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Increasing Social Awareness and Professional Collaboration in Architectural Education Towards a Sustainable and Disaster-Free Future

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Abstract

The aim of this study is to explore ways of increasing the social and professional awareness of students of architecture to educate a new generation of architects who are familiar with the concepts of social responsibility, professional collaboration, sustainable development and disaster mitigation. Turkey experiences a rapid social change due to the urban regeneration, population movements, environmental changes, new technologies and professional diversification. These phenomenon affect all aspects of life. This study explores the possibilities for applying new methods of teaching in schools of architecture to train a generation of architects who will be in tune with this new, ever-changing socio-cultural environment in Turkey. A study lasting one educational term of 14 weeks was conducted on a group of 15 second year students of architecture. A structural design course which previously had a purely theoretical and mathematical approcah to the subject matter was altered to contain background information regarding social context such as the photos, videos and narratives of earthquake affected areas of Turkey. This was done to introduce the students with the reality of the built environment and professional life in Turkey. Additionally small-scale applied projects were given as semester tasks to the students where they can experience a scaled but realistic application of the theoretical knowledge into reality. These two approaches were supplemented with theoretical knowledge to prepare the students for professional life in a realistic manner. A sudden increase in student attention and participation to the course was observed both in matters concrening the professional application and social context of their architectural projects. These findings were consistent with a previous study conducted by the author. The findings of this experimental application have resulted in a revision of the educational curriculum concerning the structural design courses to permanently include information regarding the social context and practical application of theoretical projetcs.

Keywords: Social Responsibility, Disaster Mitigation, Architectural Education

1. Introduction

Turkey is a rapidly developing country with a thriving economy, leading construction sector and a large population however; the country's economic resources are limited and it is located on one of the most active seismic belts of the planet. Large earthquakes with devastating results in terms of loss of life and loss of economic resources are common occurrences. As it was demonstrated by 1999 Yalova-Gölcük and 2011 Van earthquakes, many lives and economic developments that have taken decades to achieve can be destroyed within seconds causing the country large setbacks in terms of socio-cultural development. This fact requires that the country's decisions concerning the building sector should be governed by disaster mitigation techniques and they should be realized by qualified professionals such as well trained architects with technical expertise and awareness of social responsibility.

Successful professional education requires a combination of theory and practical application. Traditional teaching methods in Turkish schools of architecture consist of architectural design studios where architectural design projects are realized and lecture courses where theoretical and technical subjects are covered in traditional lecture format. This paper describes an experimental attempt to introduce application projects and socio-cultural contextual information to a purely technical structural design course. Since structural design is a critical element in earthquake resistant architecture, this study may guide and inspire further applications in other schools of architecture.

2. Seismic Characteristics of Turkey

Turkey is located on the Anatolian Peninsula which is at the convergence point of three continents: Asia, Europe and Africa. (Figure 1) It is surrounded by the Black Sea in the north, the Aegean Sea in the West and the Mediterranean Sea in the South. The Sea of Marmara and the straits of Bosporus and Dardanelles are also located within the borders of Turkey. Total area of the country is 780.576 km2. Geographically, 97% of its lands are on Asia and 3% of its lands are on Europe. The population of the country is approximately 75 millions. Its neighbors are Greece and Bulgaria in the west, Georgia, Armenia, Azerbaijan and Iran in the east and Syria and Iraq in the south. In terms of seismology, Turkey is located on the Alp-Himalayan Seismic Belt, which is one of the most active earthquake areas in the world. This seismic belt starts from the Azores in the Atlantic Ocean and stretches away into the Southeast Asia. Nearly 96% of Turkey is located on highly risky seismic zones and about 80% of the population is exposed to high magnitude earthquakes. Unfortunately, the most economically and socio-culturally developed regions of the country, namely the Aegean and Marmara Regions geographically coincide with the most hazardous earthquake zones. The seismic activity is very complex around the East-Mediterranean region. Most of the country is on the Anatolian Plate, which is located in the middle of the Eurasian, African and Arabian Plates. The African and Arabian plates travel north and force the Anatolian plate to move west. The majority of the destructive earthquakes take place on the borders of the Anatolian Plate. (Yılmaz, Demirtaş: 20, 21)

