	--	73	83

(Continued)

Table 2 (Continued)

Test	Pass	Moisture Content % of Dry Weight: 0- to 1/4-in. Layer	Moisture Content: 0- to 1-in. Layer	Moisture Content: 0- to 6-in. Layer	Moisture Content: 6- to 12-in. Layer	Dry Density pcf: 0- to 6-in. Layer	Dry Density pcf: 6- to 12-in. Layer	Cone Index: 0- to 6-in. Layer	Cone Index: 6- to 12-in. Layer
C107	1		35.7	34.4	--	86.0	--	74	83
	2							72	85
	3							78	88
	4							71	79
	5							74	85
	A		36.3	34.9	--	85.6	--	72	84
C108	1		37.3	35.3	--	85.3	--	73	86
	A		36.9	34.8	--	86.3	--	67	82
C109	1		35.2	33.9	--	88.2	--	74	82
	2							72	83
	3							75	80
	4							62	70
	5							69	72
	A		35.0	33.8	--	87.0	--	73	81
C110	1		36.2	35.0	--	85.7	--	55	58
	2							62	67
	3							59	57
	4							52	54
	5							58	64
	A		36.6	35.1	--	85.1	--	57	63
C111	1		35.2	33.6	--	86.7	--	75	82
	2							67	67
	3							71	75
	4							72	73
	5							78	82
	A		34.7	33.5	--	86.8	--	76	77
C115	1	38.4	39.1	39.5	39.5	78.5	76.7	34	33
C116	1	38.6	38.8	39.2	39.7	80.1	77.0	34	34
	2							33	36
	3							34	35
	A5	--	38.9	39.0	39.6	78.4	77.0	35	35
C117	1	34.8	35.6	36.1	35.8	83.9	82.0	51	51
	2							53	51
	3							46	50
	A5	--	--	36.4	36.3	82.4	79.9	47	52
C118	1	34.3	35.4	36.1	36.1	83.0	80.7	50	52
	2							48	52
	A2	--	--	--	--	--	--	38	38
C119	1	34.1	38.3	39.6	39.7	76.8	77.0	39	38
	2							35	36
	A5	--	--	39.5	39.7	78.3	77.4	39	40
C120	1	33.5	38.5	39.1	39.6	77.6	76.7	37	37
	2							35	35
	3							38	39
	A5	--	--	39.1	39.5	78.6	77.1	39	41
C121	1	34.7	34.9	36.3	35.9	81.4	82.2	47	49
	2							48	51
	3							48	51
	A5	--	--	36.6	36.8	82.4	81.2	47	49
C122	1	34.9	36.0	36.5	36.8	81.2	82.1	47	55
	2							47	49
	A	--	--	--	--	--	--	47	50
C123	1	42.7	--	44.7	44.8	72.7	73.5	20	21
	2							18	21
	3							19	21
	A5	--	--	44.3	45.1	73.6	71.3	19	21
C124*	1	43.3	--	44.0	45.5	74.6	71.6	23	21
	2							20	20
	3							22	21
	A5	--	--	44.4	45.3	73.3	71.9	22	22
C125	1	34.0	35.6	37.9	39.4	79.6	79.0	47	37
	2							50	37
	3							48	37
	A5	--	--	38.6	39.3	77.2	78.0	51	38
C126	1	37.5	38.7	39.1	39.3	79.0	79.6	36	36
	2							38	39
	3							37	37
	A5	--	--	38.4	39.3	78.9	77.6	36	37
C127	1	32.5	35.2	36.0	36.1	87.2	82.6	62	54
	2							59	55
	3							60	60
	A5	--	--	35.9	36.6	82.9	81.2	57	50
C128	1	33.9	35.9	35.6	36.4	81.3	81.1	58	60
	2							54	61
	3							55	61
	A5	--	--	36.2	36.2	82.8	81.7	57	61
C129	1	42.0	44.2	44.5	44.5	74.2	73.0	23	22
	2							21	21
	3							24	21
	A5	--	--	44.4	44.2	74.0	72.6	21	21
C130	1	41.5	41.3	43.9	44.4	74.7	73.5	24	22
	2							24	21
	3							25	21
	A5	--	--	43.2	44.1	75.2	73.1	26	24
C131	1	33.6	35.5	35.0	36.3	84.0	--	60	54
	2							64	60
	3							62	58
	A5	--	--	35.6	36.5	83.8	82.0	62	58
C132	1	34.3	35.6	35.9	36.0	84.0	--	63	66
	2							59	63
	3							54	53
	A5	--	--	36.1	36.0	83.4	81.7	64	67
C133	1	42.4	43.2	45.0	44.1	72.4	71.8	21	19
	2							21	20
	3							20	19
	A5	--	--	44.3	44.7	73.7	72.2	23	21
C134	1	41.4	43.4	43.2	44.9	75.8	71.9	23	21
	2							23	21
	3							24	21
	A5	--	--	43.9	45.7	74.9	72.0	24	21
C135	1	39.9	42.8	43.9	44.8	74.5	72.4	23	20
	2							22	21
	3							22	20
	A5	--	--	44.2	44.8	74.1	--	21	20
C136	1	41.1	41.1	43.4	--	75.4	72.2	24	22
	2							24	23
	3							25	21
	A5	--	--	43.2	44.6	76.2	72.1	24	22
C138	1	42.5	44.5	44.6	44.9	73.9	71.3	24	22
	2							22	22
	3							22	23
	A5	--	--	43.1	44.3	75.7	73.5	23	22
C139	1	--	45.3	45.6	46.3	70.8	69.9	18	20
	2							18	21
	3							17	21
	A5	--	--	46.0	47.5	72.3	69.4	17	25
C140	1	--	45.4	45.1	47.0	73.2	70.8	16	21
	2							16	20
	3							17	22
	A5	--	46.1	47.1	--	72.6	66.8	17	20
C141	1	--	36.2	36.7	36.7	82.4	81.4	57	63
	2							57	63
	3							58	65
	A5	--	--	36.6	36.8	81.7	81.6	56	63
C142	1	45.1	44.9	44.8	44.4	74.1	74.0	17	21
	2							15	18
	3							16	26
	A5	--	--	45.5	46.7	74.0	73.1	17	25
C144	1	33.1	36.1	36.3	36.7	83.2	81.1	63	68
	2							64	67
	3							63	66
	A5	--	35.5	36.2	36.7	83.8	82.5	64	67
C145	1	37.7	39.4	39.9	40.3	78.7	77.6	42	42
	2							44	45
	3							42	42
	A5	--	38.6	39.2	40.5	78.6	77.3	40	41
C146	1	37.9	39.1	39.2	40.2	80.1	78.2	42	46
	2							41	43
	3							40	41
	A5	--	38.4	38.9	41.6	78.3	77.0	39	44
C147	1	44.8	45.1	45.5	45.6	74.5	73.0	17	20
	2							16	18
	A2	--	44.8	45.0	47.5	70.8	71.0	16	18
C148	1	44.9	45.2	45.5	47.0	70.7	68.3	16	19
	2							15	19
	3							14	19
	A5	--	45.6	45.3	46.0	71.9	71.6	14	27
C149	1	42.2	44.1	43.2	--	76.7	--	25	23
	2							22	22
	A2	--	42.4	43.9	--	74.4	--	22	23
C150	1	43.1	44.4	43.5	44.5	76.0	75.2	23	21
	2							22	22
	3							21	21
	A5	--	44.4	44.7	46.5	74.4	71.9	22	22
C151	1	44.6	44.4	45.3	46.7	73.6	70.8	17	19
	2							16	22
	A2	--	44.1	45.4	45.7	74.4	72.3	19	29

(Continued)

* New standard penetrometer adopted prior to test C124. Refer to paragraphs 19-22.

Test	Pass	Moisture Content % of Dry Weight: 0- to 1/4-in. Layer	0- to 1-in. Layer	0- to 6-in. Layer	6- to 12-in. Layer	Dry Density pcf: 0- to 6-in. Layer	6- to 12-in. Layer	Cone Index: 0- to 6-in. Layer	6- to 12-in. Layer
C152	1	44.6	46.0	45.7	45.8	71.0	70.3	15	19
	2							15	22
	3							16	22
	A5	--	45.4	46.4	43.9	70.5	72.3	15	32
C209	1	36.8	36.2	36.9	36.8	81.4	82.4	40	43
	2							38	41
	3							38	41
	A3	--	36.3	36.9	37.3	80.8	80.3	40	43
C210	1	--	36.2	36.5	--	82.7	--	46	43
	2							44	44
	3							43	47
	A3	--	35.2	36.3	37.1	82.4	80.9	46	45
C211	1	35.3	36.5	37.0	37.3	81.4	82.7	36	38
	2							40	41
	3							40	40
	A3	--	35.7	36.7	37.1	81.8	82.2	40	42
C212	1	34.8	35.9	36.3	37.2	82.3	81.8	40	39
	2							42	40
	3							43	42
	A3	--	35.2	36.3	36.8	82.3	80.7	46	43
C213	1	35.5	36.6	36.9	37.0	81.1	79.6	39	42
	2							38	40
	3							38	41
	A3	--	36.6	36.6	37.0	82.4	81.0	40	40
C214	1	35.6	36.7	36.5	37.1	82.2	80.9	41	41
	2							41	42
	3							42	40
	A3	--	36.2	36.4	37.0	82.3	81.8	42	43
C231	1	32.4	34.6	35.6	35.1	84.5	83.8	49	49
	2							56	54
	3							55	54
	A4	--	34.5	35.5	35.2	83.8	84.2	53	52
C232	1	31.6	34.2	34.9	35.1	85.4	84.8	51	50
	A1	--	34.0	34.5	34.5	84.6	85.5	57	52
C233	1	34.0	34.7	35.4	35.0	84.5	85.3	50	52
	2							57	60
	A2	--	33.6	35.1	35.6	85.3	86.0	55	58
C234	1	30.7	32.9	34.7	35.0	85.1	85.2	59	57
	A1	--	31.7	34.0	34.8	86.2	84.8	70	63
C235	1	36.7	37.2	37.6	39.6	80.9	78.7	32	30
	2							31	32
	3							33	30
	A5	--	36.9	38.1	39.7	81.2	77.5	33	32
C236	1	36.2	37.4	37.9	39.6	80.8	79.5	30	31
	2							35	33
	3							32	34
	A5	--	37.7	37.8	39.5	80.3	79.2	32	32
C237	1	36.5	36.9	37.8	39.3	80.9	79.0	32	30
	2							32	31
	3							35	30
	A5	--	37.8	37.4	39.6	80.8	78.0	31	33
C238	1	36.6	37.2	37.1	39.6	81.7	78.2	33	32
	2							37	33
	3							36	33
	A5	--	37.6	37.6	39.2	80.8	78.7	33	33
C249	1	36.4	37.0	37.4	39.3	81.3	78.8	33	33
	2							34	32
	3							33	32
	A5	--	38.3	38.2	39.3	79.6	78.2	32	32
C250	1	36.4	37.0	37.4	39.3	81.3	78.8	33	33
	2							34	32
	3							33	32
	A5	--	38.3	38.2	39.3	79.6	78.2	32	32
C251	1	36.4	36.8	37.0	39.1	81.5	78.8	35	33
	2							38	34
	3							38	34
	A5	--	37.6	38.1	39.3	79.8	78.2	37	34
C252	1	36.4	36.8	37.0	39.1	81.5	78.8	35	33
	2							38	34
	3							38	34
	A5	--	37.6	38.1	39.3	79.8	78.2	37	34
C253	1	32.1	36.2	37.6	38.4	80.6	80.8	35	37
	2							34	36
	3							34	39
	A5	--	35.8	37.5	38.3	81.9	80.3	35	38
C254	1	32.1	36.2	37.6	38.4	80.6	80.8	35	37
	2							34	36
	3							34	39
	A5	--	35.8	37.5	38.3	81.9	80.3	35	38
C255	1	35.2	36.0	36.9	37.5	82.0	81.0	35	37
	2							34	39
	3							33	39
	A5	--	35.1	36.9	38.1	82.4	81.4	39	42
	A10							40	40
	A15							42	43
	A20	--	33.7	37.3	38.1	81.1	81.4	46	49
C256	1	33.1	35.4	36.2	36.0	82.1	81.9	38	41
	2							40	43
	3							41	42
	A5	--	34.1	36.3	35.3	82.6	84.0	43	44
C257	1	35.7	35.9	36.1	35.9	82.1	83.1	44	45
	2							45	47
	3							41	45
	A5	--	35.7	36.8	36.3	81.8	82.6	43	48
C258	1	34.6	35.5	36.6	35.2	81.8	82.8	40	51
	2							45	52
	3							44	50
	A5	--	34.8	36.3	35.9	81.4	82.3	48	56
C259	1	34.8	36.2	36.3	35.6	81.6	82.4	42	49
	2							46	52
	3							39	51
	A5	--	35.9	35.6	35.8	83.4	83.5	44	53
C260	1	35.2	35.6	37.0	35.9	79.3	83.1	37	45
	2							37	43
	A2	--	--	--	--	--	--	36	44
C261	1	35.2	35.6	37.0	35.9	79.3	83.1	37	45
	2							37	43
	A2	--	--	--	--	--	--	36	44
C262	1	36.4	36.0	36.9	35.9	79.8	83.3	38	45
	2							38	47
	3							38	45
	A5	--	36.4	36.8	36.1	81.5	81.8	38	46
C263	1	36.4	36.0	36.9	35.9	79.8	83.3	38	45
	2							38	47
	3							38	45
	A5	--	36.4	36.8	36.1	81.5	81.8	38	46
C264	1	36.4	36.0	35.8	35.1	83.2	82.6	38	47
	2							39	47
	3							38	45
	A5	--	35.8	36.1	36.0	82.5	83.2	41	51
C265	1	36.7	36.0	35.9	35.9	82.7	83.0	38	43
	2							40	47
	3							43	49
	A5	--	35.0	36.1	35.7	82.0	83.6	43	51
C266	1	41.6	41.0	42.2	42.8	76.5	75.4	22	22
	2							21	22
	3							20	20
	A5	--	41.5	42.1	42.7	75.9	75.3	19	24
C267	1	--	37.2	36.7	36.1	82.3	81.5	41	49
	2							38	45
	3							39	47
	A5	--	36.6	36.9	35.6	81.4	83.0	39	46
C268	1	--	37.1	36.5	35.8	82.1	81.4	39	47
	2							39	47
	3							37	46
	A5	--	37.4	37.1	35.7	82.1	83.6	39	49

Table 3

9.00-14, 2-PR Smooth Tire, Towed Condition, All Pulls Negative

Clay

First Pass

Test	Test Type*	Deflection (% δ) %	Load (W) lb	Pull (P_t) lb	Sinkage (z) in.	Slip %	$\frac{P_t}{W}$	$\frac{W}{CI}$
C22	PS	15	240	18	0.44	0.2	0.075	12.63
C60	T	15	238	6	0.00	0.8	0.025	9.92
C92	PS	15	217	6	0.00	0.0	0.028	5.29
C18	PS	15	342	27	0.38	-0.1	0.079	17.10
C107	PS	15	344	15	0.00	-1.0	0.044	4.65
C14	PS	15	469	83	1.48	1.5	0.177	26.06
C29	PS	15	465	14	0.26	0.1	0.030	11.34
C48	PS	15	410	12	0.01	0.5	0.029	10.00
C50	PS	15	462	9	0.00	0.5	0.019	6.00
C51	PS	15	460	10	0.04	-1.1	0.022	5.82
C52	PS	15	443	12	0.00	0.1	0.027	10.55
C53	PS	15	436	10	0.03	0.6	0.023	10.38
C57	T	15	462	30	0.35	1.0	0.065	17.77
C70	PS	15	441	38	0.57	0.0	0.086	20.05
C97	PS	15	440	49	0.56	-1.7	0.111	18.33
C116	PS	15	454	14	0.23	-0.8	0.031	13.35
C117	PS	15	460	8	0.00	0.6	0.017	9.08
C142	PS	15	442	86	1.01	-0.9	0.195	26.00
C147	PS	15	439	82	1.05	-0.9	0.187	25.82
C150	PS	15	441	43	0.64	-1.1	0.098	19.17
C152	PS	15	428	80	1.35	-0.5	0.187	28.53
C235	PS	15	465	20	0.39	0.0	0.043	14.53
C99	PS	15	694	36	0.40	-1.0	0.052	15.09
C102	PS	15	648	122	1.21	0.2	0.188	29.46
C62	T	15	876	198	1.72	-2.2	0.226	35.04
C68	PS	15	890	175	1.81	0.0	0.197	37.08
C75	T	15	906	126	1.26	0.2	0.139	31.24
C78	T	15	884	185	1.73	-0.5	0.209	32.74
C100	PS	15	922	78	0.60	-2.0	0.085	19.62
C149	PS	15	868	178	1.46	-0.9	0.205	34.72
C151	PS	15	832	308	2.85	-0.8	0.370	48.94
C209	T	15	889	122	1.21	0.3	0.137	22.23
C237	PS	15	915	110	1.15	0.8	0.120	28.59
C16	PS	25	301	7	0.31	0.9	0.023	15.84
C12	PS	25	462	61	0.66	-1.8	0.132	25.67
C38	PS	25	445	14	0.10	-0.5	0.031	10.35
C43	PS	25	464	0	0.00	0.0	0.000	5.95
C44	PS	25	433	0	0.00	0.0	0.000	10.31
C63	PS	25	472	16	0.21	0.5	0.034	19.67
C87	PS	25	450	8	0.00	1.0	0.018	11.25
C109	PS	25	454	10	0.00	-0.5	0.022	6.14
C120	PS	25	460	19	0.13	-0.1	0.041	12.43
C121	PS	25	466	11	0.00	-0.9	0.024	9.91
C21	PS	25	653	241	2.49	-2.1	0.369	40.81
C77	T	25	669	64	0.75	-0.8	0.096	25.73
C79	T	25	671	39	0.49	0.4	0.058	21.65
C88	PS	25	662	17	0.12	-0.5	0.026	15.76
C89	PS	25	663	130	1.26	-2.0	0.196	31.57
C106	PS	25	678	20	0.00	-1.0	0.030	12.20
C58	T	25	903	109	1.02	-1.7	0.121	37.62
C67	PS	25	898	121	1.27	-1.5	0.135	39.04
C95	PS	25	924	34	0.00	0.0	0.037	18.48
C110	PS	25	888	19	0.00	-1.5	0.021	16.15
C122	PS	25	895	34	0.05	0.0	0.038	19.04
C146	PS	25	900	50	0.23	0.0	0.056	21.43
C232	PS	25	888	48	0.24	0.7	0.054	17.41
C234	PS	25	848	32	0.15	0.0	0.038	14.37
C66	PS	25	1316	348	2.30	-3.1	0.264	52.64
C23	PS	35	235	7	0.00	-1.3	0.030	13.06
C25	PS	35	221	11	0.14	-0.6	0.050	13.00
C61	T	35	235	8	0.00	2.6	0.034	10.22
C69	PS	35	222	5	0.00	-1.0	0.023	9.65
C85	PS	35	232	4	0.00	-1.5	0.017	11.60
C96	PS	35	248	3	0.00	0.0	0.012	5.17
C7	PS	35	461	32	0.00	1.0	0.069	25.61
C9	PS	35	488	28	0.41	0.0	0.057	32.53
C11	PS	35	468	26	0.54	-1.3	0.056	27.53
C13	PS	35	470	25	0.42	-0.8	0.053	29.38
C15	PS	35	458	25	0.13	-0.1	0.055	25.44
C17	PS	35	456	14	0.10	-1.8	0.031	24.00
C19	PS	35	468	23	0.48	0.5	0.049	29.25
C20	PS	35	466	23	0.22	0.0	0.049	24.53
C28	PS	35	465	16	0.02	-1.4	0.034	11.34
C41	PS	35	432	0	0.00	-2.0	0.000	9.60
C42	PS	35	465	10	0.03	-2.0	0.022	5.67
C45	PS	35	422	4	0.00	-2.0	0.009	10.05
C46	PS	35	456	5	0.05	0.3	0.011	5.70
C47	PS	35	459	8	0.00	0.5	0.017	6.12
C54	PS	35	483	12	0.02	-1.3	0.025	24.15
C55	PS	35	486	12	0.02	-0.4	0.025	20.25
C56	T	35	473	10	0.05	-1.6	0.021	18.92
C80	T	35	451	7	0.01	-0.6	0.016	14.55

First Pass (Continued)

Test	Test Type*	Deflection (% δ) %	Load (W) lb	Pull (P_t) lb	Sinkage (z) in.	Slip %	$\frac{P_t}{W}$	$\frac{W}{CI}$
C81	PS	35	456	12	0.00	0.0	0.026	11.12
C144	PS	35	466	15	0.00	-0.5	0.032	7.40
C145	PS	35	461	16	0.00	-0.2	0.035	10.98
C148	PS	35	446	43	0.41	-0.2	0.096	27.88
C231	PS	35	471	8	0.00	1.4	0.017	9.61
C233	PS	35	437	12	0.02	0.6	0.027	8.74
C236	PS	35	476	10	0.06	1.0	0.021	15.87
C24	PS	35	721	71	0.58	-0.5	0.098	37.95
C59	T	35	736	23	0.46	-1.8	0.031	29.44
C76	T	35	726	16	0.00	1.7	0.022	25.93
C86	PS	35	704	108	1.08	-3.6	0.153	33.52
C91	PS	35	715	27	0.00	-1.4	0.038	17.44
C34	PS	35	906	47	0.00	-4.7	0.052	21.57
C108	PS	35	888	19	0.00	-0.7	0.021	12.16
C118	PS	35	908	30	0.00	-0.3	0.033	18.16
C119	PS	35	882	52	0.28	-0.5	0.059	22.62
C213	T	35	884	60	0.48	-0.7	0.068	22.67
C238	PS	35	908	39	0.32	-0.5	0.043	27.52
C257	T	35	877	15	0.08	-1.7	0.017	19.93
C259	T	35	884	25	0.13	-1.5	0.028	21.05
C39	PS	35	1010	48	0.12	1.1	0.048	22.95
C64	T	35	1022	87	0.81	-1.7	0.085	40.88
C65	PS	35	1008	114	0.85	-4.1	0.113	42.00
C82	PS	35	1016	28	0.14	-0.3	0.028	23.09

Second Pass

Test	Test Type*	Deflection (% δ) %	Load (W) lb	Pull (P_t) lb	Sinkage (z) in.	Slip %	$\frac{P_t}{W}$	$\frac{W}{CI}$
C22	PS	15	238	22	0.70	0.6	0.092	14.00
C60	T	15	239	6	0.04	0.9	0.025	10.39
C92	PS	15	208	6	0.00	-1.0	0.029	5.07
C18	PS	15	348	23	0.54	0.2	0.066	19.33
C107	PS	15	343	16	0.00	-2.0	0.047	4.76
C14	PS	15	466	85	2.04	2.6	0.182	29.12
C29	PS	15	476	19	0.39	0.4	0.040	13.22
C48	PS	15	417	10	0.03	-0.5	0.024	10.42
C50	PS	15	467	8	0.02	-0.5	0.017	6.06
C51	PS	15	462	10	0.15	-0.4	0.022	6.24
C52	PS	15	435	11	0.10	-0.4	0.025	11.45
C53	PS	15	433	8	0.13	0.2	0.018	10.07
C57	T	15	466	31	0.59	0.9	0.067	18.64
C70	PS	15	440	34	0.86	0.0	0.077	20.95
C97	PS	15	442	49	0.87	0.0	0.111	19.22
C116	PS	15	450	13	0.37	-0.3	0.029	13.64
C117	PS	15	472	14	0.10	-0.2	0.030	8.91
C142	PS	15	438	91	1.56	0.1	0.208	29.20
C147	PS	15	433	77	1.45	0.4	0.178	27.06
C150	PS	15	440	37	0.97	-0.1	0.084	20.00
C152	PS	15	420	86	1.94	2.3	0.205	28.00
C235	PS	15	480	20	0.57	0.2	0.042	15.48
C99	PS	15	694	44	0.49	-1.5	0.063	15.09
C102	PS	15	640	111	1.69	-0.1	0.173	27.83
C62	T	15	876	191	2.18	0.5	0.218	38.09
C68	PS	15	886	160	2.44	0.0	0.181	36.92
C75	T	15	904	138	1.98	0.9	0.153	33.48
C78	T	15	886	174	2.54	1.6	0.196	35.08
C100	PS	15	915	58	0.77	1.42	0.063	19.47
C149	PS	15	852	178	2.35	0.2	0.209	38.73
C151	PS	15	798	292	4.33	0.6	0.366	49.88
C209	T	15	886	108	1.58	0.3	0.122	23.32
C237	PS	15	862	92	1.39	0.7	0.107	26.94
C16	PS	25	303	6	0.34	0.5	0.020	17.82
C12	PS	25	475	50	1.37	-0.3	0.105	27.94
C38	PS	25	435	19	0.05	0.1	0.044	11.45
C43	PS	25	470	6	0.00	-0.7	0.013	6.27
C44	PS	25	435	8	0.00	0.0	0.018	10.61
C63	PS	25	472	15	0.27	0.0	0.032	19.67
C87	PS	25	446	9	0.00	-2.0	0.020	11.74
C109	PS	25	449	15	0.00	0.0	0.033	6.24
C120	PS	25	440	22	0.09	-0.1	0.050	12.57
C121	PS	25	461	9	0.00	-0.3	0.020	9.60
C21	PS	25	645	261	3.84	-1.4	0.405	50.62
C77	T	25	668	77	1.25	-0.5	0.115	27.83
C79	T	25	663	39	0.78	0.2	0.059	22.86
C88	PS	25	662	25	0.00	-2.0	0.038	15.76
C89	PS	25	658	146	0.21	0.1	0.222	32.90
C106	PS	25	680	21	0.00	0.0	0.031	10.62

(Continued)

* T, towed test; PS, programed-slip test.

