Information Note 21/2025 **August 2025**

Seismicity of Hong Kong

Key Messages:
(i) The seismicity of Hong Kong is low to moderate.
(ii) There is no clear evidence of significant recent fault activities in Hong Kong, either onshore or offshore.
(iii) The possibility of significant earthquake damage to man-made slopes, retaining walls and reclamations in Hong Kong is low.
(iv) The risk of a natural terrain landslide triggered by earthquake is much lower than that induced by rain.

Introduction

Every year, about two earth tremors are felt in Hong Kong. In order to evaluate the seismicity of Hong Kong, studies of seismic hazard in Hong Kong have been carried out by the Geotechnical Engineering Office (GEO). Seismic hazard assessment is, in simple terms, an analysis of the degree of ground shaking caused by earthquakes, with due regard to their locations, magnitudes and frequencies of occurrence. Seismic hazard can be quantified by means of rigorous engineering assessment, using probabilistic calculations, to estimate the probability of earthquakes of certain magnitude or greater striking a region during a specific period at a particular location. Based on seismic hazard studies, the seismicity of Hong Kong is classified as 'low to moderate'. The seismic hazard in Hong Kong is much lower than places like Japan, Taiwan and the western USA which lie close to the Earth's more seismically active zones along crustal plate boundaries. However, the seismic risk in Hong Kong cannot be regarded as negligible.

Causes of Earthquakes

An earthquake is a complex series of ground vibrations caused by the release of stored energy in the ground, usually during a sudden, unpredictable movement along a geological fault. Movements are ordinarily resisted by friction and only occur when the shear stress across a fault has built up to a level at which it exceeds the frictional resistance. Other natural processes, such as the movement of magma beneath volcanoes or magmatic movements beneath the Earth's crust, can generate earthquakes. Earthquakes can also result from human activities, most obviously in relation to controlled or accidental large explosions and man-made changes such as the filling of newly constructed large reservoirs.

Quantification of Earthquakes: Size and Effects

Earthquakes are generally assessed in terms of their magnitude and intensity.

(i) The **magnitude** of an earthquake is a measure of the amount of energy released at the origin of the earthquake. It is most commonly quantified in terms of the Moment Magnitude Scale (M_W) which succeeded the Richter Scale (M_L) as the preferred estimate of large earthquake magnitudes. Earthquakes of magnitude less than 4 are considered minor and unlikely to cause damage, whereas those with magnitude 6 or greater are considered major events, capable of causing great damage in some cases. As magnitude increases by

one unit, the energy released increases by about 32 times. In theory, there is no limit to the possible magnitude of an earthquake. However, the largest world recorded earthquake since 1900 was Chile earthquake on 22 May 1960, with a Magnitude of M_L 9.5.

(ii) The **intensity** of an earthquake is an assessment of its surface effects. In Hong Kong, this is quantified by means of the twelve-point Modified Mercalli Intensity Scale. Stationary people can feel an intensity III tremor; for intensity VI, many people are frightened and run outdoors; some buildings suffer from cracking under an intensity VII event; tremors causing landslides are classed as intensity VIII; intensities of IX and above are significantly destructive events. Unlike the magnitude of an earthquake, which quantifies the energy released at the source within the Earth, intensity reduces as the surface distance from the source of the earthquake increases. Hence, maps of intensity distribution related to a specific earthquake will generally show crude concentric contours around the source of the earthquake.

Global Distribution and Generation of Earthquakes

The point on the Earth's surface vertically above the source of an earthquake is its epicentre. The actual location of fault movements which generate most earthquakes felt at the Earth's surface, however, is at variable depths from a few kilometres to several hundred kilometres. Most major earthquakes occur in well established seismic zones which also contain very large fault systems. Most, but not all, of these zones are situated along the boundaries of the Earth's crustal plates. The relative movement of the plates ultimately determines the frequency and magnitude of earthquakes occurring along individual faults. Although much fewer earthquakes occur along faults located far from plate boundaries, they can nevertheless still be of large magnitude.

The Tectonic Setting of Hong Kong

Hong Kong lies within the Eurasian Plate. It is located about 600 km from the nearest plate boundary which underlies Taiwan and trends south to the Philippines and northeast to Japan. This plate boundary is associated with both frequent and large magnitude earthquakes, whose epicentres are concentrated in a zone up to 200 km wide along the eastern boundary of the Eurasian Plate. Active volcanoes also occur in this zone, as in Japan and the Philippines. Historical data indicate that the frequency of large magnitude earthquakes declines rapidly at distances greater than about 200 km from the plate boundary.

Historical Earthquakes in the Vicinity of Hong Kong

Historical records indicate that Hong Kong does not experience frequent, large magnitude earthquakes. However, occasional earthquakes are recorded at locations almost throughout the Eurasian Plate.

The largest earthquake vibration recorded in the last 100 years or so in the vicinity of Hong Kong occurred about 300 km away in the Shantou area of neighbouring Guangdong Province in 1918. This earthquake was a Magnitude M_L ~7.3 event and the corresponding intensity in Hong Kong was VI to VII. Cracks to some structures in Hong Kong were reported, and a school in the Mid-levels area had to be relocated as a result of the damage caused by the

earthquake. Historical earthquakes which occurred near Dangan Island in 1874 (Magnitude M_L ~5.75), at Macau in 1905 (Magnitude M_L ~5.5) and at Yangjiang in 1969 (Magnitude M_L 6.4) also resulted in some reported damages in Hong Kong. Other notable earthquakes that have occurred near Hong Kong include the Honghai Bay earthquake in 1911 (Magnitude M_L ~6.0) and the Heyuan earthquake in 1962 (Magnitude M_L 6.1).

