Design of the Automatic Doffer

Xiang Yu [a], Qingqian Wang [b], Jizhong Zhang [c], Binqian Yao

School of Mechanical and Electrical Engineering, Qingdao University, Qingdao 266071, China

[a]813663298@qq.com, [b]939678618@qq.com, [c]872893524@qq.com

Abstract

In order to solve the problem that the traditional doffer does harm to bobbins and spindles during the process of pulling the bobbin, a new type of automatic doffer is designed. First, a three-dimension model of the automatic doffer is built in SolidWorks software. Then, based on ADAMS software, the kinematics and dynamics analysis are completed and main parameters of clamps are shown. Finally, The finite element analysis on the clamp is carried out in Workbench software and the maximum stress and deformation of the part are gotten. The simulation results show that this design solves the problem that the traditional doffer does harm to bobbins and spindles during the process of pulling the bobbin. This design provides an excellent scheme for the development of the automatic doffer, and it has great value in application.

Keywords

Doffer, simulation, finite element.

1. Introduction

There are 115 million cotton spindles in China, and about 95% spindles are installed on the Spinning machine that has less than 480 spindles[1]. Besides, the traditional electric doffer adopts double discs in pulling bobbins, and there is a transverse force between the bobbin and the spindle during the process of pulling the bobbin. The double discs grips the center of the bobbin and it does harm to the yarn. So it's urgent for us to design new automatic doffers. Therefore, here we give a scheme about the new automatic doffer. The feed clamping device of the new automatic doffer holds the top of bobbins and it can move along the guide shaft freely, so there is a small force on the spindle and there is no damage to bobbins. Besides, there is no contact between the bobbin and the yarn, so damage to the bobbin can be avoided. This design provides an excellent scheme for the development of the automatic doffer.

2. The Three-Dimension Model of the Automatic Doffer

The distance between two spindles is 70millimeters and the automatic doffer can finish pulling 210 bobbins within 210 seconds. Based on the tract of hand-drawn bobbins, choose three positions and use graphic methods to get the main parameters of the four-bar mechanism. The diagram of the four-bar mechanism is shown in Fig.1. AB is the driven rocker, BC is the clamping mechanism, CD is the driving rocker, and AD is the frame. The values of the parameters in the Fig.1 are shown in the Table.1.

Based on the values of parameters in the Table.1, adopt SolidWorks software into building the three-dimension model of the automatic doffer, and the assembly and the clamping mechanism are shown in Fig.2 and Fig.3.

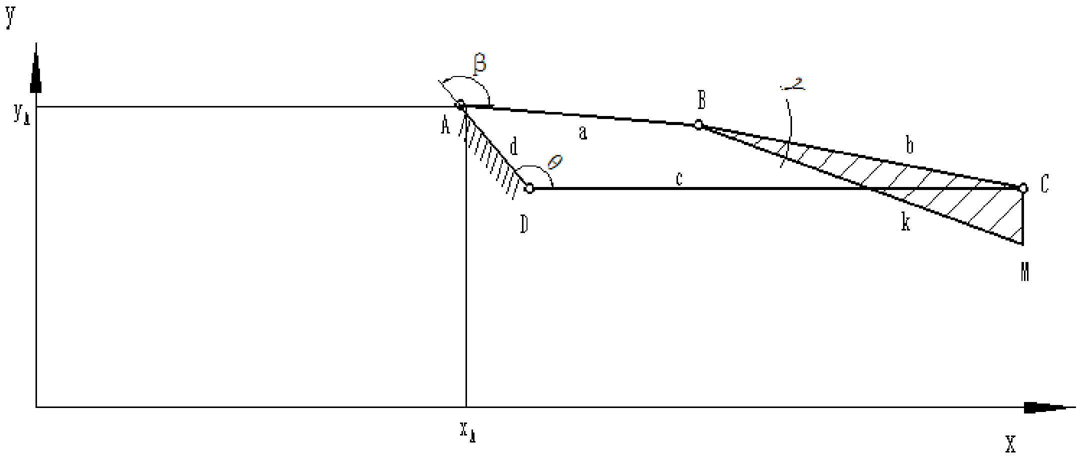

Fig.1 The four-bar mechanism

Table.1 Parameters of the four-bar mechanism

Parameters	Values	Units
A	115	mm
B	160	mm
C	240	mm
D	53	mm
γ	9	°
K	168	mm
β	49	°
x_A	160	mm
y_A	240	mm