Test	Test Type	Deflection (% δ) %	Load (W) lb	Pull (P_t) lb	Sinkage (z) in.	Slip %	$\frac{P_t}{W}$	$\frac{W}{CI}$
				Second Pass (Continued)				
C58	T	25	900	125	1.66	-1.2	0.139	40.91
C67	PS	25	880	135	2.06	-0.7	0.153	40.00
C95	PS	25	901	30	0.00	0.0	0.033	18.77
C110	PS	25	880	12	0.00	0.5	0.014	14.19
C122	PS	25	888	28	0.13	0.1	0.032	18.89
C146	PS	25	892	52	0.39	0.0	0.058	21.76
C232	PS	25	--	--	--	--	--	--
C234	PS	25	--	--	--	--	--	--
C66	PS	25	1268	341	3.79	-2.4	0.269	55.13
C23	PS	35	--	--	--	--	--	--
C25	PS	35	228	11	0.09	-0.9	0.048	13.41
C61	T	35	233	8		-1.9	0.034	8.96
C69	PS	35	212	6	0.00	-2.7	0.028	8.83
C85	PS	35	237	8	0.00	-2.7	0.034	12.47
C96	PS	35	245	4	0.00	0.12	0.016	5.10
C7	PS	35	464	41	0.32	-1.3	0.088	25.78
C9	PS	35	472	35	0.76	-1.0	0.074	31.47
C11	PS	35	468	40	0.84	-1.1	0.085	31.20
C13	PS	35	473	31	0.45	-1.1	0.066	29.56
C15	PS	35	460	22	0.23	-0.8	0.048	28.75
C17	PS	35	462	24	0.14	-0.3	0.052	24.32
C19	PS	35	460	39	0.71	0.4	0.085	25.56
C20	PS	35	474	33	0.34	-0.9	0.070	29.63
C28	PS	35	470	15	0.12	0.1	0.032	12.37
C41	PS	35	433	8	0.00	0.5	0.018	11.19
C42	PS	35	465	8	0.00	-1.0	0.017	5.67
C45	PS	35	420	6	0.00	-1.0	0.014	10.24
C46	PS	35	462	4	0.04	0.5	0.009	6.00
C47	PS	35	464	4	0.00	0.5	0.009	6.63
C54	PS	35	490	8	0.03	-1.1	0.016	21.30
C55	PS	35	481	10	0.07	-0.9	0.021	20.91
C56	T	35	485	10	0.05	-0.8	0.021	20.21
C80	T	35	449	8	0.04	-0.7	0.018	14.03
C81	PS	35	458	8	0.00	-0.5	0.017	11.45
C144	PS	35	468	14	0.00	-0.1	0.030	7.31
C145	PS	35	460	17	0.00	-0.2	0.037	10.45
C148	PS	35	434	38	0.71	-0.2	0.088	28.93
C231	PS	35	462	6	0.00	0.5	0.013	8.25
C233	PS	35	432	13	0.04	1.6	0.030	7.58
C236	PS	35	472	12	0.10	0.7	0.025	13.49
C24	PS	35	722	101	1.26	-1.8	0.140	45.12
C59	T	35	737	26	0.60	-2.4	0.035	29.48
C76	T	35	718	19	0.08	-1.5	0.026	25.64
C86	PS	35	708	116	1.72	-5.3	0.164	33.71
C91	PS	35	723	30	0.00	-0.7	0.041	18.54
C34	PS	35	963	70	0.00	-3.1	0.073	24.08
C108	PS	35	--	--	--	--	--	--
C118	PS	35	--	--	--	--	--	--
C119	PS	35	886	40	0.50	-1.7	0.045	25.31
C213	T	35	882	65	0.74	-0.8	0.074	23.21
C238	PS	35	916	42	0.55	-1.6	0.046	24.76
C257	T	35	874	19	0.12	-0.9	0.022	19.42
C259	T	35	884	26	0.22	-1.0	0.029	19.22
C39	PS	35	1010	46	0.26	-1.8	0.046	25.90
C64	T	35	1099	104	1.24	-2.7	0.095	45.79
C65	PS	35	1000	146	1.71	-2.6	0.146	43.48
C82	PS	35	1024	38	0.20	-1.0	0.037	24.38
				Third Pass				
C22	PS	15	235	17	0.68	0.5	0.072	15.67
C60	T	15	233	6	0.06	0.8	0.026	9.32
C92	PS	15	218	6	0.00	-1.0	0.028	5.32
C18	PS	15	348	31	0.79	0.4	0.089	19.33
C107	PS	15	342	12	0.00	-0.5	0.035	4.38
C14	PS	15	461	87	2.34	2.3	0.189	27.12
C29	PS	15	478	16	0.40	0.9	0.033	12.26
C48	PS	15	410	10	0.10	-0.5	0.024	10.79
C50	PS	15	464	12	0.01	1.0	0.026	5.87
C51	PS	15	461	12	0.10	-0.1	0.026	5.55
C52	PS	15	424	8	0.20	-0.8	0.019	10.34
C53	PS	15	436	13	0.23	0.2	0.030	10.90
C57	T	15	466	30	0.71	1.2	0.064	19.42
C70	PS	15	442	58	0.97	0.0	0.086	21.05
C97	PS	15	443	58	1.19	0.0	0.131	19.26
C116	PS	15	452	17	0.42	-0.5	0.038	13.29
C117	PS	15	474	12	0.03	-0.9	0.025	10.30
C142	PS	15	420	92	1.88	0.1	0.219	26.25
C147	PS	15	--	--	--	--	--	--
C150	PS	15	434	42	1.5	-0.1	0.097	20.67
C152	PS	15	412	89	2.32	4.0	0.216	25.75
C235	PS	15	446	18	0.63	0.6	0.040	13.52
C99	PS	15	698	36	0.52	-1.0	0.052	15.51
C102	PS	15	637	106	2.30	3.4	0.166	28.95
				Third Pass (Continued)				
C62	T	15	876	197	2.84	1.4	0.225	41.71
C68	PS	15	880	175	2.97	2.5	0.199	36.67
C75	T	15	900	118	2.30	2.8	0.131	34.62
C78	T	15	870	172	3.17	3.2	0.198	32.22
C100	PS	15	916	76	0.88	-2.0	0.083	19.08
C149	PS	15	--	--	--	--	--	--
C151	PS	15	--	--	--	--	--	--
C209	T	15	892	102	1.88	1.3	0.114	23.47
C237	PS	15	873	98	1.76	1.4	0.112	24.94
C16	PS	25	307	12	0.44	0.9	0.039	18.06
C12	PS	25	471	80	1.51	-1.0	0.170	29.44
C38	PS	25	441	25	0.13	-1.4	0.057	11.03
C43	PS	25	--	--	--	--	--	--
C44	PS	25	431	5	0.00	1.0	0.012	10.78
C63	PS	25	473	16	0.54	-2.0	0.034	20.57
C87	PS	25	441	10	0.00	-1.5	0.023	11.61
C109	PS	25	451	14	0.00	0.6	0.031	6.01
C120	PS	25	442	18	0.14	1.1	0.041	11.63
[illegible]	PS	25	462	10	0.00	-0.6	0.022	9.62
C21	PS	25	--	--	--	--	--	--
C77	T	25	660	75	1.59	-0.8	0.114	26.40
C79	T	25	669	52	1.02	-0.3	0.078	23.89
C88	PS	25	658	15	0.27	-0.5	0.023	14.96
C89	PS	25	670	170	2.67	0.6	0.254	31.90
C106	PS	25	698	20	0.04	1.0	0.029	10.42
C58	T	25	889	135	2.20	-0.9	0.152	38.65
C67	PS	25	880	150	2.51	-1.5	0.170	40.00
C95	PS	25	912	40	0.09	0.0	0.044	19.83
C110	PS	25	880	18	0.00	1.0	0.020	14.92
C122	PS	25	--	--	--	--	--	--
C146	PS	25	900	50	0.47	-0.5	0.056	22.50
C232	PS	25	--	--	--	--	--	--
C234	PS	25	--	--	--	--	--	--
C66	PS	25	--	--	--	--	--	--
C23	PS	35	--	--	--	--	--	--
C25	PS	35	221	8	0.02	-1.4	0.036	13.00
C61	T	35	238	6	--	-3.0	0.025	9.52
C69	PS	35	221	6	0.00	-2.0	0.027	9.21
C85	PS	35	239	6	0.00	-0.5	0.025	11.95
C96	PS	35	--	--	--	--	--	--
C7	PS	35	468	37	0.46	-1.6	0.079	27.53
C9	PS	35	475	34	0.72	1.3	0.072	31.67
C11	PS	35	463	38	1.01	-1.2	0.082	30.87
C13	PS	35	466	40	0.56	0.5	0.086	31.07
C15	PS	35	460	24	0.28	-0.7	0.052	27.06
C17	PS	35	465	19	0.32	-0.5	0.041	25.83
C19	PS	35	462	65	0.71	-0.1	0.141	28.88
C20	PS	35	470	39	0.40	-1.2	0.083	26.11
C28	PS	35	478	14	0.15	0.0	0.029	12.26
C41	PS	35	429	8	0.00	0.0	0.019	10.21
C42	PS	35	466	7	0.00	0.5	0.015	5.83
C45	PS	35	422	4	0.00	-2.0	0.009	11.11
C46	PS	35	468	6	0.16	2.0	0.013	6.50
C47	PS	35	460	9	0.00	0.5	0.020	6.57
C54	PS	35	489	12	0.01	-0.5	0.025	22.23
C55	PS	35	--	--	--	--	--	--
C56	T	35	489	7	0.07	-0.5	0.014	20.38
C80	T	35	459	5	0.07	-1.1	0.011	14.34
C81	PS	35	450	8	0.00	0.3	0.018	10.98
C144	PS	35	448	21	0.00	0.0	0.047	7.11
C145	PS	35	453	16	0.00	-0.2	0.035	10.79
C148	PS	35	434	46	0.91	-0.7	0.106	31.00
C231	PS	35	458	10	0.00	1.0	0.022	8.33
C233	PS	35	--	--	--	--	--	--
C236	PS	35	466	19	0.13	1.2	0.041	14.56
C24	PS	35	713	123	1.94	-1.1	0.173	41.94
C59	T	35	738	31	0.70	-2.1	0.042	30.75
C76	T	35	726	20	0.18	-1.1	0.028	26.89
C86	PS	35	697	108	2.14	-2.0	0.155	30.30
C91	PS	35	714	23	0.00	1.7	0.032	18.31
C34	PS	35	968	47	0.09	-3.1	0.049	24.20
C108	PS	35	--	--	--	--	--	--
C118	PS	35	--	--	--	--	--	--
C119	PS	35	892	42	0.64	-0.2	0.047	22.87
C213	T	35	878	70	0.91	-1.1	0.080	22.51
C238	PS	35	892	43	0.60	-0.4	0.048	24.78
C257	T	35	882	22	0.24	-0.6	0.025	21.51
C259	T	35	885	24	0.20	-1.5	0.027	22.69
C39	PS	35	1004	49	0.32	-1.0	0.049	24.49
C64	T	35	1024	122	1.80	-2.9	0.119	44.52
C65	PS	35	988	151	2.33	-3.6	0.153	47.05
C82	PS	35	1020	38	0.21	-1.0	0.037	25.50

(Continued)

Table 3 (Continued)

Test	Test Type	Deflection (% δ) %	Load (W) lb	Pull (P_t) lb	Sinkage (z) in.	Slip %	$\frac{P_t}{W}$	$\frac{W}{CI}$
				Fourth Pass				
C22	PS	15	236	22	0.82	1.2	0.093	14.75
C60	T	15	236	5	0.14	0.5	0.021	9.08
C92	PS	15	220	5	0.00	-2.0	0.023	5.79
C18	PS	15	350	34	0.90	1.1	0.097	19.44
C107	PS	15	349	11	0.00	-1.5	0.032	4.78
C14	PS	15	--	--	--	--	--	--
C29	PS	15	482	12	0.39	0.5	0.025	12.68
C48	PS	15	406	9	0.10	-0.5	0.022	9.67
C50	PS	15	--		--	--	--	--
C51	PS	15	457	15	0.11	0.6	0.033	5.64
C52	PS	15	429	12	0.20	-0.2	0.028	11.00
C53	PS	15	--	--	--	--	--	--
C57	T	15	465	31	0.83	0.9	0.067	18.60
C70	PS	15	434	37	1.15	2.4	0.085	20.67
C97	PS	15	443	50	1.44	-0.5	0.113	20.14
C116	PS	15	448	18	0.54	-0.1	0.040	12.80
C117	PS	15	474	10	0.12	-1.0	0.021	10.09
C142	PS	15	421	96	2.24	1.7	0.228	24.76
C147	PS	15	--	--	--	--	--	--
C150	PS	15	435	43	1.20	1.2	0.099	20.71
C152	PS	15	396	85	2.67	4.7	0.215	26.40
C235	PS	15	458	22	0.65	0.9	0.048	13.88
C99	PS	15	692	32	0.61	0.0	0.046	15.73
C102	PS	15	--	--	--	--	--	--
C62	T	15	875	196	3.45	2.3	0.224	41.67
C68	PS	15	872	171	3.46	2.9	0.196	36.33
C75	T	15	900	136	2.67	2.0	0.151	34.33
C78	T	15	850	171	3.67	3.6	0.201	32.69
C100	PS	15	924	79	1.04	-0.3	0.085	20.09
C149	PS	15	--	--	--	--	--	--
C151	PS	15	--	--	--	--	--	--
C209	T	15	--	--	--	--	--	--
C237	PS	15	876	108	2.13	2.1	0.123	28.26
C16	PS	25	299	7	0.40	0.5	0.023	17.59
C12	PS	25	474	76	1.93	-0.7	0.160	26.33
C38	PS	25	446	22	0.06	-1.0	0.049	10.62
C43	PS	25	--	--	--	--	--	--
C44	PS	25	428	9	0.00	1.0	0.021	10.70
C63	PS	25	478	25	0.51	-0.7	0.052	19.12
C87	PS	25	439	10	0.00	-0.7	0.023	10.98
C109	PS	25	446	12	0.00	0.5	0.027	6.28
C120	PS	25	452	18	0.10	0.0	0.040	11.59
C121	PS	25	460	13	0.00	-0.1	0.028	9.79
C21	PS	25	--	--	--	--	--	--
C77	T	25	670	81	1.92	-0.5	0.121	27.92
C79	T	25	670	52	1.16	-1.5	0.078	23.93
C88	PS	25	663	22	0.32	-0.9	0.033	15.79
C89	PS	25	658	178	3.17	-1.4	0.271	28.61
C106	PS	25	694	14	0.00	-0.5	0.020	9.51
C58	T	25	880	142	2.69	-0.2	0.161	38.26
C67	PS	25	858	149	2.98	-2.0	0.174	39.00
C95	PS	25	910	24	0.09	0.0	0.026	19.78
C110	PS	25	888	18	0.00	-1.0	0.020	15.31
C122	PS	25	--	--	--	--	--	--
C146	PS	25	896	64	0.62	0.0	0.071	22.97
C232	PS	25	--	--	--	--	--	--
C234	PS	25	--	--	--	--	--	--
C66	PS	25	--	--	--	--	--	--
C23	PS	35	--	--	--	--	--	--
C25	PS	35	232	7	0.15	-1.3	0.030	13.65
C61	T	35	237	5		-3.1	0.021	9.88
C69	PS	35	215	8	0.00	-2.4	0.037	9.77
C85	PS	35	234	4	0.00	0.0	0.017	11.14
C96	PS	35	--	--	--	--	--	--
C7	PS	35	464	49	0.58	-1.3	0.106	29.00
C9	PS	35	485	40	0.86	0.8	0.082	30.31
C11	PS	35	462	44	1.17	-1.2	0.095	28.88
C13	PS	35	477	42	0.69	-1.4	0.088	29.81
C15	PS	35	465	28	0.22	0.1	0.060	25.83
C17	PS	35	--	--	--	--	--	--
C19	PS	35	465	64	1.49	0.8	0.138	29.06
C20	PS	35	499	49	0.57	0.4	0.098	31.19
C28	PS	35	470	12	0.07	-0.6	0.026	12.05
C41	PS	35	433	7	0.00	-0.5	0.016	9.84
C42	PS	35	466	4	0.00	-0.3	0.009	5.68
C45	PS	35	414	6	0.00	-1.7	0.014	10.35
C46	PS	35	460	9	0.13	2.4	0.020	6.22
C47	PS	35	458	5	0.00	0.5	0.011	6.54
C54	PS	35	484	18	0.00	-1.6	--	22.00
C55	PS	35	--	--	--	--	--	--
C56	T	35	484	10	0.06	-0.8	0.021	20.17
C80	T	35	444	5	0.12	-0.7	0.011	15.31
				Fourth Pass (Continued)				
C81	PS	35	456	6	0.00	-0.3	0.013	11.40
C144	PS	35	461	16	0.00	0.5	0.035	7.20
C145	PS	35	460	18	0.00	-0.2	0.039	11.50
C148	PS	35	438	53	1.14	-1.2	0.121	31.29
C231	PS	35	463	9	0.00	1.0	0.019	8.74
C233	PS	35	--	--	--	--	--	--
C236	PS	35	473	16	0.19	-0.7	0.034	14.78
C24	PS	35	--	--	--	--	--	--
C59	T	35	732	34	0.85	-2.1	0.046	31.83
C76	T	35	726	21	0.22	-1.9	0.029	27.92
C86	PS	35	--	--	--	--	--	--
C91	PS	35	718	33	0.00	-1.0	0.046	18.89
C34	PS	35	964	46	0.22	3.3	0.048	24.10
C108	PS	35	--	--	--	--	--	--
C118	PS	35	--	--	--	--	--	--
C119	PS	35	892	48	0.71	-0.2	0.054	22.87
C213	T	35	--	--	--	--	--	--
C238	PS	35	900	48	0.71	-2.2	0.053	26.47
C257	T	35	869	22	0.34	-0.5	0.025	20.21
C259	T	35	883	25	0.27	-1.0	0.028	20.07
C39	PS	35	1015	60	0.35	-2.3	0.059	25.38
C64	T	35	1013	120	2.21	-2.4	0.118	42.21
C65	PS	35	--	--	--	--	--	--
C82	PS	35	1020	36	0.25	-1.0	0.035	24.29
				Fifth Pass				
C22	PS	15	232	17	0.71	0.6	0.073	14.50
C60	T	15	241	4	0.16	0.6	0.017	9.27
C92	PS	15	218	4	0.00	1.0	0.018	5.74
C18	PS	15	--	--	--	--	--	--
C107	PS	15	343	16	0.00	-1.0	0.047	4.70
C14	PS	15	--	--	--	--	--	--
C29	PS	15	482	16	0.42	1.7	0.033	12.68
C48	PS	15	410	12	0.15	2.9	0.029	9.76
C50	PS	15	--	--	--	--	--	--
C51	PS	15	--	--	--	--	--	--
C52	PS	15	--	--	--	--	--	--
C53	PS	15	--	--	--	--	--	--
C57	T	15	466	27	0.92	1.4	0.058	18.64
C70	PS	15	435	38	1.24	2.9	0.087	20.71
C97	PS	15	450	56	1.69	1.0	0.124	20.45
C116	PS	15	444	19	0.61	-0.8	0.043	12.69
C117	PS	15	478	12	0.12	-0.3	0.025	10.17
C142	PS	15	402	92	2.57	3.3	0.229	23.65
C147	PS	15	--	--	--	--	--	--
C150	PS	15	433	48	1.37	1.6	0.111	19.68
C152	PS	15	401	79	2.95	3.9	0.197	26.73
C235	PS	15	485	20	0.75	0.0	0.041	14.70
C99	PS	15	695	40	0.65	-3.6	0.058	15.80
C102	PS	15	--	--	--	--	--	--
C62	T	15	855	183	4.02	2.7	0.214	40.71
C68	PS	15	848	168	3.75	4.8	0.198	35.33
C75	T	15	960	148	3.16	2.9	0.154	35.56
C78	T	15	844	174	4.24	3.2	0.206	32.46
C100	PS	15	927	74	1.15	0.5	0.080	20.15
C149	PS	15	--	--	--	--	--	--
C151	PS	15	--	--	--	--	--	--
C209	T	15	--	--	--	--	--	--
C237	PS	15	883	108	2.39	2.8	0.122	28.48
C16	PS	25	299	11	0.41	-1.0	0.037	17.59
C12	PS	25	--	--	--	--	--	--
C38	PS	25	445	22	0.14	-1.2	0.049	10.60
C43	PS	25	--	--	--	--	--	--
C44	PS	25	428	10	0.00	1.5	0.023	10.70
C63	PS	25	469	21	0.63	-0.5	0.045	18.76
C87	PS	25	448	10	0.07	-1.0	0.022	11.20
C109	PS	25	449	10	0.00	-0.5	0.022	6.31
C120	PS	25	444	20	0.22	-0.1	0.045	11.38
C121	PS	25	462	10	0.00	1.0	0.022	9.83
C21	PS	25	--	--	--	--	--	--
C77	T	25	654	79	2.17	1.1	0.121	27.25
C79	T	25	668	53	1.40	0.5	0.079	23.86
C88	PS	25	658	20	0.35	-0.3	0.030	15.67
C89	PS	25	--	--	--	--	--	--
C106	PS	25	668	18	0.01	0.0	0.027	9.15
C58	T	25	876	145	3.10	-0.1	0.166	38.09
C67	PS	25	846	141	3.41	-0.7	0.167	38.45
C95	PS	25	920	42	0.17	-0.5	0.046	20.00
C110	PS	25	887	16	0.00	0.0	0.018	15.29
C122	PS	25	--	--	--	--	--	--
C146	PS	25	900	57	0.73	-0.1	0.063	21.15
C232	PS	25	--	--	--	--	--	--
C234	PS	25	--	--	--	--	--	--

(Continued)

Table 3 (Concluded)

Test	Test Type	Deflection (% δ) %	Load (W) lb	Pull (P_t) lb	Sinkage (Z) in.	Slip %	$\frac{P_t}{W}$	$\frac{W}{CI}$
				Fifth Pass (Continued)				
C66	PS	25	--	--	--	--	--	--
C23	PS	35	--	--	--	--	--	--
C25	PS	35	230	16	0.11	-1.5	0.070	13.53
C61	T	35	235	8		-1.7	0.034	9.79
C69	PS	35	213	6	0.00	-3.6	0.028	9.68
C85	PS	35	237	6	0.00	-2.0	0.025	11.29
C96	PS	35	--	--	--	--	--	--
C7	PS	35	467	63	0.78	-0.9	0.135	29.19
C9	PS	35	478	42	1.05	-0.1	0.088	29.88
C11	PS	35	468	53	1.45	-1.0	0.113	29.25
C13	PS	35	483	44	0.86	-1.6	0.091	30.19
C15	PS	35	471	28	0.46	-1.6	0.059	26.17
C17	PS	35	470	20	0.31	-0.4	0.043	26.11
C19	PS	35	467	74	1.86	0.5	0.158	29.19
C20	PS	35	522	64	0.95	-1.1	0.123	32.62
C28	PS	35	485	17	0.03	-1.5	0.035	12.12
C41	Ps	35	--	--	--	--	--	--
C42	PS	35	471	5	0.00	1.5	0.011	5.74
C45	PS	35	438	6	0.00	2.0	0.014	10.95
C46	PS	35	472	4	0.13	0.0	0.008	6.38
C47	PS	35	461	6	0.00	0.3	0.013	6.59
C54	PS	35	493	20	0.08	0.0	0.041	22.41
C55	PS	35	--	--	--	--	--	--
C56	T	35	488	13	0.14	-1.6	0.027	20.33
C80	T	35	448	2	0.09	-1.6	0.004	15.45
C81	PS	35	462	6	0.00	1.0	0.013	11.55
C144	PS	35	462	22	0.00	-0.1	0.048	7.22
C145	PS	35	455	15	0.00	-0.2	0.033	11.38
C148	PS	35	424	49	1.20	-0.9	0.116	30.29
C231	PS	35	--	--	--	--	--	--
C233	PS	35	--	--	--	--	--	--
C236	PS	35	476	10	0.35	3.4	0.021	14.88

Test	Test Type	Deflection (% δ) %	Load (W) lb	Pull (P_t) lb	Sinkage (Z) in.	Slip %	$\frac{P_t}{W}$	$\frac{W}{CI}$
				Fifth Pass (Continued)				
C24	PS	35	--	--	--	--	--	--
C59	T	35	731	39	1.07	-2.4	0.053	31.78
C76	T	35	718	24	0.24	-1.4	0.033	27.62
C86	PS	35	--	--	--	--	--	--
C91	PS	35	716	18	0.03	-0.5	0.025	18.84
C34	PS	35	--	--	--	--	--	--
C108	PS	35	--	--	--	--	--	--
C118	PS	35	--	--	--	--	--	--
C119	PS	35	920	47	0.85	-0.1	0.051	23.59
C213	T	35	--	--	--	--	--	--
C238	PS	35	888	40	0.80	-0.4	0.045	26.12
C257	T	35	875	22	0.27	-1.8	0.025	20.35
C259	T	35	876	26	0.34	-1.5	0.030	19.91
C39	PS	35	1005	43	0.38	-1.6	0.043	25.13
C64	T	35	1005	132	2.66	-2.6	0.131	41.88
C65	PS	35	--	--	--	--	--	--
C82	PS	35	1020	54	0.36	0.0	0.053	24.29

Table 4

9.00-14, 2-PR Smooth Tire, Constant-Slip Test Conditions

Clay

Test	Nom. Slip	Deflection (% δ) %	Load (W) lb	Pull (P) lb	Torque (M) ft-lb	Sinkage (z) in.	Slip %	P/W	W/CI
				First Pass					
C26	0	35	449	13	28	0.13	1.9	0.029	24.94
C26	10	35	448	93	113	0.26	8.8	0.208	24.89
C27	20	35	445	71	95	0.26	19.8	0.156	23.42
C27	30	35	445	155	209	0.50	28.3	0.341	23.42
C30	0	35	713	-32	17	0.69	0.4	-0.045	37.53
C30	10	35	722	47	112	0.61	8.8	0.065	30.00
C31	20	35	710	95	184	0.09	16.9	0.134	37.37
C32	0	15	443	-78	-22	0.91	-0.2	-0.176	23.32
C32	10	15	445	42	111	1.10	10.0	0.094	23.42
C33	20	15	435	59	153	1.19	18.5	0.136	24.17
C36	0	25	671	-122	20	1.08	-0.6	-0.182	37.28
C36	10	25	671	-28	115	1.16	8.3	-0.042	37.28
C37	20	25	679	-85	188	2.29	20.0	-0.125	37.72
C37	30	25	665	-36	274	2.20	26.7	-0.054	36.94
C90	10	25	674	-95	83	1.43	7.4	-0.141	33.70
C90	20	25	679	28	180	1.27	16.0	0.041	33.95
C94	10	35	726	49	172	1.12	9.7	0.067	38.21
C94	20	35	722	-14	237	2.07	20.6	-0.019	38.00
C98	10	15	438	14	78	0.81	7.0	0.032	19.91
C98	20	15	435	65	150	0.87	19.7	0.149	19.77
C210	20	15	890	186	344	1.18	13.5	0.209	19.35
C212	20	25	896	288	467	1.12	19.7	0.321	22.40
C214	20	35	884	392	504	0.87	15.4	0.443	21.56
C255	20	35	876	368	450	0.65	15.8	0.420	25.03
C256	20	35	905	393	475	0.54	15.4	0.434	23.82
C258	20	35	877	429	523	0.54	19.3	0.489	21.92
C266	20	15	346	119	178	0.70	19.6	0.344	15.73
				Second Pass					
C26	0	35	447	-3	21	0.20	0.0	-0.007	24.83
C26	10	35	448	99	122	0.46	8.3	0.221	24.89
C27	20	35	449	115	149	0.56	19.1	0.256	23.63
C27	30	35	448	137	198	0.87	26.3	0.306	23.58
C30	0	35	710	-35	21	1.08	0.4	-0.049	39.44
C30	10	35	714	66	129	1.13	11.1	0.092	39.67
C31	20	35	709	113	213	0.90	21.0	0.159	37.32
C32	0	15	447	-73	-19	1.21	1.0	-0.163	24.83
C32	10	15	459	33	96	1.33	9.5	0.072	25.50
C33	20	15	445	64	160	1.55	19.3	0.144	23.42
C36	0	25	678	-126	22	1.84	-1.1	-0.186	37.67
C36	10	25	670	-40	98	1.73	7.4	-0.060	37.22
C37	20	25	661	-112	172	3.40	19.2	-0.169	38.88
C90	10	25	660	-123	74	2.20	7.1	-0.186	33.00
C90	20	25	673	-13	159	1.95	15.8	-0.019	33.65
C94	10	35	714	2	147	1.98	9.6	0.003	37.58
C94	20	35	714	-65	228	3.36	20.4	-0.091	37.58
C98	10	15	456	31	104	1.16	10.8	0.068	20.73
C98	20	15	452	71	156	1.16	19.7	0.157	20.55
C210	20	15	898	200	370	1.40	12.9	0.223	20.41
C212	20	25	892	313	480	1.45	19.2	0.351	21.24
C214	20	35	895	401	515	1.07	15.1	0.448	21.83
C255	20	35	881	372	469	0.82	16.1	0.422	25.91
C256	20	35	878	389	468	0.76	15.4	0.443	21.95
C258	20	35	882	420	517	0.67	20.0	0.476	19.60
C266	20	15	342	123	158	0.99	19.6	0.360	16.29
				Third Pass					
C26	0	35	451	-5	15	0.27	-0.4	-0.011	25.06
C26	10	35	452	101	128	0.51	8.5	0.223	25.11
C27	20	35	443	133	174	0.65	18.0	0.300	26.06
C27	30	35	445	136	216	0.97	27.5	0.306	26.18
C30	0	35	712	-60	10	1.42	0.4	0.084	41.88
C30	10	35	714	60	136	1.58	9.7	0.084	42.00
C31	20	35	714	92	215	1.57	21.0	0.129	42.00
C32	0	15	449	-62	0	1.46	3.0	-0.138	26.41
C32	10	15	473	6	75	1.60	8.8	0.013	27.82
C33	20	15	447	46	143	1.84	18.1	0.103	24.83
C36	0	25	676	-163	14	2.50	-0.3	-0.241	42.25
C36	10	25	673	-69	86	2.36	7.7	-0.103	42.06
C90	10	25	665	-161	84	2.93	9.3	-0.242	31.67
C90	20	25	677	-35	165	2.55	15.4	-0.052	32.24
C94	10	35	715	-25	135	2.63	10.5	-0.035	42.06
C98	10	15	451	22	100	1.38	12.1	0.049	21.48
C98	20	15	450	69	149	1.43	19.4	0.153	21.43
				Third Pass (Continued)					
C210	20	15	900	205	365	1.60	10.2	0.228	20.93
C212	20	25	884	329	487	1.65	18.7	0.372	20.56
C214	20	35	885	402	511	1.12	14.6	0.454	21.07
C255	20	35	882	375	466	0.90	16.6	0.425	26.73
C256	20	35	878	396	483	0.74	16.2	0.451	21.41
C258	20	35	865	419	514	0.59	20.0	0.484	19.66
C266	20	15	345	112	164	1.22	19.5	0.325	17.25
				Fourth Pass					
C26	0	35	460	-21	8	0.26	-0.3	-0.046	27.06
C26	10	35	457	95	126	0.50	7.4	0.208	26.88
C27	20	35	445	135	185	0.86	18.0	0.303	26.18
C27	30	35	438	135	215	1.26	27.1	0.308	25.76
C30	0	35	710	-75	4	1.91	1.0	-0.105	41.76
C30	10	35	702	82	170	1.96	14.6	0.117	41.29
C32	0	15	437	-79	-18	1.75	0.8	-0.181	24.28
C32	10	15	451	29	91	1.88	10.8	0.064	25.06
C33	20	15	436	38	153	2.15	19.2	0.087	25.65
C36	0	25	671	-165	10	3.23	0.6	-0.246	39.47
C36	10	25	675	-68	98	3.17	10.6	-0.101	39.71
C94	10	35	713	-28	136	3.30	9.7	-0.039	44.56
C98	10	15	451	19	97	1.70	11.4	0.042	20.50
C98	20	15	450	65	160	1.63	20.1	0.144	20.45
C255	20	35	884	376	460	0.96	16.6	0.425	24.56
C256	20	35	879	393	478	0.84	15.4	0.447	20.93
C258	20	35	861	418	512	0.75	20.4	0.485	18.72
C266	20	15	334	116	168	1.42	19.9	0.347	16.70
				Fifth Pass					
C26	0	35	452	-23	7	0.41	-0.2	-0.051	26.59
C26	10	35	456	95	131	0.81	8.3	0.208	26.82
C27	20	35	442	122	186	1.01	18.0	0.276	24.56
C30	0	35	708	-81	0	2.01	0.6	-0.114	41.65
C30	10	35	703	9	93	2.31	7.3	0.013	41.35
C32	0	15	453	-102	-28	1.88	0.6	-0.225	25.17
C32	10	15	462	8	83	2.04	10.0	0.017	25.67
C36	0	25	670	-165	15	3.93	2.7	-0.246	41.88
C36	10	25	677	-98	76	3.75	8.5	-0.145	42.31
C94	10	35	701	-27	135	3.71	9.8	-0.039	43.81
C98	10	15	452	0	83	1.89	11.4	0.000	21.52
C98	20	15	453	55	155	1.94	18.7	-0.121	21.57
C255	20	35	886	376	463	1.02	16.2	0.424	24.61
C256	20	35	884	392	474	0.93	14.9	0.443	21.05
C258	20	35	868	426	517	0.83	19.9	0.491	18.87
C266	20	15	339	121	178	1.39	20.0	0.357	16.95

