

A Review on the Earthquake Resistance Building and the Effect of Earthquake in Sabah

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Abstract: This paper presents the compilation of research of earthquake events in Sabah done by past researchers. Earthquake is one of the major natural disasters in Sabah. They affect social and economic life and education negatively. In some countries in this world, multi-storied buildings are usually build due to two factors which is scarcity of land and high cost. Most builders and architects come up with asymmetrical plan configurations to utilize maximum land area. When these plans are constructed in seismic prone areas, they are easily damaged by earthquake. Designation and construction of buildings should be made in a proper and detailed way. Concept of earthquake resistance design explains that buildings should be constructed and designed to resist the forces. Earthquake resistance building was introduced to minimize the damage effect caused by sudden shaking of ground. Seismic waves that reach the Earth's surface makes the ground to vibrate at certain frequencies. Due to this, the buildings and infrastructures near the vibrating area will start to sway forward and backwards thus creating unimaginable destruction. There are few factors considered for designation and construction of earthquake resistance buildings which are structural configuration, lateral stiffness, lateral strength and ductility. In other factors, aesthetics, functionality and comfort of the buildings should also be considered. Methodology of this study focuses on three main aspects which is the review of earthquake event in Sabah as well as the causes and effects. This study was carried out in order to review the earthquake event. After reviewing it, the collection of data obtained will be analyzed for result and discussion. It consists of 30 research paper and journals that mainly discuss about the methods, the equipment used and observation of earthquake effect towards the community of Sabah.

Keyword : Earthquake, seismic, earthquake resistance building, construction

1. Introduction

Natural disasters like earthquakes can often disrupt the day-to-day activities of a business enterprise that suffered from the damages [1], [2], which in turn, will also affect the performance of the enterprise. Many previous studies on earthquake aftermath have been focused on the numerical and geological methodology to measure the overall impact of the disaster in terms of the values of loss and risk intensity [3], [4]. Similarly, several studies on the impact of earthquake in tourism sector have emphasized on the quantitative impact, like loss in revenue and tourist arrivals rate. However, there is still lack of extant studies explore the impact of earthquake to small-scale accommodation business which play a major role in contributing to the socio-economic growth in many countries [5]. In addition, there is little studies focus on exploring respondent's experience and perceptions about the impact of earthquake to their day-to-day activities for pre-disaster, during and post disaster [6]. It has been recognized in many previous studies on business performance that individual's behaviors like perceptions, experiences and processes have largely been employed in order to gather a more complete picture of the phenomenon under investigation, rather than seeking statistical significance. Therefore, the objective of this paper will be achieve by review and compilation of research of earthquake events in Sabah done by past researchers. In other hand, the effect of earthquake towards building, community and economy in Sabah will be obtain in this paper.

2. Methododology

This study has been undertaken as systematic literature review (SLR) to collect the data and results from previous study. It will explain more about the preferred required report paper. There are three phases will be will be focus on such as identification, screening and eligibility process. For more understanding about the phase to achieve the goal of this review, the flow diagram of the process carried out as shown in Figure 1.

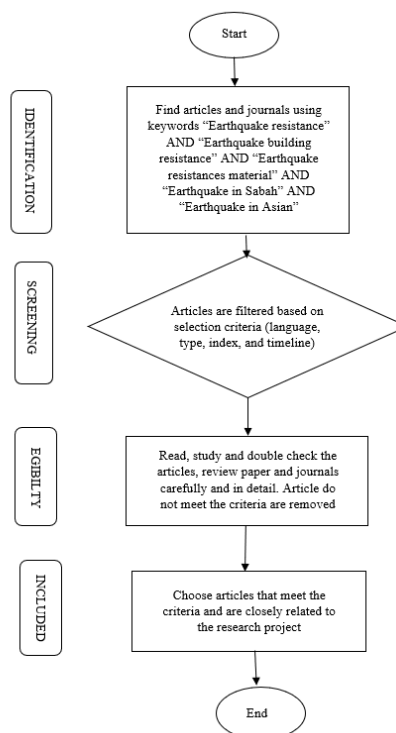


Figure 1: Flow diagram of the process involved

2.1 Systematic Review Process

The systematic review process is the method that is used manually to evaluate the findings in such studies. Three phases are being taken in this part to finalize the best and most specific research required. Identification, screening and eligibility are the phases. All the data and information obtained from the review the paper will be reported and displayed in table form.

