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STRENGTH ANALYSIS OF SHEARER BODY BASED ON ANSYS

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Taking a certain type of shearer as the research object, using the large-scale Finite Element Analysis (FEA) software ANSYS, according to the actual situation of load distribution, the stress model of the shearer body is established, the stress and deformation of the shearer body are analyzed, and the deformation curve and equivalent stress nephogram of the shearer body under working state are fitted, The stress and strain distribution of fuselage structure under working conditions are analyzed. The calculation results show that the structural design of the shearer body is more reasonable and has better stiffness and strength under normal working conditions. The calculation results have a certain reference value for the analysis and research of high-power shearer.

Keywords: shearer, stress, strain, strength, finite element analysis

INTRODUCTION

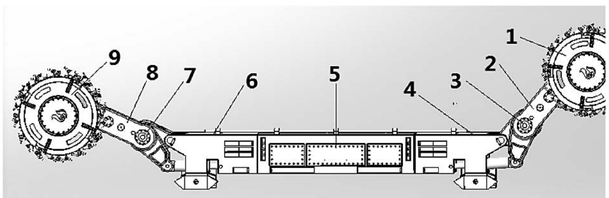
Shearer is the core equipment of fully mechanized coal mining. With the development of coal mining to deep dangerous coal seams, the maintenance time and difficulty of shearers are also increasing. Reliable and durable shearers have become an urgent demand of coal enterprises[1]. Due to the complexity of the underground working environment of the shearer, the design and use of the shearer often adopts large redundancy to ensure the reliability of the shearer. This way is easy to cause the structure of the Shearer to be too bulky, resulting in the increase of the production cost of the shearer and the waste of resources[2].

The shearer in fully mechanized mining face mostly adopts the integral building block structure.The fuselage plays the role of supporting the weight of the machine and bearing the working reaction force of the cutting part. At the same time, it connects the walking part of the Shearer to overcome the reaction impact of the floor of the working face. Its structure and strength have always been the research focus of the building block shearer, The structure of shearer body and the distribution of stress and strain under working conditions are worthy of our study.

BASIC PARAMETERS OF SHEARER

Due to the complex structure of the shearer, it is necessary to simplify the shearer when constructing the dynamic model of the shearer. Dominated by the mechanical structure of the shearer, ignoring the electrical system, hydraulic system and auxiliary system[3].

As shown in Figure 1, a certain type of shearer is a building block structure, which is mainly composed of left and right rollers, left and right cutting parts, left and right traction parts and electric control parts. The fuselage of the shearer is composed of left and right traction parts and electric control parts. The diameter of the drum is 2 000 mm, the center distance of the drum is 13 972 mm, the mining height is 2 ~ 4 m, the power of the whole machine is 1474 kw, the traction power is 90 kw, the cutting motor is 620 kw, the rotating speed of the drum is 38 rad/min, and the weight of the whole machine is 60 t.



1-right drum; 2-right cutting part; 3-right cutting motor; 4-right traction part; 5-electric control part; 6-left traction part; 7-left cutting motor; 8-left cutting part; 9-left drum

Figure 1 Overall drawing of shearer

MECHANICAL PARAMETERS OF SHEARER BODY

The body of this type of shearer is mainly composed of electric control box shell, front and rear traction box shell and corresponding walking box, guide slippers, support legs and support slippers. Therefore, the stress and strain analysis of the body is mainly transformed into the analysis of major components.

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The whole machine is supported by rear support slippers and two guide slippers. The axial direction of the whole machine is balanced by the goaf side surface inside the front guide slipper and the coal wall side surface inside the rear guide slipper. The traction speed direction is balanced by the friction generated by the upper surface inside the front guide slipper and the goaf side surface, the friction generated by the upper surface inside the rear guide slipper and the coal wall side surface, and the friction generated by the rear support slipper.

The cutting resistance of the front and rear rollers is 140 kN, the traction resistance of the front and rear rollers is 112 kN, the axial force of the front and rear rollers is 56 kN, the gravity of the whole machine is 750 kN, the traction force is 500 kN. The distance between the two guide slippers is 5,7 m, the distance from the front guide slipper to the midpoint of the front drum is 3,5 m, the distance from the rear guide slipper to the midpoint of the rear drum is 4,1 m, the vertical distance from the center of the front drum to the guide slipper is 2,4 m, the vertical distance between the support slipper and the guide slipper is 0,5 m, the vertical distance from the center of the rear drum to the guide slipper is 0,45 m, The distance from the midpoint of the goaf side surface inside the guide slipper to the upper surface is 0,5 m, the distance from the center of the whole machine to the guide shoe is 1,1 m, the distance from the middle of the drum to the guide slipper is 2,5 m, the distance between the midpoint of the inner upper surface of the guide slipper and the surface of the goaf side is 0,1 m, the friction coefficient is 0,25.

The force analysis data of the support slipper and the guide slipper are drawn up. After preliminary calculation, the direction of the support reaction force is measured. The front support slipper is not supported by the support force, and the whole machine is supported by the rear support slipper and two guide slippers. The axial force of the whole machine is the resultant force after the force on the inner side of the front guide sliding shoe (goaf side surface) and the force on the rear guide sliding shoe (coal wall side surface) offset each other. The force in the direction of traction speed is balanced by the friction generated by the upper surface inside the front guide slipper and the goaf side surface, the friction generated by the upper surface inside the rear guide slipper and the coal wall side surface, and the friction generated by the rear support slipper. The hinge constraint setting, the connection between the walking box and the guide slipper, and the connection between the support slipper and the support slipper all use the rotary connection[4].