Table 5

9.00-14, 2-PR Smooth Tire, 20 Percent Slip Condition

Clay

Test	Test Type*	Deflection (% δ) %	Load (W) lb	Pull (P_{20}) lb	Torque (M_{20}) ft-lb	Sinkage (z) in.	Slip %	$\frac{P_{20}}{W}$	$\frac{W}{CI}$
First Pass									
C22	PS	15	217	38	63	0.47	20.2	0.175	11.42
C92	PS	15	222	159	171	0.07	20.2	0.716	5.41
C18	PS	15	338	67	117	0.81	20.2	0.198	16.90
C107	PS	15	346	260	282	0.00	20.0	0.751	4.68
C266	CS	15	346	119	168	0.70	19.6	0.344	15.73
C14	PS	15	435	45	138	1.82	19.8	0.103	24.17
C29	PS	15	464	101	126	0.29	20.0	0.218	11.32
C33	CS	15	435	59	143	1.19	18.5	0.136	24.17
C48	PS	15	421	204	234	0.13	19.7	0.485	10.27
C50	PS	15	457	288	310	0.04	20.0	0.630	5.94
C51	PS	15	452	207	238	0.16	20.2	0.458	5.72
C52	PS	15	448	187	210	0.00	20.0	0.417	10.67
C53	PS	15	438	109	119	0.10	19.8	0.249	10.43
C70	PS	15	441	86	160	0.97	20.0	0.195	20.04
C97	PS	15	442	46	108	0.80	20.0	0.104	18.42
C98	CS	15	438	65	140	0.87	19.7	0.148	19.91
C111	PS	15	448	310	342	0.05	20.0	0.692	5.97
C116	PS	15	450	220	254	0.43	19.7	0.489	13.24
C117	PS	15	446	290	328	0.10	20.2	0.650	8.92
C142	PS	15	442	31	152	1.46	20.5	0.070	26.00
C147	PS	15	440	40	144	1.50	19.6	0.091	25.88
C150	PS	15	444	93	161	0.95	20.4	0.209	19.30
C152	PS	15	438	57	138	1.60	19.6	0.130	29.20
C235	PS	15	458	160	224	0.68	19.9	0.349	14.31
C99	PS	15	683	214	291	0.48	20.0	0.313	14.85
C102	PS	15	653	21	181	-.53	20.3	0.032	29.68
C68	PS	15	880	47	268	2.02	20.3	0.053	36.67
C100	PS	15	901	182	288	0.68	20.0	0.202	19.17
C149	PS	15	897	46	244	1.82	20.0	0.051	35.88
C151	PS	15	852	-142	234	3.67	20.3	-0.167	50.12
C237	PS	15	898	136	312	1.54	20.0	0.151	28.06
C16	PS	25	287	78	93	0.45	19.9	0.272	15.10
C12	PS	25	441	60	166	1.28	19.8	0.136	24.50
C38	PS	25	433	194	230	0.18	19.7	0.448	10.07
C43	PS	25	452	251	248	0.06	20.3	0.555	5.79
C44	PS	25	437	268	265	0.04	19.7	0.613	10.40
C63	PS	25	450	183	303	0.52	19.7	0.407	18.75
C87	PS	25	453	164	170	0.00	20.0	0.362	11.32
C109	PS	25	452	417	437	0.00	20.2	0.922	6.11
C120	PS	25	454	350	392	0.41	19.9	0.771	12.27
C121	PS	25	462	426	458	0.06	19.8	0.922	9.83
C21	PS	25	639	-135	186	2.86	20.4	-0.211	39.94
C37	CS	25	679	-85	178	2.29	20.0	-0.125	37.72
C88	PS	25	662	208	248	0.24	19.7	-0.314	15.76
C89	PS	25	660	27	163	1.39	19.9	-0.041	31.43
C106	PS	25	677	103	122	0.00	20.0	-0.154	9.15
C67	PS	25	879	118	288	1.71	20.0	0.134	38.22
C95	PS	25	902	386	453	0.08	20.4	0.428	18.04
C110	PS	25	900	400	460	0.08	19.8	0.444	16.36
C122	PS	25	--	--	--	--	--	--	--
C146	PS	25	880	248	344	0.52	19.7	0.282	20.95
C212	CS	25	896	288	457	1.12	19.7	0.321	22.40
C66	PS	25	1316	-230	370	3.43	20.0	-0.175	52.64
C23	PS	35	220	170	185	0.26	19.4	0.773	12.22
C25	PS	35	213	181	195	0.41	19.8	0.850	11.21
C69	PS	35	220	180	188	0.04	19.7	0.818	9.56
C85	PS	35	224	194	216	0.00	19.8	0.866	11.20
C96	PS	35	230	302	321	0.00	20.0	1.313	4.79
C7	PS	35	440	72	166	0.72	19.5	0.164	24.44
C9	PS	35	449	117	162	0.95	20.0	0.260	29.93
C11	PS	35	436	114	157	1.11	19.7	0.261	25.65
C13	PS	35	440	119	162	0.72	19.3	0.270	27.50
C15	PS	35	437	142	165	0.34	19.8	0.325	24.28
C17	PS	35	442	148	162	0.36	20.3	0.335	23.26
C19	PS	35	430	99	160	1.10	20.0	0.230	26.88
C20	PS	35	446	101	162	0.76	20.0	0.226	23.47
C27	CS	35	445	71	85	0.26	19.8	0.160	23.42
C28	PS	35	452	187	210	0.20	20.0	0.414	11.02
C41	PS	35	437	222	223	0.06	20.0	0.508	9.71
C42	PS	35	460	299	298	0.00	20.0	0.650	5.61
C45	PS	35	423	330	325	0.00	20.2	0.780	10.07
C46	PS	35	440	510	518	0.18	20.2	1.159	5.50
C47	PS	35	448	504	524	0.00	20.2	1.125	5.97
C54	PS	35	451	215	237	0.37	20.1	0.477	22.55
C55	PS	35	459	198	218	0.20	20.3	0.431	19.12
C81	PS	35	457	234	230	0.00	19.7	0.512	11.15
C144	PS	35	441	486	516	0.00	20.2	1.102	7.00
C145	PS	35	434	383	410	0.16	20.2	0.882	10.33
First Pass (Continued)									
C148	PS	35	444	114	173	0.74	20.1	0.257	27.75
C231	PS	35	472	483	510	0.00	20.0	1.023	9.63
C236	PS	35	475	343	374	0.51	20.3	0.722	15.83
C24	PS	35	700	106	202	1.25	20.7	0.151	36.84
C31	CS	35	710	95	174	0.09	16.9	0.134	37.37
C86	PS	35	708	52	178	0.98	20.4	0.073	33.71
C91	PS	35	719	346	400	0.15	20.0	0.481	17.54
C94	CS	35	722	-14	227	2.07	20.6	-0.019	38.00
C8	PS	35	870	-374	240	4.67	20.0	-0.430	51.18
C10	PS	35	895	-304	270	4.34	19.4	-0.340	52.65
C34	PS	35	900	128	201	0.00	20.0	0.142	21.43
C40	PS	35	868	315	343	0.00	19.7	0.363	19.73
C108	PS	35	892	451	493	0.00	20.1	0.506	12.22
C118	PS	35	876	530	610	0.27	19.8	0.605	17.52
C119	PS	35	882	446	541	0.28	19.7	0.506	22.62
C238	PS	35	876	314	406	0.75	20.5	0.358	26.54
C255	CS	35	876	368	440	0.65	15.8	0.420	25.03
C256	CS	35	905	393	465	0.54	15.4	0.434	23.82
C258	CS	35	877	429	513	0.54	19.3	0.489	21.92
C39	PS	35	1008	312	343	0.00	19.7	0.309	22.91
C65	PS	35	1008	62	216	1.26	20.0	0.062	42.00
C82	PS	35	1023	300	359	0.23	19.8	0.293	23.25
Second Pass									
C22	PS	15	219	40	71	0.70	20.3	0.183	12.88
C92	PS	15	211	161	172	0.11	20.0	0.763	5.15
C18	PS	15	339	63	118	1.22	20.0	0.186	18.83
C107	PS	15	344	245	262	0.00	20.0	0.712	4.78
C266	CS	15	342	123	148	0.99	19.6	0.360	16.28
C14	PS	15	435	49	143	2.40	20.2	0.113	27.19
C29	PS	15	470	101	119	0.42	20.4	0.215	13.06
C33	CS	15	445	64	150	1.55	19.3	0.144	23.42
C48	PS	15	420	206	228	0.22	20.0	0.490	10.50
C50	PS	15	460	313	338	0.14	20.0	0.680	5.97
C51	PS	15	455	247	270	0.12	20.5	0.543	6.15
C52	PS	15	435	180	209	0.29	20.4	0.414	11.45
C53	PS	15	440	164	187	0.19	19.8	0.373	10.23
C70	PS	15	444	90	148	1.09	20.3	0.203	21.14
C97	PS	15	445	56	114	1.12	20.2	0.126	19.35
C98	CS	15	452	71	146	1.16	19.7	0.157	20.54
C111	PS	15	450	320	341	0.02	20.0	0.711	6.72
C116	PS	15	447	216	259	0.56	19.4	0.483	13.54
C117	PS	15	456	286	324	0.29	20.0	0.627	8.60
C142	PS	15	440	30	152	1.96	19.8	0.068	29.33
C147	PS	15	--	--	--	--	--	--	--
C150	PS	15	450	102	153	1.28	19.9	0.227	20.45
C152	PS	15	430	49	138	2.08	19.5	0.112	28.67
C235	PS	15	478	188	231	0.95	19.8	0.393	15.42
C99	PS	15	686	232	298	0.67	20.0	0.338	14.91
C102	PS	15	651	38	168	2.06	20.1	0.058	28.30
C68	PS	15	884	43	240	2.63	20.0	0.049	36.83
C100	PS	15	900	205	298	0.88	19.9	0.228	19.15
C149	PS	15	862	44	228	2.95	20.4	0.051	39.18
C151	PS	15	829	-178	182	5.18	19.7	-0.215	51.81
C237	PS	15	868	162	302	1.93	19.8	0.187	27.12
C16	PS	25	291	73	93	0.55	19.7	0.251	17.12
C12	PS	25	435	63	157	2.00	20.1	0.145	25.59
C38	PS	25	437	157	204	0.22	20.4	0.359	11.50
C43	PS	25	466	278	292	0.08	20.3	0.596	6.21
C44	PS	25	442	243	246	0.06	20.3	0.550	10.78
C63	PS	25	455	180	285	0.59	20.3	0.396	18.96
C87	PS	25	458	175	186	0.00	19.8	0.382	12.05
C109	PS	25	454	417	440	0.00	20.3	0.918	6.30
C120	PS	25	439	342	380	0.41	20.0	0.779	12.54
C121	PS	25	456	422	450	0.06	19.8	0.925	9.50
C21	PS	25	--	--	--	--	--	--	--
C37	CS	25	661	-112	162	3.40	19.2	-0.169	38.88
C88	PS	25	664	200	250	0.39	20.0	0.301	15.81
C89	PS	25	654	6	168	2.10	20.2	0.009	32.70
C106	PS	25	678	167	202	0.00	20.0	0.246	10.59
C67	PS	25	880	114	276	2.41	20.0	0.130	40.00
C95	PS	25	892	342	410	0.23	20.0	0.383	18.58
C110	PS	25	881	396	426	0.10	19.8	0.449	14.21
C122	PS	25	890	414	498	0.46	19.5	0.465	18.94
C146	PS	25	872	240	336	0.74	19.6	0.275	21.27
C212	CS	25	892	313	470	1.45	19.2	0.351	21.24

(Continued)

* PS, programed-slip test; CS, constant-slip test.

Table 5 (Continued)

Test	Test Type	Deflection (% δ) %	Load (W) lb	Pull (P_{20}) lb	Torque (M_{20}) ft-lb	Sinkage (z) in.	Slip %	$\frac{P_{20}}{W}$	$\frac{W}{CI}$
Second Pass (Continued)									
C66	PS	25	--	--	--	--	--	--	--
C23	PS	35	--	--	--	--	--	--	--
C25	PS	35	217	158	176	0.40	20.1	0.728	12.76
C69	PS	35	210	146	151	0.00	19.7	0.695	8.75
C85	PS	35	229	169	182	0.00	20.3	0.738	12.05
C96	PS	35	225	285	297	0.00	20.0	1.267	4.69
C7	PS	35	434	58	154	1.18	19.5	0.134	18.08
C9	PS	35	440	104	184	1.44	20.1	0.236	29.33
C11	PS	35	442	98	155	1.62	19.4	0.222	29.47
C13	PS	35	449	103	167	0.97	19.5	0.229	28.06
C15	PS	35	444	123	161	0.61	19.8	0.277	27.75
C17	PS	35	447	140	175	0.53	20.1	0.313	23.53
C19	PS	35	424	36	138	1.78	19.8	0.085	23.56
C20	PS	35	450	56	140	1.19	20.0	0.124	28.12
C27	CS	35	449	115	139	0.56	19.1	0.256	23.63
C28	PS	35	460	177	193	0.13	20.5	0.385	12.10
C41	PS	35	434	262	263	0.01	20.0	0.604	10.33
C42	PS	35	456	365	360	0.00	20.6	0.800	5.56
C45	PS	35	419	296	300	0.00	20.0	0.706	10.22
C46	PS	35	442	536	554	0.17	20.0	1.213	5.74
C47	PS	35	444	502	503	0.00	19.7	1.131	6.34
C54	PS	35	461	209	216	0.55	20.1	0.453	20.04
C55	PS	35	458	197	221	0.25	19.5	0.430	19.91
C81	PS	35	454	254	256	0.00	20.0	0.559	11.35
C144	PS	35	445	471	497	0.00	19.9	1.058	6.95
C145	PS	35	436	338	370	0.00	19.9	0.775	9.91
C148	PS	35	436	93	158	1.09	19.8	0.213	29.07
C231	PS	35	469	473	520	0.00	20.0	1.008	8.38
C236	PS	35	471	315	354	0.47	19.7	0.669	13.46
C24	PS	35	713	44	186	1.81	20.0	0.062	44.56
C31	CS	35	709	113	203	0.90	21.0	0.159	37.32
C86	PS	35	718	28	168	1.72	20.0	0.039	34.19
C91	PS	35	726	336	382	0.28	20.0	0.463	18.62
C94	CS	35	714	-65	218	3.36	20.4	-0.091	42.00
C8	PS	35	864	-509	274	5.49	20.3	-0.589	57.60
C10	PS	35	--	--	--	--	--	--	--
C34	PS	35	928	142	213	0.03	19.7	0.153	23.20
C40	PS	35	876	336	378	0.14	19.4	0.384	20.37
C108	PS	35	--	--	--	--	--	--	--
C118	PS	35	--	--	--	--	--	--	--
C119	PS	35	884	468	552	0.92	19.8	0.529	25.26
C238	PS	35	882	294	380	1.00	20.2	0.333	23.84
C255	CS	35	881	372	459	0.82	16.1	0.422	25.91
C256	CS	35	878	389	458	0.76	15.4	0.443	21.95
C258	CS	35	882	420	507	0.67	20.0	0.476	19.60
C39	PS	35	996	281	353	0.56	19.5	0.282	25.54
C65	PS	35	1016	24	248	2.29	20.0	0.024	44.52
C82	PS	35	1024	300	366	0.43	20.2	0.293	24.38
Third Pass									
C22	PS	15	228	54	81	0.91	20.0	0.237	15.20
C92	PS	15	219	165	175	0.11	19.7	0.753	--
C18	PS	15	336	69	120	1.34	20.3	0.205	18.67
C107	PS	15	343	239	276	0.00	20.4	0.697	8.36
C266	CS	15	345	112	154	1.22	19.5	0.325	17.25
C14	PS	15	446	48	147	2.69	20.4	0.108	26.24
C29	PS	15	467	108	133	0.47	20.4	0.231	11.97
C33	CS	15	447	46	133	1.84	18.1	0.103	24.83
C48	PS	15	409	210	242	0.26	20.2	0.513	10.76
C50	PS	15	444	358	372	0.13	20.0	0.806	5.62
C51	PS	15	461	270	282	0.18	19.7	0.586	5.55
C52	PS	15	428	186	221	0.40	20.4	0.434	10.44
C53	PS	15	440	184	209	0.35	19.5	0.418	11.00
C70	PS	15	439	96	144	1.31	20.3	0.219	20.90
C97	PS	15	442	52	118	1.39	20.3	0.118	19.22
C98	CS	15	450	69	149	1.43	19.4	0.153	21.43
C111	PS	15	447	304	334	0.06	19.7	0.680	6.30
C116	PS	15	441	230	262	0.63	20.4	0.522	12.97
C117	PS	15	458	290	339	0.16	20.1	0.633	9.96
C142	PS	15	420	32	144	2.30	20.4	0.076	26.25
C147	PS	15	--	--	--	--	--	--	--
C150	PS	15	434	102	166	1.31	20.3	0.235	20.67
C152	PS	15	436	47	133	2.49	19.7	0.108	27.25
C235	PS	15	450	188	236	1.08	19.7	0.418	13.64
C99	PS	15	688	238	310	0.76	20.0	0.346	15.29
C102	PS	15	639	34	154	2.53	20.1	0.053	29.04
C68	PS	15	871	16	210	3.20	19.8	0.018	36.29
C100	PS	15	900	212	306	1.07	20.0	0.236	18.75
C149	PS	15	--	--	--	--	--	--	--
C151	PS	15	--	--	--	--	--	--	--
C237	PS	15	871	170	310	2.32	20.4	0.195	24.88
Third Pass (Continued)									
C16	PS	25	289	83	108	0.87	19.9	0.287	17.00
C12	PS	25	439	61	164	2.36	19.8	0.139	27.44
C38	PS	25	432	175	218	0.25	20.0	0.405	10.80
C43	PS	25	--	--	--	--	--	--	--
C44	PS	25	433	241	250	0.10	19.7	0.556	10.82
C63	PS	25	456	177	284	0.75	20.0	0.388	19.83
C87	PS	25	451	182	192	0.03	20.3	0.404	11.87
C109	PS	25	458	411	435	0.00	20.2	0.897	6.11
C120	PS	25	441	346	381	0.46	20.2	0.784	11.60
C121	PS	25	454	410	440	0.04	19.8	0.903	9.46
C21	PS	25	--	--	--	--	--	--	--
C37	CS	25	--	--	--	--	--	--	--
C88	PS	25	659	226	264	0.50	19.8	0.343	14.98
C89	PS	25	664	-16	172	2.66	19.8	-0.024	31.62
C106	PS	25	690	216	260	0.01	20.0	0.313	10.30
C67	PS	25	875	101	274	2.97	20.2	0.115	39.77
C95	PS	25	900	352	432	0.26	19.8	0.391	19.56
C110	PS	25	892	390	423	0.10	19.8	0.437	--
C122	PS	25	--	--	--	--	--	--	--
C146	PS	25	880	244	338	0.95	20.0	0.277	15.12
C212	CS	25	884	329	477	1.65	18.7	0.372	20.56
C66	PS	25	--	--	--	--	--	--	--
C23	PS	35	--	--	--	--	--	--	--
C25	PS	35	217	163	178	0.33	20.8	0.751	12.76
C69	PS	35	218	162	165	0.00	20.0	0.743	9.08
C85	PS	35	226	164	164	0.00	19.7	0.726	11.30
C96	PS	35	--	--	--	--	--	--	--
C7	PS	35	436	65	157	1.64	20.5	0.149	25.65
C9	PS	35	448	89	174	1.80	20.2	0.199	29.87
C11	PS	35	432	94	160	2.13	20.7	0.218	28.80
C13	PS	35	441	95	166	1.67	19.8	0.215	29.40
C15	PS	35	435	117	165	0.84	20.0	0.269	25.59
C17	PS	35	450	138	186	0.93	20.1	0.307	25.00
C19	PS	35	410	33	137	2.33	20.3	0.080	25.62
C20	PS	35	453	33	141	1.51	20.1	0.073	25.17
C27	CS	35	443	133	164	0.65	18.0	0.300	26.06
C28	PS	35	461	175	193	0.05	20.3	0.380	11.82
C41	PS	35	436	288	290	0.09	20.4	0.660	10.38
C42	PS	35	461	370	386	0.01	20.3	0.803	5.76
C45	PS	35	421	312	309	0.00	20.0	0.741	11.08
C46	PS	35	458	524	544	0.28	20.4	1.144	6.36
C47	PS	35	424	520	550	0.02	20.0	1.226	6.06
C54	PS	35	459	189	216	0.52	20.1	0.412	20.86
C55	PS	35	--	--	--	--	--	--	--
C81	PS	35	454	277	282	0.00	20.0	0.610	11.07
C144	PS	35	434	465	504	0.00	20.2	1.071	6.89
C145	PS	35	433	333	359	0.03	20.3	0.769	10.31
C148	PS	35	438	92	149	1.51	20.0	0.210	31.28
C231	PS	35	--	--	--	--	--	--	--
C236	PS	35	466	320	352	0.40	20.4	0.687	14.56
C24	PS	35	706	35	180	2.88	20.3	0.050	41.53
C31	CS	35	714	92	205	1.57	21.0	0.129	42.00
C86	PS	35	704	48	178	2.15	20.4	0.068	30.61
C91	PS	35	714	335	378	0.25	20.0	0.469	18.31
C94	CS	35	--	--	--	--	--	--	--
C8	PS	35	--	--	--	--	--	--	--
C10	PS	35	--	--	--	--	--	--	--
C34	PS	35	949	155	221	0.14	19.7	0.163	23.72
C40	PS	35	856	338	386	0.24	19.7	0.395	20.38
C108	PS	35	--	--	--	--	--	--	--
C118	PS	35	--	--	--	--	--	--	--
C119	PS	35	872	486	568	1.04	20.0	0.557	22.36
C238	PS	35	868	288	376	1.23	20.3	0.332	24.11
C255	CS	35	882	375	456	0.90	16.6	0.425	26.73
C256	CS	35	878	396	473	0.74	16.2	0.451	21.41
C258	CS	35	865	419	504	0.59	20.0	0.484	19.66
C39	PS	35	990	285	362	0.61	19.7	0.288	24.15
C65	PS	35	995	16	240	3.22	20.0	0.016	66.33
C82	PS	35	1016	310	381	0.54	19.8	0.305	25.40
Fourth Pass									
C22	PS	15	227	57	105	1.28	20.4	0.251	14.19
C92	PS	15	221	175	184	0.10	19.8	0.792	5.82
C18	PS	15	336	73	131	1.56	20.7	0.217	18.67
C107	PS	15	351	246	274	0.03	19.4	0.701	4.68
C266	CS	15	334	116	158	1.42	19.9	0.347	16.70

(Continued)

Table 5 (Continued)

