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Design of Damping Damping Design of New Boring Head Drive Structure

Haoyang LIU, Zhaowei MENG, Liang HAN*, Wenwu ZHANG

Yingkou Institute of Technology, Yingkou, Liaoning, 115004, China

***Corresponding Author:** Liang HAN, E-mail: 312462525@163.com*

Abstract:
This paper takes the boring head of 20 roll mill as the research object, optimizes the vibration inside the boring head through a differential damping structure, and then conducts the 3 d model inside the boring head through SolidWorks, and checks the interference of the boring head model. Finally, Ansys workbench finite element analysis software is used to analyze and verify the vibration damping characteristics of the differential damping structure.
Keywords: *Gear drive; Damping; Vibration Reduction*

1 Background and Meaning

With the progress of science and technology and the rapid development of machining technology, the quality requirements of the parts are also improved. The structure of too complex parts make the traditional processing process can not meet. The precision of some holes is more demanding. Due to the increase of space surface roughness of the boring head, the optimization design of the boring head is needed. At the same time, the mechanical system is developing towards the direction of diversification, intelligence and flexibility, and the topic of vibration reduction has increasingly become one of the important research topics at home and abroad.

In the process of gear transmission, due to the change of time-varying meshing stiffness, transmission error, in and out impact, and the change of the system input and output torque, the alternating load will cause the engagement impact of the gear. When the frequency of the shock force is close to the inherent frequency of the gear, it will cause resonance and noise [1].

Circumferential vibration, radial vibration and axial vibration are the three ways of gear vibration. Due to the error of the gear and the different changes of the gear engagement stiffness, the vibration of the shaft and bearing, which causes the vibration of the gear in the radial direction of the gear. Secondly, when the tooth load is applied on the bearing, due to the bending deformation of the shaft, the axial force caused by the friction between the shaft and the bearing is not consistent at the left and right ends of the gear, thus causing the axial vibration of the gear [2]. That is to say, both radial and axial vibration are generated by circular vibration as the starting factor.

Through reading a series of references, we learned that the common methods of vibration reduction are active design and passive vibration reduction. Active design is to optimize the existing parameters of the wheel to improve the machining accuracy of the work piece, while passive vibration reduction is to control the gear through other physical methods after the production of the finished product. One of the most effective methods today is to use damping rings for passive gear damping. The damping ring is embedded in the gear. When the transmission system begins to operate, the damping ring and the matching gear produce sliding friction. The principle of energy consumption between the sliding friction between the two, so as to reduce the vibration between the transmission system and realize the effective control of the gear vibration.

2 Main Research Content

2.1 Design of differential damping and damping structure

In this study, the speed difference between the driven gear and the damping gear is mainly used to produce friction, and the mechanical energy in the friction loss mechanism can achieve the effect of system vibration reduction. There are many structures of wheel damping ring, mainly integral, C-shaped and spiral

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damping ring. When the gear vibrates, the relative sliding movement between the gear and the damping ring occurs, that is, there is sliding friction force. Using the energy consumption principle of sliding friction force, the mechanical energy of the gear vibration is converted into the heat energy caused by friction, so as to reduce the vibration energy of the gear and achieve effective control of the vibration of the gear. However, the design of the damping ring involves many factors, because all the damping rings are generated by the relative friction movement between the ring and the gear body ring groove. The size of the friction force determines the damping effect of the ring [3]. If the friction between the damping ring and the gear is very small, even does not exist, the damping ring and the gear become two unrelated motions, the damping ring can not suppress the vibration of the gear; if the friction force is particularly large, the damping ring will move with the gear without the relative movement, which can not form friction energy consumption [4]. To solve this problem, a tooth differential damping structure is developed, as shown in Figure 1.

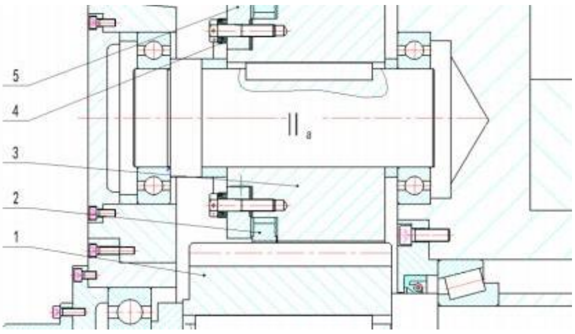

Figure 1 Diagram of differential damping damping structure

1, spindle drive gear; 2, damping gear; 3, shaft drive gear; 4, disc spring set; 5, spring pressure cover;

The damping vibration reduction structure is the process of gear engagement, the driven gear is composed of two gear body, namely damping gear 2 and shaft transmission gear 3, because the number of damping gear 2 one more teeth than the shaft transmission gear, so the boring head working process, small speed difference between damping gear 2 and shaft transmission gear transmission 3, thus forming the sliding friction between the two gears, the sliding friction to consume the mechanical energy generated by vibration in the system, so as to reach the effect of vibration reduction. By adjusting the compression amount of the butterfly spring 4 on the damping pressure cover 5 in contact with the damping gear, the damping force effect of the damping gear can be changed.

