SUMMARY REPORT 136-2(S)

A TECHNIQUE FOR MEASURING THE DISPLACEMENT VECTOR THROUGHOUT THE BODY OF A PAVEMENT STRUCTURE SUBJECTED TO CYCLIC LOADING

SUMMARY REPORT
of
Research Report Number 136-2
Study 2-8-69-136

To measure the cyclic motion of a point below the surface of a pavement structure, a miniature geophone is emplaced in a small diameter hole drilled into the structure.

Cooperative Research Program of the
Texas Transportation Institute and the Texas Highway Department
In Cooperation with the
U. S. Department of Transportation, Federal Highway Administration

August, 1971

TEXAS TRANSPORTATION INSTITUTE
Texas A&M University
College Station, Texas

A Technique for Measuring the Displacement Vector Throughout the Body of a Pavement Structure Subjected to Cyclic Loading

by

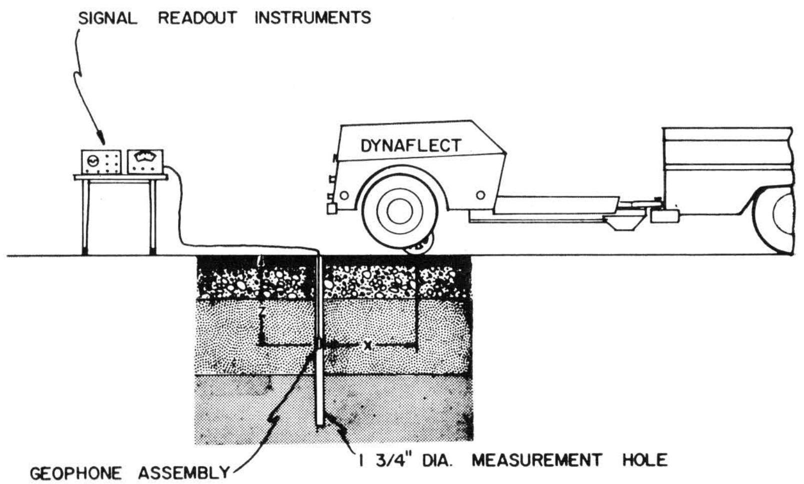
William M. Moore

and

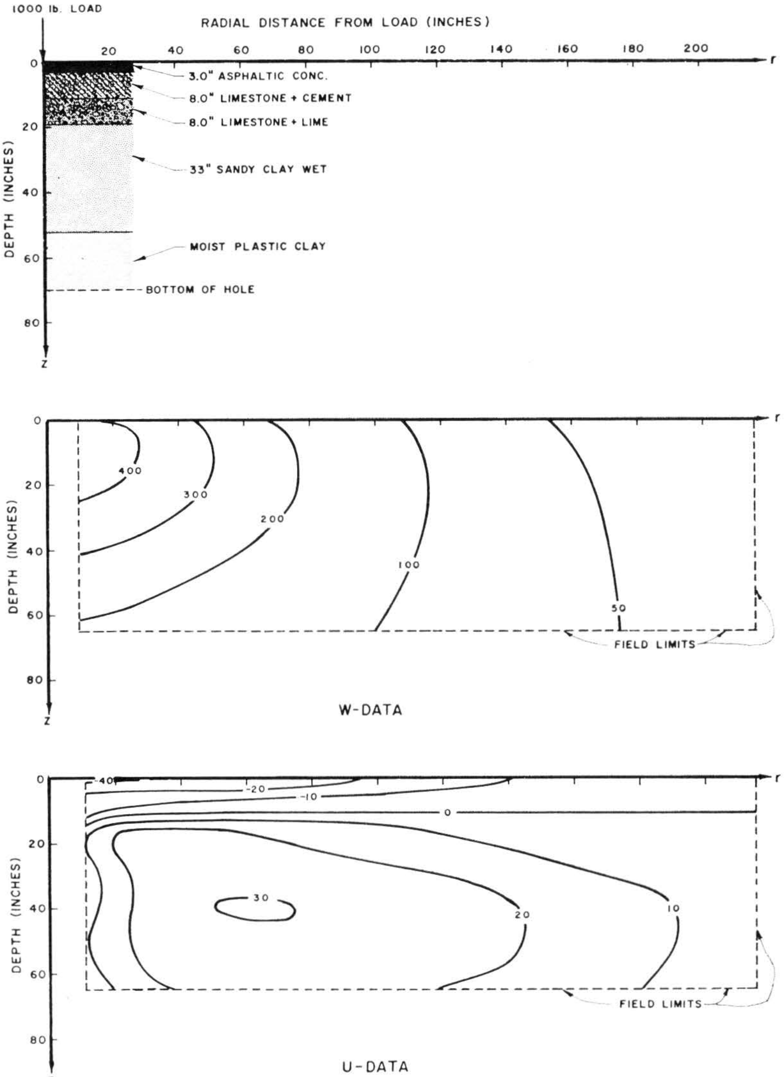
Gilbert Swift

Direct observation of the vertical deflection on a pavement surface produced by a known load is a technique widely used in the evaluation of pavement structures. The Benkelman beam, for example, permits convenient measurements of deflection produced by a dual-wheel load with respect to a base located a few feet away. The Dynaflect provides measurements of deflection caused by a cyclic load with respect to an inertial base.

The Texas Highway Department's flexible pavement design system, now on trial in several districts, relies in part upon an empirical relationship between material coefficients, layer thicknesses, and Dynaflect deflections. Use of this system has pointed out several weak points in the empirically derived deflection relationship and has indicated a pressing need for a mathematical model which more accurately describes pavement behavior. The basic objective of this study is to provide such a model.

