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The Analysis of Architectural Design Competitions within the Scope of Earthquake Resistant Design

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Abstract

In the architectural world, the competition processes have increased significantly as a method of project acquisition. It is critical to evaluate architects' approaches towards earthquake in detail within the framework of these competitions. This study aims to analyze whether earthquake is considered as a design criterion during the design process. Therefore, the first prize of city hall projects located on an active fault line are selected for analysis. As a result of the investigations, through observing, it is found that there are no significant errors that could adversely affect the earthquake behavior of structures. In this respect, it is understood that the discipline of architecture has learned great lessons from the earthquakes, and internalized its own responsibility in the losses experienced. This study aims to create an awareness about how earthquake resistant structural design decisions are handled in the architectural design.

1. INTRODUCTION

The number of architecture competitions which aim to attract new architecture projects has remarkably increased. Attempting to create a competitive environment for architects and increase architectural quality, these competitions can be considered as a way of offering rational, feasible and cost-effective solutions through discussion and participation. Because they initiate design process and provide a thought-provoking atmosphere for architecture, the contribution of architecture competitions to the formation of high-quality artificial environments and development process of construction technologies is undeniable. These competitions are one of the leading elements which reveal architectural understanding and attitudes in a given historical period [1]. When architecture competitions and designed products in Turkey during the Republican period are analyzed, it can be noted that materials and technologies reflect the particular features of their period.

At the design stage, various properties of a building to be constructed are determined and decisions regarding properties which influence structural behavior of a building are made. Therefore, the area where the building is to be constructed bears utmost importance, particularly in Turkey where earthquakes pose a major threat due to the frequency of seismic activities. The decisions made during architectural design process play a vital role in rational behaviors of the structural system in a building against an earthquake [2]. In this respect, if these decisions are made based on accurate information and effective methods, design success is very likely to improve; as a result, it will be possible to construct a long-lasting and sustainable building structure. Regarding Turkish Building Earthquake Code, the present study aims to analyze design decisions within the framework of earthquake resistance in architectural design competitions which occupy an important position in terms of architecture ethics.

The present study focuses on town halls as a public administration building since the number of competitions on these structures are high. Due to their objective of meeting citizens' various needs as well

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as their indoor and outdoor arrangement, town halls do not only fulfill administrative functions, but also aim to communicate with their users. Since town halls play a major role in the city and among the citizens, they often make administrative ideologies strongly felt. Thus, it is always important to understand various architectural criteria in their design process [3]. While the programs of the municipality city/town hall were dependent on the size and ideological preference of the municipality in the historical process, it is now possible for architects to interpret this program. Differentiation has been experienced gradually both in the use of plan and with the decisions in the vertical design. In fact, it can be thought that this possibility of interpretation was obtained through the competitions held for municipal buildings from the first years of the Republic until today. In this direction, these buildings were analyzed in the field study section of study.

2. MATERIAL AND METHOD

Earthquakes result in numerous destructive effects for both people and societies. Among these effects are structural damages in buildings, loss of lives, injuries and other social, psychological and economic damages. As it is almost impossible to predict the location, time and magnitude of an earthquake, one of the most basic precautions against earthquakes is to design a project bearing earthquake in mind during the design process. Despite the guiding principles of regulations and building inspection process for an earthquake resistant structure design, architectural design is the first and most important step in this process [4].

It is critical to evaluate architects' approaches towards earthquake in detail within the framework of architecture competitions which give them the opportunity to express their ideas. The present study aims to analyze whether earthquakes are considered as a design criterion during the design process. Therefore, projects located on an active fault line were selected for analysis (Figure 2.1). In this respect, Efeler Town Hall (Aydın), Bornova Town Hall (İzmir), Tekirdağ City Hall, İnegöl Town Hall (Bursa) and Balıkesir City Hall buildings were analyzed.

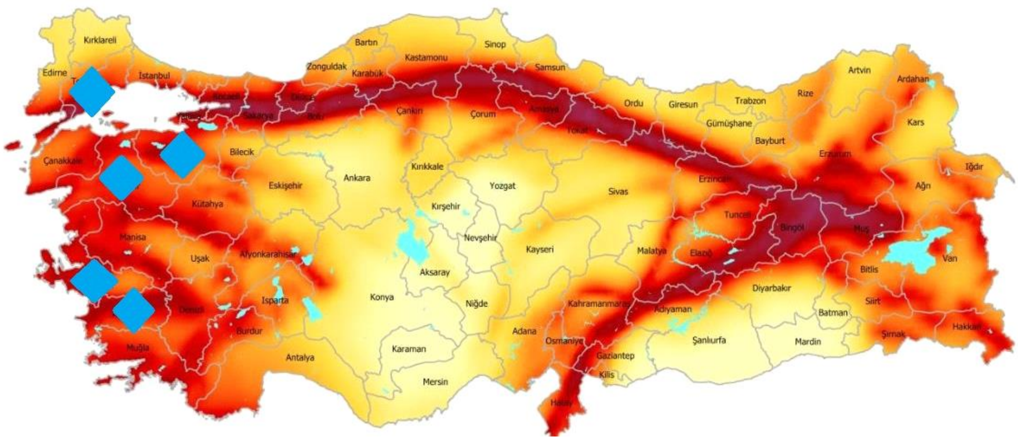


Figure 2.1. *Turkey Earthquake Map and provinces where the projects examined [5]*

A high earthquake risk makes it inevitable to take earthquake into account during the selection of structural system. Earthquake regulations are directive technical specifications which help analyze structural behaviors of a building during an earthquake and evaluate earthquake safety precautions accordingly [6]. The evaluation criteria in the present study were determined according to Turkish Building Earthquake Code-2018 [7].

