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IS MALAYSIA LOCATED IN THE PACIFIC RING OF FIRE? A LEGAL PERSPECTIVE

Siti Sarah binti Sulaiman (a)*, Megat Muhammad Luqman bin Megat Mohamad Farish (b), Putri Noor Nasyira binti Ismadi (c), Vanieda Shoudy Moosom (d), Zaidatul Azira binti Muhd. Yusrizal (e)
*Corresponding author

(a) Faculty of Law, Universiti Teknologi MARA Shah Alam, sitisarahsulaiman78@gmail.com
(b) Faculty of Law, Universiti Teknologi MARA Shah Alam, megatmuhamadluqman97@gmail.com
(c) Faculty of Law, Universiti Teknologi MARA Shah Alam, Eyraaismadi@gmail.com
(d) Faculty of Law, Universiti Teknologi MARA Shah Alam, vndshdymsm@gmail.com
(e) Faculty of Law, Universiti Teknologi MARA Shah Alam, Zaidatul.yusrizal@gmail.com

Abstract

Malaysia, particularly West Malaysia, is considered safe from any seismic disaster as it is considered not within the Pacific Ring of Fire. However, when Ranau, Sabah was hit by 6.0 magnitude and Bukit Tinggi, Pahang was hit by 3.5 magnitude, it meant Malaysia is no longer immune from seismic disaster. The occurrence of earthquakes of such magnitude may not cause severe destruction but buildings will be damaged. This is especially true as buildings in Malaysia are not designed to withstand earthquake tremors. Therefore, this paper, using the doctrinal analysis of the primary sources of law, will discuss the legal measures to regulate construction of buildings which can withstand earthquake tremors. Reference will be made to the law in Japan in order to improve the law in Malaysia. The finding reveals that "MS EN 1998-1:2015 should be enforced under the Uniform Building by laws (UBBL) and adopted by all local planning authorities in Malaysia.

Keywords: Earthquake, Pacific Ring of Fire, Building by law, Malaysia.

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1. Introduction

The belt or the Pacific Ring of Fire covers about 40,000 kilometres which is geologically the most active place in the earth comprising the most number of volcanoes generating a significant number of natural disasters such as earthquakes and tsunamis (United States Geological Survey, n.d.).

According to the Secretary-General's Special Representative for Disaster Risk Reduction, Mami Mizutori, in October 2018, "The earthquake and tsunami are a reminder that the Pacific's Ring of Fire is the most active seismic zone on the planet and requires special attention when it comes to disaster risk management. About 90% of the world's earthquakes occur there and the risk of an associated tsunami is extremely high which is why early warnings are so important along with public awareness raising and evacuation drills" (2018). UNISDR calls for greater attention to disaster risk in Pacific "ring of fire (https://reliefweb.int/report/world/unisdr-calls-greater-attention-disaster-risk-pacific-s-ring-fire).

The Pacific Ring of Fire runs from Indonesia to the coast of Chile in a 40,000 kilometre (25,000 mile) arc. As mentioned earlier, this belt is home to most of the world's active and dormant volcanos and is where the vast majority of earthquakes occur. The plate is moving between 2 to 5 centimetres per year (Abu Bakar, Jamaluddin, Omar, & Razak, 2013). According to Urrutia-Fucugauchi and Perez-Cruz (2016) plate tectonics is a global lithosphere separated by several plates moving on relative motion.

The tectonic plates' movement is the main reason for the occurrence of the Pacific Ring of Fire (Evers, 2015). The meeting of two active tectonic plate creates volcanos. It is well-known that the meeting of two tectonic plates is what causes the subduction zone which generate many earthquakes. Furthermore, according to Kagho, Dongmo and Pelap (2015), active volcanoes are the main cause of earthquakes.

