METHOD OF DETERMINING EARTHQUAKE RESISTANCE OF RESIDENTIAL BUILDINGS ON THE BASIS OF VIBRATIONAL TESTS BY MEANS OF HIGH-POWER GENERATORS

by

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Strength and eartquake resistance of various structures is quite often evaluated during eartquakes, which is rather to high a price for the information obtained.

As to the attempts of preliminar establishment of these properties, the model used in design is too idealized to make the solutions close to the actual strength and earthquake resistance of buildings. What will the actual properties of the given structure be? All the existing methods do not solve this problem in detail, and the results obtained are usually unsubstantiated.

That is why the designing and building practice on aseismic structures requires experimental investigation methods, which would evaluate the earthquake resistance of buildings more exactly and with more confidence.

The resonant method of testing structures is the most objective method of analysing the strength and earthquake resistance of full-scale structures in the shortest time and with sufficient exactness.

This method was developed in the Strength Tests Laboratory of CISED of residential buildings and made it possible to evaluate the earthquake resistance of various structural systems of residential and public buildings by means of high-power vibrational generators; in performing these tests, the bearing capacity of a building is determined as well.

The main advantage of this method consists in the possibility of testing a structure in a short time without extra expences, regardless of the location of a given structure, using the type of loading this structure will be subjected to during earthquake, and even loading the structure by definite inertial forces corresponding with the earthquake disturbance, thus estimating the weak points of a structure.

Over 45 tests were carried out by the Strength Tests Laboratory of CNIIEP zhilishcha for last several years by means of high-power vibrational generators on residential and public buildings at a vast range of horizontal inertial loads, from the very low level up to the design level, which corresponds with earthquakes of the 7-th to 9-th and higher degrees.

Buildings of various structural systems were tested, such as: brisk houses, large-block buildings, large-panel buildings, structural

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frames and monolithic buildings; the number of storyes varied from 2 to 16.

Inertial loads developed during these tests exceeded 800 tons.

A number of structures, such as: large-block buildings, structural frames and, especially, brick buildings exibited cracking at high loading levels, total destruction of partition walls, destruction of anchorage and consequent destruction of parapets and curtain walls.

The latest vibrational generator model V-3 (designed in the Strength Tests Laboratory of CNIIEP zhilishcha) develops inertial loads of 1500 tons, which is sufficient to evaluate earthquake resistance of a wider range of high-rise residential and public buildings.

The relation between the deflection and the lumped load was established for most of the buildings tested. These relations are represented by a curve with an ascending and a descending branch (as the disturbance increases after passing the maximum, the further increase of deflections is accompanied by decrease of inertial forces). The point of extremum of the "deflection v.inertial load" curve corresponds with the ultimate state of the system "building-foundation".

The bearing capacity of the building or of the foundation is not reached during vibrations, when the inertial load reaches its largest possible value, as observed in numerous tests. Total destruction of the building or of the foundation appears only at a certain level of the disturbing deflection (or acceleration) after the extreme point of the curve is passed.

High-power generators make it possible to approach the maximum of the inertial load during resonant tests. In these cases the structure obtains certain destructions and cracks, its components deform to a certain degree or the foundation deforms and deflects substantially.

The ratio of the largest possible inertial lumped load and the design load characterizes the safety margin of all types of buildings; the design load of rigid buildings on loose foundations must take account of the pliancy of the foundation.

Standartisation of the safety factor may be based on the data obtained by the Strength Tests Laboratory on non-linear responce of structures to various earthquake loadings. The safety factors of civic buildings may be assumed 2,0 (for a 7-degree earthquake), 1,8 (8-degree earthquake) and 1,5 (8-degree earthquake) as the initial approximation.

Safety factor determined for various structural systems are presented in table I, which shows the correspondence of these values and of the actual safety factors of buildings erected in seismic regions.

On of the principal cunclusions derived from the theoretical analysis and from experimental research works carried out in the Laboratory is that the steady state resonance developed by vibrational generators is the most dangerous type of loading, much more dangerous than an earthquake or an impact disturbance with account of higher modes etc.

The method proposed herein determines the earthquake resistance (bearing capacity) of a structure regardless of the allowable loading. Any changes may be taken into account by establishing another safety factor.

Table I

N	Tested structure	Degree of earthquake	Safety factor	Note
I.	Two-block four-storeyed large-panel building	9	2,15	
2.	Three-block four-storeyed large-panel building	9	1,74	
3.	Nine-storey large-panel tower building	7,5	1,9	
4.	Two-storey frame; public centre	9	2,9	
5.	Three-block four-storeyed brick building	9	0,4	non-resistant
6.	Large-panel block four-storeyed experimental building	8	2,35	
7.	Three-block five-storeyed dormatory building made of middle-sised limestone	7	2,6	
8.	Experimental four-storeyed frame (a detail of a large-panel building with frame nods)	7	4,0	
9.	I/4-scale model of a ten-storeyed concrete building	7,5	3,95	
10.	Combined structure (precast and monolithic), four-storeyed frame (a detail)	9	0,97	non-resistant
11.	Monolithic five-storeyed structural frame (hospital building)	8	0,81	non-resistant