Engineering Tripos Part IIA Project, GD2: Structural Modelling, 2024-25

Leader

Prof A McRobie [1]

Timing and Structure

Group. Second two weeks of project period in Easter Term. NOTE: this can only be taken in combination with GD1 or a language project.

Prerequisites

3D4 essential

Aims

The aims of the course are to:

- learn about the design of timber structures, such as tension structures, shells and gridshells.
- learn about the design of lightweight structures, such as tension structures and gridshells.
- gain fluency with modern parametric design tools and structrial analysis software, such as Rhino/Grasshopper and Oasys

Content

This project places central focus on design, as may be undertaken in a consultant structural engineering practice. Students will work in small teams to design some innovative lightweight timber structures to satisy a challenging design brief.

FORMAT

A combination of mini-lectures and design studios, with self-paced learning of background theory and of applicable computational techniques.

ACTIVITIES

The project will be supported by external speakers who are international experts in their fields.

The project will have a design brief requiring the design of two timber structures and a lightweight tension structure for a real client. One timber structure will be a modest residential block that will require full design, detailing and specification. The other will be a more architecturally-adventurous timber gridshell. The tension structure roof design

Guidance will be provided by world-leading experts. These are still being finalised. In previous years these have included Bill Baker, Ian Liddell and Andrew Lawrence. Bill is the Structural Partner at Skidmore Owings and Merrill in Chicago. Bill has been responsible for the design of many of the world's most iconic buildings, including the 824m Burj Khalifa in Dubai, the world's tallest. Ian was formerly the chief structural designer at Buro Happold in Bath, and is one of the world's leading designers of tension stuctures. In particular, Ian was the structural designer of the London Millennium Dome (now the O2 Arena). Andrew is a leading designer at Arup in London and was the structural designer of the spectacular Metz Pompidou roof.

Minilectures will be given by the external experts and by the course leader to explain how to approach the design of timber and lightweight structures of various typologies.

Simplified analytical theory will be presented which will allow design calculations to be made. For the tension structures equations via simple Python scripts will be written to solve the systems of nonlinear equations.

Students will be introduced to modern parametric design software such as Rhino/Grasshopper in which design parameters can be explored and developed.

Students will wortk in small teams to develop their designs.

The final output will be detailed design drawings and specification of the small residential timber building. For the larger structures, numerical models of the structural behaviour will be submitted, together with a virtual parametric model to showcase the project's architectural features, possibly accompanied by physical models for presentation to the client.

It is also intended that, as in previous years, students will go on a day trip to London to look at structures. Students will travel in small groups. Train and underground tickets will be provided. The trip will be on a day, possibly a weekend day, that suits the members of each group, and which does not clash with any of the minilectures.

MINI LECTURES

- How to design in timber
- How to design lightweight structures, such as tension structures, gridshells, tensegrity structures, kinetic structures.
- How to use modern parametric design software such as Rhino, with its Grasshopper scripting interface.
- How to use modern structural analysis software such as Oasys
- Basics of physical model building for tension structures

Coursework

Coursework
Preliminary design report Final design report Client presentation and physical model

Examination Guidelines

Please refer to Form & conduct of the examinations [2].

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Links
[1] mailto:fam20@cam.ac.uk
[2] https://teaching.eng.cam.ac.uk/content/form-conduct-examinations