Normally, earthquake of intensity III or above can be felt by people. Every year, about two earth tremors are felt in Hong Kong, most of which are small (e.g. earthquake intensity < IV), such as the Magnitude M_W 6.4 Taiwan earthquake occurring in February 2018. Larger tremors are occasionally experienced; for example, the Magnitude M_W 6.8 earthquake which occurred on 16 September 1994 aroused some public concern in Hong Kong. The epicentre of this earthquake was located at the southern part of the Taiwan Strait. The corresponding intensity in Hong Kong was V to VI. An earthquake of Magnitude M_W 3.2 occurred at Dangan Island (about 36 km to the south of Hong Kong) in 2006 also aroused some public concern. Since 1979, there have been nine recorded earthquakes with epicentres within Hong Kong as of December 2024. The strongest one, occurred on 11 May 1995, was of a magnitude 3.1 and a local Intensity IV to V. Information on locally felt earth tremors can be found on the Hong Kong Observatory's website: http://www.hko.gov.hk.

Of most concern to the public are the strong earthquakes that can cause casualties, potential damage to property, and landslides. Although the earthquake hazard in Hong Kong is considered to be very much less than in areas such as Japan, Taiwan and the western USA which are located along highly active plate boundaries, this does not mean that the risk is negligible. Small earthquakes can occur at locations within tectonic plates far away from the plate boundaries such as Hong Kong from time to time. These intraplate earthquakes, which are relatively infrequent and random, may be related to the tectonic stresses propagated from the highly active tectonic plate boundaries or the release of tectonic stresses accumulated in the tectonic plate due to various reasons, e.g. magmatic movement, human activities. The release of tectonic stresses may occur through movements at pre-existing faults. However, the precise mechanisms for small earthquake activities within Hong Kong are generally unclear.

To put the local earthquake hazard in worldwide context, it should be noted that small earthquakes are commonplace throughout the world, but the vast majority are of magnitudes so small that they are only detectable using very sensitive equipment, and their intensities are below the threshold that can be felt by people.

Research and Development Studies

The GEO has been carrying out earthquake studies since the late 1980s and the results are published both locally and internationally. Researchers in local universities and local practitioners have also carried out studies relating to earthquake engineering.

All in all, the studies have shown that the possibility of significant earthquake damage to man-made slopes, retaining walls and reclamations in Hong Kong is low (Au-Yeung & Ho, 1995; Wong & Ho, 2000). Studies by the GEO have also established that there is no compelling evidence of significant recent fault activities in Hong Kong, either onshore or offshore (Whittaker et al., 1992; Tang et al., 2009; Tang et al., 2010; Wong & Ding, 2010; Wong et al., 2010; Sewell & Tang, 2015).

The GEO has also completed an updated seismic hazard assessment of Hong Kong, in

collaboration with local seismic experts and seismologists from the Earthquake Administration of Guangdong Province (Arup, 2015). The assessment considered the latest records of earthquakes that occurred within a distance of 500 km from Hong Kong, together with the regional seismo-tectonic setting and geological setting. The findings are generally consistent with the previous studies of earthquake hazard in Hong Kong, i.e. the seismicity of Hong Kong is classified as 'low to moderate'. The calculated return periods for earthquakes of Intensity V and Intensity VII are 30 to 40 years and 500 to 600 years respectively. An Intensity VII earthquake may cause difficulty standing, vibration of suspended objects, movement or damage of furniture, cracking in masonry structures, fall of plaster, loose bricks, tiles etc.

In addition to the above, the GEO has carried out an assessment of earthquake-induced natural terrain landslides to examine the hazard relative to that due to rain-induced landslides. The results show that the risk of a natural terrain landslide triggered by earthquake is much lower than that induced by rain. Furthermore, studies of earthquake-induced natural terrain landslides from recent major earthquakes (e.g. 2016 M_W 7.8 Kaikoura Earthquake) have shown that landslide density diminishes rapidly with the distance measured from surface fault ruptures such that the natural background density is reached at a distance of about 2.5 km to 3 km from the earthquake-generating fault (Massey et al., 2018). The nearest known active fault to Hong Kong is ~36 km away (Dangan Islands Fault). It is unlikely that massive landslides would be triggered in Hong Kong. Nevertheless, the seismic risk in Hong Kong cannot be considered negligible.

Earthquake Provisions in Hong Kong

In 1993, the GEO published a guidance document on the design of retaining walls (GEO, 2020) which incorporates earthquake loading provision for the design of new retaining walls affecting high-risk structures or major lifelines. For man-made slopes, earthquake provision is not considered necessary in the design as intense rainfall is a more severe design condition. Relevant technical studies have shown that, for man-made slopes and retaining walls which are designed and constructed to meet current geotechnical standards, the effects of an earthquake up to Intensity VII would not be significant.

Many important infrastructures in Hong Kong have also been designed against earthquakes, for example highway structures and railway bridges designed in accordance with HyD (2013) and service reservoirs designed in accordance with WSD (2020). Buildings are also designed to resist earthquakes at the discretion of the owners; for example, the Tamar Development Project was one of the first government projects adopting seismic-resistant measures for buildings. They are not expected to be severely damaged by an earthquake of Intensity VII.

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Geotechnical Engineering Office
Civil Engineering and Development Department
August 2025