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Structural optimization of dynamic system considering the fatigue life in frequency domain

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Abstract

In our previous contribution on topology optimization for fatigue constraint failure constraint, a method considering transient load was developed. In our previous contribution, optimal layouts preventing mechanical failure due to transient load can be found but it was limited to a relatively simple load profile. To consider complex and random dynamic loads in structural topology optimization, the fatigue life calculation schemes in frequency domain such as the narrow band approximation, Wirsching and Light Method, Ortiz and Chen method, and Dirlik's method will be considered [1]. We implement these assessment schemes for dynamic load and formulate the topology optimization minimizing volume subject to the accumulated damage that is the similar formulation considering the static failure. Similar to the structural topology optimization for static failure, many theoretical difficulties such as the highly-nonlinear constraint, the local constraint, and the stress singularity are observed for the present topology optimization formulation for dynamic failure in frequency domain. By adopting the exiting qp-formulation, the p-norm approach and the effective gradient optimizer [2-3], the structural topology optimization problem considering the dynamic failure in frequency domain can be solved. However, due to the unstable behavior of the aggregated fatigue life constraint with respect to the design variables, we could not obtain stable optimization processes and clearly converged design. To overcome this difficulty, we present a new scaling approach that presents the oscillations of the aggregated constraint in topology optimization. With this scaling approach, we could obtain stably converged design.

References

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