



COURSE DESCRIPTION CARD - SYLLABUS

Course name

Cold formed steel structures [S2Bud1E-IOB>ZiKS]

Course

Field of study

Civil Engineering

Year/Semester

1/2

Area of study (specialization)

Smart and resilient buildings

Profile of study

general academic

Level of study

second-cycle

Course offered in

English

Form of study

full-time

Requirements

elective

Number of hours

Lecture

15

Laboratory classes

0

Other

0

Tutorials

0

Projects/seminars

15

Number of credit points

2,00

Coordinators

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Lecturers

Prerequisites

Knowledge: The student possesses fundamental knowledge of structural mechanics and strength of materials within the field of structural engineering. The student is familiar with basic design methods for industrial halls and understands the design principles of spatial steel truss structures. **Skills:** The student can apply design standards for structural analysis and dimensioning of steel structural elements. The student can design truss elements for industrial buildings, bracing systems, and structural joints. **Social Competencies:** The student understands the importance of lifelong learning and demonstrates the ability to interact and collaborate effectively within a group, assuming various roles as required.

Course objective

To acquire knowledge and practical skills related to the design methods of thin-walled cold-formed steel structures stiffened by cooperation with the building envelope.

Course-related learning outcomes

Knowledge:

The student is familiar with the fundamental principles of structural design related to roof elements, including methods of structural analysis and design principles for thin-walled cold-formed purlins

cooperating with sheathing.

Skills:

The student applies relevant building standards for structural analysis and dimensioning of thin-walled structures restrained by sheeting. The student is capable of developing a structural project and preparing complete technical documentation using CAD software.

Social competences:

The student recognizes the need for lifelong learning and is able to motivate and organize the learning processes. The student can effectively cooperate within a team, assuming different roles, and is capable of identifying and resolving professional and ethical dilemmas related to engineering practice.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

The achievement of the learning outcomes is assessed through the following methods:

- Lectures:

Written test (one per semester, duration: 1.5 hours).

- Project:

Individual or group student project combined with an oral or written defence, evaluated based on: substantive quality of the project documentation, systematic progress of work (confirmed by consultation and class attendance), quality of the project defence.

A minimum score of 50% is required to obtain credit.

Programme content

Form of Teaching: Lecture

1. Introduction to the Design of Thin-Walled Steel Structures

Current issues in thin-walled steel structures, historical background, advantages, and disadvantages. Definitions and fundamentals of thin-walled structural design. Scope of application of thin-walled steel structures.

2. Vlasov's Theory of Thin-Walled Members

Assumptions and theoretical background. Differential equations of stability, and the concept of critical load capacity and critical moment. Influence of initial geometric imperfections on critical resistance and post-buckling equilibrium paths. Lateral-torsional buckling of beams, relative slenderness in lateral-torsional buckling, buckling coefficient, and critical bending moment.

3. Local Stability and Kármán's Plate Theory

Critical stresses of ideal and real plates. Effective width of plates for different support conditions. Concept of effective cross-sections. Applicability and limits of Vlasov's theory. Interactive buckling phenomenon.

4. Design of Thin-Walled Structures Without Sheathing Restraint

Structural classes, recommended cross-sections, geometric proportions, and the influence of corner radii. Determination of effective widths according to PN-EN 1993-1-5. Load-bearing capacity of purlins not restrained by sheathing.

5. Design of Thin-Walled Purlins Restrained by Sheathing

Deformation mechanisms and degree of restraint. Computational models according to Eurocode, static schemes, and load combinations. Load-bearing capacity of cold-formed purlins restrained by sheathing, considering global, local, and distortional buckling in accordance with PN-EN 1993-1-3. Influence of restraints on purlin buckling modes.

6. Structural Solutions for Thin-Walled Purlin Systems Restrained by Sheathing

Structural solutions; advantages and disadvantages. Design principles and recommendations for purlin static schemes (laps or sleeves), detailing of eaves and ridge joints. Structural solutions for bracing and suspension systems.

7. Design Principles for Connections in Thin-Walled Structures

Types and classification of joints. Mechanical fasteners. Welded and bonded connections. Failure mechanisms and procedures for determining joint resistance and stiffness. Structural solutions and design recommendations.

8. Manufacturing Technology and Corrosion Protection of Thin-Walled Structures

Overview of the manufacturing process, material and equipment requirements. Types of anti-corrosion protection: materials, technology. Principles of shaping thin-walled, cold-formed structures to improve

their corrosion resistance.

Form of Teaching: Project

Design project involving thin-walled cold-form purlins restrained by sheathing.

Design exercises involve the practical implementation of an engineering task. This includes an initial discussion of the engineering problem. Students prepare calculation and drawing documentation step by step, consult and obtain approval for individual stages of the project, and clarify any emerging doubts. Assessment is based on systematic (confirmed by notes from the consultations) successful completion of the project and its defence (oral or written).

