Research on Strengthening Ring of Transmission Drum of Belt Conveyor

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Abstract

On the basis of establishing the model of transmission drum, the effect of reinforcing ring is verified by finite element analysis, and a series of simulation is carried out. The relationship between the cross section size of the reinforcing ring and the thickness of the cylinder skin and the maximum deformation of the cylinder is studied. The expression of the functional relationship between the three is obtained by using the data fitting in Matlab. It provides the theoretical basis for the standardization and optimization design of the drive drum ring.

Keywords

Belt conveyor, Transmission drum, Strengthening ring, Ansys.

1. Introduction

Belt conveyor is the most efficient and widely used material conveyor in the field of continuous transportation, and its application in coal mine is developing towards long distance, high power and high belt speed. The structure and size of the drum seriously affect the overall quality of the drum. The main failure modes of the driving drum are cracks, excessive local deformation, fracturing and so on. The form of failure is staggered tensile compression deformation when rotating. Liu Tiegang analyzed the relationship between the number of reinforcing rings and the principal stress of the cylinder, and studied the relationship between the inner diameter of the strengthened ring and the diameter of the tube; Wang Chunhua, Fan Changda and others designed the stiffening rings with different cross-section shapes and obtained that the effect of the reinforced rings with triangular section is better than that of rectangular section and trapezoidal section. In this paper, the problem of excessive deformation in the middle part of the transmission drum is studied, and the effect of the section size of the rectangular strengthened ring on the maximum deformation of the roller is analyzed.

2. Mechanical Model of Drive Drum

2.1 Structural Parameters of Transmission Drum

Due to the development of welding technology, the design and manufacture of roller has been gradually developed into cast-welding type, that is, the radial plate and shell are cast together, and the radial plate and shaft are connected by expansion sleeve.In an engineering practice, the structural parameters of the drive drum are as follows (unit: mm)

Table 1 Parameters list of the drum

Rub factor	Radials	Drum length	Drum diameter	Shell thickness	Radials thickness	Bearing block centerline spacing	Expansion sleeve width
0.3	1232	1400	1000	14	110	2050	96

In this paper, the strain of the cylinder shell is mainly studied. Assuming that the tension static arc of the conveyor belt on the drum is 30 degrees and the sliding arc is 180 degrees, the tension magnitude of the drum is assumed 70 KN. A model is established in Ansys Workbench DM, as shown in Figure 1.

2.2 Grid Partitioning and Constrained Load

The cylinder model is meshed with tetrahedron mesh method, the bearing position is fixed and the pressure load and friction load are applied in 180°sliding arc of the shell, the pressure load is radial direction, and the friction direction is tangent direction of circular arc. There is no friction in the static arc and the effect is shown in Fig. 2.

