Proceedings of the 2023 International Conference on Mechatronics and Smart Systems
DOI: 10.54254/2755-2721/9/20230091

Causes and recommendations for post-disaster reconstruction earthquake in Turkey

Yihe Zhang

School of Oceanography, Fuzhou University, Fuzhou, 350108, China

252003129@fzu.edu.cn

Abstract. Earthquake, also known as ground motion and ground vibration, is a natural phenomenon caused by the rapid release of energy from the earth's crust, during which seismic waves are generated. The current level of science and technology cannot predict the arrival of earthquakes, and earthquakes will be unpredictable for a long time in the future. The so-called examples of successful earthquake prediction are basically coincidences. For earthquakes, what we should do is to improve the seismic level of buildings and do a good job of defence, rather than predicting earthquakes. Turkey experienced a strong earthquake in 2023, causing a large number of buildings to collapse and casualties. One of the main reasons why the earthquake was so severe was that Turkey was located in an earthquake zone between the Eurasian continents, and the collision of plates caused the earthquake. Second, Turkey's rudimentary building structures and misuse of raw materials increased the damage caused by the disaster. For the damage of this disaster, it is necessary to establish a relatively complete earthquake relief system, including the improvement of the strength of earthquake-resistant buildings and the rescue and rescue work after the disaster.

Keywords: Turkey earthquake, earthquake-resistant buildings, building material structure.

1. Introduction

This time consisted of two earthquakes with a magnitude of 7.8, displacing south-central Turkey, close to Syria. In fact, Turkey in general, especially the east, belongs to a plateau called the Anatolian Plateau. To the east of the Anatolian Plateau is the Iranian Plateau, the Pamir Plateau, the Qinghai-Tibet Plateau, and the Yunnan-Guizhou Plateau, and such a belt is actually the famous Mediterranean-Himalayan orogenic belt, on which all of Turkey is located. This orogenic belt is formed by the northward movement of the African, Arabic and Indian plates in the south, extruding the relatively stable Eurasian plate, with extensive faults and strong tectonic deformation. In fact, orogenic belts are created by a series of faults that are constantly deformed, and earthquakes are the geological processes in which these faults continuously produce sticky and slippery deformation. In the south of Turkey, the African plate and the Arabian plate are squeezed northward, causing central Turkey to move westward, forming an extrusion fault system on the north and south sides, and the central parallel orogenic belt is the northern Anatolian strike-slip fault system. The differential movement of the African plate and the Arab plate has formed the strike-slip Dead Sea fault system, and the northernmost part of the Dead Sea fault system is the Eastern Anatolian fault system that produced this earthquake group. In different parts of Turkey, active fault systems with different characteristics are developed, and it can be seen that the western, northern,

DOI: 10.54254/2755-2721/9/20230091

central-southern and eastern parts have different combination pattern characteristics, and the tectonic properties and dynamics are very different. Under the influence of these now-active faults, the whole of Turkey is basically seismic and seems to be only slightly stable in the central part [1].

On the one hand, the design and construction of buildings were not done in accordance with seismic design specifications, and there was widespread cutting corners [2]. On the other hand, there are serious loopholes in the supervision of seismic fortification, and there is no risk assessment and corresponding measures for the largest earthquake that may occur. In view of the painful lessons of the earthquake in Turkey, it is recommended to carry out targeted earthquake safety risk assessment, scenario construction and risk source investigation according to the spatial distribution of earthquake risk and the distribution of large cities in China, and take seismic reinforcement measures for houses and buildings that may collapse or be seriously damaged in future major earthquakes. For large cities located in large cities where a major earthquake of about magnitude 8 is likely to occur, seismic fortification standards should be appropriately raised and supervision should be strengthened. This measure should run through all links of high-quality social and economic development and modernization and be incorporated into the national economic development plan to ensure its effective implementation [3]. However, houses that do not meet seismic standards will not be shaken. If a building is hit by an extreme earthquake that exceeds its seismic standards, it can still be severely damaged or collapsed. Therefore, adequate study of seismic and active faults is also extremely important. According to the global survey of major earthquake disasters, more than 95% of human casualties are caused by damage or collapse of buildings. To explore the causes of damage and collapse of buildings in earthquakes, and to prevent them, engineering the construction of earthquake-resistant buildings that can withstand strong earthquakes is the most direct and effective way to reduce earthquake disasters. Improving the seismic performance of buildings is one of the main measures to improve the comprehensive defence capability of cities, and it is also a major task of "resistance" in earthquake prevention and disaster reduction [4-6].