2.2.1 Identification

The keywords start with “Earthquake Resistance” AND “Earthquake building resistance” AND “Earthquake resistant material” AND “Earthquake in Sabah” AND “Earthquake in Asia”. There is a lot of results that was identified from the google search engine.

2.2.2 Screening

Next, the results from the first step were filtered or screening. It is because most of them were not in the criteria such as the reader is hard to understand the language used, the context in the articles or journals is not like the type the reader wants. More than that, the journal or article paper doesn't have enough indexes to understand the objective of the content. More, the timeline may be too old or too far away from the modernization era because of the future engineer need to update the knowledge due to the passage of time.

2.2.3 Eligibility

After that, those journals through an eligibility phase. The journals or articles were double check or read carefully to find the most suitable journal that is related to the topic of the project. The article that does not meet the criteria will be removed. The last phase is included which is there are about 30 articles that were chosen because of the closely related to the project.

2.2.4 Data Analysis

The data of the selected papers were classified according to each criterion to show:

- The event of earthquake in Sabah
- Method for observing the earthquake in Sabah
- Effect of earthquake in terms of social, economy

3. Results and Discussion

The results and discussion section presents data and analysis of the study. This section were organized based on the stated objectives, the chronological timeline, different case groupings, different experimental configurations, or any logical order as deemed appropriate.

3.1 Results

Table 1 summarizes the method that have been used by researchers in earthquake study in Sabah.

Table 1: Summarization of Method used for Observation

No	Title	Author	Aim	Method for Observation
1	Application of GIS for Earthquake Threat Mapping in Sabah.	Rasyidah Raduan, Mohd Effendi Daud, Masiri Kaamin , 2018	To investigate the potential of earthquake threats in certain areas.	<ol style="list-style-type: none"> 1. Use GIS (Geographic Information System) 2. Determination of Threat Index Qualitative
2	The Impact of Earthquake on Small Business Performance : Evidence from Small Accommodation Services in Ranau, Sabah	Noor Fazlinda Fabeil, Kamarul Mizal Marzuki, Izyanti Awang Razli, Mohd Rizwan Abd Majid, Marry Tracy anak Pawan, 2019	<p>To discover the impact in business performance of small accommodation business in Ranau before, during and after earthquake.</p> <p>To identify level of disruptions of earthquake in terms of business operation, physical facilities and employee emotional.</p>	<ol style="list-style-type: none"> 1. Carry out face to face structured interviews among 33 managers.
3	Probabilistic Seismic Hazard Assessment of East Malaysia using Proposed Empirical GMPE for Shallow Crustal Earthquake	Noor Sheena Herayani Binti Harith, 2016	<p>To determine the fault characteristic mechanism and layouts for East Malaysia region.</p> <p>To produce a local ground motion prediction equation (GMPE) suitable for the region.</p> <p>To determine the peak ground acceleration (PGA) and response spectral acceleration (RSA) to be a plot in map.</p>	<ol style="list-style-type: none"> 1. Determination of the fault characteristics mechanism and layouts for the East Malaysia region. 2. Develop a new ground motion prediction in terms of peak ground acceleration and response spectrum.
4	A Study on the Earthquake Generating Faults in Ranau region, Sabah using Satellite Images and Field Investigation	Navakanesh M Batmanathan, 2018	<p>To map the fault zones across Ranau region with the help of Satellite Images</p> <p>To identify sub-surface geometry of faults by GPR investigation.</p>	<ol style="list-style-type: none"> 1. ESRI ArcGIS software 2. Morphometric Analysis 3. Ground Penetrating Radar (GPR)

The result was collected from the chosen method which the journals and articles were found by Google Scholar and go through another 3 phases which is screening, eligibility, and included.

