PRESENTATION OF THE COURSE

Structural Mechanics

The ERAMCA Project

Environmental Risk Assessment and Mitigation on Cultural Heritage assets in Central Asia

v2022317

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Objectives

Objectives (1/2)

Notions and tools to:

- interpret the mechanical behavior of structures, i.e., how they respond to actions (forces, temperature variations, subsidence of foundations…) in terms of displacements, strength and stability
- understand and apply the concepts of safety and reliability
- solve simple structures and critically evaluate the results and calculation performed

Objectives (2/2)

1. Behavior of structural elements (beams): general rules obtained from the observation of how the structures react to the applied loads and mathematical models to describe their behavior
2. Methods of structural analysis: how to calculate the necessary physical quantities to design structures and verify their safety
3. Application: a laboratory activity is planned to apply the knowledge acquired

Program (1/3)

1. Course introduction
   - 1.1 Introduction, exam…
   - 1.2 Introduction to structural programs
2. Structural safety

3. Elastic rectilinear beam
   - 3.1 Introduction to beam theory
   - 3.2 Supports
   - 3.3 Remarks on ineffective constraints
   - 3.4 Kinematics
   - 3.5 Statics
   - 3.6 Virtual work theorem
   - 3.7 Constitutive equations
   - 3.8 Geometrical properties of the cross section
   - 3.9 Axial displacements
   - 3.10 Deflection of beams
   - 3.11 Stress definition
   - 3.12 Physical meaning of the material properties

3.14 Elastic stresses:

- 3.14.1 normal stress
- 3.14.2 tangential stress (shear)
- 3.14.3 tangential stress (torsion)

3.15 Failure due to exceeding the strength limit in the cross sections (material failure theories)

PREREQUISITES

Prerequisites/Assumed knowledge

- Mathematical methods and concepts are used all along the course
- Knowledge of calculus (functions, derivatives, integrals, differential equations, vector and matrix) is required

LEARNING OUTCOMES

Expected learning outcomes (1/2)

- Students will learn the fundamental notions about the mechanical behavior of structures and materials, in terms of strength and deformability and the basic concepts of structural safety.
- Students will understand the simplest models of evaluation of the structural response, being able to select the relevant geometrical and mechanical parameters, as well as the actions to be considered. In addition, the students will be able to understand and assess properly the results obtained from the calculations, included those obtained with the computer.

- Students will be able to schematize and solve a planar frame structure, and to provide the results in terms of internal forces and displacements of the structure.
- Students will be capable of assessing the strength of sections and the stability of structural elements.

Exam rules

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Exams will be written.

The questions are:

1. solution of a statically determinate structure, i.e., determination of the normal force, shear force and bending moment diagrams
2. calculation of the geometrical properties of a plane area and calculation of stresses
3. a question about one of the topics covered during the course

Assessment criteria: class attendance 40%, written exam 60%.

REFERENCES AND TOOLS

Bibliography

- Reading list:
  - F. Beer, E. Russell Johnston, J. DeWolf, D. Mazurek, Mechanics of Materials, McGraw-Hill Science, 2011
  - M. Salvadori, Why buildings stand up: the strength of architecture, W.W. Norton & Company, 1980
  - D.L. Schodek, M. Bechthold, Structures, Pearson, 2014
- Additional reading list:
  - J.H. Allen, Statics For Dummies, Wiley Publishing Inc., 2010
  - J.H. Allen, Mechanics of Materials For Dummies, Wiley Publishing Inc., 2011
  - W. Nash, M. Potter, Schaum's Outline of Strength of Materials, McGraw Hill Professional, 2010

IT TOOLS

- Internet offers many resources to deepen or clarify aspects of the subject matter (i.e., Wikipedia or Youtube). However, not all sources are equally reliable (develop critical thinking!)