



This means that a major earthquake affecting Puerto Rico would bring serious damage caused by shaking, but not as serious as in California or some of the world's other earthquake-prone areas where fault lines pass through heavily populated areas.

Earth tremors can cause structural damage, bring down poorly-constructed roofs, shake loose lighting fixtures, knock items from cabinets and shelves, break windows — even knock people down. But only where fault lines exist can the earth split open toppling buildings and people into these openings. Tidal waves, produced by the opening and closing of the earth at fault lines on the ocean floor, can cause serious damage to oceanfront areas and flooding in low-lying, inland areas. Tidal waves pose a more serious danger to Puerto Rico than the shaking of the earth itself during an earthquake.

Another key to holding down earthquake damage in Puerto Rico, compared to the recently stricken Middle East, Asia and Central America, is that buildings in Puerto Rico are relatively well-prepared to withstand earthquakes. Old building codes took into consideration the effects of hurricanes, some of which are similar to earthquake damage. A new code, in effect since 1968 and revised in 1987, mandates that buildings be specifically designed for moderate earthquake protection.

Location of fault lines

At present, there are three main fault line systems in the ocean surrounding Puerto Rico, according to seismologists. These three fault systems have been active since 1975, causing tremors that have been felt in various sectors of the island.

The frequency, intensity and location of past earthquakes led seismologist William McCann of the University of Puerto Rico in Mayaguez to predict that Puerto Rico will suffer a major earthquake measuring 7.5 or more on the Richter scale in the near future.

According to McCann, the currently active fault systems are the Puerto Rico Trench line, located 50 miles off the north coast on the ocean floor; the Mona Canyon line, located in the sub-oceanic Mona Passage a few miles off the west coast (thought to cut across land on the southwestern tip of Puerto Rico); and the Anegada Passage fault, located underwater a few miles off the east coast of Puerto Rico that faces the Virgin Islands.

McCann suspects there is a fourth fault line in the ocean a few miles from the south coast of Puerto Rico.

Four Major Earthquakes Affecting Puerto Rico In the Past 150 Years

<p>DATE: Nov. 18, 1867 ORIGIN: Anegada Fault MAGNITUDE: 7.5 IMPACT: Felt and caused damage all over Puerto Rico, especially in Vieques and Culebra. Generated a tidal wave, which is thought to have hit Vieques. Information available on this earthquake is limited.</p>	<p>DATE: Oct. 11, 1918 ORIGIN: Mona Canyon MAGNITUDE: 7.5 IMPACT: Felt strongly on the west coast of the island. Destructive over large part of Puerto Rico. Caused \$4 million in losses and 100 deaths. Generated tidal wave.</p>	<p>DATE: July 29, 1943 ORIGIN: Puerto Rico Trench MAGNITUDE: 7.7 IMPACT: Strongest impact in San Juan, but was felt in other island municipalities. No deaths were reported.</p>	<p>DATE: Aug. 4, 1946 ORIGIN: Puerto Rico Trench MAGNITUDE: 8.1 IMPACT: Strongest impact on the Dominican Republic. However, it was felt all through Puerto Rico, especially on the west coast, where some damage was reported. No deaths were reported.</p>
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However, many experts disagree with McCann, since there is not enough historical data or current activity to substantiate its existence.

McCann predicts that the faults most likely to produce the expected earthquake are the Mona Canyon fault line and the Anegada Passage, these being the closest to the island. He explained that the Puerto Rico Trench — on the ocean floor 50 miles out from our north coast — which stretches from the Dominican Republic to the south coast of Venezuela, is too far away to have any great impact on Puerto Rico.

In addition, he said that earthquakes in the Puerto Rico Trench have historically been centered closer to the Dominican Republic and have not caused serious damage in Puerto Rico.

The wave of the future

Samuel I. Diaz, a consulting engineer with the Puerto Rico Planning Board, said that there is a 50% chance that a large earthquake in Puerto Rico will produce a tsunami (tidal wave), because two of the four previous earthquakes have produced such a wave.

The first recorded earthquake to produce a tidal wave originated in the Anegada Passage fault in 1867. In 1918, an earthquake in the Mona Canyon also created a tidal

wave.

