MSAM 2021
August 16-19, 2021
Online Conference

MS1527

Simulation and Optimization of a New Energy Vehicle Power Battery Pack Structure

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Abstract

Comparing with traditional vehicles, the new energy vehicles industry should pay more attention to the safety of power battery pack structure. A battery pack structure model is imported into ANSYS for structural optimization under sharp acceleration sharp turn and sharp deceleration sharp turn conditions on the bumpy road. Based on the simulation, the battery pack structure is improved and suitable materials are determined. Then the collision resistance of the optimized battery pack is verified, and the safety level is greatly improved. While ensuring the safety and reliability of the battery pack structure, it also reduces the weight to satisfy the lightweight design, and complies with relevant technical standards.

Introduction

When a car crashes during driving, the rigidity of the battery pack body must guarantee the deformation of the battery element in its bearable range. Through the modeling and simulating of the battery pack of an electric car, the deformation and acceleration after loading are evaluated, which provides a reference for the optimal design of the battery pack structure. This paper has established a numerical simulation model to study and optimize the structure of a new energy vehicle power battery pack. The model simulates statics and modal characteristics simultaneously and optimizes the structure at the same time, which not only meet the quality requirements, but also realize lightweight processing. Moreover, the model uses the natural vibration frequency of human organs as an evaluation standard during modal characteristics analysis, which could effectively improve the comfort of the human body.

Analysis and modeling of battery pack structure

Computational and optimization process of the analyzed battery structure could be seen in Fig. 1.

