Importance of Application and Visuality at Civil Engineering Education

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Abstract:

A civil engineer is a person who plans, designs and constructs buildings, roads, bridges, airways, dams, channels, pile foundations, retaining walls and etc. Therefore, civil engineering education in bachelor degree is provided by the structural, mechanical, material science, transportation, hydraulic, construction management and geotechnical divisions. Anadolu University, Civil Engineering Department was established in 1998 and students have to prepare a bachelor degree thesis for graduation. Students started to prepare a model in the laboratory about their subjects in geotechnical division since two years. For example, a deep excavation system, a retaining wall, a shaking table and a soil mixing machine models were produced. In this study, preparation effects of the laboratory models in the civil engineering education are analyzed and improvements on the learning behavior are presented. Observations shows that, application and visuality have great importance in civil engineering education.

Key words: Civil engineering, visual education, geotechnical division, design models

1. Introduction

Civil engineer is a person who plans, designs and constructs all of the buildings such as dams, ports, roads, bridges, subway systems, airways, retaining walls, tunnels, and other public buildings. Civil engineer deals with structures of buildings, transportation systems, hydraulic structures, geotechnical structures, construction material properties and management of the construction process. Therefore, civil engineering education includes all of these different areas. Civil engineering education in bachelor degree consists of four year comprehensive courses and internship in Turkey. Civil engineering education is generally divided seven divisions such as; structure, mechanics, geotechnics, hydraulics, transport, material science and construction management [1]. Civil engineer makes statics and reinforced calculations of all structures so courses given by structural division consist of theories about determining the forces acting on the structures and sizing of the structural elements. In mechanical division courses, theories about body behavior of the elements under forces are demonstrated. Soil properties and soil structures are the subjects of the geotechnical division. Dams, water supply and sewerage systems are explained in the hydraulics division. Design theories of the roads and railways are given in the courses of transportation division. Properties of construction materials such as steel and concrete are defined in materials science and planning of the all construction steps with cost analysis is explained in the courses of construction management.

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Modern engineering needs much more science and usage of the theories in the applications [2]. For this aim, many researchers investigate the civil engineering education strategies and improvement methods. Ruddell and Wagener studied the developments for hydrology education for engineering programs [3]. Gunhan observed the effects of site trips on engineering students [4]. Lopez-Querol et al. suggested new methodology for transportation and geotechnics education [5]. Fenner et al. analyzed sustainability of civil engineering education [6]. Hurwitz et al. compared differences between practice and classroom in transportation engineering education [7]. Soibelman et al. investigated preparation of civil engineering students for international collaboration in construction management [8]. Perdoma and Pando offered using information technology in the civil engineering education [9]. Castro et al. presented the improvements of project based learning [10]. Moussai gives the differences of real world and geotechnical engineering education [11]. Wang et al. investigated technology and teaching in geotechnical engineering [12]. Slizyte et al. explained geotechnical and construction engineering education in Vilnius Gediminas Technical University [13]. Dundulis et al. studied innovative teaching technologies in geotechnical engineering [14]. Cokca evaluated computer aided learning in geotechnical engineering in Middle East Technical University [15]. And also, education methodologies about Chile, China, German, Greece, Switzerland is presented in the literature [16, 17, 18 and 19].

Interdisciplinary working and enough knowledge are required for huge projects nowadays. Developments in the construction industry bring faster thinking and application. If civil engineering students start the 3D thinking and see the real application in the courses, they can easily achieve all project details in their engineering life. Therefore, students started to prepare a model in the laboratory about their subjects in geotechnical division since two years. For example, a deep excavation system, a retaining wall, a shaking table and a soil mixing machine models were produced. In this study, preparation effects of the laboratory models in civil engineering education are analyzed and improvements on the learning behavior are presented.

