Analysis and Optimization of The Structure of the Flat Wrecker based on Ansys Workbench

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Abstract

The road is flat wrecker vehicle accident and other rescue necessary rescue equipment.As the key parts of the structural design and mechanical analysis of this paper, the stiffness and strength analysis of the research on the key structure and the structure of the traditional experience design for the optimization design. The modeling of the arm by using Solidworks software, and then imported into Ansys Workbench software to simulate the loading arm. Through the static structure analysis and Simulation of the arm were obtained the stress nephogram and deformation distribution.According to the three conditions in the ultimate limit state, optimize the stiffness and strength of the arm, and according to the optimization results to complete the new bracket.

Keywords

Wrecker, Arm, Ansys Workbench, Static Analysis, Optimization.

1. Introduction

Flat wrecker is a special kind of vehicles for strong function, mainly used to clean up the vehicle accident, exclude road obstacles, natural disaster rescue and relief, to provide help and rescue service for the driver and vehicle [1]. As the key structure connecting wrecker and fault vehicle is the main bearing and force components, the design is reasonable for the wrecker's performance parameters have a great impact, so the structural design and mechanical analysis of reasonable flat wrecker arm has an extremely important significance [2]. In this paper, the finite element analysis software Ansys based on workbench can simplify the analysis process, and in view of the weak regional bracket is improved; at the same time, through structural optimization can improve the performance in the practical application, but also to achieve the optimal layout, material utilization rate can be improved [3]. It has guiding significance for the formation of a complete and reliable strength analysis and structure optimization of system design and development of the flat wrecker.

2. The establishment of three-dimensional model of the arm

The structure consists of basic arm, a telescopic arm, arm etc. Between the arm and the telescopic arm to achieve relative sliding through the slider lap, the contact surface between the slider and the basic arm and a telescopic arm, basic arm, telescopic arm section is rectangular in shape, telescopic arm can be horizontal and vertical direction, and the swing arm can achieve a range of swing [4].

According to the current size of tire and investigate the domestic car, the size of the reference section wrecker, to determine the initial design parameters.

3. The finite element analysis

3.1 Introduction of 3D model of Workbench Ansys

In order to add convenience of material properties, material properties in Workbench, double-click the B2 bar, copy the list of structural steel in the pop-up dialog box, and then modify various properties in structure steel replication, to complete the Q550 material properties to add, similarly, add POM material properties.

3.2 Contact bracket

Wrecker arm in operation, the outer surface of the inner surface of the basic arm and the telescopic arm is not completely contact in the socket position, rely on contact with the slider and extrusion to transfer force between the two. The normal degree of freedom of the contact is restrained, and the tangential freedom is not restricted, which allows a small amount of slip [5].

Both have a hinged pin shaft between the swing arm and the telescopic arm, as well as the basic arm tail contact with the surface of the middle part of the swing arm, L type fork and the outer surface of the sleeve surface contact surface, hinged support pin hole on the sleeve and the fork pin hole with inserted pin.

3.3 The grid division

In order not to affect the properties of the various parts, before the need to cut all parts of the frozen (Freeze), and then cut, after segmentation, the need to cut each component part of the formation of the part of the new part Form. After the grid division, the model is shown in Figure 3,the mesh is divided into 184999 units, 359819 nodes [6].

3.4 Imposed constraints and loads

According to the installation form of bracket, rear basic arm vertical base plate and wrecker frame and hydraulic cylinder and the front arm are hinge pin, constraints, rotational degrees of freedom X=Y=0 mobile X=Y=Z=0 two degrees of freedom are constrained in 3 directions and 2 directions, release along the pin shaft center of rotation degree of freedom.

Table 1 the condition

Condition number	Telescopic boom state	Basic arm angle/(°)	Lift heavy quality/kg
1	Full extension	-10	2500
2	Full extension	0	2500
3	Full extension	10	2500

4. Result analysis and optimization

The level, the maximum deformation is 67.232 mm, occurred in the L type fork ends, the rest of the deformation is relatively small, because of the influence of the structure, the overall deformation is not completely elastic displacement, also includes the connection gap between the components and other components on the deformation of him. The 3 conditions of the stress distribution in Figure 1 to figure 3.

