

世博会工程专辑

自由曲面建筑一体化造型与优化设计研究

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摘要:

以建立弯曲应力为零、薄膜应力最小的曲面为目标, 提出了一种基于计算机辅助几何设计(CAGD)的一体化有限元建模技术与造型优化方法。该方法通过参数联动、模型自动更新等功能, 实现了计算机自动进行自由曲面建筑造型的目的。利用软件自身的二次开发功能, 建立了一套CAD软件与有限元软件协同建模与造型优化设计系统。该系统包含了三维参数化动态有限元建模中的若干关键技术, 如CAD/CAE集成方法、基于应变能的空间结构优化以及有限元模型的参数驱动方法等。该系统可通过调整设计参数(约束条件, 空间条件)得到多种合理曲面形态, 同时也可以对建筑意图所设定的初始形状进行修改, 为基于性能化的自由曲面建筑造型设计提供新的方法。该系统可利用建筑设计所提供的初始曲面形状进行合理的参数定义, 在此基础上通过若干次优化修正, 改善结构的力学性能。

关键词: 自由曲面 计算机辅助几何设计 应变能 形态优化

Integrated modeling and shape optimization for free form surface architectures.

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Abstract:

Based on the computer aided geometric design (CAGD), the integration FEA technique and shape optimization for free-form surface were presented on the goal of establishing surface of zero bending stress and the smallest membrane stress. The method overcame the difficulties such as the description and driving of 3D models, parameter linkage, and automatic update of finite element models, and achieved the purpose of modeling free-form surface construction by computer automatically. Using the secondary development function of commercial software, a set of CAD software and finite element modeling and shape optimization software co-design system were established. This system included a number of key technologies for 3D dynamic parameterized modeling, such as CAD/CAE integration approach, strain energy-based optimization of spatial structure, as well as the finite element model of the parameter-driven methods. The system is reasonably available to a variety of surfaces by adjusting the design parameters (constraint conditions, space conditions). At the same time the initial shape can also be modified on construction intentions. This method provides a new approach for performance-based free-form surface architectural design. The parameters can be defined from initial surface created by architects and improved the mechanical properties by optimization.

Keywords: free-form surface CAGD strain energy shape optimization

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