The tectonic setting of the earth's plates known are subduction zones generate an enormous amount of friction would undoubtedly cause certain catastrophic events onto the surrounding land masses encompassing the Ring of Fire. Hinga (2015) explained that earthquakes are the sudden slip of tectonic plates on a fault. The Ring of Fire is no stranger to earthquakes as it is a popular host of earthquakes occurring on the planet. The U.S Geological Survey reported that roughly around 90% of all earthquakes on earth occurred on the Pacific Ring of Fire alone. Surely, this is an alarming and worrying statistic for countries situated on or near the vicinity of the Ring of Fire. In 2004, a 9.1-9.3 magnitude earthquake occurred near the coast of the Sumatra which then generated a series of devastating tsunamis up to 30 metres high killing more than 227,898 people within 14 countries with majority of the deaths being in Aceh. Researchers in Caltech found that the earthquake was so fierce that it has created the greatest fault lengths of any recorded earthquake, spanning at a distance of 1500 km or longer than the state of California. Fortunately, Malaysia escaped the horrendous damage and deaths that occurred in Aceh. This is because Sumatra acts as a buffer protecting Malaysia from the worst effects of the tsunami. Nevertheless, Zulkefli (2017) reports that Malaysia was hit by a smaller tsunami which affected most of the northern coastal regions of Malaysia namely, Penang and Langkawi. This "reduced" version of the tsunami caused 67 deaths total in Malaysia with 52 in Penang, 12 in Kedah, 2 in Perak and 1 in Selangor (The New Straits Times (2017).

Donald (2916) in the National Geographic states that volcanoes are openings which lead to the crust of the earth that allows magma to reach up to the surface of the earth. Hinga (2015) explains that these volcanic eruptions are caused by subduction in which the heating of the plate is thrust into the mantle.

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Often, these eruptions send out plumes of volcanic ash high up in the skies, turning daylight into total darkness. Unfortunately, the Pacific Ring of Fire is teeming with volcanoes. Statistics illustrate that the Pacific ring is dotted with 75% of all active volcanoes on Earth (National Geographic, 2018). A string of 452 volcanoes stretches from the southern tip of South America, up along the coast of North America, across the Bering Strait, down through Japan, and into New Zealand and Indonesia. The most famous eruption which occurred in the Ring of Fire was the eruption of Krakatoa Volcano in 1883. In fact, seismic activities have regularly occurred around the Ring of Fire and can be traced back from the 19th century until the 21st century (Hinga, 2015). Malaysia, on the other hand, does not host any active volcanoes situated on the Pacific Ring of Fire.

2. Problem Statement

Malaysia is located at the edge of the Pacific Ring of Fire which means that Malaysia is not totally immune to earthquakes. According to Professor Dr Azlan Adnan, who heads UTM's Structural Earthquake Engineering Research, Malaysia is now closer to the epicentre. When earthquakes occur, the pressure will be greater. This is clear when Ranau (at the foot of Mount Kinabalu) was hit with a magnitude of 6.0 earthquake in June, 2015 and killed 18 people. It was the highest ever recorded earthquake in Malaysia since 1976 at Lahad Datu, Sabah (Tongkul, 2015; Adnan, Herayani, & Harith, 2017). Therefore, Sabah is relatively prone to seismic (earthquake related) activities as it is situated on the south-eastern Eurasian Plate, bordered by the Philippine Plate and the Pacific Plate. Sabah has experienced low to moderate seismic activities due to the interaction of these main tectonic plates and several active fault lines. Between 1900 and 2016, 182 earthquakes with moment magnitude ranging from 2.9 to 6.0 have been recorded there. Other than that, there have been numerous earthquakes in the region that caused tremors on Malaysian soil, such as the tragedy in Aceh in 2004, Nias in 2005 and in March 2012. Malaysia also felt the ground shake due to ruptures in the Indian Ocean on the Australian Plate (Liew, Danyaro, Mohamad, Shawn, & Aulov, 2017). This sent a signal that Malaysia is not immune from effects of earthquakes, making this a strong warning for Malaysia to implement seismic design for its structures.