Course topics

Lecture

1. Thin-walled steel structures - definition, scope of application, development, and current trends.
2. Theoretical foundations of thin-walled member design - Vlasov's theory.
3. Global stability of thin-walled elements - lateral-torsional buckling.
4. Local and distortional stability of thin-walled elements - plate theory and effective cross-sections.
5. Design principles for thin-walled steel elements without sheathing restraint.
6. Interaction of thin-walled purlins with roof sheathing - computational models and restraint mechanisms.
7. Load-bearing capacity of cold-formed thin-walled purlins considering various buckling modes.
8. Structural solutions for purlin systems - static schemes, structural details, and bracing systems.
9. Design of connections in thin-walled structures - fasteners, failure mechanisms, and joint stiffness.
10. Manufacturing technology of thin-walled elements and corrosion protection of steel structures.

Project / Design Exercises

1. Introduction to the design task and adoption of calculation assumptions.
2. Selection of the structural system and cross-sections of thin-walled load-bearing elements.
3. Structural analysis and dimensioning of thin-walled elements.
4. Verification of global, local, and distortional stability.
5. Design of connections and elements cooperating with sheathing.
6. Preparation of calculation and drawing documentation.
7. Design consultations and refinement of structural solutions.
8. Project preparation and defence.

Teaching methods

Monographic lectures supported by multimedia presentations, incorporating elements of problem-based and interactive discussion. Practical implementation of an engineering design task, including initial task analysis, phased preparation of calculations and technical drawings, continuous consultations, and approval of individual project stages. Successful course completion requires systematic participation (confirmed through consultation records), submission of a correctly executed project, and successful project defence (oral or written).

Bibliography

Basic:

Core Literature

1. Dubina, D., Ungureanu, V., & Landolfo, R. Design of Cold-Formed Steel Structures. ECCS Eurocode Design Manuals, Ernst & Sohn, 2012.
2. Yu, W.-W., & LaBoube, R. A. Cold-Formed Steel Design. 4th ed., John Wiley & Sons, 2010.
3. Vlasov, V. Z. Thin-Walled Elastic Beams. National Science Foundation, Washington, D.C., 1961.
4. Timoshenko, S. P., & Gere, J. M. Theory of Elastic Stability. 2nd ed., McGraw-Hill, 1961.
5. Trahair, N. S., Bradford, M. A., Nethercot, D. A., & Gardner, L. The Behaviour and Design of Steel Structures to EC3. 4th ed., Taylor & Francis, 2008.
6. Rzeszut K., Stateczność cienkościennych konstrukcji metalowych z luzami i początkowymi imperfekcjami, Wydawnictwo Politechniki Poznańskiej, 2015, ISBN: 978-83-7775-371-2.
7. Kurzawa Z., Rzeszut K., Szumigala M., Stalowe konstrukcje prętowe. Część III - konstrukcje z łukami, elementy cienkościenne, pokrycia membranowe, Wydawnictwo Politechniki Poznańskiej, ISBN: 978-83-7775-454-2.
8. EN 1993-1-1: Eurocode 3 Design of Steel Structures - Part 1-1: General Rules and Rules for

Buildings.

9. EN 1993-1-3: Eurocode 3 Design of Steel Structures - Part 1-3: General Rules - Supplementary Rules for Cold-Formed Members and Sheeting.
10. EN 1993-1-5: Eurocode 3 Design of Steel Structures - Part 1-5: Plated Structural Elements.
11. ECCS European Recommendations for the Application of Metal Sheeting Acting as a Diaphragm. ECCS Publication No. 88.

Additional:

1. Hancock, G. J., Murray, T. M., & Ellifritt, D. S. Cold-Formed Steel Structures to the AISI Specification. Marcel Dekker, 2001.
2. Davies, J. M. Lightweight Sandwich Construction. Blackwell Science, 2001.
3. Kesti, J. Local and Distortional Buckling of Cold-Formed Steel Members. Helsinki University of Technology, Doctoral Thesis, 2000.
4. Rzeszut, K. Selected aspects of stability of thin-walled steel structures with clearances and initial imperfections. In Lightweight Structures in Civil Engineering: Contemporary Problems, Łódź University of Technology, Scientific Seminar, 2018.
5. Rzeszut, K. Post-Buckling Behaviour of Steel Structures with Different Types of Imperfections. Applied Sciences, 12(18), 9018, 2022.
6. Ungureanu, V., Dubina, D., & Dinu, F. Design of Cold-Formed Steel Structures. Ernst & Sohn, 2018.
7. ECCS Technical Committee 7 Technical Working Group on Cold-Formed Steel Structures - State of the Art Reports.

Breakdown of average student's workload

	Hours	ECTS
Total workload	60	2,00
Classes requiring direct contact with the teacher	30	1,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	30	1,00