2. Case description

At 4:17 on June 2023, a 7.7 magnitude earthquake struck Kahramanmaraş province in southern Turkey, with a focal depth of 7 kilometres. As search and rescue efforts proceed, the number of casualties is expected to increase further. According to Turkish Vice President Oktay, nearly 900 buildings were destroyed in Turkey's Gaziantep and Kahramanmaraş provinces. Recep Tayyip Erdogan said at a press conference that the disaster was the worst earthquake to strike Turkey since 1939. In addition, the earthquake caused damage to the gas pipeline in the Hatay area, which caught fire and exploded, and the aftermath of the accident continues, and gas supplies to the southeastern provinces will be suspended. Heritage sites also suffered in the earthquake, which caused the collapse of an ancient castle in Turkey's Gaziantep province, which is thousands of years old and a UNESCO World Heritage Site [7]. Compared with the 1999 Turkish earthquake, this earthquake is larger and more widely affected, but unlike the 2023 Turkish earthquake, after experiencing a strong earthquake, it suffered secondary damage caused by the aftermath of the earthquake, and the intensity reached 8.0 [8]. Whole country of Turkey is at the junction of plates, the Mediterranean-Himalayan seismic belt level is high, the source is shallow, there are many aftershocks, and there are three consecutive large earthquakes in one day, and earthquakes with similar distances belong to swarm earthquakes. Plateau is extensive, the population is concentrated in river valleys, and the earthquake zone is densely populated. First earthquake occurred in the middle of the night, and it was difficult to the second occurred during the rescue, causing damage to the rescue team and reducing the rescue capacity. Buildings are mostly brick-concrete structures, and the seismic resistance is poor. the earthquake, the cold wave and snowstorm hit, the temperature dropped sharply, the rescue was difficult, and the lives of the trapped people were difficult to hold [9].

2.1. Terrain

According to the theory of plate tectonics, Turkey is located on the Mediterranean-Himalayan seismic zone and is affected by plate compression and collisions, so earthquakes are frequent [10]. Large earthquakes occurred on the Eastern Anatolian fault zone of the Anatolian Plate, but strong shaking travelled hundreds of kilometres northeast along the fault zone. This is where the Anatolian Plate, the Arabian Plate and the African Plate meet, and multiple fault zones are under pressure, with the possibility of aftershocks of higher magnitude. This earthquake belongs to the "swarm type earthquake" of the "double earthquake sequence"[11]. The usual large earthquakes are foreshock-mainshock-aftershock. Compared with ordinary earthquakes, swarm earthquakes have more continuous and powerful destructive power [12].

Turkey's terrain is high in the east and low in the west, and according to the geological structure and topographic characteristics, the whole territory can be divided into four regions [9]. The northern fold zone has little variation in its topography, rarely exceeding 1,000 in height, but east of the Sakarya River the height increases abruptly. The central massif extends inland from the Aegean coast south of Izmir, bypasses Ankara from the south, and reaches the vicinity of Sivas between Lake Tuz and Konya, the ground height generally rises from 500 to 1000 meters, and in the eastern triangle of the central massif with the top near Sivas as the top, the topography and structure become very complex, from the northeast corner of Ankara province to the east side of Lake Tuzi, the peaks are mostly 1700-2000 meters.

