Course description

Department/Unit /	KME / PMKS				**Academic Year**	2023/2024
Title	Progr. Mater. and Struct. of Buildings				**Type of completion**	Exam
Long Title	Progressive Materials and Structures of Buildings					
Accredited/Credits	Yes, 7 Cred.				**Type of completion**	Combined
Number of hours	Lecture 3 [Hours/Week] Tutorial 3 [Hours/Week]					
Occ/max	Status A	Status B	Status C		**Course credit prior to**	Yes
Summer semester	0 / -	0 / -	0 / -		**Counted into average**	YES
Winter semester	8 / -	0 / -	1 / -		**Min. (B+C) students**	10
Timetable	Yes				**Repeated registration**	NO
Language of instruction	Czech				**Semester taught**	Winter semester
Optional course	Yes				**Internship duration**	0
Evaluation scale	1|2|3|4				**Ev. sc. – cred.**	S|N
No. of hours of on-premise	0					
Auto acc. of credit	Yes in the case of a previous evaluation 4 nebo nic.					
Periodicity	every year					
Specification periodicity						
Substituted course	None					
Preclusive courses	N/A					
Prerequisite courses	N/A					
Informally recommended courses	N/A					
Courses depending on this Course	N/A					

Course objectives:

The course is focused on properties of progressive materials and their application in building structures. These materials often have the character of composites, so a significant amount of teaching is given to the composites. The basic terms for elastic materials are introduced, such as stress and strain, Hooke's Law and classification of anisotropic materials. The focus is given to unidirectional composites - laminate. Relations for off-axis stiffness and compliance and off-axis elasticity constants are derived. The summary of macromechanical failure criteria for unidirectional composites is given. Special attention is paid to analysis of laminates. It is shown how the laminate lay-up influences the mechanical properties of the laminate, stresses caused by temperature change or by moisture absorption. Analysis of thin-walled tubes prepared by filament winding is presented. The laboratory classes will include the solution both analytically and numerically and using modern computational methods. Portion of the classes will take place in computational labs where numerical simulations of mechanical behaviour of composite materials will be performed.

Requirements on student

Requirements for credit:
Elaboration of semestral work.

Requirements for exam:
Active knowledge of lectured and exercised subject matter and the ability to apply it in the solution of specific problems.

Content

1. Motivation lecture. Intoduction in Mechanic of Composite materials. Basic terms. Production and technology.
(Basic terms of mechanics of materials. Review of contemporary computaional systems for composite structures design. Basic terms of mechanics of materials.)
2. Basic relations of mechanics of anisotropic materials (stress and strain tensors), classification of anisotropic materials. Unidirectional composites. FRP composites.
(Stiffness matrice of orthotropic material computation.)

3. Elasticity constants of unidirectional composites. Experimental determination of material characteristics of composites.
(Computation of off-axis stiffness matrix elements, deformations of a curved beam from unidirectional composite)
4. Composite material failure. Failure criteria - non-interactice and interactive ones.
(Labs - unidirectional composite tensile test. Laboratory measurement evaluation, ways of determining elastic constants of a unidirectional composite.)
5. Laminate analysis - classical laminate theory. Constitutive relations, lay-up sequence of laminate.
(Failure index computation using different criteria.)
6. Progressive concrete. Composition, production technology and applications, properties.
(Composite concrete, ultralight concrete, HPC and UHPC, modifications, nanoaditives, photocatalytic effect.)
7. Progressive metals and metal-based composites, joints. Properties, applications, economic, environmental and technical context.
(Bimetal, multi-component alloys, technologies increasing the resistance of metals to environmental effects.)
8. Progressive wood-based materials. Production, properties, applications.
(Super wood, layered and glued elements, composite wood-based elements.)
9. Geopolymers and their combinations with other materials. Production, properties, applications, economic, environmental and technical connections.
(Using the Potential of the Zbuh landfill near Pilsen.)
10. Progressive ceramic elements and structural glass. Programming of properties, applications, economic, environmental and technical context.
(Lightweight elements and constructions, combined constructions, elimination of moisture absorbability, joints, technologies.)
11. Progressive and environmentally friendly thermal insulations. Properties, applications.
(Aerogel, vacuum insulations, foils, polymers, organic materials.)
12. Nano- and micromaterials. Production, properties, applications, economic, environmental and technical context.
(Structural materials, membranes, surfaces, composite components.)
13. Recycled materials and structures made of them. Properties, applications, economic, environmental and technical context.
(Silicates, plastics, organic materials.)

