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Necessity and Invention: Leveraging a Megaproject to Advance the use of Computational Design

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Abstract

The roof of the New International Airport for Mexico City is a lightweight steel shell structure and an architectural centerpiece of the new 4,432 hectare greenfield airport development. Visually exposed and structurally independent from the building beneath, it supports a 500,000m2 envelope that reaches a peak height of 45m above ground level and maximum span-to-depth ratio of nearly 60:1. While it is comprised of several subassemblies, including a 2-layer tetrahedral ball-node space frame and single-layer welded CHS shells, the roof was designed and detailed with the overt intent of achieving seamless visual continuity across the entire system. It is a mile long, nearly half a mile wide and is achieved with no movement joints. This paper focuses on the design approach, structural hazards and technical solutions for addressing global buckling and validity of welded CHS connections throughout the system.

Keywords: metal spatial structures, form finding, optimization, parametric design, earthquake design, computational design, connection design.

1. Introduction

The roof concept for the Mexico City International Airport emerged initially from the winning design competition entry, produced by a joint venture of Foster + Partners and Fernando Romero Enterprises in September of 2014. With Arup providing engineering support, the design team undertook an intensive effort to define the ideal geometry for the roof system and develop a schematic design that preserved the fundamental aim of delivering a single, unified structural system.

The system that emerged relies on shell action to achieve spans of up to 150 meters between supports despite a litany of significant environmental hazards. To ensure such shell action, architects and structural engineers collaborated on an iterative process of form finding. Considerations of structural efficiency were paired with physical and operational constraints in a parametric model that enabled the team to refine the geometry over a 12-month period.

Figure 1. Rendering of the NAICM terminal building roof (F+P/FR-EE)

2. The "One System" Challenge

The competition roof scheme came preloaded with a desired structural typology, a steel space frame extending through every region of the roof. It also

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