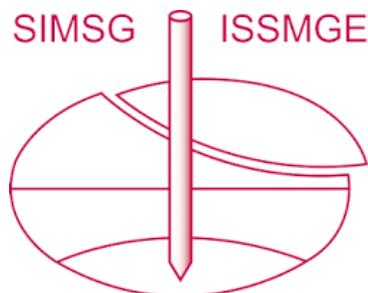


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Some aspects of comparison of geo-engineers education at the universities of Germany and Russia

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ABSTRACT: The purpose of the paper is to reveal differences and coincidences in training geotechnical engineers both in Russia and in Germany by the example of comparing curricula and syllabuses of Darmstadt Technical University, Germany, and Perm State Technical University, Russia. The researches have been carried out at support DAAD.

1 INTRODUCTION

Formation of a unified educational system is an important act of integrating different European countries. In 1999 the heads of Education Departments of 29 European countries signed the Bologna convention, the aim of which was to form a unified system of higher education in Europe. In the opinion of the participants of that conference, leveling of educational models would enlarge the exchange of students and make European Universities the centre of the world intellectual elite. Russia signed the Bologna convention in 2003. Nowadays, more than 50 countries, including nearly all European countries, have already signed the Bologna convention.

However, the process of integration is not going as fast as its authors would like to. The reason is in the fact that before the Bologna convention was signed, many countries had already had their own well-developed and proved in due course systems of training specialists, including building engineers – experts in geotechnics. Both in Germany and in Russia the system of higher education had been based on training certificated engineers professionally trained in certain fields of building engineering. That's why, a certain transitional period is required for the transition to a two-level system of education, as the Bologna convention calls for. The length of such a period depends on how ready this or that country is to change quickly its own system of education. Germany started reforming its system of education earlier than Russia. Russia is only going into this process and the results are not totally clear for the time being. A two-level system of training qualified specialists provokes a lot of questions. Therefore, the authors of this paper decided to make a comparison of training on the basis of a well-developed and cur-

rently in use in both countries system of training certificated building engineers in the field of geotechnics.

The purpose of the paper is to reveal differences and coincidences in training engineers-experts in geotechnics both in Russia and in Germany by the example of comparing curricula and syllabuses of Darmstadt Technical University, Germany, and Perm State Technical University, Russia. The following aspects such as - a general system of training building engineers in the universities; a number of lectures, seminars and laboratory tests on geotechnics and their frequency and periodicity in terms; the system of knowledge assessment (colloquia, credit tests or passes and exams); systematic connection of geotechnics with other building subjects and courses; preparation of a qualification paper - will be compared.

2 EXISTING EDUCATIONAL SYSTEMS OF TRAINING CERTIFICATED ENGINEERS IN RUSSIA AND GERMANY

2.1 *Training of building engineers in Russia*

At present time building engineers are trained in Russia under the State Educational Standard (GOST) for higher vocational training of professionally qualified specialists in the field of building engineering (635500). The present standard was adopted by the Ministry of Education of Russian Federation in March 2000. It is a compulsory normative document for all higher educational institutions (universities, academies, institutes) training building engineers. 10 main building engineering specialties are determined in this document. They are the following:

- industrial and civil engineering;
- hydraulic engineering;
- city construction and economy;
- production of building materials, units and structures;
- heat and gas supply and ventilation;
- water supply and drainage;
- building mechanization and automation;
- mechanical equipment and technological complexes for building materials, units and structures plants;
- examination and real estate control;
- design of buildings.

Normative period of study at each speciality lasts 5 years (or 10 terms) providing it is full-time tuition (i.e. students do not work). Besides, there is also tuition by correspondence (i.e. students have a permanent job but they want to study). Tuition by correspondence is done in the form of a short course of lectures, tutorials and exams at the beginning and at the end of term. At the rest of the time students learn on their own either in a library or through the Internet. The period of study is 6 years (or 12 terms).

For each speciality mentioned above there are additional specializations, which involve an in-depth learning of certain subjects of the main speciality in senior years of study. For example, the specialization of Geotechnics is part of Industrial and civil engineering speciality.

To enter the university an applicant must have a secondary education certificate (i.e. a school-leaving certificate) and pass entrance exams. Secondary education means finishing school that provides general 11-year education, taking final exams and receiving a certificate of the state pattern. Entrance exams at university are held in the form of tests, the number and content of which are determined by the university. Entering building engineering faculties of technical universities requires, as a rule, doing tests on Physics, Mathematics and Russian Language. Each test is assessed. Then, all scores are summed up and a competitive pass mark for a certain number of vacancies in the university is determined. The Ministry of Education fixes the number of students in the university.