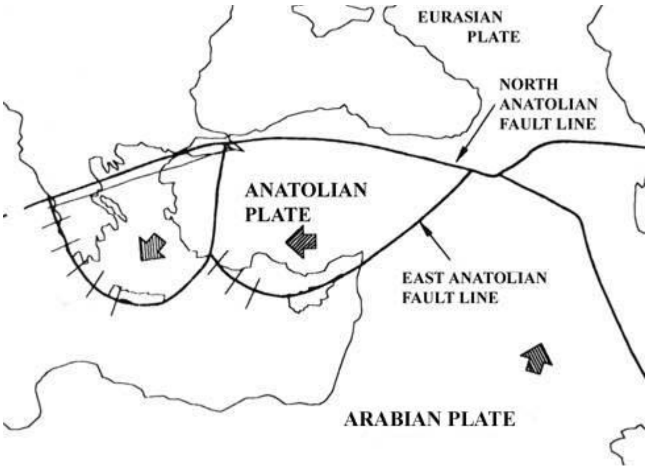


Figure 1. Seismic Plates Around Turkey

The North Anatolian Fault consists of several shorter fault lines and stretches over 1.000 km. (Figure 2) The width of the seismic zones varies between 100 m and 25 km. The annual average slide is about 5-8 mm. The East Anatolian Fault runs 400 km from Karliova to Iskenderun Bay. The width is between 2-3 km and the annual slide is around 6 mm. The most destructive earthquakes take place on these two fault lines. Bitlis compression zone is in a relatively silent state since the beginning of the last century. The Aegean Graben Zone is the reason for the earthquakes in West-Anatolia. In this region, the Anatolian Plate expands in the north-south direction and causes the formation of fault lines in the east-west direction. (Celep, Kumbasar:19,22)

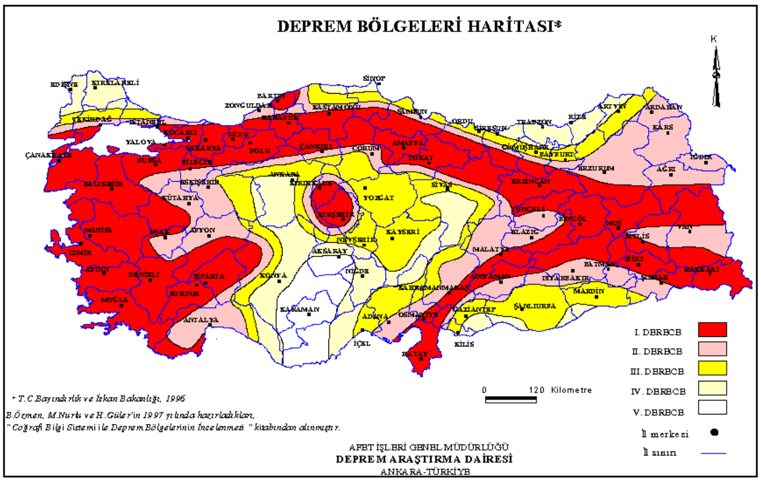


Figure 2. Seismic Map of Turkey

Earthquakes should be considered as the most hazardous form of natural disaster. There are three reasons behind this argument. First of all, earthquakes have claimed more lives in Turkey than any other form of natural disaster. Although the country often witnesses other forms of natural catastrophes in the form of floods, landslides and avalanches, only earthquakes reach a national level in terms of the human and material losses they inflict on their environment. Secondly, because of the geographical location of the country, minor earthquakes occur almost on a daily basis and major earthquakes take place very often. As it can be observed from almost every generation in the last century has witnessed an earthquake of catastrophic proportions. Each time the material losses suffered because of these earthquakes has crippled the country's already fragile economy for many years. The third but maybe the most critical reason is the close relationship between the architectural design and seismic performance of the building. A common anonymous proverb states that "It is the buildings and not earthquakes that kill people." A flood, a landslide or an avalanche can kill a person who merely stands on its way; however, people get injured or killed during earthquakes because of collapsed buildings and not the earthquake itself. Seismic activity is a natural phenomenon but an earthquake is a man made disaster.