The southern fold belt is mainly located in Antalya, Hispata, Budur and other provinces, west of Antalya Bay, almost due north and south tectonic trend, mountains rise sharply from the west bank of Antalya Bay, Middle Taurus Mountain from the Jigeik Mountain to the upper reaches of the Saihan River, East Taurus Mountain is composed of two mountain systems, the surface is more complex. Earthquake occurred in a complex terrain mainly in mountainous areas, and the characteristics of ground motion became extremely complex, which was an important reason for the severe earthquake damage [1].

2.2. Materials

The earthquake exposed a relatively serious real-time, is that there is a large number of foam projects in Turkey's buildings, many construction cut corners shoddy charging. Many buildings in earthquake zones use sea sand for concrete, which is very fine, which may lead to substandard concrete strength. More seriously, sea sand contains natural salts, which are highly corrosive. If sea sand is used in construction projects, it must be strictly controlled and scientifically used. China clearly stipulates that if concrete is used in sea sand, it must be purified, mainly to treat chloride ions and residual impurities in sea sand. Rescue teams found that the concrete used in many of the buildings that collapsed in the earthquake in Turkey shattered like tofu dregs, and did not appear to have been specially treated [1, 4]. In addition, the concrete of collapsed buildings uses a large number of smooth round bars instead of rebar, which lacks tensile force when combined with cement, which also affects the strength of the building. Concrete strength, ribless steel bars (ribbed can increase the bonding ability of steel and cement), and substandard details, but there has been no significant improvement so far. According to the Turkish Ministry of Health, the Iskenderun Provincial Hospital collapsed in the earthquake. To the U.S. Geological Survey, residents of southern Turkey live in buildings that are less earthquake-resistant. Most of these buildings use unreinforced brick masonry structures and low-rise concrete frames, so they are very fragile in earthquakes and prone to collapse.

2.3. Structure

Urban houses are mostly multi-storey frame structure and 11-14 storey small high-rise reinforced concrete frame-shear wall and frame-supported shear wall structure houses, which are relatively recent in construction and have relatively strong seismic resistance. The commercial and residential buildings facing the street are also mainly reinforced concrete frame structures, of course, there are also a large number of old masonry houses or self-built houses with chaotic structural systems that are not conducive to earthquakes, and they are very close to each other.

The special effect of the superposition of the two strong earthquakes has led to the collapse of a large number of houses, especially a large number of commercial and residential houses along the streets of towns and cities, because their underlying commercial uses require large bays with fewer walls, resulting in the difference in seismic resistance between the bottom floor and the upper floor, forming a weak layer at the bottom, resulting in a large number of collapses and casualties. This is very similar to the collapse and destruction of a large number of commercial houses in towns such as Dujiangyan and Beichuan Old County in the 2008 Wenchuan earthquake in China. At the same time, two shallow 7.8 magnitude strike-slip strong earthquakes will inevitably be accompanied by large-scale surface ruptures, further aggravating the earthquake damage of houses in the surface rupture zone.

It is worth mentioning that the damaged building structures in the Turkish earthquake are very similar to the types of house structures in the 1999 earthquake area. The vast majority of urban buildings are reinforced concrete structures, of which the maximum is a reinforced concrete frame infill wall structure of more than 7 floors, the infill wall is made of thin-walled perforated bricks, and the ground floor is used as a garage or shop, with the characteristics of a soft bottom floor; A small number of medium and high-rise houses are reinforced concrete frame shear wall structures, and high-rise houses generally do not exceed 20 floors, and the highest is 30 floors [13]. Steel structure houses are mainly large-scale modern industrial plants, and only a few light steel frame infill wall residences. The proportion of masonry houses is very small, and most of them are old buildings. About half of the rural buildings are 2~3-story reinforced concrete frame infill wall houses, and the rest are wood frame infill wall houses and brick, stone and earthen houses [2].