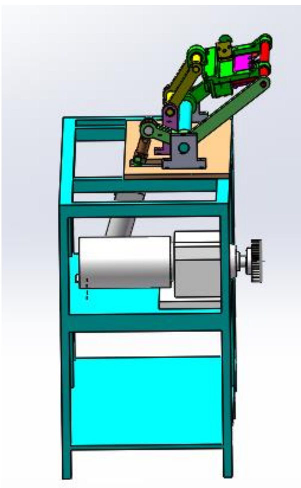

Fig.2 The assembly of the automatic doffer

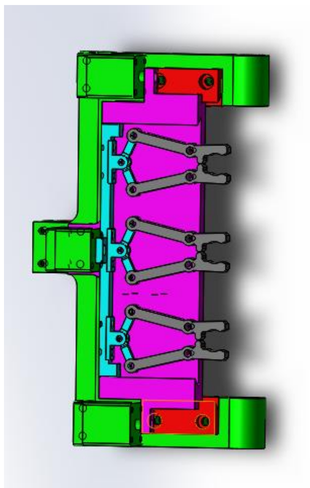

Fig.3 The clamping mechanism

3. Dynamics Simulation

3.1 Simulation

Import the three-dimension model into Adams, rename the parts, define materials, and add constrains. To get an accurate result, define the dynamic friction coefficient of revolute joints as 0.05 and define the dynamic friction coefficient of translational joints as 0.1. Finally, add the translational join motions and run the simulation. The translational join motions of the main cylinder, feed cylinders, the clamping cylinder and the reset cylinder are shown from Fig.4 to Fig.7.