It is necessary to note that at present time Russia is carrying out the reform of higher education. Essential changes have already touched upon the rules of university enrolment. For example, in addition to the places that are given by the government, universities have the right to enroll applicants who will pay for their studies by themselves. The number of them is expected to rise to 50%. The money obtained goes to the university development. What is more, final exams at school are done in the form of united tests, which are given the same status as those in the entrance exams at the university. After successful passing of school tests an applicant brings the certificate

with test results to the chosen university. In this case it is not necessary to take additional entrance exams.

In the course of studies, a future building engineer must master a number of disciplines that are divided into the following blocks:

- HSE block – general humanities and socio-economic disciplines;
- NS block – general mathematical and natural sciences;
- GPD block – general professional disciplines;
- SD block – special disciplines, including specialization disciplines;
- OD block – elective disciplines.

The general period of training a building engineer lasts 10 terms (or 260 weeks), including a practical session, diploma or project work, exams and student vacation.

Upon finishing the theoretical course of study from term 1 to term 9 a student must go through a concluding state assessment that includes the state exam on speciality and the defense of a diploma project. The order of taking the state exam for building engineers and its content are determined by the university. The graduate must acknowledge the receipt of knowledge on basic building disciplines (such as, Building Structures, Construction Technology, Design of Buildings, Geotechnics, etc.). After successful taking of the state exam on speciality a student begins to do a diploma project, the theme of which he chooses himself, agrees it with the teacher who will advise him on diploma work. It usually takes about 100 days to fulfil a diploma project. It must be presented in the form of manuscript and some illustrations (i.e., drawings, graphs and diagrams).

It is necessary to note that Russian system of education requires from students to carry out the curriculum in strict succession. It cannot be changed. For example, after entering the university students are divided into separate groups, the member of which they will be during the whole period of study. It is necessary for the optimization and planning of the educational process of the university as a whole. The number of exams and credit tests during each term is strictly determined by the university curriculum. A student failed an exam or a credit test in the course of term is not moved up to the next term or to the next year of studies after summer term. Students are allowed to re-sit exams and credit tests. A student who has not completed the theoretical course of studies successfully cannot be allowed to take the state exam and do a diploma project. As a rule, re-sitting the state exam is impossible. Those who do not cope with studies are expelled from university. It is possible to reinstate such students in their status next year and it is university administration that decides on this.

2.2 Training of building engineers in Germany

Training of qualified engineers in German universities is determined by a special document of a federal land. Thus, for the Darmstadt University of Technology it is "Education Act of the land of Hessen", which was adopted in November 1998. It determines common aims and tasks of educational institutions, their rights and duties. This act is extended only to the universities of the federal land of Hessen. In contrast to the Russian standard, this document has common characteristics and gives universities substantial rights to choose curricula and work out syllabuses. When accrediting universities the State commission is guided by this document.

The university determines concrete aims and tasks of tuition on its own, including curricula and syllabuses.

Training of building engineers also lasts 5 years (10 terms). As a rule, it is not necessary to take entrance exams in order to enter the university. The number of applicants is not regulated by the state or the university. In some universities the number of applicants is limited. It concerns, mainly, specialities dealing with humanities. An applicant is asked to demonstrate good marks after finishing school. Tuition in German schools of general education lasts 13 years and in special schools it can last 12 years. After finishing school a school-leaver is given a state certificate.

Training of building engineers is divided into some educational blocks. Block 1 is basic. It consists of general technical subjects, such as, mathematics, geodesy, physics, constructive geometry, technical mechanics, fundamentals of planning and designing, building information science and one subject from other fields of study (for example, economics, philosophy, etc.), which students have the right to choose by themselves. It is not allowed to choose elective subjects, such as, sports and foreign languages. Students are taught the subjects of this block in terms 1-3. Upon completion of block 1 students take a pre-diploma exam.

Block 2 – level A – consists of 9 basic subjects on building disciplines, such as, transport construction, hydraulic engineering construction, city infrastructure, building information science, geotechnics, reinforced-concrete constructions, steel constructions, building mechanics, geology and two subject of choice from other fields. Tuition takes place in terms 4-6.

Block 3 – level B- consists of 3 basic building subjects on which a student plans to specialize in future and 3 additional subjects that require advanced study of the same basic subjects. These subjects are taught in terms 7-8.

Block 4 – level C – includes only one basic building subject chosen by a student, on which he intends to write a diploma project. Level C means getting

thorough knowledge and skills in doing research. A student also writes a pre-diploma paper and does a diploma project in term 10. This block encompasses terms 8-10. Time given for a pre-diploma paper is not limited and it is usually 6 months. It takes 6-8 weeks to do a diploma paper, which is presented in written form with some graphic material. But before that a student must pass a building exam on the chosen speciality, which includes the knowledge of the subjects from Blocks 2-4. While studying students must do 60-day practical work in industry. Students choose when they can do it on their own.

