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MORPHOGENESIS DESIGN SUPPORT SYSTEM OF THE BUILDING ROOF

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ABSTRACT

It has been recently reported that studies relating to the optimization of structural forms using the evolutionary approach have been conducted and dynamically excellent forms have been obtained [1]-[3]. However, beauty and impression of these forms have not yet been given attention in these optimization studies. Meanwhile, the authors have performed a study of the creation of structural forms to satisfy both the aesthetic emotion of users and dynamic rationality from the standpoint of the users of the building [4]-[5]. However, we cannot ignore the aesthetic emotion of designers in the design of buildings. In this study, we developed a design support system which proposes roof forms with more dynamic rationality based upon the free line that the designer imaged, reflecting the designer's image from the standpoint of a designer.

This system consists of two systems of "Form Image Input System" and "Rational Form Evaluation System". The "Form Image Input System" is to input a roof image in each directions of X and Y of the form and the column arrangement, produce a 3D form and define the designer's image. The form is defined by SPLINE curves in each directions of X and Y. SPLINE curves are defined by passage through the control points previously specified. The "Rational Form Evaluation System" is to search and propose a more dynamically excellent form, by changing the designer's image form defined by the "Form Image Input System" a little. The search is conducted by a GA. The variable quantities at control points are defined as gene locus. A new form that was changed slightly from the designer's image form, is created by combination of the coordinate of control points that the designer inputted and the values of variable gene locus. The newly created form is analyzed using stress analysis (FEM analysis), and the obtained equivalent stress is adopted as fitness of GA operation. This system searches and proposes a form which fitness is high (i.e. equivalent stress is small) by repeating GA operation until the specified generation. An implementation example is as follows:
Fig. 1 shows the initial form that the designer imaged, Fig. 2 shows the form obtained by this system and Fig. 3 shows the variation of equivalent stress by each generation. From these figures, it is revealed that the equivalent stress becomes small by changing the original image a little and a high dynamic rationality can be obtained.

In this study, the variable quantities at the control points of SPLINE curves were defined as a gene and the equivalent stress obtained by stress analysis was adopted as the fitness. It was confirmed that a form with high dynamic rationality could be created without changing the designer's image greatly by GA operation. We confirmed that this system was useful as a design support system for designers.

Fig. 1 Original Image Form

Fig. 2 Last Generation Form

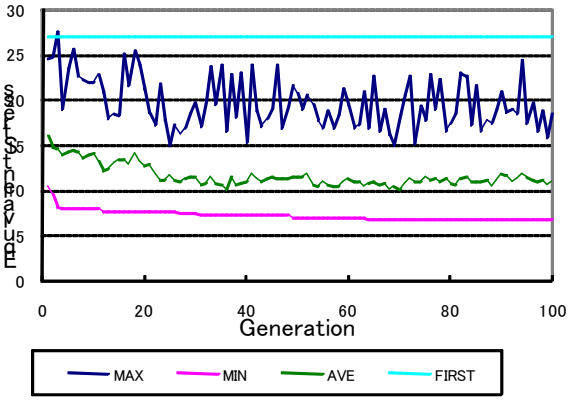

Fig. 3 Variation of Equivalent Stress

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