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THE SIMULATION OF ONE SIDE OF TETRAHEDRON AIRBAGS IMPACT ATTENUATION SYSTEM

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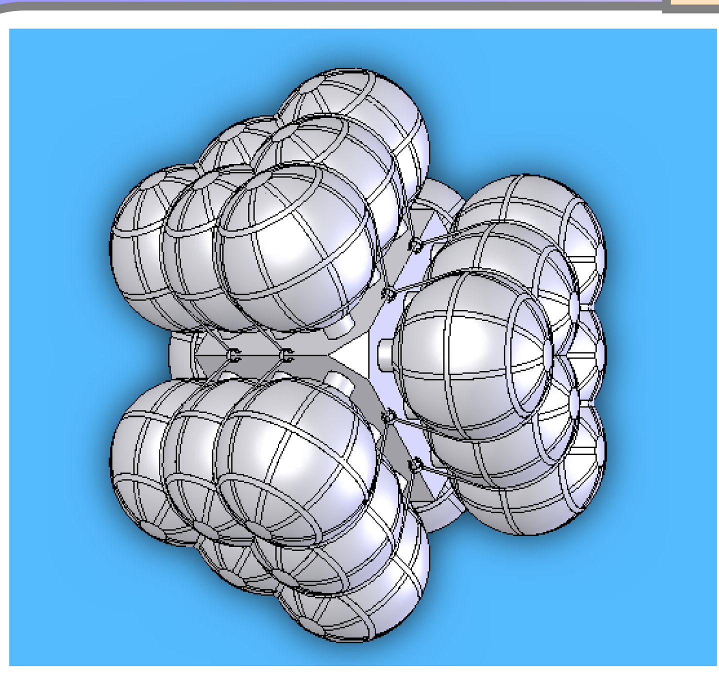
CONTEXT & OBJECTIVE

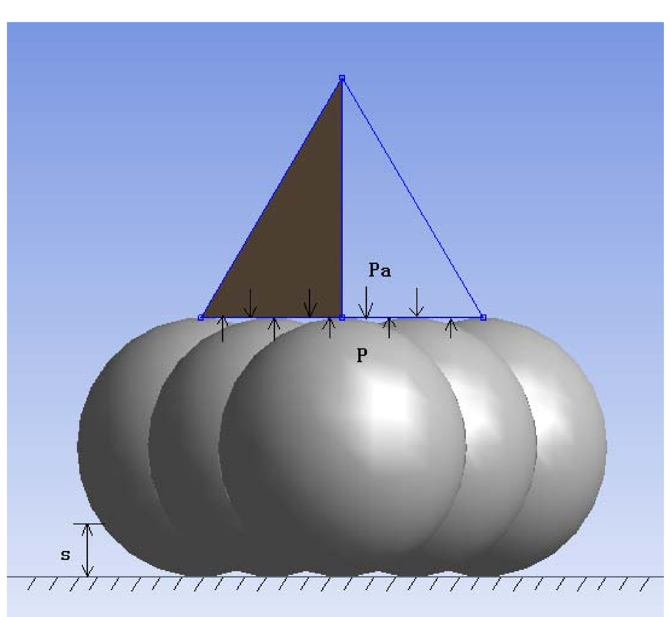
Airbag for the landing attenuation is a branch of the aircraft recovery systems which are often used in the aerospace and planetary probe. Mars Pathfinder mission, Mars exploration rover (MER) mission and Mars express program successfully using airbags had proved that airbag system was a simple and dependable attenuation equipment.

As a passive attenuation used in landing, airbag is mainly made up of fabric with all kinds of shape according to design requirement. The airbag operation process is as follow. At the beginning, the airproof airbag is inflated to the working pressure which is expected. In the attenuation phase, along with the airbag is compressed, the internal pressure of the airbag raise. At the same time, the energy is absorbed step by step, and the lander is cushion decelerated. In the operation process, closed airbags are not exhaust, and bounce time after time to dissipate the impact energy. Closed airbags are mainly used in the planetary probe.

