*IASS Annual Symposium 2019 – Structural Membranes 2019*
Form and Force
7 – 10 October 2019, Barcelona, Spain

# Computational layout optimization of building structures

Matthew GILBERT*, Jacek GONDZIO[a], Paul SHEPHERD[b], Linwei HE[c], Helen E. FAIRCLOUGH[c], Buick DAVISON[c], Andy TYAS[c], Alemseged G. WELDEYESUS[a], Antiopi KORONAKI[b], Qingpeng LI[b]

*Department of Civil and Structural Engineering, University of Sheffield,
Mappin Street, Sheffield, S1 3JD, UK
m.gilbert@sheffield.ac.uk

[b] School of Mathematics, University of Edinburgh, UK
[c] Department of Architecture and Civil Engineering, University of Bath, UK
[a] Department of Civil and Structural Engineering, University of Sheffield, Sheffield, UK

## Abstract

Currently the forms of many building structures such as tall buildings or canopy roofs are identified in an ad-hoc manner, with very limited application of optimization techniques, despite the fact that such techniques are now routinely used in other industrial sectors (e.g. automotive and aerospace). This means that material consumption and associated greenhouse gas emissions will often be far higher than necessary, and novel structural configurations that permit inclusion of energy efficient features such as light wells or atriums will often be overlooked.

This presentation describes outcomes from a UK government funded research project designed to address this problem, through the use of computational design optimization techniques to identify structures that are both materially-efficient and buildable.

In the project computationally efficient numerical layout optimization methods have been developed that automatically identify structurally efficient arrangements of members forming a given structure. Many of the methods developed have been embedded in a Rhino / Grasshopper plugin, enabling general use by designers. In the presentation a range of applications are described, including tall building exoskeleton design and long-span canopy roof design.