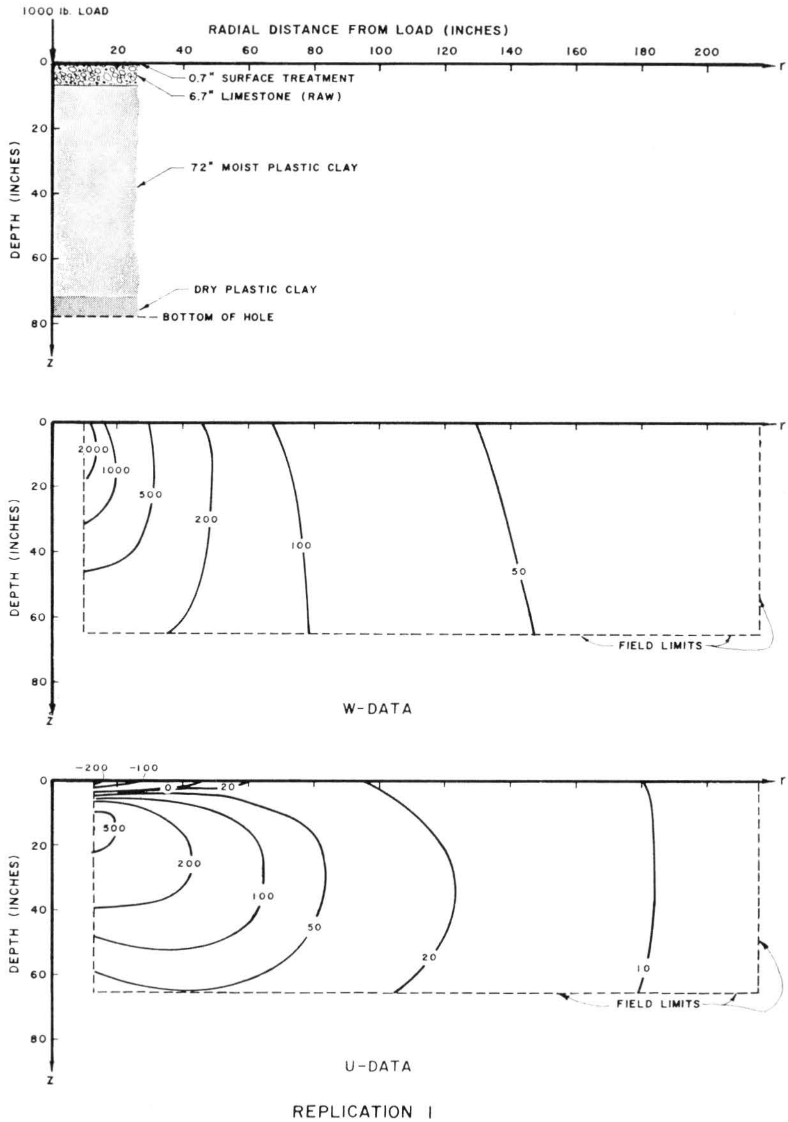


Technique for measurement of subsurface motion induced by Dynaflect. A geophone is temporarily clamped in place at a pre-selected depth in a drilled hole. The motion is measured at various horizontal and vertical distances from the load. These distances are varied by altering x and z in steps.



REPLICATION I

Displacement fields measured in section 25. The structure of the pavement section as determined in the measurement hole is shown at the top, contours of equal vertical displacement, w, are shown in the center, and contours of equal horizontal displacement, u, are shown at the bottom. Displacement values are in microinches.



Displacement fields measured in section 32. The structure of the pavement section as determined in the measurement hole is shown at the top, contours of equal vertical displacement, w, are shown in the center, and contours of equal horizontal displacement, u, are shown at the bottom. Displacement values are in microinches.

An accurate model for predicting the displacement of points within a pavement structure under load will provide design engineers with a means of calculating strains within the structure and will be an important step in the development of a more realistic approach to pavement design. Accordingly, this research has been undertaken to develop such a model from full-scale measurements of the displacement vector field (or motions of points) within the body of a pavement structure loaded by the Dynaflect.

Methodology

Using a newly developed technique, the horizontal and vertical components of the displacement vector field have been measured on the surface and within the body of several pavement test sections of the Texas A&M Pavement Test Facility. A cyclic load is applied on the surface by means of the Dynaflect. The resulting displacements at various depths within the structure are measured by means which include a miniature geophone emplaced in a 1¾ inch diameter hole drilled through the pavement. Under the influence of the 1000 lb. oscillatory vertical load on the surface, movement of the geophone produces an electrical output signal proportional to the cyclic