Stress evaluation of real shape seashell by image-based finite element analysis

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Abstract

Biomimetics, which is the imitation of natural systems, models and structures, have been applied in many field while its application for architects has been limited in ornament. The external form of seashell is optimized in nature while keeping its internal space safe and comfortable, therefore the self-organized seashell structure would be applied for shell structure of architects. Various types of optimization method of shell structure through computational technique have been proposed [1], however the optimized shell structure similar to the seashell structure has never appeared although seashells should be optimized by themselves in nature. Moreover, mechanical properties of seashell was not revealed although the geometrical properties has been studied qualitatively by many researchers [2].

In this study, mechanical properties of bi-valve shell which is a kind of seashells was investigated through the image-based finite element analysis to reveal the mechanical effectiveness of seashell structure and its applicability for structure of architects. The CT images of the upper part of bi-valve shell was taken by using micro focus X-ray to measure its real shape accurately. The finite element model with 10-node tetrahedral elements of bi-valve shell was generated from CT images semi-automatically. Fig.1 shows the results of finite element analysis under static loading in the direction of X, Y and Z axis. From the results, the region of stress concentration was different depending of the direction of loading. This means that the seashell shape was effective to prevent the stress concentration resulting in its collapse.

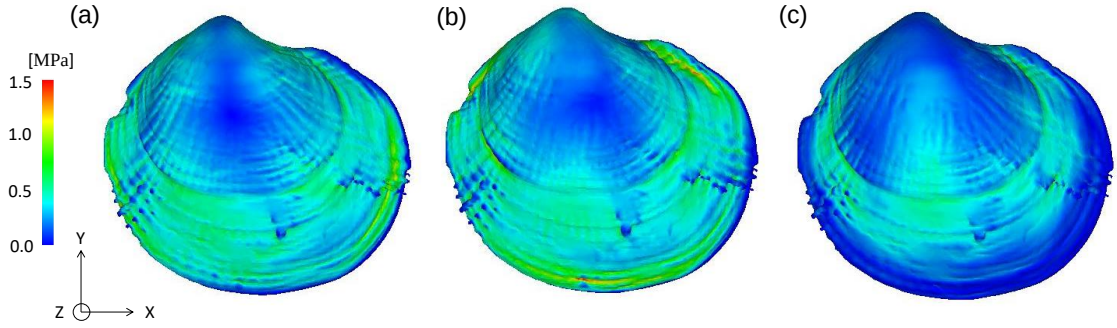

Fig. 1 Distribution of equivalent stress of bi-valve shell of (a) front, (b) back and (c) vertical cross section under static loading in the direction of (a) X, (b) Y and (c) Z axis.

References

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