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# OVER THE PLASTIC RANGE IN THE SEMI INFINITE MASS.

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According ot the theory of the semi infinite elastically isotropic mass the base pressures at the edges of a completely rigid foundation slab become infinitely large. The deformation curve of the semi infinite mass has thereby in this spots a sharp break, that means it is not continuous. The break of the deformation disappears, if the edge of the slab is rounded. Thereby the base stresses near the edge of the slab get finite values. Their size depends on the size of the radius of the rounding as there was shown already by Schubert 1). To a certain degree it is therefore possible, to influence the distribution of the base pressures, by giving the foundations special shape. Now the question is, which shape of distribution of pressures is wanted in regard to the stresses in the semi infinite mass, respectively in regard to the settlements, caused by them.

Supposing the soil stresses, found by means of Hook's rule, O.K. Fröhlich has ascertained the plastic ranges in the semi infinite mass for the uniform strip-load. As long as they are only small this statement will be sufficiently exact.

In this paper the researches of O.K. Fröhlich are extended to other pressure distributions. Intending to get qualitatively right results only the pressure distribution is supposed to be part by part linear. Thus the computation becomes easier.

Analogous to the example, given by O.K.F. in his book "Druckverteilung im Baugrund" p.78 2) for the uniformly loaded strip, here the following assumptions are made:

| | |
|---|---|
| specific gravity of the soil | $\gamma$ = 0,015 Kg/cm2 |
| angle of internal friction of the soil | $\varphi_n = 45^o$ |
| width of the strip load | b = 100 cm |
| depth of the slab under the surface | t = 200 cm |
| cohesion | c = o |

We use Mohr's graphic demonstration of the stresses in a point of the semi infinite mass (Fig. 1). Mohr's failure curve, assumed being a straight line approximately passes the origine of the co-ordinate (C = o) and incloses with the axis the angle of internal friction $\varphi_n$. The stresses in a point of the semi infinite mass are demonstrated by a circle. The angle between the axis and the tangent from the origine touching the circle may be named "characteristic angle" and is denoted $\varphi$ . By this angle the stresses in a point of the semi infinite mass are characterized by one figure only. The ratio of the characteristic angle $\varphi$ and the angle of internal friction $\varphi_n$ states how much the existing stresses differ from those, causing the flowing. Thus the characteristic angle destines the degree of the flowing danger. We now compute the characteristic angles $\varphi$ for several points of the semi infinite mass by introducing the stresses $\sigma_1$ and $\sigma_2$ in equation:

$$\varphi = \arcsin \frac{\sigma_1 - \sigma_2}{\sigma_1 + \sigma_2}$$

We further connect all points with constant $\varphi$ by curves, denoting them als "lines of equal flowing danger". These lines are found for the following strip-loads of the semi infinite mass:

