INVESTIGATION IN SPRING COEFFICIENTS FOR THE BASE OF FOUNDATIONS MADE OF CROSS CONTINUOUS BEAMS

by

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SYNOPSIS

This paper deals with the theoretical and experimental investigations of the foundations made of intersecting beams. The purpose was to study the effect of the foundation configuration and backfill on the rigidity coefficients of the base. The results of the investigation have shown in what cases the openings and the effect of the backfill may be neglected in the designs.

In many cases the effect of the elastic yielding of soil on the dynamic characteristics of building is very significant and it cannot be neglected in the calculations. But up to now, as it seems, there was a lack in data for the assignement of these coefficients for foundations of intersecting beams. Therefore the special theoretical studies based on the algorythm carried out by L.S.Yacobson and A.M.Gorlov (I), as well as the experiments in-situ on a large scale (on loess soil, typical for the seismic regions of the USSR) have been undertaken.

The foundations of various configurations have been studied: two parallel beams with various distances between them, but connected with a rigid plate placed on their upper faces (a theory and tests), the rectangular foundations with opening and various external and internal dimensions of their elements (a theory and tests), the foundation made of intersecting beams, having from I up to 10 double openings (a theory).

The vertical load P or moments M_x or M_y being given, the elastic settlements S_z or rotations φ_x and φ_y around the horizontal axes OX or OY have been found. Besides, the horizontal elastic displacements S_x of the foundation under the horizontal force Q and also the backfill influence on the rigidity coefficients have been investigated by tests.

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So the rigidity coefficients of the base K_z, $K_{\varphi x}$, $K_{\varphi y}$, K_x were determined by the relationships:

$$K_z = P/S_z, \quad K_{\varphi x} = M_x/\varphi_x, \quad K_{\varphi y} = M_y/\varphi_y, \quad K_x = Q/S_x$$

While being calculated the soil was idealised by a homogenous elastic halfspace and the foundation elements were considered as being rigid. That seems to be legal for the purpose of the investigation of the rigidity coefficients.

The tests were carried out by means of applying upon the foundation repeated loadings and unloadings and also by measuring the free vibration frequency. All this allowed to determine the rigidity coefficients. The test foundation area was various from 0.16 to 18 m^2.

The curves on Fig.1-4 show the relationships between the rigidity coefficients and some ratio of geometrical dimensions of the foundation base as well as of the number of double openings for the foundation of intersected beams. The types of the foundations together with the used denotations are shown on these Figures. The width of the beams δ varied between 0.4 and 1.2m, the size b had two values -4 and 6 m. The curves on Fig.1,2,4 correspond only to one pair- δ =0.4m and b= 4m- as the character of the curves are the same for some other above-mentioned dimensions. The continuous lines correspond to the calculations according to the algorythm of the article (I) and the dotted lines- to the continuous foundations without openings, but having the same shape as the external shape of the foundation under consideration (2). The circles refer to the test data.

In the calculations the soil elasticity modulus was 700 kg/cm^2 and the Poisson ratio -1/3. These values have been found by tests.

The results of the calculations for the rectangular foundations with openings (Fig.1,2) have shown that, when the ratio a/δ is less than 8÷10, the values of the elastic vertical translations and rotations (hence K_z, $K_{\varphi x}$, $K_{\varphi y}$) differ very little from the respective values of the continuous foundations (determined by formulae in (2)). Also the above-mentioned coefficients for the foundations of interwecting beams are very close to the corresponding values of the continuous foundations. It is true for any number of double openings (Fig.3).

So these studies permit us to believe that for the practical purposes the openings may be neglected while designing and the error is to count for little.

The results of tests with the rectangular foundation having a base 3.0m x 6.0m and a beam width 0.4m are in good agrement with the results of the calculations. The experimental and theoretical values of K_z are $52 \cdot 10^3$ ton/m and $49 \cdot 10^3$ ton/m respectively. The values of the coefficient $K_{\varphi x}$ are $28 \cdot 10^4$ ton.m and $24 \cdot 10^4$ ton.m respectively.

The curves on Fig.4 show that the distance between the beams influences very little the values of K_z when $a/\delta > 2.5$. This statement follows from the theoretical calculations (based on the (2)) as well as from the test data. For this type of foundation the coefficient $K_{\varphi y}$ is very close to the corresponding value of the coefficient for the continuous foundation (for the above-mentioned dimensions).

