10 Frequently Asked Questions

**10 Are magnitude and intensity of an earthquake the same?**

They are not. Magnitude is a measure of the energy that is released during an earthquake, while intensity is a description of the variable shaking that is experienced in different areas.

Intensity is usually written in Roman numerals (for better distinction from magnitude, which is usually in Arabic numbers).

The magnitude of an earthquake is a single number. For instance, a magnitude 7.2 is expected from the West Valley Fault that transects from Sierra Madre through Metro Manila to Batangas.

The magnitude scale is logarithmic: between magnitudes 7.2 and 7.3, the increment of energy is about 1.4 times; between magnitudes 7.0 and 8.0, about 32 times!

The wattage of a light bulb is analogous to the magnitude of an earthquake. The intensity of light or intensity of an earthquake varies according to several factors, including distance from the bulb or distance from the epicenter.

Other factors that affect earthquake intensity are rock or soil types, ground sublayer, and depth, length and type of fault displacement.

What intensities can a magnitude 7.2 earthquake from the West Valley Fault generate in Metro Manila?

According to the 2004 Metro Manila Earthquake Impact Reduction Study by the Philippine Institute of Volcanology and Seismology (Phivolcs), the Metropolitan Manila Development Authority and Japan International Cooperation Agency, intensities VIII (very destructive) to IX (devastating) may be experienced alongside Marikina River and near Manila Bay. Lower intensity may be experienced in most of Quezon City.

In the sense that large-magnitude and high-intensity earthquakes are probable, we may say that Metro Manila has high seismic hazard, as do other regions in the country.

**9 How rampant is the construction of buildings beside or on earthquake faults like the West Valley Fault?**

Construction is very rampant beside or on earthquake faults, including the West Valley Fault that transects Metro Manila. Why? And how risky is this situation?

It was in 2001 that the National Structural Code of the Philippines published the maps by Phivolcs that indicated the active faults in the country. As a result, buildings that were designed and constructed earlier did not take into account the faults.

Neither did nonengineered houses, even new ones, consider the faults.

Phivolcs now recommends avoiding construction within 5 meters on each side of a fault trace, or a total width of 10 meters. We may call this the ideal ?10-meter wide no-build zone? in the vicinity of a fault.

Ideally, we should not build in the 10-meter wide no-build zone to avoid the hazard of ground fissure.

It will be extremely difficult for the foundation of a structure to withstand ground fissures or deformations. In case a bridge or a pipeline cannot avoid crossing a fault trace, a special design will be needed to accommodate dislocations of at least one meter.

We may also speak of a 10-kilometer wide near-fault zone that requires, since 2001, the highest seismic design forces to withstand ground shaking (in contrast with the hazard of ground fissure in the 10-meter wide no-build zone.)

At present, the exposure of houses and buildings is very high within the 10-meter wide no-build zone and the 10-km wide near-fault zone.

**8 Is it true that liquefaction or ?quicksand effect? is a threat to structures located far from the 10-km near-fault zone?**

Yes, the ground may liquefy or turn into quicksand even in areas beyond the 10-km wide near-fault zone.

If the soil is sandy as in river deltas and coastal areas, the water table is just a few meters below the ground surface. If the ground-shaking intensity is high and sustained for 30 seconds or more, then the soil may liquefy.

With liquefaction, whole houses and buildings may tilt and even topple.

Tilting or toppling of structures during liquefaction tends to be slow, giving occupants enough time to evacuate. A permanent tilt or serious sinking may render a structure unusable.

Deep foundations such as concrete piles, 30 meters deep or deeper, are recommended for large buildings in areas with high liquefaction potential to avoid tilting or sinking.

There are also ground improvement techniques, meant to solidify the soil beneath and around the foundation, that may be recommended for low-rise structures.

**7 What percent of buildings comply with government standards?**

More than 35 percent of low-rise residential buildings in Metro Manila and perhaps in other regions may not be complying with current government standards for construction either because these are nonengineered structures or because these were built according to much older standards that are now inadequate.

Building construction standards are periodically updated, incorporating lessons learned from recent earthquakes in the country and overseas. Our national structural code was upgraded significantly in 2001 and recently in 2010.

More than 25 percent of mid-rise buildings may be noncompliant to current standards, mostly due to their use of the older construction code(s) and standards.

More than 10 percent of very high-rise buildings (above 30 stories), which are relatively new, may be noncompliant. Anecdotal reports indicate that some engineers are inclined or persuaded to ?optimize? or ?minimize? their structural design to reduce the initial construction cost.

The cost of the structure of high-rise buildings may be about half of the building cost, the remainder being architectural, electromechanical and other factors.

Some engineers literally aim for minimum compliance with the standard and code, rather than provide judicious allowance for ?surprises of nature.?

