Dynamic Analysis of Aerial Work Platform Working Device Based on Virtual Prototype

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Abstract—**In order to analyse dynamic response of aerial work platform working device, a virtual prototype was established by using dynamics software of ADAMS. Got the force of joint between components with the change of luffing angle which was carried by the dynamic analysis of work divece. A practical method of dynamic analysis of aerial work platform was created, and provided a reference on finite element analysis about aerial work platform working device parts in the future.**

Keywords-aerial work platform; working device; virtual prototype

I. INTRODUCTION

Working device is one of the most important parts of aerial work platform, the dynamic response of working device is directly related to the safety of staff, so it is significant to analyse the dynamic response of working device. In recent years, a great number of scholars and enterprises make lots of studies on aerial work platform [1, 2, 3, 4, 5, 6]. In this paper, Folding boom type aerial work platform was dynamic analysed by using virtual prototype, and got the force of joint between components. Provided the references of finite element analysis on working device in the future.

II. WORK PRINCIPLE OF AERIAL WORK PLATFORM WORKING DEVICE

Figure 1 demonstrates the aerial work platform working device. There were two oil cylinder to make the lower arm and the upper arm to work. The lower arm was moved by the lower oil cylinder. The lower arm range of angle was form 0° to 75°. The upper oil cylinder do not work until the lower oil cylinder stop to work. When the lower oil cylinder stop to work, the upper arm oil cylinder began to work. The upper arm range of angle was form 0° to 68°. In the process of work, the work platform kept horizontal all the time to ensure the safety of staff.

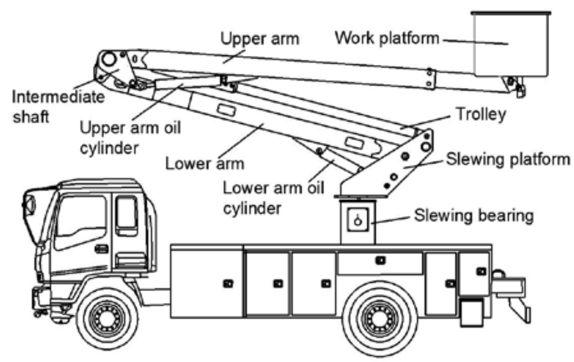

FIGURE I. AERIAL WORK PLATFORM.

III. ESTABLISH THE VIRTUAL PROTOTYPE OF WORKING DEVICE

This article is based on the hypothesis as follow as modeling：

(1) Assume the various components are rigid-body, and each kinematic pair is ideal constraints without considering the friction force between kinematic pair.

(2) In the working process of the aerial work platforms, consider only the effects on the capability of the motion components and work load, not the effect of the wind.

(3) Assume the slewing bearing as rigid-body which is fixed to the frame of aerial work platform, without considering the effects on the capability of the frame, and the suspension, the tires and ground deformation.

Because 3D geometric modeling tool in the software of ADAMS is difficult and complex, and there is no guarantee of the dimensional accuracy of the model and the setting position. For this reason, 3D modeling of working device's mechanical system were completed using the physical design software in this paper, then import 3D modeling is built to ADAMS environment, add constraint and load to the geometric model of prototype under ADAMS environment. In the model, the interrelation between the slewing platform and the lower arm, slewing platform and trolley, trolley platform and the push rod of lower arm cylinder, the tube of lower arm cylinder and the lower arm, the intermediate shaft and the lower arm, the intermediate shaft and trolley, the intermediate shaft and the upper arm, the intermediate shaft and the push rod of upper arm cylinder, the tube of upper arm cylinder and the upper arm are defined the constraint of the plane rotation pairs restriction, the interrelation between the piston rod and the cylinder is defined the constraint of the plane moving pairs. In this way, the simulation model is a bit close to the actual operation of the working device.

In the working device, the luffing angle of the lower arm is 0°, and the luffing angle of upper arm is 0°, as shown in Figure 2; The upper arm always keeps horizontal while the lower arm luffing, as shown in Figure.3; The luffing angle of lower arm is 75°, and the luffing angel of upper arm is 0° as shown in Figure 4; The luffing angle of lower arm is 75°, and the luffing angel of upper arm is 68° as shown in Figure 5.