3. Research Questions

3.1. Is Malaysia, being located close to the Pacific Ring of Fire, exposed to a seismic disaster?

3.2. How can the risk of seismic disaster be managed from the legal perspective?

4. Purpose of the Study

The objective of this study is to determine if the location of Malaysia being close to the Pacific Ring of Fire merits a discussion of legal measures to regulate construction of buildings according to "MS EN 1998-1 Eurocode 8: Design of structures for earthquake resistance – Part 1: General Rules, Seismic Actions and Rules for Building" (*MS EN 1998-1:2015)* enforced under the Uniform Building By Laws (UBBL). This is important to minimise the impact of earthquake disasters in Malaysia.

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5. Research Methods

This study employs the traditional doctrinal analysis of the primary sources of law which includes statutes. The relevant statutes for regulating development activities and ensuring the implementation of seismic design structures are the Town and Country Planning Act 1976 (TCPA 1976), Street Drainage Building Act 1974 (SDBA 1974) and Uniform Building By-Laws (UBBL). A Malaysian Standards i.e."MS EN 1998-1 Eurocode 8: Design of structures for earthquake resistance – Part 1: General Rules, Seismic Actions and Rules for Building" will also be analysed. Geological databases, geology encyclopaedias, articles and journals regarding the Pacific Ring of Fire have also been referred to. In obtaining a clear understand of the technical aspect of the subject matter, an interview with Associate Professor Mustafa Kamal [1]who is a leading researcher in the field of geology was conducted.

6. Findings

Movements of the Pacific Rim occur due to natural causes. Malaysia is situated at the edge of the Pacific Ring of Fire. Thus, Malaysia is less impacted than countries located within the ring of fire. However, due to its close location, the Air Pollutant Index (API) in Malaysia will still receive a higher reading due to the volcanic ash blowing from the nearest volcano (The News Straits Times, 2014). Despite this fact, several evidences show that Malaysia is not always immune to seismic risk. In this discussion, there is an obvious correlation between both historical and recent data of geophysical occurrences that have affected Malaysia. (Abu Bakar et al., 2013). Recently, both Indonesia and the Philippines experienced earthquakes on 11 October and 8 October 2018 respectively. These incidents affected Ranau, Malaysia with a 1.2 magnitude on 11 October. The Star Online (2018) reported that the quake was detected at a depth of 9 km, with its epicentre located 13 km northeast of Ranau. MetMalaysia works together with the Philippine and Indonesian agencies to overseer seismic activities around the region and the tidal gauge around Sabah's coast. Although Sabah is 1000 km away, there is possibility of impact.

The occurrence of earthquakes in Peninsular Malaysia is not as strong and frequent as in East Malaysia. However, on several occasions, certain areas in Peninsular Malaysia were hit with earthquakes. For example, Bukit Tinggi was affected nine times between 2009 and 2013. The highest magnitude ever recorded in Bukit Tinggi was 4.23 and the lowest was 0.31 in 2009. In addition, Kuala Pilah was hit times in 2009 with magnitudes between 3.0 and 3.5, while Manjung and Jerantut were also hit with magnitudes of 2.76 and 3.24 respectively (Abdul Latiff & Khalil, 2016).

Based on the seismic data of Malaysia in the past few years, it is safe to say that Malaysia was affected by minimal seismic tremors from the Pacific Ring of Fire. According to Associate Professor Mustaffa Kamal Shuib (2018), Malaysia experiences earthquakes which are not severe but may cause some structural damage to buildings. This statement is supported by the Civil and Structural Engineering Branch Senior Director, Public Works Department, Kamaluddin Abdul Rashid (2017), who stated that Malaysia is one of the countries that has low seismic activity. Despite this fact, Malaysia should be ready to implement disaster risk management. In this case, the relevant authorities should review the laws regulating

[1] Interview with Mustaffa Kamal Bin Shuib, Associate Professor, Department of Geology, University of Malaya (Kuala Lumpur, Malaysia, 16 October 2018)

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construction and safety of high rise buildings in Malaysia in order to minimise the impact of seismic activities.

