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Examination of earthquake effects in closed reinforced concrete structures

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Abstract

In this study, the collapse situation, which is one of the factors caused by design errors in reinforced concrete buildings that collapsed or were severely damaged under the influence of an earthquake, was investigated. It has been observed that columns, which are vertical load-bearing elements in buildings with closed cantilevers, are exposed to extra moments and shear forces due to various factors. It has been understood that this situation causes loss of bearing capacity and additional loss of rigidity. According to the results of the review, it has been understood that although closed exits have some economic advantages, their negative effects are much greater.

1. Introduction

One of the most important problems encountered in building designs in our country is the closed cantilevers, which are mostly made to increase the usage area of the building on other floors above the ground floor. In this type of buildings, various negativities occur during an earthquake and the risk of damage increases. Although projects are prepared by calculating the TAKS and KAKS (Precedent) values determined by the Zoning and Urbanization Directorates of the Municipalities, closed cantilever buildings are often projected like others because they do not impose various restrictions (limitation of building height and not specifying h max values). Thus, unlike the ground floor, the building usage areas increase on the normal floors, resulting in an extra gain in architectural and commercial terms. Any residence, office, workplace, etc. Considering that when buying and selling a real estate, pricing is done on a m2 unit price, this is seen as a great financial advantage. However, according to the recently announced data in our country, active faults pass through 45 provincial centers (URL_1) and considering the painful experiences we have had in many major earthquakes, the importance of the issue increases even more. In this context, let alone the construction of closed canopies, our perspective on existing closed canopy buildings has become a top priority issue that threatens not only financial concerns but also the safety of life and property.

Many studies have been conducted in the literature on the structural damages observed in past earthquakes and their sources, the performance of buildings and their structural defects. According to the common results of the studies, the most important causes of earthquake damage to buildings are; These are structural defects and deficiencies such as non- ductile detailing, soft story, short column, weak column-strong beam, closed overhangs and poor concrete quality. In addition, there are thousands of structures that are likely to suffer serious damage in possible medium or large-scale earthquakes (Adalier and Aydingun, 2001; Doğangün, 2004; Inel et al., 2008; Sezen, et al., 2003; Yakut et al., 2005).

2. Method

Approximately 80 percent of the housing stock in our country has covered exits (URL_2). It has been observed in the damage assessment studies in the field that buildings with closed cantilevers received more damage in most earthquakes, especially during the February 6 Kahramanmaraş-centered earthquake, than buildings with regular structures (without closed cantilevers or consoles). Figure 1 shows examples of buildings built with a closed cantilever on the left and without a cantilever on the right. According to the figure, of the two buildings located on the same street opposite each other

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in Fakıuşağı District of Osmaniye, on island 248, parcel 6 (building on the left) and island 247, parcel 9 (building on the right), the building with a closed exit was damaged, while the building without a closed exit survived the earthquake without any damage. has survived. Of course, it would be incomplete information to say that the damaged buildings were damaged only due to closures. In addition, soft storey irregularity, short column effect, ground liquefaction, inadequacy of ground improvement works, lack of engineering services and workmanship in structures, material quality, technological impossibilities, inadequacy of regulation and inspection mechanism, etc., which are generally examined under the disciplines of civil and geotechnical engineering. Many different factors can be considered.

Figure 1. Buildings with and without Canopy (Archive).

Figure 2: Image of Osmaniye Province 6 February Earthquakes (URL_3).

Figure 2 shows the earthquake-affected view of the site, which consists of 14 blocks and 9 floors, all with closed exits, located on island 2955, parcel 1, in Adnan Menderes District, Adnan Menderes District, Osmaniye Province. In case of a closed exit along with many different factors mentioned above, it is necessary to consider the earthquake effect as a whole. Therefore, if the buildings had been designed and built with a frame system that met the load-bearing system requirements from the ground up, rather than with a closed cantilever, they would have been less affected. Of course, for this purpose, a detailed scan should be made and the existing building data should be processed into the computer environment, earthquake performance analysis should be carried out in the same structure without a closed exit and the results should be compared. Only in this way can reliable data be obtained. Examining the data of previous research on the subject will provide more enlightening and accurate results.

It is known from static calculations that buildings designed and manufactured without column-beam connections are exposed to high amounts of moment and shear forces, which causes irregularities in the load transfer in the carrier system in closed cantilevered sections. Since beam deficiencies cause frame discontinuity, the load transfer mechanism between the column and beam is also negatively affected. In closed cantilevered structures, horizontal load carrying capacity and ductility decrease, causing excessive displacements in the structure (Sarı, 2010).

