Design problems in the earthquake areas

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Abstract

The rapidly increasing population of Istanbul and its increasing problems, the planning and design activities which are not able even to keep up with them, have reached an entirely chaotic dimension with the introduction of the earthquake risk, not even to mention to realize a leadership for the above mentioned developments.

The first action to be realized toward the present situation requires the determination, analysis of the situation in the existing environments and the creation of ways of solution. Initially it is compulsory that this situation is handled rapidly and with priority by the professional branches city-planning and architecture. In order to determine the condition of many sub-components of an existing environment, this environment has to be examined according to a certain systematics. Even the examination of a certain environment just in terms of city-planning and architecture requires a wide spectrum.

An effort of determination, analysis and evaluation at different levels such as these to be realized in areas under seismic risk may just be solved by examining planning-design problems at various levels as well and integrating them into the system. As a result of an approach such as this, it is possible to apply a method as described below to solve a complex fact which comprises many different areas of planning and design problems, which are differentiated among themselves.

According to this method, the existing event is examined at different levels. These levels are as follows:
- City and environmental level,
- Level of near environment of buildings – district
- Level of building – technology – ground and materials.

1. Seismic characteristics of Turkey and the Example of the Istanbul – Bakırköy County:

Turkey and Earthquake. Turkey, which is in fact a seismic country, has been reminded of this reality once more due to the earthquake risk to which a metropolis such as Istanbul is exposed. The situation having occurred during and after the Izmit Earthquake on August 17, 1999, has caused people to realize that an expected earthquake of vital importance (of 7-8 strength according to the Richter scale) is unavoidable for Istanbul and its near surroundings and that the time of taking precautions has already passed by a long time ago. Along with this, both the state and establishments associated with the state, local administrations (municipalities), universities as well as people living in this surroundings have starting to hold the same point of view (even though there are differences in the thoughts) in terms of the fact that there should be done something. In addition to people who have been affected from the earthquake in 1999 due to the demolition of the buildings, people who have not
been directly affected from the earthquake have started to look into the future with greater anxiety. However, this is not just a matter related to fear, wishing or thinking and certain undertakings have to be promptly made on short-medium and long-term basis.

While the active fault line which has been determined during the latest studies in the Sea of Marmara continues to represent a risk for the Marmara Region, Istanbul, the most significant settlement in this region, has many problems increasing day by day and resulting from rapid urbanization in addition to its historical identity and geographical position (F. 1-2). Istanbul, which features a past of about 2600 years, holds a position at least identical to Turkey due to being the most important centre of its economy, along with this historical character, and it is clearly observed by everybody that any great earthquake probably occurring here would deeply affect the whole country.

The rapidly increasing population of Istanbul and its increasing problems, the planning and design activities which are not able even to keep up with them, have reached an entirely chaotic dimension with the introduction of the earthquake risk, not even to mention to realize a leadership for the above mentioned developments.

All activities realized especially for decreasing the earthquake risk at present, constitute an ultimately less percentage of the whole. An unordered great stock of buildings is gradually increasing day by day, and just the renewal of the earthquake regulations and the existence of supervising offices do not solve the problem; these approaches remain insufficient like any project not economically supported.

The first action to be realized toward the present situation requires the determination, analysis of the situation in the existing environments and the creation of ways of solution. Initially it is compulsory that this situation is handled rapidly and with priority by the professional branches city-planning and architecture. The present communication comprises determination-area studies made for handling and analysing the above mentioned topics on various levels.

2. Approach to the determination and evaluation of the present situation:

In order to determine the condition of many sub-components of an existing environment, this environment has to be examined according to a certain systematics. Even the examination of a certain environment just in terms of city-planning and architecture requires a wide spectrum. For this purpose, determinations on different levels are required in order to obtain this kind of data comprising many different areas such as geological data starting from the environmental scale, construction status, growth of the city, stocks of buildings, conditions of single building and neighbouring buildings, technology and materials applied on buildings. Besides, it is essential that in obtaining these data the factor of earthquake is introduced and that an approach and evaluation methods “in Earthquake Risk Terms” is found.
An effort of determination, analysis and evaluation at different levels such as these to be realized in areas under seismic risk may just be solved by examining planning-design problems at various levels as well and integrating them into the system. As a result of an approach such as this, it is possible to apply a method as described below to solve a complex fact which comprises many different areas of planning and design problems, which are differentiated among themselves.

