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Research Article

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The Hit of Two Earthquakes in Turkey-Syria: M_w=7,8 Giziantep-M_w=7,5 Kahramanmaras

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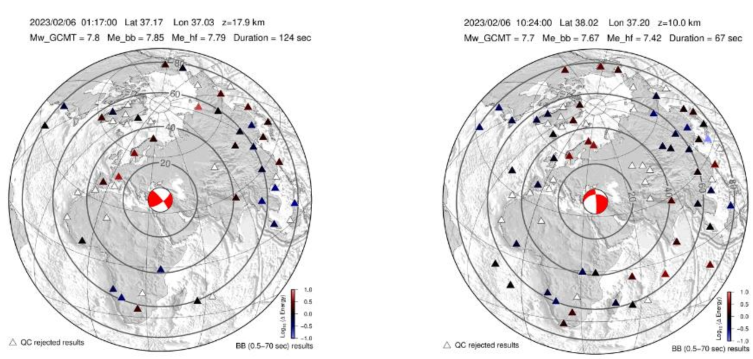
Abstract
Turkey-Syria were shaken by two large earthquakes M_w=7,8 and the other with M_w=7,5. The seismic moment shows the amount of energy accumulated due to the seismic gap in the region. Giving researchers a guideline on which they can rely on the different interpretations of data provided by different stations around the world. In addition to understanding the type of problem caused by the use of low-quality materials for the construction of buildings. The seismic moment that was calculated using the seismic moment formula can be found in the results where the moment graph is also evident; the peak seismic release at the time of the onset of the event, however many researchers will have discrepancies because they have reported the same ones that could be verified later.

Keywords: Earthquake, Aftershocks, Seismic Moment, Geodesic, Structural Collapse.

Introduction

On February 06, 2023, two big earthquakes struck Turkey and Syria. One of them, magnitude M_w=7,8 Giziantep- Nurdagi, and the second one, 9 hours later, magnitude M_w=7,5 Kahramanmaras-Ekinözü (Figure 1). These big earthquakes caused several deaths (50.000 at the time this article is written), thousands of injuries and the collapsed of more than 40.000 buildings; furthermore, this event represents the worst humanitarian crisis since the last century. Both earthquakes are associated with the Anatolia fault (Gutenberg & Richter, 1967), and all the data were recorded by the seismographic stations in excellent detail around the world; allowing a better understanding of this potential and seismic region [1].



(a) **(b)**

Figure 1: Earthquakes Turkey-Syria (a) Earthquake M^w=7,8 Giziantep- Nurdagi; (b) M_w=7,5 Kahramanmaras- Ekinözü

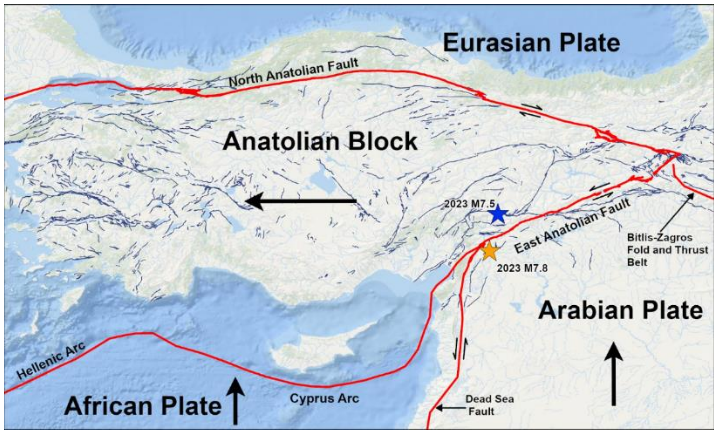


Figure 2: Anatolia Fault and epicenter of two big Turkey earthquakes

Figure 2 shows the epicenter of these earthquakes and the fault that is involucrate; furthermore, they came when Turkey started with their winter storms affecting this region and creating difficulty for the extenuating rescue operations. Since the 1900s, Turkey has experienced twenty-one or larger earthquakes; investigation reveals that eleven of these large earthquakes occurred near the Anatolian fault, and five of them occurred in the west of Turkey; are compatible with westward extrusion of Anatolia between the northern and eastern Anatolian faults in response to the convergence of Arabia and Eurasia. The complex geometry of the faults activated during this sequence of earthquakes sheds light on how the stress is divided and distributed in the middle of the faults of these triple junctions [2].

