

# Polytechnic Education for Specialists in Hydraulic Engineering

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**Abstract**— Hydrotechnical construction has always been considered a prestigious profession, which attracted the most talented students. The international practice of education also involves the allocation of transport maritime engineering from general and civil construction. The Institute of Water Transport in the structure of Admiral Makarov State University of Maritime and Inland Shipping considers the development of polytechnic education for the specialty of hydrotechnical construction as an urgent task for the future. Gradual transition to the system of polytechnic education is carried out by conducting laboratory practices and works in the field, where students independently participate in engineering surveys, studies of natural materials and soil, perform geodetic work. A new trend in development for hydraulic engineering construction is the use of building information modelling (BIM) technologies for the life cycle of structures. The introduction of BIM technologies should radically improve and interlink all the directions of design, construction and operation of such unique objects as water transport hydraulic structures. We give several examples of the introduction of polytechnic education in the system of training specialists of various levels (bachelor, master and specialist) for hydraulic engineering construction of water transport facilities, which corresponds to the best world practices. The results in the formation of new professional skills and competencies are based on the application of system analysis and a unified methodology for the synthesis of various construction disciplines that are logically related and focused on the solution of assigned tasks.

**Keywords**— *Geotechnical Engineering, Polytechnic Education, Water Transport.*

## 1. INTRODUCTION

Geotechnical engineering had always been considered a prestigious profession, which attracted the most talented students. There is an extensive network of colleges and universities in the Russian Federation that provide the tuition of specialists in the field of geotechnical engineering. The international practice of education also assumes the separation of transport geotechnical engineering from general construction. In paper [1] the basic problems at the competences formation were considered, the author's view on the basic skills necessary for engineers, incl. for polytechnic education, was offered. The licensing of professional ASCE practice [2] for bachelors in the field of construction demands the presence of relevant experience, which is based on broad technical and professional practical knowledge that provides sufficient flexibility for a wide range of roles in engineering

practice. Outside the bachelor's degree, the master's degree requires a polytechnic education. In paper [3], the authors give data about the decrease in students' interest in engineering specialties, since the traditional paradigm, which since its foundation was dominant in engineering education, does not offer future development. On the contrary, in paper [4] the author believes that education for hydraulic engineering passes to the development of new thinking skills that can be integrated with interactive educational technologies that give advantages and avoid passive attitude among students. The tasks of polytechnic education for students in the field of hydraulic engineering are discussed in detail in [5], where the importance of practical experience gained by students during the education, the balance of the study of disciplines on the mechanics of building materials, engineering surveys and design are noted.

The results of studies on the impact of the reform of polytechnical education in Finland in the 1990s are cited in [6, 7]. This reform allowed to significantly improve the quality of education in vocational colleges, bringing them closer to universities, subsequently it increased the mobility of graduates, both secondary schools and colleges. As a result, the polytechnical reform in Finland had been giving outcomes for more than a decade, with the rates increasing of 1-2% each year.

The Institute of Water Transport in the structure of Admiral Makarov State University of Maritime and Inland Shipping considers the development of polytechnic education for the specialty of hydraulic engineering as an urgent task for the future.

The subject of the study is the formation of a set of tasks and measures to ensure the high quality of education in the field of hydraulic engineering of water transport facilities.

The purpose of this paper is the analysis the current situation about the progress of higher polytechnic education and the development on this basis of conceptual proposals for the improvement of educational technologies, taking into account current achievements in various interdisciplinary areas.

## 2. MATERIALS AND METHOD

Historically, the Institute of Water Transport has preserved traditions of continuity, transfer of experience and obtaining of practical skills under existing conditions. Tuition of specialists

in the field of geotechnical engineering is carried out at several levels - from career guidance of schoolchildren to magistracy. The first "river specialized schools" formed the main educational process, which moved to modern colleges, where great attention is paid to the practical work of cadets in all courses of study. Here begins a gradual transition to the system of polytechnic education by carrying out of laboratory practices and works under the field conditions, where students independently participate in engineering surveys, studies of natural materials and soil, perform geodetic works. The number of hours in practice can be up to a calendar month, thus the primary skills are forming, which are further used in pre-diploma practice.