According to this method, the existing event is examined at different levels. These levels are as follows:

- City and environmental level,
- Level of near environment of buildings – district
- Level of building – technology – ground and materials.

Along with this, different situations of Istanbul resulting from its different character, the city's development, law and regulations have to be considered in association with these levels as well. Especially by this point of view, the works realized before and after the earthquake have to be determined in an hierarchic order from the city level until the building and materials level, and by displaying the respective relation to the whole.

3. Analysis of the present situation and planning and design problems at different levels:

The historical character of Istanbul city and its geographical settlement may be examined in many aspects (F. 3). However, the most important one of these is the point arrived at as a result of rapid and unplanned urbanization. When the insufficiency of the state's policies on macro level is combined with the practice and supervision insufficiency of local administrations on the topic, a great problem in itself arises. The rapid formation of unlicensed (F.4) and disordered buildings is the most important factor for sub-structural problems along with the occurrence of environments – buildings under seismic risk. The migration movement to great cities influences the growth of the dimensions of this problem as well.

Consequently, problems resulting from general policies have caused a very important factor such as the earthquake risk to be forgotten for years, that an important issue like human right of living has no value and also fatalism. Approaches based on sciences fail to find their exact meaning depending on the general level of society, and even the conscience of earthquake fails to exceed a certain very little percentage of society. When all of this existing unfavorable situation is combined with people's economic power, problems having last over years continue from the city level up to the level of buildings.

3.1 City and environmental level:
The unplanned and uncontrolled development of Istanbul city prevents the continuation of its existence even as a living organism, not to consider even the seismic risk. For example: The Atatürk Airport, which is situated in the
The county of Bakırköy and which is the most important airport of Istanbul, and of Turkey as well, has been a location on an empty estate outside the city, surrounded by certain industrial plants. Nowadays, however, it has been entirely surrounded by buildings and has remained among a settlement even threatening the flight security.

The communications of Istanbul, which is surrounded by the seas at three sides, is greatly depending on road access. Constructions such as bridges, viaducts, etc., built for the solution of the traffic problem arising as a result of the fact that sea and railways are not used sufficiently, are also significant in terms of the earthquake risk. It is not known exactly what kind of reaction these kind of constructions, which feature a resistance of a certain level in seismic terms, would show in case of a greater earthquake regarding both the technological as well as materials condition. Moreover, as a result of the public opinion having been formed after the earthquake, the state and other establishments (Municipalities, universities, etc.) have focused on this vital subject, have created projects and have even found some resource. However, for the present, there are not realized any improvement (supporting) works on any buildings such as any bridge, viaducts, etc. including the Bosphorus bridges. The situation in the Bakırköy county is the same.

**County Bakırköy:** The county, where a rapid urbanization (!) is seen since 1955 is one of the greatest counties of Istanbul and is surrounded by the Sea of Marmara in the south, the E5 highway and E6 highway connection roads in the north (F.6). Bakırköy extends over an area of about 35 sq.km. surface where the Atatürk Airport, hospitals, hotels, large shopping-centers are situated. In general, it features a plateau – plain and slightly wavy surface structure and does not have any significant altitudes. The altitude of the county’s center is about –20m. In the county, which comprises some minor brooks, the ground resistance level is generally at medium level, however, at the surroundings of the brook beds there is an alluvial structure observed. In the county Bakırköy, which has a shore to the sea, the situation of the buildings, which are located at the shore and a major part of which is at the sea level or below the sea level, is an important field of problem.

In case of any sinking, etc., which may occur during a great earthquake, the sliding of land into the sea as it has been with the earthquake in Izmit, may give rise to situations such as the demolition-destruction of buildings.
Additionally, the probability of occurrence of the tsunami brings this risk to higher values. The type of buildings at the Bakırköy shore is not only limited to housings. Shopping-centers, schools, hospitals, hotels, etc. buildings are situated at the shore line as well (F. 7-8). Along with expressing that buildings such as the International Hospital (F.9), the Çınar Hotel, the Galleria shopping-center are subject to the above mentioned risks, it brings the topic to the discussion of what, after a probable earthquake, would be the extend of contribution especially of an important hospital building to the after-earthquake activities.

