Some results of theoretical and experimental studies of the seismic isolated regional bank "Sberbank" building with rubber bearing supports in Irkutsk city, Siberia, Russia

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Summary:
Testing is provided in accordance with the special technical requirements for the design of " Block № 2 of the administration building of “Sberbank” at the intersection of Nizhnjaja naberezhnaja str.– Dekabrskih Sobitiy str. and Polskogo Vosstaniya str. in the city of Irkutsk." The present program of dynamic testing reflects the conditions and modes of testing with the corresponding loading schemes, measuring equipment installation scheme, a description of the registration, monitoring and analytical processing of the measured parameters, the technique of the tests and rules for processing and interpretation of test results.

Keywords: Seismic isolation, testing, rubber bearing supports

1. GOALS AND OBJECTIVES OF THE TEST

- Confirmation of the theoretical assumptions and parameters of the finite element model of the building;

- Evaluation of a damping effect provided by the seismic isolation system;

- Assessment of the distribution of rigidity and seismic behavior of the physical model when part of rubber bearings are installed in groups.

- Evaluation of the dynamic characteristics of the model of the building, a comparison of the experimentally obtained values of natural frequencies with the values calculated using the finite element model, obtaining the transition coefficients for seismic evaluation of the building;

- Evaluation of modes and boundary settings for the system monitoring the dynamic state of the building (SMDS).

- Checking the individual elements of the monitoring stations (SMDS), installed at the facility, as well as the joint operation of these elements in the monitoring system;

- Verification of compliance and completeness of the requirements for the monitoring system of the building, presented in the project;

- Development of the algorithms for the software used in the SMDS;

- Where appropriate, make recommendations for improvement of SMDS: changes in the installation scheme, adjustment of the elements of SMDS and choose the mode of communication between the elements.

2. TEST METHODS

A vibration-resonance method, allows to estimate the degree of seismic resistance of various buildings and structures with sufficient accuracy. The main point of this method is to plot and study experimental curves "action - response" that characterize the changes in the parameters of structural member capacity and deformability .

In this paper we consider the behavior of a full - scale finite element model of the building and a scaled physical model tested on the vibroplatform, in order to correlate them. The major goal of this work is to obtain comparative performance data and design data obtained by testing a physical scaled model of the object for two cases - with rubber bearing supports (RBS) and without them – therefore this test will consist of two phases respectively.

For the first phase there is a scaled model with RBS installed. The characteristics of rubber bearings include the scaling factor. The appropriate mass and stiffness characteristics of the tested model are taken into account. Input motion applied to the model has few different directions. To monitor the behavior of the model we propose the following scheme (see Fig. 2.1).