This paper simulated the characteristic of one of four sides of a tetrahedral lander with airbags impact attenuation system, and got the effect of attenuation characteristic with the diameter of the gas orifices between the airbags. According to the given condition, the better diameter of the gas orifices was selected, and some improved design was brought forward, which the design of the closed airbags could base on.

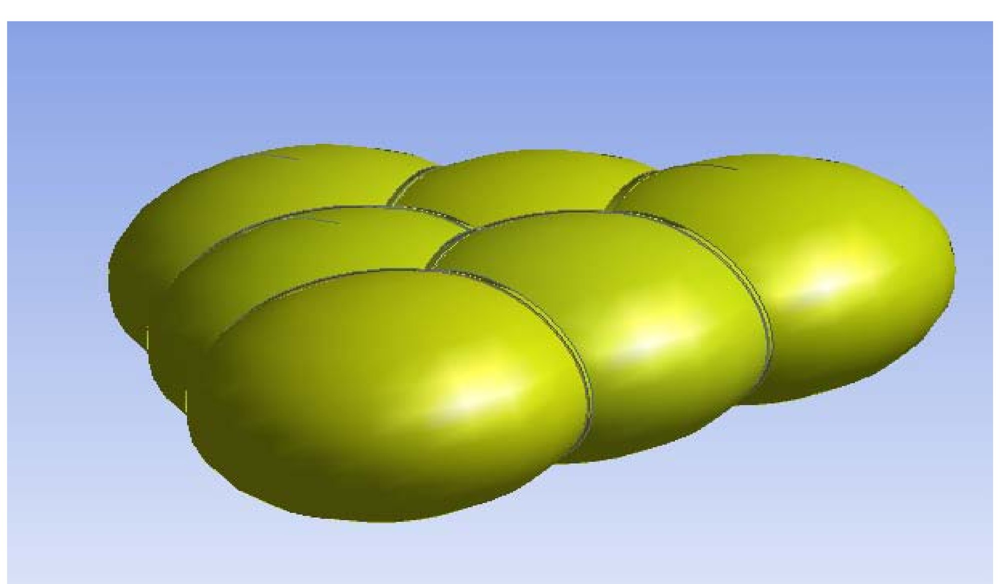
MODELING





ASSUMPTION

1. **Face impact;**
2. **Extrusion in the vertical direction;**
3. **Ideal gas.**