In contrast, it is notable that many old buildings were designed and built above the minimum standards that were applicable during their construction. Such buildings, even if old, may be audited and possibly proven adequate even by current standards and code.

**6 What maximum intensity is considered by the current building code?**

It is better to ask engineers about the maximum acceleration (movement in meters per second per second) considered by the current code.

Intensity scale, by definition, is really descriptive rather than truly quantitative. In the Phivolcs earthquake intensity scale from I (1) to X (10), Intensity VIII can be described as ?very destructive.?

In Intensity VIII, many well-built buildings are considerably damaged. Concrete dikes and foundation of bridges are destroyed by ground settling or toppling.

In terms of equivalent acceleration, it may be approximated that 40 percent of the magnitude of acceleration due to gravity (0.4 x G [9.81 meters per second per second]) is considered in seismic zone 4, the zonal classification of most of the country.

As much as double, or about 0.8G, is considered by the building code for near-fault zones.

We must note, however, that higher accelerations may still be produced by the maximum credible earthquakes from inland faults such as the West Valley Fault or the Philippine Fault System.

The building code, in other words, does not even require a design for the maximum conceivable acceleration, but only for the maximum that is likely to occur within the life span of the building.

The life span of a building is assumed to be 50 years in a typical design.

**5 Which building will experience higher intensity, a low-rise or a high-rise?**

Tall buildings will be shaken more by large earthquakes that have their epicenters far away, say 50 km.

Such earthquakes, which may center in offshore trenches or in a very long inland fault, tend to propagate long-period (low-frequency) vibratory waves that ?tune? to the natural vibration periods of tall buildings.

Low buildings will be shaken more by large or moderate earthquakes from nearby faults, such as the West Valley Fault.

Near-fault earthquakes tend to propagate short-period (high-frequency) vibratory waves that ?tune? to short buildings.

Hence, every building, whether low-rise or high-rise, needs to be designed to withstand earthquake shaking. The earthquake hazards in the country may come from nearby inland faults and offshore trenches.

**4 Can structures that comply with the national building code escape damage from an earthquake?**

No, damage is not precluded by compliance with the minimum requirements of the national building code.

The minimum standards are aimed at preventing sudden or brittle-type collapse of structures, the kind that will harm or kill some or all occupants.

A building that follows the minimum standards may still be significantly damaged in the next major earthquake to the point that it will require considerable repairs before it can be reused.

Unlike in the United States or Japan, we do not provide in the building code the choice of next higher level(s) of design criteria, the kind that will ensure uninterrupted use of the building.

Some owners of major buildings choose to require their engineers to design for higher performance standards. BPO companies and global semiconductor and electronics plants are among the examples.

Tougher or more massive structural design is not necessary even in the next higher standard.

Over the past 10 years, base-isolation technologies for low-rise buildings in which this writer became involved in the seismic design have been introduced in the country.

Dampers or damping devices against vibrations have also been introduced in a few very tall buildings.

In a few major projects, worst-case scenario earthquakes have been considered in the analysis and design, over and above the standard requirement of the code.

**3 What is the safest spot in a building during a strong earthquake?**

As explained earlier, significant damage may still happen in a well-designed building. During an earthquake, it is generally advisable to stay beside or under sturdy columns, door frames or desks to guard against falling debris.

Hollow-block walls with little or no steel reinforcement, pieces of furniture, and fixtures on walls and ceilings tend to be hazardous during strong shaking.

In the extreme event that beams or whole floors are slowly collapsing, vertically supporting elements (the column, door frame or table) may cushion the impact of falling objects or debris.

It is not advisable to move to higher floor(s). When the strong shaking is over, it is generally advisable to move out of the building, away from falling debris.

**2 Why are building owners not retrofitting or upgrading their structures?**

Upgrading or retrofitting of houses or buildings to meet current building standards involves significant costs.

Indirect costs due to disruption of occupancy during upgrading or retrofitting are also a significant deterrent.

It is less expensive to design and build with some extra provisions over and above the minimum code requirements than to upgrade or retrofit within 10 years or so.

In the United States and Japan, the government provides financial and other regulatory incentives to motivate building owners to retrofit.

The two countries retrofitted most government buildings first, in the process making the retrofitting technologies more familiar to the public and the corresponding costs less prohibitive.

**1 Who is responsible for the structural integrity of a building?**

The owner of the house or building is responsible for the structural integrity, including the physical protection of occupants and users.

Within 15 years of construction, under the Civil Code of the Philippines, engineers (or architects) and contractors (builders) are held liable for any structural failure due to defects in design or construction.

For buildings and houses that are older than 15 years, the owners are wholly responsible and liable.