

# Evaluation Of Design and Building Codes Of Earthquake Resistance For Al Mutlaa City In The State Of Kuwait

Thamer A N. Alenezi

Manager of Doctor Thamer Abdullah Nahar Alenezi Center & Institute for Studies, Researches and Authoring, Kuwait

[Thamer.A.Alenezi@gmail.com](mailto:Thamer.A.Alenezi@gmail.com)

**Abstract:-** This paper has been prepared to evaluate whether the design and building codes of earthquakes resistance are used or not being used in Al Mutlaa city. A questionnaire survey has been carried out from a wide range of professional engineering, construction and architecture practitioners operating in Kuwait. The finding from this research revealed that the proper steel/concrete reinforcements are used in all projects of Al Mutlaa city, while the design/building codes of earthquakes resistance are not being used in Al Mutlaa city. The main conclusions from output of the data could help to develop a better understanding of the proper reason for why the design/building codes of earthquakes resistance are not being used in Al Mutlaa city.

**Keywords:-** Steel, Concrete, Design, Building, Earthquake Resistance, Al-Mutlaa City, Kuwait.

## Introduction

Earthquakes are among the natural disasters that causing loss in both economic and life as well as destruction of building infrastructures. The most destructive of building infrastructures in China at Xian city were the earthquake caused of 800,000 person's death in 1956. The constructions in that area at Xian city included the familiar earth dwelling were collapsed due to the earthquake shaking (see Figure 1). Tangshan city in 1976 suffered 700,000 deaths from construction with low earthquake resistance in an area without loess houses. The building in Mexico city were collapsed in 1985 and caused 10,000 persons death due to earthquake shaking 400 km away along the Pacific coast. San Salvador city in 1986 suffered 2,500 deaths from earthquake shaking in five second or less. With regards to the extent of earthquakes shaking and they are truly the worst result in disasters. Therefore, it must be have the skills to Judge their size before they occur, recognise the sources of earthquakes, specify the motions they produce at construction sites, produce design for these motions that are earthquake defensive and provide construction that, in the final analysis, is safe.



**Figure 1.** The type of loess cave dwelling at Xian, China that collapsed in great numbers during the 1956 Great Shanxi earthquake (Krinitzsky et al., 1993).

More recently, the catastrophic earthquakes of 7.5 and 7.8 magnitudes occurred on 6 February 2023 in northern Syria and southeastern Turkey, respectively. The total numbers of 45,089 have been deaths in southeastern Turkey and 6,000 deaths in northern Syria due to the catastrophic earthquakes. It appears that 50 percent of building in southern Turkey collapse due to not built according to building codes (see Figure 2). There is a wide range of earthquake resistant design and construction to consider such as the base isolation system which allowing the building to shake during an earthquake without toppling. Additionally, a proper steel reinforcement is also allowing the building to avoid loss lives during the catastrophic earthquakes.