FINITE ELEMENT ANALYSIS OF FUSELAGE STRENGTH

The Finite Element Method is used to calculate the strength and rigidity of the fuselage of this type of shearer, and the element body with tetrahedron size of 30 mm is used. The physical parameters of the model are set. The density of the material is 7,91 kg / m^3, the Poisson's ratio is 0,27 and the elastic modulus of the material is 2,2 × 1 011 Pa[5]. At the same time, set the constraints of the model. The applied load and constraints are shown in Figure 2.

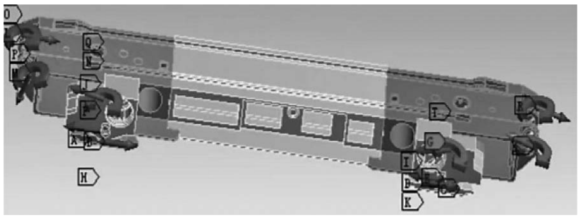

Figure 2 Load model of shearer body

Through the finite element calculation, we can observe that the shearer has large deformation, and the position appears in the cavity of the pump station of the traction department, and the deformation is about 2,21 mm, indicating that the structural stiffness needs to be improved here. The change of traction direction is relatively uniform, and the main deformation range of the fuselage is 0,7 mm ~ 1,1 mm, which meets the rigidity requirements of the shearer fuselage. The axial deformation is relatively uniform, and the maximum axial deformation is 1,5 mm. The comparison of stress and deformation data of the shearer body is shown in Figure 3. The blue curve is the overall difference, the yellow curve is the difference of coal wall side, and the pink curve is the difference of goaf side.

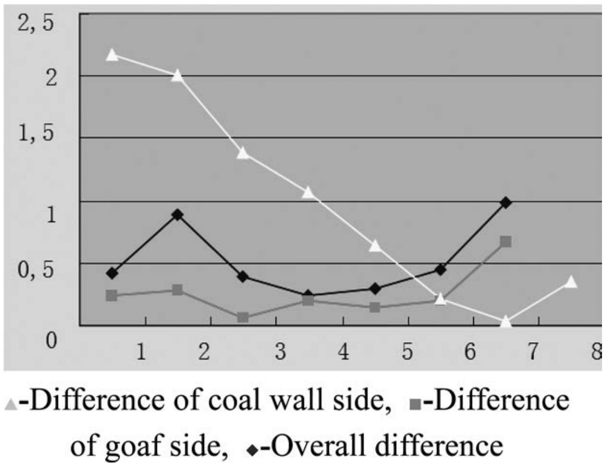

Figure 3 Comparison data of stress and deformation of shearer body

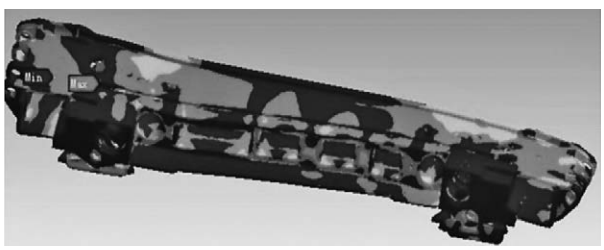

Figure 4 Equivalent stress diagram of shearer body

Table 1 **Stress of each hole of shearer body**

project name	hole on coal wall side	hole on goaf side	hole of cylinder
front of shearer body	39,6 MPa	14,4 MPa	27,5MPa
rear of shearer body	43,2 MPa	22,5 MPa	23,4 MPa
front rocker arm	29,8 MPa	7,6 MPa	42,4 MPa
rear rocker arm	50,4 MPa	20,8 MPa	50,6 MPa

The equivalent stress of the shearer body of this model is shown in Figure 4. The position of the maximum stress is 208 MPa at the root of the connecting support leg of the front traction part. When we design again, we can change the chamfer to fillet to reduce the stress value and improve the strength.

Table 1 shows the stress distribution values at each hole of the fuselage. Through comparison, it can be seen that the larger stress is mainly distributed at the ear hole of the rear rocker arm. Appropriately increasing the thickness of the ear hole of the rocker arm in the design is conducive to improving the strength of the fuselage.

CONCLUSIONS

The maximum deformation of this type of shearer under normal working conditions is about 2,21 mm, which appears on the side wall of the cavity of the pumping station of the traction department. Appropriately increasing the cavity stiffness of the pumping station is conducive to improving the stiffness of the fuselage.

The maximum equivalent stress value is about 208 MPa, which appears at the root of the connecting support leg of the front traction part. We need to effectively improve the strength of the support leg of the front traction part in the secondary design; The stress value at each hole of the fuselage is relatively uniform, and the maximum stress value is 50,6 Mpa, which appears at the hinge of the rear rocker arm.

It can be seen that this type of shearer is the mainstream model of coal mining enterprises in China. Its fuselage structure layout is more reasonable and has good strength and stiffness. This calculation result has a certain reference value for the analysis and research of high-power shearer.

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Note: The responsible translator for English language is L.Y.Huang,Anshan,China