

Analysis on Finite Element of Carbon Fiber Composites for Vehicles

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Abstract: Although the application of carbon fiber composite materials in the industry is gradually wide, the research on the properties of materials is currently lacking. In order to save the cost of each test, the simulation of the properties of the carbon fiber composite material should be carried out in a targeted manner while conducting the necessary tests. Therefore, this paper first analyzes the main characteristics of carbon fiber composites, and then uses finite element analysis software to calculate the strength of the strong ring made of carbon fiber composite material for a vehicle under tensile failure load. I hope that the research in this paper can provide reference for relevant scholars, and I hope to expand the research in the field of automotive carbon fiber composite materials.

1. Research background

1.1 Literature review

In recent years, many Chinese scholars have conducted extensive research on carbon fiber composite materials. Li et al used ANSYS software's node coupling technology and contact analysis technology to calculate the strength of the NOL ring made of a carbon fiber composite under tensile failure load, and the circumferential stress of each point on the NOL ring. The error between the two simulation methods and the experimental values was 23.6% and 5.6%, respectively, indicating that the contact analysis technique is more accurate (Li et al., 2011). Ma Xiangyu et al designed a carbon fiber composite vehicle transmission shaft for the strength and critical speed requirements of an automobile transmission shaft. The Abaqus finite element analysis software was used to simulate the transmission shaft, and the designed carbon fiber composite transmission was proposed. The performance of the shaft can fully meet the requirements of the automotive drive shaft (Ma et al., 2017). Zhang Jinguang and others believe that the integrated automotive composite drive shaft designed and manufactured using carbon fiber composite drive shafts meets the strength requirements while its minimum critical speed is much higher than the actual speed demand, providing safety and comfort for the vehicle body. A high-intensity guarantee. In addition, Abaqus finite element software is used to theoretically calculate the design of the transmission shaft shape, and the vibration mode image and amplitude value of the transmission shaft are obtained. The actual critical speed is measured through experiments, which provides a basis for the design and operation of the composite transmission shaft. (Zhang et al., 2018). Hu Renxiang and Zhou Jinyu used Altair OptiStruct software to establish a finite element model of the battery casing, and optimized the structure of the car battery casing. The entire automotive battery housing optimization process consists of three phases, namely the conceptual design phase, the system design phase, and the detailed design phase. The study concluded that the optimized design can reduce the weight of the battery case, and the weight loss ratio can be as high as 66%, so the optimization effect is obvious (Hu and Zhou, 2017). Li Yang et al proposed a new sandwich structure of carbon fiber/epoxy resin and rigid PVC foam, which was applied to a small electric vehicle floor. According to the theory of composite laminates, a finite element model is established and its bending characteristics are analyzed. Based on the original scheme, a structural optimization scheme for bending characteristics is proposed to improve the bending performance of the automobile floor and achieve the bending stiffness target setting (Li et al., 2018). Zheng Zongzheng believes that in the past automobile manufacturing, the steel transmission shaft was used, and its

bending natural frequency was small. In order to meet the requirements of high-speed driving of the car, a two-stage transmission shaft can be used, but the two-stage transmission shaft has many disadvantages that are difficult to overcome. However, the use of carbon fiber composites to make hybrid drive shafts for automobiles can solve this problem well and improve the overall performance of the car (Zheng, 2016). Based on a static loading test method, Xu Haijun and Zhang Kefeng used ABAQUS to carry out finite element simulation on the rear lower guard made of carbon fiber composites, and analyzed the influence of the carbon fiber composite paving scheme on the performance of the lower guard. It is proposed that the beam adopts a 90° single angle layering scheme, and the combination of the longitudinal beam using the mixed angle layering scheme is the best (Xu and Zhang, 2016). Based on the existing research, although scholars have carried out a lot of research on carbon fiber composite materials, these research perspectives are relatively broad. Therefore, this paper analyzes the finite element of carbon fiber composite materials for vehicles, and enriches the research in related fields.

1.2 Purpose of research

Carbon fiber composites have a series of advantages such as small specific gravity, high specific modulus, and fatigue resistance. They can greatly improve the service life of automobiles, and can improve fuel efficiency and safety and comfort. They have been recognized as the best lightweight in the automotive industry. Materials (Zhang et al., 2016). Therefore, carbon fiber composite materials have been widely used in the automotive field. The traditional carbon fiber composite molding process is mainly from the aviation industry, while the aviation industry has the characteristics of high cost and small batch size. In order to meet the high efficiency and low cost requirements of automotive carbon fiber composite materials, many mainstream automobile companies in the world have developed a number of differentiated new rapid prototyping processes in combination with the characteristics of body parts, so as to maximize the efficacy of carbon fiber composite materials. The purpose of this paper is to analyze the finite element of automotive carbon fiber composites, and even to reduce the test frequency, it can accurately predict the tensile strength of the test piece.

2. Main characteristics of carbon fiber composites

Overall, carbon fiber composites have the following characteristics: First, they are highly configurable. This is the most prominent feature of carbon fiber composites compared to other traditional materials. The mechanical and mechanical properties of carbon fiber composites can be achieved in accordance with the requirements of the use of the parts or the environmental conditions, by reasonably selecting and matching the components and materials, so as to maximize the expected results. To fully meet the performance requirements required for the specific engineering business.

Second, there is a strong dependence on the carbon fiber composite process. In the formation process of carbon fiber composite structure, there are relatively complex physical or chemical changes between the materials of each component, and the performance of each component has strong dependence on process methods and parameters. In addition, because the carbon fiber composite material is difficult to accurately control the detailed parameters of the actual process in the specific molding process, a high technical level is required in the material fabrication process.