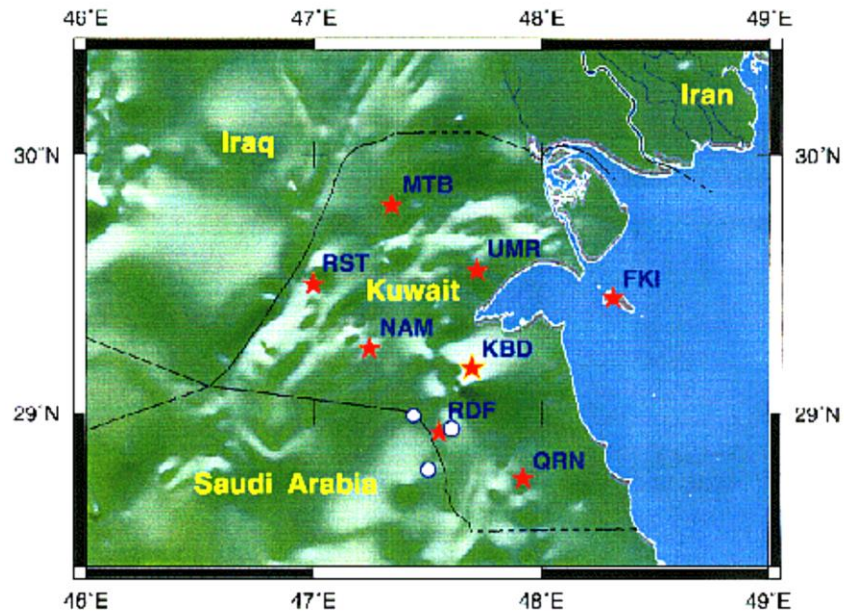
**(a)**



**(b)**

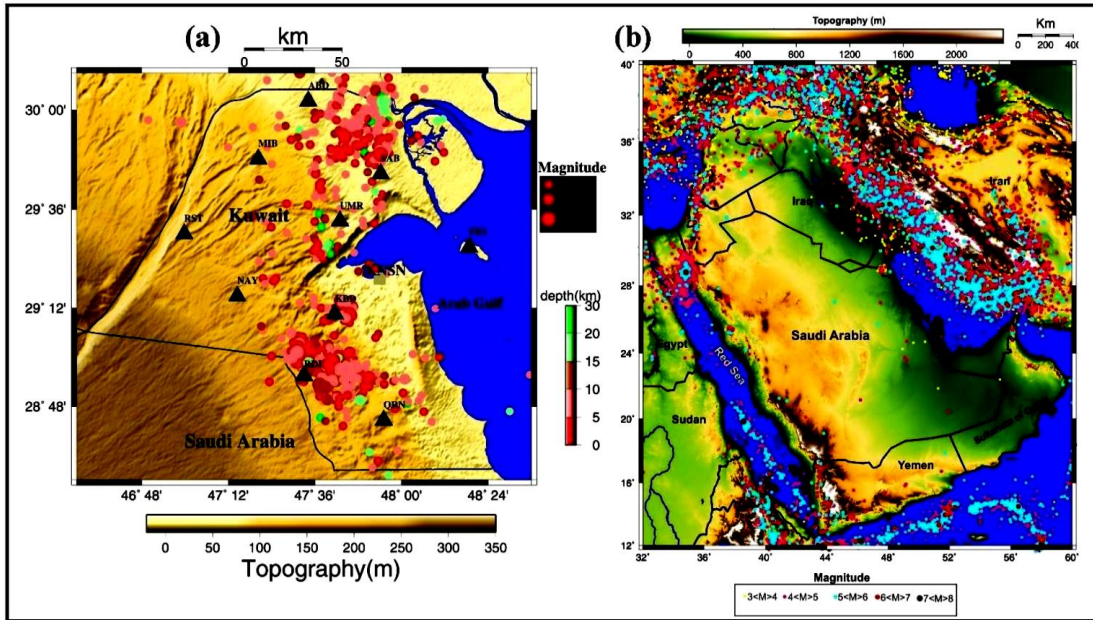
**Figure 2.** Structural fail occurred by a bad quality of materials and odd construction code (Carrera-Cevallos A and D., 2023).

On other hand, the State of Kuwait is located to the southwest of the Zagros belt, which is able to producing strong earthquakes of magnitudes 7.5. According to Bou-Rabee, the earthquake hazards should be known in order to be more effective at planning of building codes and construction purpose. The Kuwait National Seismograph (KNSN) began in March 1997 with the seven three component short period and one broad band seismometers as shown in Figure 3. The largest event located in the southern part of Kuwait was recorded of magnitude 4.3 in December 1997.