3. Urbanization in Turkey

Today, there is an emphasis on large scale housing developments by both the government and the private sector. The government has endorsed large-scale housing by means of "Mass Housing Law" and new credit mechanisms such as the "Mortgage System". A new housing market is created through the "Housing Development Administration of Turkey - Toplu Konut İdaresi (TOKİ)". Another public sector to provide mass housing developments is the municipal authorities and cooperative unions. The former "Real Estate Development Bank – Emlak Bankası" had also increased its production capacity before its abolishment in 2001, however has kept its efforts in the line of providing sample projects instead of establishing regulating mechanisms for the market. Despite all the developments in the building industry and architectural market these new mass housing projects reflect the formal and spatial characteristics of the previous generation of apartment blocks. Despite all the attempts to create a controlled urban development whether by means of the building cooperatives or mass housing projects, the small-scale "build and sell" mechanism is still the dominant building production type of the private sector in Turkey. According to the survey of the Turkish Statistical Institute 90% of all buildings are built by the private sector as opposed to the 4% built by the public sector and 5% built by construction cooperatives. (Figure 3) The results of this survey demonstrate that R/C apartment block typology will continue to be the dominant element of Turkish urban environment for the upcoming decades. (Building Census, 2001)

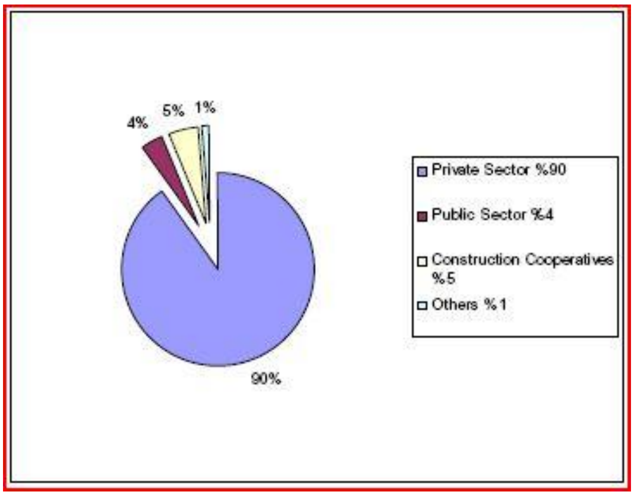


Figure 3. The Ratio of Buildings with reference to Financier Sectors

The same survey also demonstrates that housing production still constitutes the dominant portion the building works in Turkey with almost 75% of all buildings being residential apartment blocks. (Figure 4) In addition to this, a large portion of the partially residential buildings (11%) and commercial buildings (6%) also share the same building typology. Overall, it can be concluded that over 90% of all buildings in Turkey are apartment blocks. According to the same survey almost 80% of urban households live in this type of building. From these results, it is safe to conclude that, in terms of earthquake disaster prevention, it is imperative to establish a seismically secure design notion concerning the apartment typology in the heads of architects, engineers and contractors of private sector. (Building Census, 2001)

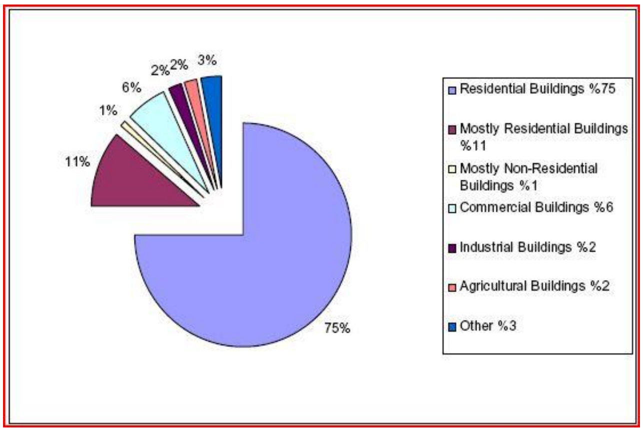


Figure 4. The Ratio of Buildings with reference to Occupancy Types

The 2000 Building Census states that over 51% of all existing buildings in Turkey have R/C skeleton system. (Figure 5) This represents a rise of more than 20% percent in the ratio of this structural system when compared to 1984 Building Census. It can also be assumed that in the 8 years following the 2000 census, this ratio has further increased. Despite the excessive criticism following the poor performance of this structural system in past earthquakes, R/C, with its established industrial and commercial infrastructure, will continue to be the chief construction material in Turkey. (Building Census, 2001)