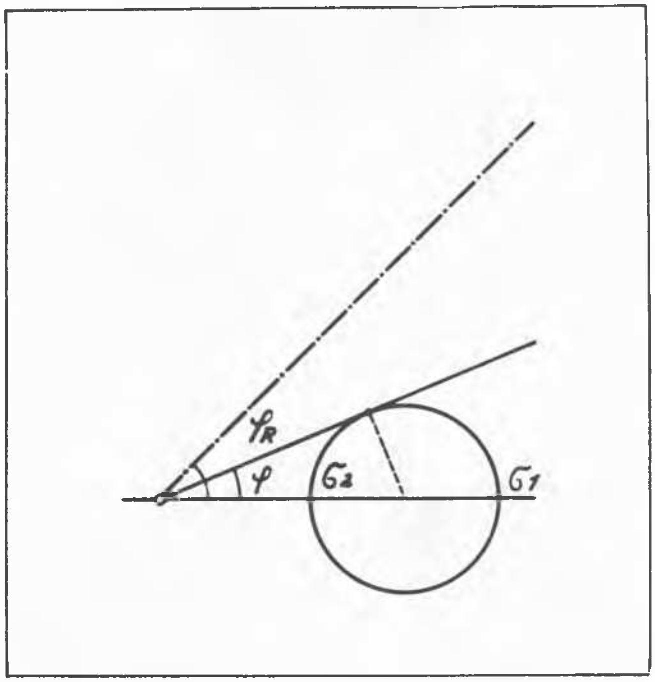


FIG. 1

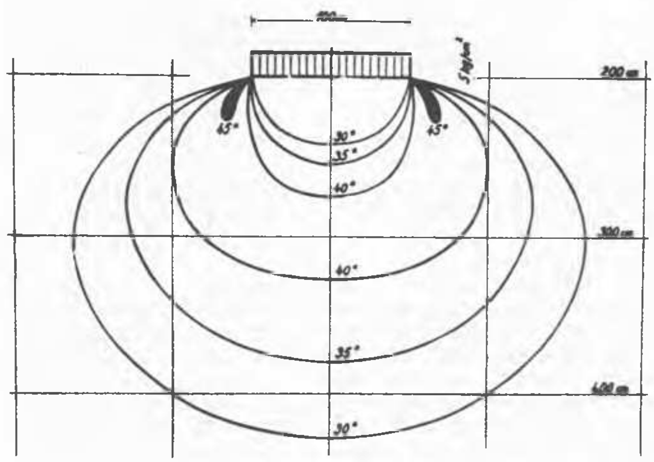


FIG. 2

1) uniform base pressure p = 5 kg/cm2 (Fig.2)
2) base pressure at the edge p = 0 increases linear to p = 10 kg/cm2 towards the centre (Fig. 3)
3) base pressure at the edge p = 10 kg/cm2 falls linear to p = 0 towards the centre (Fig. 4)
4) base pressure at the edge p = 3,33 kg/cm2 increases linear to p = 6,66 kg/cm2 towards the centre (Fig. 5)

As all the pressure distributions researched correspond to the same total load, we are able to compare the results with each other. The lines of equal flowing danger have been designed for the characteristic angles $\varphi = 30^o$, $35^o$, $40^o$ and $45^o$.

A range of the semi infinite mass is in plastic state, if $\varphi$ reaches or surpasses the

