Research on Crash Safety Design of Electric Vehicle Power Battery

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Abstract: By expounding the collision conditions of electric vehicles, analyzing the characteristics of battery collision under different collision conditions, and studying the traditional collision safety design of electric vehicle power batteries, a new safety design method based on battery damage tolerance is proposed, which aims to provide help for improving the safety protection of electric vehicle power batteries in collision and improve the safety of power batteries in collision, Meet people's requirements for vehicle safety.

Keywords: Electric Vehicle; Power Battery; Collision Protection

Introduction

In the context of today's era, in response to the call for energy conservation, emission reduction and environmental protection, people will choose electric vehicles to replace traditional fuel vehicles in the process of travel. In order to ensure the safety of electric vehicles in collision, in addition to ensuring the structural strength of the body, we should also strengthen the research on the safety of electric vehicle power battery collision, complete and improve the safety design of electric vehicle power battery collision, and ensure the safety of vehicles.

1. Electric vehicle collision condition

According to the requirements of current laws and regulations, electric vehicles can be divided into four aspects under collision conditions, including frontal collision, offset frontal collision, side collision and side pole collision. The new car crash test (new car assessment project NCAP), that is, the launch of the vehicle crash safety evaluation, has made stricter regulations on the vehicle crash safety from the above four aspects. According to the different collision conditions of electric vehicles, the main collision conditions of electric vehicles are divided into the following situations: FFB、MPDB、SOB、ODB、AEMDB、SP. FFB refers to the frontal collision between the vehicle and rigid walls such as cement soil mixing pile wall and suspended spray pile wall at the speed of 56km/h, which is simply called 56km/h frontal rigid wall. MPDB refers to the collision between the vehicle as a deformable barrier and the test vehicle (the same speed is 50km/h) at the speed of 50km/h, SOB refers to the collision between the vehicle and the rigid barrier at the speed of 64km/h, and the collision overlap area accounts for 25% of the whole vehicle. ODB refers to the collision with the deformable barrier at the speed of 64km/h, and the overlap area is 40%. AEMDB refers to the collision with the deformable moving barrier at the speed of 60km / h, SP refers to the impact of the collision object on the side rigid column in the direction of 75 ° at the speed of 32km/h [1].

2. Battery collisions under different working conditions

Through the simulation of the battery collision under different collision conditions, the damage degree inside the battery is judged according to the analysis of the battery collision. According to the damage degree of the basic framework of the battery inside the car, the battery collision results are divided into three cases.

2.1 The battery is not squeezed and the basic frame is not damaged

Through the simulation experiment, this situation mainly occurs in the four collision conditions of FFB, ODB, MPDB and AEMDB. According to the experiment, under the first three collision conditions, a large part of the vehicle body overlaps with the barrier, and the vehicle anti-collision system and body frame decompose and absorb the huge energy generated by the collision when the collision occurs. As the most important load-bearing component in the car, the front longitudinal beam of the car bears most of the collision energy, resulting in less energy transmitted to the power battery, which does not affect the basic framework of the battery. In the experiment, the vehicle did not undergo huge deformation under the protection of the anti-collision beam and the front longitudinal beam. In order to verify the impact of the vehicle on the basic structure of the battery under the condition of huge deformation, the front longitudinal beam was cut off and the powertrain was removed in the anti-collision experiment. By reducing the protection of the front longitudinal beam and the powertrain to the vehicle shape, the vehicle was greatly deformed during the collision. The results showed that under the condition of huge deformation, the basic framework of the battery was not affected. Under the AEMDB collision condition, the moving direction of the deformable energy absorption barrier added at the front end of the vehicle is perpendicular to the moving direction of the electric vehicle. In the event of a collision, most of the energy is absorbed by the B-pillar, door and other structures on the side of the vehicle body. The energy transmitted to the external framework of the battery is not enough to cause the deformation and damage of the battery frame and the battery will not be squeezed [2].