The government of Turkey declared a state of emergency (3 months) in the place where these earthquakes affected people directly. On the next table, it shows the details of these earthquake events Table 1.

Table 1: Details earthquake of the two events in Turkey

Event 1	***Event 2***
M_w=7,8	M_w=7,5
Location: 34 mi. N of:	Location: 72 mi. NNW of:
Gaziantep	Gaziantep
Latitude, **Longitude:**	Latitude, Longitude:
(37.5600, 37.4700)	(38.1100, 37.2200)
Depth: 14.9 km	**Depth:** 12.0 km

Data

The direct costs of the destruction of physical structures in Turkey because of the devastating earthquake could be as high as US$25 billion, with the affected areas representing 9 percent of the country's gross domestic product and home to 15 percent of its population [3]. Building construction codes, often referred to as building codes, provide the first line of defense against potential seismic damage and help ensure the safety of buildings constructed in accordance with these codes. It is therefore of utmost importance to examine whether local building codes provide for seismic protection at the project site. If they do, regulatory provisions regarding planning, design, and construction, as well as the type of construction and quality of materials used in seismic risk zones, must be complied with.

It is essential to examine local building regulations to establish planning, design, and construction standards. Likewise, it is essential to regulate to what extent these regulations take into account the seismic hazards of the region and whether they provide sufficient protection. To do this, talk to the local industrial community, especially those working for the municipal government. However, in regions where the capabilities of local engineers are considered limited, consider consulting outside professionals who understand the building standards required in high seismic hazard zones.

It is also essential to know when these criteria, which were last, reviewed and how frequently such reviews are carried out. Earthquake data and engineering developments evolve rapidly, and standards that not been reviewed for more than five years may not meet the requirements for project design. In such cases, it may be necessary to follow more stringent design standards.

A major earthquake near Izmir in 1999 caused 17,000 deaths and the collapse of up to 20,000 buildings. Following an earthquake in 2011 in which hundreds of people died. Although the Turkish authorities are aware that many buildings are unsafe in the event of an earthquake, it remains a difficult problem to solve. Many of the buildings are already constructed, and seismic retrofitting may be expensive or not considered a priority compared to other socio-economic challenges [4]. In addition to the significant loss of life and damage to infrastructure, both earthquakes are likely to have caused a myriad of environmental effects, such as ground rupture, soil liquefaction, and landslides. These effects may make many areas unsafe to rebuild, so reconstruction efforts must also include decisions about what can be built and where to reduce future risks. Resilient infrastructure is patchy in southern Turkey and not so far in Syria; one of the reasons why the extraordinary number of victims has been so high is the poor quality of buildings Figure 3.

(a)

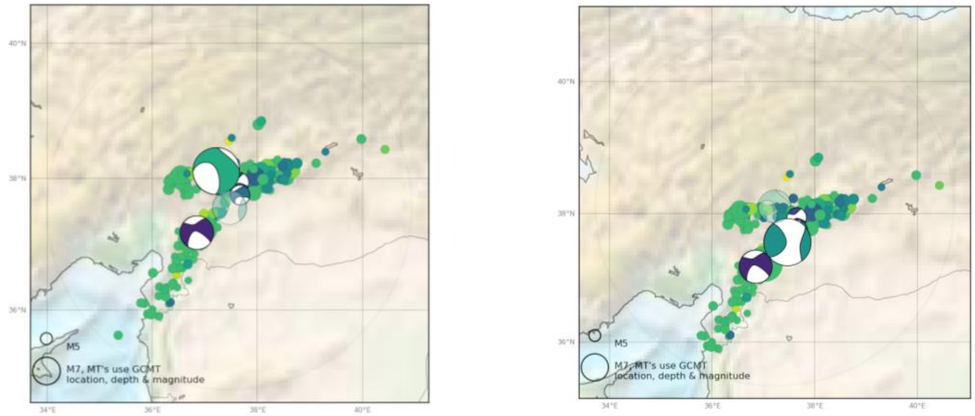
(b)

Figure 3: Structural fail occurred by a bad quality of materials and odd construction code

If local structure codes do not replicate the seismicity of the area, consider implementing and complying with the construction codes of other counties that share related geological circumstances and seismic hazards. In many countries, seismic hazards are not taken into account in building codes, either because they are rare phenomena or because the seismic history is incomplete. However, it should remembered that infrequent events could occur within the lifetime of a building that can result in large fatalities [5].