Firstly, the design principles of each project are evaluated, and earthquake risk in the project location is determined. Then irregularities in the building plan and vertical direction which poses threat to structural behavior against earthquakes are discussed through observation. The following criteria are taken into account during the analysis:

Foundation design; Foundations with different heights will result in asymmetrical and varying seismic vibrations in upper storeys due to time differences. Foundations with an equal height will reduce structural damages during an earthquake. Therefore, foundations with different types and height must be avoided. If it is necessary to build different foundations, the basement should be surrounded by a shear wall, and its ceiling and foundation should form a rigid box in order to absorb vibrations [8;9;10].

Symmetrical building plan; A building should be vertically and horizontally symmetrical for a good earthquake resistant structure. In this way, predicted earthquake behavior and actual structural behavior in a building during an earthquake will converge. Otherwise, significant torsion effects are likely to occur in the building, which makes it difficult to predict structural behavior [9].

Axle system; Randomly placed columns will encounter difficulties in transferring its load to other structural elements in a rational way. Therefore, architectural designers should pay attention to the placement of columns on an axle system. An equal distance between each axle will facilitate the construction process, contribute to a positive earthquake behavior and offer a more cost-effective construction [8].

Irregularities between adjacent storeys; One of the most common design problems contributing to the collapse of a building is sudden changes between adjacent storeys. Among these sudden changes that occur between adjacent storeys, are higher or lower storey heights compared to other storeys, removal of some partition walls on a storey and the use of vertical load-bearing elements with different dimensions or different construction materials on commercially planned ground storeys compared to upper storeys [11].

Discontinuity of Vertical Elements in Load-Bearing Systems; The continuity of vertical load-bearing elements along the building height is particularly important in terms of effectively transferring structural forces to the foundation. If the normal flow of forces in a vertical direction is interrupted, it may lead to serious tensions on building joints and compulsion on other elements [12]. In addition, if the symmetry of vertical columns and curtains is affected, some storeys may lack these elements or they may be dangerously displaced, which leads to an extra compulsion and deformations in the building structure. As a result, the building is negatively influenced by earthquake behaviors (excessive displacement, collision effect etc.) [13]. Similar to other constructional irregularities, this problem can be mainly associated with architectural attempts to obtain larger storey volumes and/or extra space [6].

Vertical Geometric Irregularity (cantilevers, setbacks); In an earthquake resistant structure design process, simplicity, continuity and symmetry are indispensable properties of the vertical plane. However, architectural approaches seeking for new building styles have recently become very popular due to aesthetic concerns [14]. In the simplest sense, building geometry is not exactly preserved along the building height, and new steps are formed on a horizontal plane such as cantilevers and setbacks [11]. These cantilevers and setbacks which are created during a structural design process may yield negative results in terms of seismic activities, and subsidence in the foundation leads to deflection in proportion to earthquake magnitude [15].

3. EFELER TOWN HALL

In 2016, an architecture competition was organized for Efeler Town Hall located in the city center. Three different criteria were taken into account during the design process as an existing urban area, the effects of the building on its environment and the internal problems of the area. Apart from these main criteria, the urban green area in the project’s site and in the city were considered insufficient. A suggestion was made for this problem in the ground floor solution of the designed building. An inner courtyard was built because the region is too hot during summer. Buildings were designed using small masses for a better harmony with their environment. Masses which comprise the town hall were placed in a lumped manner on the southern part of the land in order to cast a shadow on each other. Setbacks and eaves were built in order to create shady spots. Produced using reinforced concrete, the town hall includes numerous areas which require wide open spaces such as a conference hall, a multi-purpose hall and a chamber of assembly. It was built on an area of 30800 square meters with 5 storeys and an indoor parking garage with a capacity of 285 cars on -1st and -2nd storeys [16] (Figure 3.1 a-b).

(a) (b)

Figure 3.1. *Efeler Town Hall (a) Situation plan, (b) Perspective view*

Seismic Analysis of the Area: Aydın province is located on a first-degree earthquake zone. In addition, Efeler where the town hall was built is also located on a first-degree earthquake zone [17] (Figure 3.2).

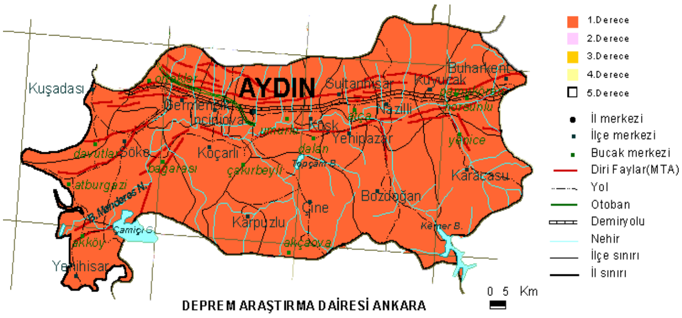


Figure 3.2. *Aydın province earthquake map [17]*

Foundation: All foundations are kept at the same level in a building in order to reduce earthquake risks, and this town hall is no exception as foundation heights were kept at the same level in all buildings (Figure 3.3). The basement foundation heights were also kept at the same level for parking garages. The foundations of independent blocks were built at different heights, which do not negatively influence earthquake behavior. Each building should be assessed under its own conditions.