**Figure 3.** Location of the seismic stations of Kuwait National Seismograph (Sadek., 2004)

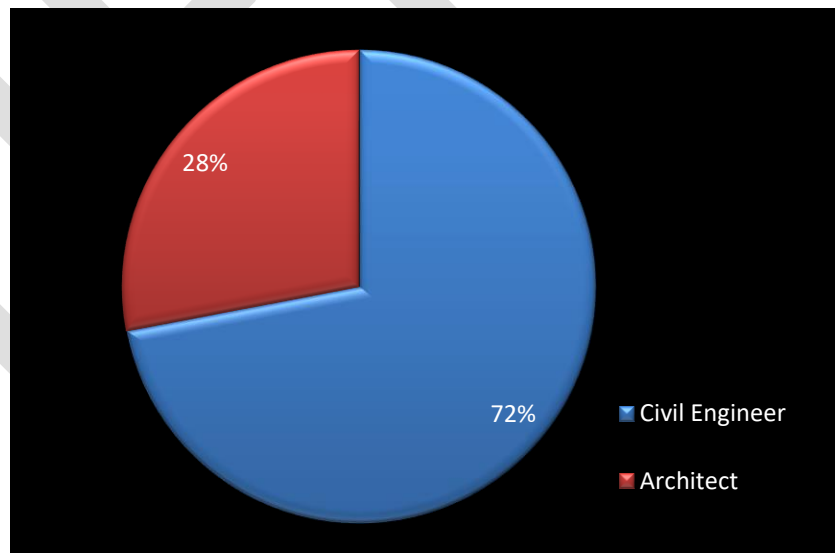
Moreover, the neighboring countries of Kuwait i.e. Iranian-Iraqi border have been subjected to many of earthquakes with a magnitude of 5.9 on the Richter scale on November 12, 2017, as shown in Figure 4, and this felt by the residents of Kuwait. Again, the residents of Kuwait felt to hundreds of Iranian-Iraqi earthquakes with magnitude of 7.5 on the Richter scale on January 6, 2019. Based on the literature review, the government of Kuwait provides lands in Al Mutlaa city for each Kuwaiti family that has been registered from the Public Authority for Housing Welfare (PAHW). The PAHW allowed to design and build their lands for each Kuwaiti family in Al Mutlaa city. Most of Kuwaiti families have completed their homes in Al Mutlaa city. Therefore, this paper aims to determine if the design and building codes of earthquakes resistance are used or not in Al Mutlaa city after the earthquakes of 5.9 and 7.5 magnitudes occurred on November 12, 2017 and on January 6, 2019, respectively, from the neighboring countries of Kuwait as well as the earthquakes of 7.5 and 7.8 magnitudes occurred on 6 February 2023 in northern Syria and southeastern Turkey. The objective was to gather the information from a wide range of professional such as engineers, project managers, design managers and architects practitioners.



**Figure 4.** (a) KNSN Recording of Local Seismic Activity in the State of Kuwait from 1997 to 2020, (b) Record of regional seismic activity in the Arabian Peninsula and the neighboring areas of Kuwait from 1997 to 2020 (after Abd el-aal et al., 2021).

### Research Methodology

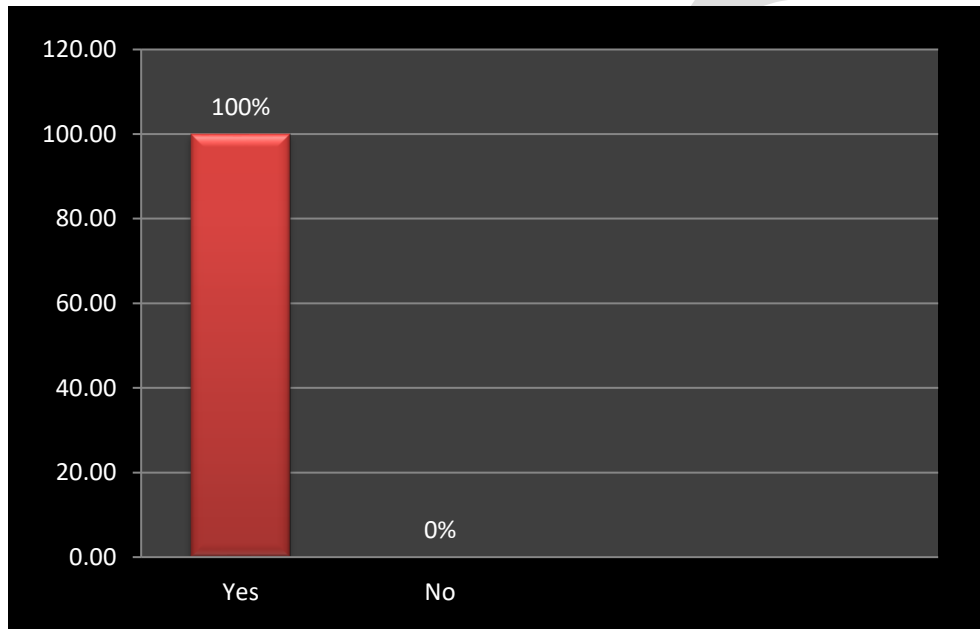
The research methodology used in this research is a questionnaire survey to collecting data from a wide range of professionals. The questionnaire was sent to 105 engineering, civil and architecture practitioners working in Kuwait. The questionnaire was launched between 11<sup>th</sup> of March 2023 to 5<sup>th</sup> of July 2023. A total of 39 completed questionnaires were received. The responses were from: 28 civil engineering and 11 architects, as shown in Figure 5.