Test	Test Type	Deflection (% δ) %	Load (W) lb	Pull (P_{20}) lb	Torque (M_{20}) ft-lb	Sinkage (z) in.	Slip %	$\frac{P_{20}}{W}$	$\frac{W}{CI}$
				Fourth Pass (Continued)					
C14	PS	15	--	--	--	--	--	--	--
C29	PS	15	473	120	142	0.42	20.4	0.254	12.45
C33	CS	15	436	38	143	2.15	19.2	0.087	24.22
C48	PS	15	409	209	252	0.30	20.0	0.511	10.22
C50	PS	15	--	--	--	--	--	--	--
C51	PS	15	453	259	286	0.26	20.7	0.572	5.52
C52	PS	15	428	192	223	0.46	20.2	0.448	10.70
C53	PS	15	--	--	--	--	--	--	--
C70	PS	15	440	94	150	1.58	19.6	0.214	22.00
C97	PS	15	442	55	115	1.59	19.7	0.124	20.09
C98	CS	15	450	65	150	1.63	20.1	0.144	21.43
C111	PS	15	446	309	342	0.02	20.0	0.693	6.03
C116	PS	15	440	241	276	0.73	19.6	0.548	12.94
C117	PS	15	458	301	337	0.26	20.3	0.657	9.96
C142	PS	15	426	31	144	2.74	20.3	0.073	26.62
C147	PS	15	--	--	--	--	--	--	--
C150	PS	15	441	104	156	1.56	19.9	0.236	20.04
C152	PS	15	420	43	132	2.81	19.8	0.102	26.25
C235	PS	15	460	186	240	1.09	19.8	0.404	13.94
C99	PS	15	678	262	327	0.83	20.0	0.386	15.41
C102	PS	15	--	--	--	--	--	--	--
C68	PS	15	864	26	220	3.80	20.0	0.030	36.00
C100	SS	15	900	226	329	1.25	20.6	0.251	19.15
C149	PS	15	--	--	--	--	--	--	--
C151	PS	15	--	--	--	--	--	--	--
C237	PS	15	872	158	296	2.63	19.5	0.180	26.42
C16	PS	25	275	85	109	0.77	19.9	0.309	17.19
C12	PS	25	435	52	166	2.37	19.7	0.120	25.59
C38	PS	25	440	185	223	0.40	20.3	0.420	10.73
C43	PS	25	--	--	--	--	--	--	--
C44	PS	25	429	242	248	0.15	19.7	0.564	10.72
C63	PS	25	458	198	301	0.87	19.7	0.432	19.08
C87	PS	25	446	181	194	0.04	20.0	0.406	11.44
C109	PS	25	453	430	451	0.00	20.2	0.949	6.12
C120	PS	25	446	362	396	0.46	20.2	0.812	11.74
C121	PS	25	450	402	434	0.00	20.0	0.893	9.38
C21	PS	25	--	--	--	--	--	--	--
C37	CS	25	--	--	--	--	--	--	--
C88	PS	25	663	232	278	0.58	19.7	0.350	15.42
C89	PS	25	662	-22	183	3.11	19.8	-0.033	30.01
C106	PS	25	686	241	292	0.00	20.0	0.351	9.80
C67	PS	25	863	83	266	3.49	20.0	0.096	39.23
C95	PS	25	893	363	449	0.36	20.2	0.406	19.41
C110	PS	25	888	370	429	0.07	19.7	0.417	15.31
C122	PS	25	--	--	--	--	--	--	--
C146	PS	25	876	252	354	1.22	20.0	0.288	21.90
C212	CS	25	--	--	--	--	--	--	--
C66	PS	25	--	--	--	--	--	--	--
C23	PS	35	--	--	--	--	--	--	--
C25	PS	35	220	163	175	0.38	20.3	0.741	12.22
C69	PS	35	210	162	165	0.00	19.7	0.771	9.54
C85	PS	35	224	162	162	0.00	20.3	0.723	11.20
C96	PS	35	--	--	--	--	--	--	--
C7	PS	35	424	60	171	1.96	20.1	0.142	26.50
C9	PS	35	435	70	182	2.21	20.0	0.161	29.00
C11	PS	35	435	83	158	2.53	20.2	0.191	27.19
C13	PS	35	441	93	176	1.76	20.2	0.211	29.40
C15	PS	35	434	117	166	1.13	19.9	0.270	24.11
C17	PS	35	461	136	--	1.18	19.8	0.295	27.12
C19	PS	35	423	24	115	3.24	20.0	0.057	26.44
C20	PS	35	462	18	126	1.92	20.1	0.039	25.67
C27	CS	35	445	135	175	0.86	18.0	0.303	24.72
C28	PS	35	461	184	193	0.10	20.0	0.399	11.52
C41	PS	35	434	296	299	0.10	20.2	0.682	10.33
C42	PS	35	456	396	389	0.00	20.0	0.868	5.70
C45	PS	35	416	336	333	0.00	20.2	0.808	10.67
C46	PS	35	444	526	528	0.24	20.0	1.185	6.00
C47	PS	35	444	530	552	0.05	20.0	1.194	6.34
C54	PS	35	456	188	209	0.50	19.8	0.412	20.73
C55	PS	35	--	--	--	--	--	--	--
C81	PS	35	455	289	291	0.00	19.8	0.635	11.38
C144	PS	35	445	458	495	0.00	20.2	1.029	6.95
C145	PS	35	446	330	360	0.07	19.9	0.740	10.88
C148	PS	35	436	86	148	1.86	19.9	0.197	31.14
C231	PS	35	--	--	--	--	--	--	--
C236	PS	35	480	312	346	0.58	20.2	0.650	14.12
C24	PS	35	--	--	--	--	--	--	--
C31	CS	35	--	--	--	--	--	--	--
C86	PS	35	--	--	--	--	--	--	--
C91	PS	35	718	336	386	0.28	19.8	0.468	18.89
C94	CS	35	--	--	--	--	--	--	--
C8	PS	35	--	--	--	--	--	--	--
C10	PS	35	--	--	--	--	--	--	--
C34	PS	35	928	157	230	0.45	19.7	0.169	23.20
C40	PS	35	872	370	400	0.33	20.0	0.424	20.28
C108	PS	35	--	--	--	--	--	--	--
C118	PS	35	--	--	--	--	--	--	--
C119	PS	35	883	464	545	1.13	20.0	0.525	23.86
C238	PS	35	880	283	378	1.43	19.8	0.322	25.14
C255	CS	35	884	376	450	0.96	16.6	0.425	24.56
C256	CS	35	879	393	468	0.84	15.4	0.447	20.93
C258	CS	35	861	418	502	0.75	20.4	0.485	18.72
C39	PS	35	1000	293	390	0.78	20.0	0.293	24.39
C65	PS	35	--	--	--	--	--	--	--
C82	PS	35	1012	311	377	0.47	20.0	0.307	24.58
				Fifth Pass					
C22	PS	15	221	65	99	1.23	19.7	0.294	13.81
C92	PS	15	220	172	183	0.09	20.0	0.782	5.79
C18	PS	15	--	--	--	--	--	--	--
C107	PS	15	343	234	264	0.00	19.4	0.682	4.57
C266	CS	15	339	121	168	1.39	20.0	0.357	16.95
C14	PS	15	--	--	--	--	--	--	--
C29	PS	15	466	130	150	0.54	20.4	0.279	12.26
C33	CS	15	--	--	--	--	--	--	--
C48	PS	15	415	213	235	0.40	20.0	0.513	10.38
C50	PS	15	--	--	--	--	--	--	--
C51	PS	15	--	--	--	--	--	--	--
C52	PS	15	--	--	--	--	--	--	--
C53	PS	15	--	--	--	--	--	--	--
C70	PS	15	436	98	150	1.74	19.7	0.225	21.80
C97	PS	15	448	54	118	1.85	20.0	0.120	20.36
C98	CS	15	453	55	145	1.94	18.7	0.121	21.57
C111	PS	15	450	310	336	0.03	20.0	0.689	6.08
C116	PS	15	444	241	281	0.73	20.1	-0.543	13.06
C117	PS	15	462	306	338	0.26	20.2	0.662	10.04
C142	PS	15	416	25	136	3.13	20.2	0.060	26.00
C147	PS	15	--	--	--	--	--	--	--
C150	PS	15	439	98	152	1.72	19.7	0.223	19.95
C152	PS	15	428	41	132	3.17	20.3	0.096	26.75
C235	PS	15	484	210	256	1.28	19.7	0.434	14.67
C99	PS	15	680	261	336	1.00	20.0	0.384	15.45
C102	PS	15	--	--	--	--	--	--	--
C68	PS	15	855	0	191	4.12	19.6	0.000	35.62
C100	PS	15	902	236	329	1.31	20.4	0.262	19.19
C149	PS	15	--	--	--	--	--	--	--
C151	PS	15	--	--	--	--	--	--	--
C237	PS	15	872	168	308	2.97	20.3	0.193	26.42
C16	PS	25	283	95	118	0.93	20.1	0.336	17.69
C12	PS	25	--	--	--	--	--	--	--
C38	PS	25	438	178	234	0.28	19.6	0.406	10.68
C43	PS	25	--	--	--	--	--	--	--
C44	PS	25	428	252	252	0.17	19.7	0.589	10.70
C63	PS	25	450	209	300	1.00	20.3	0.464	18.75
C87	PS	25	454	175	196	0.10	20.3	0.385	11.64
C109	PS	25	454	442	458	0.00	19.9	0.974	6.14
C120	PS	25	442	360	382	0.47	20.2	0.814	11.63
C121	PS	25	458	395	425	0.00	19.8	0.862	9.54
C21	PS	25	--	--	--	--	--	--	--
C37	CS	25	--	--	--	--	--	--	--
C88	PS	25	649	230	276	0.58	20.0	0.354	15.09
C89	PS	25	--	--	--	--	--	--	--
C106	PS	25	662	246	300	0.07	20.3	0.372	9.46
C67	PS	25	848	86	258	3.95	20.0	0.101	38.54
C95	PS	25	900	380	458	0.52	20.0	0.422	19.56
C110	PS	25	895	401	446	0.00	20.0	0.448	15.43
C122	PS	25	--	--	--	--	--	--	--
C146	PS	25	872	256	351	1.33	20.0	0.294	21.80
C212	CS	25	--	--	--	--	--	--	--
C66	PS	25	--	--	--	--	--	--	--
C23	PS	35	--	--	--	--	--	--	--
C25	PS	35	224	157	170	0.38	19.8	0.701	12.44
C69	PS	35	209	160	165	0.02	20.2	0.766	9.50
C85	PS	35	218	162	168	0.18	20.0	0.743	10.90
C96	PS	35	--	--	--	--	--	--	--

(Continued)

Table 5 (Concluded)

Test	Test Type	Deflection (% δ) %	Load (W) lb	Pull (P_{20}) lb	Torque (M_{20}) ft-lb	Sinkage (z) in.	Slip %	$\frac{P_{20}}{W}$	$\frac{W}{CI}$
				Fifth Pass (Continued)					
C7	PS	35	424	35	170	2.19	19.8	0.082	26.50
C9	PS	35	422	58	171	2.53	20.2	0.137	28.13
C11	PS	35	445	75	168	2.84	19.8	0.168	27.81
C13	PS	35	447	87	166	2.38	19.6	0.195	29.80
C15	PS	35	--	--	--	--	--	--	--
C17	PS	35	445	135	188	1.10	19.8	0.303	26.18
C19	PS	35	413	19	115	3.66	19.8	0.046	25.81
C20	PS	35	466	5	128	3.49	20.1	0.011	25.89
C27	CS	35	442	122	176	1.01	18.0	0.276	24.56
C28	PS	35	468	190	201	0.04	19.8	0.406	11.70
C41	PS	35	--	--	--	--	--	--	--
C42	PS	35	464	408	412	0.00	20.0	0.879	5.80
C45	PS	35	433	336	333	0.07	20.0	0.776	11.10
C46	PS	35	448	531	538	0.32	20.0	1.185	6.05
C47	PS	35	436	528	538	0.00	20.0	1.211	6.23
C54	PS	35	452	192	203	0.87	19.6	0.425	20.54
C55	PS	35	--	--	--	--	--	--	--
C81	PS	35	453	286	292	0.00	20.3	0.631	11.32
C144	PS	35	452	462	492	0.00	20.2	1.022	7.06
C145	PS	35	443	336	354	0.06	20.2	0.758	10.80
C148	PS	35	430	83	158	1.99	20.0	0.193	30.71
C231	PS	35	--	--	--	--	--	--	--
C236	PS	35	478	326	351	0.61	20.5	0.682	14.06
C24	PS	35	--	--	--	--	--	--	--
C31	CS	35	--	--	--	--	--	--	--
C86	PS	35	--	--	--	--	--	--	--
C91	PS	35	716	349	394	0.26	20.3	0.487	18.84
C94	CS	35	--	--	--	--	--	--	--
C8	PS	35	--	--	--	--	--	--	--
C10	PS	35	--	--	--	--	--	--	--
C34	PS	35	--	--	--	--	--	--	--
C40	PS	35	864	373	408	0.32	19.7	0.432	20.01
C108	PS	35	--	--	--	--	--	--	--
C118	PS	35	--	--	--	--	--	--	--
C119	PS	35	912	468	571	1.22	20.3	0.513	24.65
C238	PS	35	868	296	396	1.58	20.4	0.341	24.80
C255	CS	35	886	376	453	1.02	16.2	0.424	24.61
C256	CS	35	884	392	464	0.93	14.9	0.443	21.05
C258	CS	35	868	426	507	0.83	19.9	0.491	18.87
C39	PS	35	988	296	409	0.91	20.2	0.300	24.10
C65	PS	35	--	--	--	--	--	--	--
[illegible]	PS	35	1012	300	371	0.65	20.0	0.296	24.68

Table 6

9.00-14, 2-PR Smooth Tire, Self-Propelled Condition

Clay

Test	Deflection ($\% \delta$) %	Load (W) lb	Torque (M_{sp}) ft-lb	Sinkage (z) in.	Slip %	$\frac{M_{sp}^*}{W(r_u - \delta_{MS})}$	$\frac{W}{CI}$
			First Pass				
C22	15	238	18	0.35	1.2	0.071	12.53
C92	15	217	6	0.00	1.0	0.028	5.29
C18	15	341	28	0.46	2.7	0.076	17.05
C107	15	344	14	0.00	0.0	0.038	4.65
C14	15	458	84	1.73	12.0	0.168	25.44
C29	15	465	14	0.27	1.1	0.028	11.34
C48	15	410	11	0.00	0.5	0.024	10.00
C50	15	462	9	0.00	0.3	0.019	6.00
C51	15	460	11	0.04	1.1	0.022	5.82
C52	15	443	12	0.00	0.6	0.025	10.55
C53	15	436	10	0.03	0.6	0.021	10.38
C70	15	441	39	0.65	2.0	0.082	20.04
C97	15	439	53	0.68	6.9	0.112	18.29
C116	15	454	16	0.23	0.5	0.033	13.35
C117	15	460	12	0.00	0.6	0.024	9.20
C142	15	443	96	1.34	10.8	0.194	26.06
C147	15	439	83	1.22	10.2	0.171	25.82
C150	15	444	44	0.68	1.8	0.090	19.30
C152	15	434	80	1.49	10.0	0.138	28.93
C235	15	465	20	0.46	0.3	0.039	14.53
C99	15	694	40	0.37	0.0	0.053	15.09
C102	15	657	137	1.41	12.9	0.187	29.86
C68	15	884	179	1.81	11.9	0.181	36.83
C100	15	912	85	0.56	0.5	0.084	19.40
C149	15	884	188	1.68	13.7	0.187	35.36
C237	15	908	132	1.31	3.1	0.129	28.38
C16	25	301	8	0.30	1.0	0.027	15.84
C12	25	465	62	0.61	2.8	0.129	25.83
C38	25	445	14	0.10	0.5	0.031	10.35
C43	25	464	2	0.00	0.0	0.004	5.95
C44	25	433	0	0.00	0.0	0.000	10.31
C63	25	472	19	0.22	0.7	0.040	19.67
C87	25	450	6	0.00	1.0	0.013	11.25
C109	25	454	8	0.00	0.6	0.018	6.14
C120	25	460	18	0.13	0.4	0.039	12.43
C121	25	466	11	0.00	0.9	0.024	9.91
C88	25	662	17	0.15	0.5	0.026	15.26
C89	25	661	130	1.35	14.9	0.185	31.48
C106	25	678	20	0.00	1.0	0.029	9.16
C67	25	892	128	1.46	6.0	0.136	38.78
C95	25	923	33	0.00	1.5	0.036	18.46
C110	25	888	17	0.00	0.5	0.019	16.15
C122	25	893	34	0.10	0.9	0.036	19.00
C146	25	900	52	0.20	0.0	0.056	21.43
C232	25	892	52	0.24	0.1	0.056	17.49
C234	25	848	34	0.18	0.7	0.039	14.37
C23	35	235	7	0.00	2.1	0.030	13.06
C25	35	221	13	0.16	0.3	0.059	11.63
C69	35	222	5	0.00	1.0	0.023	9.65
C85	35	232	4	0.00	1.4	0.017	11.60
C96	35	248	6	0.00	0.0	0.024	5.17
C7	35	465	32	0.11	2.4	0.073	25.83
C9	35	478	28	0.42	0.4	0.061	31.87
C11	35	461	26	0.54	0.4	0.056	27.12
C13	35	470	26	0.56	1.1	0.055	29.38
C15	35	454	24	0.20	2.1	0.055	25.22
C17	35	458	14	0.13	1.4	0.031	24.11
C19	35	463	25	0.49	0.0	0.054	28.94
C20	35	465	23	0.27	0.5	0.052	24.47
C28	35	462	18	0.03	1.5	0.041	11.27
C41	35	432	0	0.00	2.0	0.000	9.60
C42	35	464	6	0.03	2.0	0.013	5.66
C45	35	422	5	0.00	1.0	0.012	10.05
C46	35	456	4	0.05	0.3	0.009	5.70
C47	35	459	6	0.00	0.5	0.013	6.12
C54	35	483	12	0.02	1.3	0.025	24.15
C55	35	484	12	0.03	0.4	0.025	20.17
C81	35	456	12	0.00	1.0	0.026	11.12
C144	35	466	14	0.00	0.8	0.032	7.40
C145	35	461	20	0.00	0.9	0.046	10.98
C148	35	450	41	0.48	2.1	0.091	28.12
C231	35	471	8	0.00	1.4	0.017	9.61
C233	35	438	9	0.02	0.0	0.021	8.76
C236	35	476	10	0.06	1.0	0.021	15.87
C24	35	719	72	0.70	3.8	0.104	37.84
C86	35	706	110	0.84	8.3	0.156	33.62
C91	35	715	27	0.00	0.5	0.039	17.44
			First Pass (Continued)				
C34	35	906	47	0.00	0.0	0.054	21.57
C108	35	889	19	0.00	0.8	0.022	12.18
C118	35	905	31	0.05	1.5	0.035	18.10
C119	35	882	49	0.29	0.5	0.056	22.62
C39	35	1010	50	0.18	0.3	0.050	22.95
C65	35	1008	138	1.24	10.2	0.132	42.00
C82	35	1020	31	0.14	0.0	0.031	23.18
			Second Pass				
C22	15	234	23	0.63	1.5	0.091	13.76
C92	15	209	6	0.00	0.0	0.027	5.10
C18	15	347	24	0.72	1.6	0.063	19.28
C107	15	343	18	0.00	1.5	0.050	4.76
C14	15	449	93	2.45	13.0	0.188	28.06
C29	15	475	20	0.39	0.9	0.040	13.19
C48	15	417	8	0.03	0.5	0.018	10.42
C50	15	467	8	0.02	0.0	0.016	6.06
C51	15	462	10	0.15	0.4	0.020	6.24
C52	15	435	11	0.10	0.4	0.024	11.45
C53	15	433	8	0.13	0.2	0.017	10.07
C70	15	440	36	0.90	1.0	0.075	20.95
C97	15	443	56	0.98	7.4	0.116	19.26
C116	15	450	12	0.37	0.7	0.024	13.64
C117	15	472	12	0.10	0.9	0.024	8.90
C142	15	436	100	1.88	13.5	0.204	29.07
C147	15	--	--	--	--	--	--
C150	15	440	34	1.01	1.9	0.070	20.00
C152	15	432	86	2.04	11.4	0.177	28.80
C235	15	478	20	0.60	0.6	0.038	15.42
C99	15	692	40	0.47	1.0	0.053	15.04
C102	15	650	121	1.96	14.8	0.166	28.26
C68	15	888	170	2.60	14.5	0.169	37.00
C100	15	916	70	0.72	1.0	0.069	19.49
C149	15	881	186	2.43	16.2	0.184	40.04
C237	15	864	108	1.60	4.8	0.110	27.00
C16	25	304	6	0.38	1.2	0.019	17.88
C12	25	469	50	1.31	2.6	0.101	27.59
C38	25	435	20	0.07	0.1	0.045	11.45
C43	25	470	6	0.00	0.0	0.013	6.02
C44	25	436	11	0.00	0.0	0.025	10.63
C63	25	472	15	0.29	0.0	0.031	19.67
C87	25	446	8	0.00	2.0	0.017	11.74
C109	25	449	12	0.00	0.0	0.026	6.24
C120	25	440	19	0.08	0.1	0.040	12.57
C121	25	461	8	0.00	1.5	0.017	9.60
C88	25	662	25	0.24	0.1	0.037	15.76
C89	25	654	162	2.09	19.4	0.231	32.70
C106	25	680	20	0.00	1.0	0.029	10.62
C67	25	880	150	2.28	10.7	0.158	40.00
C95	25	900	30	0.00	1.0	0.033	18.75
C110	25	880	12	0.00	2.0	0.014	14.19
C122	25	890	30	0.13	2.1	0.033	18.94
C146	25	896	51	0.41	0.5	0.054	21.85
C232	25	--	--	--	--	--	--
C234	25	--	--	--	--	--	--
C23	35	--	--	--	--	--	--
C25	35	228	13	0.06	0.1	0.061	13.41
C69	35	212	6	0.00	1.0	0.030	8.83
C85	35	237	9	0.00	1.0	0.041	12.47
C96	35	245	7	0.00	0.0	0.031	5.10
C7	35	461	42	0.39	2.1	0.093	25.61
C9	35	473	37	0.69	2.1	0.079	31.53
C11	35	465	40	0.86	1.3	0.086	31.00
C13	35	471	31	0.41	0.5	0.067	29.44
C15	35	459	24	0.27	0.5	0.054	28.69
C17	35	462	24	0.27	2.0	0.053	24.32
C19	35	458	42	0.59	1.9	0.092	25.44
C20	35	471	34	0.43	0.4	0.074	29.44
C28	35	470	16	0.20	0.6	0.035	12.37
C41	35	433	7	0.00	0.5	0.017	10.31
C42	35	465	7	0.00	1.0	0.016	5.67
C45	35	420	4	0.00	0.0	0.010	10.24
C46	35	462	4	0.04	0.3	0.009	6.00
C47	35	464	5	0.00	0.5	0.011	6.63
C54	35	490	8	0.04	0.9	0.017	21.30
C55	35	481	10	0.08	0.3	0.022	20.91
C81	35	458	8	0.00	0.5	0.018	11.45

(Continued)

* r_u , undeflected radius.

(1 of 3 sheets)

Test	Deflection ($\% \delta$) %	Load (W) lb	Torque (M_{sp}) ft-lb	Sinkage (z) in.	Slip %	$\frac{M_{sp}}{W(r_u - \delta_{MS})}$	$\frac{W}{CI}$
Second Pass (Continued)							
C144	35	468	14	0.00	1.5	0.032	7.31
C145	35	460	18	0.00	0.4	0.041	10.45
C148	35	438	40	0.78	1.3	0.091	29.20
C231	35	462	6	0.00	0.5	0.014	8.25
C233	35	432	12	0.04	1.4	0.029	2.58
C236	35	472	12	0.11	1.8	0.027	13.49
C24	35	715	106	1.71	7.7	0.143	44.69
C86	35	716	114	1.48	10.4	0.157	34.10
C91	35	723	30	0.00	0.5	0.043	18.54
C34	35	956	71	0.00	0.2	0.076	23.90
C108	35	--	--	--	--	--	--
C118	35	--	--	--	--	--	--
C119	35	889	40	0.52	1.3	0.045	25.40
C39	35	1008	49	0.27	0.2	0.049	25.85
C65	35	1012	219	2.27	17.0	0.206	44.00
C82	35	1022	40	0.20	0.0	0.040	24.33
Third Pass							
C22	15	234	18	0.67	2.2	0.071	15.60
C92	15	218	6	0.00	0.7	0.026	5.32
C18	15	343	33	0.81	3.8	0.088	19.06
C107	15	342	15	0.00	1.0	0.042	4.38
C14	15	452	90	2.93	13.3	0.181	26.59
C29	15	476	18	0.43	0.5	0.036	12.20
C48	15	410	9	0.10	0.0	0.020	10.79
C50	15	464	12	0.02	0.0	0.024	5.87
C51	15	461	12	0.10	0.4	0.025	5.55
C52	15	424	8	0.20	0.2	0.018	10.34
C53	15	436	13	0.23	0.2	0.028	10.90
C70	15	438	38	1.02	3.0	0.079	20.86
C97	15	440	59	1.28	8.3	0.122	19.13
C116	15	451	22	0.42	0.7	0.045	13.26
C117	15	474	10	0.04	0.4	0.019	10.30
C142	15	422	110	2.27	15.0	0.232	26.38
C147	15	--	--	--	--	--	--
C150	15	436	48	1.13	4.0	0.099	20.76
C152	15	429	87	2.45	14.8	0.180	26.81
C235	15	448	14	0.66	2.0	0.028	13.58
C99	15	698	40	0.52	0.0	0.052	15.51
C102	15	641	115	2.48	14.5	0.160	29.14
C68	15	871	184	3.20	17.6	0.187	36.29
C100	15	912	75	0.86	1.0	0.074	19.00
C149	15	--	--	--	--	--	--
C237	15	873	118	1.95	6.9	0.118	24.94
C16	25	306	14	0.42	1.5	0.045	18.00
C12	25	462	83	1.90	8.5	0.168	28.88
C38	25	440	28	0.12	0.0	0.062	11.00
C43	25	--	--	--	--	--	--
C44	25	431	6	0.00	0.0	0.014	10.78
C63	25	473	20	0.54	0.0	0.041	20.56
C87	25	441	10	0.00	0.3	0.022	11.61
C109	25	451	14	0.00	1.0	0.031	6.01
C120	25	442	16	0.14	1.1	0.035	11.63
C121	25	462	10	0.00	0.2	0.021	9.62
C88	25	658	16	0.26	0.2	0.024	14.95
C89	25	662	186	2.71	21.3	0.262	31.52
C106	25	698	18	0.04	1.5	0.025	10.42
C67	25	880	164	2.84	12.7	0.172	40.00
C95	25	912	40	0.10	1.0	0.043	19.83
C110	25	880	18	0.00	1.5	0.020	14.92
C122	25	--	--	--	--	--	--
C146	25	904	50	0.44	0.0	0.053	22.60
C232	25	--	--	--	--	--	--
C234	25	--	--	--	--	--	--
C23	35	--	--	--	--	--	--
C25	35	221	9	0.02	1.4	0.044	13.00
C69	35	221	6	0.00	2.6	0.029	9.21
C85	35	239	4	0.00	0.7	0.018	11.95
C96	35	--	--	--	--	--	--
C7	35	468	46	0.52	1.5	0.099	27.53
C9	35	471	35	0.82	2.3	0.075	31.40
C11	35	457	38	0.98	0.3	0.082	30.47
C13	35	461	40	0.66	2.0	0.087	30.73
C15	35	458	28	0.33	0.9	0.062	26.94
C17	35	464	20	0.21	0.7	0.044	25.78
C19	35	448	71	0.81	5.4	0.155	28.00
C20	35	467	42	0.32	0.6	0.093	25.94
C28	35	473	15	0.16	0.1	0.033	12.13

Test	Deflection ($\% \delta$) %	Load (W) lb	Torque (M_{sp}) ft-lb	Sinkage (z) in.	Slip %	$\frac{M_{sp}}{W(r_u - \delta_{MS})}$	$\frac{W}{CI}$
Third Pass (Continued)							
C41	35	428	7	0.00	0.0	0.017	10.19
C42	35	466	7	0.00	0.5	0.016	5.82
C45	35	422	4	0.00	1.4	0.010	11.11
C46	35	468	5	0.16	2.0	0.011	6.50
C47	35	460	10	0.00	0.5	0.023	6.57
C54	35	489	12	0.01	0.2	0.026	22.23
C55	35	--	--	--	--	--	--
C81	35	450	6	0.00	0.5	0.014	10.98
C144	35	448	20	0.00	1.1	0.047	7.11
C145	35	453	17	0.00	0.9	0.039	10.79
C148	35	438	46	0.98	2.8	0.103	31.29
C231	35	458	8	0.00	1.0	0.018	8.33
C233	35	--	--	--	--	--	--
C236	35	466	17	0.15	1.3	0.038	14.56
C24	35	711	137	2.45	12.4	0.185	41.82
C86	35	712	106	1.91	9.5	0.146	30.96
C91	35	714	22	0.00	0.5	0.031	18.31
C34	35	967	47	0.10	1.7	0.051	24.18
C108	35	--	--	--	--	--	--
C118	35	--	--	--	--	--	--
C119	35	889	44	0.60	2.2	0.049	24.03
C39	35	1003	53	0.29	0.4	0.053	24.46
C65	35	995	220	3.13	17.7	0.209	47.38
C82	35	1020	42	0.24	0.5	0.042	25.50
Fourth Pass							
C22	15	235	22	0.71	3.2	0.087	13.82
C92	15	220	5	0.00	0.5	0.021	5.50
C18	15	345	36	0.81	4.7	0.095	19.17
C107	15	349	11	0.00	1.5	0.030	4.92
C14	15	--	--	--	--	--	--
C29	15	482	12	0.41	0.5	0.024	13.39
C48	15	406	8	0.10	0.0	0.018	9.90
C50	15	--	--	--	--	--	--
C51	15	457	15	0.11	1.4	0.031	5.78
C52	15	428	12	0.42	0.2	0.026	10.44
C53	15	--	--	--	--	--	--
C70	15	434	38	1.26	4.2	0.080	19.72
C97	15	442	60	1.52	8.2	0.124	20.09
C116	15	448	20	0.55	1.2	0.041	13.18
C117	15	474	18	0.12	0.8	0.035	10.30
C142	15	424	110	2.73	14.9	0.230	26.50
C147	15	--	--	--	--	--	--
C150	15	436	44	1.28	4.7	0.090	19.82
C152	15	412	85	2.74	15.7	0.183	25.75
C235	15	458	16	0.68	1.7	0.032	13.88
C99	15	690	32	0.60	1.5	0.042	15.33
C102	15	--	--	--	--	--	--
C68	15	868	189	3.73	18.2	0.192	36.17
C100	15	920	80	0.99	2.7	0.078	20.44
C149	15	--	--	--	--	--	--
C237	15	879	120	2.28	8.0	0.119	25.11
C16	25	298	8	0.36	0.5	0.026	17.53
C12	25	455	80	2.48	10.0	0.164	30.33
C38	25	445	22	0.05	0.0	0.048	10.60
C43	25	--	--	--	--	--	--
C44	25	427	9	0.00	0.5	0.021	9.93
C63	25	477	24	0.49	0.5	0.048	19.88
C87	25	439	8	0.04	0.7	0.018	11.55
C109	25	446	10	0.00	1.6	0.022	7.19
C120	25	454	18	0.11	0.9	0.039	11.95
C121	25	460	10	0.00	0.1	0.022	9.58
C88	25	663	22	0.31	0.2	0.032	15.07
C89	25	662	213	3.15	22.0	0.300	28.78
C106	25	694	14	0.00	1.0	0.020	9.91
C67	25	863	166	3.33	12.7	0.177	37.52
C95	25	910	24	0.09	1.0	0.027	18.96
C110	25	888	18	0.00	1.0	0.021	17.08
C122	25	--	--	--	--	--	--
C146	25	900	63	0.61	1.0	0.066	22.50
C232	25	--	--	--	--	--	--
C234	25	--	--	--	--	--	--
C23	35	--	--	--	--	--	--
C25	35	232	8	0.16	1.3	0.038	13.65
C69	35	215	8	0.00	2.6	0.040	9.35
C85	35	234	4	0.00	0.0	0.018	12.32
C96	35	--	--	--	--	--	--

(Continued)

