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基于线性鲁棒性优化的弦支结构设计及分析

Linear robustness based optimization design of cable supported structure and its performance analysis

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英文关键词:cable supported structure robustness robust H_∞ control topology optimization

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作者	单位	E-mail
叶俊	浙江大学 建筑工程学院，杭州 310058	
高博青	浙江大学 建筑工程学院，杭州 310058	bqgao@zju.edu.cn
董石麟	浙江大学 建筑工程学院，杭州 310058	

中文摘要:

结构的鲁棒性是指结构抵抗不相称破坏的能力。目前，研究集中于框架类结构鲁棒性的评价，缺少弦支结构鲁棒性评价及设计方法。首先基于 H_∞ 理论，采用结构系统传递的 H_∞ 范数作为结构鲁棒性的定量评价指标。然后，采用SIMP模型描述建立了人工材料模型，以结构线性鲁棒性为优化目标，将结构鲁棒性设计转化成连续体拓扑优化，并通过粒算法求解。以弦支双曲球壳模型为例，通过鲁棒设计得到了鲁棒构形。最后通过作用超越静荷载，制造干扰场景，分析不同结构设计方案的非线性鲁棒性。结果表明，H_∞ 结构鲁价指标可以反映干扰与后果是否相称，通过连续体拓扑优化进行鲁棒设计，能够有效地提高结构鲁棒性，可以为弦支结构初始概念设计提供参考。

英文摘要:

Structural robustness refers to the ability of structures to avoid disproportionate consequences in relation to the initial cause.While many studies h been devoted to the evaluation of robustness of frame structures,little attention has been paid to effective methodology to robustness based design of cable supported structures.Firstly,taking basis in robust H_∞ control theory,structural robustness is assessed by H_∞ norm of the system transfer function.Followir SIMP approach,an artificial isotropic material model with penalization for elastic constants is assumed and relative density variables of elements are used describing the structural layout.The robustness based topology optimization problem is then modeled as to search for the maximum or minimum linear robustnes index and the particle swarm optimization algorithm is used to solve the problem.After that,two cable supported structures were designed according to the resulting topology and the conventional approach,respectively.Disturbance scenario was simulated by beyond static load and the response of the models were analyzed and compared.The results show that the H_∞ structural robustness index can indicate whether the structural response is proportional to its cause;In contrast to the conventional approach,the proposed framework can lead to more robust structures,thus offers new potentials to the conceptual design process.

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