2.2 The battery is squeezed, but the degree of squeezing is small and the damage of the basic frame is small

This situation mainly occurs in the ODB working condition. Under this working condition, the overlapping area of the electric vehicle body and the barrier is small, and the small overlapping area means the small contact area. Due to the small contact area, there are few structural members involved in the absorption of collision energy in the vehicle in the collision. Only a small part of the energy generated by the collision is absorbed by the vehicle structural members, and most of the energy is transferred to the wheels, control systems, etc. In general vehicles, the driving mode is divided into the front drive and the rear drive. Whether the front drive or the rear drive, the battery will be close to the wheel when installed. When the collision energy is transferred to the wheel, the wheel deformation will reduce the gap between the battery and the wheel, and even cause the wheel to squeeze the battery. However, since the gap between the two is mainly affected by the degree of wheel deformation, and the degree of wheel deformation will be affected by various factors, therefore, in the collision safety design of battery power battery, we should focus on the ODB working condition.

2.3 The battery structure is obviously squeezed, and the external structure of the battery is damaged

The simulation experiment shows that under SP working condition, when the rigid column of the car body is impacted by the side and moves longitudinally, the collision generation capacity cannot be absorbed by the frame of the car body, resulting in the deformation of the side structure of the car body, reducing the gap with the battery, resulting in the deformation of the side structure of the car body squeezing the basic structure of the battery, so that the external structure of the battery is damaged, causing the safety problem of the battery. According to the experiment, the internal structure of different vehicle models, the speed of collision, and the installation position of the battery will affect the extrusion degree of the deformed body side structure on the battery. In the three cases of the experiment, the battery pack did not move in position, and was located in the original position. According to the analysis of the installation form of the battery, when the hanging points of the battery did not have problems, the battery pack would not move in general, but when the distribution position of the hanging points of the battery was unreasonable and the rigidity and hardness of the hanging points were insufficient, the battery might move, Therefore, in the following experiments, ensure that the position and material of the hanging point meet the requirements, and the battery pack will not move because of the hanging point. To sum up, the most serious damage to the vehicle battery occurs under the SP condition, so the collision safety design of the electric vehicle power battery should focus on this condition and deal with the SP condition [3].

3. Collision safety design of electric vehicle power battery

Based on the SP working condition, the new electric vehicle power battery collision safety design is proposed below. On the basis of combining the traditional protection design, it is compared with the new concept of electric vehicle power battery collision safety design. Through the electric vehicle collision safety design method, the occurrence of battery safety accidents, leakage, fire and other safety accidents caused by battery accidents are reduced.

3.1 Traditional design concept of battery safety protection

The traditional design concept of battery safety protection is to adjust the car body structure to ensure that the battery structure will not be affected by extrusion in case of collision. The prerequisite of the design is to set up the protection standard of the battery on the basis of ensuring that the battery is not affected by extrusion. In the design, first build the rigid body model of the battery module, and then build the model of the vehicle body. Combine the two models, and then feedback the damage and stress of the battery model according to different collision conditions and results through collision experiment or simulation, When the battery module will be squeezed and deformed under the force in the case of collision, the structure of the battery will be optimized, and then the re optimized battery module will be put into the experiment until the structural information that the battery will not be stressed in the case of collision is found, so the structural design of the car body and battery is completed [4]. This traditional design method has some disadvantages, such as paying too much attention to battery anti-collision, resulting in over design of the car body. By adding anti-collision beams and structural parts to improve the anti-collision performance of the car body, the weight of the whole car is increased, which improves the power consumption of the electric vehicle during operation, reduces the battery endurance, and reduces the portability of the electric vehicle.

