OSCILLATION DECREMENTS OF BUILDINGS AND STRUCTURES

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ANNOTATION

The concern of the paper is a dependence of oscillation decrement of buildings upon the ratio of soil rigidity to the rigidity of a building envelope.

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To reveal the actual values of oscillation decrement is very important in some cases in order to define the real behaviour of structures and on this basis to select the rated values for the building design.

In our work of last years related to this problem there were discovered the peculiarities in the influence of soil, building structural types and the level of loading upon the oscillation decrement value and the laws of its changing.

These values were received by employing the data from the tests of 3 large-scale models, 12 large-panel buildings (from 5 up to 16 storeys), 10 frame buildings (from 2 up to 16 storeys), 4 brick buildings, 6 large-block buildings, 2 in-situ buildings (16 storeys), 2 box-unit buildings. Besides, there were used data obtained from the tests of 5 storey and 9-storey large-panel fragments of buildings which were brought to destruction.

Vibro tests were carried out with the application of powerful vibro machines designed and produced in TSNIIEP zhilischa in the department dealing with the strength of structures of residential buildings.

The last model of a powerful vibro-machine "B-3" ensures 250 ton force on the shaft of the vibrators and develops inertia forces in a building up to 2000 ton. It allows to test full-scale buildings under loads corresponding to the rated ones under 7-9 point seismicity and higher.

Owing to the fact it is possible to get reliable oscillation decrement values under different levels of loading as in this case there can be determined the damping of structure oscillation only for one

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range of frequencies. Other methods of oscillation decrement determination are less precise.

As it was ascertained by some investigators the obtained dependence δ of buildings only upon the rigidity of the soil or only upon the rigidity of the structure does not give a complete and real picture of oscillation damping as it depends upon the relationship of these rigidities.

Oscillation decrements determined under earthquakes, are considerably higher, as a rule, than oscillation decrements defined under vibro-testing, for example, according to the data obtained by Kanai[1].

It can be explained by an important role of soil in the structure-soil interaction system entailing the decrease in the value C_s/C_b * and, consequently, the increase in δ in rigid buildings [2, 3].

In flexible buildings it does not mean a great deal as C_s/C_b is more than 10.

In view of the fact, separate short peaks of soil acceleration under earthquakes reaching two-three-fold quantities and higher than average values are disproportionally dangerous, as in this case the energy absorption by soil is sharply increased.

The vibrational load applied to the top of a building during relatively long period (10-30 sec) is more dangerous when δ is sharply decreased compared with the case when stresses are transferred to the building through soil.

We have established that in common cases the law of changes depends not upon the absolute values of soil rigidity and not upon the absolute values of building rigidity but upon the relationship C_s/C_b.

Fig. 1 shows the curves of dependence δ upon the relationship C_s/C_b with due regard for the loads.

The curve of dependence δ upon C_s/C_b in the first rather narrow zone (from 0 up to 0.02) refers to the structures which can be described as an infinitely rigid body rested on the soil, in this case, everything almost completely depends only upon the soil properties. This zone is not sufficiently studied as there are very few experimental data in this respect except for oscillation decrements of separate foundations. It is assumed that dependence δ in this narrow zone changes approximately within 0.8 - 1.1.

The curve of dependence δ upon C_s/C_b in the second zone

C_s - summarized soil rigidity determined by the force applied to the top of a building and causing the single displacement due to soil deformation

C_b - summarized rigidity of a building determined by the force applied to the top of a building and causing the single bending.

(from 0.02 up to 5) related to the so-called rigid buildings (large-panel, brick, large-block) is presented rather clearly. The less is the soil role, the bigger is the value of C_s/C_b and the less is δ. It proves that the main factor in this type of buildings is soil.

When the values of C_s/C_b approximate 10, the soil role lessens and the building structure begins to play a decisive role in damping.

At the same time, the value of C_s/C_b is increased for one abd the same building under greater loads (as C_b is decreased) and that is why when the values of C_s/C_b are big the dependence curve is bisected.

The curve of dependence δ upon C_s/C_b in the third zone (C_s/C_b is more than 10) related to the so-called flexible buildings (framed, tall large-block buildings under big loads) is presented rather clearly too.

Under small loads δ is changed negligibly, under big loads δ is increased with the increase in C_s/C_b as under bigger loads cracks and plastic deformations in structures appear.

The reliable oscillation decrement values obtained from vibro-strike tests allowed to establish rather precise dependence δ upon C_s/C_b. This dependence is very important under big loads as it allows to analyse the behaviour of structures under seismic effects.

When. the law of δ changes is known the investigators and designers can take into consideration the definite value δ and in some cases to regulate it on the basis of the data on the rigidity of soil and a building.

The dependence of oscillation decrements upon the relationship of soil vs. building rigidity is of empirical nature, it can be clarified when new experimental data are available.

However, it can be proved that the general character of this dependence is not accidental. Thus, expressing the energy of building deformation, W_b, and the energy of soil deformation, W_s, through summarized rigidities of a building C_b and soil C_s, G.N.Ashkinadze [4] determined that

$$\frac{W_b}{W_s} = \frac{C_s}{C_b}$$

so, absorption coefficient of the system is presented by

$$\psi = \frac{\Delta W}{W} = \frac{\psi_b \cdot \frac{C_s}{C_b} + \psi_s}{1 + \frac{C_s}{C_b}},$$

where ψ_s - soil absorption coefficient when a building is non-deformable

ψ_b - building absorption coefficient when soil is non-deformable.

Thus, with ψ_b and ψ_s being constant, oscillation decrement dependence $\delta \approx \psi/2$ upon C_s/C_b is presented by the curve on Fig. 2, and for a common case - by the empirical curve given on Fig. 1.

References

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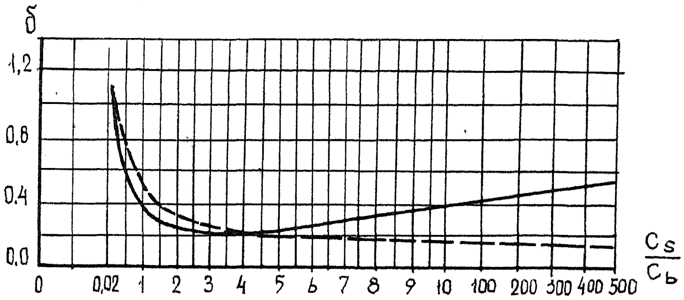

Fig. 1. Dependence δ upon C_s/C_b.
1. under small loads
2. under big loads

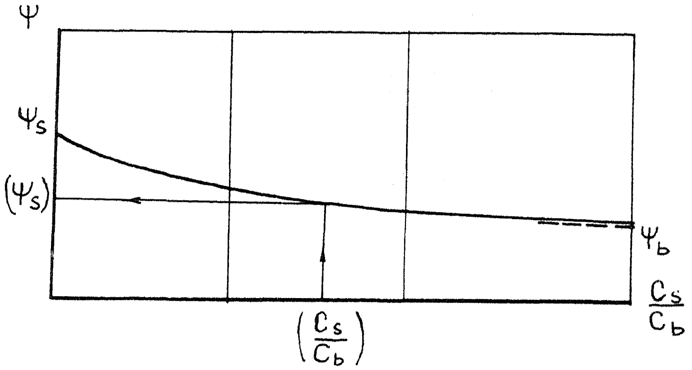

Fig. 2. Theoretical dependence ψ upon C_s/C_b.