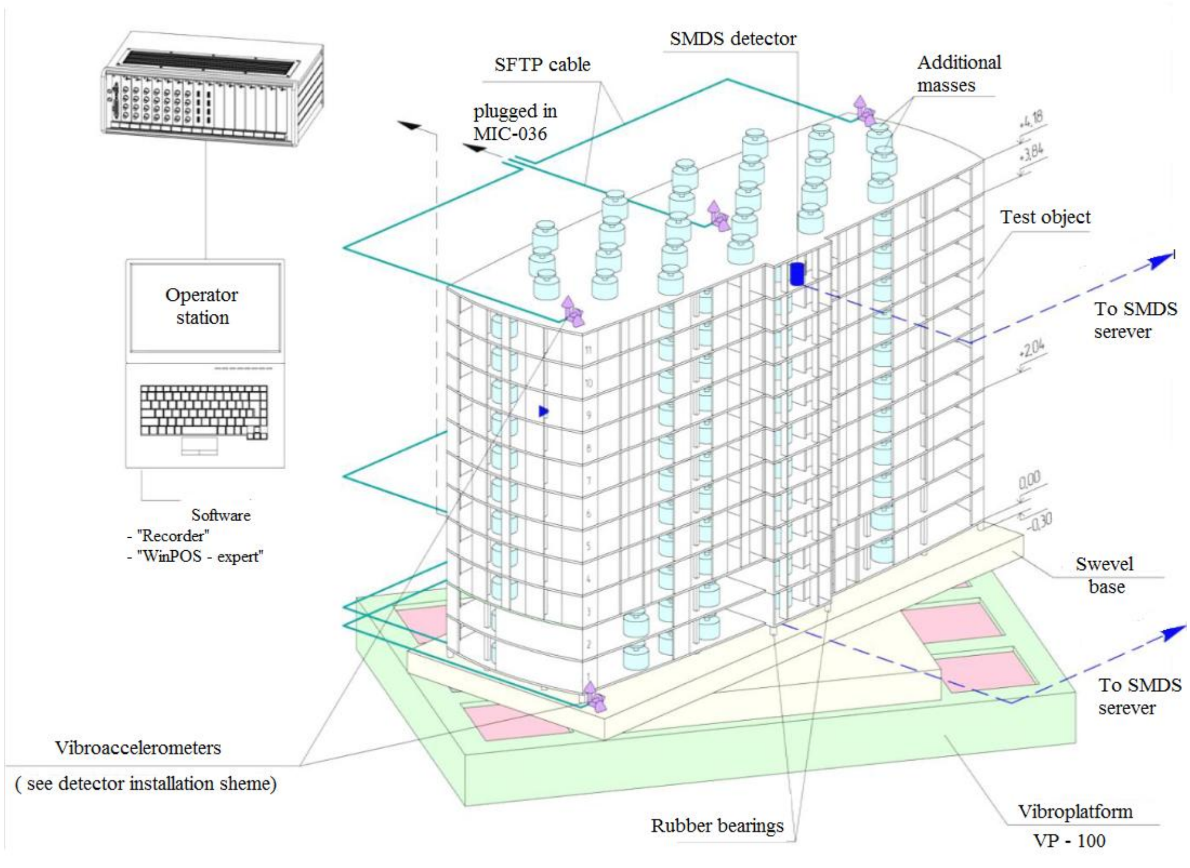

Figure 2.1. The scheme of the test object

In the vibraplatform VI-100 there is a rigid swivel base that allows changing the position of the model with respect to the direction of oscillation of the vibration table (thereby changing the direction of influence on the target of research).

In the first case the model will be installed on the swivel base using the seismic isolation systems, in the second - the object will be rigidly fixed to the rotating basis

To simulate the structural and running loads, as well as the inertial mass, a set of additional masses will be placed in the model.

Vibroaccelerometeres, which allow to determine the speed at points of registration, will be installed on the physical model and on the swivel base in order to measure the parameters of the influence and the response parameters.

The parameters of input motion applied to scaled physical model are determined depending on stiffness and strength characteristics of the seismic isolation system.

Test modes are defined taking into account the technical possibilities of the vibroplatform. Characteristics of vibration exposure produced by the platform EP-100 are shown in Fig. 2.2. Thus, the power of vibration exposure produced by the vibroplatform is sufficient for complete vibration tests at all stages of elastic-plastic performance of the model.

