

CIVIL ENGINEERING EDUCATIONAL STANDARDS IN RUSSIA

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EXTENDED ABSTRACT

Higher education in Russia faces today problems connected not only with current requirements of national economy and the need for qualified professionals, but also with the integration into the European and international educational systems. In 2003 Russia joined the Bologna process, which aims at the creation of a uniform European educational space. Many Russians had the opinion that the process is going to reform higher education system in Russia according to European standards and to implement training under "the European" programs. Russia's joining the Bologna Declaration offers the possibility for Russian Universities to participate in European educational projects, and opportunities for students and academic staff to participate in academic and scientific mobility activities. It should be mentioned that two-level education exists in Russia since 1992, but it was mostly implemented in the fields of economics, management and the humanities. Engineering programs traditionally followed five year curricula.

Higher education in Civil Engineering in Russia is offered by 14 Civil Engineering Universities and more than 140 Civil Engineering Faculties in Technical Universities. All these institutions belong to the Association of Civil Engineering Higher Schools (ACEHS). The main goal of the academic community of Civil Engineering was to create adequate bachelor and master educational standards and programs acceptable both by universities and employers from industry. At the moment there are 15 specialties in civil engineering education in Russia. They are covering main professional areas – construction, technology of construction materials, engineering systems (water supply and waste water treatment, heat- gas supply and ventilation) etc.

The new Standards in education stipulate a single unified Bachelor's Standard for civil engineering. The former civil engineering specialties now form different profiles within this single standard. To achieve the goals of the new paradigm in higher education, special "didactical groups" from different civil engineering universities were formed, which created the so-called "basic part" of bachelor standards, which are obligatory for all universities, and the "variable parts", which correspond to specialties in civil engineering already existing in Russian universities. This arrangement was necessary from three points of view: first, we tried to save traditions in civil engineering education, second, it is very difficult (practically impossible) to "turn over" the minds of academic staff, who recognize only the five-year Engineering education Diploma, and third, the employers should understand "who is who", i.e. the correspondence of each Bachelors profile with existing specialties. These difficulties were addressed by an optimized structure of the educational programs, according to which the basic part of bachelor programs does not exceed 50 % of the total curriculum, while in master programs it does not exceed 30 %. This arrangement allows all the existing civil engineering specialties to be unified under a single program, i.e., the Bachelor in Civil Engineering. At the same time, such a structure gives Universities flexibility in creating their own variations of civil engineering programs, which take into account local features and employer requirements.

KEYWORDS

Civil Engineering Education, Bologna Process, Educational Standards, Bachelor Program, Master Program, basic part, variable part.

1. INTRODUCTION

1.1 International experience

Bologna Process and the changing of traditional five-year Engineering Diploma to two-level Bachelor (3 years) and Master (2 years) programs are issues widely discussed in many countries. These changes are closer to traditional higher education models in the UK and Ireland than those in most of Continental Europe. In many countries the Process was not implemented without criticism. In much of Continental Europe, the previous higher education system was modeled after the traditional German system, which is based on a clear difference between vocational and academic higher education. However, having two types of degrees can be counterproductive in the following cases:

- The vocational three-year degrees are not intended for further study, so those students who also want to advance to a master's degree will be at a disadvantage.
- The master's degree effectively becomes the minimum qualification for a professional engineer, rather than the bachelor's degree.
- The academic three-year degrees mostly prepare students to continue for a master's degree, so students who enter the workforce at that point will not be properly prepared. Yet they would have the same academic title as the fully trained vocationally educated engineers.

The final result of the change is that the agreements between professional bodies will require reevaluation in some cases as qualifications change.

The requirement of 60 European Credit Transfer System (ECTS) per year assumes that 1,500–1,800 hours are offered per year. However, the Bologna Process does not standardize semesters, which means that if the summer break at the university is long, the same material has to fit in a shorter study year. Also, there have been accusations that the same courses have been simply redefined, e.g. one course would be 1.5 times shorter upon conversion of the local credits to ECTS, without making any change to course content or requirements. This effectively increases demands without any countermeasure. The extent of this problem alone is such that in some countries, for example in Norway, one ECTS point is defined as equivalent to 20 hours of study, while in the Netherlands, it is defined as equivalent to 28 hours. These definitions essentially prove that the "ECTS point" is not standard at all.

