Structure Design and Analysis of Portable Hoisting Equipment

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Abstract. Armor equipment replacement repair has been facing the problem is that the heavy parts in the car disassembly and assembly consume a lot of manpower. How to disassemble and assemble components efficiently and safely is not a perfect research field at home and abroad. The design of portable lifting equipment is very necessary in the disassembly process. In this paper, portable hoisting equipment is taken as the research object. Through the research on its hoisting mechanism, based on the introduction of mechanical structure and working principle, 3d modeling software Pro/E is used to model and virtually assemble portable hoisting equipment. In the later stage, the finite element analysis software can be used to check its stiffness and strength and optimize its design.

1. Introduction

Modern war is a high strength, multi-dimensional three-dimensional war, under the condition of modern high technology local war, in the face of numerous high performance precision strike weapons, equipment battlefield damage will be unusually severe, repair task will be more heavy and serious, battlefield repair equipment more and more important role in future war, in the development of military equipment is becoming more and more attention. The American army’s rush repair equipment mainly consists of mechanical repair vehicles, repair compartments, repair trailers and kangman multi-type rescue vehicles, which have a wide range of supporting repair equipment, complete types, complete functions and strong versatility.

Our army's rush repair equipment mainly consists of traditional wheeled repair engineering vehicles, repair square compartments, repair trailers, semi-trailers, crawler repair engineering vehicles and battlefield repair kits. Among them, the maintenance inspection and special tools equipped with repair engineering vehicles are mainly used for replacing and repairing armored vehicles. There is a shortage of special lifting tools for supporting heavy parts, which makes it difficult to complete the repair task in effective repair time and seriously affects the fighting capacity. To sum up, it is necessary to design portable lifting equipment to assist the repairman to disassemble and install the heavy parts.

2. Overall structure design of portable hoisting equipment

The overall structure of portable lifting equipment is shown in Figure 1. The main structures of portable lifting equipment include walking mechanism, lifting mechanism, rotating mechanism and luffing mechanism. The functions of each institution are described in detail below.
2.1. Walking mechanism
The portable lifting equipment moves under the vehicle by its own walking mechanism. In order to ensure the stability of the portable lifting equipment during operation and walking, the rigid material of the walking wheel pair can reduce the resistance and impact force. The walking mechanism is designed with a clamping mechanism and also a self-locking device, which has two functions. Second, it can realize the portable lifting equipment to move by itself. The whole mechanism is powered by the emulsion pump station, the hydraulic cylinder telescopic, the clamping device closure and release are completed by the hydraulic control valve system.

2.2. Hoisting mechanism
The lifting mechanism of portable lifting equipment includes telescopic chain, sprocket wheel, lifting hydraulic cylinder, big arm and extension arm, lifting grab and balance telescopic rod. The lifting schematic diagram is shown in FIG. 2. The weight is connected by the gripper and the telescopic chain structure, and the big arm is raised and rotated to complete the movement and installation of the nose, tail and middle chute of the scraper conveyor. Lifting tongs to fix parts, telescopic flexible chain combined with mechanical arm rising suspended objects move, balance telescopic rod can make weight in the process of moving, will not swing by moving too quickly, and at the instant of the components from the pack (ground) played a ease part of the impact of the telescopic arm, this structure can reduce the past safety problems brought by the artificial method of walking, implements the "peer-to-peer" mobile, improves the safety factor of the component disassembly and installation. Due to the different weight and structure of the parts to be hoisted, it can be used with the corresponding lifting grippers and hooks to achieve a safer and more efficient, more time saving, more man-machine parts disassembly.
2.3. Rotating mechanism
As an important structure connecting the big arm and the base in the portable lifting equipment, the rotating mechanism can not only make the big arm move more smoothly, but also enable the portable lifting equipment to lift objects in any position around. The rotating mechanism is divided into two parts: support device and rotary device: the role of the support device is to support the fixed rotary mechanism so that the telescopic boom can rotate freely along the vertical line of the center of rotation, and can withstand all the load during the rotation process; The main function of the rotary device is to enable the telescopic arm to complete the rotation in the plane. Portable lifting equipment is by the hydraulic control valve to adjust the emulsion in and out of the hydraulic components, through different mechanisms to achieve the object installation and lifting purpose. Telescopic boom and variable amplitude hydraulic cylinder are hinged into a whole, and the rotating device is connected to the whole machine through its internal rotating shaft, which is equipped with roll bearings for bearing radial load and thrust bearings for bearing axial load.