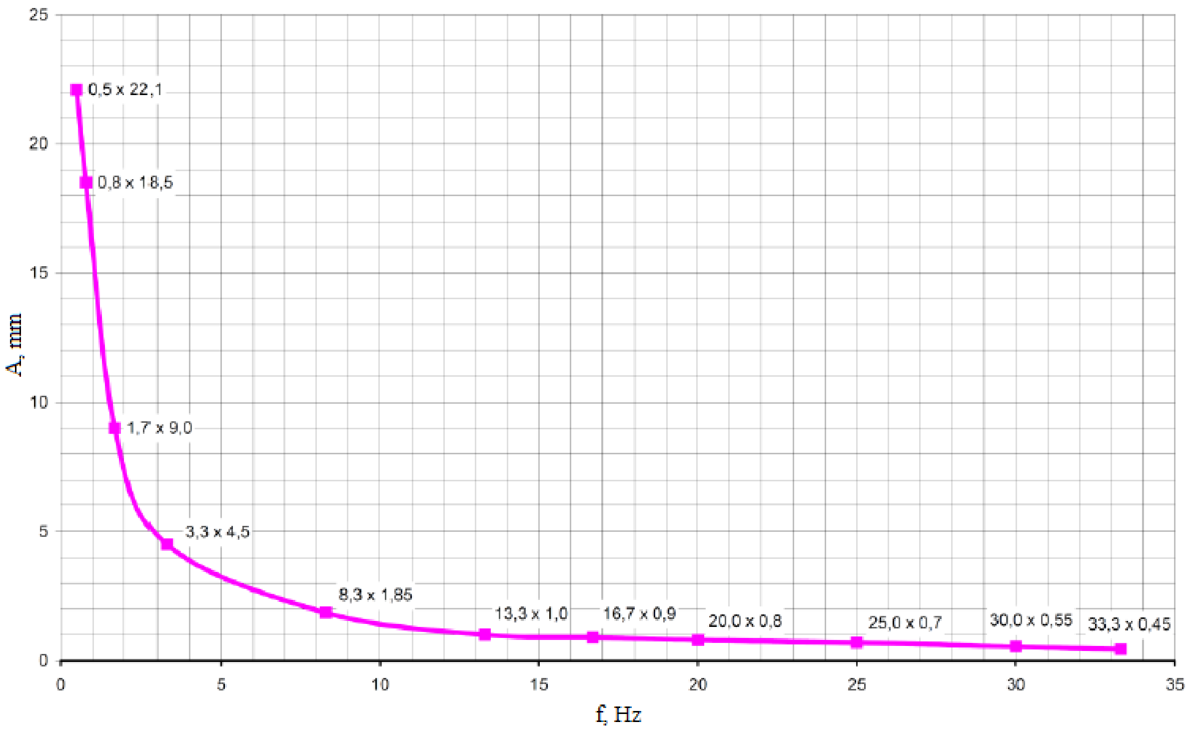

Figure 2.2. Schedule of permissible values of the amplitudes and frequencies for the vibroplatform EP-100

In addition, the components of long-term monitoring station (SMDS) will be installed at the physical model. This station is designed and assembled according to a specially developed project, to register (monitoring) the dynamic parameters of the system.

During the test occurrence of certain events will be modeled to check the performance of SMDS.

As result, it will be determined whether SMDS functions correctly and conforms to the requirements of the project.

3. DESCRIPTION OF THE BUILDING AND THE CONSTRUCTION SITE

An 11-storey building with underground part is designed on an individual project. The height of the lower ground floor - 4.250 m (3.550 m clear opening height). Here the parking for service vehicles is located. In the basement there is technical space reserved for the placement of seismic isolation system.

Functional purpose of the facility is administration building of the bank. On the first floor (Position Level ± 0,000) is a lobby with the control passage.

The height of the 1st and 2nd storeys - 4.80 meters. The height of the 3 -10th storeys - 3.60 m. 2-10-th storeys - office space. The 11-th storey height - 3.38 m, it is a technical level where equipment to service the facility is located. For the reference mark ± 0,00 the floor level on the 1-st storey is accepted, which corresponds to an absolute mark of 432.50 m. The superstructure is of different height from 39.28 m. - 42.88 m.

Dimensions of the building in terms of 60,10 × 23,00 m (56,70 × 19,30 m - in construction lines). Column grid 8,10 × (4,80 +7,20 +4,80) m. The level of responsibility of the building is II (normal) according to GOST R 54257-2010. In order to ensure seismic resistance, seismic isolation bearings with high damping - rubber bearings with lead cores (OWS) were installed in the building. Super structure is separated from the underground structure by the horizontal aseismic joint under the floor slab which is located at the position level ± 0,00. Rubber bearings are installed on monolithic reinforced concrete columns: - In the axes of "4/5"- "5/6" - "I" - "H" at the level. -5.050; in the rest of the building at the level. -0.800 m.

4. OBJECTS OF THE TESTS

The objects of these tests are:

- The physical model of the administration building of the bank at a scale of 1:10;

- The elements of the station monitoring the dynamic state of the constructions (SMDS).

The following is a description of the test object.

