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CONSTRUCTION OF HIGH-RISE BUILDINGS ON SEISMIC HAZARDOUS TERRITORIES

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According to UNESCO, among all natural disasters earthquakes rank first in the world in terms of economic damage and death toll. As a result of earthquakes, surface vibrations occur, causing the destruction of residential buildings and industrial structures. That is why the world is developing the latest methods for the construction of high-rise buildings in earthquake-prone areas. This practice is actively developing in such countries as Japan, China, the USA, etc. However, in Ukraine it is not yet developed at a sufficient level.

Traditional methods of seismic protection include [1]:

1. Simple design solutions − symmetry. If the building has a complex shape, it can be divided into sections of a simple shape (square, rectangle).

2. Reducing the size of structural elements and their weight − it is necessary to make the structure as light as possible, with the lowest possible center of gravity. For this purpose, elastic lightweight materials with sufficient strength and uniform properties are used.

3. Increasing the strength of materials and the rigidity of structures due to “fastening − linking beams, columns, slabs and walls into a single closed loop in the vertical and horizontal planes, as well as additional reinforcement of the walls [2].

There are also special methods of seismic protection (active or passive). Active ones usually require additional energy sources for their work. Passive seismic protection systems are special structural devices that are placed between the foundation and the above-ground part of the building and create a layer that protects the building from earthquakes. This layer may consist of various materials, such as springs, rubber pads or special cushioning materials. Structural insulation allows the building to “float” on the insulation layer during an earthquake, reducing the chance of damage. Usually large steel and rubber plates are used. This method serves to dissipate the energy of an earthquake so that the energy generated by the shocks is not transferred to the building (Fig.).

In seismically isolated buildings, the relative horizontal movement of the floors on the upper floors is much less than in conventional buildings. To protect against earthquake damage, a rubber seismic base, also known as RSI, is used.

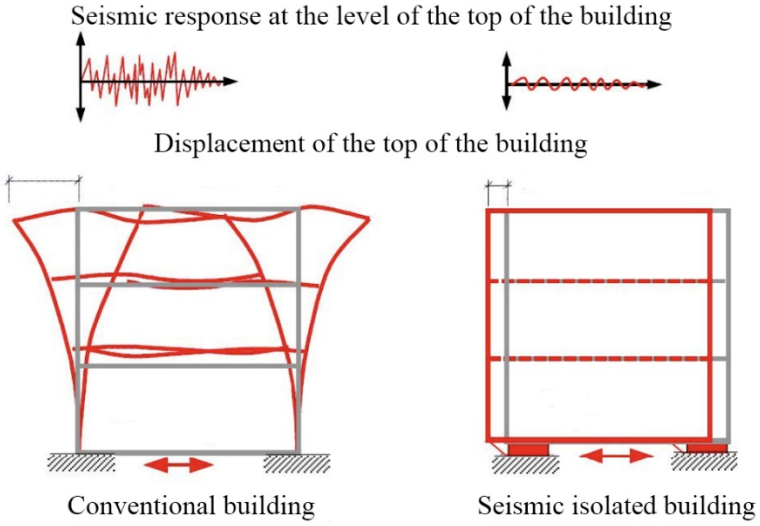

Fig. Behavior of seismically non-isolated and isolated buildings during an earthquake

The three most common isolation systems are:

1. Elastomeric isolator (thermoplastic rubber). It consists of several rubber sheets, which alternate with steel sheets and are attached to the foundation with anchor bolts. The rubber layer between the plates allows the building to compensate for forces arising from seismic loads.

2. Elastomeric isolator with a lead core (LRB). It has a lead core that helps dissipate vibration energy. It withstands vertical loads, provides horizontal flexibility and damping.

3. Friction pendulum isolator (FPS). Uses the concept of a sliding device in combination with the concept of pendulum friction to create an effective seismic isolation system in a wide frequency range [3].

The use of rubber seismic bases is widespread in various countries of the world, in particular in Europe, Asia and Latin America. The US also has a lot of experience with elastomeric insulators in seismic protection of buildings, especially in the state of California, which is also in an area of high seismic activity. Japan is one of the most active countries in the use of rubber seismic foundations. This practice has been used for seismic protection of buildings for over 30 years. These insulators have been successfully tested during the 1995 Kobe earthquake and the 2011 Fukushima earthquake, proving their effectiveness. According to a report from the Ministry of Japan (after the March 2011 Tohoku earthquake), more than 90% of the buildings in the earthquake area that met strict earthquake resistance standards survived the earthquake. Of more than 100 buildings over 100 meters high, only two buildings were severely damaged and needed to be demolished.

As a result of the earthquake on February 6, 2023, more than 164,000 buildings were destroyed in Turkey. As it turned out, many of them were built from low-quality building materials. The columns and beams in these buildings were not distributed in such a way as to effectively absorb shocks from tremors [4].

The zone of increased seismic risk occupies approximately 120 thousand square kilometers (20 % of the territory). There are state safety standards during the construction of buildings in earthquake-prone regions (ДБН В.1.1-12:2014). However, not all buildings in our country meet these standards. This means that if an earthquake occurs, then, such buildings can be dangerous for people's lives and health. Therefore, it is important that owners and management companies of buildings regularly conduct checks on the compliance of buildings with earthquake resistance and, if necessary, carry out repair work and strengthening of structures [1].

Seismically isolated foundations can undergo the following changes after earthquakes: a) the appearance of small cracks in the foundation materials due to deformations that occur during an earthquake; b) bases and insulation pads can move, rotate or shift, which can lead to a change in the position and level of the building; c) damage to seismic isolation elements, such as springs, bearings or dampers, is possible.

After an earthquake, it is necessary to inspect the building and the seismically isolated foundation to make sure that all seismic isolation elements are in working order and the foundation is not damaged [5].

Therefore, seismic isolation is an important technology to ensure the safety of multi-storey buildings in the face of possible seismic impacts. This reduces the forces and vibrations caused by earthquakes and increases the stability of building structures. However, despite the benefits of seismic isolation, its application can be costly and require some knowledge and technical knowledge. Therefore, when designing and constructing multi-storey buildings in seismically active areas, it is necessary to take into account not only the advantages, but also the limitations associated with this technology.

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