

基于灵敏度和碰撞仿真的汽车车身轻量化优化设计 Lightweight Optimization Design of Car Body Based on Sensitivity and Side Crash Simulation

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摘要: 提出了基于灵敏度分析和侧面碰撞的汽车车身结构轻量化设计方法。首先以车身结构零件的板厚为设计变量,以白车身的模态和刚度为约束条件,白车身质量最小为目标,分析了零件板厚关于车身模态和刚度的灵敏度。选取对车身模态和刚度以及抗撞性不敏感的车身零件的板厚,进行以白车身质量最小为目标的优化计算。优化结果使车身减轻14.8 kg。对轻量化后的整车和乘员约束系统进行了侧面碰撞的模拟计算,并与轻量化前的结果进行了对比,对整车耐撞性和乘员的安全性进行对比校核,根据碰撞结果对车身零部件的厚度进行了再调整。结果表明,轻量化后的车身满足碰撞安全性的要求,假人的C-NCAP得分也是可接受的。A method of lightweight about car body was developed based on the analysis of sensitivity and crashworthiness. First, the thickness of components on car body was used as design variables. The modal and stiffness of car body were the constraint. The weight of car body was the objective of optimization. The sensitivity of the thickness about modal and stiffness was obtained. Based on this sensitivity, the components whose thickness was not sensitive to modal and stiffness of car body were selected as the design variables. Using these design variables, the optimization design was carried out with the minimize weight of car body as objective. The result of optimization made 14.8 kg weight reduction of car body, and guaranteed the performance of stiffness and modal. The simulations of side crash including whole car and occupant restraint system were carried out to the car after lightweight. The performance of crashworthiness and occupant restraint system was validated through comparing the results of before and after lightweight. In order to make the lightweight car body satisfied the requirement of crashworthiness, the thickness of components was modified again according to the results of side crash. The results showed the feasibility of the lightweight method based on sensitivity and side crash simulation.

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