4.1. Physical scaled model of the building

The model is at a scale of 1:10. In the model the distribution of stiffness and mass in both plan and height corresponds to the actual building. Overall plan dimensions: 6,01 x 2,3 m (5,67 x 1,93 m - in construction lines). Column grid: 0,81 x (0,48 +0,72 +0,48) m. The storeys height is as follows: the 1-2-d - 0.48 m; the 3d - 10th - 0.36 m; the 11-th - 0.34 m.

Vertical load-bearing elements with square section are made of metal. The walls that run the full height of the building, modeled by a metal frame with sheeting of an isotropic material (fiber board, plywood, particle board).

In the model the relationship of stress, stiffness, and geometric characteristics should correspond to the real building, so to provide the most similar behavior and stress state of the model, thus we are able to obtain complete information which is necessary to evaluate the performance of the system.

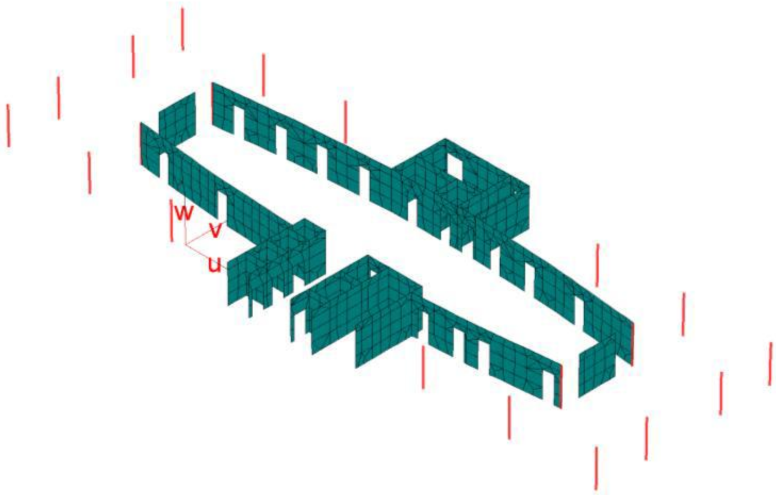

Figure 4.1. The layout of vertical bearing elements on the typical floor

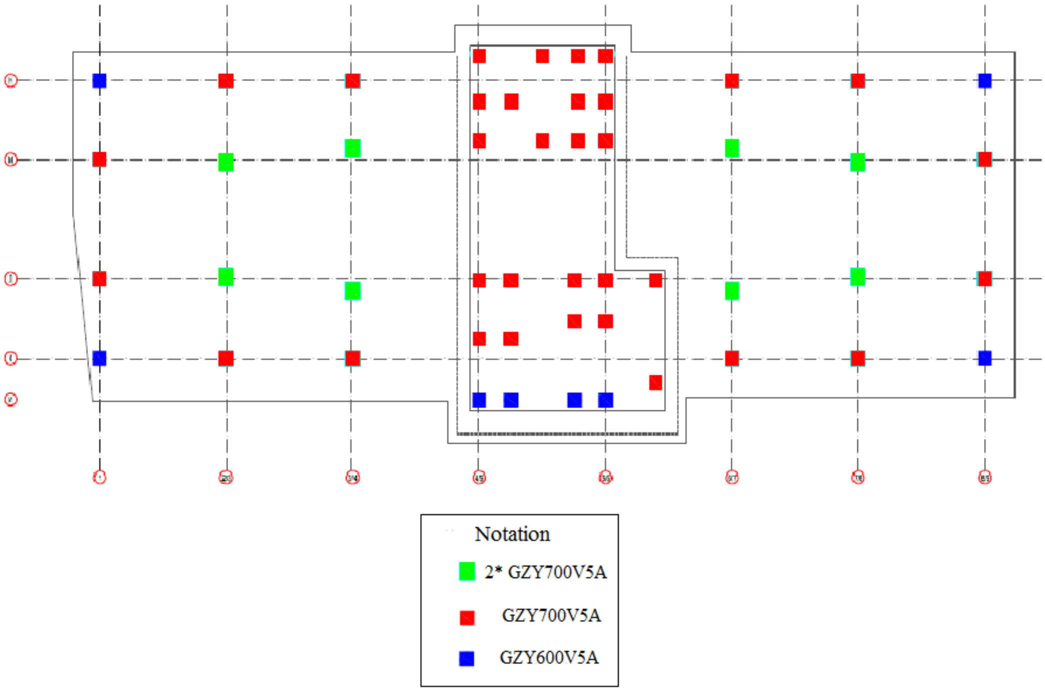

Figure 4.2. Rubber bearing installation scheme (real building)

