An optimum cutting pattern generation of membrane structures considering weld seams

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Abstract

Membrane structures are widely used because they are lightweight, efficient and artistic. Cutting pattern generation is crucial for the design of membrane structures that determines actual shape and stress distribution of the constructed structure. However, non-developability of the doubly curved surfaces and the existence of seams between adjacent strips make precise cutting analysis difficult.

This paper presents an optimum cutting pattern generation of membrane structures considering weld seams. Using the 2D displacements of membrane elements as key variables, the proposed method utilizes a geometrically nonlinear finite element analysis based on the initial cutting patterns iteratively. Meanwhile, the simulation of weld seams is integrated in the full cutting analysis for considering the influence of seams. Along longitudinal direction of seams, the displacements of membrane nodes in welded regions are restrained for the influence of seams in the warp direction. Along the direction perpendicular to seams, the fill moduli of membrane elements between adjacent seams are modified for the influence of seams in the fill direction. Finally, the optimum cutting patterns are spliced into an assembly form approaching design shape while the seam is also considered in the assembly process. The deviations of stress and shape from target value of assembly form is minimized simultaneously.

A common sphere model is chosen for numerical simulation in this paper. The cutting pattern is optimized considering seams for reducing stress error, and assembly form in equilibrium is obtained for comparison with design shape and desired stress. The numerical results show that the method achieves high accuracy of patterning and assembly.

References

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