

## Research and Design of Elevator Car Airbag

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**Keywords:** The elevator car; the elevator downhill; Airbag.

**Abstract.** The elevator has being went into people's life for 158 years. With the development of the society, High-rise buildings appear constantly, the use of the elevator is more frequent. Although the elevator safety devices is relatively complete, but there is no any safety measures within the car. So, once the elevator in the downhill, the passengers in the elevator will withstand considerable impact.

### Introduction

According to China Elevator Association's statistics, the past three years the annual sales of the country elevator has more than 180,000 units. As the end of 2010, china the number of elevators to reach 1,628,000 units at a speed of about 20% per year growth. Annual increase of the number of elevators in more than 300,000 units, accounting for more than half of the world 's total annual new elevator.

Elevator is a special equipment nominally, but be closely related to people's live, and safety requirements for high performance. Therefore, we have an idea that design an safety device used to elevator car interior, in order to reduce casualties and improve the safety factor for passenger elevator.

### Structure and Main Malfunction of the Elevator Car

**Specific Structure Of The Elevator Car.** Elevator car is divided into the car body, car frame, weighing devices, the car is used to transport passengers and cargo carrier directly. Because direct contact with a passenger car components, so inside the car measures directly affect the safety of passengers.

**Main Malfunction of the Elevator.** Elevator as an important part of the building, is an important vertical transport for people living offers many convenient. But in providing convenience, security to be provided is essential.

The current of the elevator car safety problems, combined network and field research data, final results of the existing elevator safety issues mainly to lift the most serious downhill. Mainly refers to the case when the elevator car is still inside the passenger from the elevator control system and the control system for the drive suddenly downhill, then suddenly stops or directly landed at the bottom of the well in the role of safety gear and the governor of.

Protection of existing elevators although more, but for the passengers themselves did not (inside the elevator car). In recent years, there were so many of elevator accidents, especially downhill event in the national news. Downhill got passengers in a great of safety, but in the protection of existing elevators in the elevator did not protect passenger's downhill squadron.

### The Airbag Device of the Elevator Car

**Airbag Material.** According to existing airbag's research, airbag is normally made of a module cover, air bag and a gas generator. In the bag that the airbag material we can know it is composed of outer fabric and lining coating. But in this study, which used must meet the requirements of high temperature resistance, airtight, tough, good tensile, impact resistance and friction etc. By Yanhong Yang and Zhiwei Wang<sup>[1]</sup> ET at study on the air cushion as the breakthrough point, it is a film in

which the air-cushion high frequency thermoformed PVC film filled with nitrogen, at the same time it also uses multilayer polyethylene thin film with high strength and abrasion resistant nylon cloth as surface material cushion. However, this film is susceptible to the surrounding air cushion temperature expands and contracts and applies only to light a small cushion packaging , in the present study clearly does not apply to the balloon material.

As for the coating there are generally two kinds of coating on the market, Chloroprene Rubber Coating and Silicone Coating. Silicone Coating is suitable for reasons that its chemical properties are not active and it isn't easily affected by environment (high temperature) and also has good abrasion resistance. So we mostly choose Silicone Coating as the material of airbag in the development of the airbag lately. In Jingang Wang's research for automobile safety airbag material, Silicone Coating has a low friction coefficient and good short-term thermal resistance, in the other words it can be painted a very thin and keep being in good lubrication and heat resistance on the airbag fabric. The airbag painted a silicone coating can be recycled so Silicone Coating is better than Chloroprene Rubber Coating.

Next is a fabric. The airbag material of "Mars" is a silicone coated Vectran fabric, which uses an air bag fabric coated layer to save gas, multilayer structure outer is helpful in wear, puncture proof and anti-tear. This balloon material has a high tensile strength, tear strength, the balloon inner surface of the can to withstand high loads and is not torn or pierced with the landing surface of the collision and contact friction. Because in an elevator during downhill balloon man is bound to be squeezed and the bottom of the elevator car, so we shall choose the fabric that can withstand the internal load and be tensile.

More choice in terms of research and reference materials in accordance with airbags Vectran fabric coated with silicone. Be plated on the surface of the bottom of the elevator car, while a certain weight is placed thereon slip resistant carpet to ensure that passengers using the elevator will not damage the bag tread, while the carpet in a certain weight of the bag can bounce when a balancing role play. Vectran fabric could ensure doesn't occur to rupture by the pressure of people stand on and the supports strength of elevator car bottom when it bounce. The silicone coating keep the gas in the airbag away from passengers if gas leak.