Tuition in the college allows to obtain the basic competencies in the field of geotechnical engineering, further tuition during the bachelor program expands students' knowledge in the field of geology and design of constructions. The majority of specialists in the field of water transport performs calculations and design using special software, these are calculations of slopes, retaining or quay walls, and so on. To understand the design principles, it is necessary to have the skills of "manual" solution of the simplest tasks, taking into account various factors. For civil engineering, this is a set of standard tasks with known boundary conditions, but for geotechnical engineering this is already a serious study that requires a polytechnic education. For example, in order to solve the problem of water filtration in the backfill, the fundamental knowledge in several disciplines and experience in laboratory research are needed - Fig. 1. Calculation of constructions on the ice impact is a separate scientific task that requires both fundamental and applied polytechnic knowledge.



Fig. 1. Laboratory of hydraulic structures operation

A new trend in hydraulic engineering development is the use of BIM technologies for the life cycle of constructions. The implementation of BIM technologies should radically improve and interlink all the directions of design, building and operation of such unique objects as water transport hydraulic engineering structures. If for civil and industrial construction the main states of BIM-technologies have already been applied, then for the transport infrastructure of water transport this task is just beginning. More expanded training in the field of information technologies is necessary for BIM mastering by

students, and besides the tuition should be at all courses in the cross-cutting directions, which is also an element of polytechnic education. Further improvement of the polytechnic education process and achievement of the requirements for the branch development is supposed to be carried out on the basis of BIM technologies - a uniform information system of hydraulic engineering structures of water transport, which allows to design and management by the facility efficiently at all stages of the life cycle.

The polytechnic laboratory of the Institute of Water Transport was opened In February 2018 supported by FSUE "Rosmorport" (fig.2).



Fig. 2. The polytechnic laboratory of the Institute of Water Transport

The main functions of the Polytechnic Laboratory are:

**Educational function:** interactive lectures, videoconferences and seminars, virtual laboratory works, computer training and testing, Internet testing.

**Scientific and research function:** video seminars and lectures with remote access, video lectures, scientific work, simulation, accompanied by dynamic graphics; creation of three-dimensional visualizations and reconstructions, automatic design of objects and development of various simulators and three-dimensional block diagrams of programs.

**Methodical support:** methodological materials were uploaded to the network such as electronic educational and methodical complexes, presentations of lectures, laboratory works, incl. virtual; the base of electronic textbooks and reference books, the catalog of Internet resources, files with tests, control and independent works, files with posters, maps and manuals, electronic journals, video files, block maps, reference conspectuses.

A typical example of the BIM use is the development and construction of high-precision 3D models of geotechnical engineering objects in CAD systems, export them to SCAD for engineering calculations and transfer the results of calculations to Allpan for the further formation of reports and working documentation. At the same time, work volumes are transferred, cost estimates are performed and construction costs are analyzed as the design decisions are made, with an

assessment of the reliability of the structure and the risk of safe operation.

The capabilities of the Polytechnic Laboratory fully provide students of all courses by CAD products for the basic academic disciplines.

### 3. DISCUSSION

We gave several examples of the implementation of polytechnic education in the system of specialist's tuition of various levels (bachelor, master) for hydraulic engineering of water transport facilities, which corresponds to the best world practices [8-10].

Revision of individual training program and curriculum with increasing of disciplines number on the use of CAD tools and project management is necessary for an active transition to the BIM technologies use, information modeling and life cycle management of port hydraulic engineering structures [11, 12].

Special interest in the field of port hydraulic engineering structures is available for the Arctic. In the coming years, several new unique Arctic ports will be built. The total length of the mooring front of such ports can be tens of kilometers. To realize such large-scale projects, the implementation of polytechnic education for the design and construction of facilities of water transport infrastructure will be a key task for universities and design organizations.

### 4. CONCLUSION

The tasks of polytechnic education, as the most progressive method of professional skills and competences formation, appear at the present stage of higher education development in the field of geotechnical engineering, incl.:

on the basis of a system analysis the development of a unified methodology for the synthesis of various building disciplines that are logically related to each other and oriented towards the tasks solution;

the application of a broader industrial student's practice with reference to the future work place within the framework of target education;

development of scientific research to ensure technogenic safety and accident-free operation of natural-technical systems of hydraulic engineering structures of facilities of water transport infrastructure.

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