Flexible Multi-body Contact Analysis of rounded-jointed silent chain and sprocket

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In recent years, there is a trend of small pitch, high-speed, multiple species and high-Performance in the study of silent chain, and the silent chain drive has been used more widely in the timing drive system of auto engine. The silent chain drive has been used in the car engine timing drive system and oil pump drive system in many famous international auto companies, such as GM, Ford, Chrysler, Benz, BMW, Audi, VW and so on. The silent chain has the characters of compact size, high reliability and high wear resistance, which the gear drive and belt drive don’t have. So there are broad prospects in the silent chain drive.

This paper analyzes the stress distribution of the pin and the chain plate through building the flexible multi-body contact model of rounded-jointed silent chain and sprocket by using the multi-body dynamics software Recurdyn V7R1, which is an important Mechanics basis for the structure design and the optimization of the silent chain plate.
FLEXIBLE MULTI-BODY CONTACT ANALYSIS OF ROUNDED-JOINTED SILENT CHAIN AND SPROCKET

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ABSTRACT

In recent years, there is a trend of small pitch, high-speed, multiple species and high-performance in the study of silent chain, and the silent chain drive has been used more widely in the timing drive system of auto engine. The silent chain drive has been used in the car engine timing drive system and oil pump drive system in many famous international auto companies, such as GM, Ford, Chrysler, Benz, BMW, Audi, VW and so on. The silent chain has the characters of compact size, high reliability and high wear resistance, which the gear drive and belt drive don’t have. So there are broad prospects in the silent chain drive.

This paper analyzes the stress distribution of the pin and the chain plate through building the flexible multi-body contact model of rounded-jointed silent chain and sprocket by using the multi-body dynamics software RecurDyn, which is an important Mechanics basis for the structure design and the optimization of the silent chain plate.

2. THE STRUCTURE AND THE PARAMETER OF SILENT CHAIN

To study the silent chain easily, we select the rounded-jointed silent chain which is widely used in the timing chain system. These will save a lot of time.

This paper select the straight teeth rounded-jointed silent chain for analysis. Table 1 shows the parameters of the silent chain (The gap between the pin and the chain plate is 0.01mm). The material of the silent chain is very important. Table 2 shows the material parameters of the silent chain.

1. INTRODUCTION

As we all know that, the camshaft of car engine is driven by the crankshaft. There are many driving methods between them, gear drive, chain drive, and toothed belt drive.
3. BUILD AND SIMULATE 3D MODELS OF THE SILENT CHAIN

3.1 Build the model of the silent chain

By using the CATIA V5R19, we build the model of the silent chain plate and the model of the sprocket. As shown in Figure 1 and Figure 2, then import the models into multi-body dynamics software RecurDyn V7R1. Add the forces and the constraints on the models to build the dynamics models of the rounded-jointed silent chain.

3.2 Simulation

In order to study the pressure of the silent chain, we divide the simulation into two parts.

First, there are two pins and one rounded-jointed silent chain, as shown in Figure 3. Add two constant forces F=300N on both two pins at X-direction, and the chain plate model has 3453 meshed elements. We set a zero gravity in this simulation so that we can observe the statics stress distribution clearly.
Second, in order to make the simulation easily, there are only 8 rounded-jointed silent chain plate and a sprocket in Figure 4, and there is a gap which is 0.01mm between the chain plate and the pin. The sprocket rotates at 1000 rpm in counterclockwise. The pin in the right has a 300N tensile force. At the beginning, the rows of the chain is 3x2, in this simulation we change rows into 1x2. The Figure 5 shows the simulation model of the pin, the rounded-jointed silent chain has a 2x3 rows.

4. THE RESULTS OF THE SIMULATION

4.1 The simulation results of the chain plate which has a pure tension.

We can see from Fig.6 that the stress is large at point B and point E, the gap between the pin and the chain plate is only 0.01mm, we can think that point A contact between the pin and chain plate is surface contact so that the stress at point A is not very large. From section D to section C the larger stress extends from point E to point B.

4.2 The simulation results of the pin

In the Figure.7, the stress of the contact between the pin and the two rows chain plates is larger than that in the three rows chain plates. At 0.001s the stress in the pin is 400MPa smaller than the Yield Strength of 20CrMnMo which is 885MPa, as shown in Fig. 8.
4.3 The simulation result of the rounded-jointed silent chain which is moving

In the Fig.9, we find that the stress distribution of the silent chain plate is as same as that in Fig.8, As the time runs the silent chain plate starts meshing with the sprocket. The stress at point C becomes larger and larger as shown in Fig.10 and Fig.11, and the maximum stress at point C is about 700 MPa (Fig 12). This is the reason why the silent chain plates often wear at Point C.

Fig.9 THE SIMULATION RESULT OF THE SILENT CHAIN WHICH IS MOVING

Fig.10 THE SILENT CHAIN PLATE IS MESHING WITH THE SPROCKET

Fig.11 THE SILENT CHAIN PLATE HAS MESHED WITH THE SPROCKET COMPLETELY

5 CONCLUSIONS

This paper analyzes the flexible multi-body contact of rounded-jointed silent chain and sprocket.

First, we build the 3D model of the rounded-jointed silent chain and the sprocket by using CATIA, then simulate the moving model in the multi-body dynamics software Recurdyn, finds that there is a very great stress at the mesh point when the rounded-jointed silent chains mesh with the sprocket. This is consistent with the actual. All of this is an important Mechanics basis for the structure design and the optimization of the silent chain plate.

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