INTEGRATION OF SUSTAINABLE BUILDING PRINCIPLES INTO THE NEW STUDY PROGRAMME AT THE FACULTY OF CIVIL ENGINEERING, VSB – TECHNICAL UNIVERSITY OF OSTRAVA

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ABSTRACT: The construction industry has recently undergone dynamic changes requiring adaptation to new technologies, societal demands, and environmental challenges. Increasing emphasis is placed on the sustainability of buildings, including the use of environmentally friendly materials, improvement of energy efficiency, maximisation of renewable energy use and thus the reduction of carbon footprint, as well as the enhancement of indoor and outdoor environmental quality. National and European legislative requirements for buildings are growing, alongside the importance of international environmental building certification systems. These trends increase the demands on the professional competencies of civil engineering graduates. Companies are increasingly seeking designers, engineers, and architects with expertise in energy efficiency, circular economy, and green technologies.
In response to these significant developments in building design and construction, the Faculty of Civil Engineering at VSB – Technical University of Ostrava will launch a new three-year bachelor's degree programme, "Smart and Green Buildings in Circular Construction", in the 2025/26 academic year. The programme aims to educate professionals capable of developing architectural and structural designs for energy-efficient buildings, with an emphasis on the use of ecological and sustainable materials, environmental and smart technologies, green features, and the minimisation of the environmental impacts of construction. The paper presents an overview of innovations in the new study program, aimed at expanding graduates' professional knowledge and skills in the field of sustainable building construction.

KEYWORDS: Sustainable construction; energy efficiency; circular economy; green technologies; civil engineering education.

INTRODUCTION

Sustainable construction is today one of the key topics in the field of climate protection. Buildings in the European Union are responsible for 36% of greenhouse gas emissions and account for up to 40% of total energy consumption. Since the impacts of emissions persist for decades, it is also necessary to prepare for their consequences. As we spend most of our lives indoors, ensuring a healthy indoor environment and thermal comfort is of fundamental importance [1].
The approach to sustainable construction is based on the principles of efficient use of natural resources, reduction of greenhouse gas emissions, and thorough consideration of the entire life cycle of a building—from design and implementation to demolition or recycling. A key role in this context is played by the concept of the circular economy, which promotes the reuse of materials, minimization of waste, and the adoption of innovative low-impact technologies.
Concrete principles of sustainable construction include, for example: the design of energy-efficient and passive houses, the use of renewable energy sources (solar and geothermal), rainwater and greywater management, the selection of low-carbon materials, and the adaptation of buildings to climate change impacts such as urban heat stress.
Moving towards sustainable solutions requires not only technical innovation but also a shift in mindset and values, which must form part of the training of future professionals. One of the major current challenges is the low level of awareness of sustainability among construction professionals. Although awareness of the need for decarbonization is growing, practitioners often lack access to sufficient high-quality information on how to practically achieve sustainable construction solutions. Furthermore, there is a lack of lifelong learning systems to help architects, designers, and builders navigate rapidly changing standards and technologies [1].
It is therefore essential to systematically integrate sustainability principles into the education and training of civil engineers. Only in this way can we prepare a generation of professionals capable of designing and delivering buildings that are not only technically functional and economically efficient, but also environmentally responsible and responsive to the needs of society.

BASIC PRINCIPLES OF SUSTAINABLE DEVELOPMENT

Sustainable development is based on the balance of three pillars – environmental, economic, and social (as defined at the World Summit on Sustainable Development, Johannesburg, 2002). Sustainability is understood as balanced progress across these pillars, i.e., between the economy, the standard of living, and environmental impact. The goal is to ensure that development in one pillar does not occur at the expense of the others [2].
Sustainable construction can be defined as a set of technical practices and solutions that reduce the environmental impact of buildings throughout their entire life cycle – from design through construction and operation to demolition. It focuses particularly on optimizing the use of energy, water, and materials, while reducing the amount of waste generated [3]. The fundamental principles of sustainable construction include: sustainable design, durability, energy efficiency, waste reduction, indoor air quality, water conservation, and the use of sustainable building materials [4].