3. Solution

From the perspective of seismic fortification, the recovery and reconstruction of the area should first focus on examining the outstanding causes of the structural damage of the buildings in this earthquake, learning lessons to improve seismic design codes, and strengthening the investigation and assessment of hidden dangers of earthquake disasters nationwide to eliminate risks for the next earthquake. In view of the affected area of the surface rupture and the topography and site characteristics of the local mountainous area, it is preferable to select the areas with better site conditions for restoration and reconstruction and avoid unfavourable areas. Another common problem is that it is necessary to strictly control quality and avoid inferior projects due to the pursuit of economy and the speed of recovery and reconstruction, burying hidden dangers. In addition, the application of seismic isolation technology in restoration and reconstruction projects should be strongly encouraged, and China's seismic isolation enterprises can also go abroad to try to help Turkey's recovery and reconstruction. Secondly, it is necessary to learn from the international advanced experience in earthquake prevention and disaster reduction, carry out corresponding earthquake disaster risk and hidden danger, implement housing facilities reinforcement projects, and comprehensively improve the seismic resistance of existing housing facilities. Finally, it is necessary to strengthen the popularization of emergency rescue science in the community and the modernization of rescue teams and technical equipment, so as to ensure that the rescue force is quickly activated as soon as possible after the disaster. Judging from the video data transmitted by the on-site media, the on-site rescue force is relatively weak, and basically relies on self-help and mutual rescue, which will lose a lot of golden rescue opportunities and increase casualties [4-6].

3.1. Recommendations for the construction of earthquake-resistant buildings in Turkey

In general, the seismic conceptual design of buildings should include the following: The shape of the building should be simple, regular and symmetrical to ensure that the centre of mass and the centre of rigidity coincide and avoid torsional effects during earthquakes; The support system of the seismic structure shall ensure the stability of the structure during earthquakes; The seismic structural system should have the necessary strength, sufficient rigidity, good integrity and deformation ability; And the strength and stiffness should be reasonably distributed to avoid the formation of weak parts of strength and stiffness; The structural components should have sufficient strength and rigidity, and the components should be reliably connected; Non-structural components (such as partition walls, infill walls, etc.) should be reasonably arranged to avoid the loss of structural integrity due to the failure of non-structural components [14].

3.2. Recommendations for improvement of building materials in Turkey

First is AAC.AAC is a new type of building material with light and porous weight, thermal insulation, good fire performance, nailable, sawn, plannable and certain seismic resistance. AAC is the lighter type of concrete, suitable for infill walls of high-rise buildings and load-bearing walls of low-rise buildings. The use of this material can reduce the self-weight of the entire building by more than 40% compared with the self-weight of ordinary brick-concrete buildings. Due to the reduced weight of the building and the small earthquake damage, the seismic resistance of the building is greatly improved [15]. Next is the Carbon fibre composite material. With the advantages of high tensile strength, low density, corrosion resistance and good durability, the use of carbon fibre paste for seismic reinforcement should be the preferred solution. Last one is the thermal insulation and seismic curtain wall composite materials - composed of inner panels, middle layers, polyurethane foam plastics, outer panels, honeycomb brackets, using thermal insulation and seismic curtain wall composite materials combined with the fixed profile installation given by the present invention can form a safety curtain wall, low cost, heat insulation and energy saving, light weight, seismic performance better than glass wall curtain. Needless to say, the poor quality of some building construction is an indisputable fact exposed by the earthquake. According to earthwork investigators, there were serious quality problems in the construction of houses in the earthquake area. Insufficient use of cement and steel bars is a relatively common phenomenon, some houses use unqualified steel bars, and there are also illegal operations of mixing concrete with salty sea sand [16]. Topographic factors and construction problems contributed to this serious disaster, and this research survey aims to help Turkey analyse the problems in the affected area and effectively complete the construction reconstruction planning of the affected area. It is hoped that in the future, Turkey will continue to improve its earthquake-resistant building system and be able to withstand large earthquakes.