**Gas Generator.** According to expert estimates if the airbag popularization rate close to 10%, 15,000 passengers will survive in the elevator accident a year. The Chinese government attaches great importance to the development of airbag. In 1995 airbag series are included in the development of China's auto parts and formulated the corresponding development strategies and policies and measures. At the same time China government had issued a safety regulations of car crash. This elevator airbag generator and drug can be reference to automobile airbag based on national patent number according to the Zhibo Ye and Kuijun Zhou's study of automobile airbag gas generator. Gas generator is arranged in the center of the elevator car bottom and cause nothing because the elevator is a steel frame structure. Specific as shown in Fig 1 and Fig 2.

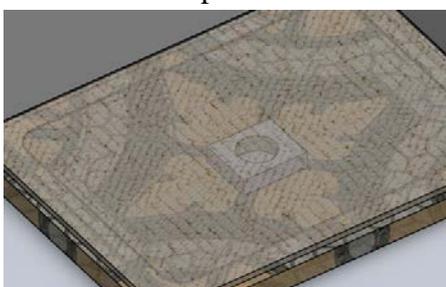


Fig. 1 gas generator

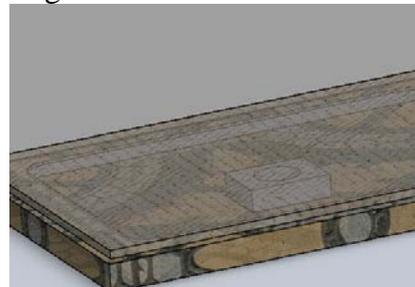


Fig. 2 gas generator

As we know. Elevator running speed in low speed, low speed and high-speed elevator. Different speed capsules downhill time limit line speed is different also. In general resident buildings, office buildings and shopping **malls** the speed is 1.75m/s. we would get hurt when it going to 6m/s. Assuming that the distance averaged of the elevator downhill only one or two floors is roughly 5m ( $g=9.8m/s^2$ ), regulating that when the speed is more than 4m/s the sensor signal to ignition, and

ignition is working and arm reminding. Via calculating it takes a few seconds that the elevator downhill to scram. It takes about 35ms that the airbag fully expanded.

**Preliminary Design Diagram.** The airbag was tiled on the bottom of the elevator and there is a layer of wear-resistant anti-skid carpet above it (At the same time as a balancing means when balloon bounce). Fig. 3 show the airbag unopened, the **translucent** one is a layer of rice white linen carpet in above the airbag, the transparent is the airbag cover bags and its components and airbag gas generator is set below it( Here are all transparent should the desired effect , the effect is not the entity).

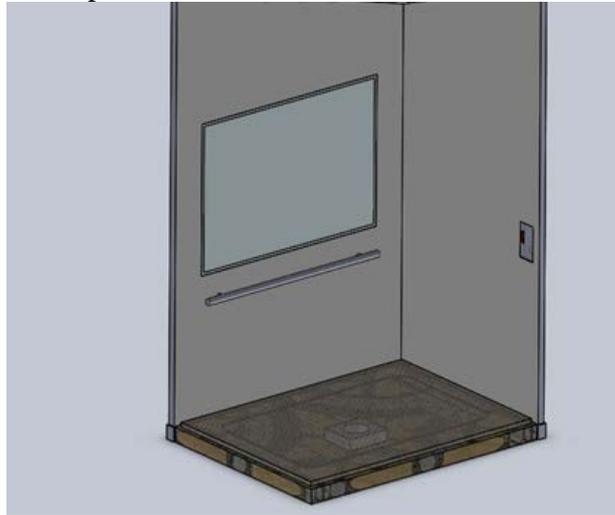


Fig. 3 unopened airbag

However notches airbag principle is that put gas generator below the bottom of the elevator and the airbag was tiled on the bottom based on automobile safety airbag. When the elevator is in the downhill and so on, airbag will bounce off (shown as Fig. 4 and Fig. 5) and shore up so passengers will not be impacted in the larger strength, and airbag and its components do not leak gas.

