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Robust Topology Optimization of Static Systems with Unilateral Frictional Contact

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In this work the robust compliance topology optimization approach presented in [1] is combined with the general framework for topology optimization of linear-elastic structures in unilateral contact of Strömberg and Klarbring [2]. Thereby, for contact treatment the augmented Lagrangian approach is used to calculate normal and tangential contact forces.

In the presented work, uncertainties at the contact surface, such as the local gap clearance or the friction coefficient, are taken into account during the optimization. This is of major importance, since the contact-constrained optimization framework [2] is very sensitive to the gap clearance. Hence, manufacturing tolerances at the support structure could lead to poor performance or even failure of the optimized structures. Further, the actual friction coefficients are usually not known in practice, which is why a random distribution of friction coefficients should be considered during optimization. Both uncertainty sources are assumed to be normal distribute dand are propagated using the first-order second-moment method. This method estimates the mean and the variance of the compliance with respect to the defined uncertainties. Both estimates are calculated analytically, so that the gradient of the objective of the robust optimization can be calculated efficiently with the help of one additional adjoint equation. Hence, a standard deterministic optimization algorithm, such as the *MMA*, can be used.

The applicability of the approach is demonstrated by testing examples, where uncertainties inside bearings are modeled with the help of the contact formulation. Additionally, the robust design is compared to the deterministic approach using Monte Carlo simulations. As a result, the proposed approach leads to less sensitive and thus more robust optimized designs at very little additional computational cost.

REFERENCES

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