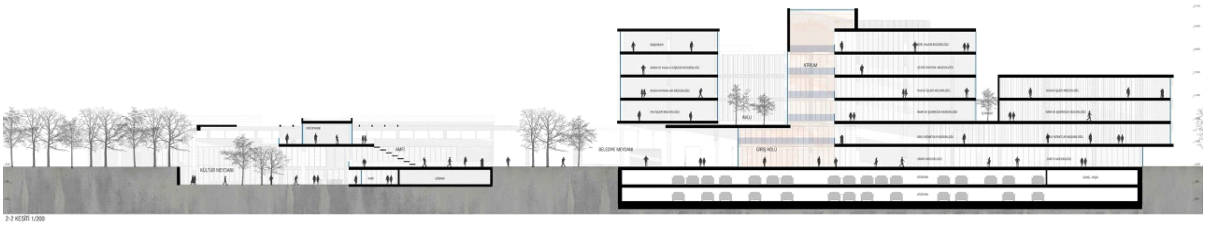
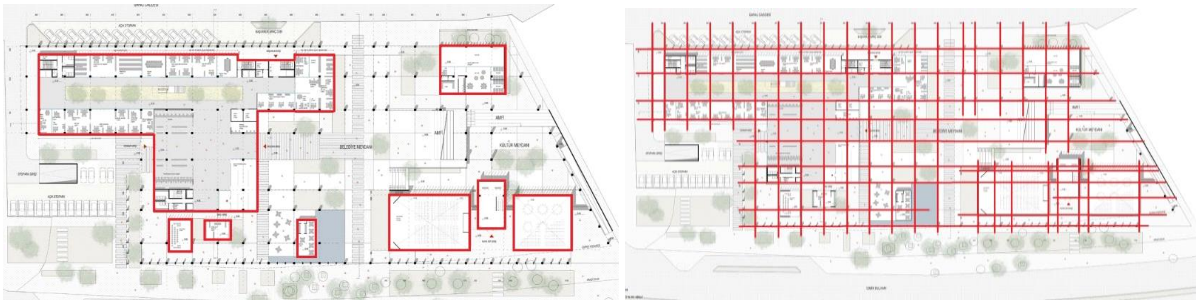


Figure 3.3. *Building section*

Symmetrical Building Plan: Different masses consisting of varying functions in the ground storey make a symmetrical plan impossible (Figure 3.4a). However, the ideal solution is to build lumped masses in square forms in order for the building to absorb earthquake vibrations equally from all directions [8].

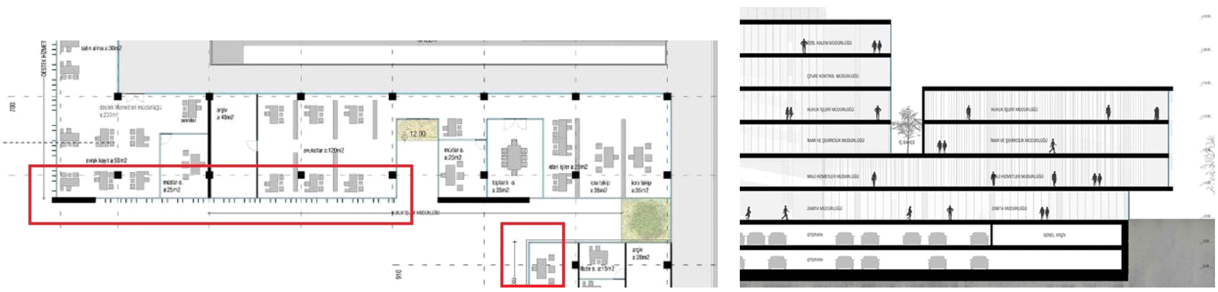
Axle System: When column diagram and axle system of the town hall are analyzed, it can be noted that columns are placed in a regular order, and that distances between axes are either equal or very close (Figure 3.4b). As for plan geometry, it can be stated that dilatation is necessary.



(a) (b)

Figure 3.4. *Efeler Town Hall (a) Ground floor plan, (b)Axle system*

Irregularities between Adjacent Storeys: In general, it can be observed that storey heights are equal (Figure 3.5a). Only courtyard and chamber of assembly have different storey heights because they are often crowded and face the building entrance. On the other hand, although heights are closer, the lower number of solid walls on the glass lined ground storey compared to upper storeys may lead to a weak storey in terms of fullness and porosity ratio in the facades.



(a) (b)

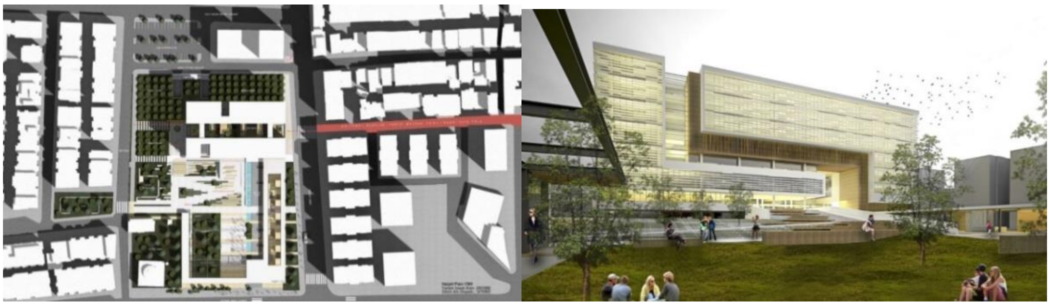
Figure 3.5. *Efeler Town Hall (a) Ground storey glass partition walls, (b) Partial section*

Continuity of Vertical Elements in Load-Bearing System: When structural sections are analyzed, it can be noted that the continuity of elements in load-bearing system is preserved. In this respect, the buildings are likely to display a positive earthquake behavior.

Vertical Geometric Irregularities: When it comes to structural geometry, each storey has a different building plan. As a result, setbacks and different masses occurred due to different storey heights, which increases earthquake risk. Additionally, it can be observed that cantilevers were also built at some points of the town hall (Figure 3.5b).

4. BORNOVA TOWN HALL

In 2015, an architecture competition was organized by Bornova Municipality. The design approach of the project was analyzed based on several criteria such as the connection between town hall and open public space, the scale of this open public space as a new square and its relationship with Bornova within the scope of its wide area, the potential of open public spaces as a recreation center and for night-time use, and the relationship of this open public space with surrounding streets. These streets were combined with a second ground floor created at +4.50 elevation. An intermediary space was planned for upper storeys of the town hall, and the structure was divided into two parts from one end to the other. These divided masses were connected to each other through steel bridges with a green roof. Thus, it was aimed to save energy during the climatization of this intermediate space instead of building a 7-storey gallery. The project consists of a town hall of 20000 square meters, a parking garage of 15000 square meters, an open public space of 17500 square meters, and it has 5 basements, a ground storey and 7 storeys [18] (Figure 4.1 a-b).



