GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	, PG_00066268						
Field of study	Civil Engineering						
Date of commencement of studies	October 2024		Academic year of realisation of subject	2025/2026			
Education level	first-cycle studies		Subject group				
Mode of study	Full-time studies		Mode of delivery	at the university			
Year of study	2		Language of instruction	Polish			
Semester of study	4		ECTS credits	3.0			
Learning profile	general academic profile		Assessment form	assessment			
Conducting unit	Department of Mechanics of Materials and Structures -> Faculty of Civil and Environmental Engineering -> Faculties of Gdańsk University of Technology						
Name and surname of lecturer (lecturers)	Subject supervisor		dr inż. Marzena Kurpińska				
	Teachers						
Lesson types	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	0.0	0.0	0.0	30.0	0.0	30
	E-learning hours included: 0.0						
Learning activity and number of study hours	Learning activity	Participation in didactic classes included in study plan		Participation in consultation hours	Self-study	SUM	
	Number of study hours	30		0.0	0.0	30	
Subject objectives	The subject "Eco-innovations in construction" aims to familiarize students with advanced building materials that are consistent with the principles of sustainable development and ecology. The main goal is to provide knowledge about modern, ecological binders and materials used in construction, their properties, applications, production methods and impact on the environment. The course also aims to develop the ecological awareness of future civil engineers, emphasizing the importance of using building materials that minimize the negative impact on the natural environment.						

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K6_W05] Demonstrate knowledge and understanding of research methods (obtaining information, simulations, experimental methods) in the field of civil engineering.	1. The student is able to analyze and compare the physical and mechanical properties of eco-binders with traditional binder materials, understanding their impact on durability and structural performance.v	[SW3] Assessment of knowledge contained in written work and projects [SW2] Assessment of knowledge contained in presentation
[K6_K02] Can work effectively in a group, as well as function in teams, which may consist of representatives of various branches and levels.	1. Can apply theoretical knowledge in practical construction projects, selecting appropriate eco-materials for specific applications. 2. Is able to interpret standards and legal regulations regarding the use of eco-binders in construction and know the certification processes of building materials in terms of their impact on the environment.	[SK2] Assessment of progress of work
[K6_K03] Can effectively, clearly and unambiguously convey information, describe activities and communicate their results/ outcomes to engineers or a wider audience using appropriate communication methods and tools.	1. Is able to develop research and analytical skills by working on projects and case studies that require the application of knowledge about eco-binders. 2. The student is able to critically evaluate case studies and scientific literature on eco-binders, developing the ability to independently search for and evaluate information. 3. Is able to present the results of research and projects, developing written and oral communication skills in a technical context. 4. The student knows the principles of operation in accordance with professional ethics and ecological awareness, promoting sustainable approaches in construction engineering.	[SK5] Assessment of ability to solve problems that arise in practice
[K6_U05] Conducts research (obtaining information, simulations, experimental methods) in the field of construction in order to solve specific tasks and report research results.	1. Understanding the basic principles of ecology and sustainable development in the context of the use of building materials, in particular eco-binders. 2. The student is able to list and describe various types of eco-binders, including their composition, properties, production methods and applications. 3. The student is able to assess the impact of eco-binders on the environment, both in terms of reducing CO2 emissions and other potential environmental benefits.	[SU1] Assessment of task fulfilment

Subject contents	Course content – project 1. Introduction to eco-binders and sustainable construction 2. Analysis of the differences between traditional binders and eco-binders, including the impact on the environment. Types of eco-binders and their properties 3. Detailed discussion of various types of eco-binders, including geopolymers, fly ash-based binders, lime and others.Eco-binder production processes. 4. Review of eco-binder production methods, including low-emission and energy-saving technologies. 5. Laboratory tests of the physical and mechanical properties of various eco-binders. 6. Applications of eco-binders in construction practice. Presentation of practical applications of eco-binders in various aspects of construction, from construction to finishing. 7. Sustainable design and eco-binders. Discussion of the principles of sustainable design and the role that eco-binders can play in reducing the carbon footprint of buildings. 8. Guest lecture: Innovations in eco-binders. A session with industry experts presenting the latest research and development in the field of eco-binders. 9. Review of existing standards, legal regulations and certification systems regarding eco-binders. 10. Waste management and recycling in the context of eco-binders. Discussion of waste management strategies and possibilities of recycling building materials, including eco-binders. 11. Group projects: Development of the concept of using eco-binders. Working on a group project involving the design of a building element or solution using eco-binders. 12. Presentations of group projects by students, summary, discussion, conclusions.
Prerequisites and co-requisites	1. Fundamentals of Chemistry: Understanding basic chemical concepts and processes, including chemical bonds, chemical reactions, and the chemical properties of materials. This is essential to understand the chemical composition and reaction mechanisms occurring in eco-binders.2. Basic physics: Knowledge of basic physics, especially thermodynamics and materials mechanics, is important for understanding the physical and mechanical properties of building materials.3. Materials Science: Basic knowledge of traditional building materials, including binders such as Portland cement, lime, gypsum, etc., their properties, applications and environmental impact.4. Basics of construction and construction: Understanding the basic principles of designing and implementing building structures, including knowledge of various structural elements and their functions.5. Ecology and sustainability: A basic awareness of issues related to ecology and sustainability, especially in the context of construction, is crucial to understanding the need to use eco-binders.6. Mathematics: A good knowledge of mathematics, especially algebra and geometry, is important for understanding and analyzing technical data and conducting engineering calculations.7. Basics of environmental engineering: Knowledge about the impact of human activities, including construction, on the natural environment and methods of minimizing negative effects.
Assessment methods and criteria	

