THEORETICAL AND EXPERIMENTAL INVESTIGATIONS OF PRECAST AND MONOLITHIC FRAMELESS BUILDINGS ON LARGE-SCALE REINFORCED CONCRETE MODELS

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The strength Tests Laboratory of ZNIIEP Zhilishcha conducts combined investigations of civil buildings of varions structural systems, including frameless buildings. These investigations include strength tests of full-scale buildings by means of high-power vibrational generators. Besides, tests of large-scale models and details of buildings are performed by means of vibrational generators of lower power and by statical loadings directed verticaly and horizontally. Theoretical investigations are concerned with development of designing methods related to civic buildings as complex spacial systems under the influence of various vertical and horizontal loadings, including earthquake.

Experimental and theoretical solutions are applied in designing by developing effective constructional methods and by developing corresponding algorithms and programs for digital computers.

Vibrational tests make it possible to obtain generalized characteristics of the total system - rigidity, oscillations, bearing capacity - (1,2). Tests carried out on 1/2 - 1/5 - scale models give additional information on influence of various factors, which makes it possible to analyse various methods of designing components. One of the main advantages of this method is the possibility of obtaining the ultimate state of a building and evaluate its bearing capacity without extra expences and in short time.

Four large-scale models of frameless residential buildings have been tested in the Laboratory. Each model was made to represent the primary features of a certain structural system. Models N1 and N2 of 1/3 of the real size represented five-storeyed large-panel buildings with large spacing of lateral bearing walls (3), the 1/4 scale model N3 was a large-panel precast 10-storeyed building with large spacing of lateral bearing walls (4), the 1/4-scale model N4 was a monolithic building of the same type. All the models were made of rein-

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forced concrete.

Testing experience showed that the construction model of large-scale objects must be simply and definited organized, with no minory members included.

Models NN1-3 were on an artificial foundation made of steel load-bearing frames, which were supported by a concrete bearing slab. Model N4 was erected directly upon the ground. This enabled to simulate the actual work of a real building and to examine the substantial influence of the foundation upon the inertial dynamic load, as well as upon the responce of the building and upon the stiffness and vibrational parameters of the entire system.

All the models were subjected to static and dynamic tests. Horizontal statical loadings were applied by hanging weights on cables suspended from the model and drawn over pulley-blocks of a straining frame. Dynamic loadings were produced by a vibrational generator model V-1 (designed in CNIIEP Zholishcha). During the dynamic tests the model was brought into one of the natural modes'resonance. In order to induce stresses comparible with those observed in full-scale buildings, the models were loaded with calibrated cast'iron weights to simulate the net load and to make up for the dead load. The tests were carried out up to the complete destruction of models.

Phisical and mechanical properties of the concrete were controlled by testing specimens (cubs and prisms), which were cast from the same mix with the model, and by non-destructive methods, i.e. directly in the model.

Experimental data was treated by mathematical statistics on digital computers.

Analyses of tests of 4-storeyed models M-1 and M-2 and comparison with results obtained during full-scale tests made it possible to establish the actual designing model of a large-panel building with large spacing of transverse walls. Besides, the influence of pliancy of foundation was evaluated with respect to translations of buildings as well as their natural frequencies.

Tests performed at a 10-storeyed model of a large-panel building evaluated the safety factor of such buildings, because the total destruction appeared at lodings, which were much larger than the specified loads. The following factors were observed to lead to this phenomena:

- plastic action of concrete and metal elements in joints;
- cooperate action of mutually perpendicular piers in all stages up to destruction.

Total destruction of the model appeared as a result of collapse of piers of the first floor due to eccentric compression.

The wall panels resting upon the floor slabs, the latter became involved in cooperate action under horizontal loadings, which lead to larger horizontal stiffness of the model compared with the specified stiffness.

A non-linear relation war observed between the total horizontal displacements of the model.

A stiffness decrease was noted during dynamic tests (lower natural frequencies at higher exitations) because of local destructions of joints between the precast members.

A monolithic model demonstrated a significantly larger stiffness and bearing capacity in comparison with the similar precast model, the dimensions of members and the phisical and mechanical properties of materials remaining equal in both models. This difference is due to distrubuted monolithic joints between all members, which is an essential feature of a monolithic structure. For example, floor slabs and lintels were involved in three-dimensional action with the walls under horizontal loads in a monolithic model to a larger degree than in a prefabricated model.

Changes of the damping logarithmic decrement under increasing vibrational loadings were evaluated in dynamic tests of a monolithic model erected on ground; the influence of the foundation was evaluated ar well. These tests proved the conclusions drawn from numerous vibrational tests of full-scale buildings (5).

Stiffness of the total system (monolithic model - foundation) decreased during vibrational tests, first due to inelastic compression of the soil under the foundation (and corresponding decrease of the rigidity of the foundation), and then - under increasing inertial loadings - due to cracking of lintels. These tests also showed the non-linearity in load-deflection relationship.

Experimental data obtained during large- scale testing lead to further development of designing methods relating to large-panel prefabricated and monolithic frameless buildings; which are considered three-dimensional designing models. This development may be formulated as:

- mechanism and sequence of destruction of separate members are determined, ultimate state of the total system is established;
- designing models of frameless buildings are specified;
- a method based on ultimate equilibrium and linear programming is developed for determination of the bearing capacity of a building.

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