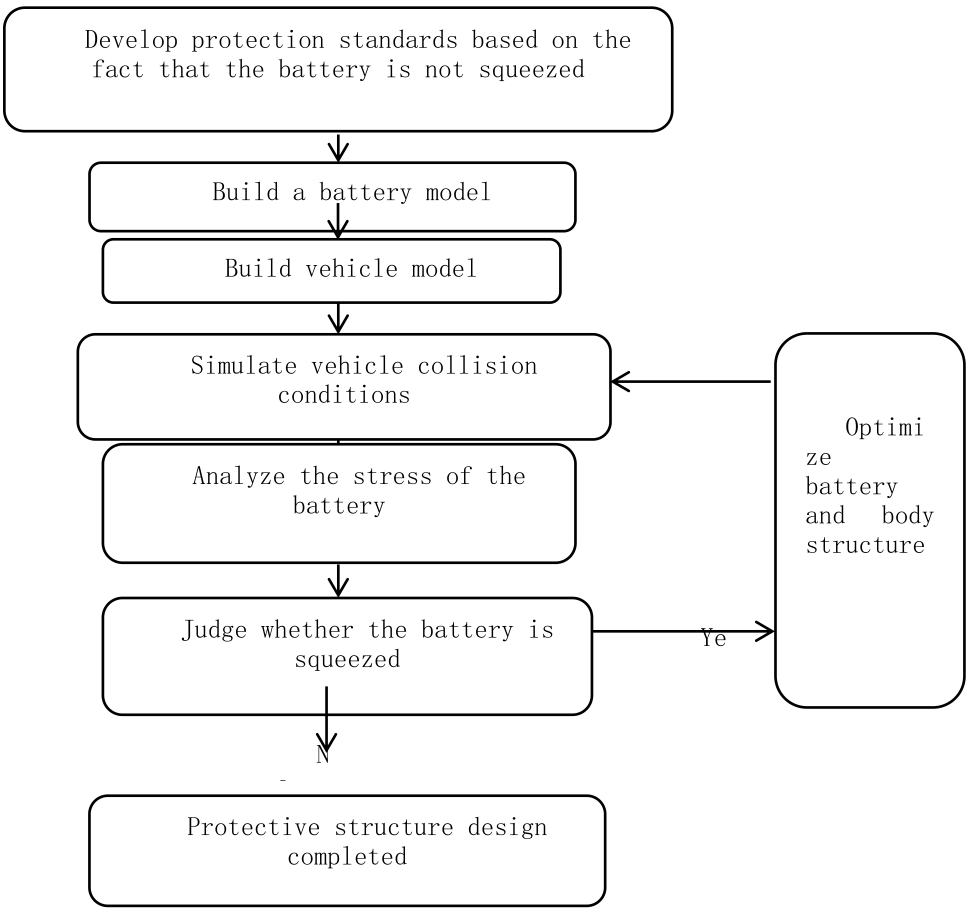

Figure 1 Traditional Protection Design Process

3.2 New battery collision safety design concept

The collision safety design of electric vehicle power battery is different from the traditional design concept. Instead of taking the electric vehicle completely free from extrusion as the design basis, the damage tolerance of the battery is taken as the design basis of battery collision protection. In the design, the initial model of the battery module is first built, and then the static test of the battery model is carried out to analyze its mechanical characteristics, Through static experiments, the maximum allowable deformation and maximum force of the battery under safe use are determined, and a user-defined standard for power battery protection is established after determination. Subsequent rectification should meet the requirements of this standard. After the static experiment, the battery model is optimized and modified according to the requirements or problems. After the battery model is modified, the whole vehicle model is built, the two models are integrated, and the whole vehicle model equipped with the battery model is subjected to the collision experiment. In the collision experiment, all the collision conditions are simulated, and the boundary conditions of battery impact under different collision conditions are extracted in the collision experiment, in the impact experiment of battery model according to the boundary conditions, through the performance of battery model in the impact experiment, the dynamic mechanical characteristics of battery model are analyzed. According to the combination of dynamic analysis and static analysis, the user-defined standard of power battery protection is improved. In the collision experiment of the whole vehicle, the battery model is analyzed to judge whether it meets the user-defined standard of battery protection. When it does not meet the standard, the structure of the battery needs to be improved and the structure of the vehicle body needs to be optimized. Finally, when the battery model can meet the user-defined standard of battery protection in the collision experiment, the design of the whole battery safety anti-collision structure is completed.

