Name of course:
FRP Composites for Civil Engineering Structures

Coordinator of course:
dr inż. Marek Urbański, mgr inż. Kostiantyn Protchenko

Type of course:
Optional

Level of education:
First cycle studies

Programme:
Civil Engineering

Group of courses:
Elective

Code of course:
1080-BU000-ISA-0606

Nominal semester:
7 / rok ak.

Number of ECTS credits:
2

Number of hours of student's work to achieve learning outcomes:
Total 50 hours = 2 ECTS: lectures 20 hours, classes 10 hours, studying literature 4 hours, consultations 1 hour, project 15 hours.

Number of ECTS credits on the course with direct participation of academic teacher:
Total 31 hours = 1 ECTS: lectures 20 hours, classes 10 hours, consultations 1 hour.

Language of course:
English

Number of ECTS credits on practical activities on the course:
Total 25 h = 1 ECTS: ćwiczenia (laboratorium komputerowe) 10 godz., projekt 15 godz.

Form of didactic studies and number of hours per semester:

Lecture:	20h
Exercise type of course:	10h
Laboratory:	0h
Project type of course:	0h
Computer lessons:	0h

Preliminary requirements:
It is required to pass the basic course of concrete structures, basic information about cross-sectional forces in beams, plates, columns, shields and shells is needed.

Purpose of course:
The use of composite reinforcement in concrete structures. The student has knowledge of the elements reinforced with FRP composites. The student is able to design a beam with FRP reinforcement.

Contents of education:
Lecture Principles of designing reinforced concrete elements with the use of composite reinforcement. Properties of composite materials. Methods of producing FRP bars. Physico-mechanical properties of FRP reinforcement. The specificity of testing FRP composites. Bond of FRP bars to concrete. Ultimate Limit States and Serviceability Limit States of FRP reinforced concrete elements. Design of concrete beams with FRP reinforcement. Design exercises Calculation example of a concrete beam with FRP reinforcement. Preliminary design of a beam reinforced with FRP bars.

Methods of evaluation:
Written test checking theoretical knowledge presented during lectures and design exercises. Completion of design exercises based on the design prepared by the Student, including calculations and drawings, and the defense of the design. The final grade is the weighted average of the marks from the project (weight 0.6) and the exam (weight 0.4).