It can hence be argued that a process that standardizes titles but not the content of the qualification creates a disadvantage for all candidates that take part in studies other than those requiring minimum effort.

So, students mobility, one of the main aims of the Bologna Process, can also be criticised because ECTS recognition in different universities needs bilateral or multilateral agreements.

1.2 The case of Russia

Russia is formally in a two-level education system since 1993, when the first Bachelor and Master educational standards were implemented. Since that time two routes of higher education existed till the end of 2010: 5-year Diploma of Engineering or 4-year Bachelor plus 2-year Master Degree. The difference between Engineering Diploma and Bachelor standards was essentially removing one year of study. This means that the first 4 years of Dipl. Eng. and Bach. curriculum are the same and students could change routes at any moment within the first 4 years of study. It should be clarified that these 4-year bachelors were not professionally oriented and were not accepted by employers. Hence, students had to continue education on Dipl. Eng. or Master Programs.

In Civil Engineering previously we had 12 State Educational Standards (SES) for Engineering Diploma Programs:

- Industrial and Civil Engineering

- Hydraulic Power Engineering
- Municipal Construction and Economy
- Construction Materials Technology
- Heat- Gas Supply and Ventilation
- Water Supply and Waste Water Treatment
- Mechanic Equipment and Technological Complexes
- Mechanization and Automation in Construction
- Building Design (Architect Engineer)
- Real Estate Expertise and Management
- Highway and Airport Runway Construction
- Bridge and Transport Tunnel Construction,

and 2 SES for Bachelor and Master Degrees in the direction "Construction".

It should be clarified that the educational system in Russia, including higher education, is based on a system of State Educational Standards (SES). To issue Diplomas recognized by the State, as well as other education-related formal documents, university programs have to be accredited by the Federal Agency on Supervision in Education according to SES. This system ensures the unity of educational space and the recognition of education received at different universities. However, such unity limits the freedom of Universities to develop their own educational programs (to only 15 % of the total amount of theoretical training).

Upon signing the Bologna Agreement in 2003, the Russian Ministry of Education and Science declared that the reform of higher education would be directed mainly towards implementing a two-level educational system. As in many other countries in Europe, most Universities, students and employers in Russia were unhappy with this reform for the following reasons:

- most Universities and students could hardly believe that academic mobility would be possible for students with total, or even partial, financial support
- employers would not accept graduates with bachelor degrees and would instead prefer engineers with five-year diplomas, hence, students could not find job after graduating from bachelor program.

In addition, many public figures in Russia believed that this reform is connected with a desire to cut down expenses on higher education.

Nevertheless, under the pressure of the Ministry of Education and Science, to which universities are subordinate, they have been forced to follow the reform. It should be mentioned that in some training directions some engineering educational programs still remain, but their number was essentially decreased. For instance, there is only one new specialty "Construction of Unique buildings and structures" left in Civil Engineering instead of 12 mentioned above. These standards of new generation are called Federal State Educational Standards (FSSES). It is easy to guess that the majority of developers of bachelor degree standards aspired to keep traditions and continuity of engineering education.

1.3 The goal of the paper

This paper aims at presenting the common requirements to Bachelor, Master and Engineering Programs according to the Federal State Educational Standards, which have been implemented since January 2011, and explain how the educational standards in Civil Engineering education were created.

2. COMMON REQUIREMENTS TO FEDERAL STATE EDUCATIONAL STANDARDS

By Russian Federal Law "EDUCATION" is stated, that workload of education should be measured in Credit Points (C.P.), one C.P. being defined as 36 hours study. Per year 60 C.P. (2160 hours) are required, weekly 1.5 C.P. (54 hours) maximum. The duration of

Bachelor Degree programs should be not less than 4 years (240 C.P.), Master Degree programs – 2 years (120 C.P.) and Engineering programs – not less than 5 years (300 C.P.). All programs are structured in Basic Part (BP) which is obligatory for all Universities and Variable Part (VP) which is a University prerogative.