Figure 3 shows the moment reduction in the column under the effect of cantilever or cantilever (Meral, 2018). In addition, the fact that the difference between the mass and center of rigidity values (eccentricity), which is vital for calculating the buckling of the building during an earthquake, is high and therefore it is prone to receive a high amount of damage, is a situation that should be evaluated separately. It is known that closed overhangs can increase the difference between the centers of gravity and rigidity of the building, and the resulting weight increase will negatively affect the seismic behavior of the building (Özmen, et al., 2011). It has been determined that closed cantilevers, especially on one side, increase the distance between the center of gravity and rigidity of the structure, and that the increase in weight affects the earthquake behavior of the structure. (Meral, 2018). Overhangs in buildings have positive and negative effects on building behavior. First of all, the increase in weight in the structure increases the construction period and causes an increase in displacement demands. In static analysis, the decrease in the moment and shear value carried by the column causes a decrease in the horizontal strength of the building (Özmen, et al., 2011). In his study in 2019, Öz examined existing low and medium height 2, 4 and 6-storey reinforced concrete buildings in 3 different groups according to the number of floors, and 24 earthquakes were affected separately on the buildings by using the SAP 2000 structural analysis program in the modeling. In each separate group, the results of the reference building were compared with the analyzes in case of closed exit.

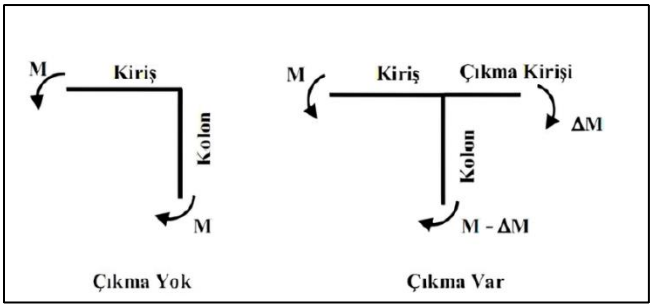

Figure 3: Moment Decrease in the Column in Case of Disconnection.

In her study in 2019, Meral carried out linear performance analyzes of 2, 4 and 7 story buildings designed on the formwork plans in Figure 2, without closed cantilever (reference building), with closed canopy with beams (1.5 m) and with closed cantilever without beams (1.5 m). It was determined by making analyzes in the non-existent time domain.

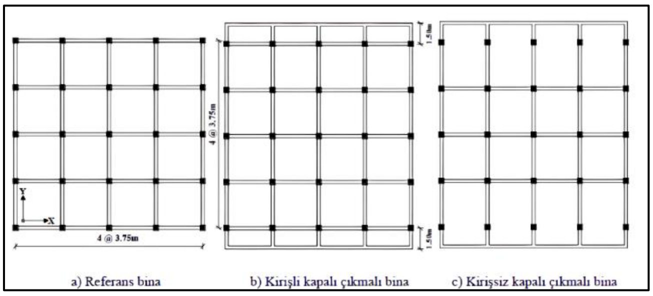

Figure 4: Formwork Plans of Reference and Cantilevered Buildings

3. Discussion

Listing the results obtained by the mentioned researchers in items will contribute to the formation of a final opinion on the subject. According to this the following results were obtained.

1. Base shear force ratio values of closed cantilevered buildings are generally lower than the values of other reference buildings (Öz, 2019).
2. The roof drift ratio of closed cantilevered buildings yielded higher results than other reference building values. Roof drift ratio values increased as the number of floors of the building increased (Öz, 2019).
3. In closed projection modeling, if there is no beam in the console section, it is seen that the earthquake performance is much more negative than the case with beams, especially due to large increases in demand values. (Özmen, et al., 2011).
4. Closed should come out of buildings of the period reference to buildings according to more to be a few accelerations of the record spectral accelerationof its value to fall reason since some results for closed should come out in buildings more low away demands was calculated (Meral, 2018).
5. Generally used earthquake acceleration records include beamless closed cantilevered buildings compared to other reference buildings and other reference buildings.closed beam should come out to buildings according to in terms of demand more negative it affects to say is possible (Meral, 2018).
6. As the number of floors increases, closed cantilevered buildings and reference buildings generally differ in terms of base shear force. The demand gap between the two is increasing. On the other hand, the difference in displacement demands between buildings is similar to 2- and 7-storey buildings. compared to 4 storey It is seen more in the building (Meral, 2018).

4. Conclusion

In line with the detailed analysis data obtained by different researchers, the design features of the structures damaged in earthquakes and the building static calculation values, it is understood that it has some positive and negative effects on buildings with partially-fully closed cantilever or cantilever features. Of course, it would not be correct to describe buildings with closed exits as completely faulty and defective without evaluating them with their features such as correct design, engineering services, workmanship and material quality, and an adequate control mechanism. However, when the positive and negative features of buildings with closed exits are compared, it is seen that their negative features are more. As positive effects; increase in the usage area of the building, an aesthetic appearance away from the appearance of the carrier system in the building, economic advantages, etc. can be sorted. However, since enclosed spaces directly threaten the safety of life and property, it is not even right to compare them with their positive aspects. The best step would be to ban or limit closed spaces in high-rise buildings, especially in cities in the 1st degree earthquake zone, such as Osmaniye province. In this direction;

- Although the Ministry of Environment, Urbanization and Climate Change has made many statements following the February 6 earthquakes and announced that closed areas will be banned up to a certain floor height (4 floors), it has recently stated that indoor areas can be allowed up to 7-8 floors.
- There are still some problems in the construction and inspection mechanism in our country,
- Failure to implement the concept of competent engineering,
- Insufficient quality of materials and workmanship,
- Design errors etc. situations,

Unfortunately, it is a harbinger of similar painful experiences in the future.

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