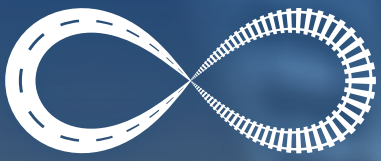

CETRA 2018

5th International Conference on Road and Rail Infrastructure
17–19 May 2018, Zadar, Croatia

Road and Rail Infrastructure V

Stjepan Lakušić – EDITOR

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CONTEMPORARY APPROACH TO ENGINEERING EDUCATION IN THE FIELD OF TRANSPORTATION INFRASTRUCTURE

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Abstract

The current legislative and regulatory framework in the field of higher education as well as the Education, Science and Technology Strategy directs the education of construction engineers towards construction innovations, new design concepts, technologies, and materials according to globally set goal – resource saving. These requirements demand the application of contemporary teaching methods like learning through work, research, putting into function learned concepts, using acquired knowledge and skills in actual examples, learning in the context of division of work and communication with other participants in teaching. This education approach is realized within the course of the Substructure of Transport Infrastructure, compulsory course at the first year of graduate study at the Faculty of Civil Engineering Osijek. The aim of the course is to familiarize students with the design and construction of the lower structure of roads and facilities therein, technology planning and the quality control of works. Familiar, classical performances of lectures and exercises are complemented with workshops, independent work of students in the laboratory, independent work on computer programs, field teaching and participation of practitioners as guest lectures. An important part of the knowledge acquisition is the work in the laboratory where, apart from getting to know how to use the equipment, students perform the standard Proctor's experiment. That way, they extend the theoretical knowledge of Proctor's experiment, remove possible confusion and understand the standards requirements that determine the experiment and make the results relevant. This paper describes the contemporary approach to the education by analyzing the concept of Substructure of Transport Infrastructure course.

Keywords: engineering education, road infrastructure, substructure of transport infrastructure, contemporary teaching methods

1 Introduction

Challenges of accentuated globalization and internationalization of the academic and scientific community have prompted the need for a new joint approach to higher education that will consolidate the European Higher Education Area and increase its international visibility. The objectives of education are directed at the Union-wide strategic document – Europe 2020, A strategy for smart, sustainable and inclusive growth and the resulting initiatives; Education and Training 2020, Education, Modernization of Higher Education and Internationalization of Higher Education. The post-industrial context, in which social changes are marked by more intensive and extensive use of information and knowledge and emerging economies based on knowledge, have put higher education at the centre of national policy development. The European Union's policy in the field of higher education is designed to support national acti-

vities and contribute to addressing common challenges, such as the aging of society, lack of skills in workforce and global competition.
The current legislative and regulatory framework in the field of higher education as well as the national Education, Science and Technology Strategy [1] directs the education of construction engineers towards construction innovations, new design concepts, technologies, and materials according to globally set goal – resource saving. These requirements demands the application of contemporary teaching methods like learning through work, research, putting into function learned concepts, using acquired knowledge and skills in concrete examples, learning in the context of division of work and communication with other participants in teaching. Advances in communication and information technology supports these developments.
Along with the new techniques, methods and procedures of acquiring knowledge, there is a need for a new curriculum structure. Goals and measures defined within the framework of the strategy are aimed at increasing the overall quality of higher education in order to achieve student's competences for a creative professional development and active participation in society, fostering the development of the economy and personal needs. The goals set out in the Strategy are in line with the goals defined by the EU in the Europe 2020 Strategy document. While defining the strategic goals and measures for achieving them in the Strategy document, it is noted, among other things, that the share of practical teaching is still too small, lacking student practice and field teaching in study programs. The need to establish a model of practical teaching is emphasized. The quality of professional practice for construction studies is one of the prerequisites for acquiring competencies, hence the better employability of graduates and their better preparedness for employers' requirements.
This paper describes the contemporary approach to the education by analysing the concept of Substructure of Transport Infrastructure course. The aim of the course is to familiarize students with the design and construction of the lower structure of roads and facilities therein, technology planning and the quality control of works. Familiar, classical performances of lectures and exercises are complemented with workshops, independent work of students in the laboratory, independent work on computer programs, field teaching and participation of practitioners as guest lectures. At the course level, the aim was to respond to the challenges of a complete and project-oriented approach to teaching and learning, which by scale, complexity and the applied teaching methods enable achieving defined learning outcomes.