Third, carbon fiber composites have higher tensile strength and lighter weight. Carbon fiber composites have relatively low density, so carbon fiber composites have significant light weight, high strength and high toughness compared with other traditional metal materials. Moreover, carbon fiber composites can reach dozens of times or more of plastic products than plastic products.

Fourth, the carbon fiber composite material has good high and low temperature resistance and high thermal conductivity. Moreover, the coefficient of linear expansion has a negative temperature effect along the axial direction of the fiber. As the temperature gradually increases, the carbon fiber composite material gradually shrinks, so the dimensional stability is good and the thermal conductivity is high.

Fifth, carbon fiber composite materials are resistant to corrosion and aging. Carbon fiber composites are resistant to acids, alkalis, and salts, and have the advantage of being resistant to corrosion by other metals. Moreover, carbon fiber composites have obvious advantages in anti-aging. Therefore, carbon fiber composites can last for more than 15 years, whether in corrosive environments or in harsh weather (Yu et al., 2005).

3. Finite element analysis

The application of carbon fiber composites in the automotive field can be summarized as follows: First, automotive carbon fiber composites have a long history. Regardless of whether it is an F1 car or a super-luxury car, in addition to considering a series of advanced indicators such as lightweighting, it is also necessary to consider the basic cost problem. For small-volume production, the cost of carbon fiber composite material is obviously lower than that of metal zero. Parts of. Second, with the concept of “energy saving and emission reduction, green environmental protection” gradually became popular, people began to realize that green is a certain amount of social cost. Therefore, from “carbon emissions” to “carbon dollar”, it has gradually evolved into a complex problem, so the application range of carbon fiber composite materials in the automotive field will gradually expand. Third, any auto company in the world needs to assess the “lightweight benefits” of the whole life cycle on time. This will create a problem that reduces the overall benefits of heavy asset investment and whether it can cover heavy assets. The cost of investing. If this problem can't find a reasonable answer, then the product will not be able to occupy a certain market competitiveness, and auto companies will face the threat of bankruptcy. Fourth, carbon fiber composites are in their infancy, and carbon fiber composites for vehicles are also in their infancy (Li et al., 2016).

Based on the above analysis of the application of carbon fiber composite materials in the automotive field, it is known that the research on carbon fiber composite materials for vehicles is difficult. Therefore, the finite element method can be introduced in this paper to simplify the complicated problems. Specifically, in order to further study the finite element of carbon fiber composites for vehicles, this paper conducts finite element analysis on the tensile test of NOL ring (strength ring) based on the known material properties and related parameters. In the specific research process, this paper mainly adopts the node coupling technology, in order to accurately simulate the state of the strong ring on the separation disc during the stretching, the corresponding coupling of the nodes of the inner ring of the strong ring and the nodes of the outer circular surface. action.

3.1 Solid model construction

The basic idea of the finite element method is to use a relatively simple physical model, that is, to divide the continuous solution area into a finite number of combinations of units that are connected to each other in a certain way to replace the original complex problem. Thereby solving. The advantage of the finite element method is that it can be applied to any field problem, without geometric constraints, boundary conditions and loads are not limited, material properties are not limited to isotropic, and the approximation of the solution can be easily improved by mesh subdivision. . Therefore, this paper uses the finite element analysis software ANSYS to establish a finite element analysis model of the powerful ring test piece and the test die, in order to simplify the complex problem and obtain the solution. Considering that the structure, load, etc. all have symmetry characteristics, in the process of actually building the model, it is usually only necessary to establish a 1/2 model for analysis. Therefore, in the study of this paper, the mold was simplified into a semi-circular cake.

3.2 Unit selection and network partitioning

This study used SOLID45 unit steel mold, SOLID46 unit strong ring, SOLID45 is an 8-node solid three-dimensional solid unit, which can simulate steel mold well. In order to fully guarantee that the shape of the unit is regular, the strong ring adopts a mapping grid to divide, and the mold

adopts a sweeping grid to divide. In the actual finite element analysis, the node coupling technique is mainly used to ensure that the number of circumferential nodes in the inner ring surface and the outer surface of the strong ring is the same. After calculation, the strong ring was divided into 15 equal parts. In the actual test process, it is assumed that no slip occurs between the layers of the composite layer, and each single layer is further analyzed according to the state of the plane stress.

3.3 Boundary conditions

With the rapid development of science and technology, high-performance carbon fiber composite materials are widely used in the field of vehicle manufacturing. It has high specific modulus, high designability, good fatigue resistance, corrosion resistance and easy to form large-area integral molding. It has better performance than traditional steel, aluminum alloy and other structural materials. Therefore, this study assumes that the structure is in a symmetrical state, and assumes that the mold is in a completely rigid state without any deformation. When displacement constraints are applied to both sides of the mold, it can only move in the direction of the load.

3.4 Calculation results

The average load of the strong ring in the test was applied to the model at 4800 N. At this time, the maximum value of the stress intensity generally appeared at the edge of the strong ring, and the value was 3090 MPa.

4. Conclusion

In general, carbon fiber composites are widely used as a material with a wide range of applications, such as light weight and high strength. Especially in the field of automobile manufacturing, carbon fiber composite materials can be used to make body surface coverings, aerodynamic components, etc., and comprehensively, the performance of the entire automobile can be effectively improved. In this paper, the finite element analysis of carbon fiber composites for vehicles is analyzed. It is concluded that the application of the finite element method to automotive carbon fiber composites can effectively shorten the number of tests, especially to reduce trial and error and experience. Errors, which in turn increase test efficiency.

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