2.2 Dimensional modeling and assembly of boring head parts

The SolidWorks software is used for 3D modeling of the boring head parts and simulated assembly to better express the "148" structure transmission layout of the boring head parts, as shown in Figure 2.

Figure 2 The 3 D model diagram of the boring head

The structure of boring head parts is complex and there are many kinds of parts. If there is no interference inspection on the three-dimensional model of boring head assembly, there may be hidden danger of collision teeth and other parts in the later factory processing. The interference inspection can effectively reduce and minimize our loss. Although the traditional interference inspection of parts drawings can find a certain amount of interference parts, but the efficiency is low and easy to miss. Therefore, this paper uses the "interference check" module of Solidworks software to calculate the interference inspection of the boring and head parts after simulated assembly. The place with interference is marked as shown in Figure 3. After the interference position is gradually eliminated, and then checked to ensure that the 3 D drawing is completed without interference.

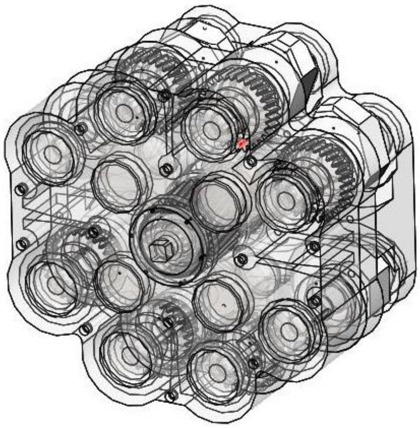

Figure 3 Interference gram of 3D model of boring head

2.3 Comparison of shock effect of differential damping structure

According to the calculation, the damping force of the differential transmission damping structure can be controlled by adjusting the butterfly spring compression or replacing the friction damping material between the damping gear and the transmission gear. The damping force of this structure is easy to adjust and the damping force is constant and reliable. In the setting of the damping force, this paper extracts a pair of meshing gears in the boring head, and calculates the vibration reduction characteristics of the Damping ring on the axial Vibration of the gear system published by the domestic scholar Qingyang Wang and others.

Before optimization, the gear engagement is analyzed, the active gear and driven gear are selected, and a constraint is applied on the active gear to make it engage. Through the overall vibration displacement image, the maximum vibration displacement of the gear engagement is 0.01283mm. After optimization, the damping gear is added before the driven gear, the butterfly spring in front of the damping gear, and the transmission system is analyzed to find the minimum vibration displacement of the gear when the damping force is 561.845N, and the vibration displacement during the engagement is 0.002496mm, which can effectively explain the vibration reduction results, as shown in Figure 4 and Figure 5:

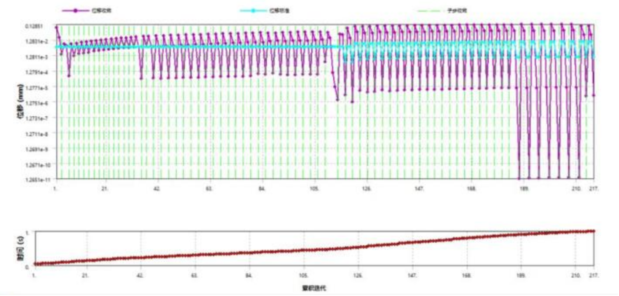

Figure 4 Graph of vibration displacement convergence during unoptimized front gear engagement

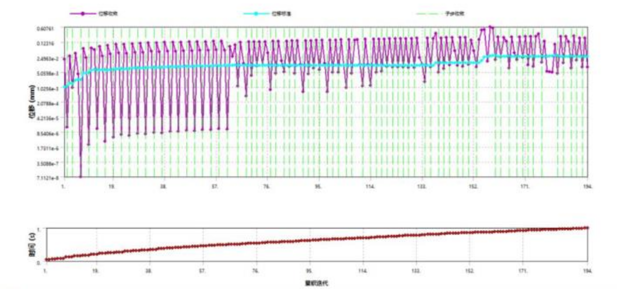

Figure 5 Convergraph of vibration displacement during optimized gear engagement

3 Summary of this Article

According to the problem of machining of mill frame, a special boring head of 20 roll mill frame is developed, which aims 8 holes of the machining hole system with a walking blade. The "gear-damping" vibration reduction system is applied to produce a better processing effect. This method is based on the gear in the original transmission system, plus a damping gear, damping gear than a gear number, so in the process of transmission, there is a certain speed difference between damping gear and transmission gear, further form sliding friction, reuse sliding friction energy consumption principle, consumption vibration generated mechanical energy, so as to achieve the effect of vibration reduction. At the same time, the amplitude of the boring head transmission system changes nonlinear with the damping force, through the simulation model of the transmission system.

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