Figure 9. International Hospital  Figure 10. Church

Figure 11. Traditional separated order  Figure 12. Traditional/neighbouring order

3.2 Level of near environment of buildings – district:
Considering the near environment of buildings, the situation we are confronted with first in the county Bakırköy is again the continuation of the unplanned development of Istanbul city and its historical character. Examples of buildings of different cultures and different eras, today carry on their existence as one embraced by the other. Sometimes we come across a church building (F.10), sometimes examples of traditional wooden housing architecture which have remained less in number (F. 11-12).

Figure 13. Center of Bakırköy  Figure 14. Traditional/neighbouring order

This settlement in neighboring or separated order, being the most important elements of the cultural heritage included in the city's case, is unfortunately exposed to its destiny. These buildings cannot be renewed due to insufficient resources and to the fact that the users do not have any economical potential of their own.
Whether in the county’s center or in a narrow street (F.13 – 14), this kind of buildings are almost not even able to remain standing any longer, not to mention to resist any earthquake, within a cosmopolitan environment caused by the construction laws and changing formation of buildings.

In many cases, they are burnt or demolished on purpose and thus removed one by one. Especially traditional wooden housings are confronted with this kind of dangers, because the economical profitability of the environment has increased and a great majority of real estate owners wish to benefit from this. Religious buildings among this entire group of historical buildings succeed in remaining standing depending on people’s beliefs, but they are also under the risk of earthquakes since there isn’t made any supporting work on them neither.

In general, the county Bakırköy is a housing area and has become a center constructed mostly in reinforced concrete, neighbouring and separated order as a result of the change in the construction conditions in time (F. 15). In the past, it also comprised certain industrial plants since it had been located in the end part of the city. One of them, the Vita fat factory, has remained right in the center due to the growth of the county and has been removed due to the pressure caused by the prices of the real estate, the value of which has been increasing in time, and finally, a shopping-center has been designed in the place of it (F. 16). The building in this area, which has been designed just as shopping-center and worksite – office first, has been converted into a hospital project with the thought of providing a better profitability gradually coming more to the foreground today.

The block presently located on the Carousel shopping-center has brought an additional traffic charge on the Bakırköy county center and the building complex in which it has been included with its different function inspite of its having a separated entry – exit.

The railways axis passing from one end of the Bakırköy county to the other one, represents an example for the formation of buildings in the framework of the buildings’ near environment. As a result of the railways’ linear structure the buildings have been constructed both in the neighbouring order (F. 17-18 Bakırköy center) and in the separated order (F. 19-20 Florya).
These two districts, where we observe an environmental difference in economical terms, the difference of the constructional conditions has influenced the environmental quality. These buildings which have been situated more normally and embraced with all units of the environment and positioned as made possible by the land in the first example, strive to remain standing in a row in the neighbouring order. These buildings, most of which are made of low grade reinforced concrete, are included in the group with the higher earthquake risk. Whereas in the second example, Florya, the case is somewhat different. The environment, where the most distinguished and expensive buildings of Istanbul are situated, has lost this property after the Izmit earthquake. The revelation of the ground’s weakness as a result of the damages having occurred and the determinations made after the earthquake, has caused these expensive buildings mostly arranged in separated order to rapidly devaluate. Despite of this, many of the people living here behave in the same way as the people living in the center of Bakırköy and, with a fatalist approach, do not perform any support on their buildings inspite of their being stronger than them in economical terms.

The district Ataköy, which has completed its construction in a process continuing from the 60’s up to date among this complex formation of buildings of the Bakırköy county, represents an example of modern city-planning (F. 21).

The housings produced by the undertaking of the state bank Emlak Bankası form a modern environment together with its substructure and the other different functions. It is an example of a sound and safe environment due to both the planned settlement and the environment-building relation solved to a great extent, and to the earthquake-resistant technology (tunnel mould, reinforced concrete large panel construction system) having increased in the recent years (starting with the 80’s). Along with this, despite the fact that in the reinforced concrete skeleton system housings produced in its first years (F. 22, Division 1-2 and 3-4) the environmental quality has been good, there is the earthquake risk resulting from the ground and the building’s technology – its becoming worn out.

3.3 Building – Technology – Ground and Materials level:
While the connection between earthquake and architecture is related to the above explained levels such as the entire city – environment – building’s near environment, and different scales, the most important level is the level
of the building. This situation arises since the earthquake risk results from the building and since the level of people’s being affected from any earthquake is entirely depending on the building they are in. Even if isolated from all other influences, the condition in which buildings are in terms of earthquake-design includes a great number of problems of different characteristics. Along with this, it is possible to discuss the limits at building level shortly under the main headings architecture – technology – ground – materials.

