

A Study on New-type High-Overload Loading Technology Based on Stress Wave Propagation under the Impact of Air Explosion

Wanjun Wang

China Academy of Engineering Physics

E-mail: wangwanjun@caep.cn, Tele: +86-15681915620

1. Introduction

2. Outline of the Method

3. Experiment and Discussion

4. Finite Element Simulation

5. Future work

6. Acknowledgement

1. Introduction
2. Outline of the Method
3. Experiment and Discussion
4. Finite Element Simulation
5. Future work
6. Acknowledgement

1. Introduction

- High overload in penetrating will lead to failure of projectile-born devices, such as fuze, detonator, and other electron device.
- In order to reinforce the projectile-born devices, it is necessary to study the failure mechanism caused by high overload during penetrating.
- Numerical simulation is unusable in most cases because of the structural complexity of the devices.
- Existing experiment method, such as Split Hopkinson Bar, Light-Gas Gun, Machete Hammer, etc. is limited because the peak magnitude and duration of the acceleration is insufficient compared with that in real penetrating.
- A new-type indoor method for high overload loading is proposed in this presentation, which is characterized by high peak acceleration, long duration, high efficiency and low cost.

1. Introduction

2. Outline of the Method

3. Experiment

4. Result and Discussion

5. Future work

6. Acknowledgement

2. Outline of the method

- The proposed method is based on a viewpoint that devices failure during penetrating is due to the stress wave propagation.

- In case of structure impact by high pressure and high velocity explosion product, the propagation of stress wave in the structure is similar to that in penetrating.

- Cylindrical LLM-105 explosive is used. A specific structure containing a sample is impact by the explosion product in this presentation.

