Structural Optimization for Timber Gridshell Structures Using Geodesics
- Comparison of Optimized Solutions in Different Grid Patterns -

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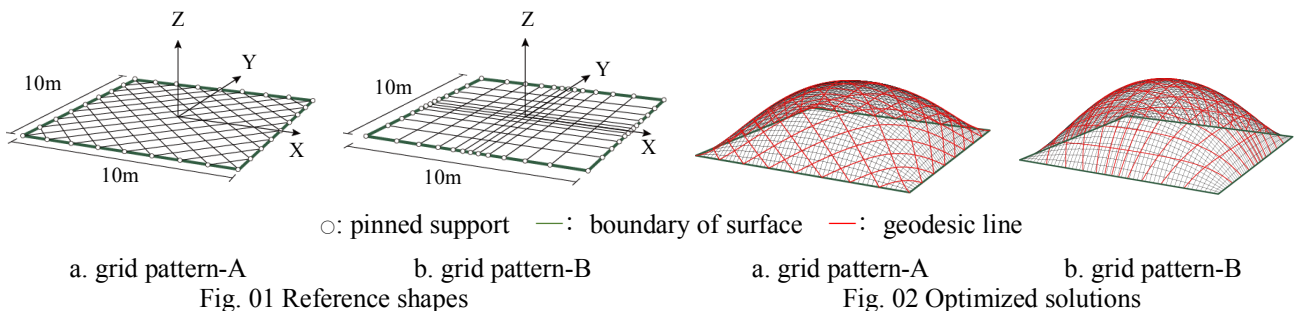
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This paper presents the structural optimization for timber gridshells[1] using geodesics and indicates a variety of grid patterns on the optimized structural form from the obtained numerical results. In recent years, timber gridshell structures have been constructed by improving of the construction technique such as digital fabrication and building information modeling (BIM). These structures involve geometrically complex freeform surfaces and provide attractive internal space[2], characteristics of timber utilized in these structures is mentioned as natural material, light-weight and low environmental burden. On the other hand, the form-finding analysis using elastica curves which are useful approaches for timber gridshells have been proposed[3)-4)]. An elastica curve is formed by initial bending of frame members. However, applicability of structural optimization has difficulty to manipulate local coordinates of structural members with rectangular cross section in three dimensional spaces because three coordinate axes are not fixed. Therefore, we adopt a geodesic obtained for an arbitrary curved surface shape as a curved frame member. As a result, the normal direction of the curved surface can be determined uniquely as the reference of a local coordinates of structural members in three dimensional spaces.

In this paper, we indicate the formulation of searching a geodesic and perform structural optimization for timber gridshell structures using geodesics in multiple boundary shapes. then, we compare the structural form of optimized solutions, and investigate the mechanical property depending on the different grid patterns. Figure 1,2 show the reference shapes and optimized solutions of different grid patterns in a model.

○: pinned support   —: boundary of surface   —: geodesic line

a. grid pattern-A   b. grid pattern-B   a. grid pattern-A   b. grid pattern-B
Fig. 01 Reference shapes   Fig. 02 Optimized solutions

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