1) Sustainable design – also known as green design, involves designing buildings with the aim of minimizing or completely eliminating negative impacts on the environment.
2) Durability – emphasizes the use of materials resistant to weather conditions, corrosion, degradation, and long-term wear.

3) Energy efficiency – includes design strategies and techniques that minimize energy consumption during planning, construction, and ongoing maintenance of the building or project.
4) Waste reduction – involves processes and strategies that minimize waste throughout construction, promote recycling and the use of recycled materials, and follow the waste management hierarchy: reduce – reuse – recycle – dispose.
5) Indoor air quality – sustainable design and construction should improve indoor air quality and provide a healthy and comfortable environment for building users.
6) Water conservation – the construction sector is known for its high energy and water consumption. It is essential to minimize water use both during material production and construction itself.
7) Sustainable building materials – include products that are selected, manufactured, and integrated in ways that minimize their environmental impact.

NEED FOR INTEGRATING THE PRINCIPLES OF SUSTAINABLE CONSTRUCTION INTO EDUCATION

As shown by various studies and statistical surveys, the construction sector continues to lack thousands of qualified professionals, while interest in studying construction-related fields is not significantly increasing [5]. According to CEEC Research, the shortage of graduates is a problem for the majority of companies in the construction industry – specifically, 89% of respondents [6]. The main reasons include the low attractiveness of the sector, limited cooperation between companies and educational institutions, and insufficient motivation of students to enter the field. Compared with other disciplines such as IT, marketing, or finance, construction is not perceived by students as appealing. This is evidenced by a decline of more than 40% in the number of applicants for technical fields related to construction compared to 2010, despite an overall increase in the number of university students. Untapped potential for making the sector more attractive lies in promoting digitalization and Building Information Modeling (BIM), as well as advances in sustainability, as young people are particularly sensitive to these issues [5].

Traditional engineering education has long placed emphasis primarily on technical competencies, often at the expense of broader aspects of sustainability. However, today's engineers are increasingly expected to assess long-term environmental impacts, consider life-cycle costs, and collaborate with a wide range of stakeholders – skills that are still insufficiently represented in many academic programs [7].

Sustainability requires qualitative and interdisciplinary collaboration that enables the integration of diverse knowledge for more sustainable solutions. Nevertheless, engineering programs remain overly specialized and often fail to support broader cross-disciplinary cooperation [7].

Raising awareness of sustainable construction means embedding knowledge of environmental, social, and economic aspects into the education of future civil engineers. From the outset of their studies, it is essential to focus on creating solutions that address current technical and economic needs while also supporting long-term ecological balance and social well-being. Since engineering disciplines influence much of the built environment and industrial operations, integrating sustainability principles into curricula is key to preparing engineers capable of addressing global challenges such as climate change, resource depletion, and the ethics of development [7].

