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MEASURING SOIL PROPERTIES IN VEHICLE MOBILITY RESEARCH. REPORT 7. BEHAVIOR OF FINE-GRAINED SOILS UNDER HIGH-SPEED TIRE LOADS

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Vicksburg, Mississippi

June 1975

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Report 7

BEHAVIOR OF FINE-GRAINED SOILS UNDER HIGH-SPEED TIRE LOADS

by

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June 1975

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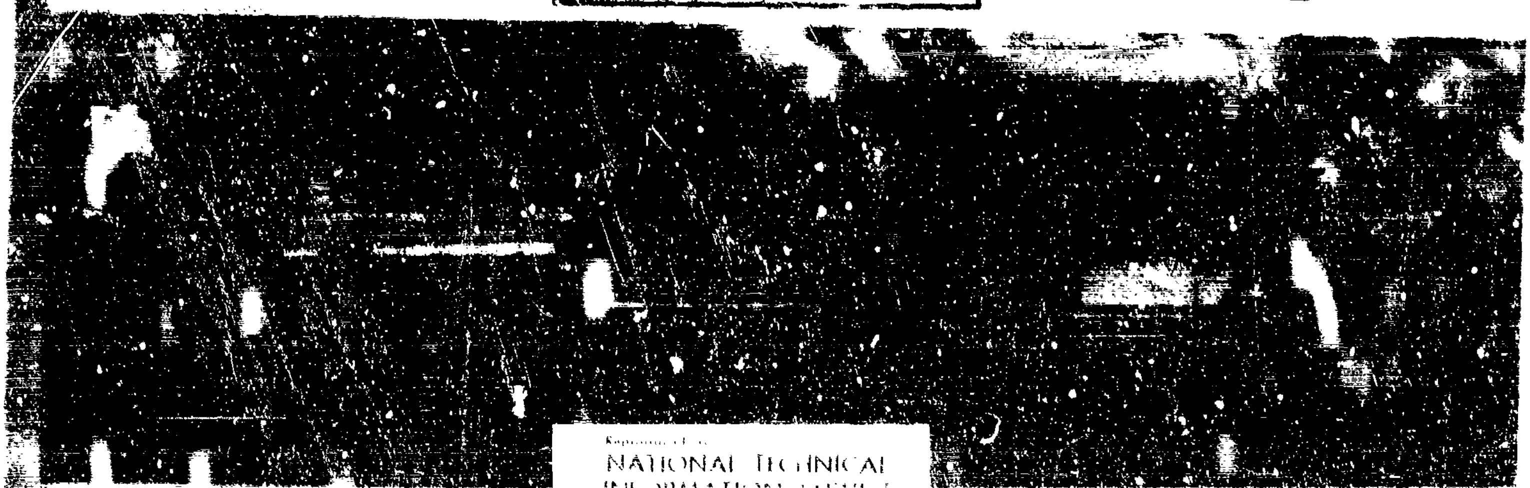

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This study examined the effects of wheel speed on the performance in fine-grained soils of single pneumatic tires, full-size wheeled vehicles, and a prototype aircraft under several tire operational modes. Results from powered-wheel single-tire tests conducted at WES showed that the dimensionless clay-tire numeric $N_{cl} = (C_s bd/W) \times (\delta/h)^{1/2} \times 1/[1 + (b/2d)]$, where C_s = standard cone index, b = tire section width, d = tire diameter, W = wheel load, and δ/h = tire deflection ratio, can be used to describe tire performance (Continued)

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20. ABSTRACT (Continued).

at speeds to at least 18 ft/sec if the value of C_s in N_{c1} is adjusted to reflect viscouslike soil strength behavior caused by tire-soil interaction. Results from WES speed tests of five prototype wheeled vehicles in the field indicated that the same velocity-adjusted numeric as above (except that rating cone index RCI replaces cone index C_s) is closely related to the soil motion resistance coefficient R_s/W_v. Data from tests conducted for the U. S. Air Force showed that for one particular combination of aircraft, running gear, and wing-flap setting, a clay-tire numeric, $N_{c0} = (C_s bd/W) \times (\delta/h)^{1/2}$, is closely associated with the percent increase in takeoff distance required on unsurfaced clay runways as compared to that on a paved runway. From another study conducted for the Air Force, data revealed that a relation between the dimensionless drag coefficient and the Reynolds number (modified from fluid mechanics to fit the clay-tire situation) can be used to describe the combined influence of viscouslike and inertial changes in soil strength on the drag of a free-rolling tire at speeds to about 150 ft/sec. For the braked-wheel operational mode, a simple method of predicting drag ratio (D/W) was developed on the basis of a reasonably stable, linear relation that exists between D/W and the rut depth coefficient (r/d) for wheel speeds to about 150 ft/sec.

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PREFACE

The study reported herein was funded by Department of the Army Project 4A061101A91D, "In-House Laboratory Independent Research," under the sponsorship of the Assistant Secretary of the Army (R&D). The study was conducted during 1973-1974.

The project was conceived by Mr. G. W. Turnage, Mobility Research and Methodology Branch (MRMB), Mobility Systems Division (MSD), Mobility and Environmental Systems Laboratory (MESL), at the U. S. Army Engineer Waterways Experiment Station (WES). Most of the data analyzed in this report were obtained from tabulations in the published literature. Also presented are some hitherto unreported data from a previous test program accomplished by personnel of MRMB and the Mobility Investigations Branch (MIB), MESL. This study was conducted under the general supervision of Messrs. W. G. Shockley, Chief of MESL, and A. A. Rula, Chief of MSD, and under the direct supervision of Mr. C. J. Nuttall, Jr., Chief of MRMB. The report was prepared by Mr. Turnage.

Special acknowledgment is made to Dr. E. T. Selig and Mr. C. T. Wang, State University of New York at Buffalo, Buffalo, New York, for furnishing the author with a corrected tabulation of data from tests conducted at the NASA Langley Research Center, Landing Loads Test Track, and for their permission to use these data.

BG E. D. Peixotto, CE, and COL G. H. Hilt, CE, were Directors of WES during the conduct of the study and the preparation of the report. Mr. F. R. Brown was Technical Director.

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CONVERSION FACTORS, U. S. CUSTOMARY TO METRIC (SI) UNITS OF MEASUREMENT

U. S. customary units of measurement used in this report can be converted to metric (SI) units as follows:

Multiply	By	To Obtain
inches	2.54	centimetres
feet	0.3048	metres
square inches	6.4516	square centimetres
square feet	0.09290304	square metres
pounds (mass)	0.4535924	kilograms
pounds (force)	4.448222	newtons
tons (mass)	907.1847	kilograms
pounds (force) per square inch	6.894757	kilopascals
inches per minute	2.54	centimetres per minute
feet per second	0.3048	metres per second
knots (international)	0.5144444	metres per second
miles per hour (U. S. Statute)	1.609344	kilometres per hour