6.2. Legal perspectives

6.2.1. Earthquake-resistant Building

Earthquake-resistant buildings or shockproof structures are defined by Encyclopedia Britannica (2015) as "the fabrication of a building or structure that is able to withstand the sudden ground shaking that is characteristic of earthquakes, thereby minimizing structural damage and human deaths and injuries." This differs from conventional buildings. According to Asteris, Tzamtzis, Vouthouni and Sophianopoulos (2005), conventional buildings are normal structure buildings made mainly out of concrete and with the involvement of builders lacking earthquake resistant schematics. The Rakyat Post (2015) reports that most buildings in Malaysia are not designed to withstand the impact of earthquakes, resulting in major destruction to the buildings in the event of a high impact magnitude earthquake.

6.2.2. Malaysian Standard (MS EN 1998-1:2015)

Malaysia has taken measures pertaining to natural disasters by drafting the Malaysian Standards MS EN 1998-1:2015. Prof Dr Jeffrey Chiang (2015) in his article highlighted that prior to and since 2010 when the United Kingdom (UK) had withdrawn all British Standards (BS) pertaining to structural design, Malaysia, through the Institution of Engineers Malaysia, (IEM) has been taking initiatives to draft the Malaysian Standard (MS) EN Eurocodes to replace all British Standards pertaining to structural design used since 1957 (Eurocodes – What are Eurocodes? (n.d.)). Together with the Ministry of Science, Technology and Innovation (MOSTI), through the Department of Standards Malaysia or Standards Malaysia, Malaysia has developed a Malaysian Standards (MS) on earthquakes known as "MS EN 1998-1 Eurocode 8: Design of structures for earthquake resistance – Part 1: General Rules, Seismic Actions and Rules for Building" in 2015 (The Sun Daily, 2017). It includes technical instructions used by European countries to set standards when designing buildings. The Eurocode prevents buildings from falling apart and it is made to ensure sustainability of buildings when facing natural disasters. The code covers on the basis of design, actions on structures, design of structural elements in concrete, steel, composite steel, and concrete, timber, masonry and aluminium; together with geotechnical and seismic design. They cover the design of bridges, buildings, silos, tanks, pipelines, towers, masts and more.

MS EN 1998-1:2015 applies to the design and construction of buildings and civil engineering works in seismic regions. Its purpose is to ensure that in the event of earthquakes, human lives are protected, damage is limited and structures important for civil protection remain operational. Section 2 of MS EN 1998-1:2015 provides that "structures in seismic regions shall be designed and constructed in such a way that the following requirements are met, each with an adequate degree of reliability". The first requirement is that "the structure shall be designed and constructed to withstand the design seismic action without local or global collapse, thus retaining its structural integrity and a residual load bearing capacity after the seismic events". Secondly, the structure shall be designed and constructed to withstand a seismic action having a larger probability of occurrence than the design seismic action, without the occurrence of damage and the

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associated limitations of use, the costs of which would be disproportionately high in comparison with the costs of the structure itself".

Sections 5 to 9 of the MS EN 1998-1:2015 contain specific rules for various structural materials and elements respectively for concrete buildings, steel buildings, composite steel-concrete buildings, timber buildings and masonry buildings. For example, section 5.2.1(1) of MS EN 1998-1:2015 provides that "the design of earthquake resistant concrete buildings shall provide the structure with an adequate capacity to dissipate energy without substantial reduction of its overall resistance against horizontal and vertical loading".

Inasmuch as the MS EN 1998-1:2015 contains detailed specifications for designing earthquake resistant structures, it does not of itself confer immunity to developers from legal obligations. Therefore, it can be questioned as to whether MS EN 1998-1:2015 is binding on the developer. In answering this question, the power of the local planning authority in implementing the Malaysian Standards will be discussed in the following paragraph.