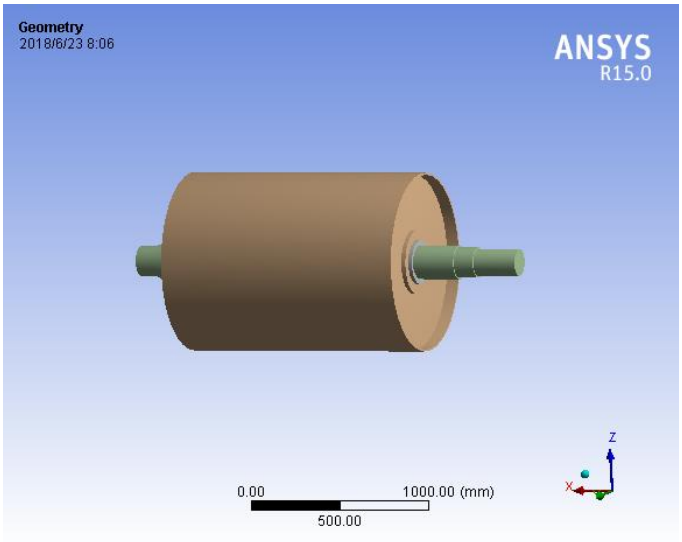

Fig. 1 Model of the Drum

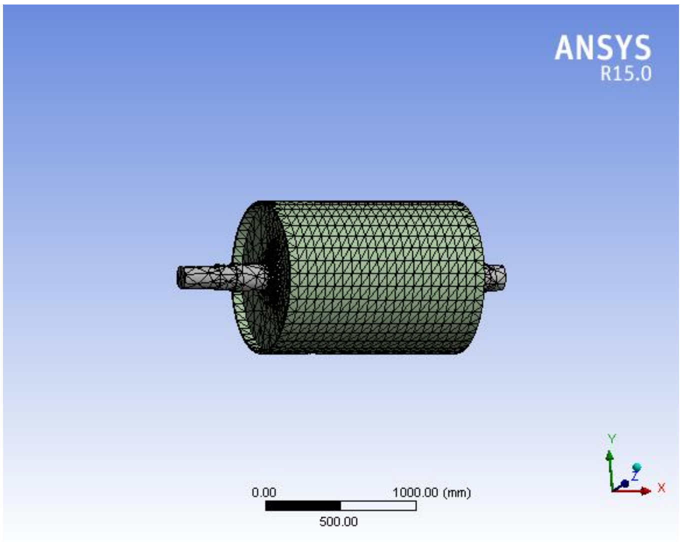

Fig. 2 Grid partitioning effect

The main load on the transmission drum is the pressure load and friction load exerted by the conveyor belt, in which the pressure changes continuously along the circumference direction, and its pressure changes with the change of the circumference angle.

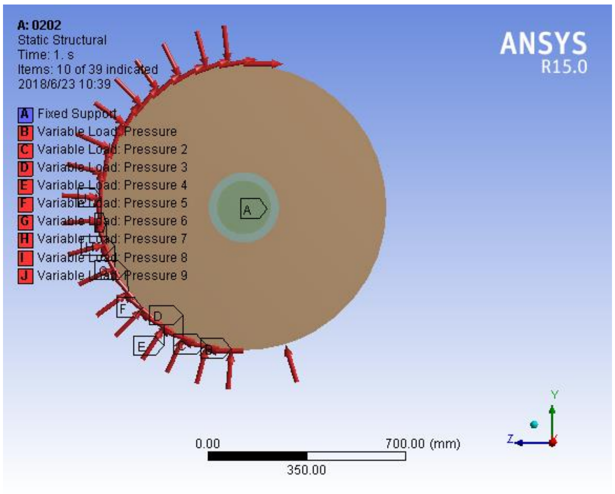

Fig. 3 The load of all the drum

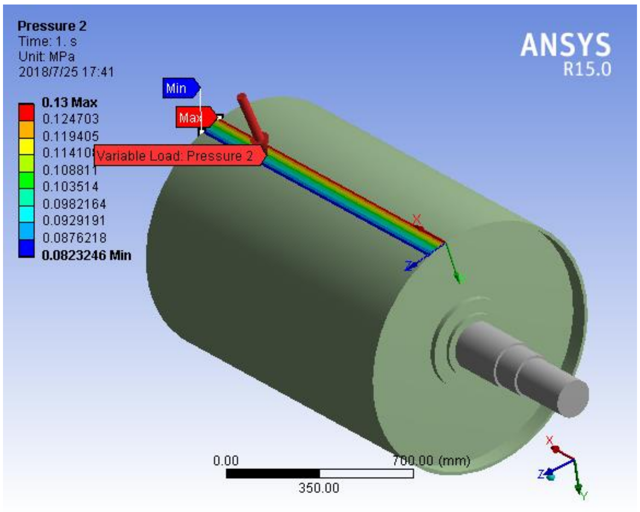

Fig. 4 The load of each part

3. Interpretation of Result

On the basis of the pre-processing of the finite element analysis, the displacement and strain of the driving drum without reinforcement ring are obtained by solving.