2. Method

Anadolu University, Civil Engineering Department was established in 1998. The department is located at the iki Eylul Campus, Eskişehir, Turkey and occupies a covered area of 5000 m^2. 4 Professors, 4 Associate Professors, 5 Assistant Professors and 11 Research Assistants currently working in the department. In the first year of education, as well as the other engineering departments, basic courses which include physics, chemistry and mathematics are given. In the following three years before graduation, courses regarding the branches of civil engineering like structural and geotechnical engineering, hydraulics, material science, construction management and transportation engineering are instructed. Students have to prepare a bachelor degree thesis for graduation in the last year. Under the scope of the courses, theoretical education is supported and reinforced by laboratory studies. There are four special laboratories in the department in which modern equipment are provided. They can be listed as structure, geotechnical, hydraulic and transportation laboratories. In addition, the computer rooms which supply the software for computer-aided-design (CAD) provide convenience for the students. In the civil engineering department, it is aimed to give training regarding the designs of all types of buildings, highways,

railways, airports, tunnels, harbors, dams, irrigation systems, bridges and geotechnical investigation issues. Students after graduation can establish their own companies, work in the field or design engineers or continue their researches and also make academic career.

In the geotechnical division, the design, analysis and practical applications of soil structures such as foundations, retaining walls, slopes, deep excavations are performed based on theory of soil mechanics, laboratory and field experiments. Soil properties such as physical and mechanical properties are determined to use environmental protection of structures, sanitary landfill design and solid waste management. There are also several completed and ongoing scientific projects. The faculties, currently employed in the division, are 2 Professors and 3 Research Assistants. The faculties are also serving as a consultant in the geotechnical engineering applications. The other guide lines for study are as follows; giving to opportunity to learn Plaxis program to make 2D and 3D static and dynamic analyzes of deep excavation, pile foundations and slope stability, and there are also other programs such as M-Pile, Talren, Msheet, Mfoundation, Krea etc. Department has Pile Foundation Machine for application of pile foundations, Jet-Grout Machine for soil improvements and boring machine. Soil mechanics laboratory has all equipment to determine mechanical and engineering properties of soils and research laboratory to perform dynamic soil tests such as dynamic triaxial test and resonant column test. The division also has field experiment systems such as pressuremeter, inclometer, seismic and standard penetration tests.

2.1. Model Study

Compulsory courses are soil mechanics I, foundation engineering I, civil engineering design, geotechnical design and application of design in civil engineering and the elective courses are soil mechanics II, foundation engineering II, soil improvement, foundation engineering and computer applications, introduction to soil dynamics in geotechnical division. The course which named application of design in civil engineering must be taken for preparing graduate thesis. Retaining wall project model was produced in 2012-2013 academic year. Deep excavation design project model, a shaking table model for liquefaction potential and a soil mixing machine model were produced in 2013-2014 academic year.

Retaining walls are constructed to resist lateral earth pressures for slopes [1]. Retaining walls are one of the most chosen soil structures to resist lateral earth pressure due to its low construction costs. There are three types of retaining walls such as cantilever, gravity and counterfort [1]. One of the students, Emre Odabaşı, prepared a retaining wall prototype model for his graduate thesis in 2012-2013 academic year. His subject is a retaining wall design and he did calculations for proper design. In addition, he constructed a prototype model consist of three different types of wall [20]. The prototype model is given in Fig. 1.

Figure 1. Retaining wall model

Deep excavations are commonly chosen for basements of multi-storey buildings in the developed countries due to inadequate construction areas. Many of them are constructed nearby existing constructions so support systems should preserve the stability and control displacements next to the excavation. The other student, Şeyma Serin, prepared a deep excavation support system and anchorage & soil nailing prototype model for her graduate thesis in 2013-2014 academic year. Her subject is deep excavation support systems and she investigated anchorage calculations [21]. In addition, she constructed a prototype model consist of anchored pile system for deep excavations support. The prototype model is given in Fig. 2.

Figure 2. Deep excavation support system with anchorage model

Soil improvement is defined as the improvement of the some soil parameters by using different methods when the soil properties are insufficient againist static and dynamic loads. The Deep Soil Mixing (DSM) is an in situ soil treatment technology whereby the soil is blended with cementitious and/or other materials. The other student, Alihan Tosun, prepared a deep soil mixing machine prototype for his graduate thesis in 2013-2014 academic year [22]. His subject is deep soil mixing and he compared soil improvement methods In addition, he constructed a prototype model explained working principle of deep soil mixing machine. The prototype model is given in Fig. 3.