Test	Deflection (% δ) %	Load (W) lb	Torque (M_{sp}) ft-lb	Sinkage (z) in.	Slip %	$\frac{M_{sp}}{W(r_u - \delta_{MS})}$	$\frac{W}{CI}$
Fourth Pass (Continued)							
C7	35	464	58	0.68	3.8	0.126	33.14
C9	35	473	41	0.95	1.9	0.087	33.79
C11	35	457	44	1.27	2.3	0.095	30.47
C13	35	471	43	0.82	1.8	0.092	27.71
C15	35	461	30	0.19	0.7	0.067	25.61
C17	35	471	--	0.26	0.3	--	--
C19	35	445	72	2.28	12.4	0.155	34.23
C20	35	492	52	0.52	2.2	0.109	32.80
C28	35	470	13	0.07	0.6	0.029	12.05
C41	35	432	8	0.00	0.0	0.019	9.39
C42	35	466	3	0.00	0.3	0.007	6.13
C45	35	414	6	0.00	0.5	0.015	10.35
C46	35	460	8	0.13	2.4	0.018	5.97
C47	35	458	7	0.00	2.0	0.016	6.27
C54	35	434	18	0.00	1.7	0.039	21.04
C55	35	--	--	--	--	--	--
C81	35	456	4	0.00	0.5	0.009	11.69
C144	35	460	16	0.00	0.5	0.037	7.19
C145	35	458	17	0.00	0.9	0.039	11.17
C148	35	433	50	1.27	4.2	0.111	31.29
C231	35	463	9	0.00	1.0	0.021	8.57
C233	35	--	--	--	--	--	--
C236	35	473	12	0.20	1.6	0.026	14.75
C24	35	--	--	--	--	--	--
C86	35	--	--	--	--	--	--
C91	35	718	35	0.00	0.0	0.050	18.41
C34	35	952	49	0.00	0.0	0.053	23.80
C108	35	--	--	--	--	--	--
C118	35	--	--	--	--	--	--
C119	35	892	49	0.73	2.2	0.054	24.11
C39	35	1012	60	0.36	1.8	0.059	25.30
C65	35	--	--	--	--	--	--
C82	35	1012	39	0.24	1.0	0.040	23.53
Fifth Pass							
C22	15	231	18	0.70	1.8	0.072	14.44
C92	15	218	4	0.00	1.0	0.017	5.45
C18	15	--	--	--	--	--	--
C107	15	343	15	0.00	0.0	0.041	4.76
C14	15	--	--	--	--	--	--
C29	15	480	16	0.41	1.9	0.032	12.63
C48	15	410	12	0.15	0.5	0.027	10.00
C50	15	--	--	--	--	--	--
C51	15	--	--	--	--	--	--
C52	15	--	--	--	--	--	--
C53	15	--	--	--	--	--	--
C70	15	435	38	1.35	2.3	0.080	19.77
C97	15	448	60	1.80	10.7	0.122	20.36
C116	15	444	18	0.62	2.6	0.037	13.59
C117	15	476	16	0.11	0.3	0.031	10.35
C142	15	414	104	3.06	16.4	0.223	25.88
C147	15	--	--	--	--	--	--
C150	15	434	46	1.42	3.8	0.095	19.73
C152	15	414	80	3.07	14.1	0.172	25.88
C235	15	484	18	0.82	1.0	0.034	14.67
C99	15	692	41	0.65	0.7	0.054	15.73
C102	15	--	--	--	--	--	--
C68	15	855	191	4.12	19.6	0.197	35.62
C100	15	928	76	1.12	1.0	0.073	20.17
C149	15	--	--	--	--	--	--
C237	15	878	120	2.58	8.2	0.120	26.60
C16	25	298	12	0.45	0.1	0.039	16.56
C12	25	--	--	--	--	--	--
C38	25	445	24	0.16	1.5	0.053	10.85
C43	25	--	--	--	--	--	--
C44	25	428	10	0.00	1.0	0.023	10.70
C63	25	469	21	0.64	0.0	0.043	19.54
Fifth Pass (Continued)							
C87	25	448	9	0.07	0.0	0.020	11.20
C109	25	449	10	0.00	1.0	0.022	6.51
C120	25	445	20	0.22	1.2	0.044	11.71
C121	25	462	8	0.00	1.0	0.017	9.62
C88	25	658	20	0.35	0.3	0.029	15.67
C89	25	--	--	--	--	--	--
C106	25	668	19	0.01	0.0	0.028	9.15
C67	25	846	168	3.79	13.3	0.183	38.45
C95	25	924	41	0.18	0.0	0.044	19.66
C110	25	887	13	0.00	0.7	0.015	15.29
C122	25	--	--	--	--	--	--
C146	25	896	58	0.69	1.0	0.061	22.40
C232	25	--	--	--	--	--	--
C234	25	--	--	--	--	--	--
C23	35	--	--	--	--	--	--
C25	35	229	18	0.14	0.4	0.086	14.31
C69	35	213	6	0.00	2.6	0.030	9.68
C85	35	237	6	0.00	1.0	0.027	11.29
C96	35	--	--	--	--	--	--
C7	35	452	89	1.43	9.4	0.192	28.25
C9	35	468	47	1.14	3.4	0.099	29.25
C11	35	460	53	1.53	5.0	0.112	30.67
C13	35	477	48	1.09	2.0	0.100	28.06
C15	35	--	--	--	--	--	--
C17	35	470	20	0.29	0.1	0.043	24.74
C19	35	445	84	2.86	12.0	0.180	29.67
C20	35	516	72	1.28	4.1	0.139	30.35
C28	35	483	18	0.00	1.1	0.039	12.38
C41	35	--	--	--	--	--	--
C42	35	471	6	0.00	1.5	0.013	5.74
C45	35	438	5	0.00	2.0	0.012	10.95
C46	35	472	4	0.13	0.0	0.009	6.38
C47	35	460	7	0.00	0.3	0.016	6.39
C54	35	492	21	0.08	0.7	0.045	22.36
C55	35	--	--	--	--	--	--
C81	35	462	7	0.00	1.0	0.190	11.55
C144	35	462	22	0.00	0.6	0.050	7.22
C145	35	457	14	0.00	0.4	0.032	11.15
C148	35	426	54	1.38	4.2	0.123	30.43
C231	35	--	--	--	--	--	--
C233	35	--	--	--	--	--	--
C236	35	476	10	0.36	1.6	0.022	14.88
C24	35	--	--	--	--	--	--
C86	35	--	--	--	--	--	--
C91	35	716	16	0.03	0.0	0.023	18.36
C34	35	--	--	--	--	--	--
C108	35	--	--	--	--	--	--
C118	35	--	--	--	--	--	--
C119	35	920	48	0.85	2.4	0.052	24.86
C39	35	1003	47	0.37	0.5	0.047	23.88
C65	35	--	--	--	--	--	--
C82	35	1015	52	0.39	0.5	0.052	24.76

Table 7

9.00-14, 2-PR Smooth Tire, Nonstandard Speed Conditions

Clay

Test	Test Type*	Deflection (% δ) %	Load (W) lb	Pull (P) lb	Torque (M) ft-lb	Sinkage (z) in.	Slip %	Speed fps	$\frac{P}{W}$	$\frac{M}{Wr_d}$**	$\frac{W}{CI}$
First Pass											
Towed Point											
C71	PS	15	467	-26		0.27	0.3	2.98	0.055		18.70
C72	PS	25	912	-92		0.96	3.8	2.88	0.101		33.80
C73	PS	35	462	-7		0.00	0.0	2.84	0.015		18.47
C74	PS	15	908	-170		1.48	-1.5	3.03	0.187		36.30
C123	PS	35	475	-19		0.00	0.0	4.10	0.040		23.75
C124	PS	35	904	-112		1.10	-2.7	4.25	0.124		39.30
C125	PS	15	455	-16		0.18	-0.8	4.45	0.035		9.65
C126	PS	15	448	-29		0.39	-0.2	4.23	0.065		12.42
C127	T	15	893	-73		0.43	-0.9	0.57	0.082		14.40
C128	T	15	896	-61		0.43	-0.6	6.20	0.068		15.40
C129	T	35	455	-22		0.14	-0.1	0.55	0.048		19.70
C130	T	35	459	-19		0.02	-0.1	6.15	0.041		19.10
C131	T	15	897	-52		0.24	-0.2	17.95	0.058		14.90
C132	T	15	1308	-138		0.66	-0.5	17.95	0.106		20.75
C133	T	15	457	-78		1.33	-0.5	0.57	0.170		21.80
C134	T	15	464	-60		0.89	-0.6	6.26	0.129		20.15
C135	T	15	442	-44		0.45	-0.6	17.80	0.100		19.20
C136	T	35	444	-24		0.00	-1.8	17.60	0.054		18.50
C138	PS	15	458	-48		0.66	-1.2	3.41	0.105		19.10
C139	PS	15	450	-66		0.79	-1.0	3.36	0.147		25.00
C140	PS	35	462	-24		0.08	-2.0	3.15	0.052		19.25
C141	PS	15	910	-61		0.29	0.0	3.45	0.067		15.95
C264	PS	15	438	-12		0.17	-1.3	2.70	0.027		11.52
C265	PS	15	450	0		0.11	0.8	11.44	0.000		11.82
C267	PS	15	439	-14		0.30	-1.2	8.80	0.032		10.70
Self-Propelled Point											
C71	PS	15	464		26	0.28	1.0	2.92		0.053	18.54
C72	PS	25	908		114	1.10	6.1	2.75		0.124	33.60
C73	PS	35	462		7	0.00	0.0	2.80		0.016	18.47
C74	PS	15	904		268	1.94	27.8	2.26		0.276	34.75
C123	PS	35	472		22	0.00	0.0	4.07		0.049	23.58
C124	PS	35	897		118	1.28	2.7	4.00		0.137	39.00
C125	PS	15	454		16	0.17	-0.2	4.40		0.033	9.65
C126	PS	15	452		28	0.40	0.8	4.38		0.058	12.52
C138	PS	15	462		48	0.68	8.5	3.11		0.097	19.23
C139	PS	15	452		73	0.95	9.4	3.04		0.151	25.10
C140	PS	35	462		26	0.13	0.1	3.08		0.060	19.52
C141	PS	15	906		62	0.25	1.3	3.35		0.063	15.90
C264	PS	15	438		13	0.18	0.2	2.68		0.027	11.52
C265	PS	15	450		0	0.11	0.8	11.44		0.000	11.82
C267	PS	15	439		14	0.31	0.0	8.80		0.030	10.70
20% Slip Point											
C71	PS	15	454	122	178	0.50	19.7	2.59	0.269		18.15
C72	PS	25	892	122	270	1.36	20.3	2.33	0.137		33.05
C73	PS	35	444	169	282	0.00	19.7	2.36	0.381		17.75
C74	PS	15	898	-13	227	1.84	19.7	2.44	0.014		34.50
C123	PS	35	454	206	239	0.29	20.2	3.25	0.454		22.72
C124	PS	35	892	148	308	1.77	19.8	3.29	0.166		38.75
C126	PS	15	462	218	280	0.50	19.7	3.49	0.472		12.81
C138	PS	15	457	29	86	0.71	20.0	2.75	0.063		19.05
C139	PS	15	456	37	132	1.08	19.6	2.72	0.081		25.30
C141	PS	15	880	240	342	0.38	19.8	2.75	0.273		15.43
First Pass (Continued)											
20% Slip Point (Continued)											
C249	CS	15	454	136	186	0.46	14.2	1.02	0.300		13.76
C250	CS	15	458	155	213	0.44	14.0	2.03	0.338		13.88
C251	CS	15	439	195	241	0.45	20.6	3.25	0.444		12.54
C252	CS	15	447	198	259	0.64	19.8	4.54	0.443		12.77
C253	CS	15	436	184	246	0.54	17.3	4.81	0.422		12.46
C254	CS	15	441	196	260	0.52	17.3	3.08	0.444		12.60
C260	CS	15	456	161	215	0.57	18.3	1.58	0.353		12.32
C261	CS	15	451	150	206	0.54	13.8	0.84	0.332		12.19
C262	CS	15	439	151	203	0.47	17.6	1.60	0.344		11.55
C263	CS	15	447	170	224	0.45	17.7	0.80	0.380		11.76
C264	PS	15	438	170	222	0.34	19.9	2.18	0.388		11.52
C267	PS	15	439	222	264	0.45	--	6.48	0.506		11.55
C268	CS	15	454	176	231	0.37	18.1	6.98	0.388		11.64
Second Pass											
Towed Point											
C71	PS	15	463	-28		0.46	1.0	3.00	0.060		18.50
C72	PS	25	896	-102		1.55	0.0	2.89	0.114		34.45
C73	PS	35	468	-12		0.00	-1.5	2.70	0.026		18.00
C74	PS	15	900	-170		2.31	1.0	3.02	0.189		37.45
C123	PS	35	464	-18		0.00	-0.4	4.12	0.039		25.80
C124	PS	35	908	-124		1.84	-3.9	4.50	0.137		45.40
C125	PS	15	449	-26		0.17	-0.3	4.48	0.058		8.99
C126	PS	15	442	-23		0.52	-0.1	4.49	0.052		11.60
C127	T	15	916	-74		0.69	-0.9	0.58	0.081		15.50
C128	T	15	896	-58		0.58	-1.2	6.12	0.065		16.60
C129	T	35	458	-23		0.26	-1.8	0.52	0.050		21.85
C130	T	35	468	-18		0.15	-0.4	6.12	0.038		19.50
C131	T	15	894	-54		0.35	-1.5	18.00	0.060		13.95
C132	T	15	1304	-133		0.99	-1.0	17.40	0.102		22.10
C133	T	15	463	-72		1.7[illegible]	-0.6	0.54	0.156		22.05
C134	T	15	456	-52		1.24	1.5	6.19	0.114		19.82
C135	T	15	443	-53		0.79	0.2	17.60	0.120		20.15
C136	T	35	445	-23		0.00	-2.4	17.60	0.052		18.55
C138	PS	15	458	-38		0.97	-0.5	3.40	0.083		20.85
C139	PS	15	446	-59		1.23	0.3	3.25	0.132		24.80
C140	PS	35	454	-28		0.21	-2.5	3.22	0.062		28.35
C141	PS	15	920	-60		0.42	0.0	3.50	0.065		16.12
C264	PS	15	438	-17		0.39	1.4	2.78	0.039		11.25
C267	PS	15	434	-10		0.36	1.6	8.75	0.043		11.41
Self-Propelled Point											
C71	PS	15	463		29	0.47	1.0	2.98		0.059	18.52
C72	PS	25	888		110	1.74	4.8	2.69		0.123	34.15
C73	PS	35	468		12	0.00	-0.7	2.70		0.027	18.02
C74	PS	15	900		208	2.46	19.7	2.54		0.206	37.45
C123	PS	35	464		18	0.00	1.6	4.05		0.041	25.80
C124	PS	35	896		144	2.12	7.7	3.85		0.167	44.80
C125	PS	15	449		26	0.20	-0.3	4.40		0.054	8.99
C126	PS	15	442		23	0.55	-0.2	4.41		0.049	11.60
C138	PS	15	460		38	0.99	3.9	3.30		0.077	20.90
C139	PS	15	440		62	1.35	10.8	3.00		0.132	24.45
C140	PS	35	454		29	0.26	0.0	3.10		0.067	28.35

(Continued)

* PS, programed-slip test; T, towed test; CS, constant-slip test.
** r_d , deflected radius.

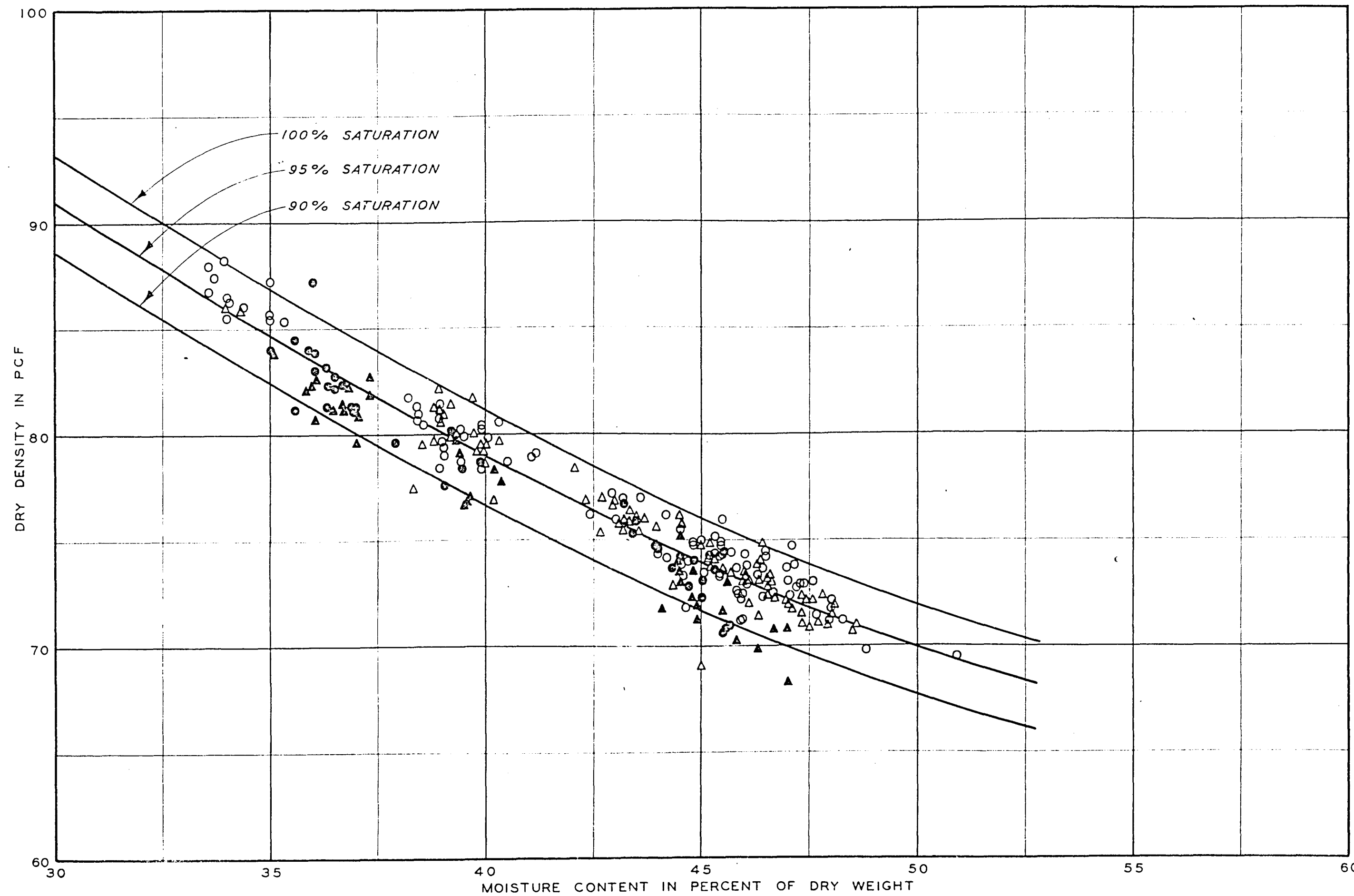
Table 7 (Continued)

Test	Test Type	Deflection (% δ) %	Load (W) lb	Pull (P) lb	Torque (M) ft-lb	Sinkage (z) in.	Slip %	Speed fps	$\frac{P}{W}$	$\frac{M}{Wr_d}$	$\frac{W}{CI}$
Second Pass (Continued)											
Self-Propelled Point (Continued)											
C141	PS	15	908		63	0.34	2.1	3.35		0.064	15.91
C264	PS	15	438		17	0.39	1.7	2.68		0.036	11.25
C267	PS	15	434		9	0.36	0.4	8.75		0.019	11.41
20% Slip Point											
C71	PS	15	456	138	186	0.66	19.6	2.58	0.303		18.25
C72	PS	25	888	112	270	2.05	20.6	2.32	0.126		34.15
C73	PS	35	450	176	192	0.04	20.0	2.32	0.391		17.30
C74	PS	15	904	5	213	2.47	20.3	2.53	0.005		37.60
C123	PS	35	443	174	207	0.27	20.2	3.28	0.393		24.60
C124	PS	35	892	123	298	2.73	19.8	3.17	0.138		45.10
C126	PS	15	454	220	269	0.65	19.5	3.49	0.485		19.30
C138	PS	15	458	97	162	1.17	19.6	2.79	0.212		20.85
C139	PS	15	440	47	134	1.57	20.4	2.71	0.107		24.45
C141	PS	15	880	272	362	0.54	19.7	2.72	0.309		15.43
C249	CS	15	456	133	179	0.70	10.7	1.02	0.292		13.41
C250	CS	15	462	51	245	0.77	20.6	2.10	0.110		13.59
C251	CS	15	439	226	279	0.67	27.2	3.26	0.516		11.53
C252	CS	15	452	245	307	0.81	27.8	4.62	0.542		11.89
C253	CS	15	442	196	247	0.71	17.9	4.80	0.443		13.00
C254	CS	15	445	215	278	0.75	18.0	3.06	0.483		13.09
C260	CS	15	460	180	235	0.78	23.3	1.48	0.391		12.43
C261	CS	15	460	175	227	0.78	19.9	.79	0.380		12.43
C262	CS	15	444	160	210	0.63	19.3	1.59	0.360		11.68
C263	CS	15	445	178	228	0.64	17.9	.81	0.400		11.71
C264	PS	15	436	182	234	0.60	20.3	2.12	0.417		11.18
C267	PS	15	431	234	256	0.56	--	6.49	0.543		11.95
C268	CS	15	454	180	--	0.50	19.2	6.92	0.396		11.64
Third Pass											
Towed Point											
C71	PS	15	470	-29		0.57	1.0	3.08	0.062		19.50
C72	PS	25	900	-114		2.03	-0.5	2.90	0.127		37.50
C73	PS	35	470	-17		0.00	-1.5	2.72	0.036		18.07
C74	PS	15	900	-186		2.89	1.2	3.00	0.207		37.50
C123	Ps	35	462	-14		0.00	-0.2	4.10	0.030		24.30
C124	PS	35	889	-154		2.18	-3.4	4.32	0.173		40.40
C125	PS	15	447	-15		0.32	-0.1	4.40	0.034		9.32
C126	PS	15	442	-19		0.62	-0.7	4.43	0.043		11.93
C127	T	15	908	-69		0.85	-1.2	0.57	0.076		15.15
C128	T	15	899	-58		0.66	-0.4	6.10	0.065		16.32
C129	T	35	459	-26		0.45	-2.2	0.51	0.057		17.65
C130	T	35	464	-19		0.22	-0.6	6.11	0.041		18.55
C131	TS	15	894	-55		0.40	-0.8	18.00	0.062		14.41
C132	TS	15	1301	-123		1.18	-0.4	17.40	0.095		24.05
C133	TS	15	463	-72		2.10	1.0	0.56	0.156		23.15
C134	TS	15	462	-56		1.46	0.8	6.19	0.121		19.25
C135	TS	15	432	-47		1.02	1.1	18.10	0.109		19.65
C136	TS	35	450	-24		0.08	-1.4	17.60	0.053		18.00
C138	PS	15	460	-40		1.23	-0.3	3.36	0.087		20.90
C139	PS	15	422	-69		1.61	0.5	3.26	0.164		24.80
C140	PS	35	458	-25		0.40	-2.0	3.15	0.055		26.95
C141	PS	15	892	-58		0.49	0.0	3.46	0.065		15.39
C264	PS	15	443	-12		0.38	-0.2	2.72	0.027		11.67
C267	PS	15	449	-14		0.48	-0.1	8.61	0.031		11.52
Third Pass (Continued)											
Self-Propelled Point											
C71	PS	15	468		30	0.60	2.9	3.00		0.061	19.52
C72	PS	25	896		138	2.34	10.3	2.63		0.152	37.30
C73	PS	35	471		17	0.00	0.0	2.70		0.038	18.10
C74	PS	15	903		206	3.10	19.0	2.56		0.212	37.65
C123	PS	35	462		14	0.00	-0.2	4.08		0.032	24.30
C124	PS	35	896		154	2.68	6.8	3.77		0.178	40.70
C125	PS	15	448		15	0.31	-0.1	4.39		0.031	9.34
C126	PS	15	447		20	0.63	-0.2	4.41		0.042	12.09
C138	PS	15	460		42	1.24	4.9	3.23		0.085	20.90
C139	PS	15	428		78	1.81	13.4	2.93		0.170	25.75
C140	PS	35	457		25	0.48	0.4	3.10		0.058	26.90
C141	PS	15	892		58	0.51	1.3	3.32		0.060	15.39
C164	PS	15	443		12	0.37	0.8	2.68		0.025	11.67
C167	PS	15	449		12	0.48	0.1	8.61		0.029	11.52
20% Slip Point											
C71	PS	15	452	128	192	0.84	19.6	2.58	0.283		18.80
C72	PS	25	892	98	260	2.59	20.6	2.30	0.100		37.15
C73	PS	35	452	187	210	0.01	20.0	2.29	0.398		17.37
C74	PS	15	903	5	212	3.10	19.9	2.52	0.005		37.65
C123	PS	35	446	178	204	0.43	20.4	3.20	0.399		23.70
C124	PS	35	876	72	272	3.50	19.7	3.23	0.082		39.70
C126	PS	15	453	220	272	0.67	19.7	3.52	0.486		12.22
C138	PS	15	452	112	176	1.45	19.7	2.72	0.248		20.52
C139	PS	15	434	35	126	1.89	19.7	2.71	0.081		25.50
C141	PS	15	876	284	366	0.64	19.7	2.67	0.324		15.10
C250	CS	15	460	145	190	0.76	11.3	2.09	0.315		13.94
C251	CS	15	443	225	274	0.73	23.3	3.19	0.508		11.66
C252	CS	15	450	233	296	0.97	22.6	4.45	0.518		11.84
C253	CS	15	442	201	265	0.78	18.3	4.79	0.455		13.00
C254	CS	15	448	214	276	0.82	17.8	3.06	0.478		13.18
C262	CS	15	388	160	211	0.71	17.8	1.60	0.365		11.53
C263	CS	15	448	181	234	0.73	16.5	0.82	0.404		11.79
C264	PS	15	438	190	234	0.71	20.4	2.12	0.423		11.81
C267	PS	15	449	222	258	0.60	--	6.58	0.492		11.52
C268	CS	15	451	181	233	0.59	16.8	6.91	0.401		12.19
Fourth Pass											
Towed Point											
C71	PS	15	481	-27		0.75	1.0	3.09	0.056		18.50
C74	PS	15	900	-186		3.62	1.5	3.03	0.207		39.15
C123	PS	35	470	-19		0.00	-0.9	4.10	0.040		24.72
C124	PS	35	896	-152		2.61	-4.5	4.30	0.170		40.70
C125	PS	15	441	-23		0.37	-0.3	4.50	0.052		8.91
C127	T	15	916	-69		1.00	-1.1	0.58	0.075		15.63
C128	T	15	892	-57		0.80	-0.4	6.10	0.064		15.90
C129	T	35	461	-27		0.57	-2.2	0.52	0.059		20.50
C130	T	35	462	-20		0.27	-0.3	6.14	0.043		18.12
C131	T	15	872	-58		0.51	-0.8	18.00	0.067		14.07
C132	T	15	1304	-127		1.31	-0.1	17.45	0.097		23.80
C133	T	15	460	-74		2.46	1.0	0.58	0.161		21.40
C134	T	15	463	-55		1.66	2.3	6.18	0.119		19.30
C136	T	35	442	-25		0.12	-1.1	17.80	0.057		18.05
C138	PS	15	454	-46		1.31	-0.4	3.33	0.101		20.20
C139	PS	15	430	-72		1.90	-2.8	3.18	0.167		25.30
C140	PS	35	452	-28		0.43	-1.3	3.17	0.062		26.60
C141	PS	15	900	-60		0.66	-0.2	3.38	0.067		15.80
C264	PS	15	446	-15		0.43	-0.6	2.78	0.034		11.30
C267	PS	15	444	-11		0.45	0.0	8.63	0.025		11.38

(Continued)

Table 7 (Concluded)