Exam:
no

Literature:
1.ACI 440.1R-06. (2006). Guide for the Design and Construction of Structural Concrete Reinforced with FRP Bars. Farmington Hills, MI.: American Concrete Institute. 2. ACI440.3R-04. (2004). Guide Test Methods for Fiber-Reinforced Polymers (FRPs) for Reinforcing or Strengthening Concrete Structures. Farmington Hills, MI, USA: ACI. 3. Bank L. C. (2006). Composite for Construction, Structural design with FRP materials,. Hoboken, New Jersey: John Willey and Sons Ltd. 4. CSA S806-02. (2002). Design and Construction of Building Components with Fibre Reinforced Polymers. Mississauga: Canadian Standards Association. 5. FIB Bulletin 40. (2007). FRP Reinforcement in RC Structures. Ghent: fib TG 9.3. 6. Garbacz, A.; Urbański, M.; Łapko, A. (2016). BFRP bars as an alternative reinforcement of concrete structures - Compatibility and adhesion issues . Advanced Materials Research (1129), pp. 233-241. 7.Łapko, A. i Urbański, M. (2013, 03). Problemy badania betonowych elementów zginanych zbrojonych prętami bazaltowymi. Materiały Budowlane. 8.Łapko, A.; Urbański, M. (2015a). Experimental and theoretical analysis of concrete beams deflections reinforced with basalt rebar. Archives of Civil and Mechanical Engineering (15), strony 223 -230. 9. Łapko, A.; Urbański. M. (2015b). Zastosowanie cięgien BFRP do wzmacniania elementów nośnych techniką zewnętrznego sprężania. Konferencja Naukowo-Techniczna KS2015 Konstrukcje sprężone, Kraków 2015 (strony 57 -67). Kraków 2015: PK. 10.Urbanski, M., Lapko, A. i Garbacz, A. (2013, May). Investigation on concrete beams reinforced with basalt rebars as an effective alternative of conventional R/C structures. Procedia Engineering(57), strony 1183–1191. 11.Urbanski, M.; Łapko, A.; Suprynowicz, K. (2016). Analysis of the Crack Propagation Process in BFRP Beams with Digital Image Correlation Method. Solid State Phenomena (240), strony 55-60. 12.Urbański, M. . (2014). Badania wytrzymałościowe belek zbrojonych prętami bazaltowymi,. W J. Bzówka, Monografia: ”Wiedza i eksperymenty w budownictwie”, Praca zbiorowa pod redakcją Joanny Bzówki. (strony 379-386). Gliwice : Wydawnictwo Politechniki Śląskiej . 13.Urbański, M.; Łapko, A. (2014 a). Doświadczalna i teoretyczna analiza stanu ugięcia belek z betonu zbrojonego prętami BFRP. Acta Scientiarum Polonorum, Seria Architectura. 13 (3) , strony 17 -25. Warszawa: SGGW. 14. Urbański, M.; Łapko, A. (2014 b). Przyczynek do oceny stanu zarysowania belek z betonu zbrojonego prętami BFRP. Budownictwo i architektura. 13(3), strony 201-208. Lublin: PL. 15. Szmigiera, E.; Protchenko, K.; Urbański, M.; Garbacz, A. Mechanical Properties of Hybrid FRP Bars and Nano-Hybrid FRP Bars.

Arch. of Civ. Eng., 2019, 65(1), pp. 97-110. 16.Protchenko, K., Szmigiera, E. D., Urbański, M., & Garbacz, A.. Development of Innovative HFRP Bars. MATEC Web of Conf., 2018, 196, pp.1–6. 17.Protchenko, K.; Dobosz, J.; Urbański, M.; Garbacz, A. Wpływ substytucji włókien bazaltowych przez włókna węglowe na właściwości mechaniczne prętów B/CFRP (HFRP). Czasopismo Inżynierii Lądowej, Środowiska i Architektury, JCEEA, 2016, 63, 1/1, pp. 149–156. 18. Protchenko, K., Szmigiera, E.D., Urbański, M., and Garbacz, A.: Development of Innovative HFRP Bars, 2018, MATEC Web of Conferences 196, 1–6. 19. Urbanski, M. Compressive Strength of Modified FRP Hybrid Bars. Materials. 2020, 13(8), 1898, 17 pp.

Website of the course:

Notes:

Charakterystyki przedmiotowe

General academic profile - knowledge

Charakterystyka W1:
He knows the principles of design and analysis of complex general and industrial buildings with FRP reinforcement.

Verification:

Substantive assessment based on the written article and presentation.

Powiązane charakterystyki kierunkowe: K1_W04, K1_W05, K1_W13

Powiązane charakterystyki obszarowe: P6U_W, I.P6S_WG.o, III.P6S_WG

General academic profile - skils

Charakterystyka U1:
Is able to design complex concrete building elements and structures with FRP reinforcement.

Verification:

Assessment of the design exercise

Powiązane charakterystyki kierunkowe: K1_U07, K1_U21, K1_U15, K1_U03, K1_U06

Powiązane charakterystyki obszarowe: III.P6S_UW.o, P6U_U, I.P6S_UW.o

General academic profile - social competences

Charakterystyka K1:
Understands the importance of responsibility in engineering activities, including the reliability of the presented results of their work and their interpretation..

Verification:

Substantive assessment based on the written article and presentation.

Powiązane charakterystyki kierunkowe: K1_K01, K1_K07

Powiązane charakterystyki obszarowe: P6U_K, I.P6S_KR, I.P6S_KK