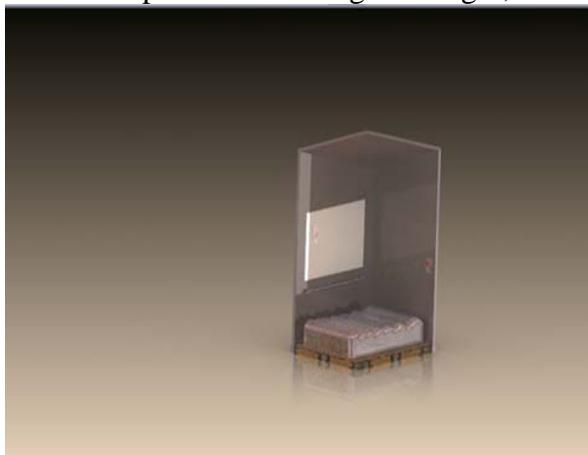


Fig. 4 notches airbag

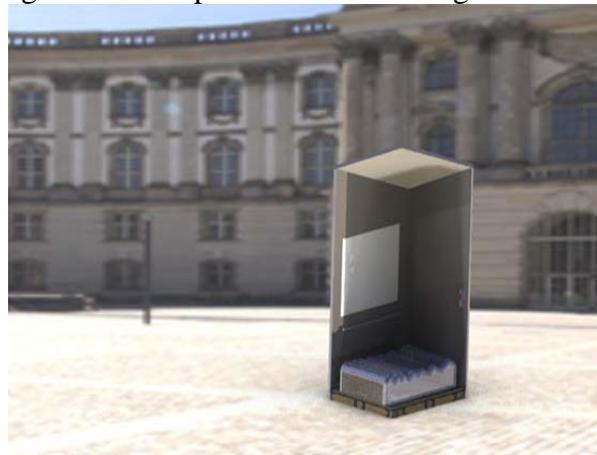


Fig. 5 notches airbag

Beside of a safety airbag hammer, in order to prevent occur to circuit fault setting a line. Pushing the red switch away by a certain thrust and press the red button (shown as diagram 2.5) to make the airbag pop up when happen to accident. This switch is not easy to change by children, which would prevent them turn it on accidentally.

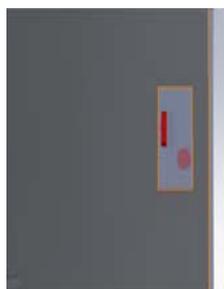


Fig. 6 the switch

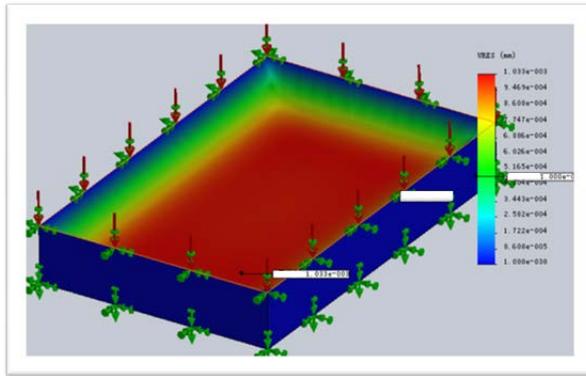


Fig. 7 the stress analysis diagram

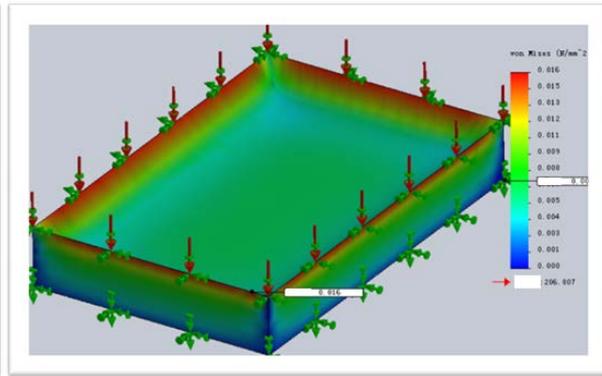


Fig. 8 displacement analysis diagram

After the model is completed, we continue to use the software (solid works) for finite element analysis of the late. the data obtained show that the airbag will occur deformation and displacement when the device get pressure generated by the above. The central part's displacement( $1.033e-0.03$ ) is the largest but it is still less than the height of the air sacs(30~40cm).

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