Fields of study

Guarantors and lecturers

- **Guarantors:** prof. Ing. Vladislav Laš, CSc.
- **Lecturer:** Ing. Petr Kesl, Ph.D. (50%), prof. Ing. Vladislav Laš, CSc. (50%)
- **Tutorial lecturer:** Ing. Petr Kesl, Ph.D. (100%)

Literature

- **Basic:** BODNÁROVÁ, Lenka. *Kompozitní materiály ve stavebnictví*. CERM, 2002. ISBN 80-214-2266-1.
- **Recommended:** BUNSELL, A. R. a J. RENARD. *Fundamentals of Fibre Reinforced Composite Materials*. Londýn, 2005. ISBN 0-7503-0689-0.
- **Recommended:** Barbero, Ever J. *Introduction to composite materials design*. Second edition. 2011. ISBN 978-1-4200-7915-9.

Time requirements

Full-time form of study

Activities	Time requirements for activity [h]
Contact hours	78
Graduate study programme term essay (40-50)	50
Preparation for an examination (30-60)	60
Total:	**188**

assessment methods

Knowledge - knowledge achieved by taking this course are verified by the following means:

Combined exam

Seminar work

Skills demonstration during practicum

Skills - skills achieved by taking this course are verified by the following means:

Combined exam

Seminar work

Skills demonstration during practicum

Competences - competence achieved by taking this course are verified by the following means:

Combined exam

Seminar work

Skills demonstration during practicum

prerequisite

Knowledge - students are expected to possess the following knowledge before the course commences to finish it successfully:

ovládat odbornou terminologii pozemních staveb

orientovat se ve vlastnostech stavebních materiálů, konstrukcí a technologií

Skills - students are expected to possess the following skills before the course commences to finish it successfully:

charakterizovat základní parametry stavebních materiálů

charakterizovat stavebně technické řešení stavebních konstrukcí

Competences - students are expected to possess the following competences before the course commences to finish it successfully:

N/A

N/A

N/A

teaching methods

Knowledge - the following training methods are used to achieve the required knowledge:

Lecture

Practicum

Group discussion

Self-study of literature

Discussion

Skills - the following training methods are used to achieve the required skills:

Lecture

Practicum

Group discussion

Self-study of literature

Discussion

Competences - the following training methods are used to achieve the required competences:

Lecture

Practicum

Group discussion

Self-study of literature

Discussion

learning outcomes

Knowledge - knowledge resulting from the course:

orientovat se ve vlastnostech a aplikacích progresivních stavebních materiálů

vysvětlit vlastnosti stavebních konstrukcí z progresivních stavebních materiálů

popsat princip kompozitních materiálů

Skills - skills resulting from the course:

charakterizovat výhody a nevýhody stavebních konstrukcí z progresivních materiálů

analyzovat vlastnosti progresivních stavebních materiálů a rozhodovat o jejich aplikacích

porovnat progresivní materiály s tradičními materiály

Competences - competences resulting from the course:

N/A

N/A

N/A

Course is included in study programmes:

Study Programme	Type of	Form of	Branch	Stage	St. plan v.	Year	Block	Status	R.year	R.
Civil Engineering	Postgraduate Master	Full-time	Navrhování a provádění budov	1	2020	2023	Specializační předměty	A	1	ZS