A tidal wave usually reaches the coast line 15 to 20 minutes after the earthquake tremors have ended. Tidal waves occur when fault lines in the ocean open up and water pours into them; when the shifting ends water is forced out, creating the wave. In Puerto Rico, experts anticipate that a tidal wave resulting from an earthquake of this magnitude would reach up to 20 feet high when it hits the coastline.

McCann said that, although a 20-foot wave is not unusually large as tidal waves go, the danger inherent in a tidal wave is its speed and intensity. He recommends that people who live near the coast begin moving inland immediately after the earthquake tremors stop.

There may still be people living who remember the Mayaguez earthquake of 1918, which killed 100 people and seriously damaged the city, leaving behind \$4 million in property loss. The Mayaguez earthquake produced a tidal wave which, according to experts, was probably the cause of the many deaths because, at that time,

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Earthquakes

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people did not know how to react to the natural phenomenon and many walked towards the coast to see what was happening.

One of Puerto Rico's main advantages over such highly vulnerable places as California, is that it does not have a large fault line system inland, which eliminates the possibility of the earth opening up during a major earthquake, causing the collapse of the structures above.

McCann, who believes that the Mona Canyon fault cuts through the southwestern tip of Puerto Rico, said that there were claims in 1987 that a crack had opened up in a sector of the municipality of Lajas after a 4.7 earthquake. However, he said that those claims remain unconfirmed.

Better ready than sorry

Although for some 50 years the government and the private sector have not given much credence to the possibility of a large earthquake happening in Puerto Rico, both sectors are now beginning to get ready to minimize the impact of a large earthquake should it occur.

In June 1988, Gov. Rafael Hernandez Colon created an earthquake commission to establish public policy concerning earthquakes and to begin a public awareness campaign to ensure that the community is instructed on how to act during and after an earthquake.

According to Mickey Espada, executive director of the commission, there are 15 members from government agencies and the private sector.

"The commission is concerned about the condition of public schools and government buildings and is working on a safety plan for them," Espada said.

McCann, also a member of the commission, said that the group is planning future evaluation of the condition of

private buildings on the island and will be drafting a safety plan for these as well. However, due to the commission's limited economic resources and personnel, it will be at least ten years before it can start working with the private sector.

Establishing standards

The seismic activity on the island and the high probability of a large earthquake occurring led the Puerto Rico Planning Board to revise the Puerto Rico Building Code in 1987 to include requirements that will minimize structural damage during earthquakes as well as prevent buildings from collapsing. Every building constructed in Puerto Rico after 1987 has been bound by the new requirements for better earthquake resistance.

Diaz, a consultant to the Planning Board, said that several studies were done during the revision of the Building Code concerning local seismic activity and the nature of the soil.

A 1973 study by California seismic consultant George W. Houssler for the Planning Board recommended using the same standards of construction in Puerto Rico as in California's zone II, but 1.5 times stricter. He explained that Puerto Rico's general seismic history is similar to zone II in California but that there are sectors of the island where quakes of a greater intensity have occurred and where more rigorous requirements are needed.

According to Diaz, the 1987 Building Code aims to minimize structural damage and prevent buildings from collapsing. However, during a large earthquake centered close to the island, there will always be some structural damage, although not necessarily any collapse of buildings, because the Building Code is not 100% earthquake proof.

"There is not one building code in the world that is 100% earthquake proof, since that type of construction would be extremely expensive," Diaz said.

According to Jose Luis Capacete, consultant to Caribbean Soil Testing Inc., under the revised 1987 Building Code, engineers are required to reinforce both the short

side of a building and the long side. Generally speaking, the weakest part of a building during an earthquake is the long side, as its weight will impel it to shake and collapse.

Buildings constructed under the previous codes (1968 and 1954) will show a certain amount of lateral force resistance during an earthquake because they were designed to resist strong hurricane winds. However, the masonry buildings found in older sections of large municipalities do not have sufficient flexibility to ride out an earthquake and many will suffer 100% structural damage, Capacete said. What is considered 100% structural damage does not necessarily entail the building's total physical collapse.

Most of the buildings on the island were constructed under the Building Code of 1968 and have some amount of earthquake resistance. According to Capacete, should an earthquake occur measuring 7.5 on the Richter scale and centered 12 miles from the island, about 3% of the structures on the island would suffer severe damage. However, the damage an earthquake can cause depends on its magnitude, acceleration and point of origin, and the soil type.