displacement. The structure is explored in depth by shifting the vertical location of the geophone, and the distance from load to measuring point is varied by positioning the Dynaflect at various horizontal distances from the measuring hole. Separate geophones are used to measure vertical and horizontal displacement components.

The displacement component fields have been measured on several different pavement sections. The fields were found to differ appreciably from one pavement to another, but to resemble generally the fields computed for layered elastic systems.

Replicate sets of observations, made at two locations approximately 24 feet apart, were compared for three test sections. The replication errors within sections were found to be acceptably small in comparison with the differences observed between sections.

Conclusions

From the results to date in this study the following conclusions appear warranted:

1. A practical fieldworthy measuring technique has been developed for use with the Dynaflect to observe the displacement vector throughout the body of a pavement section.

2. Replication errors observed on a test section are reasonably small compared to variations between sections.

3. The observed vector displacement fields resemble fields computed for a layered elastic system to which an equal static load is applied.

4. It appears feasible to determine for each section a set of elastic layers for which the computed displacement fields will substantially match the observations.

5. Examination of the data indicates that it should be possible to formulate a useful and practical mathematical model representing the displacement response of the several pavement sections.

Implementation Statement

The end results of this research study are expected to provide a significant improvement to the empirical deflection equation currently being used in the Texas Highway Department's flexible pavement design system.

The published version of this report may be obtained by addressing your request as follows:

R. L. Lewis, Chairman
Research and Development Committee
Texas Highway Department—File D-8
11th and Brazos
Austin, Texas 78701 (Phone 512/475-2971)