Wrocław University of Science and Technology
Doctoral School

# COURSE CARD

## 1. Basic information

| | | |
|---|---|---|
| Course name in English: | Advanced steel-concrete composite constructions | |
| Course name in Polish: | Zaawansowane konstrukcje zespolone stalowo-betonowe | |
| Number of hours: | 30 | |
| Type of course: | Elective course | |
| Form of course: | lecture | |
| Code of course: | ILQ100170W | |
| Course leader: | Prof. dr hab. inż. Wojciech Lorenc *Title Name Surname* | |
| Faculty of the course leader: | W2 Faculty of Civil Engineering | |
| Email address of the course leader: | wojciech.lorenc@pwr.edu.pl | |
| Scientific discipline(s) assigned to the course (doctoral students representing the marked disciplines can participate in the course): | Architecture and urban planning | ☐ |
| | Automation, electronic, electrical engineering and space technologies | ☐ |
| | Information and communication technology | ☐ |
| | Biomedical engineering | ☐ |
| | Chemical engineering | ☐ |
| | Civil engineering, geodesy and transport | ☒ |
| | Materials engineering | ☐ |
| | Mechanical engineering | ☒ |
| | Environmental engineering, mining, and energy | ☐ |
| | Mathematics | ☐ |
| | Chemical sciences | ☐ |
| | Physical sciences | ☐ |
| | Management and quality studies | ☐ |

## 2. Objectives

Familiarization with contemporary steel-concrete composite structures.

Familiarization with advanced methods of laboratory tests of steel-concrete composite structures.

Familiarization with advanced methods of numerical simulation of behavior of steel-concrete composite structures.

## 3. Content

*Detailed information about the course content, including topics and form of classes.*

| No. | Topic | Number of hours | Form of classes |
|---|---|---|---|
| 1 | Subject and scope of the lecture, literature, rules of getting credit. State-of-the art of classic steel-concrete | 2 | lecture |

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|---|---|---|---|
| | composite structures. Introduction to general composite section | | |
| 2 | Introduction to The History of the Theory of Structures. Working with old structures: strengthening and external prestressing of composite structures | 2 | lecture |
| 3 | Composite structures in buildings and bridges: main differences.<br>Bridge construction – a strong driving force for developments in composite construction | 2 | lecture |
| 4 | Evolution of composite bridges. Basis of design of composite bridges. Un-cracked analysis and cracked analysis | 2 | lecture |
| 5 | From welded studs to composite dowels: evolution of shear connection.<br>Fundamentals of Eurocode 4: steel skeleton | 2 | lecture |
| 6 | Evolution of composite dowels: from VFT to VFT-WIB | 2 | lecture |
| 7 | Composite dowels: searching for the shape and construction of first bridges. The first generation of bridges using composite dowels | 2 | lecture |
| 8 | Composite dowels: searching for design procedures and technology of production of steel part | 2 | lecture |
| 9 | Composite dowels: the final solution. Formal design procedures. The second generation of bridges using composite dowels | 2 | lecture |
| 10 | The concept of general composite section. The third generation of bridges using composite dowels. The forms constructed nowadays and predictable future | 2 | lecture |
| 11 | Laboratory testing of composite constructions: tests under static loads | 2 | lecture |
| 12 | Laboratory testing of composite constructions: tests under cyclic loads | 2 | lecture |
| 13 | FEM for purposes of laboratory testing | 2 | lecture |
| 14 | FEM for purposes of design. Development of EC4 | 2 | lecture |
| 15 | Final test | 2 | lecture |

## 4. Prerequisites

*List of prerequisites relating to knowledge, skills and other competences for course participants.*

Has the necessary advanced knowledge of the mechanics of construction and civil engineering
Has the necessary knowledge of the steel-concrete composite constructions.
Has the necessary knowledge of the FEM.

## 5. Learning outcomes

*List of learning outcomes at level 8 of the Polish Qualifications Framework assigned to the course (mark the learning outcomes in the last column).*