(a) (b)

Figure 4.1. *Efeler Town Hall (a) Situation plan, (b) Perspective view [16]*

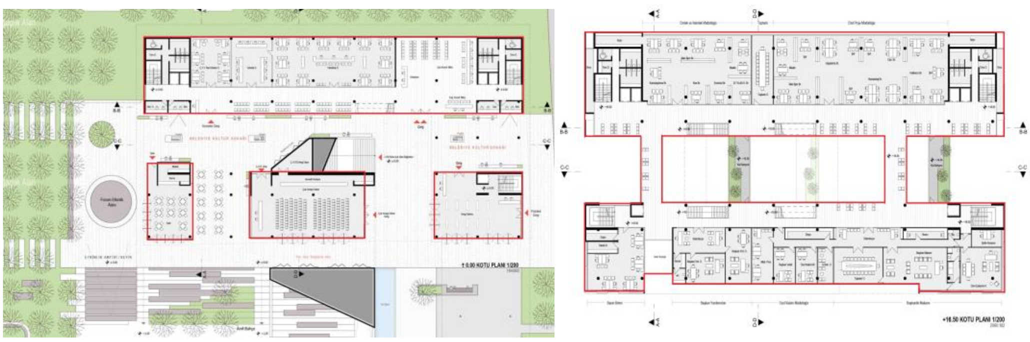
Seismic Analysis of the Area: İzmir province is located on Aegean grabens [19]. The whole city is located on a first-degree earthquake zone (Figure 4.2a). Therefore, the area where the building is to be built is also located on an earthquake risk zone. When earthquakes that have happened in İzmir in the last ten years are analyzed, it can be noted that numerous small magnitude earthquakes frequently occurred in the city center [20].

(a) (b)

Figure 4.2. *(a) İzmir province earthquake map [20], (b) Building section*

Foundation: When the foundations of the building are examined, they were located at the same elevation on the planes with their sockets. Thus, it can be argued that foundations were designed in a rational way (Figure 4.2b).

Symmetrical Building Plan: The structure was built by connecting two rectangular buildings through bridges. The load-bearing system of the main building is reinforced concrete although semi-open spaces on the ground storey are designed using steel profiles. A symmetrical structure can be observed when ground and upper storeys of the building are analyzed (Figure 4.3 a-b).



(a) (b)

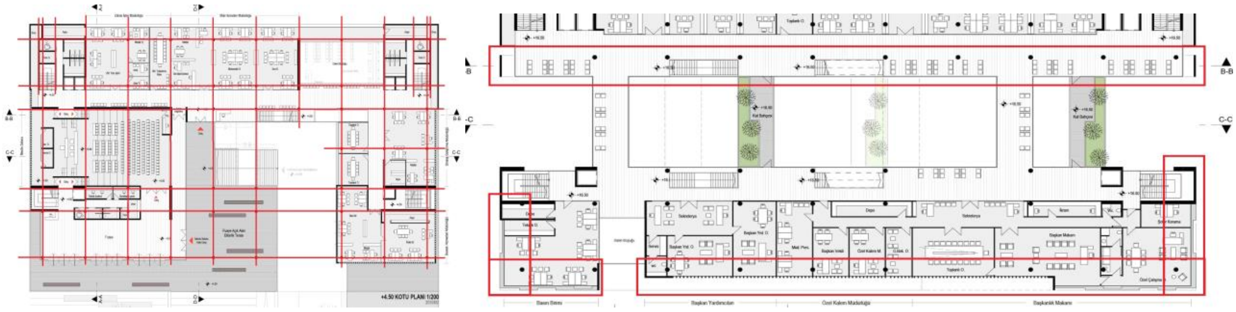
Figure 4.3.(*a) Ground Floor Plan, (b) +16.50 elevation plan*

Axle System: It is important to place columns based on a certain axle diagram rather than random placement. However, it can be observed in the building plan that the distances between axes are equal on one direction, while they are not equal on the other direction (Figure 4.4a), which will eventually weaken the structure and make it uneconomical. The design does not pay attention to corner columns as an important structural element, and L column was not preferred. In addition, it can be inferred from building dimensions that dilatation is necessary.

Irregularities between Adjacent Storeys: It can be observed in this structure that ground story is at a height of 450 centimeters, while other storeys are at a height of 400 centimeters. However, a rigidity may differ between the ground and upper storeys due to the existence of open spaces on the ground storey and the fact that these spaces are covered by walls on upper storeys.

Continuity of Vertical Elements in Load-Bearing System: It is of vital importance to ensure the continuity of load-bearing system in order to obtain a durable structural behavior against seismic forces. It can be observed in this structure that the load-bearing system can maintain its continuity.

Vertical Geometric Irregularities: It can be noted in the structure that the number of the same-shaped flooring is high on a vertical plane. However, bridges located at different points on upper storeys may change the gravity center of flooring. In addition, it can be also observed that there are many cantilevers in the structure (Figure 4.4b).