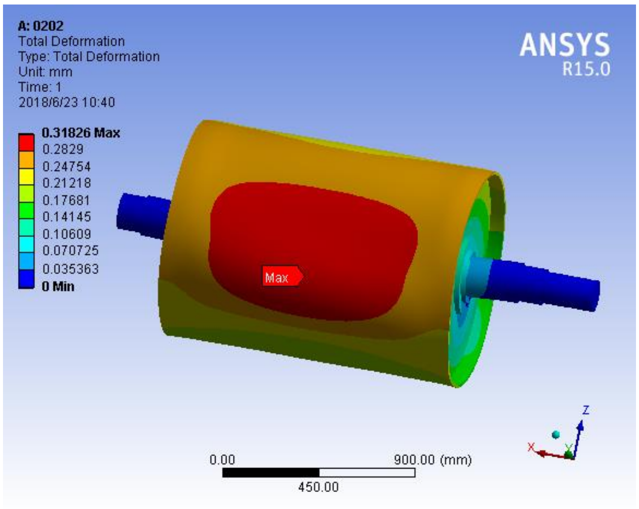

Fig. 5 Total deformation

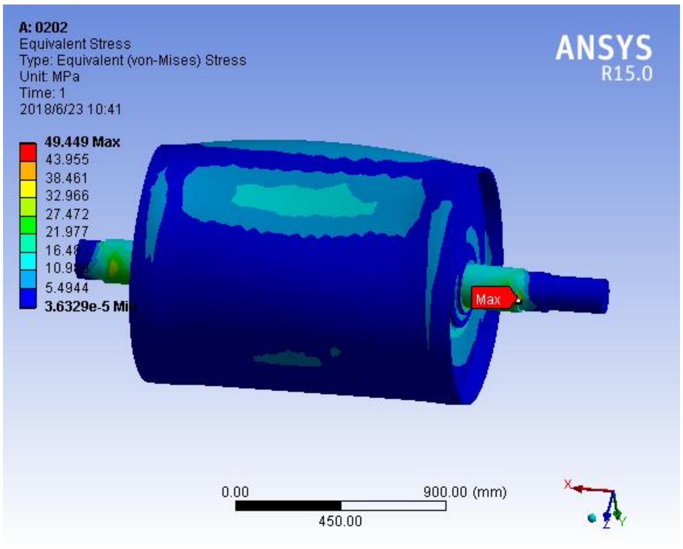

Fig. 6 Equivalent Stress

It can be seen from the equivalent displacement cloud diagram that the maximum deformation of the drum appears in the middle position of the shell, and the maximum deformation is 0.31826 mm.

The stress of the transmission drum is mainly concentrated on the shaft between the bearing and the bulging sleeve, and the middle part of the drum shell. The maximum stress is 49.449MPa.

4. The Effect of Strengthening Ring

The rectangular stiffening ring is added in the middle of the drum. The cross section size of the rectangular stiffener ring is as follows: width: $b = 14mm$, height: $h = 14mm$. The displacement and stress cloud diagram are obtained by adding the same constraints and loads.

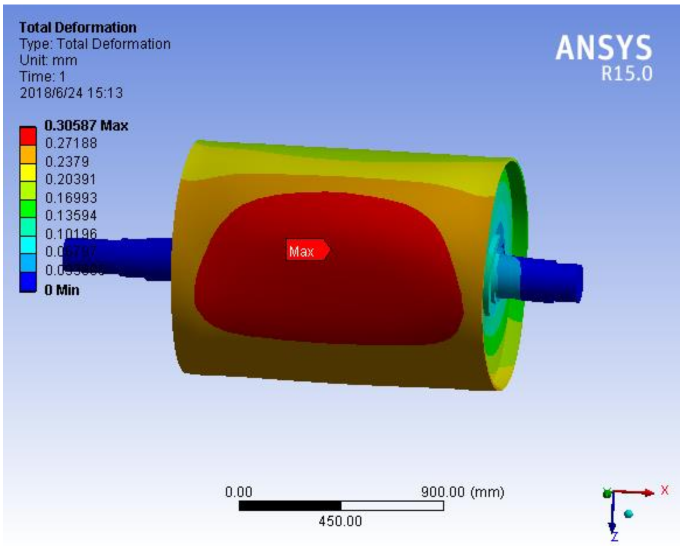

Fig. 7 Total deformation of the drum with Strengthening Ring

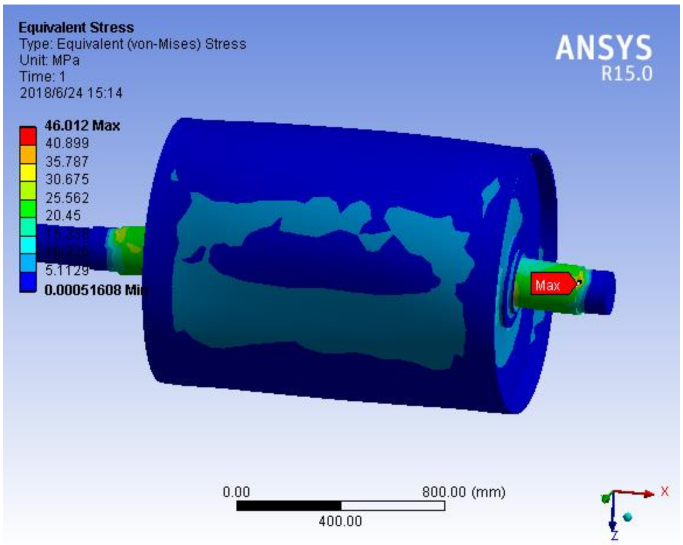

Fig. 8 Equivalent Stress of the drum with Strengthening Ring

It can be seen from the diagram that the maximum deformation of the transmission drum is 0.30587mm, and the maximum deformation is still in the middle of the cylinder shell. The maximum deformation is reduced by 3.89% in comparison with the drum without reinforcing ring device. It can be seen that the addition of reinforcing ring in the middle position can reduce the maximum deformation of the drum.

