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A New Active Type of Collision Energy Absorbing Equipment*

CAO Li-bo , XIAO Zhi

(College of Mechanical & Automotive Engineering, Hunan University, Changsha 410082, China)

Abstract: During the course of vehicle impact, the impact energy is absorbed by vehicle body deformation. Because the deformation length is limited by the living space for the occupants, the impact force will be too large for vehicle and occupants to endure. This paper presented a new active type of collision energy absorbing equipment. This equipment can stretch out the energy absorbing section and the bumper in front of the automobile when collision is unavoidable . The collision force can be effectively controlled with the extended deformation length during crashes. So, the damage of the automobile and the force act on the occupants can be significantly decreased.

Key words: active type; collision; energy absorbing equipment

1 Introduction

Various energy-absorbing equipments used in some vehicles today to absorb collision energy by deforming when the collision takes place. For this kind of energy absorbing equipment fixed on automobile, the collision force may be very great if the deformation of the automobile body to be controlled within limited energy absorbing length. The supporting structure usually can't bear it. On the other hand, in order to decrease collision force, the deformation space must be increased, which makes automobile design more difficult. So, the energy-absorbing equipments used in vehicles today is difficult to obtain better energy-absorbing effect and the vehicle body will be badly damaged unavoidable, and passengers willffer great collision load.

The new type of energy-absorbing equipment presented in this paper will put forward the bumper and the energy-absorbing section when it examines the unavoidable collision. The collision force can be well controlled because the energy-absorbing equipments have large deformation space, which helps to decrease the damage of the vehicle and the collision load on the passengers. So, both the vehicle and passengers are proected. This kind of equipment has a simple structure and low cost. It is therefore valuble for widely using in new vehicle design.

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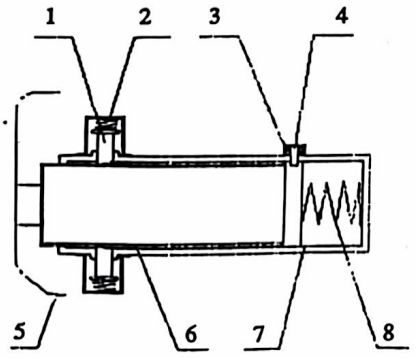
2 Structure and Working Mechanism

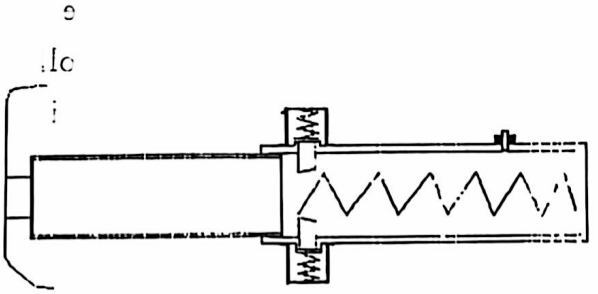
The vehicle collision process is a process transforming the mechanical energy to deformation energy and other types of energy. According to formula (1), if the kinetic energy is determinate, the work(W) which added on the vehicle is determinate. To decrease the collision force(F) and the acceleration the passengers endured, the action distance (S) of the collision force must be increased.

$$W=FS \tag{1}$$

In the ordinary automobile body design, designers must ensure the front part of vehicles absorb energy as much as possible and limit the force and acceleration act on the passengers in regulated range when the front collision happens. This will make it difficult to prevent engine and gear-box invading into passenger compartment and will lead to great damage of vehicle body and other structures in front of vehicle. So, deformation space must be increased in front of vehicle to decrease collision acceleration and prevent over great damage of vehicle body.

Usually, many collision accidents occurred not because the drivers have not found the barrier in front of their automobile completely, but because it's too late for them to brake or take other measures to prevent the collision. Hence, if the deformation space can be increased in a short time when the control system has detected the driver's urgent brake which usually taken by the driver when they find the barrier, energy-absorbing effect will become much better.





1. bounding poles 2. spring 3. electromagnet 4. bolt 5. bumper
6. energy-absorbing columns 7. shell 8. impel device (spring)

Fig. 1 Working mechanism figure of the active type of energy-absorbing equipment

Several shells (7) are fixed on the vehicle body or carlings, energy—absorbing columns (6) are assembled within the shells, sections of columns and shell can be designed as rectangle、rotundity and other polygons which can make the intension and the energy-absorbing effect of columns perfect. The front extreme of column connect with bumper (5), and the other extreme connect with Impel device (8). The impel device