In addition, in a region where there had not been a major earthquake in two-hundred years or any warning, the level of preparedness was lower than in more accustomed regions. There are two types of strategies for designing earthquake-resistant structures: conventional and advanced. “The former are the ones that are mostly built”. This type of building are constructed in such a way that it has the ability to stably dissipate energy; in other words, during an earthquake, the energy that has been introduced into the ground survives and the building is able to eliminate part of the energy. These types of structures are designed so that in areas of high seismicity, they have the capacity to “deform plastically” in a ductile way without breaking. Therefore, this type of deformation means that the energy that these buildings have been subjected to during the earthquake can be dispersed. This means that the building can move laterally and continue to carry the vertical load it has been subjected to. However, when there is correct plasticizing and correct projection, the buildings suffer lateral deformation and significant damage but do not collapse structurally.

Many aftershocks continue to shake Turkey-Syria, a process that can last not only for days but also for months or years if necessary, as there is a very high seismic swarm in the epicenter area. The aftershocks tend to decrease in frequency and severity as time goes by, as shown in Figure 4 below, which shows the various aftershocks along the fault line in the original earthquake as well as the aftershocks caused by the 7.5 magnitude earthquake.



(a) **(b)**

Figure 4: Aftershocks along the earthquake fault: (a) represents the first earthquake of magnitude 7.8 with aftershocks of varying magnitude; (b) represents the second earthquake, which was nine hours later of magnitude 7.5 also showing aftershocks of varying intensities.

The general population exposure Figure 5 of this region lives in extremely vulnerable structures, which are seismically vulnerable, however, there are resistant structures. Vulnerable buildings are predominantly masonry and concrete structures without ductility and of poor quality [6].

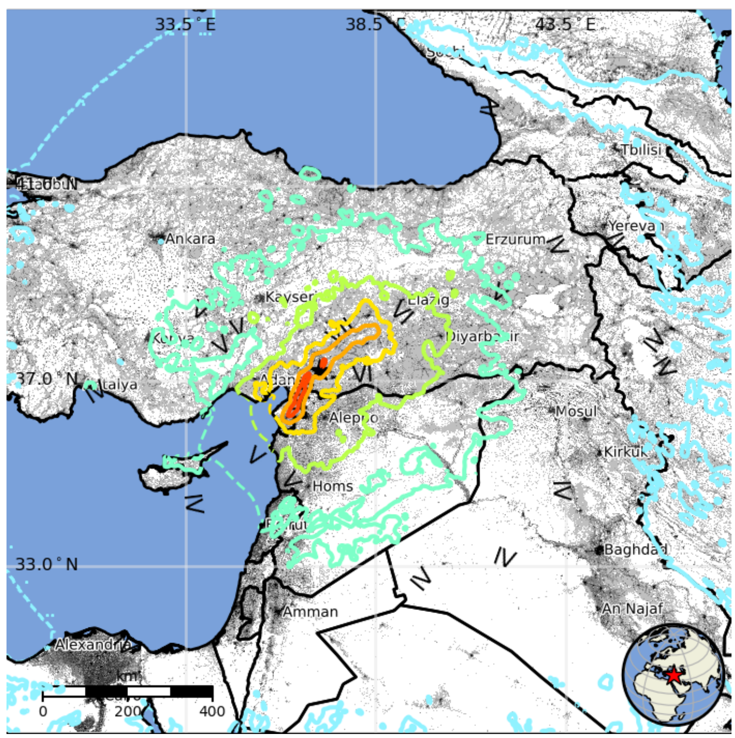
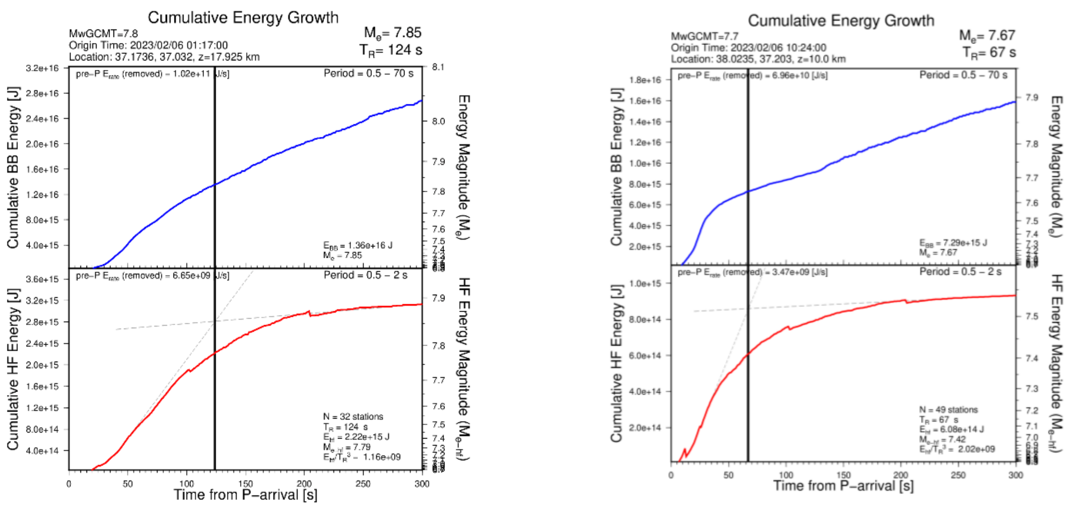