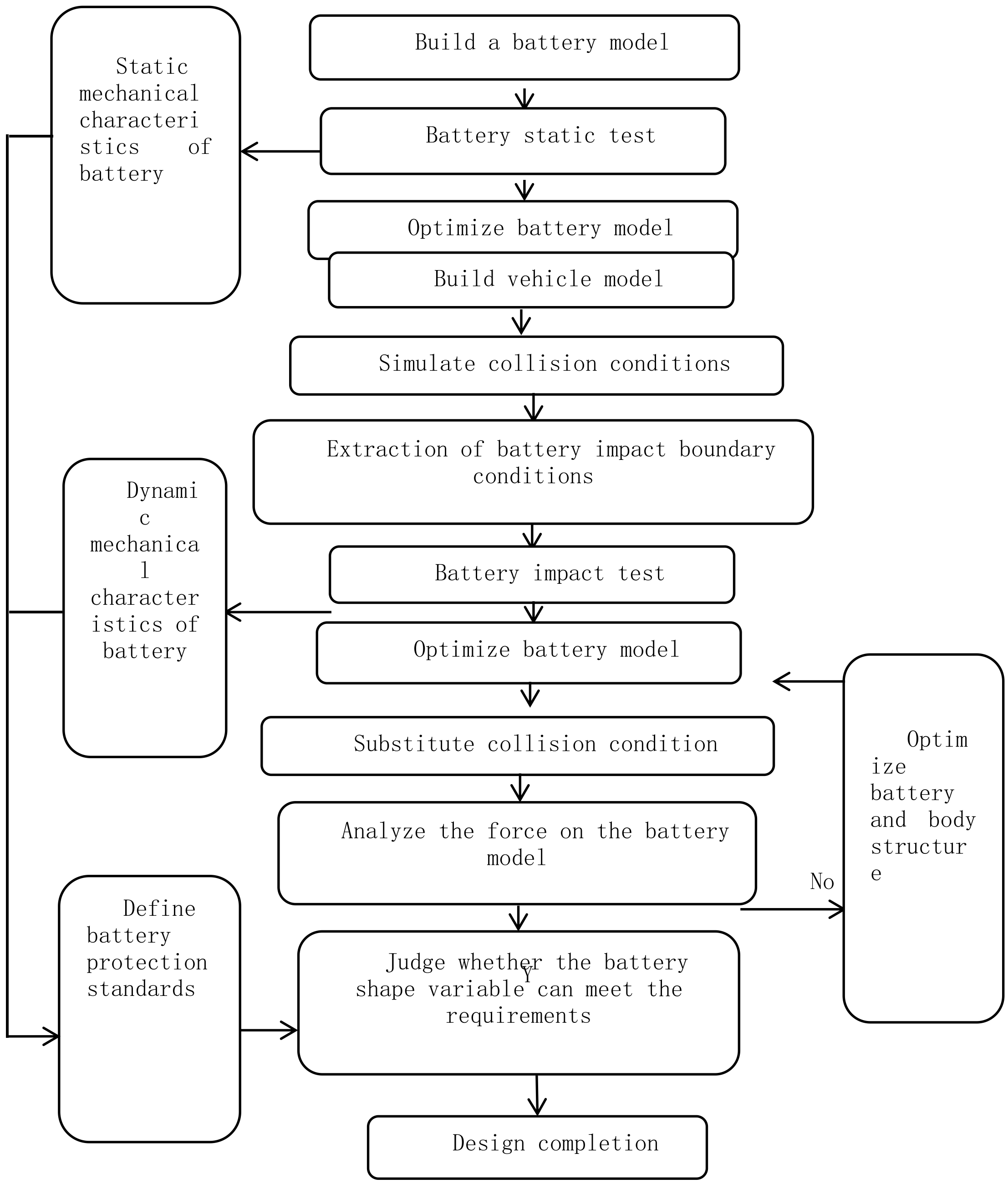

Figure 2 New Battery Collision Safety Design Process

4. Conclusion

By studying the damage and characteristics of batteries under common electric vehicle collision conditions and different collision conditions, combined with the battery protection design method, this paper puts forward a new design method for the protection of electric vehicle power batteries. By designing the battery damage tolerance to replace the requirements of traditional methods for the battery not to be damaged, and by establishing the tolerance, the requirements for the vehicle body are relaxed under the condition of ensuring the battery safety; the cost in battery safety protection design is reduced.

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