

SIMULTANEOUS TOPOLOGY AND JOINT POSITION OPTIMIZATION CONSIDERING JOINT LOAD LIMITS

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Abstract

In mechanical systems, joints remain indispensable for modular assembly, maintenance, and overcoming build-volume limits. Bolts are widely used mechanical fasteners, and the position of bolted joints can decisively influence the resulting topology and structural performance. At the same time, joints are often critical points of failure. Simultaneous optimization of topology and joint position, combined with a joint load constraint, can therefore increase performance while ensuring joint loads remain within allowable limits.

Common approaches optimize the joint position by introducing spring elements between mesh nodes [1], which leads to mesh-dependent and discrete (non-continuous) joint positions. Ambrozkiwicz and Kriegesmann [2] presented a mesh-independent approach for continuous joint position optimization in combination with topology optimization. Joint load limits for bolted joints were addressed in [3] by means of a constraint formulation. In this contribution, the joint load constraint from [3] is integrated into the simultaneous joint position and topology optimization framework in [2]. Compliance is minimized subject to a volume constraint and joint load limits, treating the joint coordinates as continuous design variables. The joint load constraint considers combined shear and normal loads.

An industrial use case of a powertrain mounting system serves as a demonstration example. The results show that including joint position as a design variable decreases compliance even for small position changes. Enforcing the joint load constraint increases compliance but yields feasible designs with admissible joint loads. Overall, the approach can be used to reduce required bolt size and the number of bolted joints

References

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