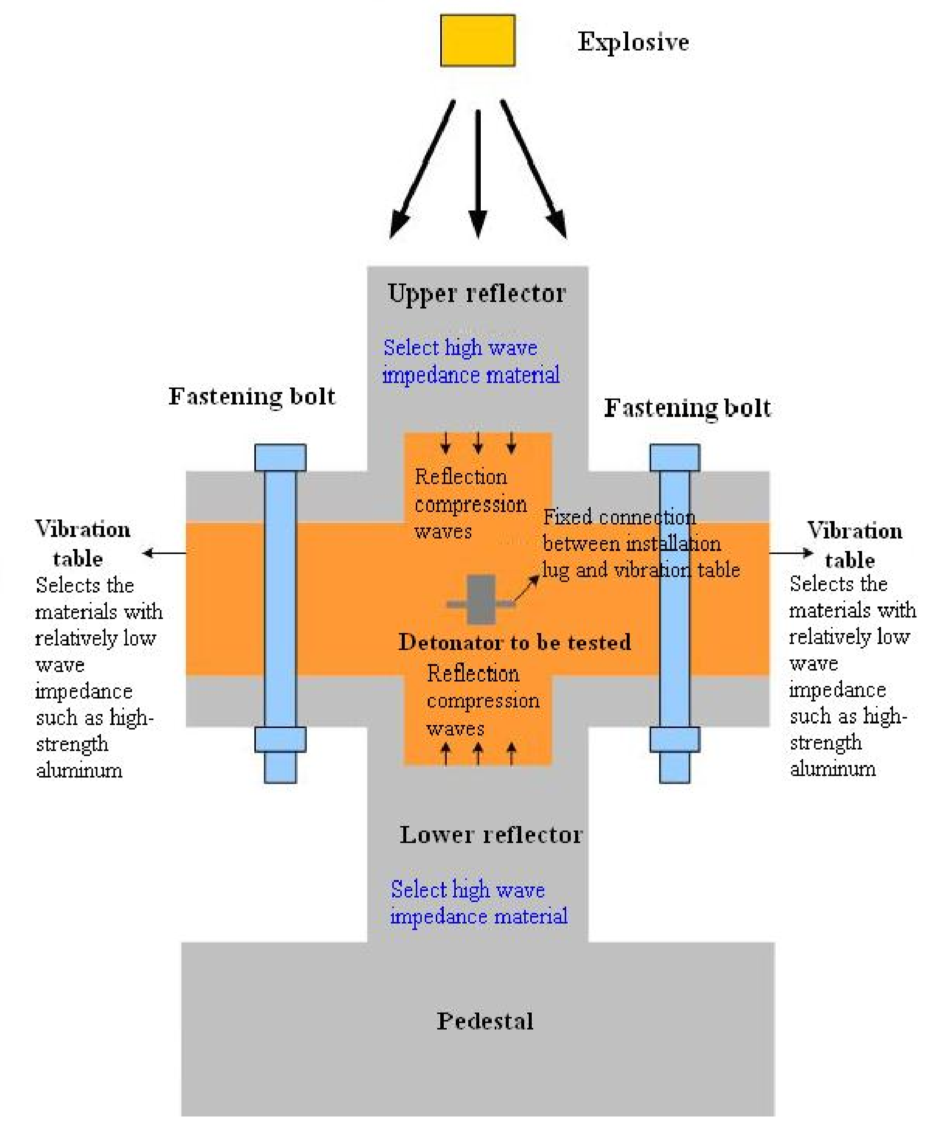

Fig.1 Schematic of the proposed method

1. Introduction

2. Outline of the Method

3. Experiment and Discussion

4. Finite Element Simulation

5. Future work

6. Acknowledgement

3. Experiment and Discussion

- The experiments were conducted indoor. A structure as shown in Fig.1 was impact by explosion product. Φ40mm×23mm LLM-105 explosive was used and initiated by a 8# detonator.
- The explosive was 500m, 400mm and 300mm away from the structure, respectively. An acceleration sensor was fixed by two M2 bolts inside the structure, as shown in Fig.3.
- No plastic deformation happens in the structure, so it can be reused for many times.

Fig.2 Experiments arrangement

✓ Bottom of the sensor was lef t blanket, in order to protect th e sensor from the impact of str ess wave.