4. Conclusion

Some earthquake disasters that have caused heavy casualties internationally have shown similar phenomena, in addition to the scale of earthquakes, mainly because of the collapse of a large number of houses that have not been well designed and constructed for earthquake resistance. And these houses are often completely collapsed into a pile of stone ruins, burying people alive; Such a scenario is very similar in the disaster earthquake of the Izmit earthquake in Turkey on August 17, 1999. Therefore, it is the most direct and effective way to reduce earthquake disasters by discussing the causes of damage and collapse of buildings in earthquakes, and preventing them, and engineering earthquake-resistant buildings that can withstand strong earthquakes. This paper conducts research from the aspects of building materials and building structure, and finally puts forward suggestions suitable for the development of earthquake-resistant architecture in Turkey. Turkey's geographical location is likely to continue to experience earthquakes in the future, so the development of an earthquake-resistant construction industry is particularly important. It is also hoped that Turkey's architecture can reach the level where large earthquakes cannot collapse, medium earthquakes can be repaired, and small earthquakes cannot be damaged.

References

[1] ZHOU Zhipeng. Crustal structure of the Anatolian Plateau in Turkey and its comparison with the Qinghai-TibetPlateau[D]. ChinaUniversityofGeosciences,2022.
[2] Jing Jun. Construction corruption behind the earthquake disaster in Turkey[J]. Integrity Outlook,2023,No.591(04):50-51.)
[3] GAO Mengtan. Turkey earthquake:Earthquake resounds the alarm bell[J].China Emergency Management,2023,No.194(02):34-36.)
[4] MIAO Chonggang,ZHAO Ming,TAO Yulu. Izmit earthquake disaster and post-earthquake emergency response[J]. International Earthquake Dynamics,2000(01):28-35.)
[5] GAO Mengtan. Turkey earthquake:Earthquake resounds the alarm bell[J].China Emergency Management,2023,No.194(02):34-36.)
[6] Pershing Lai. Enlightenment of the earthquake in Turkey[J]. Urban and Disaster

Reduction,2003(01):44-45.)
[7] Guan Xiaopu, Chai Yaxin. Strong earthquake hits Turkey[N]. China Discipline Inspection and Supervision Daily,2023-02-08(004).
[8] JIANG Haofeng. Rare "double earthquake", Turkey on the rift[J]. Xinmin Weekly,2023,No.1221(06):66-71.)
[9] Wu Na. The superposition of multiple factors caused serious disasters in Tuxu[N]. Beijing Daily,2023-02-08(012).
[10] ZHANG Wenguo. Seismic structure and earthquake prediction in the eastern Mediterranean[J]. International Seismic Dynamics,1984(09):21-23.)
[11] CHEN Xi. The destructive power is huge, and the continuous strong earthquake in Turkey is a "swarm earthquake"[N]. Science & Technology Daily,2023-02-10(002).
[12] ZHOU Feifei. Earthquake through "fault"[N]. China Natural Resources News,2023-02-20(003).
[13] ZHANG Minzheng, CHEN Huaran. Strong ground motion and seismic disaster of Izmit earthquake[J]. International Seismological Dynamics,2000(01):13-15.)
[14] LIAO Ying, LI Jing, XIA Haili. Discussion on seismic resistance of buildings from the earthquakes of Turkey and Taiwan[J]. Science and Technology Progress and Countermeasures,2000,(04):145-146.)
[15] Qiangkebao. Experimental study on basic properties of autoclaved aerated concrete blocks[J]. Brick and Tile,2022,No.420(12):13-15.
[16] Jin Lei. A brief discussion on the capacity building of disaster reduction in China: Reflections on disaster reduction triggered by the earthquake tragedy in Turkey[J]. Engineering Design CAD and Intelligent Building,2000(06):1-5.