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THE DISTRIBUTION OF SOIL PRESSURES

UNDER PAVEMENTS

THESIS FOR DEGREE OF B. S.

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Permanents

Take Soil pressure
under permanent

THE DISTRIBUTION OF SOIL PRESSURES UNDER PAVEMENTS

A Thesis Submitted to

The Faculty of

THE MICHIGAN STATE COLLEGE

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By

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Candidates for the Degree

of

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Introduction.

The present need for intense study of subgrade condition is evident in the number of subgrade failures which have resulted in the failure of the hard surface above it. In the future there will be over so many more miles of concrete roads built than in the past. Larger units of traffic must be considered, thus greater chance for failure. Previous road slabs were not designed for uniform strength, but rather of uniform thickness. In places it was too thick and in some places too thin.

High speed traffic which results in high impact stresses and high stresses resulting from the added tendency to increase truck loads throughout the country result in the destruction of many types of road surfaces. Whether or not these conditions are the result of inadequate laws they must be met in the future. Some speed and load regulation should be made but still there is the question of economic design, design for uniform strength and not for uniform thickness.

Present specifications call for uniform thickness over all classes of soil. We will attempt to show how experiment will indicate an economic need for uniform strength specifications carrying specific loads over whole length and width of pavement regardless of type of soil or sub soil conditions.

The pavements on clay, loam, or peat soils must have an added thickness while a much lesser thickness will suffice on the more stable soils such as sand or gravel. A great waste may be saved by the proper design of concrete roads.

Indication of failures may lead one to note that there is something wrong with the present road design. Failures on soils of high bearing power total 17%, while under same conditions failures on low bearing soils are as high as 70%. On gravel and sand soils failures are as low as 2 to 3% and are usually due to faulty construction.* These figures would further indicate that uniform strength design should replace the obsolete uniform section design.

The most important need is the determining of the bearing power of the different soils and the determining of the maximum wheel loads. The latter, set by the state law, leaves the determining of the bearing power of the different classes of soils undone.

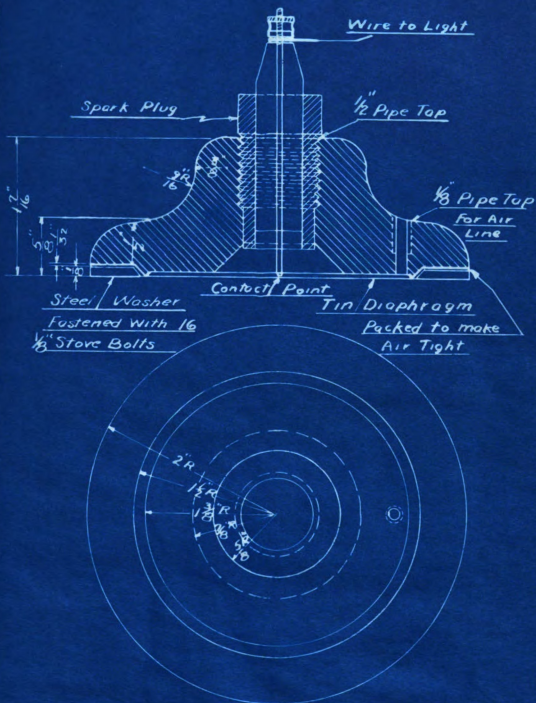
The greater part of the time allowed to this thesis was spent in the design of an instrument that would accurately measure soil pressures. In the construction of this apparatus we attempted to find a means of measuring the pressure directly under the pavement in pounds per square inch. This apparatus was constructed from a casting machined into the desired shape with an electric connection and diaphragm so connected that when the diaphragm was subjected to pressure it deflected and completed the electric circuit and lit the light. Air was then pumped in above the diaphragm until the connection was broken indicated by the light going out. At this point the soil pressure and the air pressure was assumed to be in equilibrium so that the air pressure in pounds per square inch would equal the soil pres-

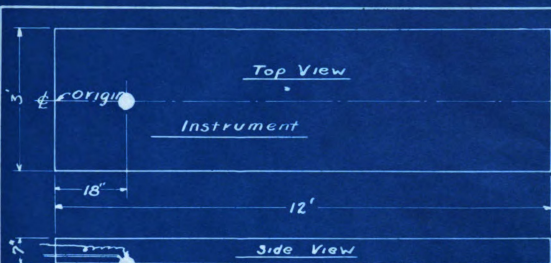
ure in pounds per square inch under any load.

