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BUILDING STRATEGIES FOR EARTHQUAKE PROTECTION

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Annotation: *In this article dedicated building strategies for earthquake protection. We have constructed magnificent cities and structures throughout history, only for them to be destroyed by natural forces. One of the most damaging natural phenomena on the Earth are earthquakes, which send seismic waves through the ground and cause buildings to collapse, kill people, and cause enormous financial losses due to damage and restoration.*

Key words: *earthquake, foundation, dampers, skyscrapers, seismic waves, collapse, concrete rings.*

Earthquakes affect man-made structures before looking at the characteristics of earthquake-proof buildings. When an earthquake happens, it causes shockwaves to travel across the ground in brief, quick bursts that reach all directions. Buildings can typically withstand the vertical forces generated by their weight and gravity but not the side-to-side forces produced by earthquakes.

Walls, floors, columns, beams, and the connections that hold them together shake as a result of this horizontal movement. Buildings' bottom and top movements diverge, putting significant stress on the supporting frame and ultimately leading to the collapse of the entire structure.

Engineers labor to strengthen the structure and mitigate the effects of a prospective earthquake while creating an earthquake-proof building. Since structures are pushed in one direction by the energy released during earthquakes, the technique entails having the building push in the opposing direction. Here are a few techniques for making structures more earthquake-resistant.

1) A flexible foundation must be created

Base isolation is a technique used to "raise" the building's foundation above the ground in order to withstand ground stresses. Base isolation entails erecting a structure on top of flexible steel, rubber, and lead pads. The isolators vibrate when the base shakes during an earthquake, but the building itself doesn't move. As a result, seismic vibrations are successfully absorbed and kept from passing through the building.

2) Counter forces with damping.

You might be shocked to find that engineers also utilize a variation of shock absorbers in earthquake-resistant structures if you're familiar with the ones used in automobiles. Shock absorbers work similarly to how they do in automobiles: they lessen the force of the shockwaves and lessen the strain on the structure. Pendulum power and vibrational control devices are used to achieve this.

This technique includes inserting dampers between columns and beams at each level of a structure. Each damper comprises of a cylinder containing silicone oil and piston heads. When there is an earthquake, the structure's vibrational energy is transferred to the pistons, which press against the oil. The force of the vibrations is then dissipated as a result of the energy's transformation into heat.

Pendulum power, which is mostly employed in skyscrapers, is another typical dampening technique. Engineers do this by suspending a large ball on steel cables that are attached to a hydraulic system at the top of the structure. The ball works as a pendulum and swings in the opposite direction to steady the building when it starts to shake. These characteristics, like damping, are adjusted to coincide with and counteract the movement of the building during an earthquake.

3) Shield Buildings from Vibrations

Researchers are working with methods that structures may completely deflect and redirect the energy from earthquakes rather than merely counteracting pressures. This invention, known as the "seismic invisibility cloak," entails making a cloak out of 100 concentric plastic and concrete rings and burying it at least three feet beneath the building's foundation. The ease of travel forces seismic waves to pass through to the outer rings as they enter the rings. They are consequently essentially directed away from the structure and dissipate into the ground.

4) Reinforce the Building's Structure

Buildings must disperse the seismic forces that pass through them in order to withstand collapse. A building can be reinforced by shear walls, cross braces, diaphragms, and moment-resisting frames.

Shear walls are a practical construction technique that can assist in transferring earthquake forces. These walls, which are composed of several panels, assist a structure in maintaining its form while being moved. Shear walls are frequently supported by steel diagonal cross bracing. These beams are capable of supporting both compression and tension, which helps them resist push and pressure stresses.

Another essential component of a building's construction is its **diaphragm**. Diaphragms, which are made up of the building's floors, roof, and decks atop them, assist in pushing pressures to the building's vertical supports and relieving floor strain.

Concrete and mortar

Use river sand for making mortar and concrete. It should be sieved to remove pebbles. Silt must be removed by holding it against the wind. Coarse aggregate of size more than 30 mm should not be used. Aggregates should be well-graded and angular. Before adding water, cement and aggregate should be dry and mixed thoroughly.

Tall buildings are subjected to heavy horizontal forces due to inertia during the earthquake.

Hence they need shear walls.

Shear walls should be provided evenly throughout the buildings in both directions and from bottom to top. Apart from providing shear walls, the given following techniques are also used for making tall buildings earthquake-resistant:

Base Isolation-This idea behind isolation is to detach (isolate) the building from the ground, so that earthquake motions are not transmitted through the building or at least greatly reduced.

The concept of base isolation is explained through an example of a building resting on a roller.

When the ground shakes, the roller freely rolls, but the building above does not move. If the gap between the building and the vertical wall of the foundation pit is small, the vertical wall of the pit may hit the wall. Hence 100% frictionless rollers are not provided in practice. The building is rested on flexible pads, which offer resistance. This helps in reducing some effects of ground shaking on the building.

The flexible pads are called base-isolator, whereas the structures constructed utilizing these devices are called base-isolated buildings.

Moment-resisting frames provide architects more freedom when designing a structure. These elements are positioned between joints in a building, allowing columns and beams to flex while the junctions stay stiff. As a result, the building can withstand an earthquake's greater pressures while still allowing architects to organize building components as they see fit.

Shock absorbers, pendulums, and "invisibility cloaks" could, to some extent, assist in dispelling the energy, but the materials choose for a structure are also in charge of its stability.

A material must have high ductility—the capacity to withstand significant deformations and tension—in order to be able to withstand stress and vibration. Structural steel, which comes in a variety of forms and allows buildings to flex without breaking, is frequently used in the construction of modern buildings. Due to its considerable strength in comparison to its lightweight structure, wood is also an unexpectedly ductile material.

Engineers and scientists are working to create new construction materials that retain their form even better. Shape memory alloys are an example of an innovation that can withstand significant stress while still returning to its original shape. Additionally, columns can be covered with fiber-reinforced plastic wrap to offer up to 38% more strength and ductility. This type of plastic wrap is created from a range of polymers.

In order to strengthen structures, engineers are now resorting to natural materials. Both the spider silk's high strength-to-size ratio and the inflexible yet sticky fibers of mussels show promise for use in building materials. In addition to being lightweight, interlocking structures with virtually endless design options, bamboo and 3D printed materials have the ability to increase a building's resilience even further.

Engineers and scientists have developed a number of successful earthquake-proof building construction methods throughout the years. Although today's materials and technology are quite sophisticated, it is not always feasible for buildings to entirely resist strong earthquakes without suffering damage. However, we may still consider it a huge achievement if a structure is able to prevent collapse and preserve people's lives and communities.

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