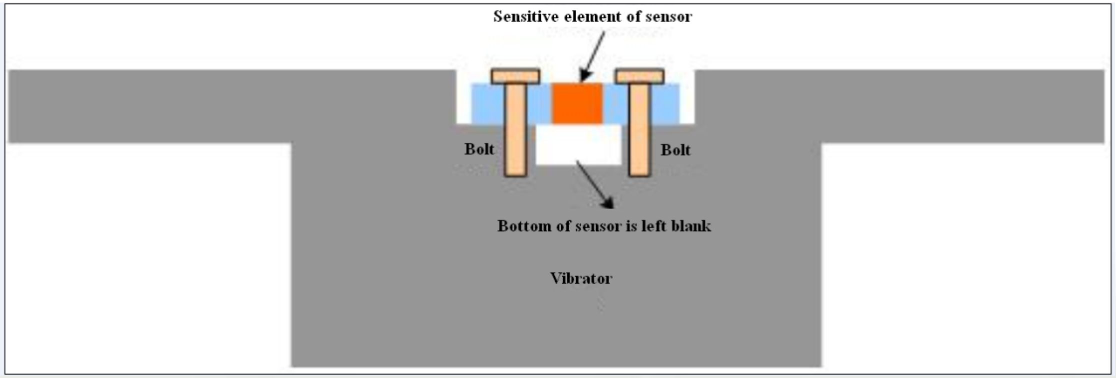

Fig.3 Schematic of the installation of the sensor

3. Experiment and Discussion

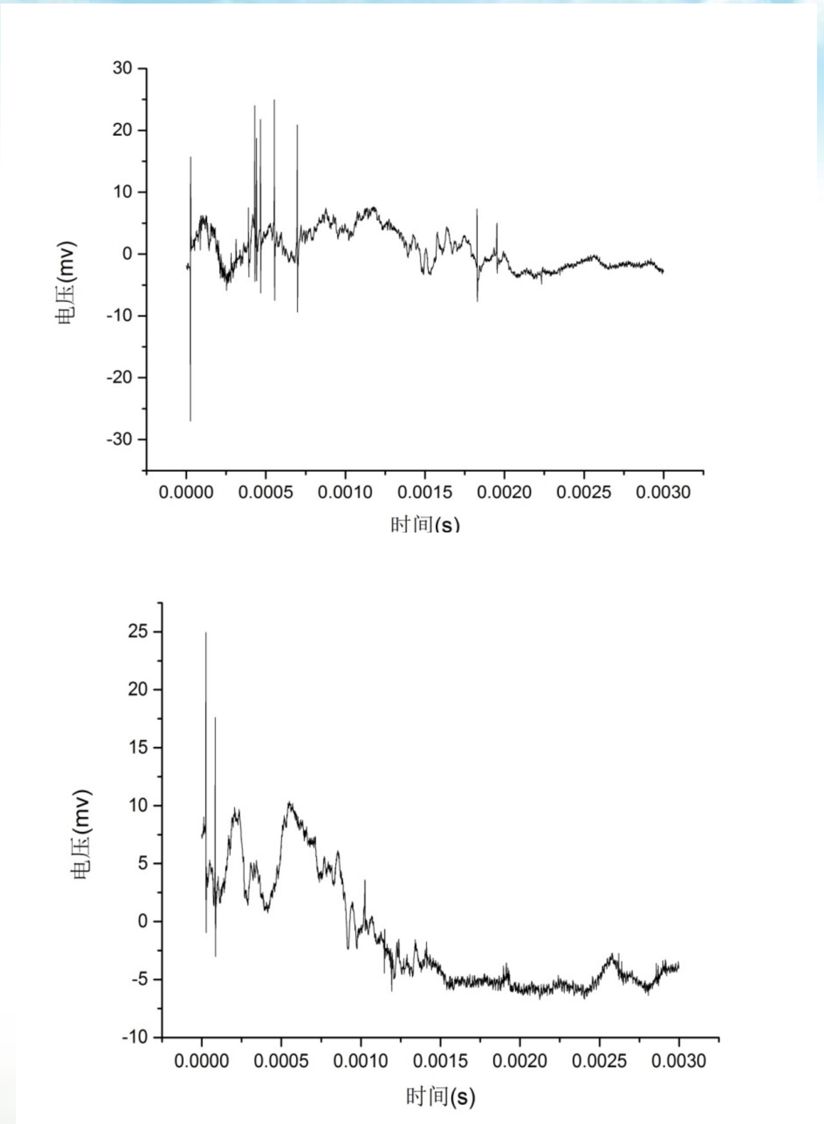

Fig.4 Typical Voltage Signal in Experiment

- Typical voltage signal from experiment is shown in Fig.4. The voltage signal can be translated into acceleration if the sensitivity of the sensor is given.
- In the case of explosive 400mm away from the structure, the peak acceleration was 33000g, while the duration is 1.5ms.
- The peak acceleration could be even higher if the distance between the explosive and the structure was shorten.
- The overload level in real penetrating could be achieved without difficulty by changing the distance between the explosive and the structure, or the size of the explosive.

1. Introduction
2. Outline of the Method
3. Experiment and Discussion
4. **Finite Element Simulation**
5. Future work
6. Acknowledgement

4. Finite Element Simulation

• In order to reveal the mechanism of the acceleration history, a finite element simulation with LS-DYNA code was conducted.

• From the simulation, we can conclude that both the shock wave in air and the explosion product contribute to the acceleration.

• It is clear that the stress wave reflection at the material interface will influence the acceleration history.