Figure 5: Representation of the population exposed by the 7.8 and 7.5 earthquakes respectively.

Results

In the selected area (Turkey), the earthquake hazard is classified as high according to currently available information. This means that there is more than a 20% probability of a potentially damaging earthquake occurring in your project area in the next 50 years. Based on this information, the impact of an earthquake must be taken into account in all phases of the project, in particular during design and construction. Decisions regarding project planning, project design and, construction methods should consider the level of seismic hazard.

The first major earthquake PGA is around ~0.7g; with a spectral acceleration, which exceeded 2g around 0.5-0.6 seconds. For mid-rise structures (five- twenty stories), it exceeded the design acceleration. The overlaid spectrums clearly indicate that collapse expectations for mostly mid-rise buildings (five- twenty stories). Many of the buildings were built before the 2000s causing around 40,000 buildings collapsed (for now) by the EQ_s. Consequently, those buildings were designed on old Turkish construction code. They did not provide enough reinforcement (rebar's are expensive) for the ductility that they relied on. Therefore, the buildings did not provide performance in the plastic region.



(a) **(b)**

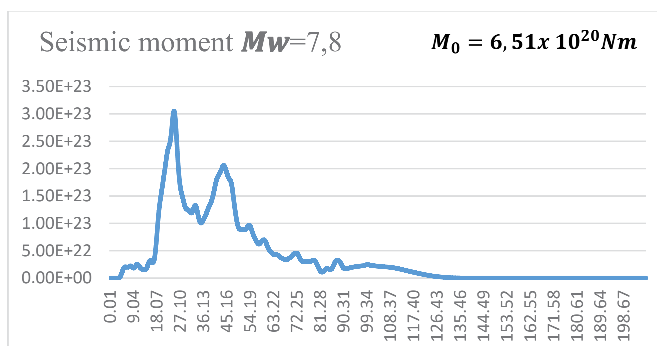
Figure 6: Cumulative EQ's of the two earthquakes: (a) correspond tow the first main shock M_w=7,8; (b) correspond to the second main shockM_w=7,5, 9 hours later to the first event.

