Numerical Analyses for Shape Optimization Problems in Mechanical Engineering Problems

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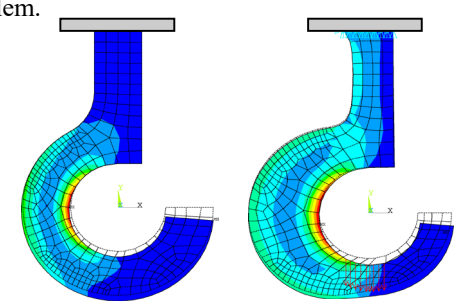
Research Outline

Shape optimization problems of mechanical structures, such as liner elastic bodies, heat conduction fields, flow fields, and heat transfer fields, for improving performance are important in engineering fields. Our research group have proposed numerical analysis methods by using Finite Element Method for these shape optimization problems and shape identification problems.

Figure 1 shows numerical results in order to achieve stiffness maximization in the elastic bodies for 2D hook problem.



Initial shape Optimum shape

Fig.1 2D hook problem

Figure 2 shows numerical results for dissipation energy minimization problem in 3D branch channel viscous flow fields problem. Fluid flows in from a boundary Γ0 and flows our from two boundaries Γ1.

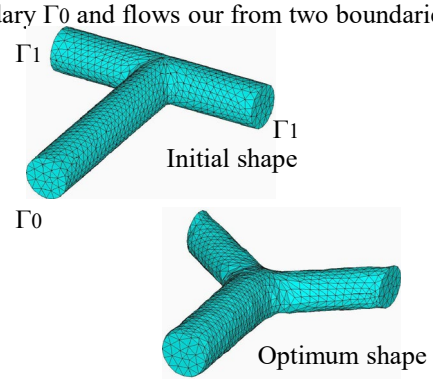
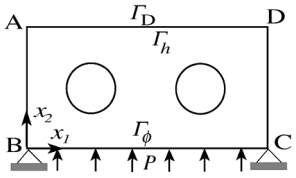
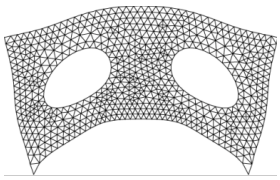


Fig.2 3D Branch channel problem

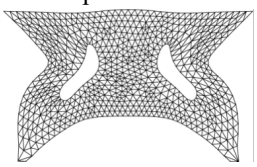
Figure 3 shows numerical results for thermo-elastic body problem. The purpose of this analysis is to identify the shape for which the displacement distribution at sub-boundary A-D in the x2 direction due to thermal deformation becomes as uniform as possible. For simplicity, we consider a case under the following conditions: specified temperature boundary and surface force boundary on B-C, heat transfer boundary on A-D.



Problem



Initial shape after deformation



Identified shape after deformation

Fig.3 2D plate problem with two holes

We confirm that the thermal displacement at boundary A-D for the identified shape becomes uniform.

This problem is very important in the development of machine tools that are subject to thermal deformation, and the shape design of the equipment for the purpose of improving machining accuracy by decreasing the thermal deformation is a problem that is directly related to this study. Moreover, the establishment of such shape design technology is also desired in the development of precision measurement equipment in which the thermal deformation influences the measurement error.