Change the dimension parameter bh of rectangular reinforced ring section, analyze and compare its effect, the result data is shown in the following table:

Table 2 Total deformation with different b and h(unit: mm)

h \ b	14	21	28	35	42	49	56	63	70	84
14	0.30587	0.30546	0.30362	0.30235	0.30229	0.30179	0.30114	0.30044	0.30044	0.30008
21	0.30305	0.30121	0.30054	0.29968	0.29902	0.2982	0.29711	0.2962	0.2962	0.29597
28	0.30028	0.29891	0.29754	0.29661	0.2961	0.29533	0.29414	0.29338	0.29338	0.29289
35	0.29823	0.29649	0.29491	0.29395	0.29336	0.29265	0.29161	0.29088	0.29088	0.29048
42	0.29636	0.29448	0.29322	0.2924	0.29172	0.2911	0.29008	0.28956	0.28956	0.28914
49	0.29409	0.29237	0.29144	0.29052	0.28992	0.28959	0.28917	0.28827	0.28827	0.28791
56	0.29295	0.29129	0.28981	0.28901	0.28858	0.28812	0.28774	0.28692	0.28692	0.28666
63	0.29137	0.28986	0.28863	0.28795	0.2875	0.28707	0.28715	0.28645	0.28645	0.2862
70	0.2903	0.28895	0.28804	0.28742	0.28706	0.28662	0.28639	0.28585	0.28585	0.28569
84	0.28859	0.28743	0.28657	0.28614	0.28582	0.2855	0.28532	0.28254	0.28513	0.28494

It can be seen that with the increase of b and h, the maximum deformation of the cylinder decreases gradually. When the width is 84mm and the height is 84mm, the maximum deformation of the drum is 0.28494mm, compared with the drum without the stiffening ring. The maximum deformation decreased 10.469%, and the effect was obvious.

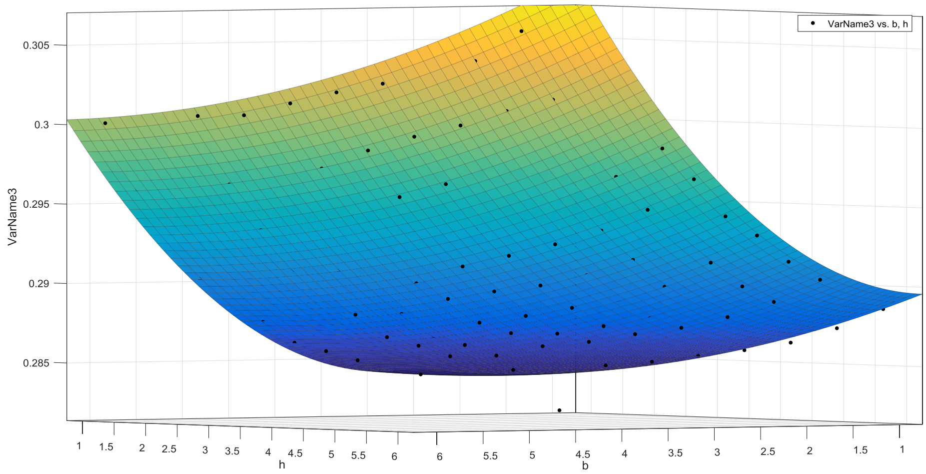

Fig. 9 Fig data fitting

Through the least square method ($f(x,y)=ax^2+by^2+cxy+dx+ey+f$) fitting the surface can we get the function expression:

$$f=10^{-4}(2.606x^2+6.324y^2+1.382x\cdot y-34.56x-80.12y+3167) \tag{1}$$

f —Maximum displacement of transmission roller

x —Stiffening ring width / shell thickness

y —Stiffening ring height / shell thickness

Fitting error square sum in this function is 2.652e-05, Equation determination coefficient is 0.9912,and we get a good fitting result.

Y (or h) has a great influence on the maximum deformation.It can be seen from the diagram that when the width is greater than 4 times the thickness of the shell, the effect of increasing the width of the reinforcing ring is not obvious; when the height is greater than 5 times the thickness of the shell, the effect of increasing the height of the reinforcing ring is not obvious. On the other hand, the bigger the upper b and h, the more obvious the effect will be. But if the size of the reinforcing ring is increased blindly, the quality of the driving drum will be increased, resulting in additional energy waste, which does not meet the lightweight requirements of the driving drum and does not conform to the green development concept of energy saving and emission reduction.

5. Summary

1. The rectangular stiffening ring can reduce the maximum deformation of the shell.
2. The height of the rectangular stiffener ring has a great effect on the effect of the ring.

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