Test	Type	Deflection (% δ) %	Load (W) lb	Pull (P) lb	Torque (M) ft-lb	Sinkage (z) in.	Slip %	Speed fps	$\frac{P}{W}$	$\frac{M}{Wr_d}$	$\frac{W}{CI}$
Fourth Pass (Continued)											
Self-Propelled Point											
C71	PS	15	480		27	0.77	2.0	3.04		0.055	18.48
C74	PS	15	896		201	3.78	19.7	2.54		0.209	38.95
C123	PS	35	470		18	0.01	0.1	4.05		0.040	24.72
C124	PS	35	888		180	3.66	11.6	3.67		0.211	40.40
C125	PS	15	439		23	0.39	1.5	4.02		0.049	8.87
C138	PS	15	456		48	1.38	3.9	3.15		0.098	20.25
C139	PS	15	440		82	2.03	15.1	2.82		0.174	25.85
C140	PS	35	452		28	0.44	1.8	3.05		0.065	26.60
C141	PS	15	900		63	0.67	2.2	3.28		0.064	15.80
C264	PS	15	446		14	0.44	1.0	2.76		0.029	11.30
C267	PS	15	444		14	0.45	0.5	8.63		0.030	11.38
20% Slip Point											
C71	PS	15	460	146	202	1.09	20.4	2.66	0.324		17.70
C74	PS	15	896	0	201	3.78	19.7	2.54	0.000		38.95
C123	PS	35	454	182	208	0.53	20.4	3.22	0.401		23.92
C124	PS	35	872	62	276	4.07	19.8	3.23	0.071		39.62
C138	PS	35	452	121	192	1.67	20.0	2.72	0.268		20.05
C139	PS	35	440	25	118	2.05	19.7	2.70	0.057		25.85
C141	PS	35	888	280	358	0.80	20.4	2.68	0.315		15.57
C250	CS	35	458	159	206	0.87	11.8	2.09	0.347		14.31
C251	CS	35	439	242	295	0.83	25.1	3.22	0.551		11.55
C252	CS	35	447	256	323	1.04	26.5	4.50	0.573		11.76
C253	CS	35	437	207	267	0.83	17.6	4.85	0.474		12.85
C254	CS	35	447	220	281	0.91	16.6	3.10	0.492		13.15
C262	CS	35	449	163	209	0.80	15.8	1.63	0.363		11.82
C263	CS	35	446	168	214	0.75	12.4	.85	0.377		11.74
C264	PS	35	440	208	256	0.78	19.6	2.05	0.474		11.12
C267	PS	35	439	220	254	0.74	--	6.51	0.484		11.25
C268	CS	35	455	198	247	0.61	18.1	6.92	0.435		11.97
Fifth Pass											
Towed Point											
C71	PS	15	463	-29		0.77	2.4	3.10	0.063		20.10
C74	PS	15	893	-191		4.19	2.0	3.06	0.214		38.80
C123	PS	35	466	-19		0.00	-0.4	4.09	0.041		24.55
C124	PS	35	875	-156		3.21	-3.0	4.29	0.178		39.70
C125	PS	15	450	-19		0.44	-0.8	4.40	0.042		9.09
C127	T	15	915	-68		1.14	-0.2	0.60	0.074		15.63
C128	T	15	888	-56		0.87	-0.4	6.11	0.063		15.86
C129	T	35	462	-25		0.64	-2.0	0.53	0.054		20.55
C130	T	35	467	-19		0.32	-0.1	6.15	0.041		18.30
C131	T	15	890	-58		0.62	-0.2	18.00	0.065		14.35
C132	T	15	1292	-127		1.50	2.2	17.55	0.098		23.60
C133	T	15	463	-70		2.78	2.0	0.60	0.151		21.70
C134	T	15	461	-54		1.86	2.4	6.18	0.117		19.20
C136	T	35	455	-21		0.18	-2.0	17.60	0.046		18.58
C138	PS	15	462	-44		1.53	0.0	3.22	0.095		20.50
C139	PS	15	440	-84		2.22	4.4	3.15	0.191		25.90
C140	PS	35	461	-35		0.74	-1.8	3.11	0.076		27.10
C141	PS	15	893	-49		0.70	-0.1	3.35	0.055		15.67
C264	PS	15	446	-18		0.48	-0.7	2.68	0.040		11.30
C267	PS	15	446	-15		0.46	-1.3	8.76	0.034		11.40
Fifth Pass (Continued)											
Self-Propelled Point											
C71	PS	15	464		29	0.77	2.0	3.05		0.059	20.15
C74	PS	15	893		215	4.39	19.7	2.56		0.224	38.80
C123	PS	35	468		18	0.02	-0.4	4.02		0.040	24.60
C124	PS	35	855		178	4.16	9.8	3.62		0.216	38.85
C125	PS	15	450		19	0.44	1.1	4.37		0.039	9.09
C138	PS	15	459		58	1.58	6.9	3.12		0.118	20.40
C139	PS	15	447		96	2.29	17.0	2.82		0.200	26.30
C140	PS	35	460		36	0.83	0.0	3.01		0.082	27.05
C141	PS	15	893		52	0.68	2.2	3.28		0.053	15.67
C264	PS	15	446		17	0.51	0.9	2.64		0.036	11.30
C267	PS	15	446		12	0.47	-0.7	8.74		0.025	11.40
20% Slip Point											
C71	PS	15	451	140	199	1.02	19.7	2.62	0.310		19.60
C74	PS	15	893	-2	215	4.39	19.7	2.56	0.002		38.80
C123	PS	35	448	182	209	0.47	20.2	3.20	0.406		23.60
C124	PS	35	846	57	270	4.75	20.2	3.28	0.067		38.45
C138	PS	35	454	122	200	1.96	19.7	2.65	0.269		20.20
C139	PS	35	449	18	118	2.32	19.7	2.70	0.040		26.40
C141	PS	35	869	292	370	0.92	20.5	2.69	0.336		15.23
C250	CS	35	458	148	197	0.92	11.0	2.09	0.323		14.31
C253	CS	35	442	208	273	0.93	17.6	4.84	0.470		13.00
C254	CS	35	445	220	289	0.96	16.8	3.09	0.494		13.09
C262	CS	35	437	172	215	0.86	16.5	1.64	0.394		11.50
C263	CS	35	440	181	227	0.80	13.6	.85	0.411		11.58
C264	PS	35	444	209	266	0.77	19.9	2.00	0.470		11.24
C267	PS	35	450	232	270	0.70	--	6.50	0.515		11.52
C268	CS	35	444	198	245	0.74	17.5	6.94	0.446		11.68



LEGEND

O 0- TO 6-IN. LAYER
Δ 6- TO 12-IN. LAYER

OPEN SYMBOLS - INITIAL TESTS
CLOSED SYMBOLS - LATER TESTS

NOTE: PNEUMATIC-TIRED ROLLER USED FOR COMPACTION.

SATURATION CONDITION OF TEST CLAY

PLATE 1

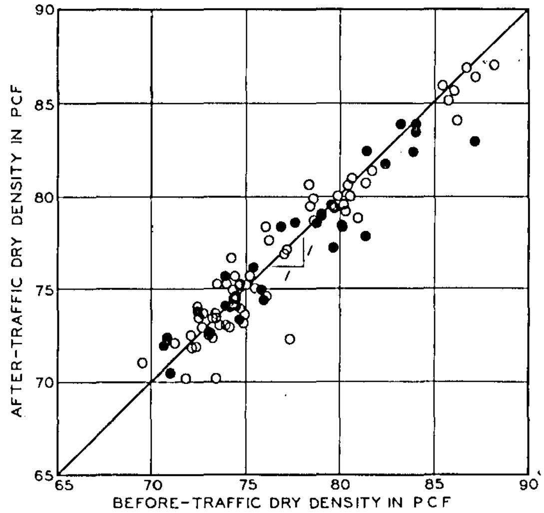


FIG. a. 0- TO 6-IN. DRY DENSITY

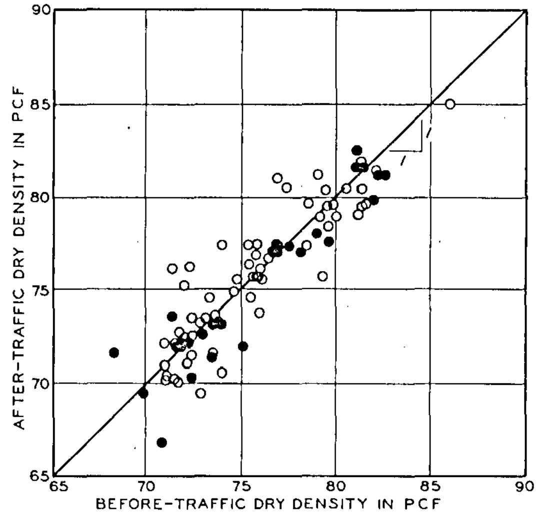


FIG. b. 6- TO 12-IN. DRY DENSITY

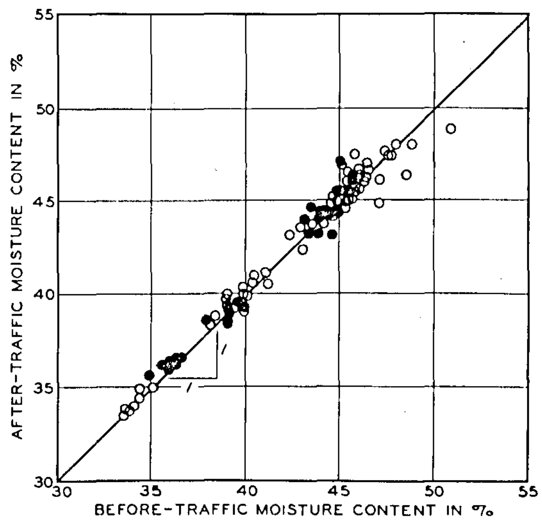


FIG. c. 0- TO 6-IN. MOISTURE CONTENT

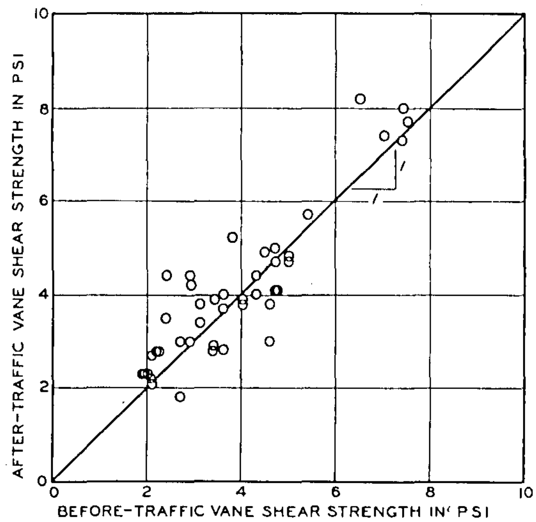


FIG. d. 2- TO 4-IN.
VANE SHEAR STRENGTH

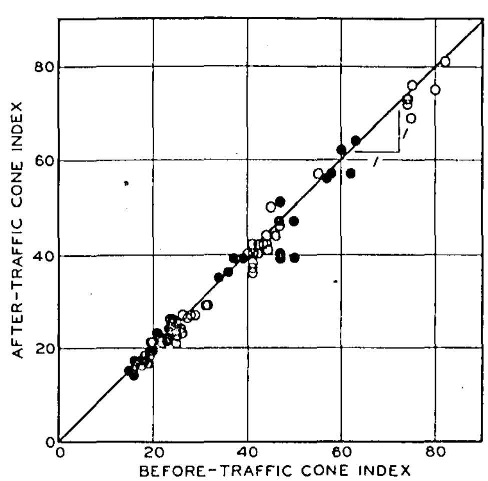


FIG. e. 0- TO 6-IN. CONE INDEX

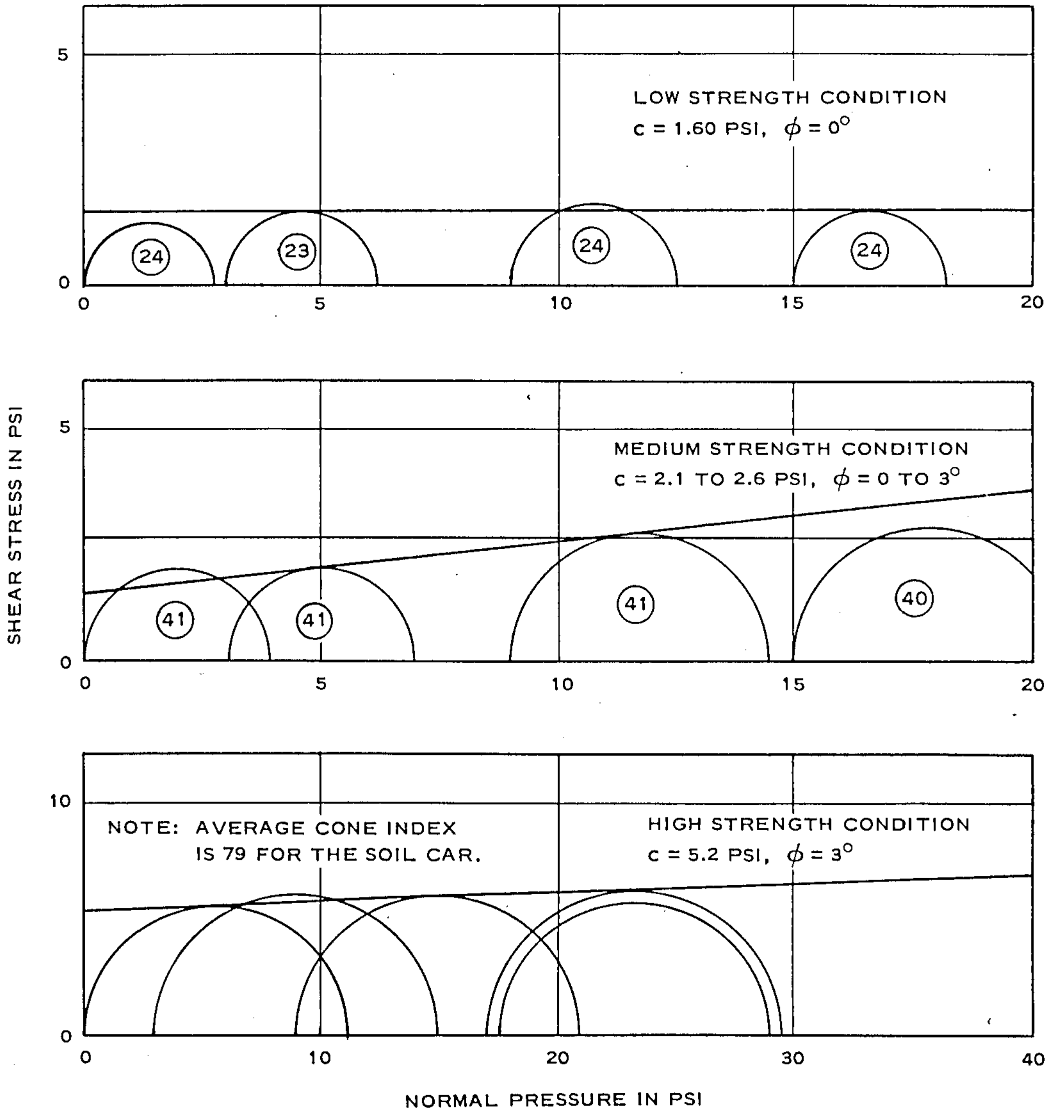
LEGEND

o INITIAL TESTS
● LATER TESTS

LOAD DEPENDENCE OF CLAY UNDER REPETITIVE TRAFFIC

9.00-14, 2-PR SMOOTH TIRE

5 PASSES



NOTE: CIRCLED NUMBER DENOTES CONE INDEX OF TEST SPECIMEN.

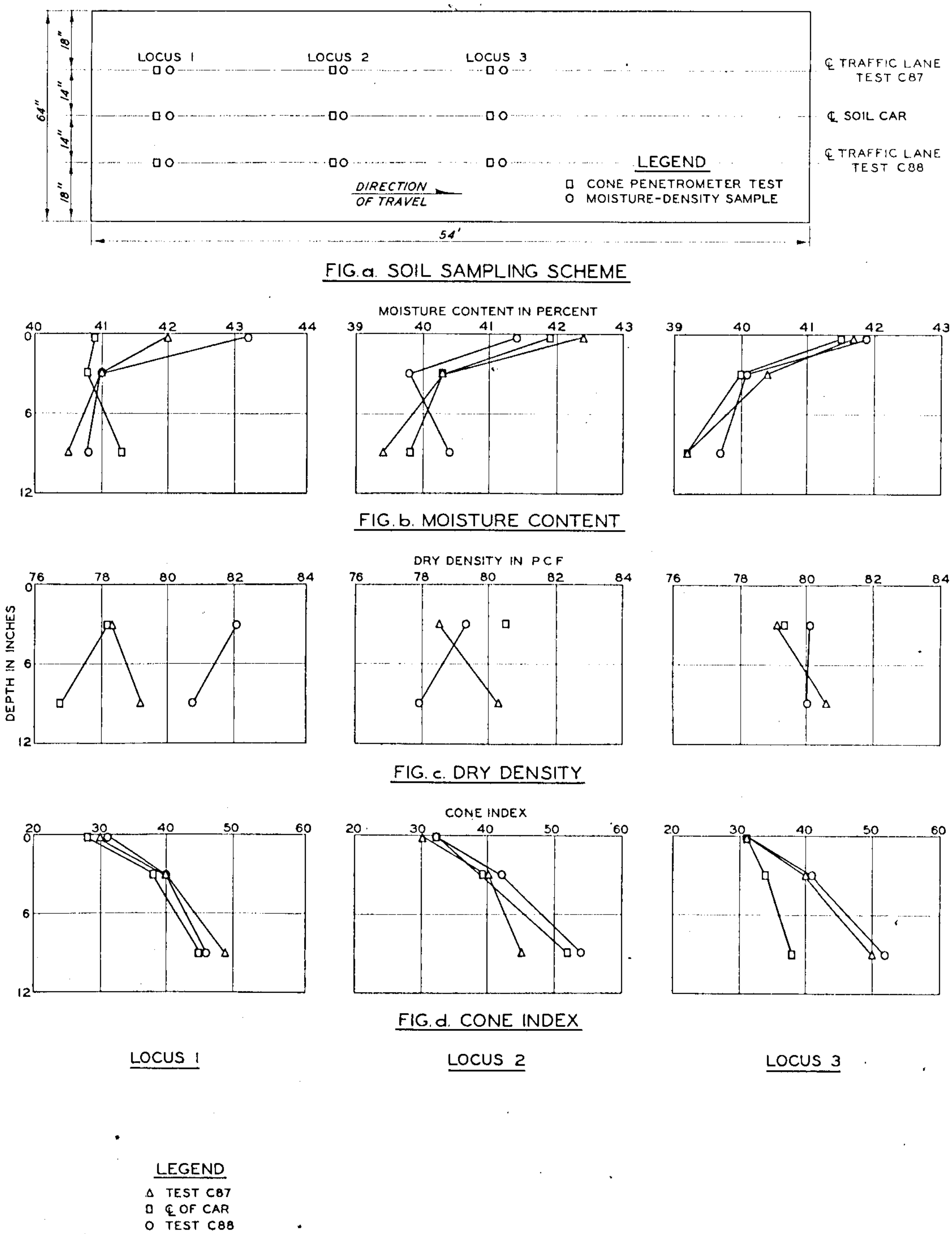
c - COHESION, PSI.

φ - ANGLE OF INTERNAL FRICTION, DEG.

TRIAXIAL TEST RESULTS

TYPICAL STRENGTH CONDITIONS

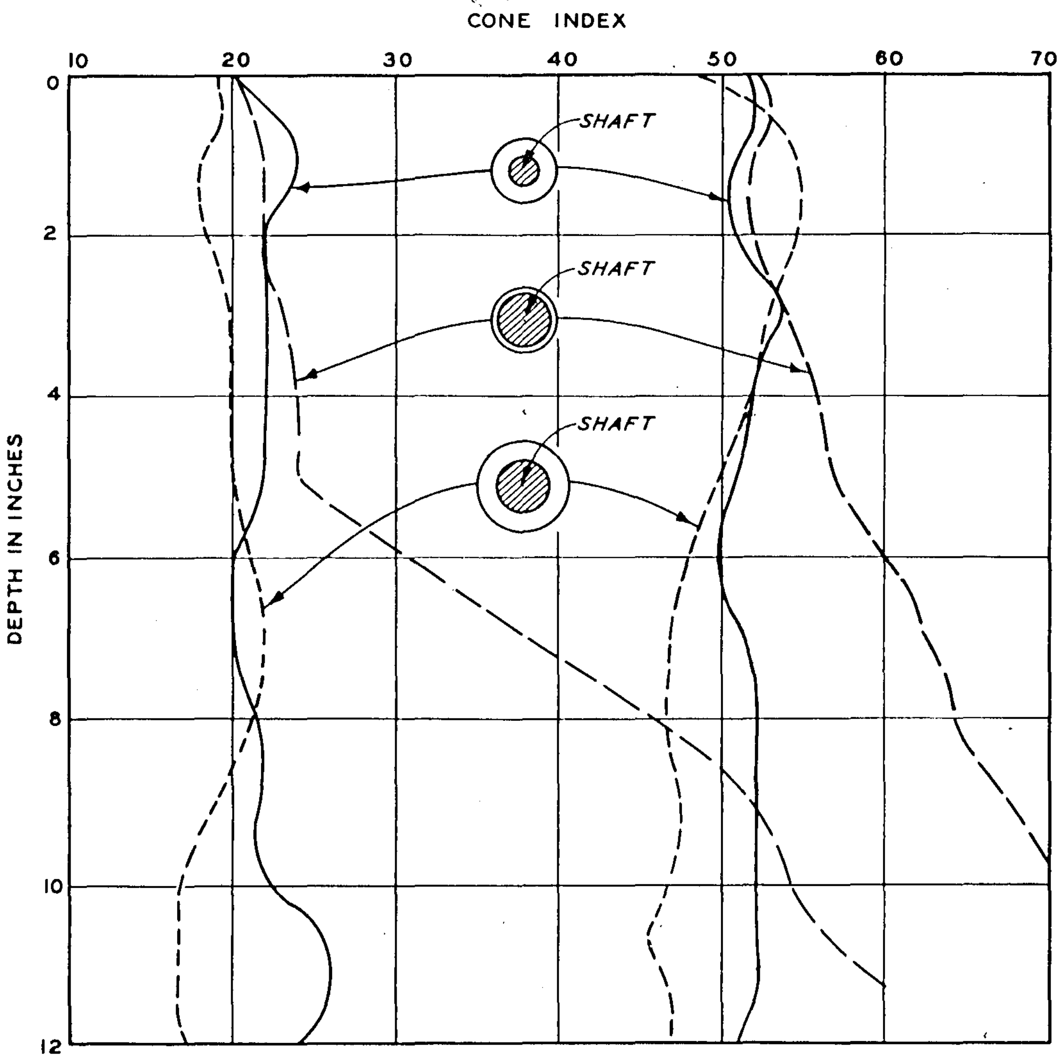
CLAY



SOIL MEASUREMENTS FROM INITIAL TESTS

CLAY

PLATE 4



LEGEND

———— ½-SQ-IN. CONE, ⅜-IN.-DIAMETER SHAFT

— — — ½-SQ-IN. CONE, ⅝-IN.-DIAMETER SHAFT

- - - - - 1-SQ-IN. CONE, ⅝-IN.-DIAMETER SHAFT

CONE PENTROMETER PROFILES

CLAY

PLATE 6

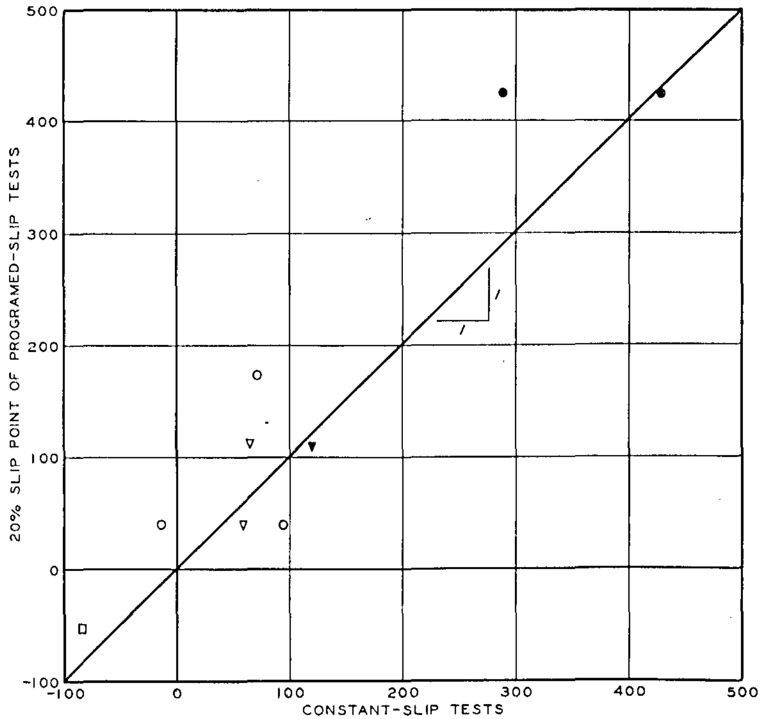


FIG. a. PULL AT 20% SLIP COMPARISON (LB)

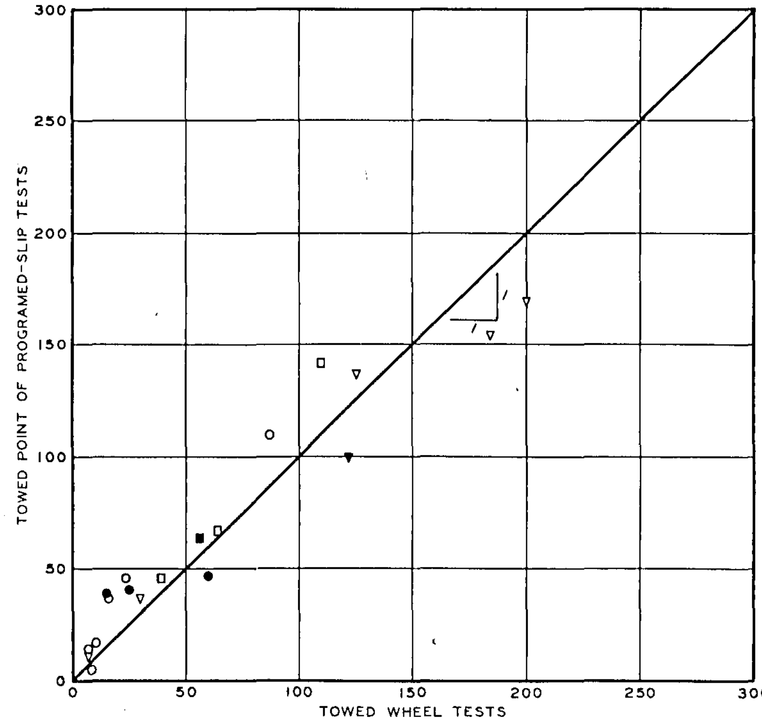


FIG. b. TOWED FORCE COMPARISON (LB)

LEGEND

▽ 15% DEFLECTION
□ 25% DEFLECTION
○ 35% DEFLECTION

OPEN SYMBOLS - INITIAL TESTS
CLOSED SYMBOLS - LATER TESTS

NOTE: MEASURED DATA WERE USED FOR CONSTANT-SLIP AND TOWED-WHEEL TESTS WHILE VALUES FROM FAIRED LINES WERE USED FOR PROGRAMED-SLIP TESTS.