(a) (b)

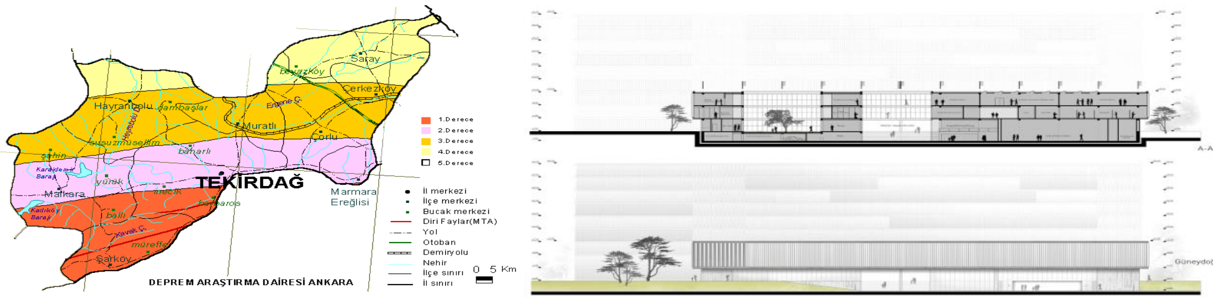
Figure 4.4. *(a) Ground storey axle system, (b) Cantilevers of the structure*

5. TEKİRDAĞ CITY HALL

In 2016, an architecture competition was organized in Tekirdağ, and the project land is located in Süleymanpaşa district. The city hall is not a structure that completely sits on the ground, but it is shaped by leaving the ground completely to the urbanite. It contributes to urban green areas, sustainability of building, and was designed with an attitude questioning classical town halls. This complex is considered as the center of urban life. Therefore, it was designed as a public space which turns its spatial limits into an advantage, allows citizens to naturally experience urban life, encourages and benefits from citizens' participation instead of being a town hall which is only frequented by citizens for official business. Moreover, it is far from being an inaccessible urban area outside working hours and is not isolated from the city and its citizens. Streets surrounding the area and green axes designed within the scope of urban decision-making process were maintained in the land, and enabled the town hall to be integrated into the structural integrity of the city. The project consists of 2 basements and ground storey and 8 storeys, and has an area of 68.825 square meters [21;22] (Figure 5.1).

Figure 5.1. *Tekirdağ City Hall view [21]*

Seismic Analysis of the Area: Tekirdağ province includes regions with first-degree, second-degree, third-degree and fourth-degree earthquake zones. North Anatolian Fault Line which traverses Marmara Sea is one of the leading factors that influence seismic activities in Tekirdağ. Şarköy district is in a first-degree earthquake zone as there is an active fault line on the northern part of it. However, earthquake risk gradually decreases towards the north (Figure 5.2a). The project will be built in Süleymanpaşa district which is a second-degree earthquake zone [23].



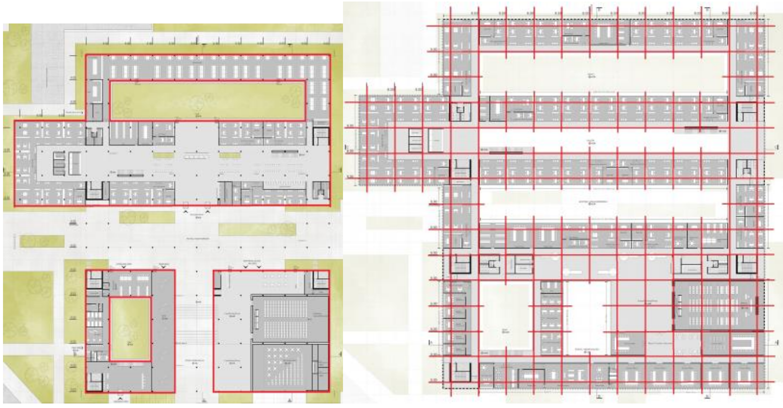
(a) (b)

Figure 5.2. *(a) Tekirdağ province earthquake map [23], (b) Building section*

Foundation: The building which includes two basements does not pose any risks in terms of foundations on the same plane (Figure 5.2b).

Symmetrical Building Plan: Three independent masses with different functions on the ground storey are connected on the first storey (Figure 5.3a). The design lacks symmetry in terms of its masses; thus, it is not earthquake resistant. As for building plan, the courtyard may lead to complex and sudden rigidity differences. Therefore, it should be divided by joints for a square-shaped or rectangular building plan.

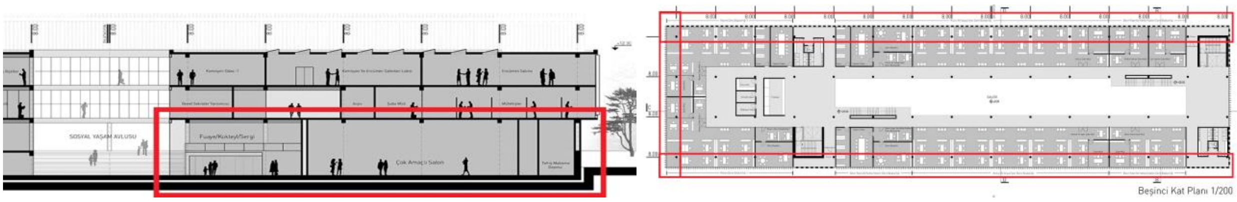
Axle System: When building plans are analyzed, it can be noted that the building has equal axle distances and a reinforced concrete load-bearing system. Because the distances between axes do not exceed 8 meters, they will contribute to earthquake behavior positively (Figure 5.3b).



(a) (b)

Figure 5.3. *(a) Ground floor plan, (b)Axle system*

Irregularities between Adjacent Storeys: When storey heights in the project are analyzed, basements have a 3-meter height, conference hall and foyer area have a 7-meter height, and other spaces have a 4-meter height (Figure 5.4a). Since the storey height is different due to conference hall, this storey will be relatively weaker compared to upper storeys. In addition, due to the circulation density on the ground floor of the building, the wall ratio in the load-bearing frames is lower than the other floors which may result in a weaker storey.



(a) (b)

Figure 5.4. *(a)Weak storey risk; Multi-purpose hall section, (b) Cantilevers of the structure*

Continuity of Vertical Elements in Load-Bearing System: The vertical load-bearing system is observed to maintain its continuity. Therefore, it can be argued that the structure will display a positive earthquake behavior.

Vertical Geometric Irregularities: While the building has the same plan diagram on the first and second storey, it has a different plan diagram on the third and upper storeys. This may lead to geometric irregularities in the structure. In addition, cantilevers which constitute various problems in terms of earthquake risk are encountered at many points in the structure (Figure 5.4b).