(8) is located between the bottom of column (6) and that of the shell (7), and can impel the column and bumper (6) at the moment just before collision to increase the vehicle deformation distance. The impel device can be designed as spring or gas-generating device. The gas-generating device explodes and generates gases to impel column (6) before collision. A hole in the back end of column (6) accords with the hole in the shell (7), bolt (4) inserted in the two holes can be pulled out by electromagnet (3). Two or more bounding poles (1) are put on the shell (7) and each connects with a compressed spring (2). Ordinary, as in figure 1(a), column (6) is installed in shell (7), bolt (4) is inserted in the holes in shell (7) and column (6) which makes column (6) cannot move in shell (7). When driver takes urgent brake before collision happening, the vehicle will suffer great acceleration, and the control system will detect it and send command to the electromagnet (3). The electromagnet (3) will be electrified, bolt (4) will move upward and be divorced from columns (6) and shell (7). At the same time, the compressed spring (2) will push out the bounding pole (1) to let the bounding pole prevent column (6) move backward, shown as figure 1(b). In this way, the part of column pulled out can provide large deformation distance. It drapes, absorbs collision energy to protect vehicle and passengers when collision happens. This kind of equipment can provide large energy absorbing distance, decrease collision acceleration, increase energy absorbed by deformation and ensure the living space for passengers.

3 Energy-absorbing Performance of Thin Walled Columns

Thin walled columns are made of thin steel plate (thickness: 1～2mm), the section shape can be rectangle, rotundity and other polygons. Researches make it clear that the thin walled column with rotundity section has better energy—absorbing effect.

By the careful design of the configuration parameter of thin walled columns, the deformation state of the thin walled columns can be well controlled in collision process, so the accceleration of the vehicles can be controlled in an ideal condition. Acceleration curve of one kind of vehicles in front collision without accessional energy-absorbing equipments is shown as figure 2. Another vehicle with thin walled columns to absorb energy is shown as figure 3. It can be seen that with the columns to absorb energy, the collision acceleration of vehicles will become flatter and the acceleration peak value decreased, which is an ideal state for passengers.

We also analyzed energy — absorbing process of columns with various section shape, thickness using LS — DYNA analysis software, acquired the parameters of columns demanded by various vehicles, as shown in Figure 4 and 5.

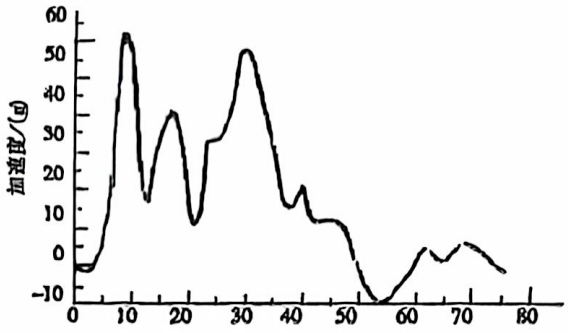


Fig. 2 Without energy-absorbing equipments

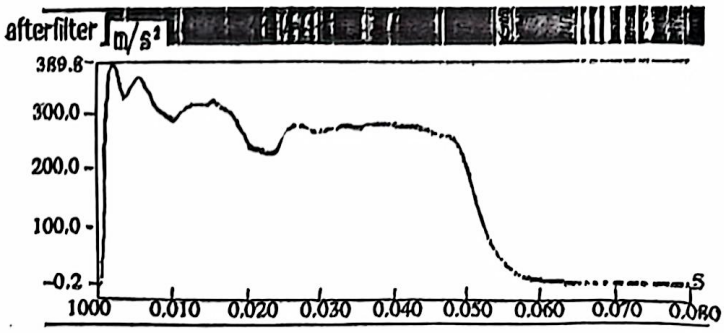


Fig. 3 With energy-absorbing equipments

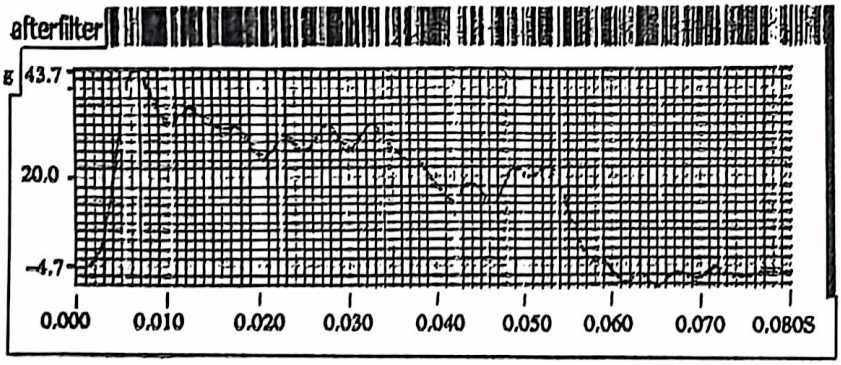


Fig. 4 Acceleration curve of the sled with square section thin wall energy absorbing column

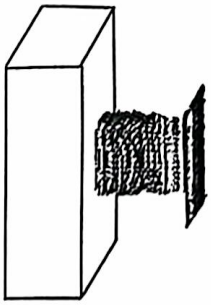


Fig. 5 Finite element analysis result

4 Conclusion

The new active type of collision energy absorbing equipment decreases the collision acceleration to protect passengers through increasing the deformation space. It can also minimize or avoid damage to the vehicle body when collision happens through using the equipment to absorb much collision energy.

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