Bachelor Program consists of Cycles:

B1 – Humanities, Sociology and Economics Cycle

B2 – Mathematic, Natural and Basic Technical Sciences Cycle

B3 – Professional Cycle

B4 – Physical Training

B5 – Field and Professional Practice

B6 – Preparation of Final Bachelor Degree Design

The workload of BP for Cycles B1 – B3 shouldn't exceed 50% of total workload of these Cycles.

Master Program consists of the following Cycles:

M1 – General scientific cycle

M2 – Professional Cycle

M3 – Professional Practice and Research Work

M4 – Presentation of Final Master Degree Dissertation

The workload of BP totally for Cycles M1 – M2 shouldn't exceed 30% of total workload of these Cycles.

Engineering Program consists of Cycles:

S1 – Humanities, Sociology and Economics Cycle

S2 – Mathematic, Natural and Basic Technical Sciences Cycle

S3 – Professional Cycle

S4 – Physical Training

S5 – Field, Professional Practice and Research Work

S6 – Preparation of Final Bachelor Degree Design

The workload of BP totally for Cycles M1 – M3 should be no less than 70% of total workload of these Cycles.

VP of Bachelor, Master and Engineering Programs should consist of two parts: the Main Part and optional disciplines, which should be not less than a third of VP.

New Federal State Educational Standards should be created according to:

- Competency approach (standards are describing cultural and professional competencies instead of previous didactic units, which students should gain after studying disciplines,
- The final-result orientation (the graduates should achieve a constant amount of professional skills prescribed by FSES),
- Employers participation.

Summarizing, we can clearly see that the most flexible are the Master Degree Standards, which allow the creation of various educational programs reflecting up-to-date developments in science and technology. Bachelor Degree Standards are rather more flexible than previous Engineering Diploma Standards, hence allowing the creation of a number of different programs reflecting various applications in professional activity and regional requirements. Engineering Standards are strictly determined to the specific field of professional activities and allow only close specializations.

3. CIVIL ENGINEERING EDUCATIONAL PROGRAMS

3.1 Bachelor Degree Programs

The greatest difficulty encountered was with the creation of the Bachelor Degree Standard. The problem was that, according to the educational reform, previously existing specialties should be transformed, under the new bachelor's system, to profiles. Taking into account the wide spectrum of specialties presented in Section 1.2, it was decided to give as much as possible C.P. for BP in cycles B1 and B2 and minimize cycle B3. The credit distribution between Cycles, Basic and Variable parts are shown in the table 1.

Table 1: Credit distribution of Bachelor program

Cycle	Credit Points , (C.P.)	Basic Part		Variable Part					
				Total		Main		Optional	
		C.P.	%	C.P.	%	C.P.	%	C.P.	%
B1	30	21	70	9	30	6	66,7	3	33,3
B2	70	55	78,6	15	21,4	10	66,7	5	33,3
B3	105	25	23,8	80	76,2	56	70	24	30
B4	2 (400 hrs)	Summary for B1 – B3 Cycles: 205 C.P. Basic Part: 101 C.P. (49,3 %) Variable part: 104 C.P. (50,7 %)							
B5	18								
B6	15								

The use of VP has allowed to develop the profiles. Moreover, a big (24 C.P.) optional module in B3 Cycle allows to deepen the current profile program. As an example, the content of the profile "Industrial and Civil Engineering" is shown in Table 2.

Table 2: The content of Bachelor program, profile Industrial and Civil Engineering

Cycle	Basic Part		Variable Part	
	Discipline (Module)	C.P.	Discipline (Module)	C.P.
B1	History	3	Main part	
	Philosophy	3	Psychology of social interaction	3
	Foreign Language	9	Sociology in Civil Engineering	3
	Jurisprudence. Legislation fundamentals in construction	3	optional	3
	Economics	3		
B2	Mathematics	12	Main part	10
	Informatics	5	optional	5
	Engineering graphics	5		
	Chemistry	4		
	Physics	6		
	Ecology (Environment)	3		
	Mechanics: Theoretical Mechanics Applied Mechanics Soil Mechanics	5 5 2		