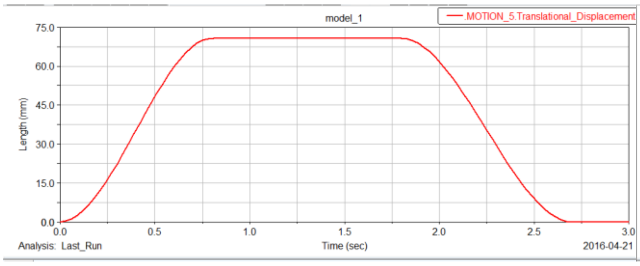

Fig.4 The join motion of the main cylinder

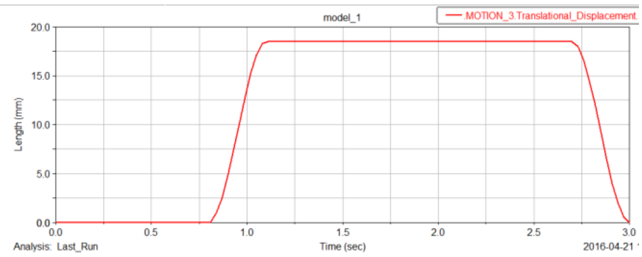

Fig.5 The join motion of feed cylinders

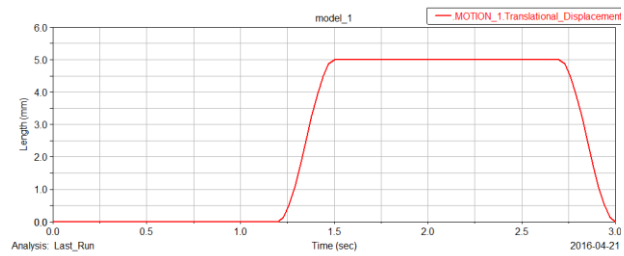

Fig.6 The join motion of the clamping cylinder

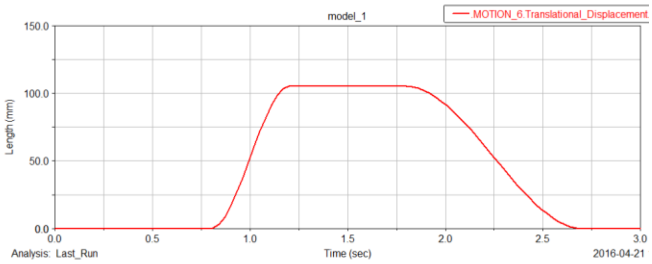

Fig.7 The join motion of the reset cylinder

3.2 Forces on the Clamp

The contact trip, the rod of clamps and bobbins exert forces on the clamps. The force between clamps and the contact trip, the force between clamps and the rod of clamps, the pressure between clamps and bobbins and the friction between clamps and bobbins are shown from Fig.8 to Fig.11. We can find the forces on clamps reach the maximum values at 1.8 seconds. The maximum values and minimum values of the forces are shown below.

(1)The force between clamps and the contact trip:F_{max}=57.5N, F_{min}=0.5N;

(2)The force between clamps and the rod of clamps:F_{max}=0N, F_{min}=-17.2N;

(3)The pressure between clamps and bobbins:F_{max}=247N, F_{min}=25N.

(4)The friction between clamps and bobbins: F_{max}=36N, F_{min}=0N.