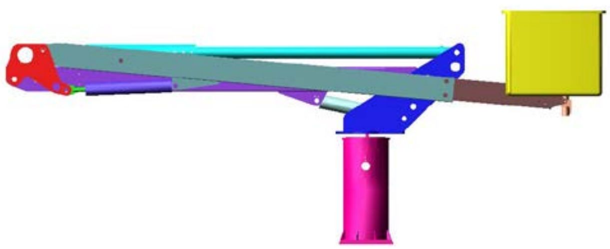

FIGURE II. LOWER ARM 0°AND UPPER ARM 0°.

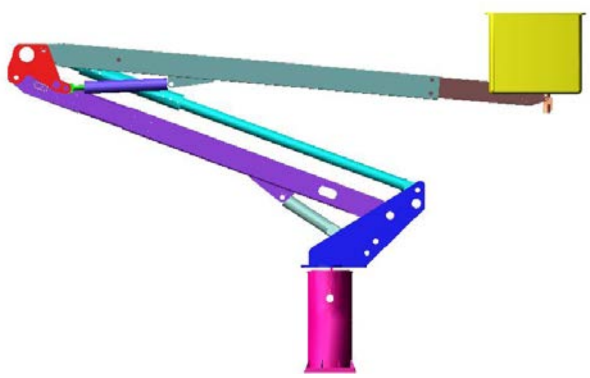

FIGURE III. LOWER ARM AND UPPER ARM LUFFING.

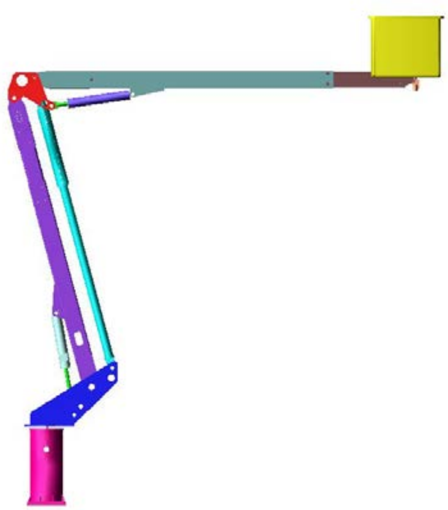

FIGURE IV. LOWER ARM 78°AND UPPER ARM 0°.

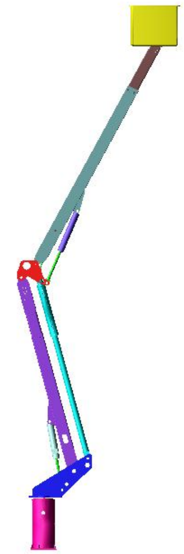

FIGURE V. LOWER ARM 78°AND UPPER ARM 68°.

IV. THE FORCE OF WORKING DEVICE

In the simulation calculation, the work platform was loaded at 200kg, the luffing process was simulated by translation joint between hydraulic cylinder and cylinder rod. The force of lower arm and upper arm changing by the luffing angle was showed as follows:

Figure 6 demonstrated the force of lower arm oil cylinder changing with the luffing angle. As shown in Figure 6, the force of lower arm was reducing with the luffing angel increasing. The maximum force appeared at the initial position. The curve had a sudden change when the lower arm luffing angle at 75°, the reason of these suddenly change was the lower arm cylinder stop to work.

Figure 7 demonstrated the joint force between lower arm and slewing platform changing with the luffing angle. As shown in Figure 7, the force of the joint force between lower arm and slewing platform was reducing with the luffing angel increasing. The maximum force appeared at the initial position, and this was the maximum force in this working device, reaching up to 270000N. The curve had sudden change when the lower arm luffing angle at 75°, the reason of these suddenly change was the lower arm cylinder stop to work.