3.2 Discussions

According Earthquake Track [7],[8], there was a big incident happened in Ranau, Sabah. On 5th June 2015 an earthquake in Sabah, especially at Ranau was happened with a magnitude of 6.0 and it was lasted for 30 seconds. Earthquake in Ranau Sabah which called the strongest earthquake happened in Malaysia. Malaysian Meteorological Department [9] also reported that the state of Sabah was the most affected by the earthquake (magnitude scale) with earthquake-related points such as Ranau, Lahad Datu, Kudat, Sandakan, Semporna and Tawau [10]. This puts the state of Sabah geographically vulnerable to the threat of high-level earthquakes, including Ranau tourism destinations. The Ranau earthquake causes massive landslides were shaking around the Mount Kinabalu Mountain. Based on Tija [11], the Ranau earthquake is shacked by the active movement that gives a lot of damages in that area. It was because Ranau is placed near the regional fault zone. Crocker error and Zone error are the two error involved in this earthquake.

The main cause of the Ranau earthquake happened in Sabah is active fault line. Sabah is receiving forces from the three main tectonic plates [12]. These three tectonic plates are interacted each other. The origin location of Sabah is on the southeast Eurasia Plate, Philippine Plate and Pacific Plate. The Eurasian plate is colliding with the Philippine and Pacific Plate which move west about 10 cm per year. Furthermore, the Australian Plate moves at the speed of 7cm per year to the north. This makes the plates all moves actively and not in stable condition. Seismic waves happened when the energy released after an earthquake [13]. Seismic waves contain three types of waves which are primary, secondary and surface waves [14].

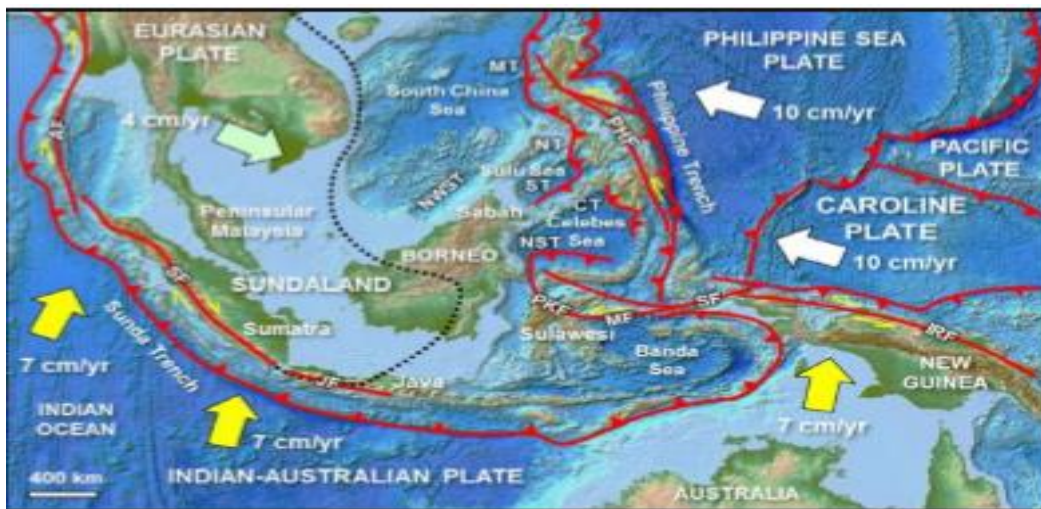


Figure 2: Tectonic setting of Sabah showing major plate movements [23]

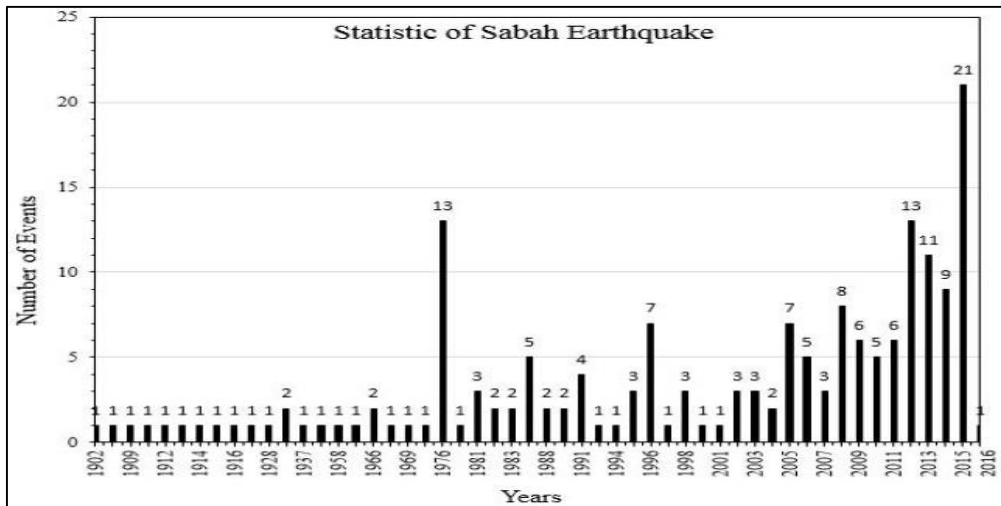


Figure 3: Statistic of Sabah Earthquake [19]

