UCLouvain

# lgciv2033

*2020*

# Steel and composite steel-concrete structures

Due to the COVID-19 crisis, the information below is subject to change, in particular that concerning the teaching mode (presential, distance or in a comodal or hybrid format).

| 5 credits | 30.0 h + 30.0 h | Q1 |
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| Teacher(s) | Doneux Catherine ;Vassart Olivier ; |
| Language : | English |
| Place of the course | Louvain-la-Neuve |
| Main themes | Characteristics of steel and durability, design of steel frames, dimensioning calculation requirements, welded and bolted connections, composite steel-concrete structures, fatigue, fire resistance design. |
| Aims | With reference to the AA baseline of the "Master in Civil Engineering" program, this course contributes to the development, acquisition and evaluation of the following learning outcomes: AA1.1, AA1.2, AA1.3, AA2.1, AA2.3, AA5.4<br>At the end of this course, the student must be able to apply some specifications of Eurocodes 3 (EC3) and 4 (EC4) and in particular be able to:<br>STEEL PART:<br>• Describe the characteristics of structural steel, how it is made and its various designations;<br>• Understand and apply the general rules of frame design: bracing, expansion joints, descent of loads, flow of forces from their point of application to the foundations, classification of frames, influence of the choice of the structural system on the transmission of loads in the frames;<br>• Understand and apply the notions of section of classes as described in EC3;<br>• Control the dimensioning criteria and the calculation according to the EC3 of the metallic elements subjected to simple tension, simple compression, simple bending, composed bending, biaxial bending and deflected bending (taking into account the buckling and lateral torsional bucking);<br>• Design simple joints, welded and/or bolted connections according to the criteria defined in EC3 and understand the mechanisms of failure involved in beam-to-beam, beam-column assemblies under various loads;<br>1<br>COMPOSITE STEEL-CONCRETE PART:<br>• Know and knowingly choose the fundamental assumptions that govern the calculation of a composite beam, a composite column and a composite floor;<br>• Calculate the normal plastic strength of a composite column and the resistant plastic moment of a composite beam;<br>FATIGUE PART:<br>• Master the principles of the calculation of fatigue strength in steel structures using the concept of cumulative damage with or without consideration of the fatigue limit.<br>FIRE RESISTANCE PART:<br>• Restore and apply the Eurocode approaches concerning the calculation of thermal actions in metallic and composite structures;<br>• Explain how to evaluate the mechanical behavior of a steel structure in case of fire.<br>- - - -<br>*The contribution of this Teaching Unit to the development and command of the skills and learning outcomes of the programme(s) can be accessed at the end of this sheet, in the section entitled "Programmes/courses offering this Teaching Unit".* |
| Evaluation methods | **Due to the COVID-19 crisis, the information in this section is particularly likely to change.**<br>Written exam in two parts<br>PART 1 (closed books): theoretical part<br>PART 2 (open books): exercises |
| Teaching methods | **Due to the COVID-19 crisis, the information in this section is particularly likely to change.**<br>Traditional teaching based on slides. Exercises with the aid of a teaching assistant. |
| Content | Chapter 1 : Steel characteristics and durability<br>Chapter 2 : Design of steel frames |

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| | • Modelling and simplifying assumptions ;<br>• Bracings and dilatation joints;<br>• Design of one storey structures (type « hall » - monovolumes) ;<br>• Design of multi-storey structures (type « building») ;<br>• Main typologies of high rise buildings ;<br>• Classification of frames.<br><br>Chapter 3 : Dimensioning elements criteria<br><br>• Classification of the sections<br>• Section resistance and associated dimensioning criteria (pure tension, pure compression, pure bending, composed bending, bi-axial bending, shear) ;<br>• Extension of the dimensioning criteria to take into account the instabilities as buckling, lateral-torsional buckling and second order effects ;<br>• Application to hot rolled sections;<br>• Presentation of particular structural elements : welded fabricated sections (PRS) with or without reinforcing flange, beams with holes (Angelina), truss beams, thin walls sections.<br><br>Chapter 4 : Welded and bolted connections<br><br>• Properties and classification of the welds, resistance criteria for welds under tension, shear and combined loads;<br>• Basic calculation of simple welded connections ;<br>• Properties and classification of the simple and prestressed bolts, boulons normaux et précontraints, resistance criteria for bolts under tension, shear and combined loads ;<br>• Resistance of the connected elements<br>• Design principles of moment resisting connections, basics of stiffness, resistance, rotation capacity, semi-rigid connections.<br><br>Chapter 5: Composite steel-concrete structures<br><br>• Calculation of the degree of connections of the slab to the steel beam, full connection, effective collaborating width, behaviour of the composite beams and composite slabs with and without steeldecks, evaluation of the plastic moment.<br><br>Chapter 6: Fatigue<br><br>• Resistance to fatigue, actions, effects of random stresses, damage accumulation, fatigue security checks, basics of fracture mechanics.<br><br>Chapter 7: Fire resistance<br><br>• Thermal analysis, heating of composite steel-concrete elements, mechanical hot resistance, general principles of a « fire design » of a steel and steel-concrete structure ;<br>• Practical means of protection against fire. |
| Inline resources | Moodle UCL website including the slides of the courses, resolved exercises and other useful documents |
| Bibliography | • En français : Traité de Génie Civil de l'Ecole polytechnique de Lausanne : volumes 10 et 11.<br>• En anglais, publications de l'ECCS (= European Convention for Constructional Steelwork) |
| Other infos | Visit of a steel plant and/or a building site following the opportunities. This visit will not be organized in 2020 because of Covid-19. |
| Faculty or entity in charge | GC |

## Programmes containing this learning unit (UE)

| Program title | Acronym | Credits | Prerequisite | Aims |
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| Master [120] in Architecture and Engineering | ARCH2M | 5 | | |
| Master [120] in Civil Engineering | GCE2M | 5 | | |