Accompanying ~~were~~ sketches of apparatus, test slab, load, and data which was obtained by experiment on a slab 3' by 12' by 7". The accuracy and plausability of the instrument was ascertained in the measurement of the soil pressure through the data obtained.

* From a paper presented before the American Road Builders Association, Chicago, Illinois., by H. G. Shirley.

DETAIL DRAWING of PRESSURE APPARATUS



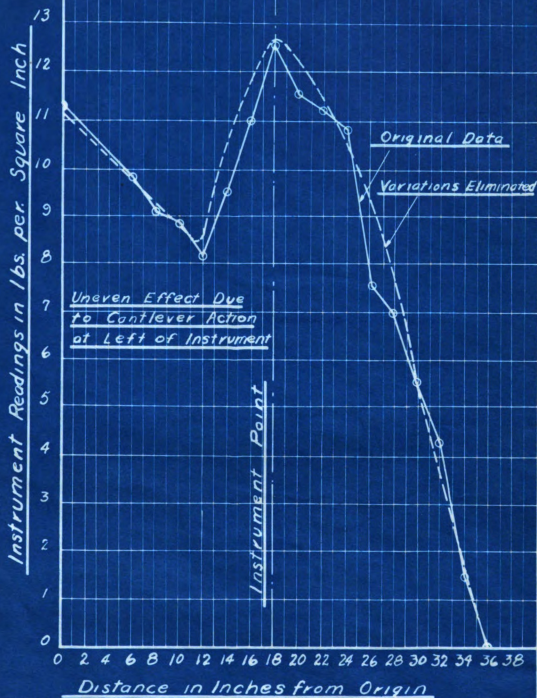


Drawing of Concrete Slab Showing Location
of Instrument

DATA SHEET

<u>Distance from</u> <u>origin 0 in inches</u>	<u>Readings in</u> <u>lbs. per sq. in.</u>
6	9.8
8	9.1
10	8.8
12	8.2
14	9.0
16	11.0
18	12.5
20	11.5
22	11.2
24	10.8
26	7.5
28	7.0
30	5.5
32	4.3
34	1.5
36	0.0

Loads applied along centerline of concrete slab



Graph Showing Distribution of Pressure
on
Test Slab

DATA ON LOADS

Weights of Truck Used.

Total Truck Weight	22,600#
Two Rear wheels	18,600#
Left Rear Wheel	9,450#

LOAD TOTAL USED	9,450#
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* * * * *

Calculation of load total from pressure
distribution - using areas affected as
running across slab.

72 sq. in. x 12.5 =	900
144 " " x 11.5 =	1656
144 " " x 11.2 =	1613
144 " " x 10.8 =	1555
144 " " x 7.5 =	1080
144 " " x 7.0 =	1008
144 " " x 5.5 =	792
144 " " x 4.3 =	619
144 " " x 1.5 =	<u>216</u>

Check in calculation

- - - - -

9450

9439

- 11 error

Very close check. May

or may not be representa-
tive.

9439



A complete soil pressure apparatus is represented by this photograph, including pressure gage, dry cells, pump, small light, pipe connections and soil pressure measuring instrument. ---



As shown in this photo which adequately shows spark plug, diaphragm fastened onto casting by means of ring and stove bolts, and the pressure line leading away from instrument to gage and pump.



This is a photo taken on Michigan Avenue between East Lansing and Lansing and represents probably the most satisfactory way of obtaining a firm foundation for road bed, by means of excavation of the muck and peat material and the replacing unsound materials with that of sand which is one of the best of bearing soils. This is one of the first experiments of this kind carried on by the state. It may or may not prove successful because in order to count on sand as having high bearing power it must be confined. The sand may slump under traffic due to the bulging at the edges.

Conclusion

In this thesis we have attempted to design a soil pressure measuring apparatus and indicate the uses and necessity of such an apparatus. This thesis can mean only a starter in soil pressure analysis.

Analysis may proceed along lines of,-

1. Field analysis of soil pressure and division of soils as near as possible and as to their load bearing capacity.
2. Accompanying these tests should be soundings and drainage recommendations.
3. A study of the treatment of subsoil for the prevention of absorption.
4. The effect thawing and freezing has upon the sub soil, in the change of volume of the soil which results in the heaving and the breaking down of pavements.
5. The further classification of soil under different conditions, mainly the moisture content of each.
6. The design of surface to make strength of whole road bed of uniform degree.
7. Finally the reduction of soil characteristics to the extent that all soils can be compared to a set standard and these systematic operations aid in the design in uniform strength surface over entire length.

Pocket
empty

10/20/09

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