Layout Optimisation: an Industry Perspective

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Abstract

Structural layout optimisation, the determination of the best configuration for a structural system, has its roots in the 19th century theories of Maxwell and Michell, but only in recent years have computational advancements allowed for building-scale structures to be readily considered [1].

Highly computationally efficient linear programming-based optimisation techniques have recently been developed within EPSRC research project EP/N023471/1 *Computational Design Optimization of Large-Scale Building Structures: Methods, Benchmarking & Applications*. Taking advantage of geometry optimisation techniques [2], a cutting-edge software plugin now performs discrete layout optimisation on user-defined load scenarios within a 3D modelling environment [3], generating structural forms at speeds compatible with early stage, exploratory, multi-disciplinary design work.

By finding the lightest possible configuration of discrete elements to support a defined set of loads in a given design space, these layout optimisation techniques are well suited to design of truss-like space structures in industry practice, where minimising structural self-weight is a core goal. Over the past three years the authors have applied these on both past project case studies and live projects, including stadium roof form-finding, film studio roof trusses, tall building stability, long span transfer trusses over critical infrastructure, and composite floor trusses integrating building services.
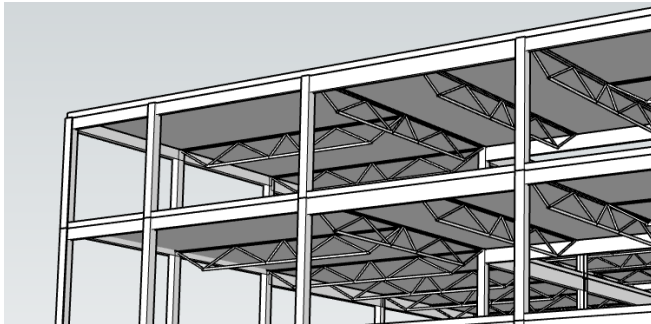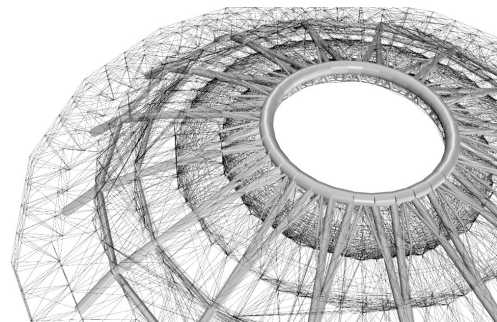
Figure 1: Office Floor Structure

Figure 2: Stadium Roof

This paper presents these case studies and their findings, forming an assessment of opportunities and limitations of layout optimisation in a day-to-day industry context, along with a practical perspective on its integration in multidisciplinary building design practice.

While demonstrating a reduction in structural material, layout optimisation can also inspire architectural form and fundamentally challenge the preconceptions of structural designers.

References

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