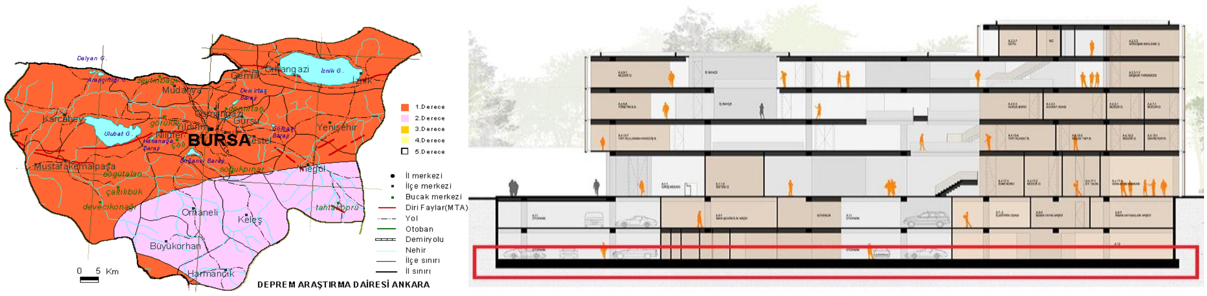
6. İNEGÖL TOWN HALL

In 2016, an architecture competition was organized by İnegöl Municipality for a project located on a land surrounded by a green area. Therefore, the project design mainly aimed to avoid ruining this green area and turn it into an effective center for public use. The ground floor of the town hall was planned by taking a landscape area which allows citizens to freely move into account. In addition, alternative spaces in this landscape area were designed as leisure time spaces where citizens can sit and rest even when they do not have any official business in the town hall. Four different buildings are located among trees and connected to each other through bridges. All storeys in the area are connected to each other through ramps, which allow the circulation in the public space to continue. The project has an area of 19369 square meters and consists of 2 basements, a ground storey and 4 upper storeys [24] (Figure 6.1 a-b)

(a) (b)

Figure 6.1. *İnegöl Town Hall (a) Situation plan, (b) Perspective view*

Seismic Analysis of the Area: Bursa province is listed as one of first-degree earthquake zones, and first-degree earthquake risk is observed in various densely populated districts such as Osmangazi, Yıldırım and Nilüfer (Figure 6.2a). Similarly, İnegöl district, where the town hall is going to be built, is located in a first-degree earthquake zone [25]



(a) (b)

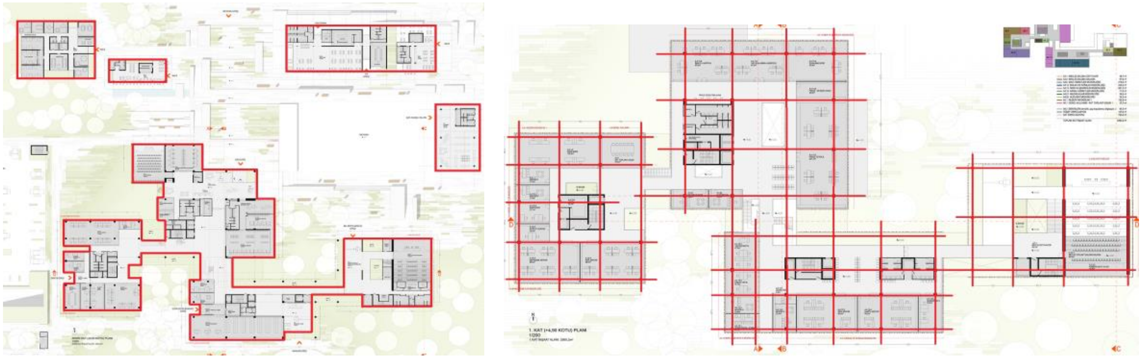
Figure 6.2. *(a) Bursa province earthquake map [25], (b) Building section*

Foundation: It can be noted that it is not in a stepped form and all foundations have the same height, which results in a positive earthquake behavior (Figure 6.2b).

Symmetrical Building Plan: Given that symmetrical building plans offer an advantage during an earthquake, it can be observed that the building plan in this structure is symmetrical. Stress intensity and excessive torsion may occur on the corners due to niches and eaves in the building plan and eccentricity. Therefore, dilatation is necessary (Figure 6.3a).

Axle System: The structure does not include a regular axle system as the distances between axes are usually different (Figure 6.3b). Structures without a regular axle system cannot be evaluated positively in terms of rigidness and prevents it from being economical.

Irregularities between Adjacent Storeys: There are some differences in this structure in terms of storey height. While the ground storey has a height of 490 centimeters, 2 basements and 1st, 2nd, 3rd and 4th storeys have a height of 340 centimeters. On the other hand, chamber of assembly, foyer area and town hall entrance have a height of 830 centimeters. Therefore, higher storeys pose risks in terms of earthquake (Figure 6.4a).

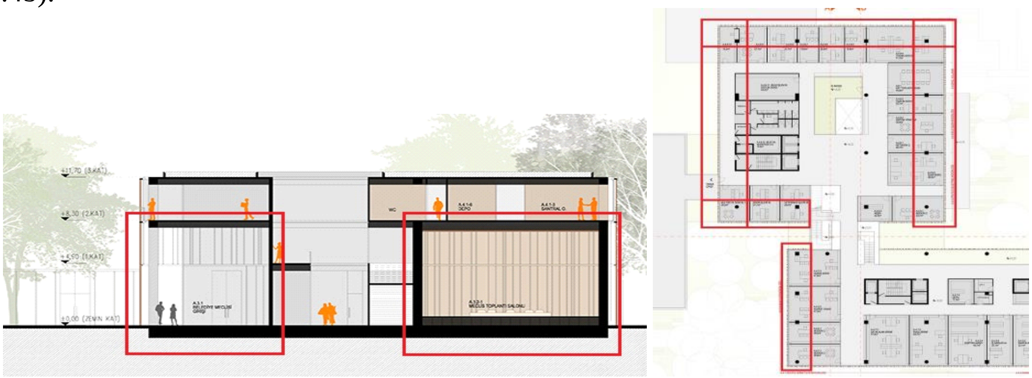


(a) (b)

Figure 6.3. *(a)Ground floor plan, (b) First floor axle plan*

Continuity of Vertical Elements in Load-Bearing System: It was observed in the structure that the load-bearing system maintains its continuity, which is a positive architectural design criterion in terms of earthquake behavior.

