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STABILITY OF STRUCTURES OF BUILDINGS AND STRUCTURES FROM PARASEISMIC EFFECTS (DETONATION WAVES)

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Abstract
A brief review of paraseismic forces that affect the structures of buildings and structures is presented. We also refer to paraseismic forces the energy of a detonation wave, which is capable of influencing the structures of buildings and structures. The influence of a detonation wave on the structures of buildings and structures has been studied for many years using the developed gas detonation unit, which makes it possible to cause artificial ground vibrations. The basics of the technique and the scheme of the experiments are presented. The principle of operation of a gas detonation unit that causes a detonation wave is described, and schemes of the impact of these waves on the structures of selected buildings are given. A method for controlling the frequency and strength of the induced vibrations by choosing the composition and amount of the combustible mixture for the gas detonation unit is highlighted.

Keywords: Structures of buildings and structures, seismic resistance, paraseismic forces, detonation wave, ground vibrations, gas detonation unit.

In accordance with [1], as a preliminary method of approach to the determination of paraseismic impacts, one can apply their characteristics similar to those of real earthquakes caused by various types of human activity.

- Sources of paraseismic impacts are classified as follows:
- - Underground and overground explosions;
- - Tremors from active (also inactive) mines;
- - Above ground explosions (eg quarrying);
- - Overhead shocks and impacts (for example, when driving piles);
- - Vibrations caused by traffic and transmitted through the ground to buildings (from highways and railways, metro);
- - Other sources, such as the operation of industrial enterprises, mechanisms, equipment, etc.

In this regard, we propose to include the detonation wave energy, which is capable of influencing the structures of buildings and structures, as paraseismic forces. The influence of the detonation wave on the CZiS has been studied by us for many years with the help of the developed gas detonation unit, which makes it possible to cause artificial ground vibrations.

In continuation of the working hypothesis set forth in [4], that the detonation wave caused by the gas detonation unit described in [5] creates artificial ground vibrations, which can be equated to paraseismic effects. Based on the hypothesis put forward, the goal was set: with the help of artificial ground vibrations, to study the supporting structures of buildings for seismic resistance and develop a daily available scientific and practical method for expedient and cost-effective technical inspection of structures, operated buildings for designers, builders and utilities, which is extremely important during renovation processes taking place in Uzbekistan. To achieve this goal, the following tasks are planned:

- - Choose the research methodology;
- - Select and group research objects according to seismic zoning, soil conditions, design solutions, materials used;
- - To link the gas-dynamic apparatus developed earlier at FerPI to ongoing research with the choice of the most optimal composition of the fuel (or mixture), which makes it possible to control the frequency and strength of oscillations;
- - Develop a scheme for conducting experiments;
- - To develop a methodology and tools that enable express study of the technical condition of the supporting structures of buildings;

The methodology and scheme of the conducted studies take into account such seven factors and principles that are taken into account in the design of seismic-resistant SC&S, such as:

1. Characteristics of construction sites subject to seismic impacts, taking into account microzoning criteria, soil behavior under large deformations, the possibility of liquefaction, topography and other factors, or, the interaction between them);
2. Careful selection of the type of foundation according to the type of construction, category and type of soil, local soil conditions such as soil section, subsoil disturbance and groundwater level. Forces and strains transmitted through foundations should be properly assessed, taking into account the stresses acting on the soil during induced vibrations, as well as the kinematic and inertial interactions between the soil and the foundation.
3. The choice of simple building configurations both in plan and vertical, elements subject to horizontal paraseismic actions should be located so as to minimize torsional effects.
4. The effect of non-structural structural elements of a building consisting of non-structural and load-bearing elements should be clearly defined as a system resistant to lateral loads, which can be analyzed accordingly. When calculating the reaction of a building, the influence of not only load-bearing frame structures, but also walls, floors, partitions, stairs, windows, etc. is taken into account.
5. The strength and ductility of the structural system and its load-bearing elements (both parts and connections) must have a sufficient degree of strength and ductility to withstand paraseismic effects. The structure must have sufficient strength to resist paraseismic impacts and sufficient ductility to provide sufficient energy absorption. Particular attention is paid to the strength and brittle behavior of the load-bearing members, such as buckling, debonding, shear failure and brittle fracture. The reduction of the restoring force under the influence of cyclic loads is taken into account.

