REPORT OF DEPARTMENT OF SOILS INVESTIGATIONS

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DIGESTS OF REPORTS PRESENTED AT THE MEETINGS OF THE SOILS INVESTIGATIONS DEPARTMENT

RECENT TRENDS IN SOIL MECHANICS[1]

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Modern soil mechanics considers the problem of determining stresses within the earth resulting from applied load and the deformations, volume changes, etc , in the earth that are produced by these stresses

The ground work provided in the problem of the determination of earth stresses are the formulas of Boussinesq for earth stresses produced by a point load at the earth surface

In deriving these formulas, Boussinesq assumed the solid stressed by the point load to be elastically isotropic. This assumption may be only approximately true and then in only certain more or less ideal cases

With the point load formulas as a starting point, others are derived for.

1. Loads over areas of great length relative to width, that is for conditions of plane deformation or strain. These are problems in which only two dimensions are involved.
2. Problems involving three dimensions For the use of these formulas, various ingenious graphical methods have been worked out that save time and labor.

John H Griffith and O K. Frohlich, in 1929 and 1932, respectively, published conclusions reached from theoretical studies of stresses resulting from a point load. Both concluded that the derived stress equations contain a variable integral parameter, designated by the letter, n, the value of which is adjusted to suit materials other than elastic isotropic solids As this parameter takes on the increasing values, 3, 4, 5 and 6 in the stress equations, the stress is concentrated more and more in the regions near the center axis of loading

Some conclusions by A E Cummings and D P. Krynine in this field are to be found in the August and October 1935 issues of the Proceedings of the American Society of Civil Engineers.

In the April 1937 Proceedings A. S C E Krynine reported an empirical formula (containing the concentration factor n) from which, depending on n, the distribution of vertical pressure at the contact surface of an absolutely rigid circular foundation and supporting earth is obtained. For $n = 3$, his formula reduces to the one derived both by Boussinesq and Professor Sadowsky of the University of Minnesota and contact pressure is in this case an inverted parabola, the pressure being least at the center and greatest along the perimeter of the loaded disk. Professor Krynine's paper on this point is to be found in the April 1937 Proceedings of the American Society of Civil Engineers

At this meeting, Professor M. G. Spangler of Iowa State College suggested an empirical formula for computing the

[1] A resumé of recent activity and a digest of the reports presented at the Eighteenth Annual Meeting (1938) of the Highway Research Board The complete reports will be found in Part II, Vol 18, Proceedings, Highway Research Board

horizontal earth pressure produced on a retaining wall by a concentrated wheel load applied to the surface of the backfill In this formula, two experimentally determined empirical constants designated as *m* and *K* appear The value *m* depends on the relative rigidities of wall and backfill and in the value *K* there is included the effect of the interruption of continuity and strains within the backfill by the retaining wall

Stress equations for the case when there are planes of discontinuity have been presented by Carothers, Jurgenson and Biot A typical case is the one where a load is supported by a clay stratum underlaid by rock

Professor Pickett of Kansas State College presented stress equations for the case when it is assumed that there is sufficient friction between earth and rock to prevent slipping of the clay at the rock surface. Two cases were considered, that of plane strain, and the three dimensional case of axial symmetry, and his derived equations for stresses are for three different assumed values of Poisson's ratio, namely, 0, $\frac{1}{4}$ and $\frac{1}{2}$ Biot restricts his paper to an incompressible soil (Poisson's ratio = $\frac{1}{2}$) and is concerned only with vertical pressure at the rock surface

Professor Gregory P Tschebotareff gave an interesting account of "Factors affecting the accuracy of settlement rate forecasts" Certainly great progress has been made in recent years as compared to the previous complete inability to make any numerical forecast whatsoever on the matter or even to understand the process of soil consolidation. He has recently published a comprehensive article on settlement studies in Egypt in the Proceedings of the American Society of Civil Engineers, October 1938 He concludes that "results obtained from observations in one locality are not necessarily valid in other localities. Therefore such settlement studies should be undertaken in all large cities," and that, "Systematic settlement observations of full-sized structures are the only reliable means for obtaining accurate data on the behavior of structures and the soil on which they are erected"

In the consideration of the general problem of lateral earth displacement, two papers were presented, one by A E. Cummings concerning the stability of foundation piles against buckling under axial load and another paper by Professor D M Burmister pertaining to the stability of bridge piers The material contained in these two papers is of much practical importance to all bridge engineers

In a paper, "Stresses (especially shears) underneath a foundation," presented by Professor D P Krynine, it is shown that the stresses within a loaded earth mass may be determined by using the general conceptions of the theory of elasticity with numerous limitations Outstanding points considered in Professor Krynine's paper are the following

1 The great difficulty in stress computation because of the presence of a so-called "disturbed zone" under the structure itself Elastic constants and physical properties of the earth in the disturbed zone change during the process of loading

2. Consideration must be given to the stresses near the structure Stresses at remote distances from the structure are not likely to cause failure, the soil being constrained at such points

3 The greater the distance from load, the more correct is the use of formulas of elasticity, which is in accordance with Saint Venants' principle. Even if a deep point is considered however, there is an elastic disturbed zone between it and the boundary

4 Professor Krynine believes that shear failures are surface phenomena and can occur only close to the earth

surface and that what an engineer needs is a rough estimation of the shearing stress and its checking against the shearing value. For this purpose, any simple method of study leading to a practical result may be used.

5 It is proposed to determine the maximum shearing stress from the radially acting three dimensional stress and to add, say, fifty percent to take care of the uncertainty of the Poisson's ratio.

6 Since the maximum shearing stress is a half stress difference, the principal stresses are to be computed. These are visualized as volumes and an apparatus for the determining of these volumes has been devised

Professor D W Taylor presented an interesting example of the application of the method of slices in computing the stability in the design of an earth embankment

Mr. A T. Goldbeck presented badly needed information concerning the proper use and installation of pressure cells

It was the concensus at this meeting that the triaxial compression or stabilometer device is the most useful shearing test method and despite all obstacles it is proposed to obtain and use complete stress-deformation diagrams in connection with highway problems