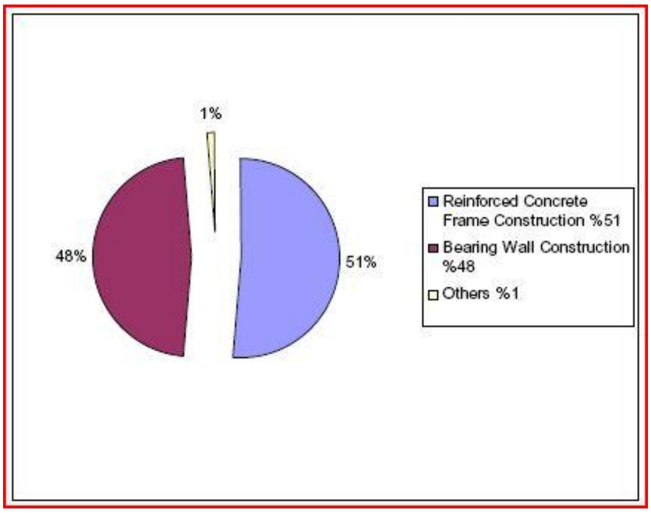


Figure 5. The Ratio of Buildings with reference to Structural System Types

Parallel with the increase in the country's R/C production capacity and development of the transportation sector, this material is extensively used in not only the urban areas but also even in the most remote rural regions. (Figure 6) The steady increase in population results in the rapid development of small towns and even villages. The 2000 Building Census shows a significant increase in the ratio of buildings built outside of the country's traditional metropolitan areas. This development brings along a steep rise in the building stock vulnerable to high seismic risk. (Building Census, 2001)

