Dynamic analysis of the harvester seat

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Dynamic analysis of the harvester seat

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Abstract. The comfort of the harvester seat is the key to the overall comfort experience, the comfort of the seat mainly includes static comfort and dynamic comfort. The seat human body model is established by the CAD software CATIA, and the joint angles of the human body in a suitable sitting posture are obtained. The simulation results of the motion simulation software ADAMS are analyzed. The results show that the acceleration of the seat increases with the increase of the seat suspension stiffness. As the seat suspension damping increases, the seat acceleration decreases. The appropriate range of seat suspension stiffness is 80 – 120 N/mm, the appropriate range of damping is 3 – 5 N·s/mm.

1. Introduction

The harvester seat is the most frequently used part of the driver's contact with the harvester. The comfort of the harvester not only affects the competitiveness of the harvester, but also has an important impact on the health of the occupants and the safety of the ride. The comfort of the harvester seat is an important part of the comfort of the harvester. The comfort of the harvester seat mainly includes two aspects: static comfort and dynamic comfort, static comfort and seat geometry, adjustment characteristics, related to physical characteristics, dynamic comfort is mainly related to vibration characteristics [1]. The main three damping parts of the harvester vibration system are tires, harvester suspensions and seats. The study found that changes in the performance parameters of the tire and harvester suspension affect other relevant performance of the harvester, while the dynamic parameters of the seat change. There is no impact on the other relevant performance of the harvester, so researching and improving the dynamic performance of the harvester seat can greatly enhance the comfort of the harvester ride.

2. Introduction of the harvester seat

Vehicle seats are generally divided into two types, one suspension type, one non-suspension type, the suspension type is mostly used for engineering vehicles or commercial vehicles, and the non-suspended type is mostly used for cars. The harvester seat is mostly suspended. As an important part of the harvester's interior, it is a system engineering product integrating ergonomics, mechanical vibration, mechanical analysis and control engineering. The harvester seat emerged along with the birth of the harvester. From the simple wooden wool structure at the beginning to the now sophisticated high-end seats with various functions, it is moving towards safety, comfort, beauty and lightness. At the same time, more and higher requirements were put forward for seat design and researchers. In recent years, the comfort of the harvester seat has become the focus of attention.
The harvester seat is generally composed of a headrest, a backrest, a seat cushion, a seat frame (as shown in Fig. 1), a seat connecting member and some adjusting mechanisms, as shown in Fig. 2, wherein the backrest and the seat cushion are generally made of a foaming sponge. Plus the seat skin is composed. The foaming sponges are generally foamed with high-rebound polyurethane. The foams obtained from different formulas have different physical properties, which affects the comfort of the seat to a certain extent [2]. The seat frame supports the entire seat and is the basic structure of the seat. It includes the headrest frame, the backrest frame and the seat cushion frame. The strength of the seat frame is the guarantee of seat safety. It is usually made of rolled profiles (steel pipes, steel bars) or welded with steel stampings. The back frame and seat cushion frame are assembled by seat joints. The adjustment mechanism of the seat includes a recliner, a lift, a slide rail and the like [3]. The recliner is installed between the backrest frame and the seat cushion frame, and the rider can adjust the comfortable backrest angle suitable for the rider; the lift is generally located on the seat cushion [4]. Below, adjust the up and down position of the seat; the slide rail is installed at the bottom of the seat to adjust the front and rear position of the seat and the body for the driver's operation [5].

3. Seat comfort analysis

3.1. Establishment of a human body model

The establishment of human body models is a necessary step in ergonomic design. Many software’s provide human body model libraries. The AnyBody software developed by the biomedical engineering research team at Aalborg University in Denmark can simulate human body interactions. Changes in indicators. The products of Assault in France, CATIA software also developed the ergonomics design and analysis module, which can greatly facilitate the design and development of designers, which greatly shortens the design cycle of designers. This article uses CATIA software to reference the human body model. First select the Optional option under the New Manikin command, then select Chinese in the population option, then select different genders in the Manikin option, and select 50 for the Percentile option (where 50 represents the average). As shown in Figure 3 and Figure 4.
The male and female models are built as described above, as shown in Figure 5. After setting up the human body model, select the New Package command to generate the steering wheel, seat and foot pedal diagrams, and use the Occupant Posture Prediction command to match the two together. Figure 6 shows the assembled model diagram. The angle of the joint is a comfortable angle for the human body, which can effectively alleviate the fatigue in a long sitting position, and needs to be considered in the process of seat design.