2 Contemporary approach to engineering education

2.1 The concept of University graduate study of Transport Infrastructure

At the graduate university study of the Faculty of Civil Engineering in Osijek with the already existing three fields of specialization: Supporting Structures, Organization, Technology and Management in Construction and Hydraulic Engineering from the academic 2013/2014 course of the year, the new field of specialization on the Transport Infrastructure [2] is performed. The study program is conceived to meet the contemporary demands placed on future young engineers [3] and also to achieve the appropriate learning outcomes for all types of transport infrastructures, their specifics as well and the geotechnical area important for overall understanding and solving problems in transportation engineering.
At the graduate study of Transport Infrastructure students take seven compulsory and seven elective courses during three semesters. Obligatory courses are: Substructure of Transport Infrastructure, Pavement structures, Geotechnics in Transport Infrastructure, Urban Roads, Railways, Maintenance and rehabilitation of Transport Infrastructure and Road Intersections. Optional courses are: GIS and Engineering Geodesy in Transport Infrastructure, Airports, Modeling of Transport Infrastructure, Characteristics of pavement surface, Application of Geosintetics, Monitoring and measurement and Traffic simulation in the city road network.

2.2 Substructure of Transport Infrastructure

Substructure of Transport Infrastructure is compulsory course at the first year of graduate study at the Faculty of Civil Engineering Osijek. The aim of the course is to familiarize students with the design and construction of the substructure of road and railway infrastructure and facilities therein, technology planning and the quality control of works. Teachers from the field of transportation engineering and from the field of construction management and technologies are participating together in execution of the course. The course is designed in 30 hours of lectures and 30 hours of exercises, the course is awarded with 5.0 ECTS credits, and the specifics of the course will be described below.

2.2.1 Continuation of work on undergraduate assignments – preliminary road design

During the semester, within the exercise hours, students create a semester project that includes various tasks and within it is needed to:

- make a quantity survey
- create the WBS project structure
- analyse the cost for the selected items from the quantity survey
- create a dynamic plan using the TILOS software package
- draw a line of surface, mass haul diagram and line of equalization, and
- create a hydraulic calculation of the concrete pipe culvert.

All the given assignments are performed as continuation on the preliminary design of road, the semester project students have created during the fifth semester of the undergraduate study in the Road course. This way of working ensures the integrity of the solution, while at the same time it is easier for the students because they are familiar with the project they have created themselves. In the existing preliminary design of road, which contains the horizontal and vertical alignment and the characteristic cross-sections, work continues by producing a cut and fill calculations for each cross-section, calculation and mass alignment, after which the line of mass and alignment line are drawn up. The hydraulic calculation of pipe culvert, for which a cross-section is a part of preliminary project, is performed and then the applied diameter of the pipe culvert is verified. The technical description is complemented by a detailed description of the selected technology in construction of road substructure, with control and quality assurance program.

During the part of project in area of construction management and technology, student work on choosing the appropriate technology for construction of the designed road. The primary goal of choosing construction technology is that the applied machinery and their corresponding performance (for assumed or default conditions and work limitations) give minimum cost per unit of product. With the choice of construction technology, students are required to make cost analysis and cost estimate for selected items from the quantity survey, which simulates the process of developing a complete road construction project.

For the phase of earthworks within the semester program, students create a dynamic plan using MS Project or TILOS computer programs. Usage of specialized computer programs in teaching is aimed at establishing a stronger link between formal education and engineering practice. As building information modeling (BIM) is becoming a standard practice in construction, in recent years the Faculty is trying to integrate BIM concepts and skills into a course program [4].

By this approach, connecting the fields of transportation engineering and construction management, all the elements related to the execution of road project are included – from the design idea to the preparation for construction of the road substructure.

2.2.2 Laboratory exercises

The importance of understanding the procedures for various tests that are part of quality control during substructure construction has been noted. So the usual lectures and exercises are complemented with the possibility for student independent work in the laboratory and in the field. Laboratory exercises are performed in the Geotechnical and Road Construction Laboratory at the Department for Geotechnics, Transportation and Geodesy of the Faculty of Civil Engineering Osijek. The laboratory has basic equipment for laboratory and field testing. During the lab exercises within the course Substructure of Transport Infrastructure students learn about the available equipment and laboratory work, steps of various test performance along which certain test are demonstrated to them (such as the CBR). Apart from getting familiar with the equipment and testing, an important part of the lesson includes student involvement by conducting standard Proctor test. Within a 5-hour class, students perform standard Proctor experiments by preparing and manually compacting samples (Fig.1.), after which they analyse results and determine maximum dry density and optimal moisture content.

Independent testing by students in the laboratory not only tests and extends theoretical knowledge about Proctor test and removes possible unknowns, but also teaches the importance of reading and understanding the requirements of the test standards so that the obtained results are relevant. The students show satisfaction with laboratory work, some of them express interest in continuing laboratory work and are further involved in laboratory tests conducted for the purposes of scientific research.

Regarding the application of standards for laboratory work, it should be emphasized that students have access to the digital repository of the Croatian Standards Institute HRN4You – web application that allows search and review of the standard http://hrn4you.hzn.hr. Application is available through the AAI @EduHr system.