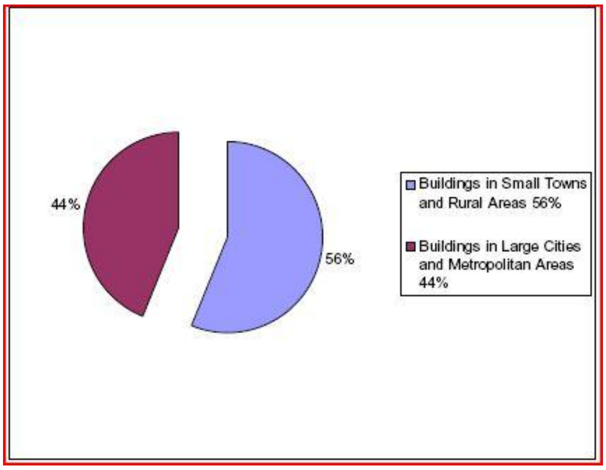


Figure 6. The Ratio of Buildings in Rural Areas vs. Metropolitan Areas

4. Structural Design Education in Çankaya University

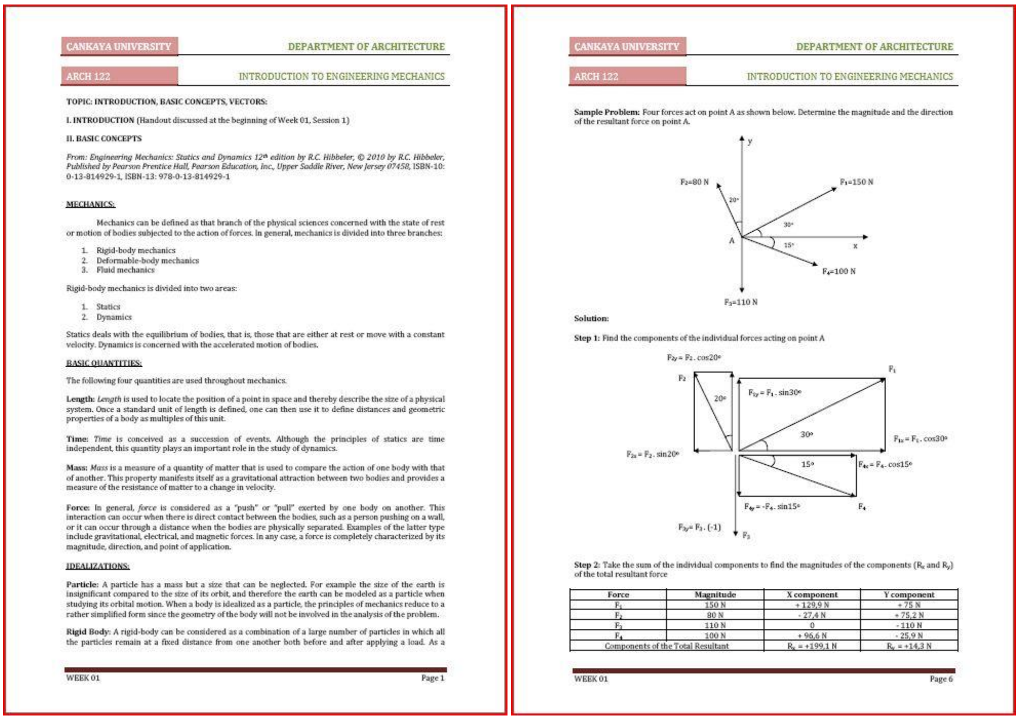
Çankaya University Department of Architecture was established in 2011. The undergraduate education consists of eight semesters. At the end of the first four semesters students receive an associate's degree and at the end of eight semesters a bachelor's degree. Graduates of the architecture undergraduate program gain the right to register to the Turkish Chamber of Architects and professionally practice architecture in Turkey.

The original curriculum of the department was inspired from the existing curriculums of major international and Turkish schools of architecture. The teaching system was designed around a central coursed named the Architectural Design Studio. In this course students are trained in the art of architectural design through design projects the complexity and scope of which are gradually increased and finalized by a diploma project.

The technical and theoretical knowledge base of architectural design activity is conveyed through theoretical courses mostly in the form of classical lectures. The major categories of these lecture courses are architectural theory, architectural history, structural design, construction technology as well as introductory courses on architectural conservation, city planning and professional practice. There are also technical drawing and architectural detailing courses which combine theoretical lectures and limited application.

Structural Design course in Çankaya University Department of Architecture was a lecture course in traditional format where theoretical basis of scientific concepts was taught through verbal means with little help from modern representation techniques such as over-head projections and Microsoft's PowerPoint software. Conceptual teaching was supported with theoretical examples in the form of sample problems. (Figure 7) Structural design was considered as an isolated topic and purely within the domain of structural statics.

There was little or no mention of its overall role in the totality of architectural design and its socio-cultural context. Students had problems with associating the role structural design plays in the earthquake resistance of buildings and its consequent effect on saving human lives and economic resources. To address this deficiency an experimental approach which contains lectures on the social context of structural design decisions, computer simulations and application projects was introduced during one semester in the structural design course. The method and results is explained in the next section.



ÇANKAYA UNIVERSITY DEPARTMENT OF ARCHITECTURE

ARCH 122 INTRODUCTION TO ENGINEERING MECHANICS

TOPIC: INTRODUCTION, BASIC CONCEPTS, VECTORS:

I. INTRODUCTION (Handout discussed at the beginning of Week 01, Session 1)

II. BASIC CONCEPTS

From: Engineering Mechanics: Statics and Dynamics 12th edition by R.C. Hibbeler, © 2010 by R.C. Hibbeler, Published by Pearson Prentice Hall, Pearson Education, Inc., Upper Saddle River, New Jersey 07458, ISBN-10: 0-13-814929-1, ISBN-13: 978-0-13-814929-1

MECHANICS:

Mechanics can be defined as that branch of the physical sciences concerned with the state of rest or motion of bodies subjected to the action of forces. In general, mechanics is divided into three branches:

1. Rigid-body mechanics
2. Deformable-body mechanics
3. Fluid mechanics

Rigid-body mechanics is divided into two areas:

1. Statics
2. Dynamics

Statics deals with the equilibrium of bodies, that is, those that are either at rest or move with a constant velocity. Dynamics is concerned with the accelerated motion of bodies.

BASIC QUANTITIES:

The following four quantities are used throughout mechanics.