EQUATIONS

$$m \times a + m \times g + Pa \times A = P \times A$$

$$a = \frac{P - Pa}{m} \times A - g$$

$$u = u_0 + \int a \cdot dt$$

$$s = \int u \cdot dt$$

$$V = f(s)$$

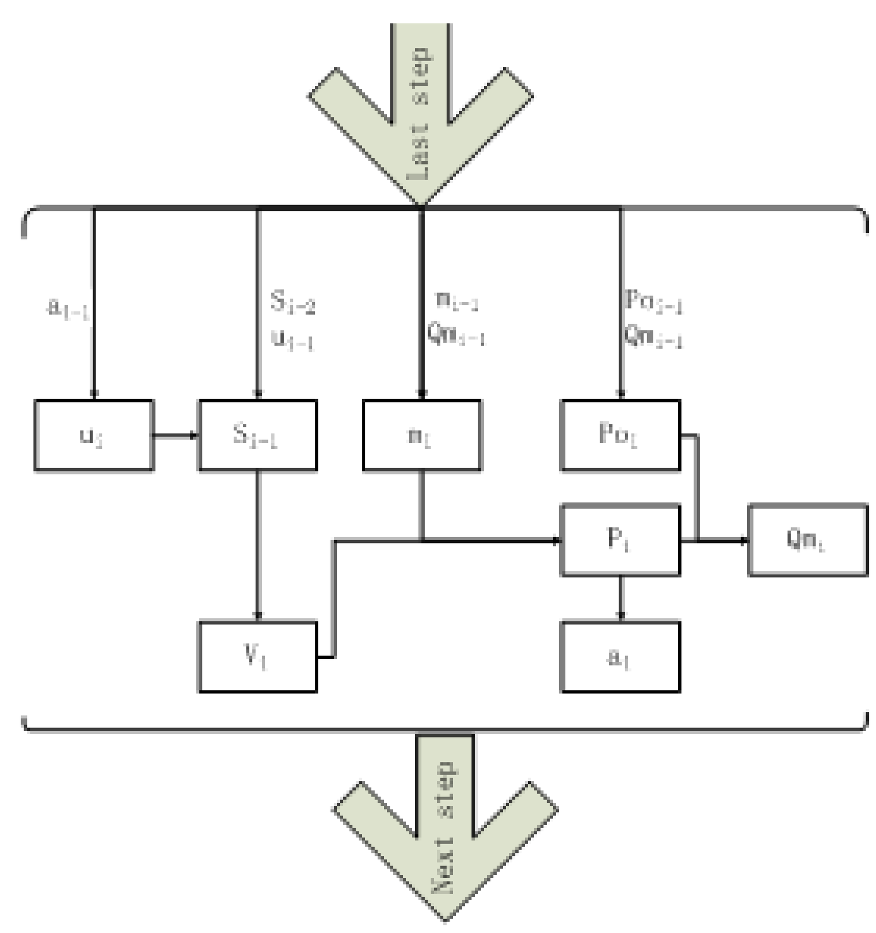
$$m = m_0 - \int Q_m \cdot dt$$

$$P = C \times \frac{m}{V}$$

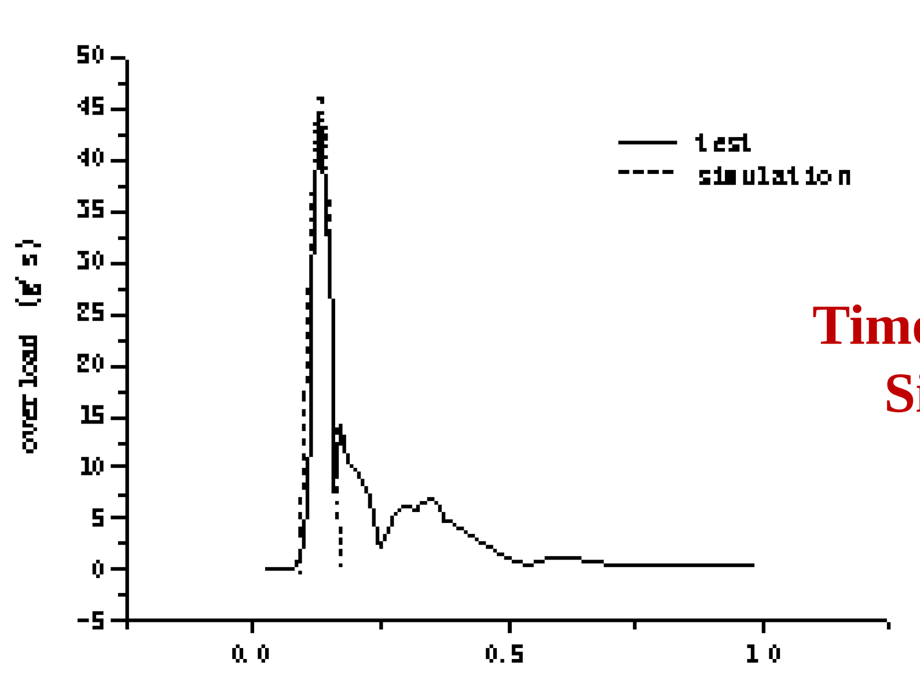
$$Pot = P_0 + \frac{C \times \int Q_m \cdot dt}{3 \times V_n}$$

$$Q_m = \frac{P \times S}{C} \times \left(\frac{Pot}{P}\right)^{\frac{1}{k}} \times \sqrt{\frac{2 \times k}{k-1} \times c \times \left[1 - \left(\frac{Pot}{P}\right)^{\frac{k-1}{k}}\right]}$$