NEW BACHELOR'S PROGRAM AT THE FACULTY OF CIVIL ENGINEERING, VSB – TECHNICAL UNIVERSITY OF OSTRAVA

The reasons outlined above led to the proposal to expand the existing study programs at the Faculty of Civil Engineering, VSB – Technical University of Ostrava, with a new bachelor's program that responds to the dynamic development of the construction sector in recent years, takes into account the requirements of sustainable development, fosters greater interdisciplinary collaboration between faculties, and strengthens the direct connection to practice through professional student internships. We believe that the concept of the new program will be attractive to prospective students.
The preparation and accreditation of the new program have been successfully completed, and in the 2025/26 academic year, the Faculty of Civil Engineering at VSB – Technical University of Ostrava will launch the three-year bachelor's program "Smart and Green Buildings in Circular Construction." The implementation of the program was financially supported by the National Recovery Plan project for VSB-TUO, Specific Objective B: Academically Oriented Bachelor's Program "Smart and Green Buildings in Circular Construction," registration number NPO_VSB-TUO_MSMT-16605/2022. The project ran from 2022 to 2024. Its aim was to prepare and accredit a new full-time bachelor's program originally designed for four years of study. After careful consideration, however, it was decided to shorten the program to three years—a very prudent decision, as all four-year bachelor's programs in civil engineering at Czech universities are currently being transformed into three-year programs.
The Faculty of Civil Engineering at VSB – Technical University of Ostrava drew inspiration for the development of its new study programme from international experience [8, 9, 10] and from similar study programmes offered by universities in the Czech Republic and other European Union countries. For example, the Faculty of Civil Engineering at Brno University of Technology offers a four-year Bachelor's degree programme in Sustainable Building Design and a three-and-a-half-year Bachelor's degree programme in Environmental Engineering. The Faculty of Civil Engineering at the Czech Technical University in Prague offers a three-year Bachelor's degree programme in Buildings, Landscape and Environment. Likewise, technical universities across the European Union integrate the principles of sustainable construction into education through their study programmes – for instance, the University of Natural Resources and Life Sciences, Vienna (BOKU), offers a two-year Master's degree programme in Green Building Engineering.
The innovative contribution of the Smart and Green Buildings in Circular Construction study programme at the Faculty of Civil Engineering, VSB – Technical University of Ostrava, lies not only in its shortened duration of study, but above all in the expansion of the traditional range of construction-related courses to include disciplines reflecting current trends in the construction industry and the principles of sustainable development.
This required not only the innovation and creation of new courses within the Faculty of Civil Engineering but also the inclusion of courses from other faculties and institutions of VSB – Technical University of Ostrava. Another innovative feature is the introduction of one specialized course taught in English.
As mentioned, theoretical knowledge in sustainable construction is crucial for students, but practical skills are equally important. These are primarily acquired through solving specific project tasks in collaboration with industry partners. Therefore, the program includes the involvement of construction companies in teaching as well as mandatory professional internships of 160 hours for students. The cooperating companies

were selected from both design and construction sectors, focusing on building construction, technical building systems, BIM design, energy and environmental assessment of buildings, green facades and interior greenery, water treatment and purification, and rainwater management.
The development of students' practical skills will be further supported through the use of new interactive models, modern software equipment, and a newly renovated classroom

Graduate Profile

The study program is designed to prepare graduates for the design of energy-efficient and sustainable buildings with a healthy indoor environment. Graduates will be capable of developing architectural and construction concepts for energy-efficient buildings, taking into account the use of ecological and sustainable materials, environmental and smart technologies, green features, and the environmental impact of the building throughout its preparation, construction, operation, and eventual decommissioning.
The program also expands knowledge in areas such as digitalized design (BIM), and the use of virtual reality and artificial intelligence in building design and implementation. Emphasis is placed on developing soft skills, particularly language proficiency and fundamentals of behavioral economics. To enhance graduates' employability in practice, the program includes mandatory professional internships of 160 hours in construction companies.
Graduates of the three-year bachelor's program may continue their studies at the Faculty of Civil Engineering, VSB–TUO, either in the newly accredited two-year follow-up master's program Smart and Green Buildings in Circular Construction or in the follow-up master's program Civil Engineering – BIM Engineering. Other follow-up master's programs at the Faculty of Civil Engineering will be newly transformed and accredited next year, extending from the current 1.5-year format to the standard two-year study period.

Multidisciplinary Composition of Courses

As mentioned earlier, the new study program includes both fundamental "classical" theoretical and specialized construction courses, as well as modernized or newly created subjects. The program is designed to be multidisciplinary – in addition to the Faculty of Civil Engineering at VSB–TUO, teaching is also provided by the Faculty of Electrical Engineering and Computer Science, the Faculty of Materials Technology, the Faculty of Economics, the Faculty of Safety Engineering, and the Centre for Energy and Environmental Technologies.
The expanded course offerings focus primarily on sustainable construction, renewable energy sources, circular economy, smart and environmental technologies, ecological and sustainable materials, green architecture, water management within buildings, minimization of negative environmental impacts of construction projects, as well as digitalized design (BIM) and the use of virtual and augmented reality in building design and implementation. The curriculum also includes foundations of traditional, behavioral, and circular economics. Over the three-year program, students complete a total of 51 courses, of which 43 are mandatory and 8 are compulsory electives.

