Fissures in rock masses are generally considered to be the main cause for the reduction of the bearing capacity of rock foundations. However, a qualitative appraisal of the influence of fissures on the modulus of deformation of rock masses has not yet been developed. B. D. Zelenskii proposed, for the calculation of deformations at the contact between rocks, a formula derived for the case of contact between surfaces of metals; this formula, however, is not correct, inasmuch as rocks are characterized by brittle failure and not by viscoplastic flowing. Furthermore, the relations used by B. D. Zelenskii include seven parameters, among them, \( H_p \), the Brinell hardness number; \( b \) and \( v \), coefficients characterizing the curves of the bearing surfaces; and so on. The numerical values of these parameters can hardly be determined with good reliability for actual rock masses.

The model presented below is based on the well known fact that every fissure has a finite length and that its edges converge and diverge erratically, forming gaps and portions in close contact.

The average free length of a fissure, that is, the distance through which its edges do not come in contact, is usually small in comparison with the dimensions of the structures built on the rock foundations.

For this reason, under usual conditions, the total aggregate of the small macrofissures constitutes an aggregate of voids, which stands in relation to the structure just the same as the soil voids stand in relation to a sample. The deformation properties of such a foundation may be described with the aid of the same set of constants as for a continuous medium; however, the numerical value of the modulus of deformation will be lower than for an unbroken mass. If the free length of the fissure is comparable to the dimensions of the structure, then it should be considered as a fault or fracture. Such a fissure will have random influence on the settlement of the structure and the distribution of pressures, depending on its position with respect to the foundation. In this case it is wholly unadvisable to include the influence of the fissure by lowering the value of the modulus of deformation of the rock mass.

A second generally known fact is that in the overwhelming majority of solid rocks the linear dependence between the stresses and the deformations is maintained up to the moment of failure. Crushing of the projections at the contact surfaces is attended by brittle failure, without occurrence of plastic flow, where-by the contact area increases with the pressure. For this reason a foundation model divided by an infinitely long fissure, and subjected to uniaxial compression from a uniform load, acting perpendicularly to the direction of the fissure, may be represented by a system consisting of two springs having different stiffnesses, placed one next to the other, the weaker spring having variable stiffness. In this case, the \( \sigma - \epsilon \) diagram has the form of a curve with its convex part turned toward the \( \epsilon \) axis and with its asymptotes parallel to the corresponding \( \sigma - \epsilon \) curve for nonfissured rock. Precisely that is the form of the experimentally obtained diagram for composite soil samples. If the spring simulating the deformation of the contact surfaces has constant stiffness and moves freely up to the time when the spires close, through a distance equal to the width of the fissure, then the \( \sigma - \epsilon \) curve is represented by a broken line. However, it is practically impossible to calculate the settlement of a structure or the displacement of a tunnel lining on the basis of such relations. For this reason the real relation between \( \sigma \) and \( \epsilon \) must be replaced by a linear relation.

Let us introduce a few definitions.

The following designations are used: \( L \) = linear characteristic dimension of the structure, for example, an arch dam, a foundation, or a plate; \( h \) = the average distance between the fissures of the system; \( l \) = the average length of the fissure; and \( \delta \) = average width of the fissure.

Let us examine two cases.

Fist, \( L \leq l \) and \( L > h \).
The first case may take place, for example, when testing with plates or pressure gauges, and when investigating composite soil samples. Inasmuch as the fissure cuts across the whole body under examination, the applied loads are transmitted only through the point contacts between the surfaces at the fissure. The area of these contacts is negligibly small in comparison with the area of the surfaces of the fissure. As a statistical characteristic of the compactness of the contact, for solution of the plane problem, we introduce the dimensionless quantity \( \xi \), obtained as the relation between the length of the rock contacts within the limiting section \( L \) and the dimension \( L \) of the structure.

For the second case the quantity \( \xi \) is equal to

\[
\xi = \frac{L - \Sigma l_i}{L} = 1 - \frac{\Sigma l_i}{L},
\]

in which \( \Sigma l_i \) is the aggregate length of the fissures in the section \( L \).

In the relation (3) we neglected the length of the rock contacts within the limits \( l_i \), since this quantity is lower than the length of the pillars between the fissures.

By considering that this model of the fissured rock is subjected to plane stress, it is possible to draw a schematic picture in which the fissures of the system are brought together in the region 2, identified by hatching (Fig. 1). The unhatched portion (indicating absence of fissures) is called region 1. The pressure \( \sigma \) is transmitted through the pillars between the fissures and through the rock contacts. From considerations of equilibrium, it follows that in the section of length \( \xi \) a concentration of stresses results, whereby the average pressure is equal to \( \sigma/\xi \).

The total shortening of the elementary rectangle along axis 1, according to Hooke's law, is equal to

\[
\frac{\sigma (h + \xi)}{E_1} - \frac{\sigma h}{E_2} = \frac{\sigma h}{E_2},
\]

in which \( E_L \) is the modulus of deformation in the direction perpendicular to the system of fissures;

\( E_1 \) is the same, for rock without fissures (in region 1);

\( E_2 \) is the same, in region 2.

If there is not filler material in the fissures, then \( E_2 = E_1 \), since at the portion of contact there is just the same rock as in region 1. This is a limiting case. If there is filler material in the fissures, then all the results obtained by considering non-filled fissures are strengthened.

Thus, the model of the fissured rock having one system of regulated fissures is a layered medium formed by alternating layers of two types: the first with thickness \( h \) and characteristics \( E_1 \) and \( \nu_1 \), and the second with thickness \( \delta \) and characteristics \( E_2 \) and \( \nu_2 = 0 \).

From relation (4) we find

\[
E_L = \frac{\xi (h + \xi)}{h + \xi} E_1.
\]

The remaining two moduli of deformation are found from the corresponding equations for the deformation along axis 2 and the shearing deformation in the plane 1, 2:

\[
E_2 = \frac{h + \xi}{h + \xi} E_1, \quad G = \frac{\xi E_1 (h + \xi)}{2(1 + \nu_1) E_2},
\]

in which \( E_2 \) is the modulus of deformation in a direction parallel to the fissuring;

\( G \) is the shear modulus in the plane 1, 2.

Thus, the existence of one system of fissures leads to the appearance of a deformation anisotropy.

Generally, the ratio \( \delta/h \) in macrofissures is on the order of 0.01–0.001. Accordingly, Eqs. (5) and (6) may be written as

\[
E_L = \frac{\xi (h + \xi)}{h + \xi} E_1.
\]