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EFFECT OF DETONATION WAVE ON BUILDING STRUCTURES

Abdullaev Ibrohim Numanovich
Fergana Polytechnic Institute, Ph.D., Associate Professor,
i.abdullayev@ferpi.uz, (ORCID 0000-0003-4009-5422)

Abstract
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. With the use of modern electronic equipment, as well as the chosen methodology and schemes for conducting experiments, a group of objects is observed that differ in design features and material. Preliminary results are given based on the data obtained.

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

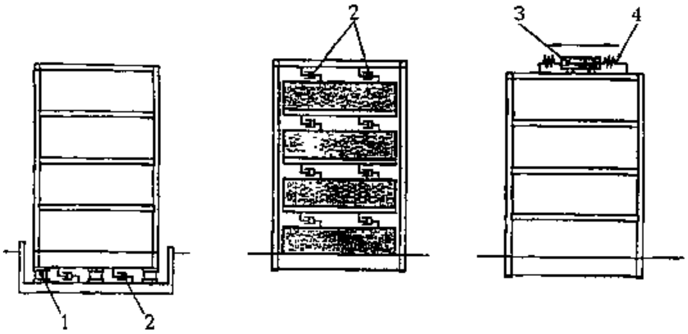
Recently, response control systems, including seismic isolation, have been increasingly applied to various types of structures, such as buildings, road bridges and power plants. Reaction control systems are used not only for new designs, but also for retrofitting existing types of structures. There are several reaction control systems to protect the property inside the structure, isolating the ceilings on which the property is located, etc.

All systems except active (and combined) systems can be converted into passive reaction control systems. Seismic isolation should reduce the response of the structure through vibration isolating bases, which are usually installed between the foundation and the structure. Since vibration dampers lengthen the period of natural vibrations of the structure, and vibration dampers increase damping, the acceleration response is reduced, as shown in Fig. 3, but a relatively large displacement occurs at the level of the installed vibration damper. Energy absorbing devices and additional masses for structures are also used to control the reaction. Energy absorbing devices increase the damping of structural vibrations due to plastic deformation or viscous resistance of the devices. Structural response is also reduced by vibration of additional masses or liquid materials. Active reaction control systems reduce the structural response caused by earthquakes and winds by using additional computer-controlled masses or by using prestressed reinforcements.

Reaction control systems are used to reduce the reaction of floors and reduce intra-storey horizontal deflection. Reducing floor response can ensure seismic safety, improve occupancy of the building, reduce occupant anxiety, prevent furniture from falling, etc. Reducing the intrastorey horizontal deflection can lead to a reduction in the amount of building material used, reduce the degree of damage to non-load-bearing structural elements, increase the degree of freedom in structural design, etc. Some response control systems may or may not be very effective depending on the type of structure, soil type, frequency response of the ground, the response control system itself, etc.

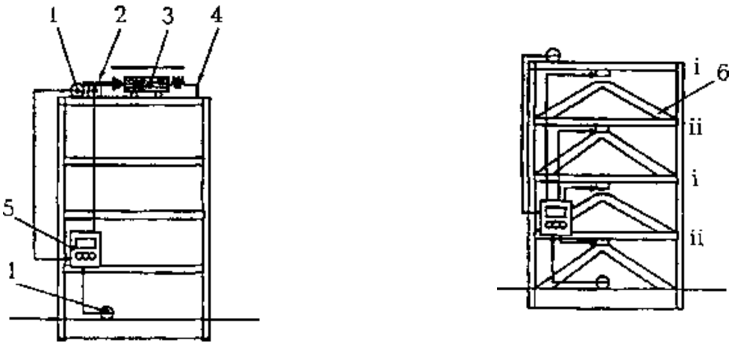
When calculating these systems, the mechanical characteristics of vibration isolating bases or additional devices, such as hysteresis, friction and hydraulic vibration dampers, should be taken into account. For these systems, it is preferable to perform a dynamic analysis, since the restoring force characteristics of the vibration isolating bases and devices have a great influence on the performance of the structures. Analytical models for newly developed materials should be verified through experimentation.

Since these systems can be affected by environmental conditions, the effects of aging, creep, fatigue, temperature, moisture, etc. are taken into account.



a) b) c)

Figure 4. Passive control system: a - seismic isolation; b - energy absorption; c - mass action mechanism: 1 - vibrating support; 2-vibration damper; 3 - weight; 4-spring



a) b)

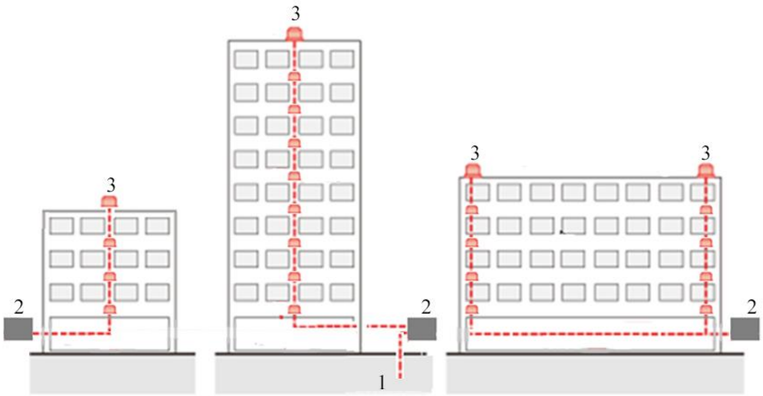
Figure 5. Active control system: a - the mechanism of the impact of mass; b – stiffness control: 1 – sensitive element; 2 - power drive; 3 - weight; 4 - spring; 5 - computer; 6 – clamp; i - off/on; i I –on/off

