EFFECT OF SEISMIC DESIGN ON THE COST OF STRUCTURAL WORKS FOR TWO-STOREY RESIDENTIAL BUILDING

Hanis A Roslan[1], Mohd I Adiyanto [1]*

[1]Faculty of Civil Engineering Technology, Universiti Malaysia Pahang, 26300 Gambang,Pahang, Malaysia

Keywords: COST ESTIMATION, EUROCODE 8, NATIONAL ANNEX, SEISMIC DESIGN, STRUCTURAL WORK

Abstract

Malaysia's low to moderate seismic threat should not be disregarded, and seismic design in structures should be considered. The region has previously seen significant earthquakes, especially in Sabah, as evidenced by the current increase in the frequency of minor earthquakes every day, where a current moderate earthquake magnitude of M_w 6.0 struck on 5th June 2015 in Ranau. Although the Ranau earthquake was not high-level. Malaysia suffered fatalities and millions of dollars in infrastructure and building destruction. This is mainly caused by the fact that structural design in Malaysia only considers gravity loads and does not account for seismic practices. Recent research has demonstrated how seismic designs affect material prices and cost-influencing parameters. In this study, Type 1 and Type 2 two-storey reinforced concrete residential buildings were chosen as models. Four seismicity levels were employed, each corresponding to the reference peak ground acceleration value, α_{gR}= 0.07g, 0.10g, 0.13g, and 0.16g, as well as two soil types, Soil Types B and D. According to observations, seismic design increases the cost of structural works, ranging from 0.62% to 2.16% higher than nonseismic design for Type 1 models. Furthermore, the increment for Type 2 models ranges from 0.24% to 1.71%.

1 Introduction

Malaysia is not exempt to earthquakes because it is surrounded by seismically active countries, particularly Indonesia and the Philippines. The 2004 Acheh earthquake proved that the neighbouring country's tragedy also impacted Malaysia. As can be seen, Malaysia occasionally experiences tremors as a result of distant earthquakes in Sumatra. Seismic waves of high magnitude from Sumatran earthquakes severely disrupt high-rise structures in Penang, Kuala Lumpur, Putrajaya, and Johor Bahru [1]. This tremendous event resulted in deaths and destruction. Furthermore, the Mensaban and Lobou-Lobou active fault zones in Kundasang and Ranau-Kinabalu resulted in earthquakes that caused non-structural damage at Kundasang High School and teacher's quarters. Sabah is considered Malaysia's most seismically active area [2, 3].

On 5th June 2015, around 7:15 am near Ranau, Sabah, Malaysia experienced an unusual earthquake with a magnitude of M_w 6.0. The 2015 Ranau earthquake caused over 100 aftershocks and damaged 61 structures, including mosques, schools and hospital [4]. The earthquake caused minor to moderate structural and non-structural damage to existing reinforced concrete structures [5-6]. Overall, according to their observations, the brickwall with the X-mark crack experienced the most damage due to shear failure. Although the Ranau earthquake was not categorised as a significant earthquake, Malaysia resulted in deaths and millions of dollars in damage to infrastructure and buildings. This is mostly because structural design in Malaysia does not consider seismic practices. As a result, seismic design practices should be used to minimise building damage, particularly in Sabah, which is categorised as a moderate seismic zone [7]. However, the adoption of seismic design has its own impact, particularly when it comes to expense. It is interesting from an economic standpoint to study the impact of seismic considerations that influence the material cost. As a result, all stakeholders in the building industry would have a comprehensive vision for better planning and management. Moreover, by implementing seismic design, expenditures for maintenance and repairs can be minimized [8].

Seismic design circumstances are crucial in analysis and design with various parameters. Different parameters cause the cost of materials to increase proportionally as steel reinforcement increases [8-12]. Before establishing National Annex [13], a review of previous research papers revealed that almost all researchers considered the seismic load based on Eurocode 8 [14], which did not entirely resemble Malaysia's specified soil condition. In addition, previous studies used the lateral force method for analysis. This research will provide a cost estimation model that may be used to predict the increment in cost of structural work of reinforced concrete (RC) residential buildings with different levels of seismicity and soil type in seismic design. The resultswould be useful for future reference.