6.2.3. Regulating and implementing MS EN 1998-1:2015 at the local planning authority level

The Town and Country Planning Act 1976 (TCPA 1976) under section 19(1) provides that all persons except the local planning authority are required to apply for planning permission prior to commencing or carrying out development as a means to control development. Apart from the requirement to obtain planning permission with the submission of the layout plan and development proposal report, the project proponent is required to obtain approval for various other plans such as earthworks plan, building plan, road and drainage plan and the environment impact assessment report. Therefore, the Street, Drainage and Building Act 1974 (SDBA 1974) and the Uniform Building by-Laws 1984 (UBBL) will complement the provisions in the TCPA 1976 to ensure all other aspects of development control are taken into consideration. Part V of the SDBA 1974 provides for rules pertaining to buildings including provisions in reviewing safety and stability of erection of buildings, demolition of unauthorized buildings, penalty for letting out and sale of unauthorized buildings and many more. The UBBL 1984 is the subsidiary law of the SDBA 1974. This subsidiary law stipulates the procedures for building plans approval and other means of development and construction control in further detail. UBBL 1984 is the minimum guideline for constructing buildings in each state. In order to secure the planning permission, all conditions and requirements must be fulfilled by the applicants. Development which is contrary to planning permission is prohibited. In this regard, the local planning authority, through these legal instruments, has the power to impose conditions relating to earthquake resistance buildings to new development.

By-Law 80(1) of the UBBL 1984 provides that "the structure of a building above the foundations shall be designed and constructed to safely sustain and transmit to the foundations the combined dead and imposed load and wind loads without such deflation or deformation as will impair the stability of, or cause damage to the whole or any part of the building". In this regard, the UBBL 1984 was amended in 2012 by substituting for paragraph (2) of By-law 80, the following paragraph:

"(2) The requirements of paragraph (1) shall be deemed to be satisfied if the design and construction of the structure or part of the structure complies with the following Standards:

MS EN 1990 – Basis of Structural Design;

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MS EN 1991 – Actions on structures;
MS EN 1992 – Design of concrete structures;
MS EN 1993 – Design of steel structures;
MS EN 1994 – Design of composite steel and concrete structures;
MS EN 1995 – Design of timber structures;
MS EN 1996 – Design of masonry structures;
MS EN 1998 – Design of structures for earthquake resistance; and
MS EN 1999 – Design of aluminium structures."

This amendment replaced the British Standards with Eurocodes and was adopted as the Malaysian Standards, known as the MS EN standards. Thus, by virtue of this amendments, rules relating to structures for earthquake resistance have been made available. However, not all local planning authorities have adopted the revised UBBL 2012. Only local planning authorities in the states of Selangor and Terengganu have adopted and gazetted the revised UBBL 2012. The other problem relating to the implementation of the revised UBBL 2012 is the level of awareness and confidence among the registered professionals and engineers in the industry. A survey was conducted among 1398 engineers and 64% responded negatively to the question on familiarity with the Eurocodes or MS EN (Chiang, 2015). When most engineers are not familiar with the application of the Eurocodes or MS EN, it is impossible to implement the revised UBBL 2012 smoothly.

Considering that the law in Malaysia is insufficient to regulate the construction of earthquake resistant buildings, reference to the law in Japan is considered relevant.

6.2.4. Japan's Earthquake Resistant Construction Regulation

Japan is a seismically active country and they have a good disaster risk management system in place. Vastag (2011) reported that Japan is a world leader in earthquake-resistant construction. He quoted Eduardo Kausel, a professor of civil and environmental engineering at MIT who positioned the Japanese at the forefront of seismic technology as the Japanese have strong building codes that specify rules for short, medium and tall buildings.