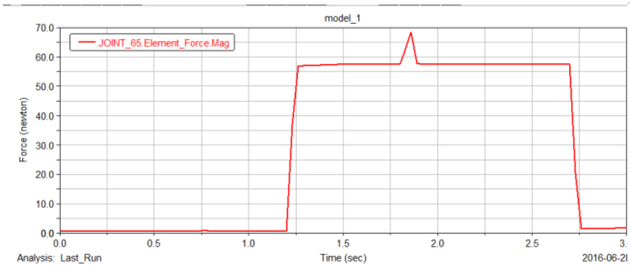

Fig.8 Forces between clamps and the contact trip

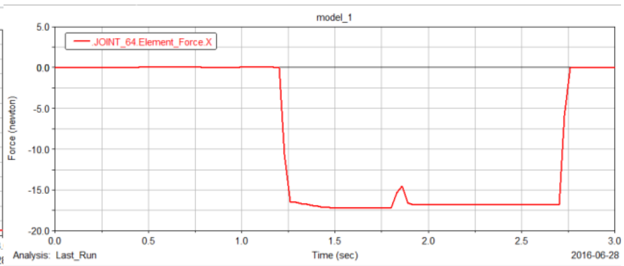

Fig.9 Forces between clamps and rods of clamps

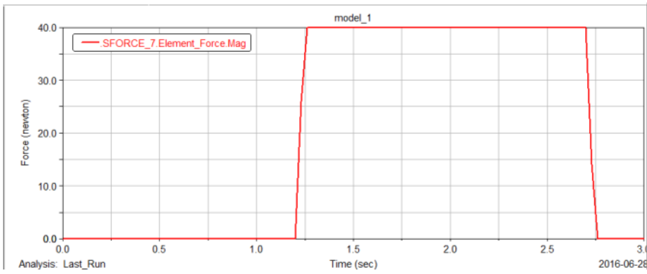

Fig.10 the pressure between clamps and bobbins

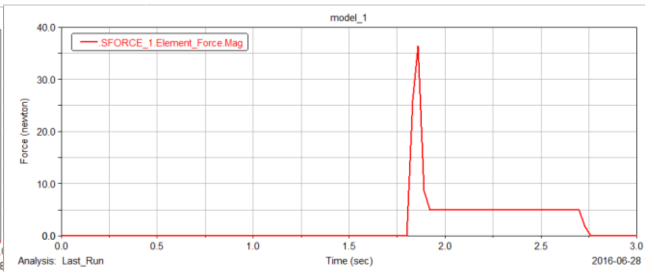

Fig.11 the friction between clamps and bobbins

4. Finite Element Analysis on Clamps

There are complicated forces on clamps and the clamps are the key parts of the automatic doffer, so do finite element analysis on clamps to ensure the security of the part. Import the three-dimension model of the clamp into ANSYS Workbench, and give static analysis. And then define materials, add constrains and force, and divide mesh. The mesh of the clamp is shown in Fig.12.

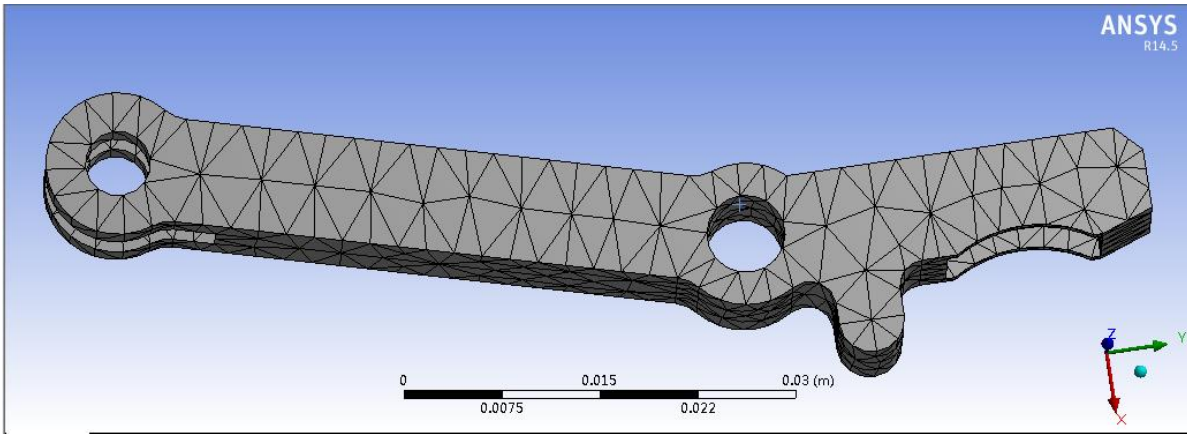

Fig.12 Mesh of the clamp

Choose equivalent stress and total deformation as the solution of the finite element analysis , and then calculate the part. Equivalent stress and total deformation are shown in Fig.13and Fig.14. From Fig.13, we can find that maximum equivalent stress appears on the right hole, and the maximum value is 28MPa. Fig.14 shows that maximum total deformation appears on the far left of the part, and the maximum value is 0.0046mm. The solution shows the clamp is safe.

