VIBRATION CONTROL

Sabiha Gökçen International Airport terminal, Istanbul, Turkey

The largest seismically isolated building in the world, the airport terminal, which opened in 2009, is able to withstand a magnitude 8.0 earthquake and remain completely operational afterwards – which is handy considering Istanbul straddles three tectonic plates. The terminal sits on 300 triple-friction pendulum isolators, which lift the whole building off the ground and absorb shockwaves to significantly slow down movement during an earthquake. The isolators were installed according to advanced computer simulation and modelling technology that can predict how a building will react.

THE GIANT PENDULUM

Taipei 101, Taipei, Taiwan

Currently the world's third-tallest skyscraper, Taipei 101 in Taiwan contains a giant 660-tonne Tuned Mass Damper (TMD) suspended like a pendulum inside the 508m tower. It's the largest TMD in the world and, together with two smaller 4.5-tonne spheres in the tip of the 60m spire, it helps to counteract any swaying. There are also 36 vertical columns and 380 concrete piles sunk 80m into the ground to provide further stability. The strength of the design became evident during construction when a 6.8-magnitude earthquake rocked Taipei in March 2002, toppling two construction cranes but causing no structural damage to the tower.

SEISMIC RETROFIT

The San Francisco–Oakland Bay Bridge, California, US

Following the 7.1-magnitude Loma Prieta earthquake in 1989, the Bay Bridge has undergone a major seismic retrofit, including the complete replacement of the East Span. Additions include viscous dampers to isolate, absorb and diffuse seismic energy; hinge pipe beams, designed to move within their sleeves during expansion or contraction of the decks; steel plates and lateral braces to increase stability; and replacing original rivets with high-strength bolts.

DUAL-PURPOSE DESK

LifeGuard

Available in a range of sizes and designs, each LifeGuard table comprises a steel skeleton, top, floor and heavily padded sides to keep the person safe from building collapse, bullets and blasts, even if the whole unit rolls. Also, a 'Crumple Zone' on top absorbs energy from falling objects like a car bumper. The inside, where there is enough room to lie down, usually contains food, water, medical supplies, and emergency lighting and signalling devices.

lifeguardstructures.com

HOW TO BEAT AN EARTHQUAKE

FROM LIFE-SAVING EMERGENCY PACKAGES TO VAST SWINGING DAMPERS IN SKYSCRAPERS, HERE ARE SOME OF THE WAYS WE'RE FIGHTING BACK AGAINST NATURAL DISASTERS

Words by **Samantha Whitaker**

CORE OF STEEL

US Bank Tower, Los Angeles, California, US

The tallest building in California, the US Bank Tower was constructed to withstand an 8.3-magnitude earthquake, which scientists believe is stronger than the San Andreas fault can produce. The 310m building's resilience is due to a free-span chevron-braced steel core working with perimeter moment-resisting frames.

FLATPACK HOUSES

Toyota Home, Japan

Bringing the knowledge and technology of the Toyota Group to the housing market, Toyota Home provides customers in Japan with earthquake-resistant prefabricated houses. Based on the 'skeleton and infill' approach, common in Japanese architecture, the design features a durable steel structure combined with a flexible infill designed to withstand even a major earthquake.

EMERGENCY SUPPLIES

ShelterBox

When an earthquake does strike, ShelterBox provides an emergency refuge and the essentials a family needs to survive. Each ShelterBox is tailored to a specific disaster but typically contains a large tent, blankets, water storage and purification equipment, cooking utensils, a basic tool kit, mosquito nets, solar lamps and a children's activity pack. Even the large, green box itself can be useful as a baby's cot or food container.

shelterbox.org

SAFER CITIES

Earthquakes and Megacities Initiative (EMI)

An international, not-for-profit organisation dedicated to improving the resilience of cities to disasters, EMI promotes tested disaster risk-reduction policy and practices. Founded in 1998, in response to the urgent need to stimulate urban earthquake-damage mitigation in developing countries, EMI's approach is to empower local-level institutions and organisations by developing informed leaders and practitioners through training and knowledge-sharing programmes.

emi-megacities.org

ROLLING FOUNDATIONS

Yokohama Landmark Tower, Yokohama, Japan

A combination of modern engineering and ancient design, the Yokohama Landmark Tower was built with the same theoretical structure as Japanese pagoda temples – which, amazingly, have endured multiple earthquakes. The entire 296m-tall skyscraper sits on rollers, which allow the earth to undulate beneath the structure without shaking it. It's also weighed down by an active mass damper system, and is made from flexible materials that can bend with the earthquake instead of crumbling.

A SOLID BASE

Transamerica Pyramid, San Francisco, California, US

While the Transamerica Pyramid Building was designed as such to allow maximum light to filter down to the streets below, the bottom-heavy structure is much more stable, and moves less in strong wind, than most other skyscrapers. It also rests on a block constructed from more than 300 miles of steel rods encased in concrete sunk 16m into the ground, which is designed to move with earth tremors.

SELF-SUPPORTING STRUCTURES

Monolithic Domes

The compound curve of Monolithic Domes makes them stronger than virtually any other structure. To create the shape, an Airform balloon is fully inflated and then covered by a rebar [reinforcing bar] cage and sprayed with concrete. When the concrete sets, the Airform is deflated and removed, and the interior is hand-plastered. With proper care, the Airform balloon can be reused more than 100 times. Rated by FEMA [the Federal Emergency Management Agency] as providing 'near-absolute protection', the Domes are able to withstand tornadoes, hurricanes, earthquakes, fire, termites and rot, and can be designed to fit almost any architectural need, from sheds and cabins to homes, schools, churches and even stadiums. Built in exactly the same way, only without the insulation, EcoShells provide affordable, permanent disaster-proof housing in hot and temperate climates, and are also ideal for disaster recovery – for example, Domes for the World constructed 100 EcoShells in Indonesia after the Yogyakarta earthquake in May 2006.

monolithic.com