No one at the helm

At present, Puerto Rico does not have seismologists to operate the seismic measuring network, which includes the eight or nine seismometers installed in 1972. Until a few months ago, McCann operated this network, which belongs to the University of Puerto Rico in Mayaguez. However, he resigned his position at UPR as seismologist after failing to obtain the state-of-the-art equipment needed to establish a sufficiently modern operation.

As a result, UPR is not currently operating the seismic network for lack of an experienced seismologist. Capacete said that the UPR Mayaguez campus is making an attempt to update the seismic measuring network by installing some highly sensitive motion instruments and hiring another seismologist to reactivate and operate the network. ■

UPR professor offers safety suggestions

Worst threat during earthquake stems from falling objects; solidity of P.R. structures minimizes danger of collapse

By MARI CARMEN SCHELL
CARIBBEAN BUSINESS Reporter

An earthquake cannot be anticipated several days in advance as can other natural phenomena, such as hurricanes. Usually, an earthquake can be felt eight seconds before the earth actually begins to shake, which does not allow enough time for warnings and making preparations.

According to earthquake experts in Puerto Rico, now is the time to begin implementing procedures and designing contingency plans to minimize losses should a serious earthquake occur.

William McCann, a seismologist and professor at the University of Puerto Rico's Mayaguez campus, said that during an earthquake the best thing to do is get down under a solid table or desk, seeking protection from objects that might fall during the quake.

Contrary to popular opinion, standing under a door frame is not always the best way to seek protection because door frames in houses and buildings are not necessarily structurally sound elements. McCann said that people should be familiar with the structural elements of their offices and homes and try to stand near them for protection during an earthquake if they are not going to get under a solid table or desk.

"Become familiar with the working and home environment. Look for a solidly built hiding place that can be reached quickly and easily," McCann said.

Objects on shelves as well as hanging decorations and breaking windows are a great hazard during an earthquake and people should avoid being close to them because they will most likely fall and could cause an injury.

"The probability of people dying during an earthquake is slight if they are well-protected and know how to act calmly without panicking," McCann said. "Most buildings in Puerto Rico are solidly constructed and not likely to collapse."

People in crowded places during an earthquake should not attempt to run outside, but rather hide underneath something that can resist the impact of falling objects.

According to McCann, people in the streets should not panic but look for an open area far from trees, buildings, electric cables and telephone lines. Experts anticipate that, during a strong earthquake, most of the telephone lines and electric cables will fall down and could injure people standing underneath or near them. McCann does not anticipate cracks opening up in streets or the collapsing of bridges. He said that people in cars during an earthquake, one of the safest places to be, should find a place to park far from trees and light posts.

If you happen to find yourself in a supermarket during an earthquake, McCann said, you can turn shopping carts upside down and hide underneath them. It

is recommended that people get away from shelves containing bottles and jars to avoid damage from shattering glass.

After the earthquake, which will only last some 30 seconds, people living near low-lying coastal areas must begin moving inland so as to protect themselves in case a tidal wave was created at the fault line out in the ocean and the wave is coming towards land. McCann recommends that people walk instead of driving, since they will not know what obstacles will be on the road. A tidal wave following earthquake tremors will take about 20 minutes to reach the coastline of the island because of the distance of the fault lines from Puerto Rico. A tidal wave hitting the coastline could come in up to 20 feet high.

Several months after a large earthquake there will be aftershocks, in which small earth tremors will be felt. McCann said that, during the aftershock, people must take the same precautions as during the large earthquake, because things that did not fall down before could fall then, after having been loosened by the stronger earthquake.

Electrical service will most likely be interrupted in sectors hard hit by the earthquake because the lines will probably fall down. As a result, McCann recommends that people always have a supply of canned food, drinking water and nonperishable foods at home.

Field experts assert that, if all precautions are taken, the possibility of people dying in Puerto Rico during an earthquake is extremely low. With exception of the Mayaguez earthquake, no deaths have been attributed to earthquakes in Puerto Rico. On that occasion, according to McCann, the cause was not the collapsing of structures, but the ensuing tidal wave. ■