2.4. Luffing mechanism
Luffing mechanism is the direct factor that determines the performance of hoisting machinery. According to its performance, it can be divided into two types, one is non-balance simple luffing, the other is balance complex luffing. The primary problem of the former in the process of mechanical amplitude variation is that the center of gravity of the whole mechanism changes due to the lifting load, which causes too much inertia in the movement, thus reducing its performance. In order to reduce the extra load and power generated by inertia and increase the complexity of the mechanism, the corresponding mechanism is used to adjust the body's center of gravity in the lifting amplitude, so as to achieve the balance. Portable lifting equipment transformer extended their work on the one hand can make the lifting of lifting heavy weights in a horizontal direction, on the other hand before lifting, luffing attempt should be made to adjust the lifting position of the manipulator, with the overall scheme of disassembly equipment installed, thus greatly improves the flexibility and accuracy of portable lifting equipment.

Figure 3 for the luffing mechanism of portable lifting equipment, the whole is controlled by the scale and range of two hydraulic cylinders, telescopic crane telescopic boom roots and rotating stents hinge, hydraulic cylinder luffing two hinged point connected to the telescopic arm and rotating stents respectively, through the hydraulic control valve to adjust the telescopic crane scale, the location of the luffing mechanism, so that they can reach the suspended parts position accurately, to achieve its horizontal displacement and vertical lifting, luffing mechanism of portable lifting equipment of the transformer device belongs to the balance to the simple.

![Fig.3 The schematic diagram of jib lubbing mechanism](image)

1. telescopic hydraulic cylinder 2. range of hydraulic cylinder

3. Physical modeling of portable lifting equipment

3.1. Introduction of 3d software Pro/ENGINEER
The Pro/ENGINEER 3d modeling software developed by the famous PTC company in the United States is a large CAD/CAM/CAE integrated software that is parametry-driven and USES features to complete
model creation. Three-dimensional design has been accepted by people, and Pro/E is innovation, from 1.0 to 5.0 and now CREO series, constantly improve, multi-function of design software, especially in the machinery industry, all kinds function can meet the needs of designers in the field of the whole machine, has modeling, mapping, assembly, mold, sheet metal, CNC, simulation, surface, structure analysis and so on many functions, involved in the field of small to watches, electronics, big to automobile, aircraft and aerospace, etc.) has been employed, the parameterized method to make a design more human, modify more convenient operation, and by the entity prototype to virtual assembly, can save a lot of cost for the enterprise.

Pro/E software is also very powerful in terms of compatibility, and can be connected with professional finite element analysis software like ANSYS, which not only avoids the complexity of modeling in ANSYS, but also gives play to the advantages of detailed and accurate modeling Pro/E. In this paper, I will use Pro/E to conduct entity modeling of the single-arm manipulator and analyze it through Workbench, so as to verify whether the designed mechanism is reasonable and feasible.

3.2. Solid modeling of hoisting components in the whole machine

Model of lifting mechanism of the whole machine, mainly including lifting gripper, telescopic chain, lifting arm and the hydraulic cylinder and so on, through the analysis of in the face of the structure before checking, used by the geometry size, draw sketch in the software, in accordance with the relevant reference, constraint and dimension driven, complete the 2d figure, using 3d tools according to the characteristics of components in turn form characteristics, finally the three-dimensional modeling of finished parts. On the basis of the part model, the whole machine is assembled and matching conditions are applied to the joint points to make the model more real.

3.3. One-arm manipulator assembly

After modeling each part of the single-arm manipulator, the assembly function in Pro/E is used to integrate the assembly of the mechanism. Through the virtual model, the interference problem between parts can be intuitively found and adjusted in time. The virtual prototype can also achieve the role of the physical prototype and reduce the cost. Before the general assembly, the small parts in the relevant mechanism are assembled for sub-assembly, and then constraints are added to each sub-assembly to complete the general assembly. This has the advantage of reducing the amount of work between assemblies and avoiding many errors due to constraint conflicts.

4. Conclusion

In this paper, the common disassembled components of armor equipment weapon system are taken as the main research object, the components and turret structure of weapon system are systematically analyzed, the hoisting equipment principle and structure of existing emergency repair equipment are combed, and the structure design of portable hoisting equipment is studied. The equipment introduces the mature single-arm manipulator technology applied locally, and its compact design is very versatile. It can assist maintenance support personnel to achieve the main tenance and rapid repair of armored equipment parts to ensure safety and safety, reduce the labor intensity of personnel, and thus greatly improve It improves the efficiency and quality of equipment maintenance support and improves the efficiency of equipment maintenance comprehensive support.

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