# THE DEPENDENCE OF INERIAL FORCE UPON DISPLACEMENTS IN THE NON-LINEAR AREA UNDER OSCILLATIONS (basing on the data resulted from the high-capacityvibro-tests of structures)

by
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## SYNOPSIS

To determine earthquke loads and response of structures there are used in some cases the data obtained by the network of earthquake registering stations reconding the oscillations of the ground and the response of various structures suffering severe earthquakes.

Such a method implies a long-term accummulation of material characterizing the behaviour of many objects located in different areas of the world. On the other hand, a more speedy way is also possible, i.e. studying and testing performance of structures by means of high-capacity vibrators.

Vibro (resonanse) tests of life-size buildings of various structural systems carried out at the Strength test laboratory of this Institute (TSNIIEP zhilischa), made it possible not only to achiev designed inertial seismic loads, but also to considerably exceed them.

Such tests of large models and life-size buildings permitted to observe the behaviour of the structures at all the stages of loading and to evaluate the extent of seismic resistance (strength).

## INTRODUCTION

The inertial loading upon the structure effected through the vibrators is different from the earthquake force, but its approximately similar character of frequencies, the possibility of obtainin a much longer test time, as well as the behaviour of structures in a developed resonanse (as proved with tests and theoretic analyses), permit to conclude that the resulted inertial forces would be greater than the earthquake ones.

Hence, were the extra strength assumed to be an initial dependence between forces and displacements resulted from the vibro-tests, the number of important conclusions evolved from studying the laws of changes in the state of stress of structures under inertial load could serve as the basis for the analyses of structural performance.

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## TEST RESULTS

Vibro-tests of buildings and models have shown that under great loads in the corredtly designed structures there occurs not on a sudden failure, but the gradual development of irreversible deformations, separate components failing, which leads to the change in the spatial performance of structures and to the plastic deformations and eracking in components and joints. Here there were obtained the dependencies of inertial force due to the displacement in all the area of the curve "force - displacement" and this to include the area of the downward branch (cf.the figure).

This curve is of the following general nature;

$$Q = \alpha A_{max}^{\chi} - \beta A_{max}^{2}$$

$Q$ - being the summarized initial force (t/f),

$A_{max}$ - being the displacement of the top of the building, mm,

$\chi, \alpha, \beta$ - being the co-efficients determined by the results of experimental tests.

There were also obtained from the vibro-tests the curves of dependencies. There was analysed the performance of structures in 12 large-panel buildings, 4 brick and 4 block buildings, 10 framaless buildings and 2 box-unit buildings, as well as in 2 in-situ concrete ones, 2 box-unit buildings all this allowed to define the extent of their resistance to earthquake forces (strength) by cimparing the maximal inertial loads with the rated ones. When testing with high-capacity vibrators some life-size structures there were obtained horizontal inertial forces up to 1.000 t/f.

## REFERENCES


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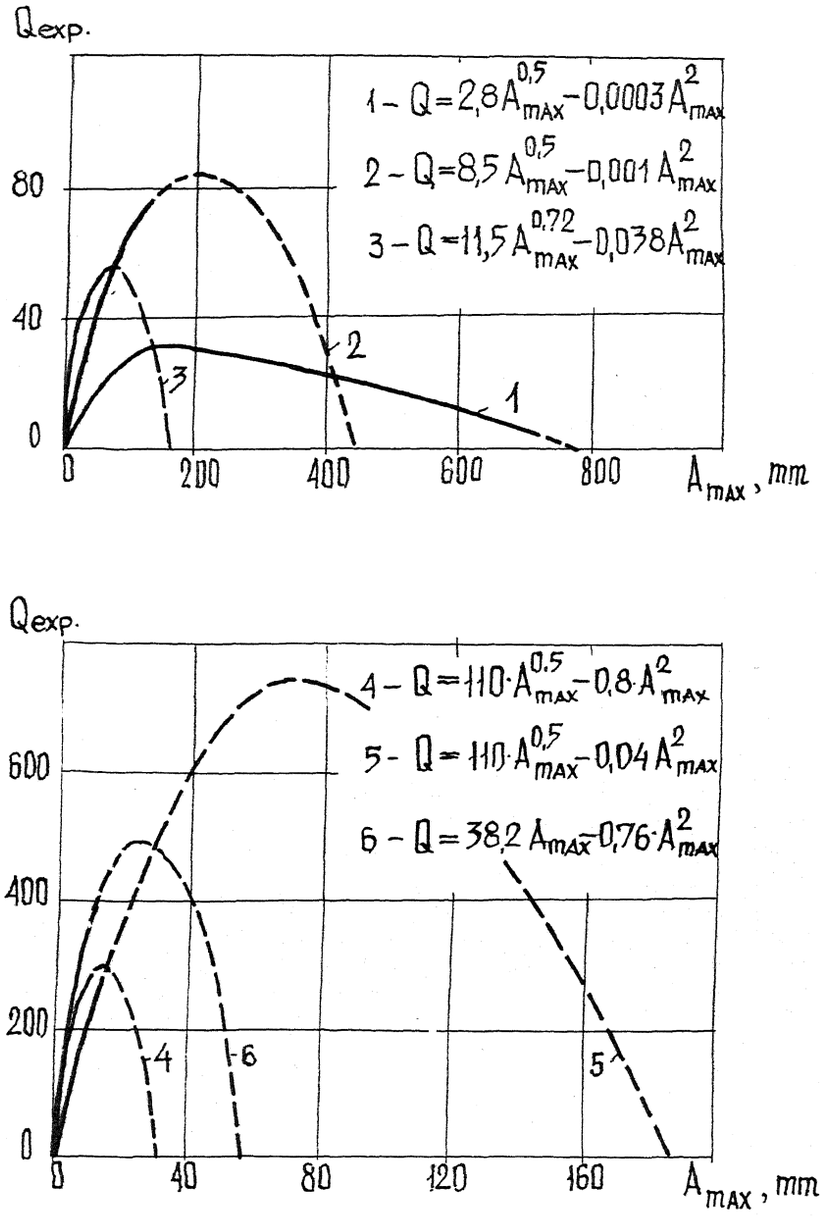


Fig.1 The dependence of inertial force upon displacements.
1,2,3 – frameless; 4 - Block buildings; 5,6 - large-panel buildings.