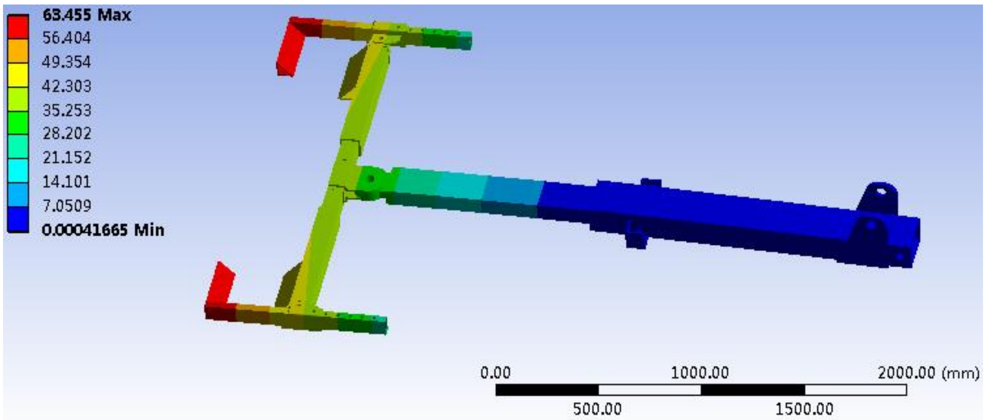

Figure 1 case 1 bracket displacement

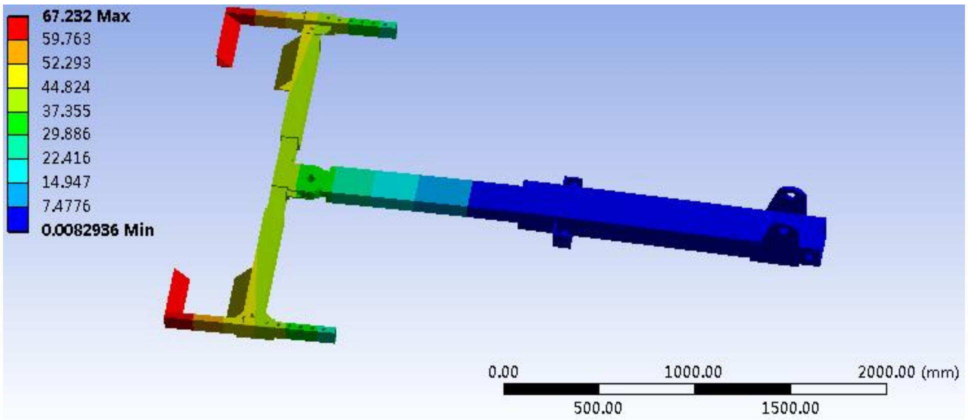

Figure 2 case 2 bracket displacement

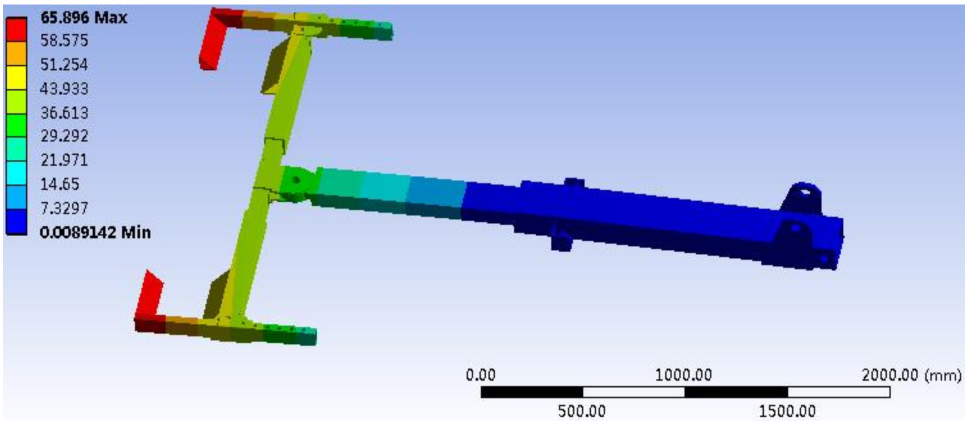

Figure 3 case 3 bracket displacement

It can be seen that the 3 conditions of maximum stress were 765.37771.19740.74 MPa, occurs in the basic arm, not only exceeded the allowable stress [δ]=367 MPa materials, and more than the yield limit of the material thickness of s=550 MPa, so it is necessary to optimize.

By the overall stress distribution can be seen, the exceeding the allowable stress area occurred in the basic arm and a telescopic arm,3 of the second conditions under the condition of maximum stress, the basic arm extraction under this condition and the stress nephogram of telescopic arm[7].

The basic arm beyond the allowable stress zone at the front end of the base and the basic arm joints, on the base of the root, and the hydraulic cylinder hinge pin basic arm front side and the bottom surface of the angle, the front part of the telescopic arm exceeded the permitted area with stress region of contact in the telescopic arm and the slider.

In order to ensure the strength and stiffness, need further improvement to the basic arm and telescopic arm. On both sides of the bottom of the rectangular section basic arm into a trapezoidal section, between the two at the bottom of the base of welding steel plate, thereby increasing the contact surface of the basic arm, the front arm and the basic thickening, the bottom or side angle add fillet, the telescopic arm and the slide contact area with medial thickness. The improved and applied the same constraints and loads on the arm.

The maximum equivalent stress of the modified basic arm is 372.84 MPa, less than the yield strength of 550 MPa, than the allowable stress of 367 MPa only 5.84 more MPa, another point here belongs to the stress concentration, so the basic arm improved to meet the strength requirements; the improved telescopic arm of the maximum equivalent stress is 259.47 MPa that is less than the allowable stress, meet the strength requirements; also improved the overall maximum displacement is 52.71 mm, the improved arm stiffness is improved, reduce deformation.

5. Conclusion

Through the combination of SolidWorks and ANSYS Workbench, the static analysis of the application to obtain the equivalent loads and constraints of the stress and deformation distribution, which is the improvement has laid a good foundation; when the arm in the most dangerous working conditions, part of the regional basic arm and the telescopic arm can meet the strength requirements, due to the overall strength of the poor in this paper, based on the displacement and stress distribution by changing the section size, the thickness of the plate and other measures of the arm is optimized to provide a reliable reference for the design staff, also formed a set of complete and reliable strength analysis and structure optimization of the system, has a very important guiding significance for the design and research of flat wrecker bracket.

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