PROGRAMED SLIP VS CONSTANT AND TOWED SLIP

9.00 - 14, 2-PR SMOOTH TIRE

FIRST PASS, CLAY

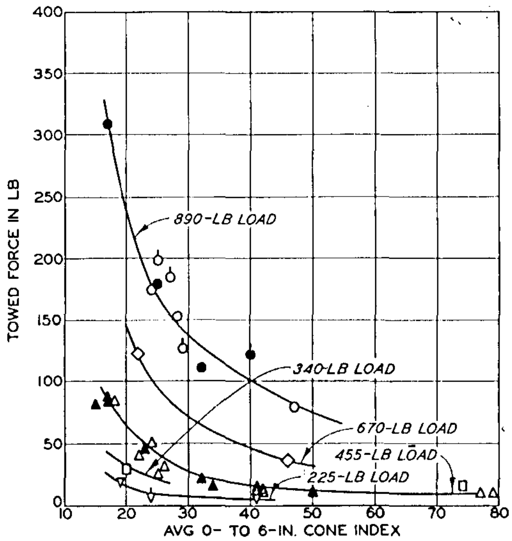


FIG. a. 15% DEFLECTION

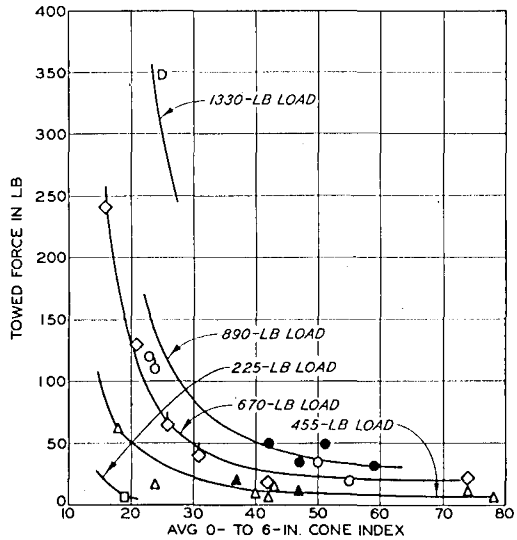


FIG. b. 25% DEFLECTION

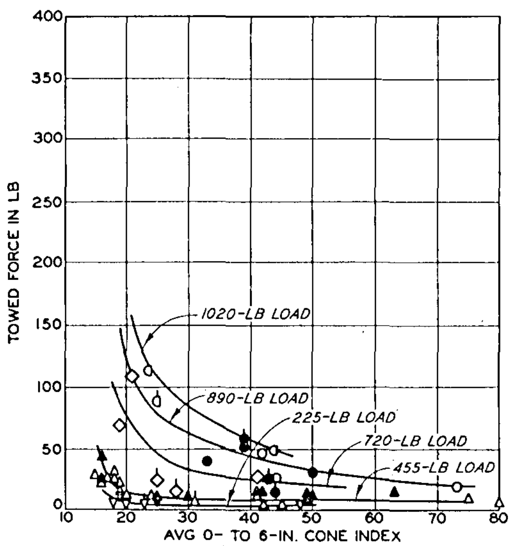


FIG. c. 35% DEFLECTION

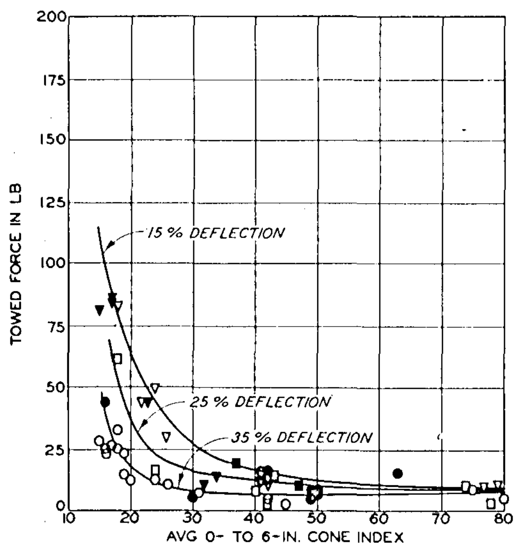


FIG. d. 455-LB LOAD

LEGEND

	LOAD, LB			DEFLECTION, %
	a	b	c	d
▽	225	—	225	15
□	340	290	—	25
△	455	455	455	—
◇	670	670	720	—
○	890	890	890	35
⌂	—	—	1020	—
D	—	1330	—	—

I INDICATES TOWED TEST

OPEN SYMBOLS - INITIAL TESTS
CLOSED SYMBOLS - LATER TESTS

TOWED FORCE VS CONE INDEX

9.00-14, 2-PR SMOOTH TIRE

FIRST PASS, CLAY

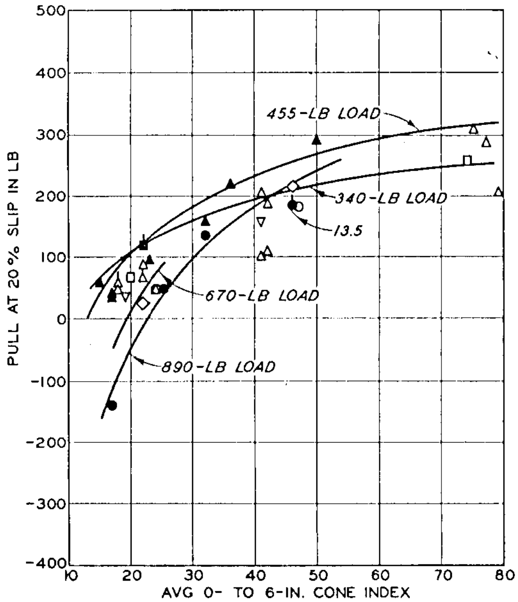


FIG. a. 15% DEFLECTION

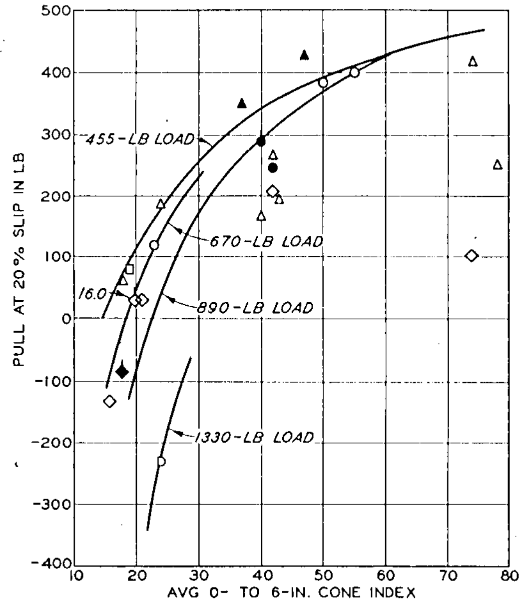


FIG. b. 25% DEFLECTION

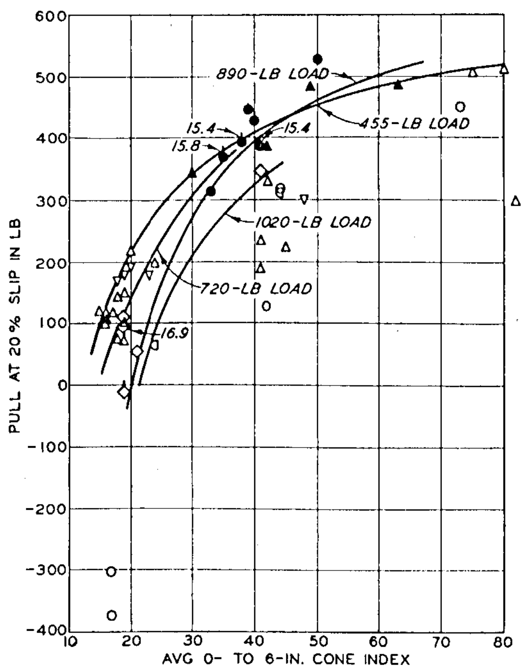


FIG. c. 35% DEFLECTION

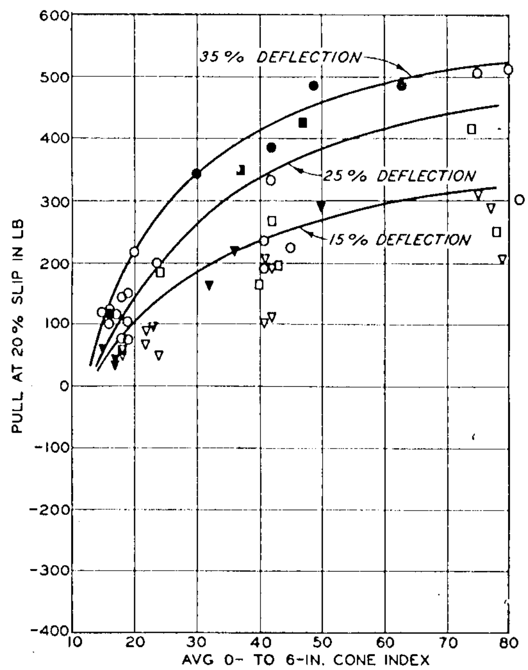


FIG. d. 455-LB LOAD

LEGEND

	LOAD, LB a	LOAD, LB b	LOAD, LB c	DEFLECTION, % d
▽	225	—	225	15
□	340	290	—	25
△	455	455	455	—
◇	670	670	720	—
○	890	890	890	35
◖	—	—	1020	—
D	—	1330	—	—

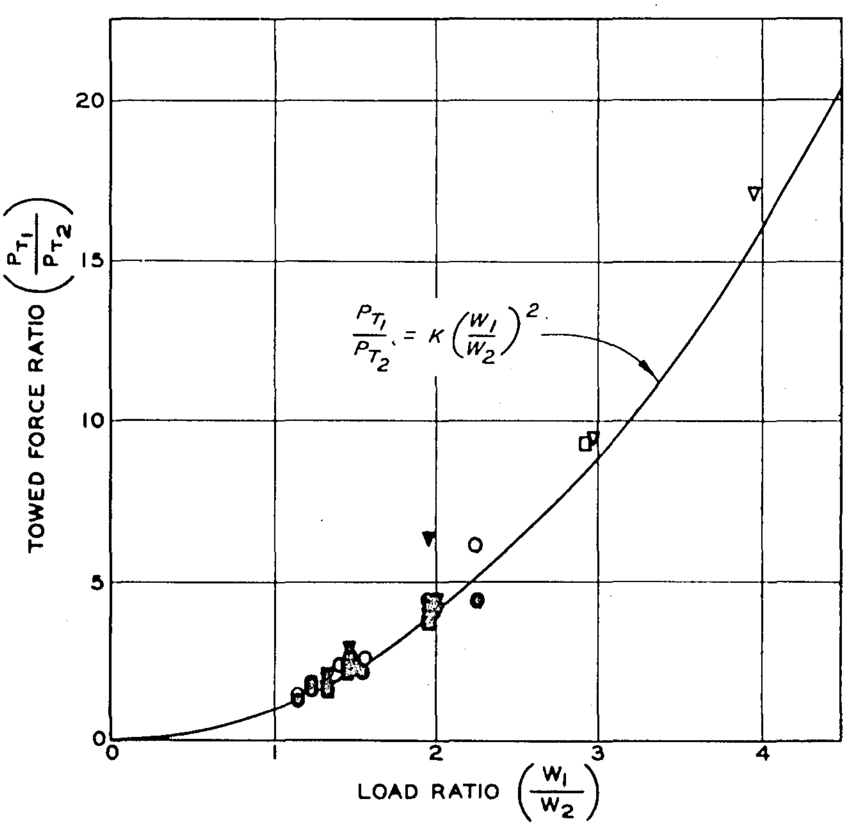
I INDICATES CONSTANT-SLIP TEST
OPEN SYMBOLS - INITIAL TESTS
CLOSED SYMBOLS - LATER TESTS

NOTE: NUMBERS BY SYMBOLS INDICATE SLIPS OTHER THAN 20%.

PULL AT 20% SLIP VS CONE INDEX

9.00-14, 2-PR SMOOTH TIRE

FIRST PASS, CLAY



LEGEND

▽ 15% DEFLECTION
□ 25% DEFLECTION
○ 35% DEFLECTION

OPEN SYMBOLS - VALUES AT 25 CONE INDEX

CLOSED SYMBOLS - VALUES AT 40 CONE INDEX

LOAD VS TOWED FORCE

9.00-14, 2-PR SMOOTH TIRE
FIRST PASS, CLAY

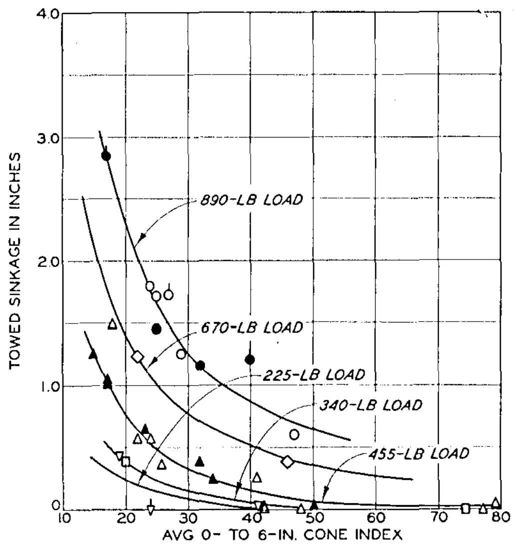


FIG. a. 15% DEFLECTION

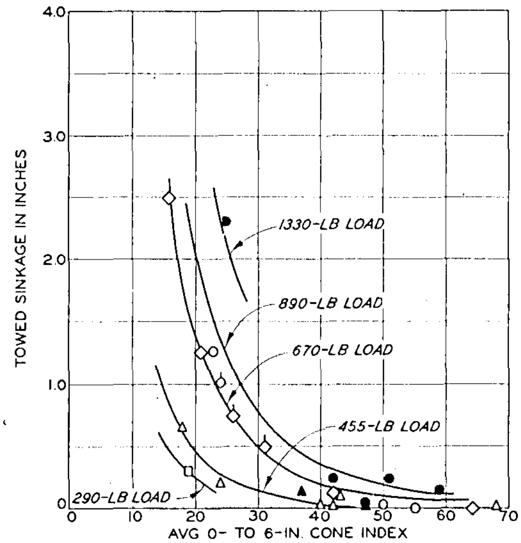


FIG. b. 25% DEFLECTION

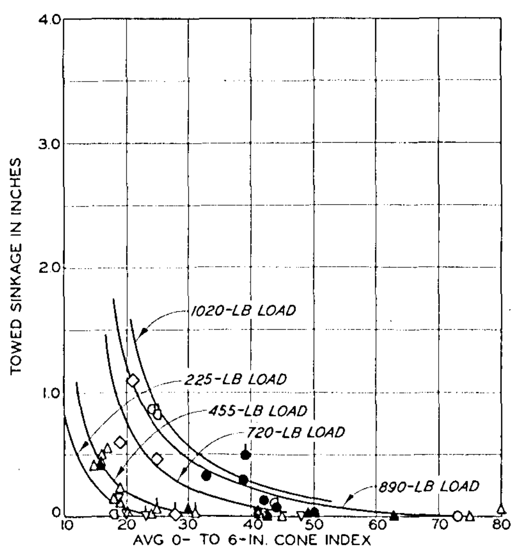


FIG. c. 35% DEFLECTION

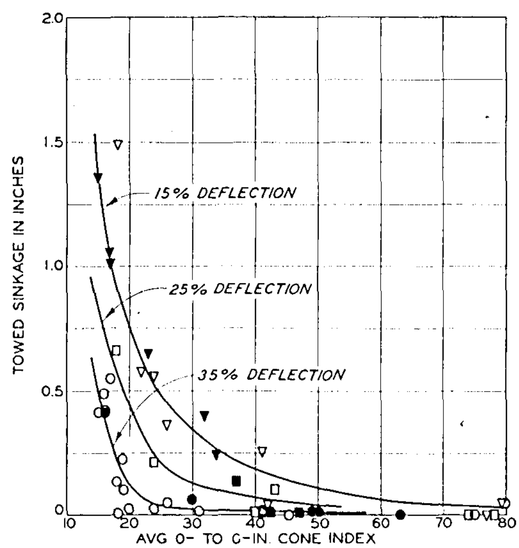


FIG. d. 455-LB LOAD

LEGEND

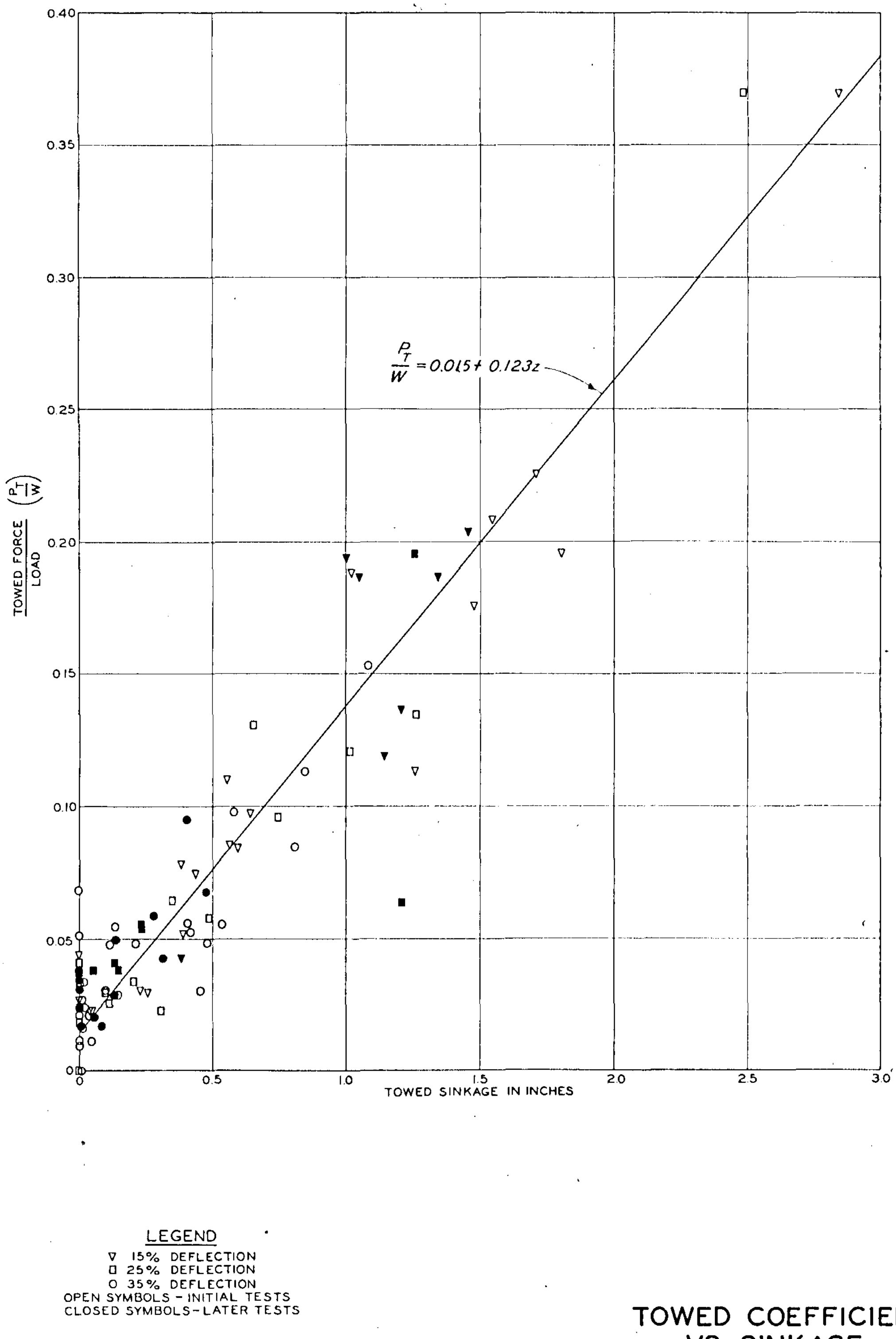
	LOAD, LB a	LOAD, LB b	LOAD, LB c	DEFLECTION, % d
▽	225	—	225	15
□	340	290	—	25
△	455	455	455	—
◇	670	670	720	—
○	890	890	890	35
ɑ	—	—	1020	—
D	—	1330	—	—
I	INDICATES TOWED TEST			

OPEN SYMBOLS - INITIAL TESTS
CLOSED SYMBOLS - LATER TESTS

SINKAGE OF TOWED WHEEL VS CONE INDEX

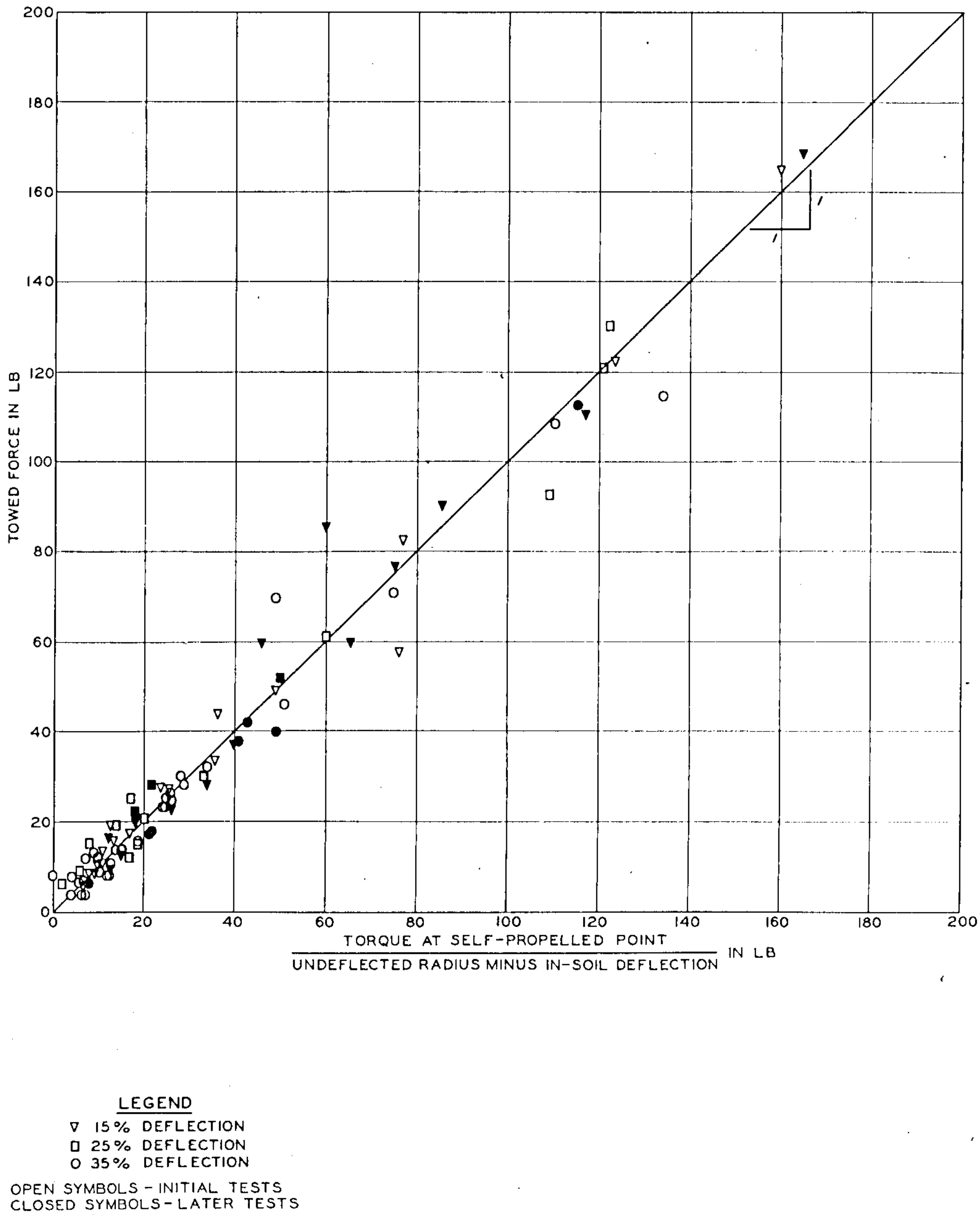
9.00-14, 2-PR SMOOTH TIRE

FIRST PASS, CLAY



TOWED COEFFICIENT VS SINKAGE

9.00-14, 2-PR SMOOTH TIRE
FIRST PASS, CLAY



TOWED FORCE VS $\frac{\text{TORQUE}}{\text{DEFLECTED RADIUS}}$

9.00-14, 2-PR SMOOTH TIRE
FIRST PASS, CLAY

U. S. ARMY ENGINEER WATERWAYS EXPERIMENT STATION
CORPS OF ENGINEERS
OFFICE OF THE DIRECTOR
VICKSBURG, MISSISSIPPI 39181

EFER TO

21 April 1966

Errata Sheet

Technical Report No. 3-666

PERFORMANCE OF SOILS UNDER TIRE LOADS

Report 3

TESTS IN CLAY THROUGH NOVEMBER 1962

February 1966

Plate 13, fig. d: Change label on top curve, which reads "15% deflection," to read "35% deflection," and change label on bottom curve, which reads "35% deflection," to read "15% deflection."

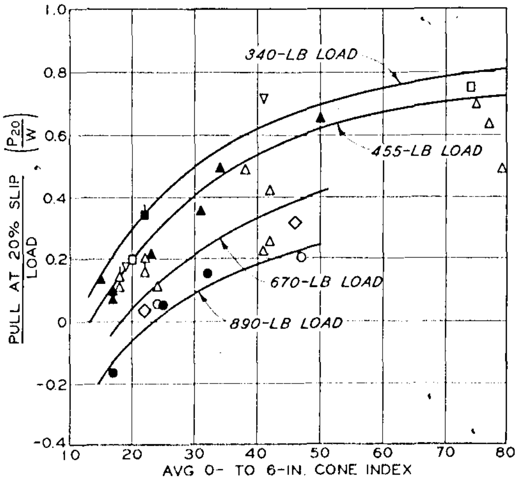


FIG. a. 15% DEFLECTION

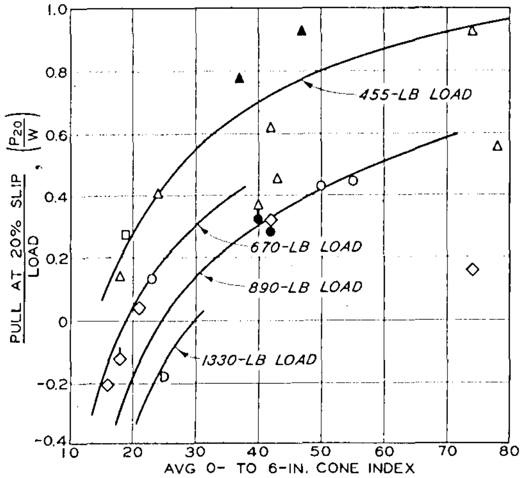


FIG. b. 25% DEFLECTION

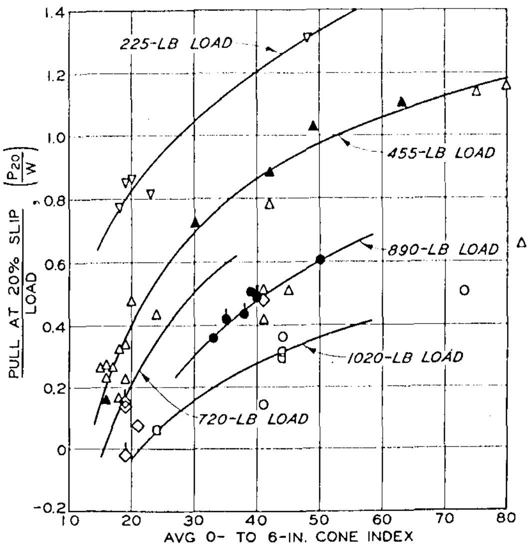


FIG. c. 35% DEFLECTION

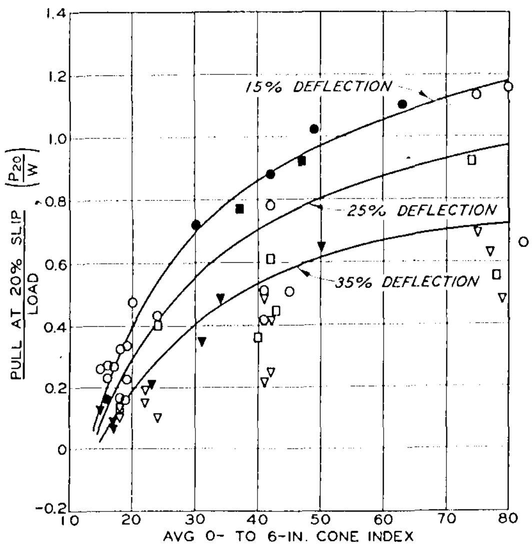


FIG. d. 455-LB LOAD

LEGEND

	LOAD, LB d	LOAD, LB b	LOAD, LB c	DEFLECTION, % d
▽	225	—	225	15
□	340	290	—	25
△	455	455	455	—
◇	670	670	720	—
○	890	890	890	35
⊂	—	—	1020	—
⊃	—	1330	—	—

I INDICATES CONSTANT-SLIP TEST
OPEN SYMBOLS - INITIAL TESTS
CLOSED SYMBOLS - LATER TESTS

PULL COEFFICIENT VS CONE INDEX

9.00-14, 2-PR SMOOTH TIRE
FIRST PASS, CLAY

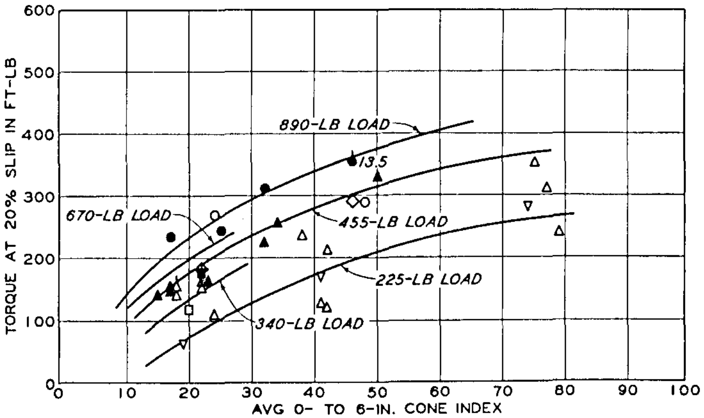


FIG. a. 15% DEFLECTION

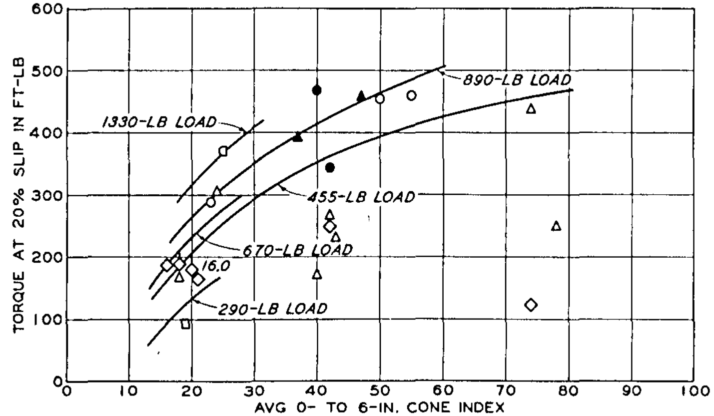


FIG. b. 25% DEFLECTION

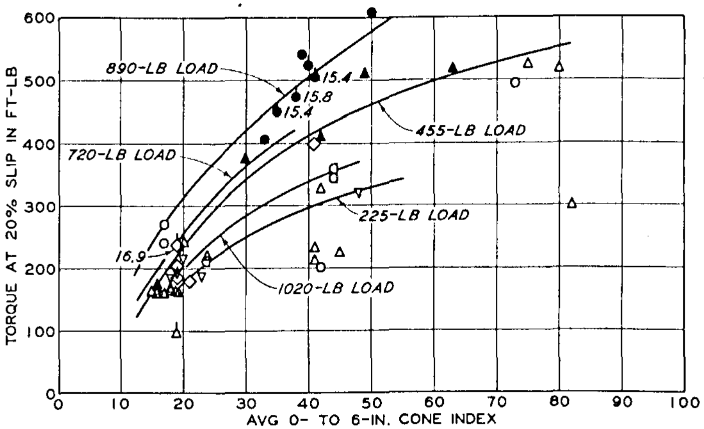


FIG. c. 35% DEFLECTION

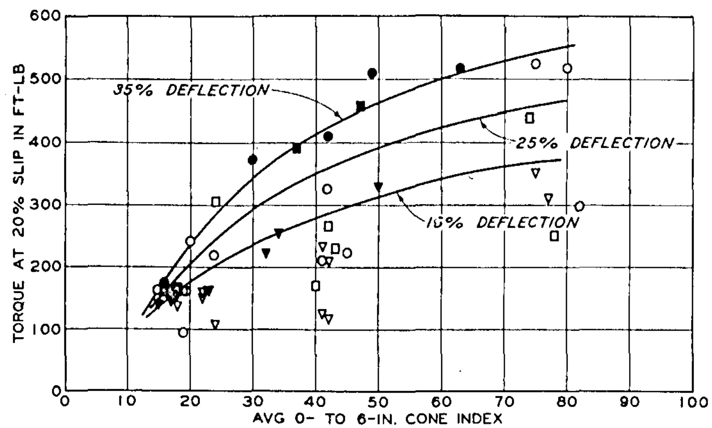


FIG. d. 455-LB LOAD

LEGEND

	LOAD, LB d	LOAD, LB b	LOAD, LB c	DEFLECTION, % d
▽	225	—	225	15
□	340	290	—	25
△	455	455	455	–
◇	670	670	670	–
○	890	890	890	35
ɑ	—	—	1020	–

I INDICATES CONSTANT-SLIP TEST

NOTE: OPEN SYMBOLS - INITIAL TESTS
CLOSED SYMBOLS - LATER TESTS
NUMBERS BY SYMBOLS INDICATE SLIPS OTHER THAN 20%.

