Shape Optimization by Presence of Antiplane Shear Deformation in Free-Form Shell Structure

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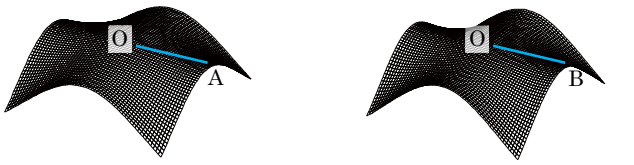
Abstract

In this study, we investigate a difference of forms obtained by shape optimization using shell element with/without the antiplane shear deformation for free-form shell structures. Free-form shell structures with a long span are designed many practical projects recently. Such structural systems need to satisfy both designability and mechanical rationality. However, a decision of a curved shape for the free-form shell structure by a designer's experience and intuition is difficult. In the shape optimization computation using the coordinates of curved surface and the shell thickness as design variables, the influence that receives stress concentration is different according to the type of the support condition. Therefore, the support neighborhood tends to make the shell thickness thick by the shape optimization [1], and in the computation that uses the shell element (finite element) without the antiplane shear deformation (Kirchhoff-Love theory) [2], there is a possibility of not indicating a correct stress state.

In this paper, we indicate the difference of numerical solutions for shell element based on Kirchhoff-Love theory and Mindlin-Reissner theory [3] using a support with stress concentration in an analysis model of a shape optimization. Next, we apply a support condition of easing the stress concentration in the analysis model. The solution search approach of shape optimization adopts Artificial Bee Colony (ABC) [4] that is one of the heuristic procedures. The figures below are an example of the numerical result by the shape optimization using shell element with/without the antiplane shear deformation.



a. by Kirchhoff-Love theory　　b. by Mindlin-Reissner theory

Figure. Solution forms

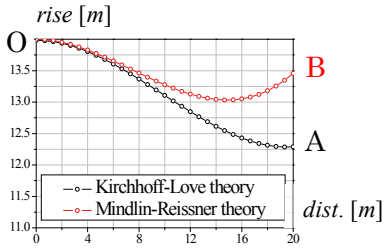


Figure. Cross-sectional shape (━)

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