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Buildings as bridges: Hangzhou Greenland inter-tower bridge and draped roof

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1 Abstract

The Hangzhou Greenland project consists of two towers connected by a 60m long-span bridge housing a ballroom and outdoor space and a hanging canopy structurally suspended between the two towers that covers the outdoor space. The geometry of the hanging canopy was developed through an intensive collaboration between the architecture and engineering teams, with the result that the structural quantities are minimized, the doubly-curved surface is tiled with faceted flat quadrilateral glazing, and the nodal connections have no geometric torsion. The geometric intricacy of the structure required the development of a tightly integrated digital workflow to allow refinement of the design and communication of design data and intent to the local engineer and architect. A pressure tap wind tunnel study was used to estimate expected wind loads, and performance-based evaluation of glass panel warping and shear was developed. The final design tightly integrates the bridge, tower, and hanging canopy in a fine-tuned whole.

Keywords: architectural surface panelization, scaled-translational surface, torsion-free nodes, catenary, graphic statics

2 Introduction

The Hangzhou Gate project is located on the east bank of the Qiantang River, between the core of the old city and the airport. The project site is located in Xiaoshan District, between the International Expo Center in the northeast and the Olympic Sports Center in the southwest. The twin towers form the gateway to the city center, which is close to the abstract English letter “H” of Hangzhou, as shown in Figure 1 . The east and west towers of the project are 64 floors, the height of the structural roof is 282m, and the height of the crown of the tower is 302.6m. The two towers are connected by an arched steel bridge spanning 60m. The steel bridge is disengaged from the ground above the tower through expansion joints. Hanging from a truss structure at the 21st floor of the towers is a doubly-curved steel lattice drape consisting of catenary curves. The catenary geometry allows the drape to efficiently span between the towers under gravity. The drape is laterally restrained by a glazed sidewall structure spanning between the bridge and the drape. The focus of this paper is the geometric design strategy of the bridge, drape and sidewall assembly, which is tightly interwoven with the structural design and which required custom digital workflows to accurately design and document.

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