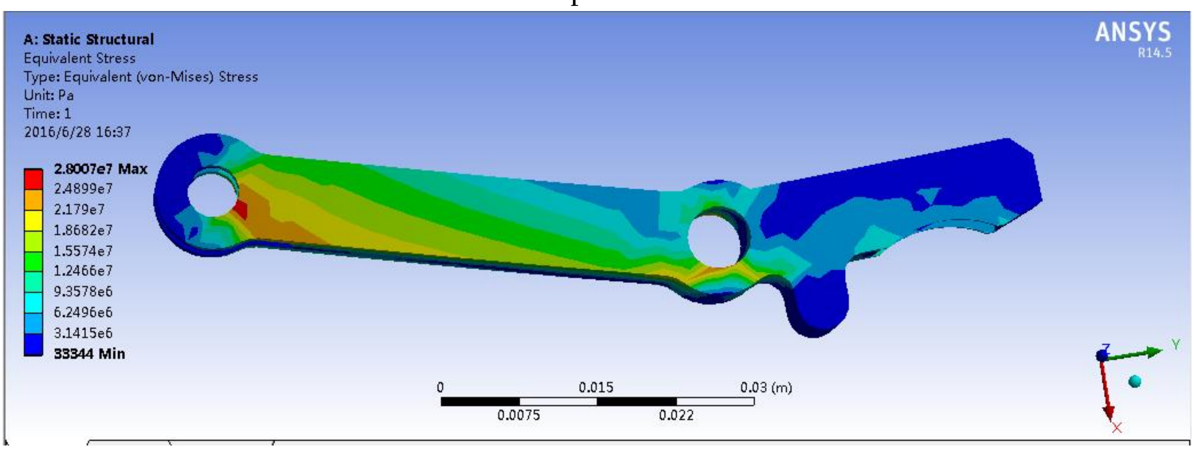

Fig.13 Equivalent stress of the clamp

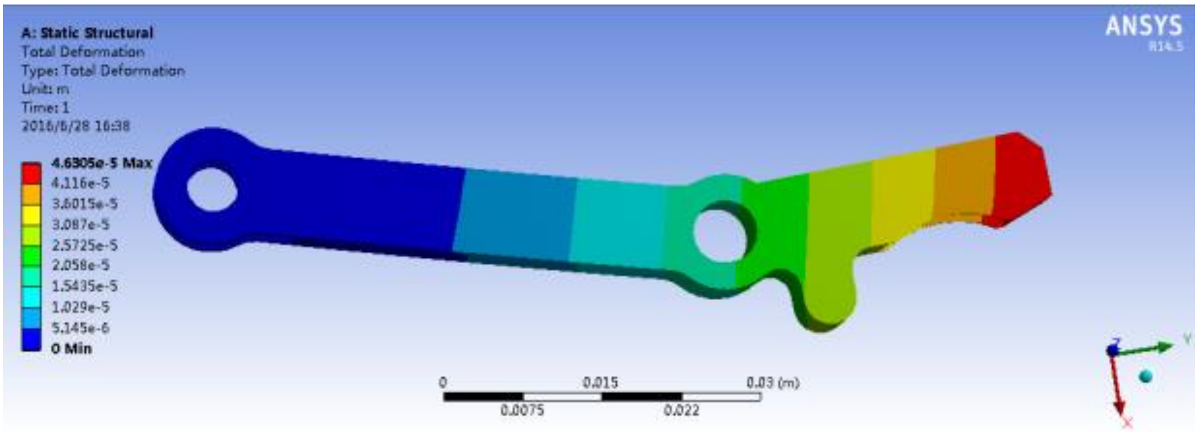

Fig.14 Total deformation of the clamp

5. Conclusion

A three-dimension model of the automatic doffer is built in SolidWorks software in this text, and it meets the requirement that there is no interference between bobbins and spindles during the process of pulling the bobbin. Based on ADAMS software, the kinematics and dynamics analysis are completed and main parameters of the clamp are shown. The finite element analysis on the clamp is carried out in Workbench software and it shows the clamp is safe. This design provides a Superior scheme for the development of automatic doffers.

References

[1] Zhang J Z, Liu S G, Zhang Z. The pulling bobbins device of automatic doffers: CN, 201210451312.5 [P].2014-11-05.

[2] Zhu B L, Zou J W, Yi-Fei W U. Design of all-electric drive automatic doffer[J]. Shanghai Textile Science & Technology, 2012.

[3] Hou G. Positioning mechanism of clamping device of automatic doffer: CN, CN 203475000 U[P]. 2014.

[4] Song M, Fan Y, Zu L. Imitation and optimization design of six-bar linkage punch mechanism based on ADAMS[J]. Journal-Nanjing University of Science and Technology, 2006, 30(3): 285.

[5] Li Q. Automatic doffer structure: CN, CN 103510208 A[P]. 2014.