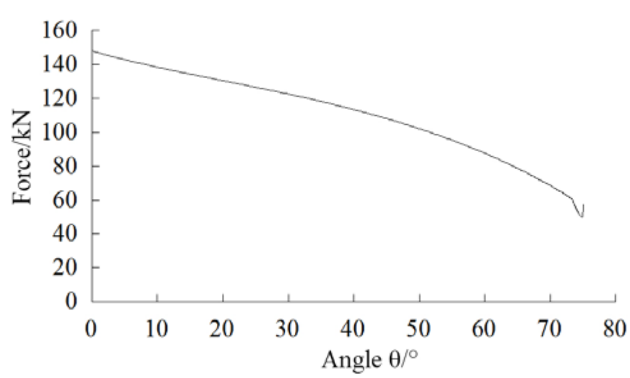

FIGURE VI. LOWER ARM OIL CYLINDER FORCE.

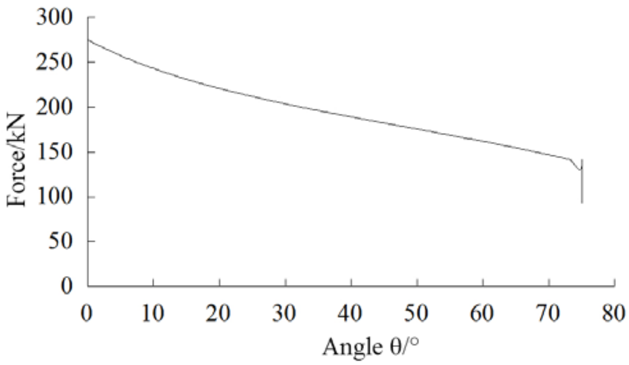

FIGURE VII. LOWER ARM FORCE.

Figure 8 demonstrated the joint force between upper arm and intermediate shaft changing with the luffing angle. As shown in Figure 8, the force of the joint force between upper arm and intermediate shaft was reducing with the luffing angel increasing. The maximum force appeared at the initial position.

Figure 9 demonstrated the joint force between upper arm oil cylinder and intermediate shaft changing with the luffing angle. As shown in Figure 9, the force of the joint force between upper arm oil cylinder and intermediate shaft was reducing with the luffing angel increasing. The maximum force appeared at the initial position.

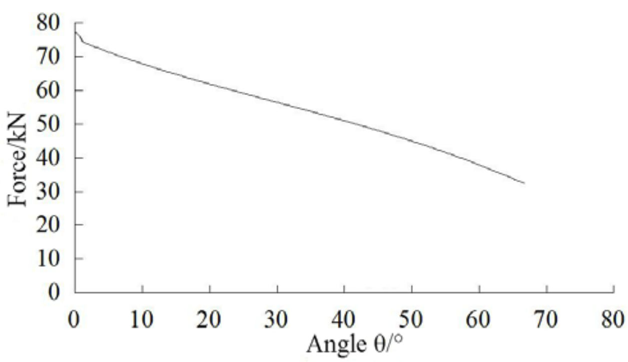

FIGURE VIII. UPPER ARM FORCE.

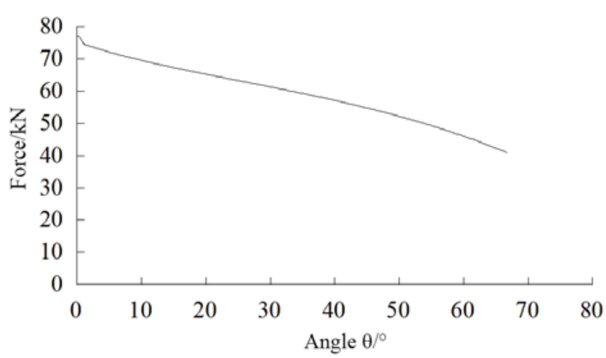

FIGURE IX. UPPER ARM OIL CYLINDER FORCE.

V. SUMMARY

(1) According the structural parameters of aerial work platform, this paper established the virtual prototype of aerial work platform by the Multi-body dynamics analysis software of ADAMS.

(2) The force of oil cylinder changed with the luffing angle during work process of working device. The maximum force occured at the initial position. The maximum force of lower oil cylinder was 1480000N and the maximum force of upper oil cylinder was 75000N.

(3) The maximum force of aerial work platform occured at the joint between lower arm and slewing platform in the initial position, size of 270000N. Finally the force stabilized at 88000N.

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