**Figure 5.** Respondents' from a wide range of professionals

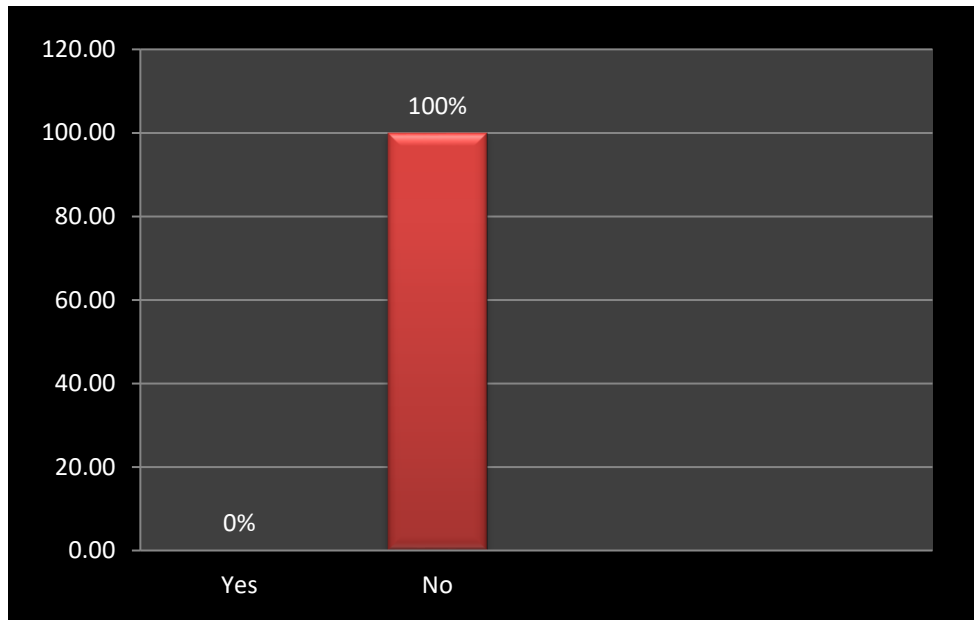
## Findings and Discussion

The majority of the respondent (39%) worked for small organization. The annual turnover of their organization was between £7.5m and £37.5m. The respondents were involved in building projects for houses. Respondents also had experience in both private and government sectors. The main finding of the questionnaire survey showed that the respondents (100%) indicated that the proper steel/concrete reinforcements are used in all projects of Al Mutlaa city, as shown in Figure 6. Hence, this is in line with literature review which reported that the proper steel/concrete reinforcement is allowing the building to avoid loss lives during the catastrophic earthquakes.



**Figure 6.** The total respondents in percentage for the proper steel/concrete reinforcements are used in Al Mutlaa city.

Moreover, Figure 7 showed that (100%) of the respondents indicated that the design/building codes of earthquakes resistance are not being used in Al Mutlaa city. Based on literature review, reported that the earthquake resistant i.e. base isolation system which allowing the building to shake during an earthquake without toppling. Therefore, further research is required to provide the reason for why the design/building codes of earthquakes resistance are not being used in Al Mutlaa city.



**Figure 7.** The total respondents for the design/building codes of earthquakes resistance are not being used in Al Mutlaa city.

## Conclusion

The design and building codes of earthquakes resistance for Al Mutlaa city in Kuwait has been evaluated and the main conclusions of this paper revealed that the proper steel and concrete reinforcements are used in all projects of Al Mutlaa city, while the design and building codes of earthquakes resistance are not being used in Al Mutlaa city. Clearly, further research is required to develop a better understanding. For example, face-to-face interviews with a wide range of professional engineering, construction and architecture are operating in Kuwait to provide the reason for why the design and building codes of earthquakes resistance are not being used in Al Mutlaa city.

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