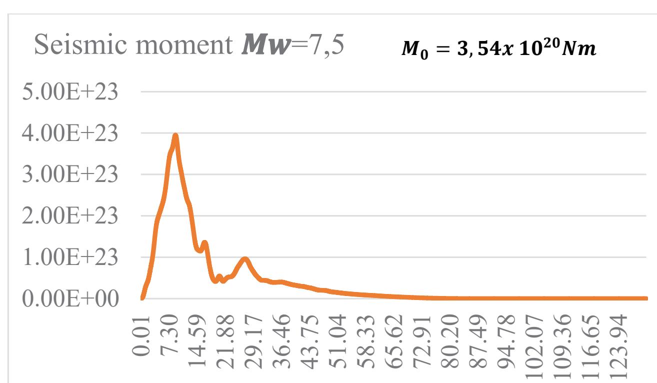
Magnitude M_w=7,8 occurred at 4 am, and Magnitude M_w=7,5 occurred at 1 pm (many 6.5 amidst). So every EQ_s softened the buildings, and when 7.5 happened after all, it destroyed all the softened buildings. Investigations show that many of the buildings partially or total collapse, because many of them had, on their constructions, bad quality concrete. Much of the energy that the earthquake releases absorbed by builds, which were in the area and the near regions. However, this is a critical parameter for scientist and researchers because it helps to evaluate the damage introduced in buildings by the two shocks [7].

These earthquakes shows a seismic moment, which was, calculate by the definition of magnitude [8].

$$M_w = \frac{2}{3} * \log 10\, M_0 - 10.7$$

This caused a seismic moment release of M_0=6,51 x 10^{20} for the M_w=7,8 earthquake, which we also rely on the moment graph, and for the M_w=7,5 earthquake, it caused a moment release of M_0=3,54 x 10^{20} which we also rely on the moment graph.





Discussion

The rupture process in the event had a questionable release of energy, so it is intuitively related to the extension of the fault, this through the seismic moment that occurred and the incompatibility between the stress at the time the fault occurred and the frictional stress caused. Thus, the initial gives the energetic amount accumulated in the deformation on the fault because of the telluric load.

The foundation is the lowest part of a building, which interacts with the ground and transmits the load of the structure to the underlying soil. Before deciding on the type of foundation, it is necessary to understand the soil characteristics of the building site. This is done through soil surveys, which should be carried out by a geotechnical engineer who will test the soil in situ and write a report indicating the physical properties of the soil, its bearing capacity, chemical composition, liquefaction potential (see below), stability of natural slopes and other aspects that need to be taken into account in the design. Soil properties may vary from site to site and from layer to layer, even within the proposed project. It is therefore very important for projects to carry out these tests, since buildings erected on unfavorable soils may experience excessive ground movement or suffer from the effects of liquefaction and ground failure. Structural designers will use the results of the soil surveys and their analyses to design the foundations and structural elements needed to make buildings earthquake resistant.

Previous studies reveal that the focal energy at the epicenter of the earthquakes has a large seismic accumulation. Being a clearly close pulse in the attribution of the rupture phenomenon so a late phase arrival of the event in the seismograph would assume that the second earthquake, of magnitude 7.5, supports the hypothesis of association with the earthquake of magnitude 7.8 associated with the rupture. These two events evidence a relatively equivalent size. Therefore, many of the buildings that collapsed were not only the result of the accumulation of energy from the seismic recurrence gap but also because of the quality of construction to which the structures subjected, resulting in a one hundred percent collapse.

Conclusions

In most earthquakes, building collapses cause the greatest number of deaths and injuries. Building codes help to ensure the safety of buildings. It is important that technical personnel involved in construction projects in earthquake-prone areas understand all the provisions of building codes. In addition, why they are necessary for the design and construction of earthquake-resistant structures. They must understand the demands that arise during shaking on the various building components and design countermeasures so that loss of life and damage to property can be limited.

Many of the collapsed buildings appear to have been constructed of concrete without adequate seismic reinforcement. Seismic building codes in this region suggest that these buildings should be able to withstand strong earthquakes (where the ground is 30-40% higher than normal gravity) without collapse.

Appropriate technical advice is essential to ensure that project structures can withstand multiple hazards. For project structures to have adequate seismic resistance, the technical staff involved must also have relevant experience and expertise in the conceptualization, design, and construction of earthquake-resistant structures. The design and construction of large structures is always a challenge, which is even more so when they are built in earthquake-prone areas. Earthquake engineering requires additional technical skills to those of ordinary structural engineering. All projects in high seismic hazard areas should have the services of technical personnel with knowledge and experience in the construction of earthquake-resistant structures. It is also important that the team includes geologists specialized in applying geology to engineering projects, commonly referred to as engineering geologists, in order to better understand current geological processes, seismic potential, and the threat of secondary geological hazards.

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