Figure 3. Deep soil mixing machine model

Finally, the soil liquefaction problem was studied. Liquefaction is defined as loses strength and stiffness under dynamic loads for saturated loose sand and silts. Shaking table is a test system to simulate earthquakes. This is a device for shaking models and identify behavior of soils and structures. The other student, Melik Saral prepared a shaking table for his graduate thesis in 2013-2014 academic year [23]. In addition, he constructed a shaking table test prototype to perform liquefaction tests. The prototype is shown in Fig. 4 and 5.

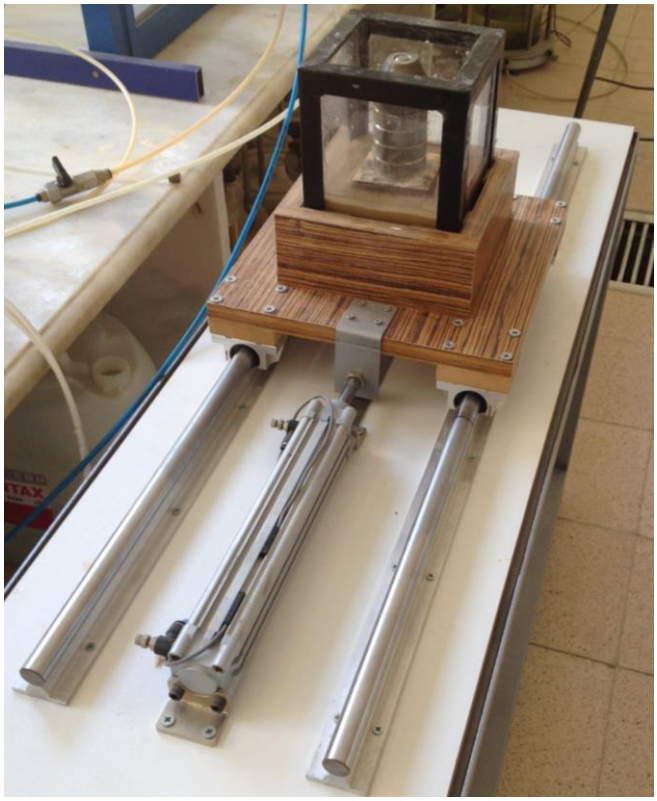

Figure 4. Shaking table model

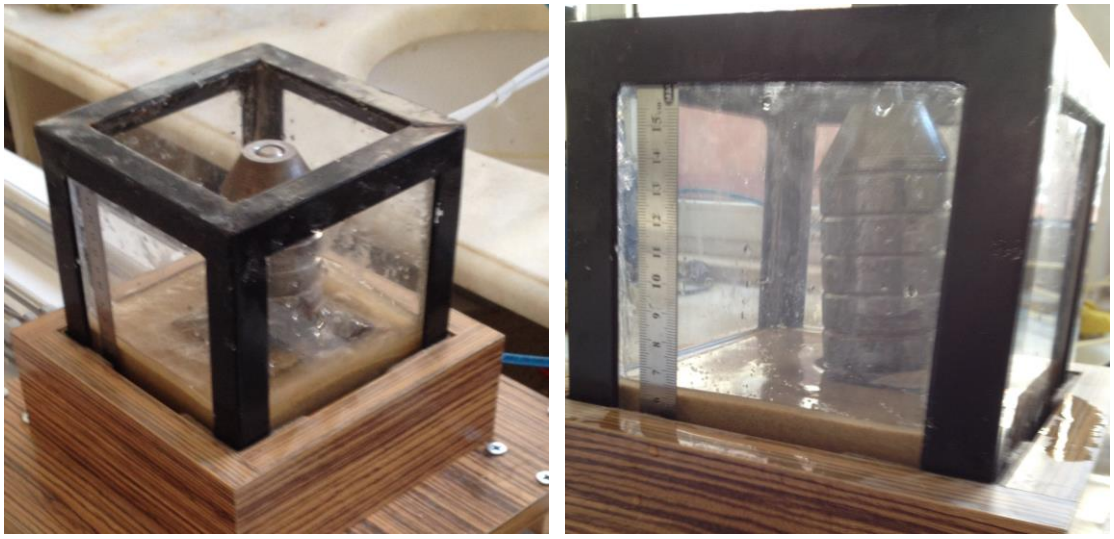

Figure 5. Liquefaction phenomenon

3. Results

The models are started to use in the courses such as INS 342 Foundation Engineering I and INS 481 Soil Mechanics II while explaining the theories to the students. Students examined the prototype models with the subjects and their interests and success are encouraged. The average grade of success for the courses year by year is given in Table 1. The average grades of students were increased year by year because visuality is positively affected learning potential. Student interests are increasing to the subjects with observing the laboratory applications.

Table 1. The Average Grades

	INS 342	INS 481
2010-2011 Academic Year	44,0	36,0
2011-2012 Academic Year	44,0	39,0
2012-2013 Academic Year	44,0	40,0
2013-2014 Academic Year	49.0	44,0

On the other hand, the prototype models were exhibited at the Anadolu University, Faculty of Engineering Project Fair and Competition – 2014. Approximately 45 different thesis were competed and the jury were selected between experienced engineers. The shaking table prototype model won the highest prize (1000 TL) and got 1st rank. Deep soil mixing prototype model won prize (500 TL) got the 3rd rank of the competition. During the exhibition, the prototype models were examined the models interestedly by guests.

Students who wants to select graduate thesis from geotechnical division is increased for two years. Only six students wanted before the prototype models but minimum ten students want their graduate thesis from geotechnical division now.

Conclusions

Civil engineers should continue learning new theories and technics .Students are started to prepare a model in the laboratory about their subjects in geotechnical division at Anadolu University in the department of civil engineering. In this study, preparation effects of the laboratory models in the civil engineering education are examined and improvements on the learning behavior are presented. Observations show that, application and visuality positively affect the civil engineering education.

References

[1] Gündüz Z, Dagdeviren U. Awareness of professional liability on the geotechnical science in civil engineering education. In Proceedings of the First Civil Engineering Education Symposium: 06-08 November 2009; Antalya. p. 429-437.