Final semester project also contains the documentation created in the laboratory during performance of standard Proctor test (description of the test procedure, photo documentation, completed test form) (Fig. 1).

Figure 1 Performing of standard Proctor's test in the laboratory [5]

2.2.3 Fieldwork

Field trips and work are an important and compulsory part of the lessons within the course of the Substructure of Transport Infrastructure. Depending on the planned content, they are either half-day or full-day. The main purpose of fieldwork is to supplement the theoretical knowledge of students and to gain a complete insight into the issue of constructing road substructure and objects and necessary organization of the construction site [6].

The choice of construction site depends on the current work being done on them and on the complexity of these works. Attempts are made to select the construction site which allows students to see different types of work on the road or rail substructure, bridges, drainage devices, etc. Fieldwork included a visit to complex construction sites such as bridge construction site across Drava river near Petrijevci on the A5 motorway, Franjo Tuđman airport construction site in Zagreb, or construction site of the Gradec – Sveti Ivan Žabno railway line (Fig.2). Every year a visit is organized to the Sector of Transport and Construction Machinery of the Osijek-Koteks company where students are introduced to the particularities of the machines involved in construction works.
Before going to the selected site, students are briefly introduced with the construction site and the works they will see, which at the same time tests their theoretical knowledge. On construction sites, students are introduced with the project, and after, during the tour of the site they are introduced to dynamics of works, machines and methods used, and (potential) problems the contractors encounter during construction. Different tests that are being carried out for the purpose of quality control are demonstrated to the students at the construction sites. They also have the opportunity to participate in the tests themselves which they point out as particularly interesting experience in fieldwork exercises.

Figure 2 Subgrade construction sites of airport (left) and railway (right)

Analysis of the results of the survey conducted among the students at the end of the academic year, shows there is a clear satisfaction with the scope of fieldwork and its contribution to the understanding of the syllabus, as well as the level of involvement of construction professionals in the course realization.

2.2.4 Guest lecturers

Another specialty of this course are the guest lecturers. By inviting various guest lecturers, professionals from construction industry, students have been able to gain insight into the current issues related to design or infrastructure construction, as well as getting a different view on a common problems from the point of view of different professions.
Therefore, the lecture on archaeological excavations during the road construction was held by the archaeologist Tino Leleković, PhD. Within the lecture “Archaeology and transportation infrastructure” he described types, actions and the dynamics of archaeological excavations. He introduced to the students the legislative framework for the protection and preservation of cultural goods and obligations of the contractor in case of archaeological discovery. He emphasized the need for understanding and cooperation between these two professions during construction. He presented examples of archaeological finds that were discovered during road construction in our country, with special reference to the rich archaeological site (Ivandvor site) discovered during the construction of junction Đakovo on the A5 motorway (Fig. 3).
The main project designer of the southern bypass of the city of Osijek, Mr. Hrvoje Dragovan, MSc.Civ.Eng. from the IGH Institute, spoke to the students (Fig. 3) about upgrading of the southern pavement of the bypass. Students were familiarized with the design documentati-

on, track condition, road construction problems in the high embankment zone and with the importance of teamwork, respectively with the need of good mutual coordination between different experts. The lecture was a good introduction for a visit to the construction site of the southern Osijek bypass that was organized a week later (Fig. 3).

Figure 3 Archaeological research on the Ivandvor site (left) and detail of the southern Osijek bypass site (right)

Lecture by guest experts are set in the context of syllabus so that theory can be best linked to practice. After the lectures students were actively involved in the discussion and expressed satisfaction that they had the opportunity to hear about actual examples and to get acquainted with the problems during the execution of the works that are an integral part of everyday construction.

3 Conclusion

Described modern approach to student education has been designed with the aim of implementing requirements and changes in higher education in recent years along with other contemporary achievements in education of construction engineers at university level. Furthermore, the labor market requires competent engineers who can accurately describe what they can do after finishing a particular course. Interdisciplinarity in work is appreciated. These were the guidelines for cooperation and joint work between teachers from the transportation engineering and construction management and technology, for the course Substructure of Transport Infrastructure. Good teaching cooperation between these areas has been going on for number of years, from the academic year 2006/2007 [3]. Collaborative practice and its success and efficiency are fully expressed by launching field of specialization in Transport infrastructure on the graduate university study of the Faculty of Civil Engineering Osijek [7]. Described modern interdisciplinary approach to the education of students in the area of transportation infrastructure allows development and acquisition of competences that are in line with the expectations and demands of employers. This approach meets the demands of contemporary teaching – the acquisition of knowledge is conceived in a way that the teaching content forms a complete and logical system. In this way, in the educational process students equally acquire theoretical and practical knowledge and develop the abilities to comprehend it as a whole, enabling them to choose and apply appropriate strategies for solving engineering problems in practice.

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