Estimating load condition having caused structure failure and an optimal design taking account of the estimated result

T. Muromaki[1)], **K. Hanahara**[2)], **Y. Tada**[2)], **S. Kuroda**[3)], and **T. Fukui**[3)]

[1)] Graduate School of Engineering, Kobe University, Kobe, 657-8501, Japan, muromaki@opt.cs.kobe-u.ac.jp

[2)] Graduate School of System Informatics, Kobe University, Kobe, 657-8501, Japan, hanahara@cs.kobe-u.ac.jp, tada@cs.kobe-u.ac.jp

[3)] Martec K. K., Kobe, 650-0046, Japan, kuroda@martec.co.jp, fukui@martec.co.jp

Keywords: *load estimation; optimal design; database; finite element analysis.*

Abstract

Avoiding failure of structure system is one of the most important mission for design engineer of structures. In order to improve an existing structure so that it does not fail, it is important to know the load condition that causes structure failure. In the current study, we deal with a design approach that is based on estimated load condition obtained by means of examination of such failed structures.

We develop an estimation method of loading conditions based on images of failed structures and an FEM analysis model. Preparing a database that consists of deformation data of the structure corresponding to various load conditions, our system is able to estimate the load conditions that caused structure failure based on the processed images of failed structure samples. Adopting elasto-plastic model of the structure, the magnitude of the load having caused the failure is also estimated in addition to the position and orientation of the critical load. We adopt the EM algorithm (McLachlan and Krishnan 1997) to obtain the distribution of the critical load.

An optimal design problem that takes account of the distribution of the estimated critical load condition is formulated as a minimization problem with a multi-objective function; the deformation, the stiffness and the structural weight are also adopted as the evaluation items that make up the objective function. The particle swarm optimization (PSO) is adopted as the optimization algorithm.

The approach is applied to crane-hook. The result of estimated critical load distribution and the optimal design based on the load distribution are demonstrated.

References

McLachlan, G. J. and Krishnan, T. *The EM Algorithm and Extensions*, Wiley-Interscience 1997.