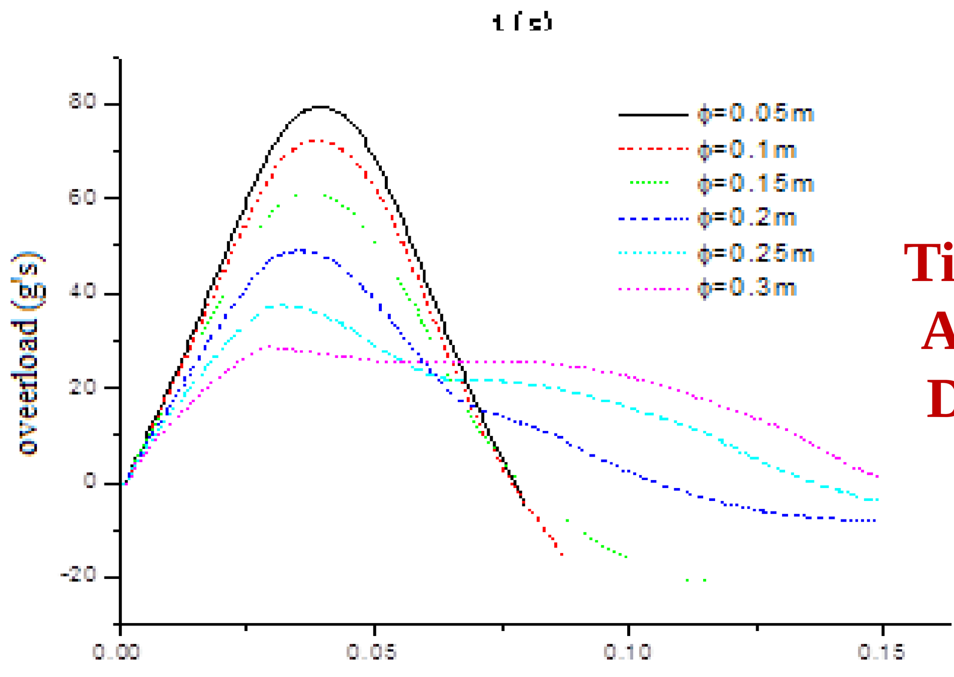
ITERATION



RESULTS 1



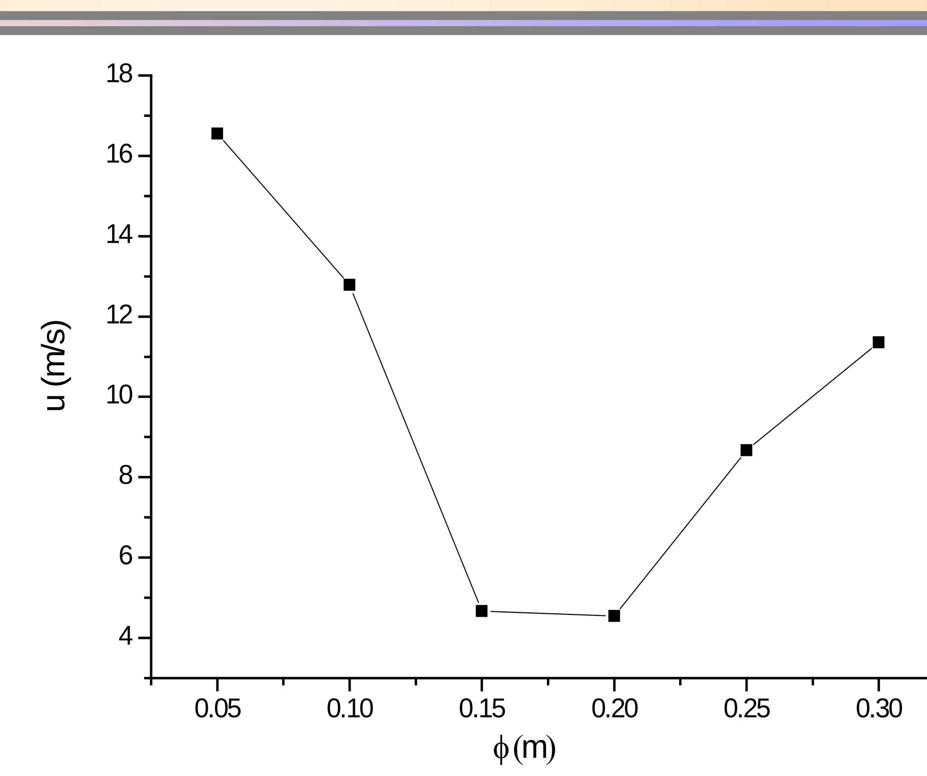
Time Domain Curve of the Simulation and Test