[2] Scott JS. Civil engineering. 1rd ed. USA: Longman; 1975.
[3] Ruddell BL, Wagener T. Grand challenges for hydrology education in the 21st century. J of Hydrologic Engineering 2015; 20, SPECIAL ISSUE: Grand Challenges in Hydrology, A4014001.
[4] Gunhan S. Collaborative Learning Experience in a Construction Project Site Trip. J. Prof. Issues Eng. Educ. Pract. 2015:141(1):04014006.
[5] Lopez-Querol S, Sanchez-Cambronero S, Rivas A, Garmendia M. Improving civil engineering education: transportation geotechnics taught through project-based learning methodologies. J. Prof. Issues Eng. Educ. Pract. 2015:141(1):04014007.
[6] Fenner RA, Cruickshank HJ, Ainger C. Sustainability in civil engineering education: why, what, when, where and how. Proceedings of the Institution of Civil Engineers-Engineering Sustainability. 2014:167:228-237.
[7] Hurwitz DS, Swake J, Brown S, Young R, Heaslip K, Bernhardt KLS, Turochy RE. Influence of collaborative curriculum design on educational beliefs, communities of practitioners, and classroom practice in transportation engineering education. J. Prof. Issues Eng. Educ. Pract. 2014:140(3):04013020.
[8] Soibelman L, Sacks R, Akinci B, Dikmen I, Birgonul MT, Eybpoosh M. Preparing civil engineers for international collaboration in construction management. J. Prof. Issues Eng. Educ. Pract. 2011:137(3):141-150.
[9] Perdomo JL, Pando MA. Using information technology to incorporate natural hazards and mitigation strategies in the civil engineering curriculum. J. Prof. Issues Eng. Educ. Pract. 2014:140(1): 04013004.
[10] Castro A, Nunez C, Valcarce I, Carballo R, Fuentes P. Project-based learning in civil engineering training: improvements for the academic year 2012-2013. In Proceedings of the 7th international technology, education and development conference: 04-06 March 2013; Valencia. Edited by Chova LG, Martinez AL, Torres IC. 2013. p. 914-9.
[11] Moussai B. Geotechnical engineering education and the real world needs. In Proceedings of the 6th international technology, education and development conference: 05-07 March 2012; Valencia. Edited by Chova LG, Martinez AL, Torres IC. 2012. p. 2249-2251.
[12] Wang Q, Chen JP, Chen HE. The engineering geological investigation and technology with teaching and education in engineering geology and geotechnical engineering. In Proceedings of the 2011 international conference on economic, education and management: 05-05 March 2011; Macao. Edited by Tan HH. 2012. p. 127-9.
[13] Slizyte D, Medzvieckas J. Geotechnical and construction engineering in VGTU Civil engineering bachelor's degree programs. In Proceedings of the 6th AECEF symposium on civil engineering education in changing Europe: 28-30 May 2008; Vilnius. Edited by Vainiunas P, Juknevicius L. 2008. p. 103-8.
[13] Dundulis K, Stragys V, Slizyte D, Mackevicius R. Innovations in teaching methodology in geotechnical engineering. In Proceedings of the 6th AECEF symposium on civil engineering