Subject passing criteria	Passing threshold	Percentage of the final grade
presentation, discussion	60.0%	40.0%
attendance	75.0%	30.0%
design, laboratory tests, report	60.0%	30.0%

Recommended reading	Basic literature	[1] EN 196-1:2005 Methods of testing cement-Part1: Determination of strength. [2] EN 197-1:2011 Cement. Composition, specifications and conformity criteria for common cements. http://www.puntofocal.gov.ar/notific_otros_miembros/mwi40_t.pdf. [3] A. Baziak, K. Pławecka, I. Hager, A. Castel, and K. Korniejenko, Development and characterization of lightweight geopolymer composite reinforced with hybrid carbon and steel, Materials (Basel)., vol. 14, no. 19, 2021, doi: 10.3390/ma14195741. [4] A. Hegyi et al., Study on the Possibilities of Developing Cementitious or Geopolymer Composite Materials with Specific Performances by Exploiting the Photocatalytic Properties of TiO2 Nanoparticles, Materials (Basel)., vol. 16, no. 10, 2023, doi: 10.3390/ma16103741. [5] A. Aboulayt, H. Hannache, A. I. Adib, M. Gomina, and R. Moussa, Preparation and characterization of a composite material based on a geopolymer binder and quartzite aggregates, Chem. Mater. Res., vol. 5, no. November, pp. 2730, 2013, [Online]. Available: http://iiste.org/Journals/index.php/CMR/article/view/10003. [6] W. W. A. Zailani et al., Characterisation at the bonding zone between fly ash based geopolymer repair materials (Grm) and ordinary portland cement concrete (opcc), Materials (Basel)., vol. 14, no. 1, pp. 114, 2021, doi: 10.3390/ma14010056.
	Supplementary literature	[1] T. H. Kim, C. U. Chae, G. H. Kim, and H. J. Jang, Analysis of CO2 emission characteristics of concrete used at construction sites, Sustain., vol. 8, no. 4, 2016, doi: 10.3390/su8040348. [2] S. Talukdar, S. T. Islam, and N. Banthia, Development of a lightweight low-carbon footprint concrete containing recycled waste materials, Adv. Civ. Eng., vol. 2011, 2011, doi: 10.1155/2011/594270. [3] T. Kim, S. Tae, and S. Roh, Assessment of the CO2 emission and cost reduction performance of a low-carbon-emission concrete mix design using an optimal mix design system, Renew. Sustain. Energy Rev., vol. 25, pp. 729741, 2013, doi: 10.1016/j.rser.2013.05.013. [4] S. Abd El-Aleem, M. A. Abd-El-Aziz, M. Heikal, and H. El Didamony, Effect of cement kiln dust substitution on chemical and physical properties and compressive strength of portland and slag cements, Arab. J. Sci. Eng., vol. 30, no. 2 B, pp. 263273, 2005. [5] A. M. Brandt, Cement-Based Composites Second Edition, Published. London and New York: Taylor&Francis, 2009 [6] J. Matsimbe, M. Dinka, D. Olukanni, and I. Musonda, Geopolymer: A Systematic Review of Methodologies, Materials (Basel)., vol. 15, no. 19, 2022, doi: 10.3390/ma15196852.
	eResources addresses	

Example issues/ example questions/ tasks being completed	1. Omów różnice między tradycyjnymi spoiwami a ekospoiwami pod kątem ich wpływu na środowisko. Pytanie wymaga od studenta zrozumienia głównych różnic między konwencjonalnymi spoiwami, takimi jak cement Portlandzki, a ekospoiwami, w tym ich produkcji, aplikacji i degradacji środowiskowej. 2. Wyjaśnij, jakie właściwości ekospoiw sprawiają, że są one postrzegane jako materiały budowlane zrównoważone. Odpowiedź powinna zawierać omówienie kluczowych właściwości ekospoiw, takich jak niska emisja CO2 w procesie produkcji, wykorzystanie odpadów przemysłowych, trwałość i efektywność energetyczna. 3. Przedstaw proces produkcji geopolimerów i wyjaśnij, dlaczego są one uważane za ekologiczną alternatywę dla tradycyjnych spoiw. Pytanie skupia się na zrozumieniu technologii produkcji geopolimerów, w tym surowców, procesu syntezy i korzyści środowiskowych płynących z ich stosowania. 4. Jakie są główne wyzwania związane z wprowadzaniem ekospoiw na rynek budowlany? Odpowiedź powinna uwzględniać analizę barier technicznych, ekonomicznych i regulacyjnych, które wpływają na adopcję ekospoiw w branży budowlanej. 5. Opracuj przykładowy scenariusz zastosowania ekospoiw w projekcie budowlanym, uwzględniając ich korzyści środowiskowe i techniczne. Pytanie wymaga od studenta zastosowania zdobytej wiedzy do praktycznej sytuacji, projektując rozwiązanie, które wykorzystuje ekospoiwa do poprawy zrównoważenia projektu, wskazując konkretne korzyści wynikające z ich użycia.
Practical activites within the subject	Not applicable

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