Manufacturing constraints for structural aluminium nodes in free form reticulated structures

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Abstract

The geometry of shell and spatial structural surfaces are typically described by analytical geometries or generated with form finding based on physical models or numerical methods. A more general description of such surfaces, that does not exclude form finding or shape optimization, are free form surfaces – a surface described as a NURBS-surface. A common way to define a geometrical model for a shell surface is to divide the surface in to a grid-topology, or gridshell, also known as a reticulated structure. The nodes of reticulated structures, are structural elements that normally transfer beam forces, but also handle geometric complexity [1]. With respect to the fabrication, the nodes are either repeated or customized. When repeated, the overall structure is made from one or few node-types. The nodes will then typically cater for a limited number of angles and rotations between bars, and the design options of the global shape is limited to structures like barrel-vaults and geodesic domes. On the contrary, customized nodes allowing for every node in theory to be different, enable free-form structures. With the help of a digital parametric model, complex node geometry can be designed, prepared for fabrication, evaluated for structural feasibility [2][3]. Reticulated structures are commonly produced with steel nodes with connecting steel bars. Compared to steel, aluminium has different manufacturing constraints, providing new design options for corrosion resistant light weight structures. This paper will describe state of the art manufacturing methods and their constraints for fabrication-aware design of mass customized aluminium nodes. Based on this, the paper will discuss the future potential of aluminium as a structural material for free form shells and spatial structures. An overview on how constraints regarding manufacturing and construction provide options and limitations for shell geometries is presented.

References

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