Structural Morphogenesis for Grid Shell with Member of Uniform Length and Cross Section by Genetic Algorithms to Implement Manipulation of Decent Solutions Search

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Abstract

In this paper, the structural morphogenesis for a grid shell with the members of uniform length and cross section is indicated. The design of the grid shell structure with free curved surface for a large space became realizable from the confirmation of the structural rationality and the improvement in construction technology. However, the constraint for the productivity and constructability of these structures are produced in the length and cross section of the structural members.

In general, an optimization technique is used to obtain the global optimal solution. One of the authors proposed GA with immune system (ISGA) [1] for the structural optimization procedure that implemented the manipulation of the decent solutions search. The decent solutions have comparatively high evaluation value including the global optimal solution and the local optimal solutions and those neighborhood solutions. The decent solutions obtained by ISGA maintain diversity both in the design variable space and the objective function space. This structural optimization procedure with the manipulation of the decent solutions search is applied to structural morphogenesis for the grid shell [2]. The acquisition of the obtained rational and diversified solution forms will be used to support designer's idea.

In the numerical examples, the decent solution forms of the analysis model for the symmetric grid shell structure are shown for an in plane rectangular geometry. First, we indicate the geometric relationship and computational procedure for creating curved surface using Bézier when the structural members are set to a uniform length and cross section. Next, we apply this technique to the structural morphogenesis for a grid shell with single-objective optimization problem for the total strain energy minimization or the bending strain energy minimization. Last, the structural properties of these decent solutions obtained by ISGA containing a global optimal solution and local optimal solutions are verified.

Figure below are some numerical examples of the decent solution forms for the grid shell structure with uniform length of all members. The cross section of the member in these forms has been optimized. In the boundary condition of the analysis model, the corner parts are pinned support.
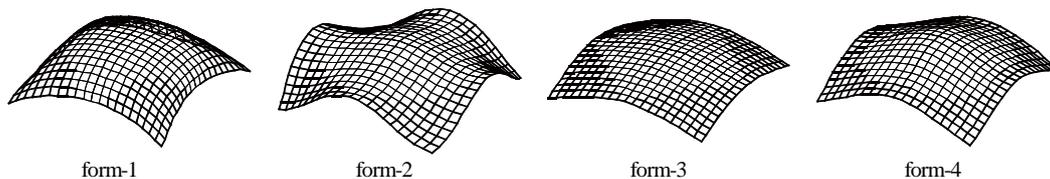

| form-1 | form-2 | form-3 | form-4 |

Figure. Decent solution forms with uniform length

References

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