		Continuing of the Table 2		
Cycle	Basic Part	Variable Part		
	Discipline (Module)	C.P.	Discipline (Module)	C.P.
B2	Geotechnics:			
	Geology	2		
	Geodesy (Surveying)	2		
	Architecture and Design	4		
B3	Health and safety	3	Main part	
	Building Materials	3	Strength of Materials	6
	Fundamentals of metrology, standardization, certification and quality assurance	3	Structural Mechanics	6
	Engineering systems of buildings and structures:			
	Electricity supply and vertical transport	3	Architecture	6
	Heat- Gas Supply and Ventilation	3		
	Water Supply and Waste Water Treatment	3		
	Technological Processes in Construction	4	Steel Strictures including Welding	7
	Bases of Organization and Management in Construction	3	Reinforced Concrete Structures	7
			Timber and Plastic Structures	5
			Basements and Foundations	5
			Building Machines and Equipment	4
			Technology of Construction	5
			Organization, Planning and Management of Construction	5
			One of the Modules by Choice	
			Research and Design of Buildings and Structures	24
			Technology and Management of Construction	
		Project Management		
		Inspection, Testing and Reconstruction of Buildings and Structures		
		Safety of Buildings and Structures		
B4	Physical Training	2		
B5	Field and Professional Practice			
	Geology	3		
	Geodesy (Surveying)	3		
	Professional (Construction Site or Design Company)	12		
B6	Preparation of Final Bachelor Degree Design	15		

3.2 Master Degree Programs

For Master Degree 5 types of programs are foreseen:

- scientifically oriented research programs,
- educational research programs which include not only engineering aspects, but also didactical issues in teaching civil engineering,
- experimental programs,
- design programs,
- technological programs.

In comparison with the Bachelor Program, the structure of Master Program looks simpler, as shown in table 3.

Table 3: Credit distribution of Master program

Cycle	Credit Points (C.P.)	Basic Part		Variable Part					
				Total		Main		Optional	
		C.P.	%	C.P.	%	C.P.	%	C.P.	%
M1	30	9	30	21	70	14	66,7	7	33,3
M2	30	9	30	21	70	14	66,7	7	33,3
M3	57	Summary M1 – M2 Cycles: 60 C.P. Basic Parts: 18 C.P. (30 %) Variable parts: 42 C.P. (70 %)							
M4	3								

The Basic Part of Master Programs consists of common disciplines:

M1 General scientific cycle:

- Philosophical Problems of Science and Technology
- Mathematical Modelling
- Special Chapters of Higher Mathematics
- Methodology of Scientific Research

M2 Professional Cycle:

- Information Technology (IT) in Construction
- Business Foreign Language
- Methods of Solving Scientific and Technical Problems in Construction
- Basics of Pedagogy (including aspects of adult learning)

Variable Parts of Engineering Programs are created by Universities themselves and correspond to Master Programmes. In Moscow State University of Civil Engineering, these programs include the following:

- Energy Efficiency and Energy Saving in Construction,
- Development and Expertise in Investment Activity in Construction,
- Systems of Microclimate Maintenance in Buildings and Structures,
- Urban Planning, Architectural and Constructional Concepts of Design in Available Environment,
- Architectural and Constructional Aspects of Energy Efficient Buildings Design
- Urban Planning Aspects of Underground Space Development.

The main goal in Master Degree programs is focused on research work and preparation of Master Dissertation (Thesis).

3.3 Engineering Programs

As it was mentioned above, instead of 12 specialties in Civil Engineering we got only one – "Construction of the Unique Buildings and Structures" with a 6-year duration (360 C.P.). This allowed to create a technical program of high standards, reflecting up-to-date scientific and engineering trends in construction. The specialty has five specializations:

- Construction of High-Rise and Long-Spanned Buildings and Structures,
- Construction of Underground Structures,
- Construction of Highly Reliable Hydraulic Engineering Structures,
- Construction of Heat and Nuclear Power Stations,
- Construction of Highways, Airport Runways and Special Transport Structures.

The credit distribution between Cycles, Basic and Variable parts are shown in the table 4.

Table 4: Credit distribution of Engineering program

Cycle	Credit Points , (C.P.)	Basic Part		Variable Part					
				Total		Main		Optional	
		C.P.	%	C.P.	%	C.P.	%	C.P.	%
S1	33	31	94	2	6	2	6	0	0
S2	115	113	98	2	2	2	2	0	0
S3	145	120	83	25	17	15	67	10	33
S4	2 (400 hrs)	Summary S1 – S3 Cycles: 293 C.P. Basic Parts: 264 C.P. (90 %) Variable parts: 29 C.P. (10 %)							
S5	33								
S6	30								

As an example the content of specialization "Construction of High-Raised and Long-Spanned Buildings and Structures" is shown in table 5.