Length: *Length* is used to locate the position of a point in space and thereby describe the size of a physical system. Once a standard unit of length is defined, one can then use it to define distances and geometric properties of a body as multiples of this unit.

Time: *Time* is conceived as a succession of events. Although the principles of statics are time independent, this quantity plays an important role in the study of dynamics.

Mass: *Mass* is a measure of a quantity of matter that is used to compare the action of one body with that of another. This property manifests itself as a gravitational attraction between two bodies and provides a measure of the resistance of matter to a change in velocity.

Force: In general, *force* is considered as a "push" or "pull" exerted by one body on another. This interaction can occur when there is direct contact between the bodies, such as a person pushing on a wall, or it can occur through a distance when the bodies are physically separated. Examples of the latter type include gravitational, electrical, and magnetic forces. In any case, a force is completely characterized by its magnitude, direction, and point of application.

IDEALIZATIONS:

Particle: A particle has a mass but a size that can be neglected. For example the size of the earth is insignificant compared to the size of its orbit, and therefore the earth can be modeled as a particle when studying its orbital motion. When a body is idealized as a particle, the principles of mechanics reduce to a rather simplified form since the geometry of the body will not be involved in the analysis of the problem.

Rigid Body: A rigid-body can be considered as a combination of a large number of particles in which all the particles remain at a fixed distance from one another both before and after applying a load. As a

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ÇANKAYA UNIVERSITY DEPARTMENT OF ARCHITECTURE

ARCH 122 INTRODUCTION TO ENGINEERING MECHANICS

Sample Problem: Four forces act on point A as shown below. Determine the magnitude and the direction of the resultant force on point A.

Solution:

Step 1: Find the components of the individual forces acting on point A

Step 2: Take the sum of the individual components to find the magnitudes of the components (R_x and R_y) of the total resultant force

Force	Magnitude	X component	Y component
F_1	150 N	+ 129,9 N	+ 75 N
F_2	80 N	- 27,4 N	+ 75,2 N
F_3	110 N	0	- 110 N
F_4	100 N	+ 96,6 N	- 25,9 N
Components of the Total Resultant		R_x = +199,1 N	R_y = +14,3 N

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Figure 7. Sample Course Notes

5. An Experimental Approach in Structural Design Courses

In interviews students often describe the classical lecture format of structural design courses dull, boring and too technical. Students' strategy for success in this course consists of working before the exams in a concentrated manner and getting a grade that is as high as possible. They are unable to transfer the concepts acquired during this course to the design studio.

The study was conducted on a class of 15 students who were all 2nd year students of architecture during an academic semester of 14 weeks. These students were selected because they had previously received structural design courses in classical lecture format and as a result they were in a position to compare the two teaching methods. The first step of the study was to give students a series of lectures concerning the social aspects of earthquake phenomenon. Due to the heavy technical aspect of the issue and its apparent unpopularity among many architects structural design and related earthquake resistant design is falsely placed under the sole responsibility of structural engineers. As a result students of architecture often perceive the issue as secondary to the actual architectural design.

During their architectural education students work on hypothetical projects which will never come into realization. This prevents the students from perceiving the social impact of their design work on the occupants of their buildings and the community in which their project is built. Architects only truly face the socio-cultural aspect of their work after graduation during their professional lives. At this stage mistakes that are made during architectural and structural design are not paid with low grades but human lives. The aim of the lectures is to demonstrate the socio-cultural aspect of architectural design decisions and mistakes during undergraduate education where lessons can be learned from past mistakes and corrected before getting into professional life. (Figure 8) Interviews conducted with students after the lectures demonstrated that students were little informed on the performance of existing building during the major earthquakes of the last two decades. Technical knowledge and images of the aftermath of these earthquakes provided the students with a sense of awareness and social responsibility towards the issue.