Vertical Geometric Irregularities: The structure consists of different heights and masses, which can be considered as a negative design approach in terms of earthquake risk. Cantilevers which are placed in this town hall may lead to various negative situations in terms of seismic vibrations during an earthquake (Figure 6.4b).



(a) (b)

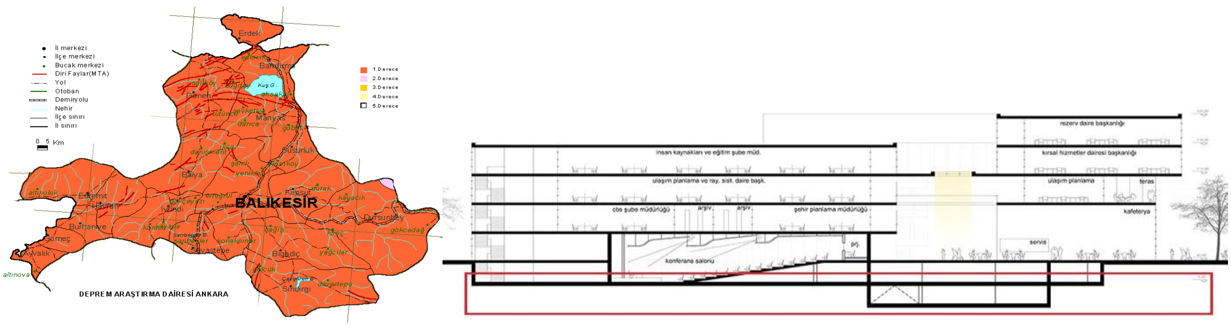
Figure 6.4. *(a): Chamber of assembly-town hall entrance section, (b) Cantilevers on the second storey*

7. BALIKESİR CITY HALL

In 2016, an architecture competition was organized by Balıkesir Metropolitan Municipality for a town hall building, and the winning project is located on a land in east-west direction in order to interact with its land and surrounding environment as much as possible. The structure faces the urban park located in its southern part, and approaches this park as a public square. The formation of a moving mass on the southern facade of the structure can be attributed to the objective of integrating the mass into urban view and benefiting from physical properties of the southern facade. The placement decisions were made in order to increase this structural permeability. The atrium which connects northern and southern masses also connects program functions and transfers structural permeability to upper storeys. The structure consists of 2 basements, a ground storey and 4 upper storeys [26] (Figure 7.1).

Figure 7.1. *Balıkesir City Hall view [26]*

Seismic Analysis of the Area: Balıkesir province is located in a first-degree earthquake zone (Figure 7.2a). Balıkesir and neighboring regions often encounter 4 or 4.5-magnitude earthquakes during the year. This region is known to experience frequent earthquakes since ancient times [27].



(a) (b)

Figure 7.2. *(a) Balıkesir province earthquake map [28], (b) Building section*

Foundation: When the structure section is analyzed, foundations with different heights can be spotted (Figure-7.2b). Therefore, necessary precautions should be taken as this may lead to subsidence.

Symmetrical Plan: In the designed structure, it can be noted that two different moving masses consisting of inner courtyards and gallery void are connected to each other through bridges. When service core and plan forms are analyzed, it can be observed that the designed masses are not symmetrical (Figure 7.3a). Since its one dimension in the platform is relatively larger compared to the other one, dilatation is necessary for this structure in order to eliminate problems such as vibration, heat, shrinkage or different subsidence.

(a) (b)

Figure 7.3. (a) Second floor plan, (b) Second floor axle plan

Axle System: Although the structure is not symmetrical, it consists of columns with a regular axle system. The distances between axes are 560 centimeters in general. The difference in the axle diagram can be ignored as far as structural points which are connected through bridges are concerned (Figure 7.3b).

Irregularities between Adjacent Storeys: When the structure is analyzed on a vertical plane, it can be observed that ground storey height is equal to the heights of other storeys. The empty surfaces on the ground storey are filled on upper storeys, which may lead to a negative situation for the structure (Figure 7.4).

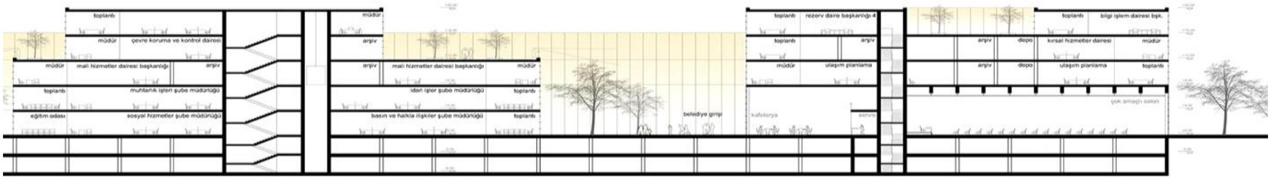


Figure 7.4. *Building section (with different floor heights)*

Continuity of Vertical Elements in Load-Bearing System: It can be observed in the structure that the continuity of vertical elements in load-bearing system is maintained in the design process.

Vertical Geometric Irregularities: Different flooring shapes were used in the structure because of mass forms in storey plans, which pose a threat in terms of earthquake risk. Additionally, it must also be noted that the structure includes dangerous cantilevers in terms of seismic activity (Figure 7.5).