TORQUE AT 20% SLIP VS CONE INDEX

9.00-14, 2-PR SMOOTH TIRE

FIRST PASS, CLAY

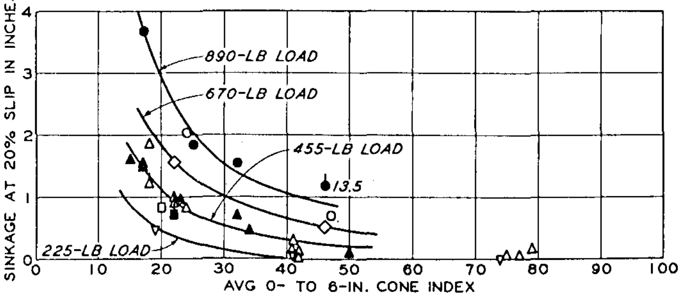


FIG. a. 15% DEFLECTION

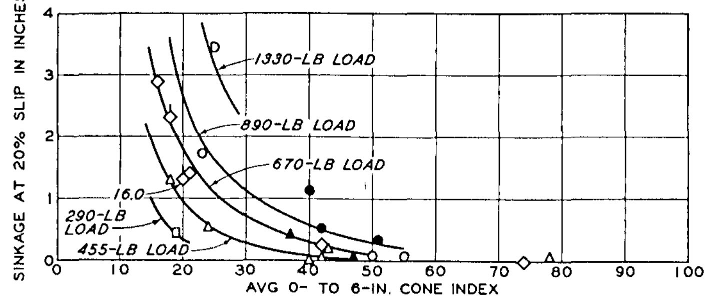


FIG. b. 25% DEFLECTION

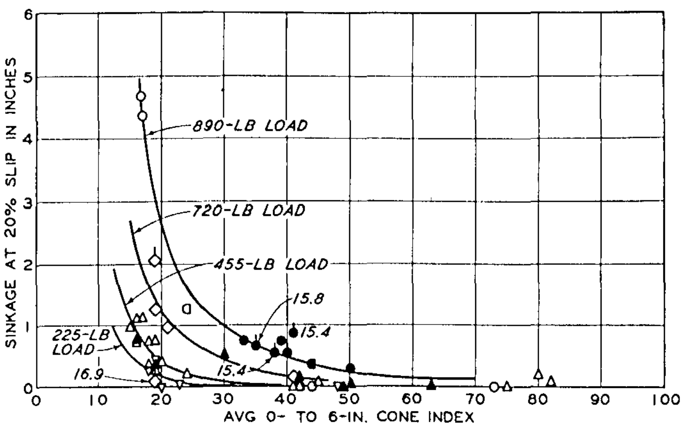


FIG. c. 35% DEFLECTION

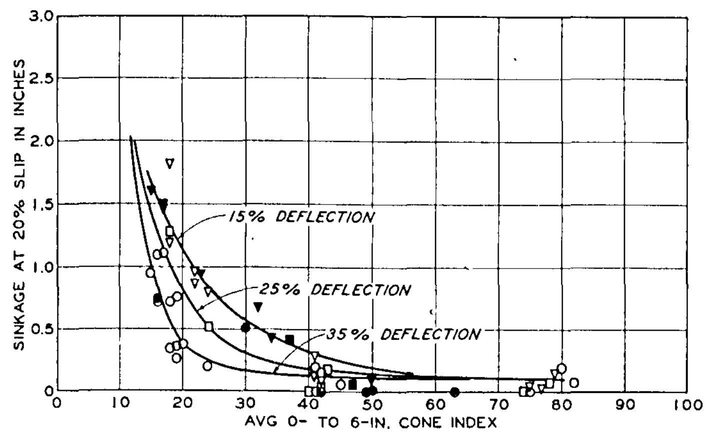


FIG. d. 455-LB LOAD

LEGEND

	LOAD, LB a	b	c	DEFLECTION, % d
▽	225	—	225	15
□	340	290	—	25
△	455	455	455	—
◇	670	670	720	—
○	890	890	890	35
⊓	—	—	1020	—
D	—	1330	—	—

I INDICATES CONSTANT-SLIP TEST

NOTE: OPEN SYMBOLS - INITIAL TESTS
CLOSED SYMBOLS - LATER TESTS
NUMBERS BY SYMBOLS INDICATE SLIPS OTHER THAN 20%.

SINKAGE AT 20% SLIP VS CONE INDEX

9.00-14, 2-PR SMOOTH TIRE

FIRST PASS, CLAY

PLATE 15

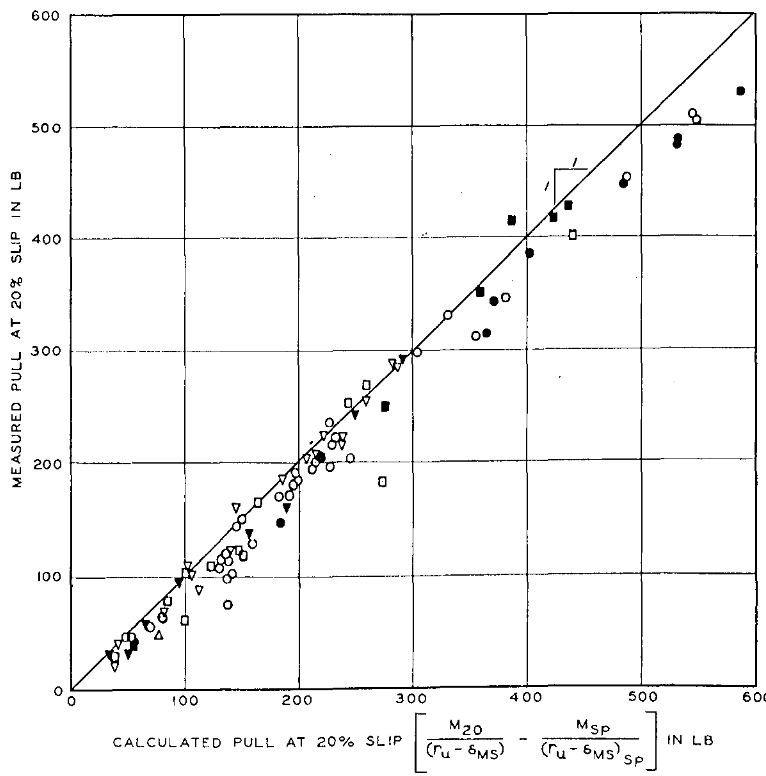


FIG. a.

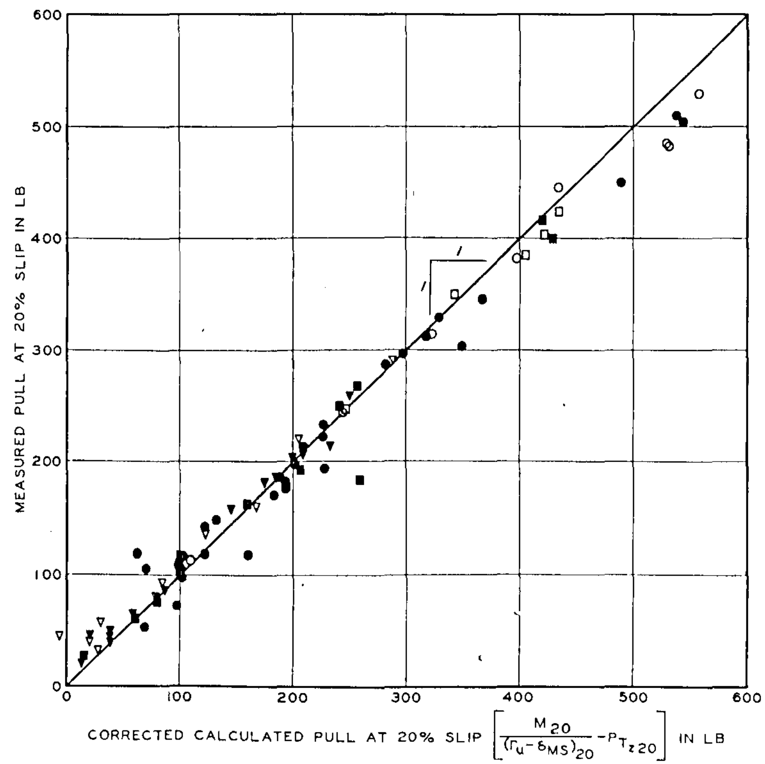


FIG. b.

LEGEND

▽ 15% DEFLECTION
□ 25% DEFLECTION
○ 35% DEFLECTION

OPEN SYMBOLS - INITIAL TESTS
CLOSED SYMBOLS - LATER TESTS

MEASURED VS CALCULATED PULL AT 20% SLIP

9.00-14, 2-PR SMOOTH TIRE

FIRST PASS, CLAY

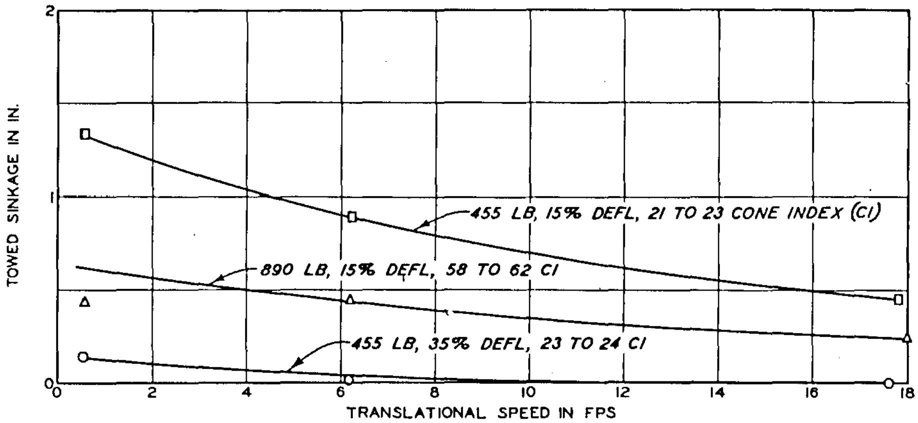


FIG. a. TOWED SINKAGE

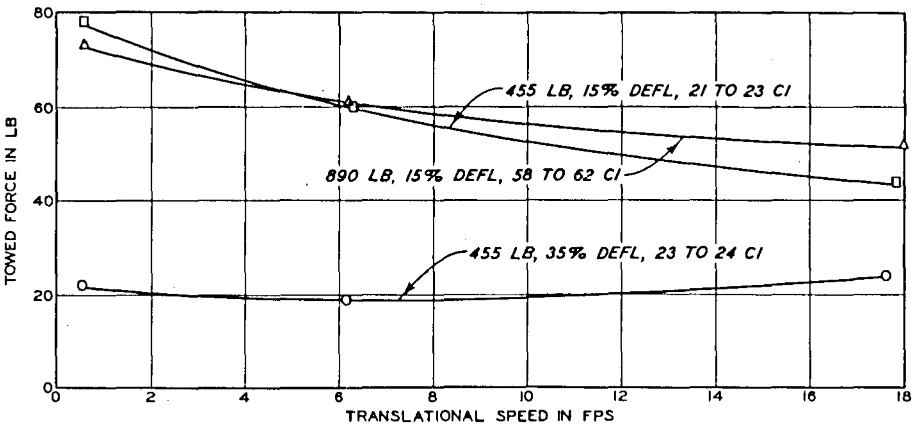
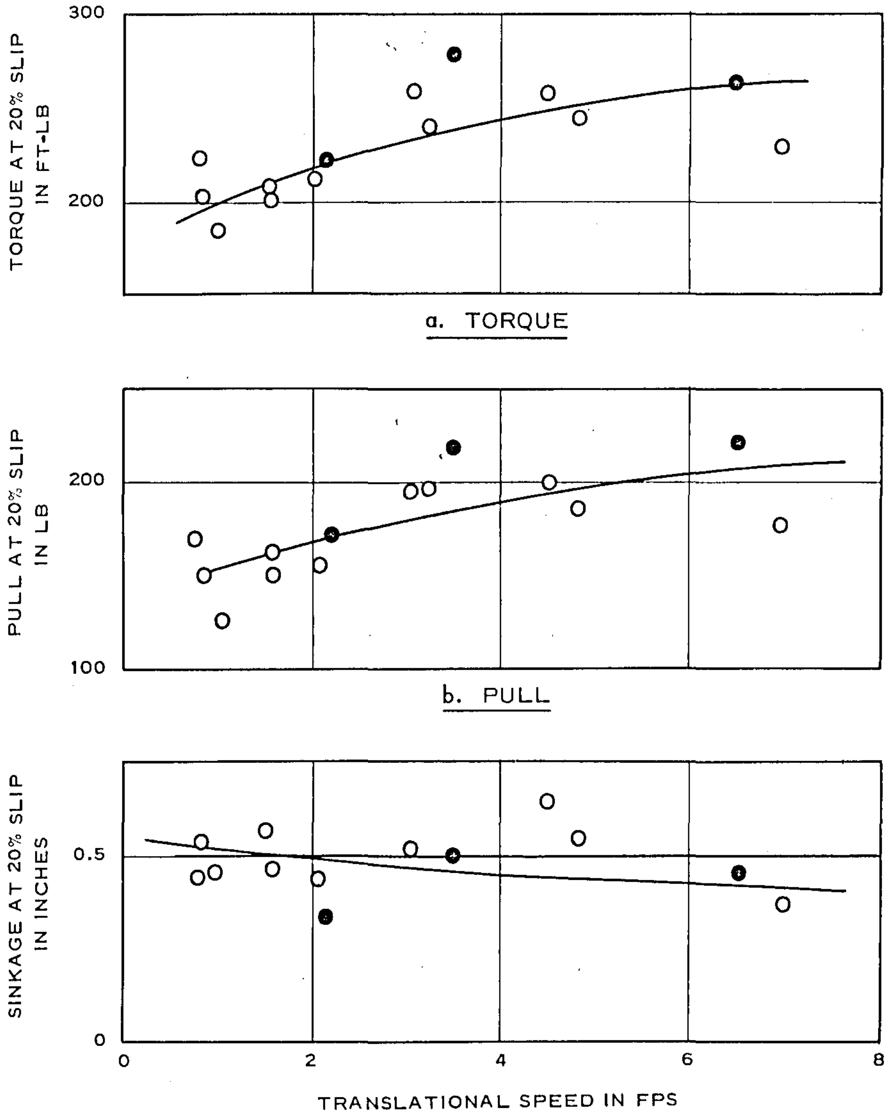


FIG. b. TOWED FORCE

EFFECT OF SPEED ON TOWED-WHEEL PERFORMANCE

9.00-14, 2-PR SMOOTH TIRE

FIRST PASS, CLAY



a. TORQUE

b. PULL

c. SINKAGE

LEGEND

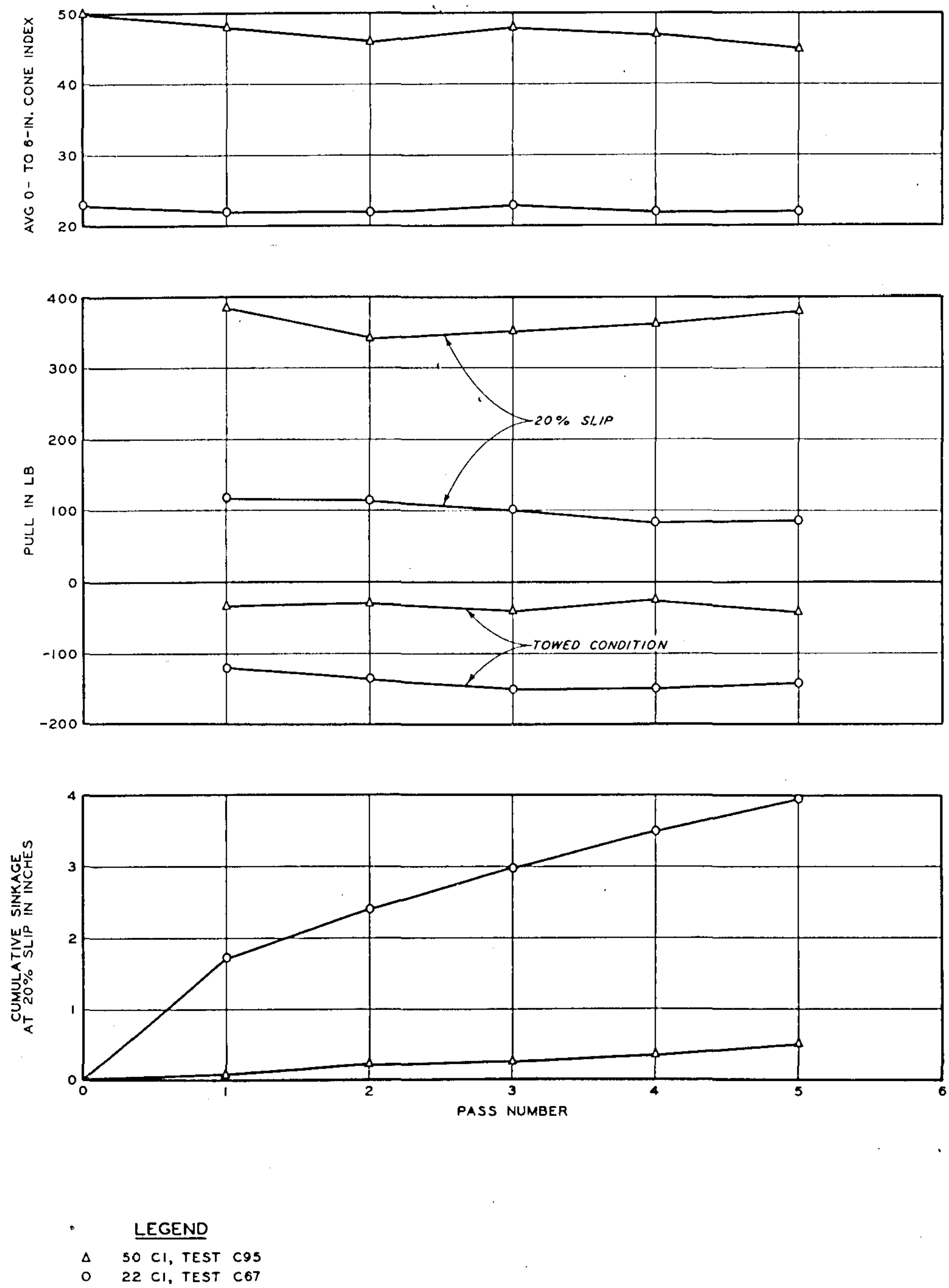
O CONSTANT-SLIP

● PROGRAMED-SLIP

EFFECT OF SPEED ON
POWERED-WHEEL PERFORMANCE

455-LB LOAD, 15% DEFLECTION, 36 CONE INDEX
9.00-14, 2-PR SMOOTH TIRE

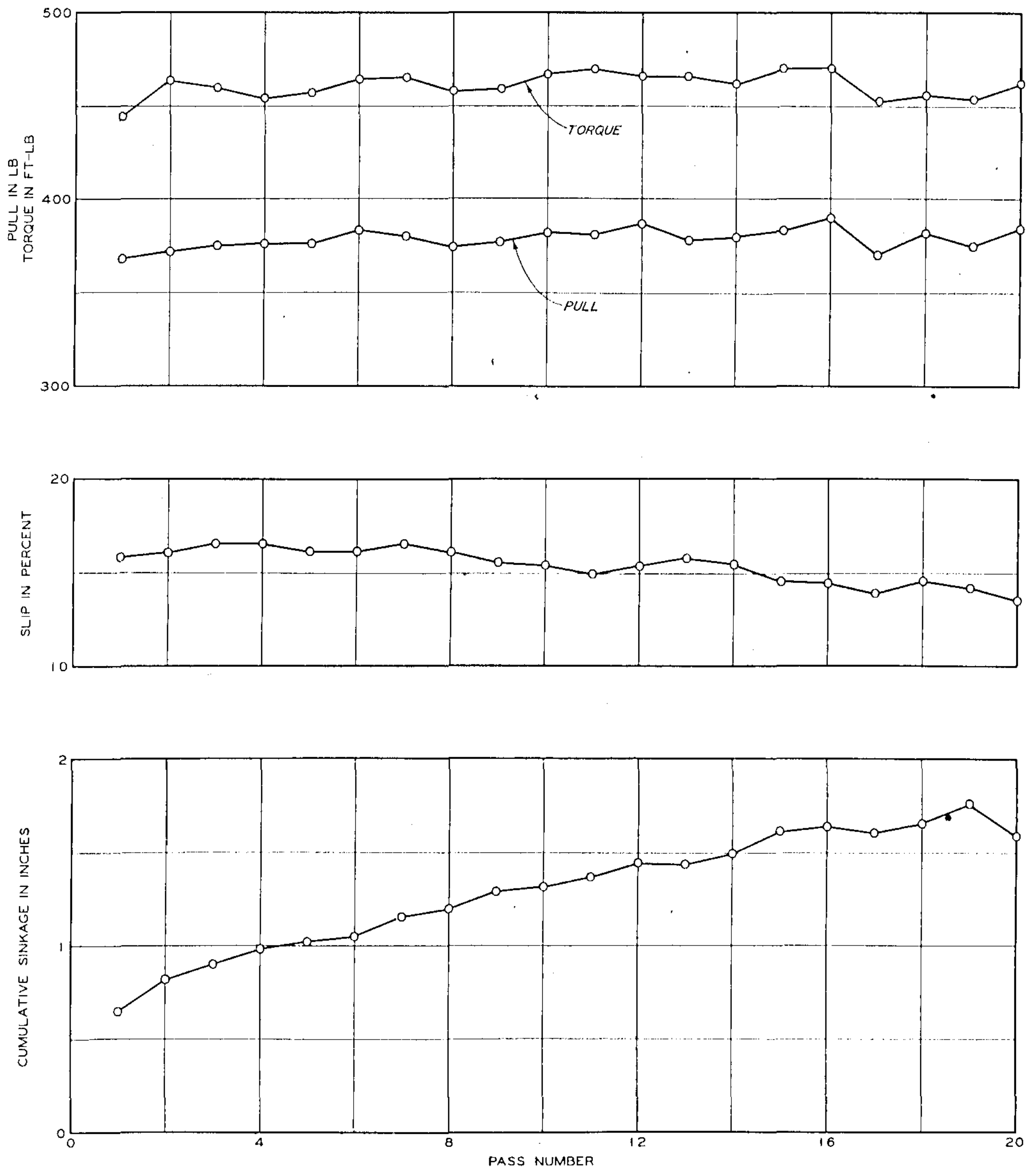
FIRST PASS, CLAY



EFFECTS OF REPETITIVE TRAFFIC ON PERFORMANCE IN HIGH- AND LOW-STRENGTH CLAY

890-LB LOAD,
25% DEFLECTION, 5 PASSES

9.00-14, 2-PR SMOOTH TIRE



EFFECTS OF REPETITIVE TRAFFIC ON PERFORMANCE

890-LB LOAD, 35% DEFLECTION, 35 CONE INDEX, 20 PASSES

9.00-14, 2-PR SMOOTH TIRE

CLAY

PLATE 20

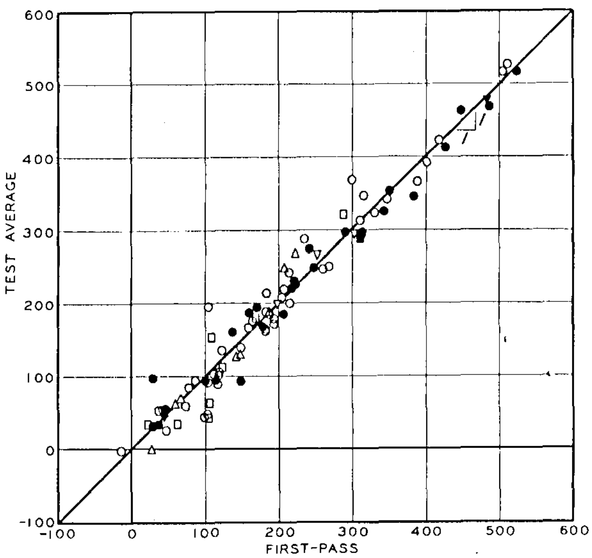


FIG. a. PULL (LB) AT 20% SLIP

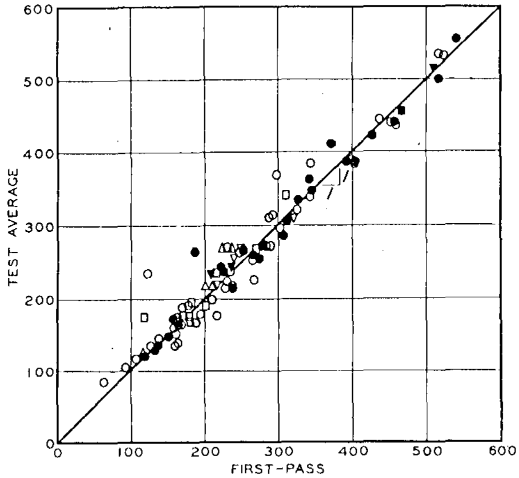


FIG. b. TORQUE (FT-LB) AT 20% SLIP

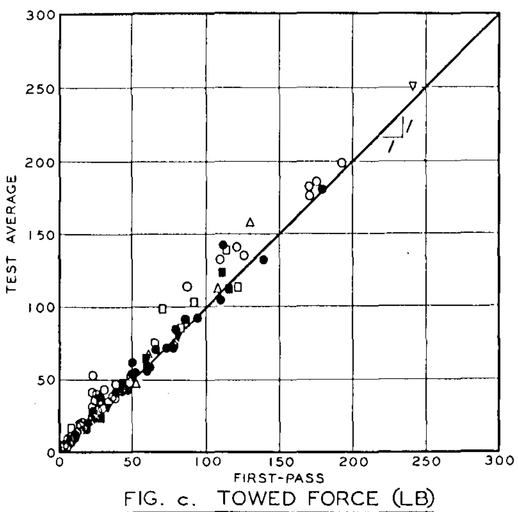


FIG. c. TOWED FORCE (LB)

LEGEND

O	5 PASS TEST
Δ	4 PASS TEST
□	3 PASS TEST
∇	2 PASS TEST

OPEN SYMBOLS - INITIAL TESTS
CLOSED SYMBOLS - LATER TESTS

NOTE: ALL PASSES USED TO DETERMINE TEST AVERAGE.

RELATION OF TEST AVERAGE TO FIRST-PASS PERFORMANCE

900-14, 2-PR SMOOTH TIRE

CLAY

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13. ABSTRACT

This report analyzes the results of 184 multiple-pass tests with a single, smooth, pneumatic tire (9.00-14, 2-PR) in a fat clay at a high degree of saturation. These tests were performed using a wide range of tire loads, tire deflections, and soil strengths. Some of the tests were conducted to study the influence of speed on performance. Basic plots of the data (one dependent versus one independent variable with all other independent variables held constant) show the relative effect of each independent test variable on tire performance. Scatter of the pull and torque data points was found to be quite large for the early tests. An examination of the data showed that a difference in soil strength between the soil surface and the remainder of the soil mass was the probable cause of the scatter. Improvement in soil processing techniques subsequently produced more uniform soil conditions and virtually eliminated this scatter in the later tests. A simple static analysis was found adequate to represent the forces and moments on a towed or powered pneumatic tire operating at small sinkages in a soft clay.

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