The test data for the rigidity coefficient K_x of the horizontal translation have confirmed the statement that its value is close to $0.7 \div 0.8\ K_z$. The corresponding circles for this case (Fig.4) are connected by thin line. The static pressure in this experiment was 1 kg/cm^2.

The tests on the effect of the backfill on the behaviour of the foundation have shown the increasing of K_z and K_φ up to 10% and K_x up to 20% when the backfill depth was less than the minor dimension of the foundation base.

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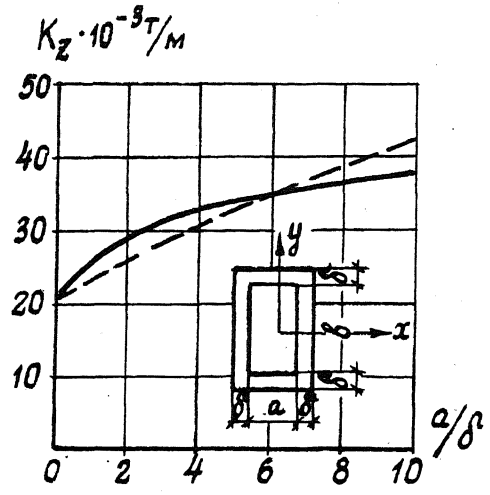

Fig. 1

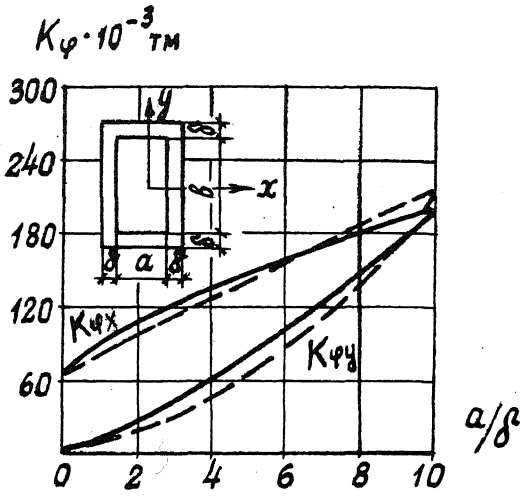

Fig. 2

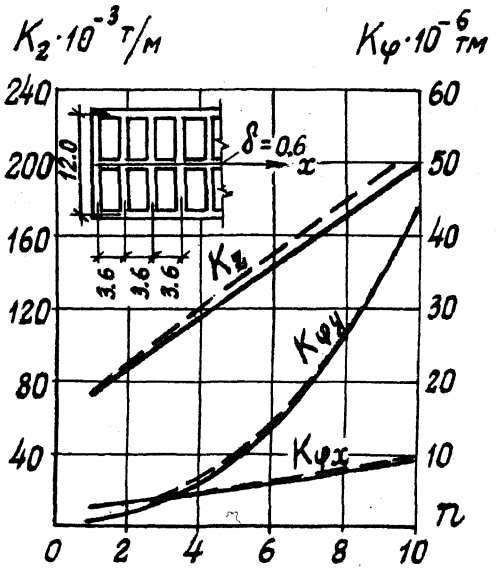

Fig. 3

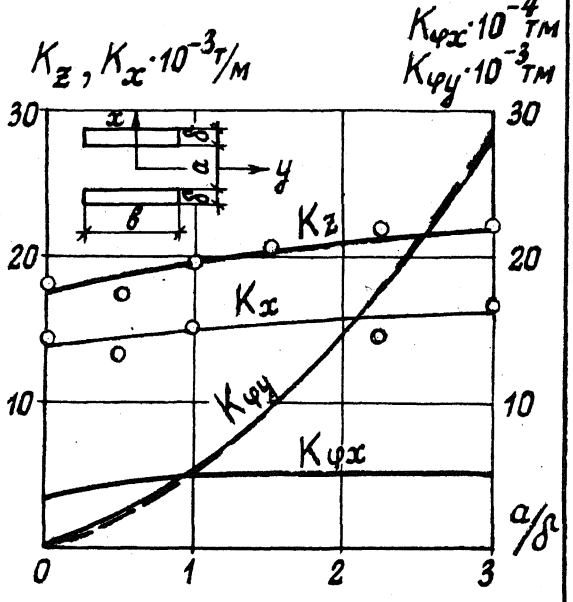

Fig. 4