2015/16 MSc Research Grant Scheme

Project title: Structural Topology Optimisation of Lattice Masts under Dynamic Loads (exoskeleton morphology to novel members and connections)

University: University of Leeds

Supervisor: Dr Konstantinos Tsavdaridis

Student: TBD

Aims of research:
The proposed project carries out a two-fold study with respect to the design of tall-slim steel lattice-towers, addressing the treatment of their structural dynamic vulnerability, and utilises optimisation procedures towards a cost-effective outcome.

Climate change effects and the codification evolution in the last decade impose a need to develop new explicit studies of the imposed loads. The objective of this project is to take further steps in the field of analysis and design of lattice telecommunication towers, by using advanced computational FE models that can predict accurately their response and expose fallacies of the past, thus achieve resilience and sustainability.

Description of method:
The proposed research activity exploits advanced computational techniques to predict the structural response of the steel spatial towers, focusing on unperceived dynamic behaviours, and especially the wind-sensitivity, like loading that surpasses the currently assumed wind loads (tornadoes, gust effect, etc.) and not yet covered by the Eurocodes. Such loads are characterised by increased intensity due to the rapid change and continuous impact of climate change. The project will also address the effect of ice loading and the temporary change of the cross-sections.

We theorise that the performance of the structural members (locally) and the entire towers (globally) can be significantly enhanced using formal structural optimisation techniques combined with variable topology shape optimisation studies. Topology optimisation solvers utilise the firmest mathematical basis, to account for improved weight-to-stiffness ratio and perceived aesthetic appeal. The SIMP technique will be employed as it is currently accepted being the most prevalent method. Aerospace and automotive engineers routinely employ optimisation techniques and have reported significant structural performance gains as a result. This work focuses on the optimisation and effective design of various novel typologies of steel spatial structures to replace the conventional constructional forms and details. Scaled-models will be developed using 3D-printers within the Mechanical Engineering and the physical models will be tested at the Sorby Environmental Dynamic Laboratory.

The project builds upon recent MSc research that we have been undertaking on the development of advanced load models and model testing. The FE modelling will be performed using ANSYS and the optimisation using Altair’s Hyperworks and Optistruct. All required software licences are available within the University of Leeds. Experiments will be conducted using both conventional and optimised typologies to validate the numerical work and establish comparative studies. The students will be co-supervised by members of staff from the School of Mechanical Engineering and Earth and Environment.

Benefits to structural engineering:
On the way towards more cost-effective structures with better dynamic response characteristics and a deeper understanding on their structural details, this research will attempt to provide another elegant yet unexplored solution concerning the design of flexible lattice-masts. The findings could be further applied to other areas in the field of structural engineering, such as the design of wind turbine towers, jack-up platforms and tall-flexible towers. The knowledge in advanced computational modelling and testing we develop to accurately account for changing climate conditions. The current
study intends to encourage practicing engineers to use novel optimisation tools readily available in design nowadays.

**Proposed finish date:** September 2016