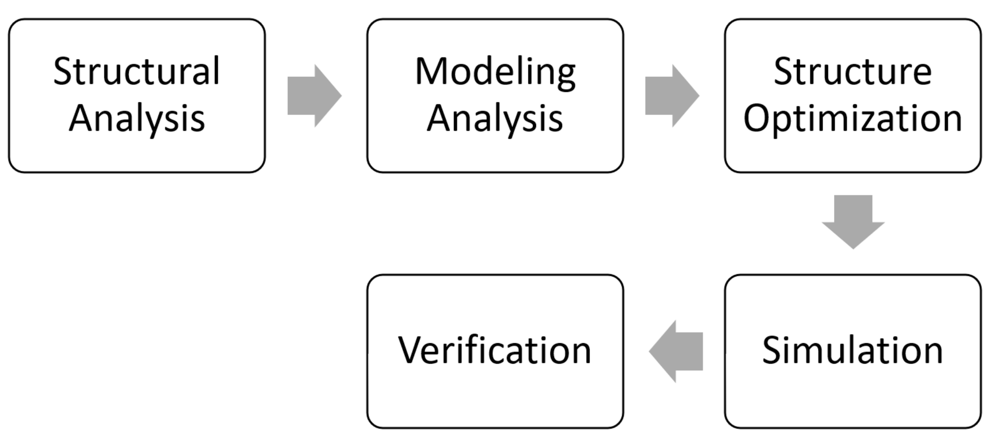

Fig. 1. Computational and optimization process

Static simulation of battery pack

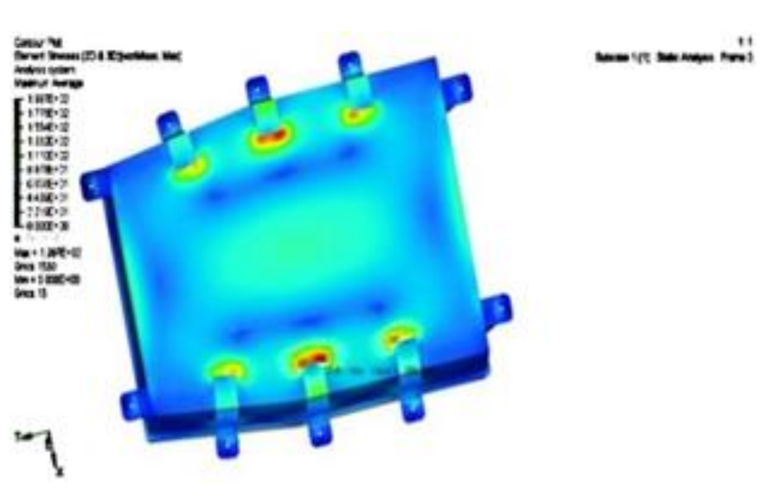

Fig. 2. Stress distribution of battery pack body under working condition 1

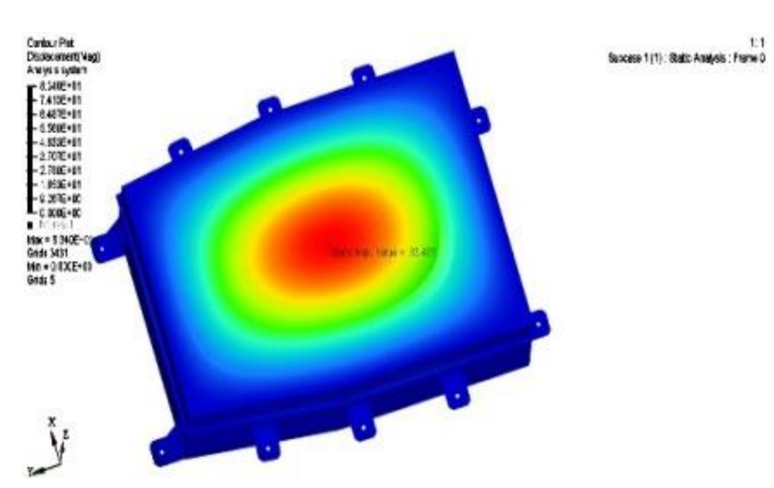

Fig. 3. Displacement distribution of battery pack body under working condition 1

Modal characteristics analysis of battery pack

Table 1. Constraint mode frequency table of each order of battery pack

order	before optimization	after optimization
1-order modal	13.54 Hz	19.07 Hz
2-order modal	18.05 Hz	21.98Hz
3-order modal	21.39 Hz	23.92Hz
4-order modal	25.66 Hz	28.41Hz
5-order modal	32.70 Hz	35.04Hz
6-order modal	34.24 Hz	37.61Hz
7-order modal	37.99 Hz	39.74Hz
8-order modal	41.17 Hz	45.63Hz
9-order modal	43.74 Hz	51.05Hz
10-order modal	51.63 Hz	55.48Hz

Optimization of Battery Pack Structure

It had been explored that the potential locations of the battery pack structure may rupture the battery pack due to load and excitation vibration from the static and modal perspectives. According to the repeated material distribution optimization and structural optimization demonstration on the ANSYS solver, it was found that adding a layer of reinforcing ribs which penetrates the lower case and cover of the battery pack, can effectively improve the above shortcomings.

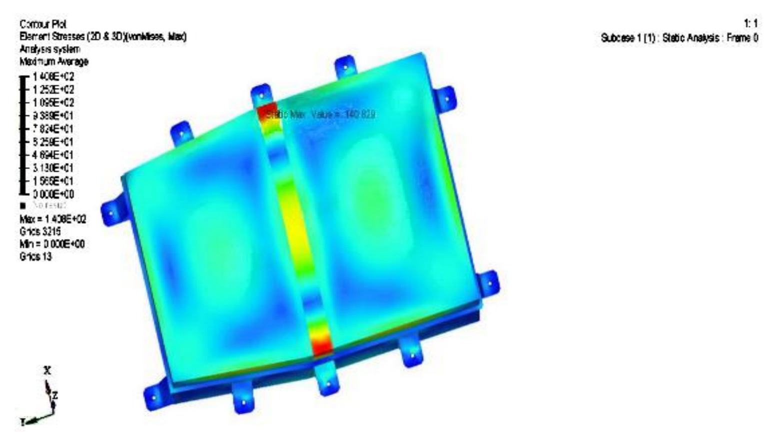

Fig. 4. Stress of working condition 1 after optimization

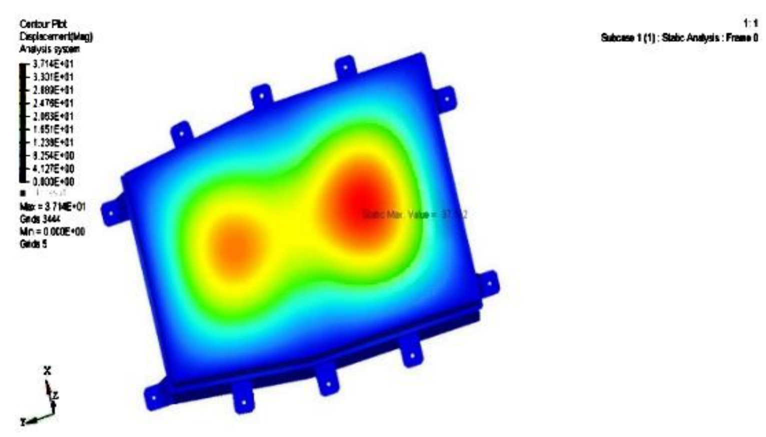

Fig. 5. Strain of working condition 1 after optimization

Compared with the previous static simulation, the stress and maximum deformation are reduced by 30.09% and 54.59%, respectively.

Conclusion

In this paper, Hypermesh, ANSYS and other simulation analysis software are used to analyze the static strength and dynamic modal.Through finite element analysis and calculation, the maximum stress occurs in the connection area between the battery pack ears and the box. The maximum deformation is 86 mm, which is located in the middle of the lid. Therefore, the selection of the thickness is too conservative. According to the results of modal simulation, it can be seen that the natural frequency of the first-order mode is 13.54 Hz, and the natural frequencies of other modes are all greater than 15 Hz. The natural frequency of human organs is also between 5-15 Hz, so the natural frequency of all modes should be greater than 15 Hz as much as possible. These are common problems in battery pack structure. Then a simulation optimization model is established in the post-processing software. Finally, with the assistance of the Hypermesh solver, by adding reinforcing ribs, the battery toughness is improved, the natural frequency is increased, and the amount of battery pack materials is reduced.

FOR MORE INFORMATION:

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