Therefore, a reference to the law in Japan is vital to the veracity of this study. According to Tomohiro (2013), the Kanto earthquake which occurred in 1923 hastened the introduction of earthquake resistant construction regulations. However, these regulations only applied in town areas. The Building Standards Act known as *kyu-taishin* was introduced in 1959. These standards were enforced nationwide and not limited to just town areas. An amendment to these standards included wooden structures to be reinforced by concrete foundation. In 1978, the damage caused by the Miyagi Earthquake led to a major revision of the standards. The previous standards of earthquake building codes known as *kyu-taishin* were replaced by the more recent *shin-taisyin*. *Shin-taisyin* stipulated that buildings constructed after 1981 must be designed to withstand shocks to the building itself and lower the potential harm to life and limb from the quake. As most of the collapsed buildings were those which were constructed before 1981, seismic retrofitting became an urgent issue in Japan. Then, the law for Promotion of Seismic Retrofitting of Buildings was established

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and enforced in the same year which was 1995. The Act was revised with the latest amendment and enforced in 2006.

6.2.5. Shin-Taisyin Building Codes

"*Shin*" means new and "*taishin*" means resistance. The *Shin-taisyin* building code is the latest applied in Japan for building construction. If a building received its Certificate after June 1, 1981, it is called a *shin-taishin* building. Realestate.co.jp (2017) reported that The Building Standards Law governs the new standards for designing earthquake resistant buildings. Even though the cost is a bit higher to purchase, safety comes first in the matter of purchasing houses or buildings that abide by the *shin-taisyin* code. There are three *shin-taisyin* earthquake resistant construction methods. First, *Taishin* refers to the basic earthquake resistance required by law. The walls or load-bearing pillars are reinforced with specific stiffening materials to make them stronger against shaking. Second, *Seishin* refers to vibration control. The building is equipped with dampening devices (like shock-absorbers) designed to dissipate kinetic energy. As this method is more expensive than the regular method (*Taishin*), it is optional and not required by the law, but is recommended for high-rise buildings. The third method, *Menshin*, refers to base isolation system which incorporates a device separating the building from the ground which prevents shock waves from being transmitted to the structure. This is also optional and not required by the law.

Buildings in Japan have been built to be earthquake proof, and construction focuses on deep foundation and massive shock absorbers to dampen seismic energy in the event of an earthquake. Horyu-Ji Temple, Japan's oldest wooden building survived after it was struck by a magnitude 7.0 earthquake (Tarantola, 2011). *Shinbashira* technology, used in Horyu-Ji temple helps to keep the floors from flexing too far. In simple words, *shinbashira* is a giant stationary pendulum with enough mass to prevent the lighter floors from freely winging around. This damping technology is still in use today.

The Building Standard Law (BSL) is the primary law on building codes (Tomohiro, 2013). Based on the BSL, the local government may order building owners to retrofit their buildings if the building faces a risk of collapse. If the building owners refuse to follow the order, they will be punished with penalties. The Act was revised in 2006 with the aim of placing seismic assessment under an obligation and to make public the assessment results. However, seismic assessment and seismic retrofitting would naturally become a burden for the building owner as high costs are involved. Thus, based on types of the buildings, the Japanese government, through the National or the Local government provide subsidies to the owner (Earthquake Building Codes and Technology in Japan, 2017).

The BSL is a law that applies to all buildings throughout Japan. However, the standards stipulated are not uniform throughout because additional standards are determined in accordance with regional conditions. The BSL is enforced through administrative procedure, and all buildings must conform to requirements determined by the BSL and the documents under the BSL.

7. Conclusion

Although seismic impact is minimal, Malaysia will not forever be immune to seismic risk. Thus, related disaster risk management should be regulated and enforced to reduce and mitigate the impact. Therefore, MS EN 1998-1 Eurocode 8: Design of structures for earthquake resistance – Part 1: General

Rules, Seismic Actions and Rules for Building" must be implemented by all local planning authorities throughout Malaysia in regulating construction of earthquake resistant buildings in Malaysia as mandated code under the Uniform Building By Laws 1984. A reference should also be made to the Building Structure Law in Japan to learn valuable lessons from their experiences in facing earthquake disasters.

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