Table 1.Comparison of education criteria in Russia and Germany.

Criteria	Darmstadt University of Technology	Perm State Technical University
Availability of a regulating educational document	Education Act of the land of Hessen; University Charter	State Educational Standard; University Charter
Curricula and syllabuses	made and approved by the university	made and approved by the university on the basis of the State Standard
Length of building engineer tuition	10 terms	10 terms
University entrance exams	not required	Required
Tuition fee	free education (before the year 2007) and paid education (since the year 2007)	free education (50%) and paid education (50%)
Structure of education	by educational blocks	by educational blocks
Knowledge assessment	colloquia, exams	passes or credit tests, exams
Interdisciplinary exam	available	available
Final qualification work	done in term 10	done in term 10
Given qualification	building engineer	building engineer
Choice of profession	in the process of studies	before studies begin
Study arrangement	individually	in student groups
Possibility of independent study planning	exists	only in agreement with the dean's office
Length of tuition	Unlimited	limited
Study of humanities and social sciences	not more than one of a student's own choice	block of social sciences and humanities
Study of foreign languages and sports disciplines	not included in a syllabus; elective study is possible	included in a syllabus

The analysis of German system of training building engineers allows to come to a conclusion that stu-

dents have good opportunities to choose their future profession. They can make their final decision before starting a diploma project in senior years of study, whereas, Russian system of education requires from an applicant to decide on his future profession before entering the university. According to German system of education, a student can choose a scheme of study on his own, guided only by the final result on the chosen engineering profession. Furthermore, students are not bound to certain groups and can freely take different subjects in term. Training by the German system does not have a limited character.

3 TRAINING OF GEO-ENGINEERS IN TECHNICAL UNIVERSITIES OF RUSSIA AND GERMANY

3.1 *Geotechnical subjects delivered in Russian educational institutions*

Two basic courses on Geotechnics – Soil Mechanics (60 study hours in the block of general professional disciplines) and Bases and Foundations (150 study hours in the block of special disciplines) are delivered in technical universities of Russia under the State Educational Standard (GOST). Universities are given the right to include an additional subject into the block of specialization. The concrete distribution of study hours in the course of Geotechnics and their content will be considered further by the example of the curriculum of the State Technical University of Perm.

The course of Soil Mechanics is delivered in term 7. It consists of lectures (1,5 study hours a week) and laboratory tests (1 study hour every other week). In this course the following issues are discussed: composition, structure and state of soils; physico-mechanical properties of foundation soils; distribution of stresses in soil body, foundation bed analysis on deformations, carrying capacities and stability. Upon completion of the course in winter term students pass credit tests.

The course of Bases and Foundations is delivered in term 8. It consists of a two-hour lecture a week and practical trainings (1 study hour a week). Students also carry out a course project on this discipline that consists of designing foundation of a certain building in definite geo-engineering conditions. They do it on their own on the basis of the tasks that are solved during practical trainings. In this course the following issues are discussed: general principles of base and foundation design; foundations in open trenches on natural bed; pile foundations; methods of artificial improvement of foundation soils, trench design, deep foundations, embedded and underground structures; construction on structurally unstable, rocky, alluvial grounds and on karst and worked up territories; foundations under dynamic

impacts; renovation of foundations and base reinforcement; computer-aided (automated) foundation design. Upon completion of the lecture course students pass credit tests.

The course of Underground Space Renovation is delivered in term 8. It is part of the block of specialization disciplines and consists of a two-hour lecture a week and one-hour practical training every other week. In this course the following issues are discussed: underground structures and the terms of their construction; types and classification; engineering design of underground structures; building technologies of erection and renovation of underground structures (cut- and- cover, sunk wells, ...?..., anchors); special methods of construction and underground structure renovation; moistureproofing; waterproof and dewatering of territories; underground structure loads; design methods for underground structures; underground structures operation. Upon completion of the course students pass credit tests.

3.2 *Training of geo-engineers in Germany*

As it was mentioned above (see section 2.2), engineers in Germany are trained on four basic levels. Geotechnical subjects are assigned for 3 special levels – levels A, B, C (terms 5-9). The distribution of courses on Geotechnics in Darmstadt Technical University will be considered further.

