2IN5010 – Bridge Building challenge

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Department: DÉPARTEMENT MÉCANIQUE ENERGÉTIQUE PROCÉDÉS
Language of instruction: FRANCAIS
Campus: CAMPUS DE PARIS - SACLAY
Workload (HEE): 40
On-site hours (HPE): 27,00
Elective Category : Engineering Sciences
Advanced level : Yes

Description
The principle of this experimental teaching is to build, according to a given set of specifications, a cardboard bridge model capable of supporting the greatest possible load. The main objective is to highlight the interactions between modelling, experimentation and numerical simulation.

Quarter number
Intensive week of the SG6 and at the end of the SG8

Prerequisites (in terms of CS courses)
1EL5000 (Continuum mechanics) or 1EL4000 (Materials) or ST2 CVT (Performance modelling and hybridization in the preliminary design phase) or ST4 CVT (Digital transformation and integrated engineering: digital model and life cycle of structures and vehicles)

Syllabus

- Monday, all day (in parallel):
    - Characterization of the mechanical properties of the cardboard
        - tensile tests on cardboard specimens cut in different directions to determine the moduli of elasticity, Poisson's ratio (using marker tracking) and tensile strengths (each group offers two different specimens and thus contributes to the realization of a collective experimental basis)
    - Brainstorming on the possible architectures for the bridge
        i. use of topological optimization software (TopOpt)
        ii. study of first simple models with Comsol
- Tuesday, all day (in parallel):
    - Structural tests
        - compression tests on "profiled" beams
        - tensile tests on beams assembled by gluing

        - (possibly) tests of various assemblies
    - Design of bridge models
        - precise design of bridges using finer numerical models on Comsol and structural tests
- Wednesday, all day (in parallel):
    - Construction of bridge models (laser cutting of the designed parts at la Fabrique)
    - Complementary numerical models (or additional experimental tests)
    - Preparation of the next morning's presentations
- Thursday :
    - Morning: presentation of the different models
        - every group of students must announce the load that their model will be able to support
        - the groups also vote for the model they think will win
    - Afternoon (for those who can): test of bridge models in a "challenge" configuration, open to the public
- Friday:
    - Morning: analysis of test results and interpretation of discrepancies with predictions
    - Afternoon: writing of a summary note on the learning of the activity

Grading

work within the project + intermediate defense + final summary note.

Resources

- Software: Comsol (Structural Mechanics module)
- Equipment-specific classrooms: LMPS laboratory (Matter block of Eiffel building)

Learning outcomes covered on the course

At the end of this course, students will be able to:

- conduct tests for the mechanical characterization of a material or structure
    - experimentally determine the mechanical properties of a material for use in a real structure
    - conduct tests on real structures to evaluate their mechanical performance
- dimension a structure from a mechanical point of view
    - propose models, analytical or numerical, and of increasing complexity, of real structures

- obtain, using these models, relevant quantities to make design choices

- present in a convincing and reasoned way a mechanical design approach

    - present the modeling choices and the results resulting from a mechanical dimensioning
    - explain the differences in performance of the actual structure with respect to the developed model(s)

Description of the skills acquired at the end of the course

The validation of the milestones 2 of competences C1, C2 and C8 are assessed individually throughout the week, as well as in the Intermediate Defense and the Final Briefing Note from a team point of view.