Shape optimization of structures using Reaction-Diffusion System and Finite Element Method

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Recently, analysis of bone form using FEM is studied to get their dynamic traits. Bone is porous material with structures adapted to dynamic stress. iBone proposed by Tezuka is a hypothetical model of bone remodeling. iBone modifies the shape of bone to realize uiform stress distribution by coupling the bone forming and absorbing in response to local stress using reaction-diffusion system[1]. iBone has two calculation processes. 1st is calculation of stress distribution using FEM. Final is shape adaptation to the given external mechanical stress. As a result, iBone reduce stress concentration caused by cracks. The efficacy of iBone represents a principal model how bone cells can form a cooperative system that adapts the microstructure of bone to the voluntary mechanical loads; and that reaction-diffusion system can be applied for designing stress adaptation models.

Shape optimization to obtain a stronger shape with less volume is one of the major topics not only in bone biology but also in mechanics and architecture. We apply iBone to structure dynamics. In this paper, shape optimization of 2-D structures using reaction-diffusion system and FEM is presented. We discuss the result in comparison with results of homogenization design method[2], one of the most effective methods for topology optimization, by some 2-D examples. We show that optimum solution obtained using iBone is similar to that obtained using homogenization design method from the some points of view.

References

[1] K. Tezuka, Y. Wada, and M. Kikuchi, “iBone: A Reaction Diffusion Based Shape Optimization Method” , Key Engineering Material, in print

[2] D. Hujii, K. Suzuki, and H. Otubo, “Topology optimization of structures using the voxel finite element method”, Transactions of JSCES, Paper No.20000010 (in Japanese)