education in changing Europe: 28-30 May 2008; Vilnius. Edited by Vainiunas P, Juknevicius L. 2008. p. 89-93.
[14] Cokca E. Geotechnical engineering education in METU and computer aided learning resources. In Proceedings of the 1st International Conference on Education and Training in Geo-Engineering Science: 02-04 June 2008; Constanza. Edited by Manoliu I, Radulescu N. 2008. p. 369-374.
[15] Verdugo R, Foncea C. Report on geotechnical engineering from Chile. In Proceedings of the 1st International Conference on Education and Training in Geo-Engineering Science: 02-04 June 2008; Constanza. Edited by Manoliu I, Radulescu N. 2008. p. 145-6.
[16] Qiu Y. Historical review and current status of civil engineering education in China. In Proceedings of the 1st International Conference on Education and Training in Geo-Engineering Science: 02-04 June 2008; Constanza. Edited by Manoliu I, Radulescu N. 2008. p. 151-7.
[17] Arslan U, Huber H. German education and training in geo-engineering sciences. In Proceedings of the 1st International Conference on Education and Training in Geo-Engineering Science: 02-04 June 2008; Constanza. Edited by Manoliu I, Radulescu N. 2008. p. 171-6.
[18] Pantazidou M, Tsiambaos G, Atmatzidis DK. Geotechnical engineering education and training in Greece and links with the geo-engineering sciences. In Proceedings of the 1st International Conference on Education and Training in Geo-Engineering Science: 02-04 June 2008; Constanza. Edited by Manoliu I, Radulescu N. 2008. p. 187-191.
[19] Caprez M, Springman SM, Anagnostou G. Geotechnical engineering education and training in Switzerland. In Proceedings of the 1st International Conference on Education and Training in Geo-Engineering Science: 02-04 June 2008; Constanza. Edited by Manoliu I, Radulescu N. 2008. p. 247-252.
[20] Odabası E. Pile foundation retaining wall design & deep excavation support system. Bachelor Degree thesis. Anadolu University, Civil Engineering Department, 2013.
[21] Serin S. Pile foundation design, deep excavation support system and anchorage & soil nailing prototype. Bachelor Degree thesis. Anadolu University, Civil Engineering Department, 2014.
[22] Tosun A. Pile foundation design, deep excavation support system and deep mixing prototype. Bachelor Degree thesis. Anadolu University, Civil Engineering Department, 2014.
[23] Saral MM. Pile foundation design, deep excavation support system and soil liquefaction. Bachelor Degree thesis. Anadolu University, Civil Engineering Department, 2014.