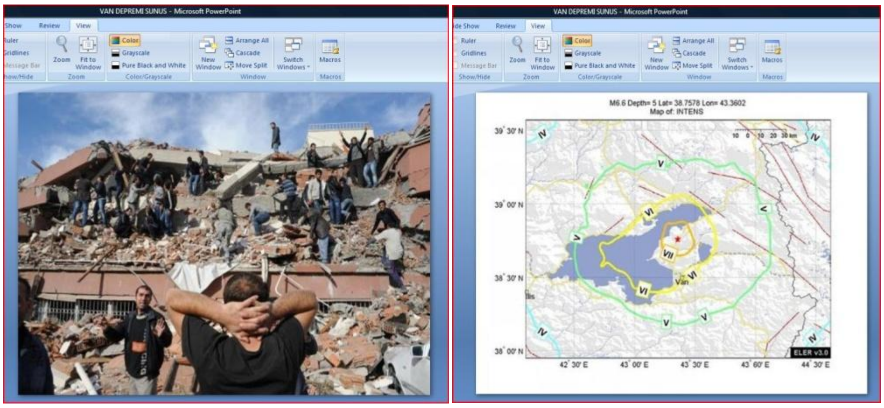

Figure 8. Slides from a Lecture about Van Earthquake

After establishing the social context of the work the second step is to carry the students beyond the sphere of theoretical knowledge and into the realm of simulated applications. The first application project is that of a wooden truss bridge. (Figure 9) An experiment setup simulating a span of 90cm was built. A load set of 25kg was prepared. Steel loads were modular and consisted of 0,25kg, 0,5kg and 1,5kg units. A total of 12 bridges were built. Bridges were built using 3mm x 3mm pine timber sticks and fast drying glue. Bridges were evaluated by two criteria. First criterion was the weight of the bridge itself and the second criterion was the load the bridge can carry without breaking down. Loading experiment was recorded with high resolution camera. Two of the twelve bridges survived the experiment. The bridges which survived the experiment were the heaviest ones therefore received low points according to the self-weight criterion. Best results were obtained by bridges which were relatively light and carried relatively high loads. Additional multi-media lectures were organized where the videos were examined in detail and collapse mechanisms were evaluated by the students.

Figure 9. Student Works from The Bridge Project

The third step was a space cover experiment. (Figure 10) The weight set, allowed structural materials and evaluation criteria were the same. This time students were expected to design a space cover for an imaginary semi-spherical volume with a radius of 90cm. A total of 8 models were built. All models survived the loading experiment with two models displaying excessive deformations. Lectures were organized and collapse mechanisms were evaluated by the students.

Figure 10. Student Works from The Cover Project

6. Results and Comparison to Previous Studies

Interviews were conducted with the students at the end of the semester questioning the level of technical and social awareness. The students were asked to compare the teaching method of the previous structural design courses they took with the new one. The students have expressed that receiving information about the social context of their structural design work has really helped them to gain a wider perspective towards the role of architecture in the society. The students have expressed that seeing the photographs of collapsed buildings with their occupants and rescue teams have helped them understand the reality of earthquake phenomenon and social responsibility.

From a technical point of view the use of application projects through the construction of small-scale models were a continuation of a former study conducted in Middle East Technical University (METU) Department of Architecture. In contrast with this experiment, the study in METU was conducted in Architectural Design Studio. In that study a similar method was applied to a group of 20 2nd year students of architecture. The architectural design of a bridge was requested from the students. The students were given structural design lectures and table critics by faculty members specialized on these issues during studio hours. In that study instead of constructing small-scale models computer models of selected projects were prepared and subjected to gravity and earthquake loading scenarios. In contrast with the Çankaya University experiment students were not given lectures on the social context of their design and small-scale models were not utilized. At the end of METU experiment students have expressed that the structural efficiency of the proposed bridge designs have increased significantly as a result of the mutual discussions with structure instructors and also students expressed that computer modeling of their proposals have helped them understand and visualize the actual structural behavior of their designs. (Ünay, Özmen,2006:270)

Similar with the reults obtained in METU, Çankaya University students of architecture have expressed that the opportunity to apply the theoretical knowledge into real design issues in a controled environment has helped them to experiment with structural design options to find the optimum solution. They have also expressed that working with small-scale structural models have provided them with a sense of reality where a building is no more a conceptual object but a real one they can experience with all of their senses.

7. Conclusion

As a result of the experiment the portion of the curriculum of the Çankaya University Department of Architecture concerning the structural design course series was revised and updated to include more application projects and more lectures concerning the technical, economical and socio-cultural aspect of structural design decisions. It is projected that the new teaching method will help the formation of a new generation of architects with better technical competency and increased social awareness.

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