Table 5: The content of Engineering program, specialization "Construction of High-Raised and Long-Spanned Buildings and Structures"

Cycle	Discipline (Module)	C.P.
S1	Basic Part	
	History	3
	Philosophy	4
	Foreign Language	9
	Jurisprudence. Legislation fundamentals in construction	3
	Economics	3
	Sociology	3
	Psychology	3
	Cultural Science	3
	Urbanistic tendencies of development high-rise and long-spanned buildings and structures construction	2
	Variable Part	
	History of Architecture and Construction Techniques	2

Continuing of the Table 5

Cycle	Discipline (Module)	C.P.
S2	Basic Part	
	Mathematics	19
	Informatics	9
	Descriptive Geometry and Engineering graphics	8
	Chemistry	5
	Physics	13
	Ecology (Environment)	4
	Theoretical Mechanics	7
	Applied Mechanics: Strength of Materials	6
	Structural Mechanics	6
	Elasticity theory with plasticity and creep fundamentals	3
	Soil Mechanics	3
	Fluid Mechanics	3
	Technical Heating Engineering	2
	Theoretical fundamentals of Electrical Engineering	2
	Fundamentals of metrology, standardization, certification and quality assurance	3
	Geotechnics: Geology	3
	Geodesy (Surveying)	4
	Architecture	4
	Stochastic Methods in Structural Mechanics and Reliability Theory of Structures	6
	Chemistry in Construction	3
Variable Part		
Modern Building Materials	2	
S3	Basic Part	6
	Health and safety	
	Building Materials	6
	Nonlinear Problems of Structural Mechanics	6
	Theory of Plates and Shells Design	6
	Dynamics and Stability of Structures	5
	Seismic Stability of Constructions	5
	Reinforced Concrete Structures	9
	Steel Structures including Welding	8
	Process Technology in Construction	6
	Organization and Management in Construction	8
	Manufacturing Process in Construction	7
	Mechanization and Automation in Construction	5
	Economics in Construction	7
	Project Management	4
	Physics in Construction (includes acoustic engineering, heat engineering, illumination)	4
	Inspection and Testing of Structures	6
	Operation and Reconstruction of Structures	8
	Architecture of Industrial and Civil Constructions	5
	National Codes for Design of High-Rise and Long-Spanned Buildings	3
	Engineering systems of buildings and structures: Electricity supply and vertical transportation (elevators and escalators)	2
Heat- Gas Supply and Ventilation	2	

Continuing of the Table 5

Cycle	Discipline (Module)	C.P.
S3	Water Supply and Waste Water Treatment	2
	Variable Part	
	Basements and Foundations	5
	Timber and Plastic Structures	4
	Structures Monitoring by Natural and Technogenic (man triggered) Hazard Impacts	3
	Eurocodes	3
	Optional Advanced Module:	
	Theory of Structures	11
	Reinforced Concrete Structures	11
	Steel Structures	11
	Architecture	
	Erection of High-Rise and Long-Spanned Buildings	
S4	Physical Training	2
S5	Field and Professional Practice	
	Geology	3
	Geodesy (Surveying)	3
	Computer and Informatics	6
	Professional (Construction Site or Design Company)	12
	Research Work	9
S6	Preparation of Final Engineering Degree Design	30

4. CONCLUDING SECTION

The goal of this article was to present the changes made in Civil Engineering education in Russia, as a result of the Bologna reform. Moscow State University of Civil Engineering together with academicians from Russian Civil Engineering Universities and Employers from leading construction companies and professional associations managed to create bachelor educational standards practically equivalent to former Diploma Engineering programs. They managed to achieve this by reducing credits for the Humanities, Sociology and Economics Cycle and by increasing the Professional Cycle.

Flexibility of Bachelor and Master standards allows Universities to create their own educational programs according to requirements of employers in their region.

New Diploma Engineering Standards "Construction of Unique Buildings and Structures" are covering all up-to-date requirements for a Civil Engineer.

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