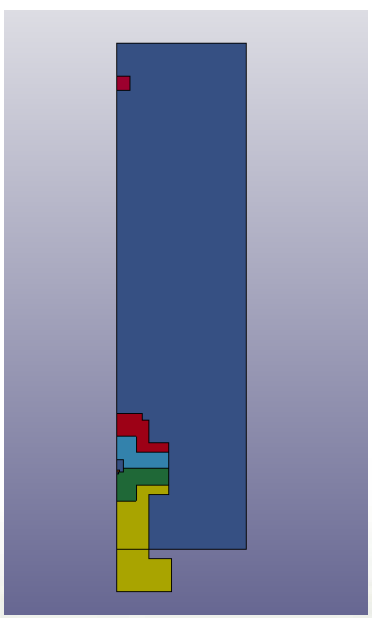

Fig.5 Simulation Model

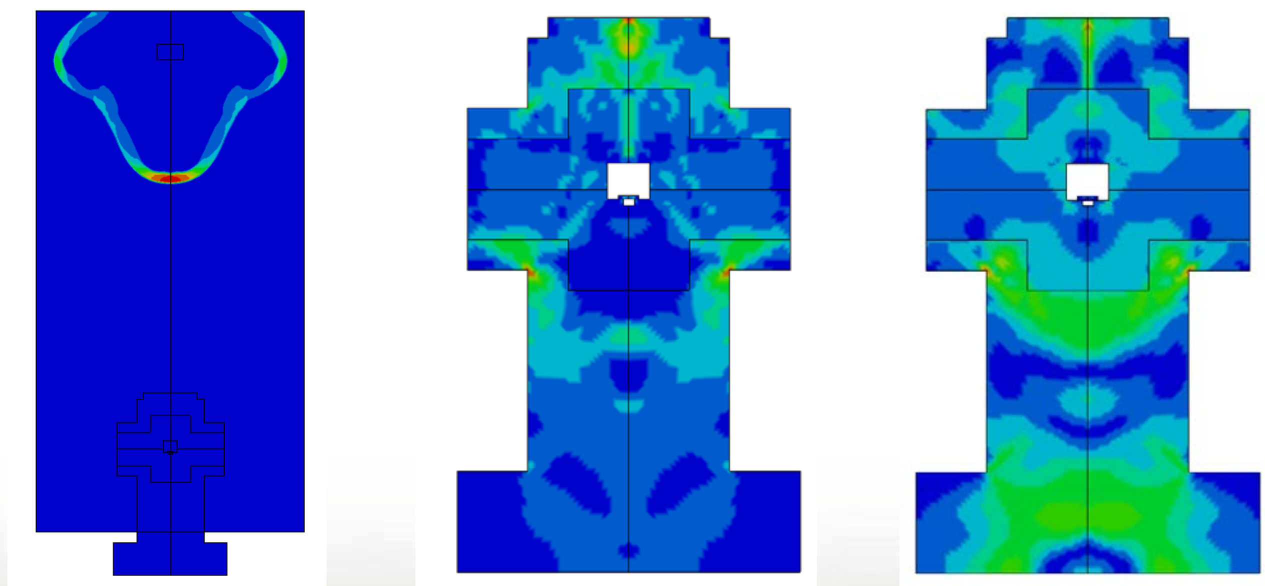

Fig.6 Stress wave propagation in the structure

1. Introduction
2. Outline of the Method
3. Experiment and Discussion
4. Finite Element Simulation
5. Future work
6. Acknowledgement

5. Future Work

The future work will be focused on the following 3 directions:

- More accurate simulation will be conducted, in order to give more insight into the relation between the stress wave propagation and the acceleration;
- By designing the structure carefully, the acceleration history will be controlled.
- The application of the proposed method: such as evaluating the anti-overload performance of electronic devices, studying the failure mode of the projectile-born devices during penetrating, reinforcing the projectile-born devices.

1. Introduction

2. Outline of the Method

3. Experiment and Discussion

4. Finite Element Simulation

5. Future work

6. Acknowledgement

6. Acknowledgement

化工材料研究所
EFIs集成设计开发团队
Team of Integrated EFI System

让交流融合思想，用集成汇聚力量！

The presented work is supported by Mingshui Zhu, Qiubo Fu, Fan Lei from Team of Integrated EFI System, Institute of Chemistry Material, CAEP.

Thanks for your attention!

Any question is welcome!