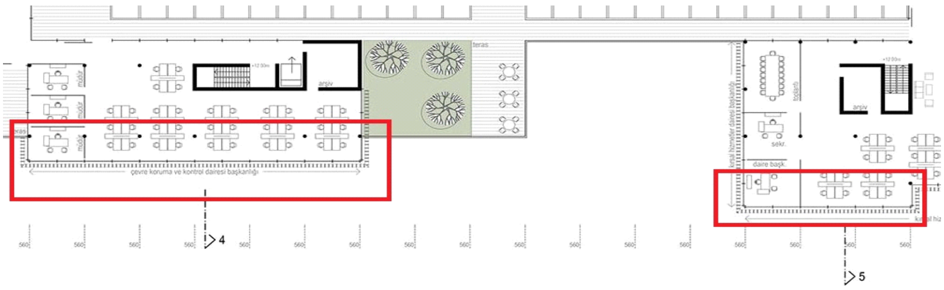


Figure 7.5. *Cantilevers on the third storey*

8. RESULTS AND DISCUSSION

This study focused on determining whether projects presented in various architectural design competitions took earthquake risk into account as a design criterion. In this respect, town halls were analyzed. Furthermore, these structures are among leading public administration buildings for which architectural design competitions are frequently held.

The number of town halls being constructed is directly proportional to the number of architecture competitions. These structures fulfill a number of functions simultaneously. When the above-mentioned competition projects are analyzed, it can be argued that a number of architectural design criteria such as green areas, cultural texture, public squares and areas for the handicapped should be considered. All projects aim to interact with users within the framework of urban design and create a new living center for the city and citizens. In addition, they prefer courtyards in order to increase the number of semi-open public spaces.

Design components which effectively make these structures earthquake resistant can be summarized as follows (Table 8.1):

-All projects designed in different cities are located in first-degree earthquake zones and thus bear the risk of experiencing earthquakes. However, it is known that Turkey is already over 92% have earthquake zone.

-All projects prefer reinforced concrete load-bearing systems in terms of construction type which consists of materials and load-bearing configuration. This finding confirms the fact that most of the residential buildings are type of reinforced concrete structures. Turkey is the country's concrete structure.

-As for areas of the projects, Bornova and Tekirdağ town halls have larger areas compared to other town halls. In addition, these projects have the highest number of storeys. In this respect, the independence of the mass and height change from the function will negatively affect the earthquake behavior to a great extent.

Table 8.1. *Location and general features of selected projects*

CRITERIA			Efeler Town Hall	Bornova Town Hall	Tekirdağ City Hall	İnegöl Town Hall	Balıkesir City Hall
Location and General Features	Province and Seismicity	Aydın	✔				
		İzmir		✔			
		Tekirdağ			✔		
		Bursa				✔	
		Balıkesir					✔
		Seismicity of the Province					
		1st Degree	✔	✔	✔	✔	✔
	Type of Construction	RC Structural System	✔	✔	✔	✔	✔
		Steel Struct. System					
	Construction Zone	Smaller than 20,000 m^2				✔	
		20.000 m^2-50.000m^2	✔				✔
		Larger than 50,000 m^2		✔	✔		
	Number of Floors	Fourfold				✔	✔
		Five-fold	✔				
		Sevenfold		✔			
		Octuple			✔		

The criteria regarding load-bearing system configuration of the buildings can be analyzed as follows (Table 8.2):

-Apart from Balıkesir City Hall, it can be observed that all projects benefit from regular foundations.

-Even though it is well known that a symmetrical building plan will yield positive results in terms of seismic activities, non-symmetrical building plan is observed in these projects except Bornova Town Hall.

-When axle systems are analyzed, it can be noted that regular axle systems were designed in all projects.

- It was observed that all buildings are likely to encounter weak storeys due to their architectural configuration because there are voids instead of solid walls in ground storeys of reinforced concrete buildings and all storeys have different heights.

- It was observed that cantilevers are used in all structures although they do not seem to pose threats in terms of earthquake risk.

- When the vertical continuity of load-bearing systems are analyzed, it was understood that these systems maintain their vertical continuity.

- When structure forms, storey plans and sections are analyzed, a vertical geometric irregularity can be observed, which may lead to some negative results in terms of seismic forces.

- All projects need dilatation due to their plan dimensions and configuration. However, dilatation lines cannot be observed because construction projects were not obtained.

Table 8.2. *Examination for structural system configuration*

CRITERIA			Efeler Town Hall	Bornova Town Hall	Tekirdağ City Hall	İnegöl Town Hall	Balıkesir City Hall
Structural System Configuration	Foundation	*regular*	✔	✔	✔	✔	
		irregular					✔
	Plan Symmetry	*available*		✔			
		unavailable	✔		✔	✔	✔
	Regular Axle System	*available*	✔	✔	✔	✔	✔
		unavailable					
	Irregularities between Adjacent Storeys	*available*	✔	✔	✔	✔	✔
		unavailable					
	Cantilever	*available*	✔	✔	✔	✔	✔
		unavailable					
	Continuity of Vertical Elements in Load-Bearing System	*available*	✔	✔	✔	✔	✔
		unavailable					
	Vertical Geometric Irregularities	*available*	✔	✔	✔	✔	✔
		unavailable					

The findings of the present analysis demonstrate that town halls designed in the above-mentioned first-degree earthquake zones take earthquake risk into consideration. Even though regulations, materials, construction methods and inspections are important elements for the minimization of earthquake risks, architectural design process should deal with the question of constructing an earthquake resistant structure. All architectural design processes including competition projects or original designs should attach importance to earthquake risk as a critical factor. In conclusion, there is no doubt that if architects will combine their knowledge and imagination without risking buildings and leave safe and secure architectural structures to upcoming generations, their ability to implement earthquake resistant architectural design criteria improves.

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