Support for Teaching

As previously mentioned, thanks to financial support for the preparation of the new bachelor's program from the NPO project, several investments were made to enhance teaching. The most significant of these was the renovation of an existing classroom into the "Smart Laboratory for Teaching the Use of Artificial Intelligence in Building Management." This is a modern computer lab supplemented with interactive models for teaching specialized subjects. The renovation included not only structural modifications but also a complete replacement of electrical installations and data networks, installation of forced ventilation with heat recovery, and creation of a smart system for controlling lighting and ventilation, including monitoring of indoor environmental parameters – temperature, relative humidity, CO_2 concentration, and VOCs (volatile organic compounds).
All technologies used will serve as practical demonstrations for similar "smart" spaces in the context of teaching. Special attention was also given to selecting construction materials to create a healthy and comfortable environment for students – Heraklith panels were used for wall and ceiling cladding, which also contributed to improved acoustics in the classroom. The architectural study for the classroom renovation was designed by Ing. arch. Josef Řezníček (Fig. 1).

Fig. 1: Renovation and modernization of the classroom at the Faculty of Civil Engineering, VSB–TUO (Source: photo by author, architectural design: Ing. arch. Josef Řezníček)

Among the interactive models acquired for the new study program is the teaching measurement wall for building services (TZB) located in the newly renovated classroom. During exercises, students can, for example, practice the hydraulic balancing of a heating system, i.e., setting the correct flow of heating water to individual radiators. This ensures even heat distribution, the required thermal comfort in rooms, and simultaneously reduces energy consumption and operational costs (Fig. 2).

Fig. 2: Teaching interactive model – Building services measurement wall (Source: photo by author)

Other teaching models include a rainwater retention tank and a green facade. The tank was constructed next to a passive-standard timber building on the Faculty of Civil Engineering campus and is primarily used for irrigating the newly implemented green wall on the building's north facade. The facade system is modular ("grid" or "basket") and consists of special basalt wool placed in modular baskets, into which plants are installed. The plants can be pre-grown and then easily placed into the system. Irrigation is provided by an automated drip system connected to a pump in the re-

tention tank. Students can learn the principles of the system, participate in its maintenance, and monitor the consumption of rainwater as well as supplementary potable water. Key operational challenges include dry periods, when the tank must be manually replenished, and winter, when the system must be shut down due to low temperatures (Fig. 3).
One of the main objectives of the new study program is to develop skills in 3D digital design (BIM), visualization, and the use of virtual reality and artificial intelligence in building design and implementation. These competencies are supported by new computer equipment and software acquired through the NPO project. Practical applications of virtual and augmented reality in specialized courses are also integrated into the curriculum.

Fig. 3: Teaching interactive model – green facade and rainwater retention tank (Source: photo by author)

CONCLUSION

In recent years, the construction sector has undergone dynamic changes, requiring adaptation to new technologies, societal demands, and environmental challenges. Raising awareness of the fundamental principles of sustainable construction is therefore important not only among industry professionals but especially among future civil engineers through education and study programs. Today, graduates of construction-related fields are increasingly expected to design and implement buildings that are not only technically functional and economically efficient, but also environmentally responsible and responsive to societal needs.

The Faculty of Civil Engineering at VSB – Technical University of Ostrava responds to this challenge with a new three-year bachelor's program, Smart and Green Buildings in Circular Construction, which complements traditional civil engineering disciplines with courses focused on current industry trends and the principles of sustainable development. The Faculty of Civil Engineering at VSB – Technical University of Ostrava anticipates that the new study programme will lead to a higher level of student interest as well as increased demand from industry for its future graduates.

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