An Analytical Method for Precise Forming of Membrane Structure Considering the Spindle Direction of Membrane Material

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ABSTRACT

Membrane structure is a three-dimensional Gaussian surface formed by splicing plane membrane strips. In current studies, it is difficult to accurately predict the actual state of membrane structure because the direction of spindle of membrane material on plane cutting strips is usually inconsistent with that on three-dimensional finite element model. In this paper, an analytical method is proposed to re-mesh membrane strips and reset the direction of spindle of membrane elements in accordance with the actual membrane material after membrane structure has been divided into several membrane strips, so that the membrane elements on spatial curved surface can correspond to those on the plane cutting membrane strips one by one. By modifying the direction of spindle of membrane element of plane cutting strips and applying the modified direction of spindle to the membrane element on space surface, the actual stress state of membrane material can be obtained. This method can be applied to the iterative process of precise forming of membrane structure, and the difference between design form and actual form is calculated at each iteration step. By adjusting the position of the cutting line and compensating the stress difference, the shape and size of cutting membrane strips are adjusted and the difference between design form and actual form can be reduced to a certain range. Therefore, the cutting membrane strips with higher precision and the actual shape and stress distribution of membrane structure are obtained.

Keywords: Membrane structure, spindle direction, precise forming, stress distribution.