Structural resistance; it achieves sense as a result of the building’s coming up as a product resulting from a process starting from the process of design and continuing with the establishment of the ground and building relation. The relation between ground and building is a concept ranking at the first place of the earthquake-resistant building notion and especially after the İzmit earthquake in 1999 this concept is focused on even more. At many buildings situated in the county of Bakırköy this incident is observed negatively. Taking into consideration the insufficiency of technology applied on the building together with the week ground conditions, it is seen that a great part of the existing stock of buildings is under ultimate risk.

The building illustrated and situated in the Bakırköy county – Yesilköy market and trade area has suffered partial damages after the earthquake in 1999 and has been partially repaired instead of being entirely renewed (F. 23-24). This solution, which we may consider as a temporary solution, is an artificial solution since the entire building has not been subject to any supporting work in terms of earthquakes, and thus the work performed just represents some kind of make-up (!). (Here, the sound ground is at the altitude –6m and the building is not seated on this ground, its floating). The pre-earthquake risk of this building, the ground support of which has not been performed, is actually the same. Furthermore, even if this building was entirely renewed and strengthened, it would be affected of the movement (collosion-demolition) of neighbouring buildings during a probable earthquake since it is arranged in neighbouring order.
Whereas in the other example (F. 25-26), they are right examples where damaged buildings in the same environment having suffered damages due to the weakness of the ground and due to being at lower level, have been entirely pulled down and new buildings have been constructed in accordance with the rules. These new buildings have been constructed both according to the new earthquake regulations and under a close supervision of the supervising firms. On the right plot of land, where there has been a similar block as the one left on the F. 26, there is this new building now. Whereas the high storey building on the other photograph has also been constructed with two basements and seated on sound ground, at a place where the sound ground is at lower level (-6m).

Figure 27. Florya /today  
Figure 28. Florya/ materials

The environment around Bakırköy-Florya, where expensive housings mostly arranged in separated order are situated, has started the process of construction again since the current values are always high and since there is always a certain group of people to purchase the new housings (F. 27).

Besides the weak ground conditions in this region, we are confronted with the technology-materials problems as another vital topic. It is seen that in the production of many buildings made of reinforced concrete skeletal system, sand obtained from the sea has been used without being washed and sieved (F. 28 – building at the right side). As a natural result of this actually corrosion and self-breaking caused by the mussel shells in the concrete is observed in most of these buildings. Consequently, these buildings do not even have the strength to wait for any earthquake to happen.

A good example for the economical resource problem is the bank building seen left on the photograph (F. 29). Since the Ziraat Bankası, which is a state bank, has the necessary financial support, it is strengthened and made more resistant to earthquakes. The lower two storeys of the building in the corner and next to this building (F. 30) has just undergone decoration and front facade modification, and has not been strengthened and/or reconstructed since the proprietors do not wish to lose profitability.

Figure 29. Bakırköy/bank  
Figure 30. Bakırköy / decoration
4. Result:

In the topic which we have examined on Istanbul city in general and the county Bakırköy in particular, the following common points are coming to the foreground as a result of the analysis of the existing environments on different levels:

. For the solution of the problem in the environments under earthquake risk, initially new State policies have to be developed.

. Macro decisions are necessary for the city-planning – environment level. For this purpose, new construction and application plans have to be developed.

. The existing unsound stock of buildings should be examined, the way of their examination should be determined as a result of a right determination and analysis activity. Incidents where the strengthening and/or reconstruction of buildings is compulsory should be definitely revealed.

. Improvement on the environmental scale should not just be made depending on the building level, but at the same time in the framework of new plans to be prepared for realizing modern town regions.

. Building land production for new, defined and technology supported modern urban regions on building level should be provided and this kind of new environments should be created on long-term basis.

. There should be building restrictions at certain areas, efforts should be shown for the entire renewal of buildings in neighbouring order instead of strengthening the buildings one by one.

. Buildings of special importance (hospitals, schools, etc.) and bridges and viaducts should be strengthened taking precedence,

and most important

. Planning and design activities should be handled on different levels and should be solved together as a whole.

Remark: The determinations included in the communication have been obtained as a result of the examinations made on the site until December 2003. The studies of the author on the topic starting with the Erzurum-Kars Earthquake in 1983, have continued with the Izmit Earthquake in 1999 and continue up to the present.
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EXPERTISE AREAS
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