The local bearing capacity of the structure may be higher than that allowed for in the analysis. Such excess bearing capacities are taken into account when evaluating the behavior of the structure, including the type of failure of load-bearing elements, the mechanism of structural failure, and the behavior of foundations under strong impacts.

6. Deformation of the structure under the action of paraseismic loads is limited so as not to cause destruction of the structure, and also not to endanger people under strong impacts.

Limiting the total displacement is related to establishing sufficient distances between two nearby structures to prevent destructive contacts during large earthquakes. Limiting the total displacement can also reduce the vibration amplitude of a building and prevent panic and discomfort from moderate vibrations. When evaluating deformations caused by strong vibrations, one should usually take into account the effects of the second order of additional moments due to gravity and vertical forces acting on the structure displaced as a result of strong vibrations.

7. The reaction control system necessary to ensure the smooth functioning of the structure during moderate vibrations and to prevent the collapse of structures during strong vibrations can be used, for example, paraseismic isolation.

Irregular planforms that cause an eccentric distribution of forces are undesirable because they create torsional effects that are difficult to accurately assess and that can increase the dynamic response of the structure. Torsional moment i-ro of the structure level M, which is usually calculated in each direction of the rectangular structure axes x and y, shown schematically in fig.I. can be determined by the formula:

M,=V.e. , where V, is the seismic shear strength of the i-th level (1)V,= ZFj , j = l , (1)

where n is the number of levels above the base

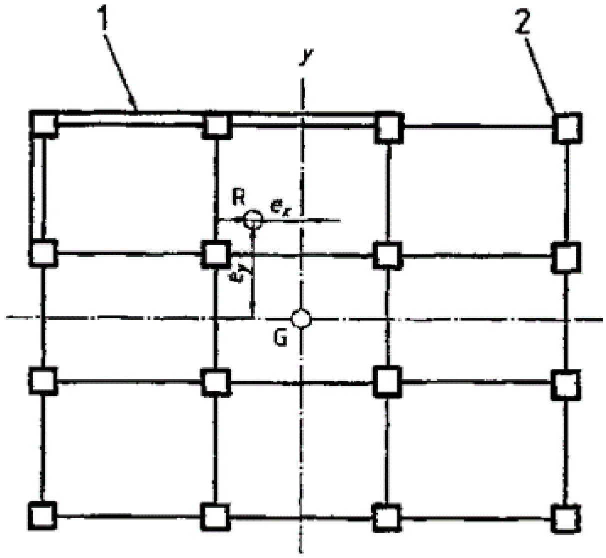


Figure 1-Center of mass G, center of rigidity R and eccentricity ext ey : 1-stiffness wall; 2-rack

The value of the dynamic zoom factor, for example, can take values from 1 to 2. (specified in national regulations).

The irregularity of the vertical shape leads to a change in the mass, rigidity and bearing capacity along the height of the structure. Therefore, to prevent the concentration of destruction, these indicators must be minimized.

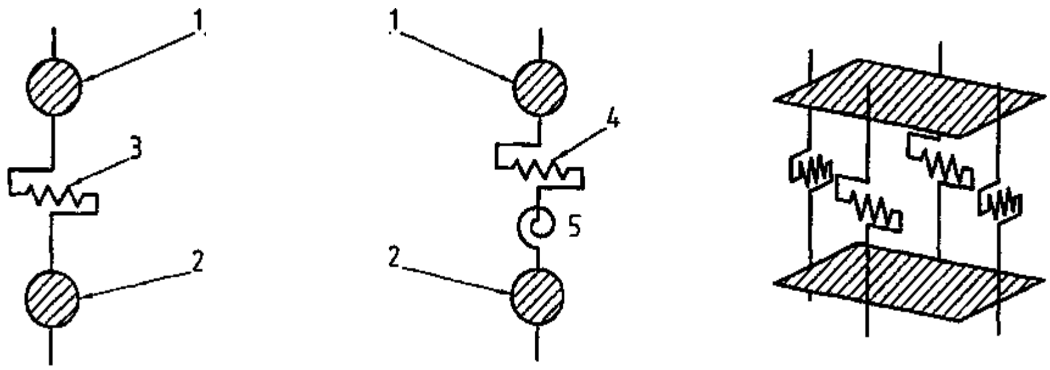
Taking into account the above characteristics of the seismic force parameters, the seismic force distribution coefficient, kFi, can be determined as follows:

$$^{k}F_i=F_{Cl}, \text{h, v b}_{Gj}\text{ h;} \qquad (2)$$

where F $_{C\,l}$ - load of the structure from its own weight at the i-th level,

which includes the probable variable live load (0.2-0.3 of the total live load);

h - height above the base at the i-th level;
n is the number of levels above the base.
The exponent v can be expressed as follows:
v \u003d 0 for very low buildings (for 2-storey buildings) or structures for which T < 0.2 s;
v = from 0 to 1 for low-rise buildings (3 - 5-storey buildings) or structures for which 0.2 sec<T<0.5 sec;
v = 1 to 2 for medium buildings or structures for which 0.5 s <T< 1.5 s;
v = 2 for high-rise buildings (above 50 m or more than 15-storey buildings) or structures for which T> 1.5 sec.
Structure models are selected depending on the purpose of the analysis. Basically, the models used in this analysis are the same as those used in the analysis of the response spectrum. Examples of such models are shown in Figure 2.

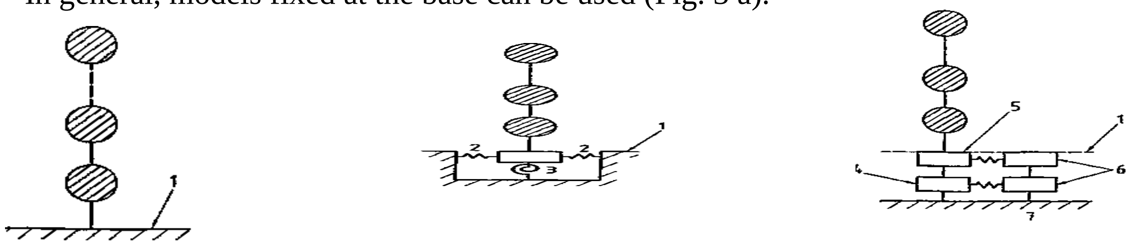


а) б) в)

Figure 2 Models of building structures subject to analysis:
a - shear model; b - bend shear model; c – simplified spatial model: 1 – mass at the level (i+1); 2 – mass at level i; 3 – spring equivalent to shear, 4 – shear spring; 5 - curved spring.

In many cases, for buildings of small and medium height, shear models with one-dimensional concentrated mass are used, in which the concentrated mass is the mass of each floor, and the lateral stiffness of the floors is considered uncoupled or independent (Fig. 2a). For high-rise buildings and bar structures (in which the height-to-width ratio exceeds 3, it is recommended to use shear-bending models, taking into account the axial deformation of the columns or the deformation of the full bending of the structure (Fig-2 b). Flexural stiffness can be considered as elastic, even in the stiffness range shear beyond the elastic limits Simplified three-dimensional models (Fig. 2c) are used to evaluate the response of a structure to a torque.
In Figure 3, one can see the classification of models in terms of the relationship between the structure and the soil.

In general, models fixed at the base can be used (Fig. 3 a).



а) б) в)

Figure 3. Models of the interaction of the structure with the soil:

a - model, reinforced at the base; b - model swinging in horizontal and vertical directions; c - relationship model: 1 - ground level; 2 - a spring moving in a horizontal direction; 3 - spring moving in the vertical direction; 4 - pile; 5 - foundation / foundation; 6 - soil; 7 - bedrock

When considering the results of soil matching, you can use models that swing in the horizontal and vertical directions, which contain springs that swing horizontally, springs that swing vertically, or a combination of these springs (Fig. 3b). When determining the movement of the soil during induced vibrations at the level of the bedrock, models of the relationship between the structure and the soil can be used (Fig. 3c).

The material about the influence of the detonation wave on the structures of buildings is presented in subsequent publications.

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