Shape optimization of freeform shell structures considering the effect of edge beams

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Abstract

Edge beams have a large influence on both the structural form and its mechanical behavior of shell structures [1],[2]. In this paper, the influence of the edge beams on the geometry of the shell after shape optimization is investigated, along with the mechanical performance of the shell structure.

A single shell structure with four different edge beams conditions are studied, including on shell without an edge beam. To minimize the bending moments in the shells, shape optimization is carried out using a Genetic Algorithm to adjust the control points of the NURBS shell geometry. To investigate the effect of edge stiffness, an interesting but relatively under-appreciated method of load path analysis [3] is used to understand the behavior of the shells under external loads, and this method is compared to more usual critical parameters such as displacement and buckling factor as a means of optimizing shells.

The case study shows that the existences of edge beams has a non-negligible effect on the optimal shape of shell structures and on their mechanical performance. With edge beams of sufficient large stiffness, reverse curvature at the free edges can be avoided. Whereas the careful use of reverse curvature at the edges can provide a more efficient means of stiffening the shell. It also demonstrates the usefulness of the load-path method for such shell studies.

References

