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Topology Optimization for Crashworthiness using an Explicit Time Integration Scheme

***Kohei YUGE[1], Kaoru KOBAYASHI[2] and Yohei YUANEZAWA[3]**

[1] Department of Electrical and Mechanical Engineering, Seikei University
3-3-1 Kichijoji-Kitamach
Musashino-shi, Tokyo 180-8633,Japan
yuge@st.seikei.ac.jp

[2] Department of Mechanical Engineering, Seikei University Graduate School
3-3-1 Kichijoji-Kitamach
Musashino-shi, Tokyo 180-8633,Japan
Dm063104@st.seikei.ac.jp

[3] Dai Nippon Printing Co., Ltd.
1-1-1, Ichigaya Kagacho
Shinjuku-ku, Tokyo, 162-8001, Japan
Tsuganezawa-Y@mail.dnp.co.jp

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ABSTRACT

In this study an algorithm of topology optimization of thin-walled structural members for crashworthiness is presented. This algorithm employs the density method[1] and the crash analysis is conducted with an explicit time integration scheme using Belytschko-Tsay Shell element[2] , which employs the one point quadrature and is known to be very fast to evaluate inner forces.

It is well known that the density approach tends to result in checkerboard patterns, where a high density element and a low density element are arranged alternately. To cope with this problem the design variable, the material density, is set on the node and the element density is interpolated from the nodal densities. The external work is used as the object function and sensitivities of it are calculated with the difference method from the nodal displacement histories. The design variables are updated based on the optimality criteria method.

In the automobile safety design it is sometimes necessary to design a structure to have a desirable load-displacement curve. To demonstrate the present algorithm a square box beam with fixed ends subject to the lateral loads on the center is optimized to have a prescribed load displacement curve. In Fig.1 the load-displacement curves of the optimal and initial designs are compared with the target one. It can be seen that the curve of the optimal design is very close to the target line. Fig.2 shows the calculated optimal design and its deformed configuration with Von Mises stress contours. In this design the structure deforms globally first. Then local bucklings take place near the loading point. Due to these buckling the load displacement curve is kept flat through deformations.

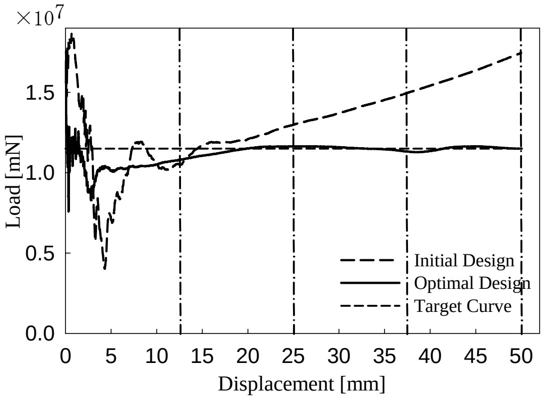

Fig.1 Load Displacement Curves

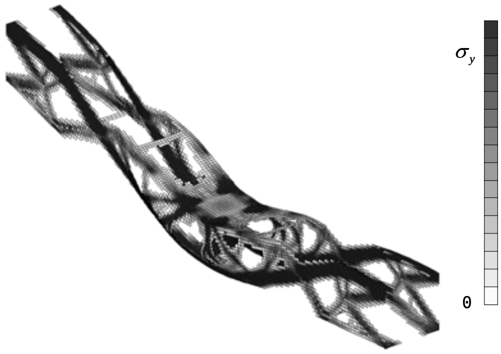

Fig.2 Deformed Shape of Optimal Design

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