### Figure 5. Human body model diagram

### Figure 6. Suitable sitting angle

#### 3.2. A subsection

The dynamic comfort of the seat is mainly related to the stiffness and damping of the seat. The stiffness and damping of the existing seat are respectively $k = 100 \text{N/mm}$, $c = 5 \text{N\cdot s/mm}$, In order to obtain the frequency response characteristic curve of the suspension seat, a sinusoidal scan of 0-20 Hz is input to the suspension seat system model by SWEEP function in the ADAMS, and the equation (1) is SWEEP function. The input and output are time domain signals, and the time domain signal is subjected to FFT transformation to obtain a frequency domain signal.

$$\text{SWEEP}(x, \ a, \ x_0, \ f_0, \ x_1, \ f_1, \ dx)$$

Where: $x$ is the action time; $a$ is the angular velocity amplitude; $x_0$ is the start time; $f_0$ is the scan start frequency; $x_1$ is the end time; $f_1$ is the scan end frequency; $dx$ is the simulation iteration step size.

Observe the different effects of the two factors on seat comfort by changing the stiffness and damping parameters of the seat separately. In order to study the influence of two factors on the comfort of the seat, the control variable method is adopted to first keep the damping of the suspension seat unchanged $c=5\text{N\cdot s/m}$, change the stiffness of the seat, set the different $k = 60\text{N/mm}$, $80\text{N/mm}$, $120\text{N/mm}$, $140\text{N/mm}$, $160\text{N/mm}$ respectively, and different parameters to the seat acceleration. The simulation results are shown in (a1), (b1), (c1), (d1), and (e1).
When the suspension seat is not damped and the stiffness changes, the peak results of the acceleration of the seat dynamic simulation are listed in Table 1.

| Suspension damping N·s/mm | Suspension stiffness N/mm | Frequency Hz | Acceleration peak mm/s² |
|---------------------------|---------------------------|--------------|-------------------------|
| 5                         | 60                        | 3.2          | 0.78                    |
| 5                         | 80                        | 3.2          | 0.90                    |
| 5                         | 120                       | 3.2          | 0.99                    |
| 5                         | 140                       | 3.2          | 1.10                    |
| 5                         | 160                       | 3.2          | 1.20                    |
Keep the stiffness of the seat constant $k = 100\text{N} \cdot \text{s}/\text{mm}$, adjust the damping of the seat $c = 2.0\text{N} \cdot \text{s}/\text{mm}, 3.0\text{N} \cdot \text{s}/\text{mm}, 4.0\text{N} \cdot \text{s}/\text{mm}, 5.0\text{N} \cdot \text{s}/\text{mm}, 6.0\text{N} \cdot \text{s}/\text{mm}$. The simulation results are shown in (a2), (b2), (c2), (d2), (e2), and (f2).

When the suspension seat stiffness is constant and the damping changes, the peak results of the acceleration of the seat dynamic simulation are listed in Table 2.
Table 2. Acceleration peak of the seat when the damping changes

| Suspension damping N·s/mm | Suspension stiffness N/mm | Frequency Hz | Acceleration peak mm/s² |
|---------------------------|---------------------------|--------------|-------------------------|
| 2.0                       | 100                       | 3.2          | 1.49                    |
| 3.0                       | 100                       | 3.2          | 1.23                    |
| 4.0                       | 100                       | 3.2          | 1.15                    |
| 5.0                       | 100                       | 3.2          | 1.08                    |
| 6.0                       | 100                       | 3.2          | 0.91                    |

4. Conclusion

It is not difficult to find from the simulation results that when the damping of the seat suspension is constant, the acceleration of the seat increases as the stiffness of the suspension increases; when the stiffness of the suspension does not change, the acceleration of the seat follows The damping of the suspension is increased and decreased; but in practical applications, the stiffness cannot be reduced or the damping does not change much when the damping is taken

- 3N·s/mm
- 4N·s/mm
- 5N·s/mm

It can be seen from Table 2 that, in the case of keeping the stiffness constant, the acceleration of the seat does not change much when the damping is taken

- 3N·s/mm
- 4N·s/mm
- 5N·s/mm

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