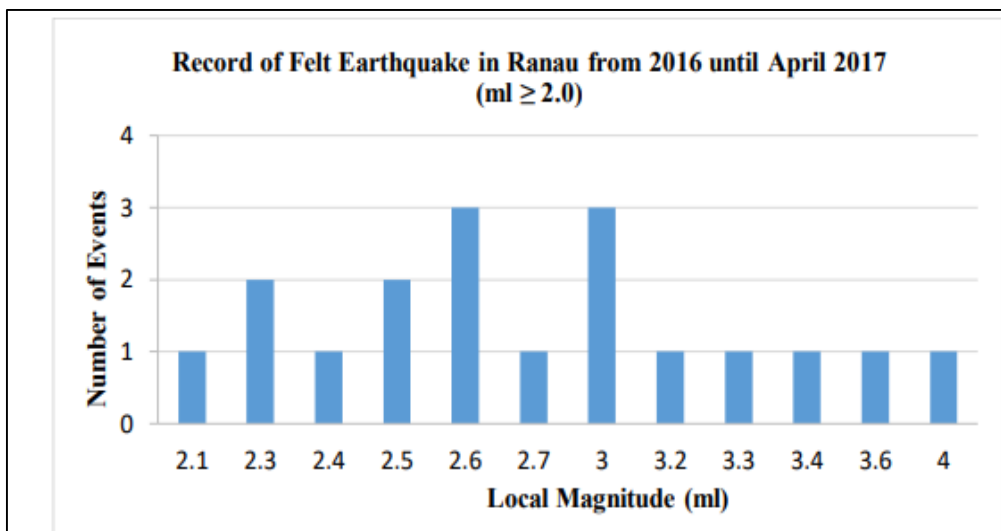


Figure 4: Record of felt earthquake observed in Ranau from 2016 to May 2017 [16]

During this earthquake, infrastructures were severely damaged. There are 23 schools and Ranau Mosque was damaged by this earthquake. Figure 2 show the tectoning setting in Sabah while Figure 3 shows the events of earthquake based on years in Sabah. There were increasing lately. Houses near the Mount Kinabalu also damaged. The construction buildings located in Kota Belud dan Tuaran were also affected by Ranau earthquake [15]. There was also got water supply distruption after the main drainage was leaked and broked near the area Kundasang and Ranau. Many factories also affected by the leakage of leaking tanks during this earthquake. Figure 4 shows the number of earthquake events by the local magnitude in year 2016 untill 2017 in Ranau. The highest peak that earthquake were confirmed in Ranau is magnitude 4 and mostly earthquake that were happen in Ranau are 2.6 and 3 magnitude.

One of the method is used to prevent earthquake is probabilistic seismic hazard analysis. The probabilistic seismic hazard analysis is used to develop ground motion. The strong ground motion forecasts is needed in probabilistic seismic hazard analysis to estimate the earthquake parameter which includes dispersal paths, geological condition and characteristics of earthquake. Estimate earthquake hazards are the most effective way to reduce earthquakes [16], [17]. The most effective way to reduce earthquakes. It is might be helpful to do better design in the construction of buildings [18].

5.0 Conclusion

As a conclusion, this study has successfully covered few researcher methods on investigating the earthquake event in Sabah. The objectives of this project have been achieved. This study is beneficial to all people in Sabah especially the one that lives near the predicted areas of earthquake event [19]. Moreover, earthquake events are highly predictable when the preferred location have a history of earthquake [20], [21], [22]. This compilation of earthquake studies done by past researchers will enable us to know and track the development of earthquake recovery program and earthquake resistance buildings [23], [24]. By having this report, it is also important for the society as it will create awareness of earthquake thus making the whole neighborhood safer than it always been [25].

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