| Symbol | Learning outcome | |
|---|---|---|
| | *KNOWLEDGE. Doctoral student knows and understands:* | |
| SzD_W3 | the main trends in the development of the scientific or artistic disciplines covered in the curricula; | ☒ |
| SzD_W4 | research methodology; | ☒ |
| SzD_W5 | the rules for the dissemination of scientific results, including in open access mode; | ☐ |
| SzD_W6 | the fundamental dilemmas of modern civilization; | ☐ |
| SzD_W7 | the legal and ethical conditions of scientific activity; | ☐ |
| SzD_W8 | the economic and other relevant conditions of scientific activity; | ☐ |
| SzD_W9 | basic principles of knowledge transfer to the economic and social spheres and commercialisation of results of scientific activity and know-how related to these results. | ☒ |
| | *SKILLS. Doctoral student is able to:* | |
| SzD_U2 | use knowledge from different fields of science or art to creatively identify, formulate and innovatively solve complex problems or perform research tasks, in particular:<br>- define the purpose and subject of scientific research, formulate a research hypothesis,<br>- develop research methods, techniques and tools, and use them creatively,<br>- draw conclusions on the basis of scientific research;<br>critically analyse and evaluate the results of scientific research, expertise and other creative work and their contribution to knowledge development;<br>transfer the results of scientific activities to the economic and social spheres; | ☒ |
| SzD_U3 | communicate on specialised topics to the extent that they enable an active participation in the international scientific community; | ☒ |
| SzD_U4 | disseminate research results, including in popular forms; | ☒ |
| SzD_U5 | initiate debates and participate in a scientific discourse; | ☐ |
| SzD_U6 | be able to speak a foreign language at B2 level of the Common European Framework of Reference for Languages to a level that enables them to participate in the international scientific and professional environment; | ☐ |
| SzD_U7 | plan and implement an individual or collective research or creative activity, including in an international environment; | ☐ |
| SzD_U8 | independently plan and act for one's own development and inspire and organize the development of others; | ☒ |
| SzD_U9 | plan classes or groups of classes and implement them using modern methods and tools. | ☐ |
| | *SOCIAL COMPETENCES. Doctoral student is ready to:* | |
| SzD_K3 | fulfilling the social obligations of researchers and creators, initiate public interest activities, thinking and acting in an entrepreneurial way; | ☐ |
| SzD_K4 | maintaining and developing the ethos of research and creative environments, including:<br>- carrying out scientific activities in an independent manner,<br>- respecting the principle of public ownership of research results, taking into account the principles of intellectual property protection. | ☒ |

## 6. Evaluation

*Short description of the method(s) used to evaluate the learning outcomes assigned to the course, e.g., exam, test, report, presentation, etc.*

Final test

## 7. Teaching methods

*Short description of the teaching methods used during the course, e.g., multimedia presentation, discussion, literature studies, developing written documents, own work, etc.*

Lecture, presentation, laboratory testing, discussion, self work

## 8. Literature

*List of primary and secondary literature used to prepare the course and including additional knowledge for participants, e.g., books, textbooks, research papers, standards, web pages, etc.*

[1] Kurrer K-E. The History of the Theory of Structures: Searching for Equilibrium. Ernst & Sohn 2018.
[2] Wojciech Lorenc, Maciej P. Kożuch, Sebastian Balcerowiak, Wybrane zagadnienia modelowania przęseł mostów belkowych z dźwigarów zespolonych stalowo-betonowych. Wrocław: Dolnośląskie Wydawnictwo Edukacyjne, 2018. 168 s.
[3] Jacques Berthellemy, Günter Seidl, Wojciech Lorenc Recent structures and bridges built with the CL steel-concrete connection. W: Tomorrow's Megastructures : 40th IABSE Symposium 2018, Nantes, France, 19-21 September 2018. Zurich : IABSE, 2018. art. S2-51, s. 1-9.
[4] Dennis Rademacher, Wojciech Ochojski, Wojciech Lorenc, Maciej P. Kożuch Advanced solutions with hot-rolled sections for economical and durable bridges. Steel Construction. 2018, vol. 11, nr 3, s. 196-204.
[5] Wojciech Lorenc Nośność ciągłych łączników otwartych w zespolonych konstrukcjach stalowo-betonowych. Wrocław: Oficyna Wydawnicza Politechniki Wrocławskiej, 2010. 131, [2] s.
[6] Wojciech Lorenc The model for a general composite section resulting from the introduction of composite dowels. Steel Construction. 2017, vol. 10, nr 2, s. 154-167.
[7] Wojciech Lorenc Non-linear behaviour of steel dowels in shear connections with composite dowels: design models and approach using finite elements. Steel Construction. 2016, vol. 9, nr 2, s. 98-106.
[8] Wojciech Lorenc The design concept for the steel part of a composite dowel shear connection. Steel Construction. 2016, vol. 9, nr 2, s. 89-97.
[9] Wojciech Lorenc. Nowe technologie budowy mostów zespolonych. W: Mosty hybrydowe : Seminarium Naukowo-Techniczne Wrocławskie Dni Mostowe, Wrocław, 29-30 listopada 2018 / [red. Jan Biliszczuk, Jerzy Onysyk]. Wrocław : Dolnośląskie Wydawnictwo Edukacyjne, [2018]. s. 101-118.
[10] Günter Seidl, Wojciech Lorenc Innovative Konstruktionen im Verbundbrückenbau mit Verbunddübelleisten. Stahlbau. 2018, Jg. 87, H. 6, s. 547-554.
[11] Wojciech Lorenc, Tomasz Kołakowski, Andrzej Hukowicz, Günter Seidl Verbundbrücke bei Elbląg : Weiterentwicklung der VFT-WIB-Bauweise. Stahlbau. 2017, Jg. 86, H. 2, s. 167-174.

## 9. Other remarks

*Additional remarks, comments, (e.g., language of the course)*

Course in English