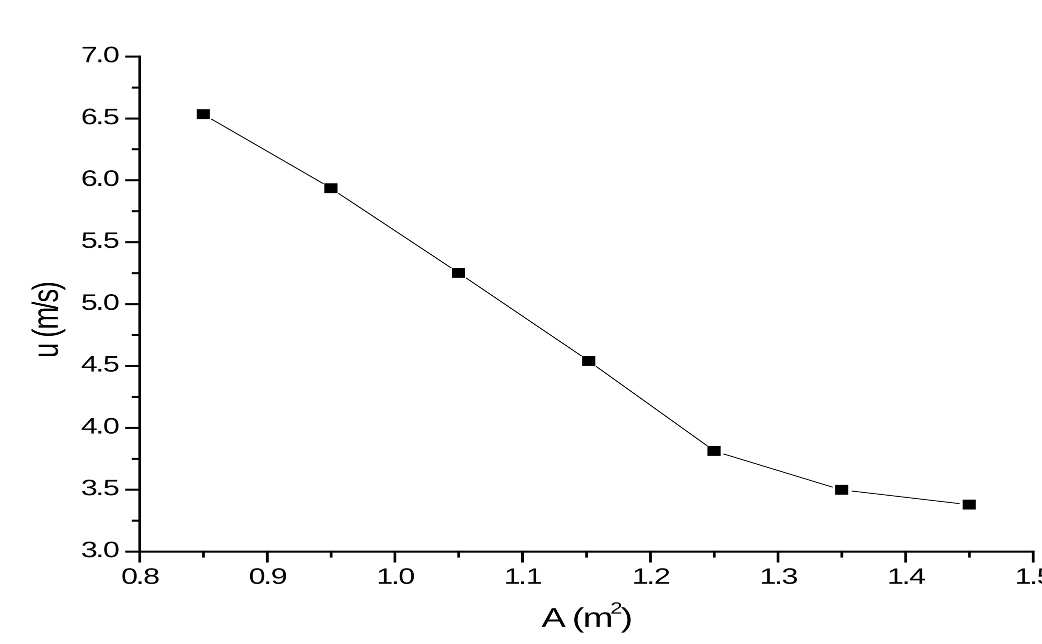
Time Domain line of Airbag Overload with Different Diameter of Air Orifice

RESULTS 2

Rebound Velocities at Different Diameter of Gas Orifices



Rebound Velocity at Different areas of Airbags Face



CONCLUSION & OUTLOOK

- **the increasing diameter of gas orifices would reduce the maximum overload, defer the attenuation process, and smooth the change of internal pressure and acceleration.**
- **the proper diameter of gas orifices would reduce the rebound velocity and increase the dissipative energy in the attenuation process.**
- **the initial differential pressure has a little effect on the attenuation characteristic.**
- **the decrease of area would reduce the maximum overload, but increase the rebound velocity.**

The simulation of this paper introduced some assumptions that would restrict above conclusions. The farther research will be independence from some assumptions, and focus on edge impact and point impact.