UNICUSANO
ROME

Code: CEAR-07/A **Credits: 9**
Course: Design of Structures
Main language of instruction: Italian
Other language of instruction: English

Teaching Staff

Head instructor
Prof. Barbara Ferracuti - barbara.ferracuti@unicusano.it

Introduction

1. *Objective of the course:*

The course deals with the design of complex civil engineering structures. It provides the fundamental theoretical and methodological tools relevant to design structures at serviceability and ultimate Limit States. The analyzed structures are reinforced concrete RC structures with shear walls, reinforced concrete frame structures and prefabricated reinforced concrete beams for roof of industrial buildings. Moreover, the long-term behavior of reinforced concrete frame structures at serviceability loading condition is accounted (Cracking conditions and creep). Finally, the non-linear response of reinforced concrete frame structures is evaluated by limit state analysis and incremental analysis.

Objectives

The course has the following educational objectives:

- To understand the response of structures to horizontal forces and the role of the Rigid diaphragm vs flexible one in civil structures.
- To analyze the behavior of reinforced concrete structures with shear walls with different possible configuration of frames and shear walls.
- To design prefabricated reinforced concrete beams for roof of industrial buildings.
- To know the cracking condition for reinforced concrete members and its effect on the stiffness of RC members.
- To be able to evaluate the ultimate capacity of existing Reinforced concrete structures thought the limit state analysis or the incremental analysis

Competencies:

A. Knowledge and understanding.

At the end of the course, students will be known complex structures such as Reinforced concrete shear walls structures, prefabricated reinforced concrete beams for roof of industrial buildings. They will enhance their knowledge of non linear behavior of RC members due to cracking conditions and to failure. Moreover, they will know how to evaluate the long term effect on RC members due to creep in concrete material.

B. Applying knowledge and understanding.

The students will be able to identify the most appropriate models to determine the structural response of RC structures accounting the non linear behavior of the construction material.

C. Making judgements.

At the end of the course the students will be able to use the modern design criteria and choose the solutions more suitable for specific problems in order to guarantee the required structural performances.

D. Communication skills.

The student will be endowed with the technical-scientific language needed to interact with other experts in the discipline, and with decision makers in construction sector and governments.

E. Learning skills.

The course will provide knowledge and methodological tools in order to develop the ability to learn new concepts to solve unfamiliar problems concerning new and existing structures. Additionally, they will have the opportunity to pursue further studies (Ph.D.) in the field of structural civil engineering.

Syllabus

Subject 1. Shear Walls

Proposed topic: response of structures to horizontal forces and the role of the Rigid diaphragm vs flexible one in civil structures and vertical resistant members (columns, shear walls). The behavior of reinforced concrete structures with shear walls with different possible configuration of frames and shear walls.

Subject 2. RC Beams with small Thickness

Proposed topic: To design prefabricated reinforced concrete beams for roof of industrial buildings.

Subject 3. Cracking phenomenon in RC Members

Proposed topic: Development of cracks in RC members: distribution of stress in concrete and steel bars for tensile RC members, evaluation of transfer length and of crack openings. Effect of cracks in RC members subjected to bending moment. Numerical example and calculations.

Subject 4. Shrinkage and Creep in RC members

Proposed topic: Shrinkage phenomenon and evaluation of strain in concrete member; Creep in reinforced concrete members and evaluation of the long-term effect in RC member response for isostatic and hyperstatic structures.

Subject 5. Non linear mechanical behavior

Proposed topic: Non-linear mechanical behaviour of material, cross-section and members. Definition of plastic hinge, conventional length and Moment-curvature curve.

Subject 6. Demand and supply economic theory. Costs.

Proposed topic: Estimation of the capacity of RC structures: limit state analysis versus incremental analysis. Definition of the analysis, their strength and their drawback. Application of the two methodologies on simple examples.

Evaluation system and criteria

The examination consists of a written test aimed at assessing the student's analytical and conceptual understanding, as well as a series of activities (e-tivities) completed during the course in virtual classrooms. The e-tivities involve essays assigned upon the student's request on the main topics covered in the course. The evaluation of the e-tivities, graded on a scale of 0 to 3 points, is conducted during the correction of the written test. The exam includes exercises and open-ended questions. The exercises are designed to assess the student's ability to apply knowledge. Exercise represent 33% of the total exam score. The open-ended questions evaluate the student's understanding of the theoretical aspects. The remaining 13% is attributed to the e-tivities. The exam duration is 90 minutes in total.

Bibliography and resources

Notes written by the instructor are available.

Suggested readings are:

- Franco Angotti, Matteo Guiglia, Piero Marro, Maurizio Orlando (2022). Reinforced Concrete with Worked Examples. Springer.

- E. H. F. Leonhardt (1973) The Reinforcing of Concrete Structures.