The fundamental course - Geotechnics 1 and 2 is delivered in terms 5 and 6. It is one of the basic 9 courses given for all building engineers. The course consists of a two-hour lecture and a two-hour practical exercises a week in each term. In this course the following issues are discussed: ground phases and its basic and calculated ingredients; ground and rock stresses; deformation and stress indexes in bases; types of limit ground states; methods of foundation arrangements; geotechnical holding structures; soil and rock physics; soil classification; soils as building materials; quality management in geotechnics; geotechnical test work; design and calculation of shallow foundations; design and calculation of deep foundations; designing of holding elements; introduction into the geotechnics of environment. Students have a colloquium on the topics delivered in each term.

Block B is preliminary specialization. Training is done in terms 7 and 8. Students choose three building subjects out of nine. In this block there are two basic courses of geotechnics in autumn and winter terms – Geotechnics 3 and Geotechnics 4. Each course consists of a two-hour lecture and a two-hour practical training a week in each term. In these courses the following issues are discussed: theoretical soil mechanics; testing methods; ground waters and their control; limit ground and rock states; slope stability;

loss of stability; breast wall design; methods of observation; geotechnical retaining structures and walls; foundation- base mode of behavior; shallow foundations; calculation of foundation settlement with time; piles; pile and panel-wall foundations; geotechnical categories. In each term students have a colloquium on the topics delivered. In addition, under the scheme of studies in German higher educational institutions extra courses on Geophysics that enrich the knowledge of the subject are offered, for example, Deep Excavation Works (one-hour lecture and one-hour practical training a week in term 7), Finite Elements Method in Geotechnics (one-hour lecture and one-hour practical training a week in term 7), Skyscraper Foundations (one-hour lecture and one-hour practical training a week in term 7), Geocynthetics in Geotechnics (one-hour lecture and one-hour practical training a week in term 7), etc. Students can choose not more than 1-2 additional courses.

Block C is final specialization of a geotechnical engineer. It consists of two basic disciplines – Geotechnics 5 (in term 8) and Geotechnics 6 (in term 9). Each course consists of a two-hour lecture and a two-hour laboratory tests a week in each term. Block C is aimed at advanced study of the main subject on the basis of which a student intends to write a diploma project. In these courses the following issues are discussed: soil investigation; soil classification; lab soil test; field soil trial; real (practical) study of geotechnical project; basic project estimator; application limits of geotechnical programs. In each term students have a presentations and reports on the topics delivered. Also, in term 9 a seminar in the form of a business game is held. Students make reports and discuss them. Such seminars are held every other week and take 2 study hours.

More than that, a student who chose Geotechnics as his specialization must take a total exam on all courses of Geotechnics 1-6. Those who passed this exam are allowed to do a diploma project.

Table 2. Comparison of geo-engineer training criteria in Russia and Germany

Criteria	Darmstadt University of Technology	Perm State Technical University
Kinds of lessons	lectures, practical classes, laboratory tests	Lectures, practical classes, laboratory tests
Delivered courses	Geotechnics 1,2,3,4,5,6 And advanced courses (up to 12 courses of a student's own choice)	Soil Mechanics, Bases and Foundations, Underground Space Reconstruction
Terms	terms 5, 6, 7, 8 , 9	Terms 7,8 coincides
List of basic themes on Geotechnics	Coincides	

Total number of study hours per week during the whole study period	18 -20 hours	10 hours
Knowledge assessment	colloquia, exam	pass or credit test, course project allowed
Theme choice on Geotechnics for diploma work	Allowed	

4 BASIC RESULTS OF COMPARISON AND DISCUSSION ISSUES

Comparing two systems of education it is necessary to note that they have much in common, for example, equal normative terms for training building engineers, term distribution of subjects, grouping of subjects into study blocks, the necessity of knowledge control at different training stages, having interdisciplinary exams and practical training as integral part of educational process, writing and presentation of a qualification project at the final stage, getting of a qualification certificate.

The same similarities and differences as were mentioned above can be seen in training geo-engineers in both universities. Thus, the list of issues being studied by future geo-engineers in the courses of Geotechnics coincides (about 80-85%). There are differences in specific issues connected either with climatic and geological conditions of construction or with the specific character of construction methods in different countries. In both countries the course of Geotechnics is delivered in senior study years after general and basic technical subjects. In both countries in addition to lectures there are laboratory tests and practical lessons aimed at consolidating students' knowledge of Geotechnics. In both countries the basic speciality is of a building engineer. A student is given the right to write a final qualification project on Geotechnics or on other building subject-matter. But in German universities the course of Geotechnics has more study hours than in Russian universities. The difference in the number of hours accounts for 40-60%. This fact allows the lecturers of the course to expand the issues and students to understand the meaning of problems being solved in this course.

Based on the analysis of training in two universities the authors of the paper would like to discuss the basic results that were obtained at the conference and to know the opinion of their colleagues.