The following are guidelines for the use of coefficients for assessing seismic impacts:

kz - seismic hazard zoning factor can be taken from seismic hazard zoning maps obtained separately from random checks or direct measurements:

kE,u> ke,s - representative ground motion rates may also be obtained from random checks or direct measurements; one should take into account the fact that in general the period of repeated oscillations is very short in comparison with the periods of earthquakes;

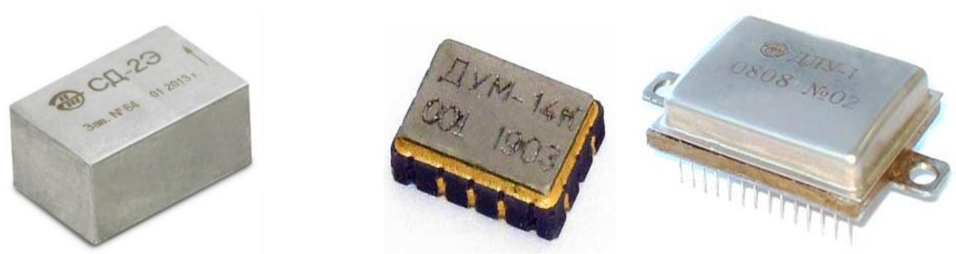
ko - coefficient, taking into account the design features, to reduce the design forces, is used only in exceptional cases and its value should not be less than 0.5;
kR - normalized calculated response spectrum can be taken from carefully designed drawings or based on individual measurements.
The normalized calculated reaction spectrum is similar to that shown in Fig. C.1. The parameters for mining explosions, for example (a) in coal mines and (b) in copper mines, are as follows:
RRO =3; T 'с = 0,1 сек; T= 0,3 сек для (а) и 0,2 сек для (Ь) и р =0,5.
In many cases, multiple components of the horizontal and vertical directions must be considered simultaneously, in particular for closely spaced shock sources.
Taking into account the above, 3 types of buildings were selected for the experiments, which differ structurally (Fig. 6):
a) - 2, 3 and 4-storey brick residential buildings;
b) - 4, 5 and 9-storey large-panel residential buildings;
c) - 5-storey frame educational building with a grid of columns 6x6 m.;



a) b) c)

Figure 6. Location diagrams of the gas-dynamic unit and seismometric control sensors: 1-detonator; 2-gas-dynamic unit; 3-sensors.

Figure 7 shows the highly sensitive seismic control sensors used for the observations.



a) b) c)

Figure 7. Seismometric control sensors: a - compact piezoceramic seismic sensor SD-2E; b - compact shock sensor DUM-14K; c – linear acceleration sensor DLU-1E
a) piezoceramic compact seismic sensor SD-2E. It is a dust and moisture protective housing, which contains sensitive piezoceramic sensors and electronic signal pre-processing systems.

The output signal is analog, allowing both normal load and twisted pair on each coordinate. Installed on the supporting structures of buildings with monitoring systems;
b) small-sized shock sensor DUM-14K is used: - as primary transducers in seismic and vibration measuring systems and complexes; - as a sensor of the threshold level of fluctuations of the base of the building;
c) - linear acceleration sensor DLU-1E - designed to convert accelerations acting along the measuring axis into a proportional electrical signal; for observations of detonations and vibrations.
The proposed method is a specialized seismic monitoring, within the framework of which continuous observations are made of the structures of buildings and structures in order to ensure safety and prevent possible negative consequences.
The methods of verification and means of ensuring the seismic resistance of building structures are based on the accumulated centuries-old factual material on the consequences of strong earthquakes and the experience of preventing them or at least minimizing them, minimizing the threat of seismic shocks to people's lives, products of their activities and the environment. Calculation determination of seismic resistance of structures of buildings and structures is a mandatory step in the design of new types or modifications of existing equipment structures in earthquake-resistant construction.
The current building codes and regulations determine the approach to ensure the seismic performance of structures according to the level of responsibility. So, the following requirements are imposed on normal and responsible objects: the structure must withstand the seismic loads of one maximum earthquake and several design earthquakes, while the vital activity of the structure should not be disturbed.
Continuous seismometric monitoring of buildings and structures is designed to determine the current seismic loads on structures and compare them with the values laid down during the design. Even with relatively weak seismic impacts, visually unidentifiable defects can appear, which can lead to the destruction of the structure. The presence of such defects leads to a change in the shape of the reaction spectrum of the structure, which makes it possible to detect them at the early stages of development.
This work provides: protection of life and health of the population and minimization of the consequences of seismic impacts on buildings; accounting for seismic and geological conditions; protection of the population in emergency situations associated with seismic and man-made activity; operation of buildings and structures in seismically active regions; development of earthquake-resistant construction technologies.
To perform work at the facilities, it is planned to deploy a modern seismometric control system that ensures the safety of vital objects, economic feasibility and full compliance with building codes and rules of the Republic of Uzbekistan.

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