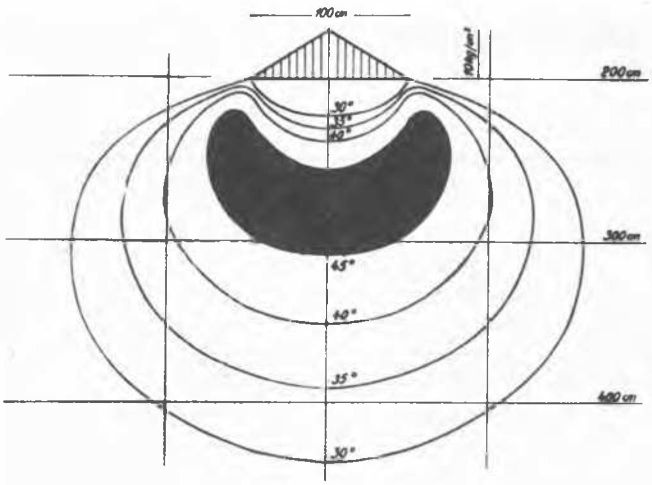


FIG. 3

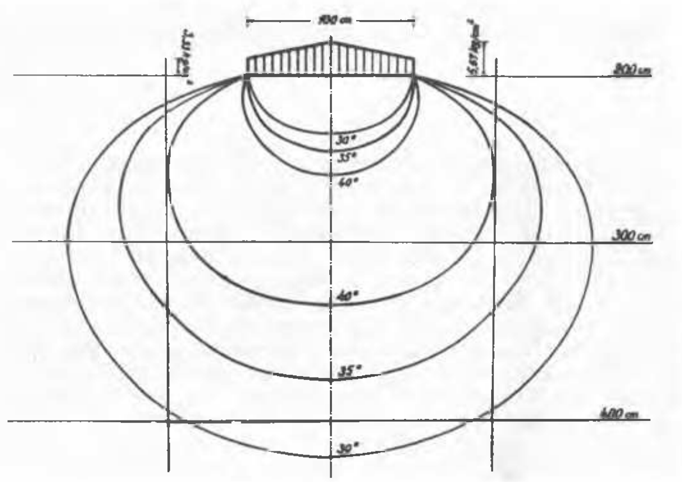


FIG. 5

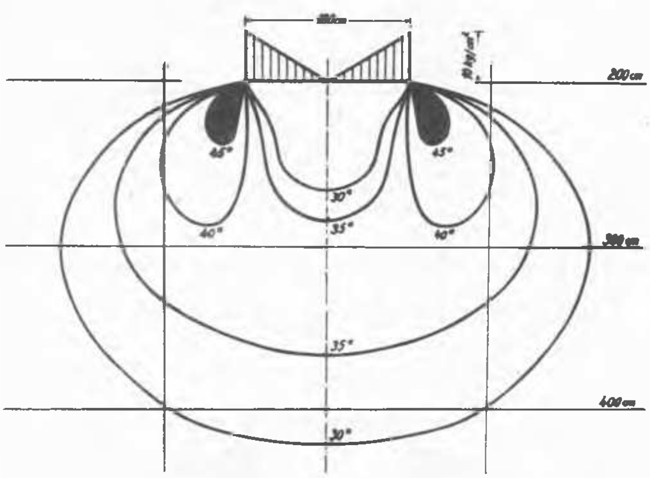


FIG.4

value of 45°. In the figures that range is painted black. The range, inclosed by the lines for $\varphi = 30°$ and 45°, will likewise flow by increasing load.

By this way of demonstration it is possible to recognize at once, in which part of the semi infinite mass the main settlements must be searched. In the axis of load they are found chiefly in the depth of 1,0 - 2,5 b. Surprisingly the range directly below the foundation joint does not contribute to the settlements, because the value of $\varphi$ becomes zero there. The main settlements of the surface of the semi infinite mass will reach to a distance of 2b of the load centre.

We now consider the case of an uniform strip-load (Fig. 2). At the edge of the strip a comparatively small and narrow plastic range exists. The computed maximum value of $\varphi$ is about 46°. In the load axis the maximum amounts 41.5°.

Quite an other form for the lines of equal flowing danger we obtain for the pressure distribution in fig. 3. The plastic ranges at the edge of the slab have disappeared and instead of them one large and connected plastic range below the whole slab is arisen. The corresponding maximum values of $\varphi$ are 47.5°, respectively 47° in the axis.

The pressure distribution in fig. 4 gives much better results. Indeed the plastic ranges at the edges are larger and wider than those of the uniform load (Fig. 2) and the maximum values of $\varphi$ surpasses 50°, but the angles $\varphi$ in the load axis become essentially less. The maximum value of $\varphi$ was computed with 38° there.

Moreover, in order to complete the results, the pressure distribution according to fig. 5 was researched. In this case the base pressure in the centre is twice as large as the rim stresses. Considering fig. 5 we neither get plastic ranges at the edge nor in the axis. The maximum value of the characteristic angle $\varphi$ is 44,5°, respectively 43° in the axis. Accordingly we get $\varphi$ most equalized with regard to its maximum values below the edges and the centre of the slab.

The results are the following ones:

The increase of base pressures is not at all disadvantageous, if lateral yield of soil is prohibited by sufficient depth of foundation or by large values of cohesion. Thereby a favourable pressure distribution is obtained. The soil pressures spread more quickly with increasing depth and we get comparatively smaller settlements. Therefore the foundation slab has to get sharp edges.

In case the soil is able to yield laterally, the rim stresses have to be diminished. This is obtained by rounding the edges.

A too large concentration of the base pressures in the axis of the slab is unfavourable (shown in fig. 3).

REFERENCES

1) Schubert Ing.-Arch. 3,1942, P.132
2) O.K. Fröhlich "Druckverteilung im Baugrund" Vienna 1934.