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論 文 内 容 の 要 旨
Abstract of Dissertation

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The objective of this thesis is to propose and verify a new update method for design variables that is easy to use and efficient for engineers. Conventional optimality criteria (OC) method does not find optimum solutions depending on parameter settings. In this study, a modified OC method is proposed by incorporating the Newton's method, which is known for its ability to rapidly obtain a solution on nonlinear equation, into the OC method, which is often employed in density-based topology optimization. Topology optimization on several optimization problems are performed, using the proposed method. In addition, the guideline for setting up optimization problems by tensile testing is clarified.

In chapter 1, the background and the outline in this thesis were summarized in detail.

In chapter 2, a modified OC method was proposed based on the concepts of Newton's method and OC method. To compare the results obtained using the update methods, topology optimization in the problem of self-adjoint relationship was performed when strain energy was used as the performance function. Topology optimization when using the modified OC method did not require the setting of weighting factor and obtained a density distribution that was independent of the move-limit. The number of iterations when using the modified OC method was less than that when using the OC method.

In chapter 3, topology optimization in the problem of non-self-adjoint relations was performed when von Mises stress was used as the performance function. A max-min normalized (MMN) modified OC method is newly proposed because this optimization problem includes the second-order derivatives of negative values. As in chapter 2, numerical analysis example proved that the setting of weighting factor is not required. Additionally, the obtained density distribution was confirmed to be independent of the move-limit. It is mathematically proven that the convergence property of the modified OC method is more than first-order convergence.

In chapter 4, tensile testing was used to verify whether the strain energy minimization problem or the von Mises stress minimization problem is more suitable for manufacturing. For all volume rates, the specimens obtained by the von Mises stress minimization problem had higher strength than those obtained by the strain energy minimization. From chapter 2, it was found that the strain energy minimization problem is a highly stable optimization problem for topology optimization analysis, and from chapter 4, it was found that the von Mises stress minimization problem is an excellent optimization problem from a strength perspective.

In chapter 5, multi-objective topology optimization was performed for strain energy minimization and von Mises stress minimization. Multi-objective topology optimization when using the MMN modified OC method was too slow to update. Thus, the modified OC method based on map function, the mapping-based modified OC method, was newly proposed. As in chapters 2 and 3, numerical analysis example proved that the setting of weighting factor is not required. Additionally, the obtained density distribution was confirmed to be independent of the move-limit.

In chapter 6, findings from numerical analyses and tensile testing on the newly proposed method in this thesis are summarized.