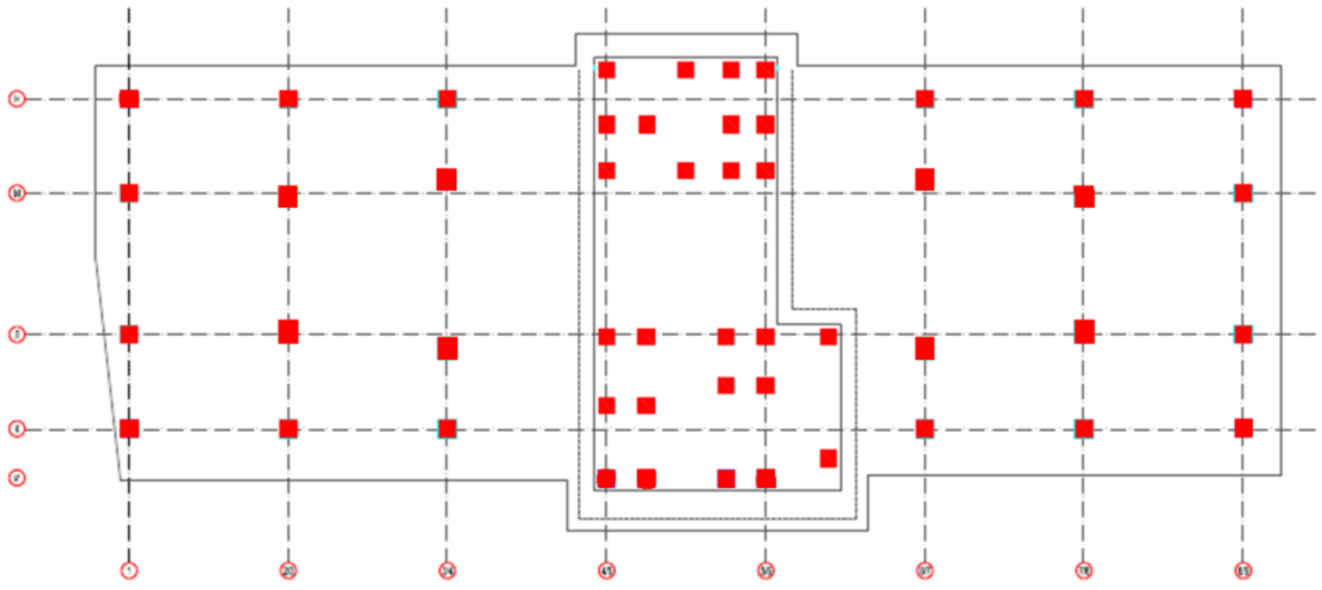

Figure 4.3. Rubber bearing installation scheme (scale model)

To carry out these pilot studies the physical model should have sufficient strength and rigidity so we have minimal impact on the reliability of research results.

5. TEST EQUIPMENT

For the tests we planned to use the following types of equipment.

1. Testing equipment includes the following items:

- Vibroplatform (shaker), VP-100;

- Swivel base for the installation of the test object in a desired position relative to the direction of vibration;

- Ancillary equipment needed to fix the physical model, and to simulate dead load and running load.

2. The measuring equipment to ensure the registration of acceleration in the control of different points of the test object. The measuring equipment includes the following components:

- Vibroaccelerometers AT 1112 and AT 1105;

- Device for recording, collecting and processing the data: MIC-036 - 2 pcs;

- Operator station with installed software «Recorder»;

- Cable connecting vibroaccelerometers with MIC-036.

3. The software "WinPOS-Expert» aimed for processing and detailed analysis of the results of tests using standard mathematical and statistical methods.