

# Simulation Study on Missile Penetration Based on LS - DYNA

**Jue Tang\*, Xinli Sun**

Xi'an High Technology Institute, Xian 710025, China

\*Corresponding author e-mail: 353396300@qq.com

**Abstract.** Penetrating the shell armor is an effective means of destroying hard targets with multiple layers of protection. The penetration process is a high-speed impact dynamics research category, involving high pressure, high temperature, high speed and internal material damage, including plugging, penetration, spalling, caving, splashing and other complex forms, therefore, Analysis is one of the difficulties in the study of impact dynamics. In this paper, the Lagrang algorithm and the SPH algorithm are used to analyze the penetrating steel plate, and the penetration model of the rocket penetrating the steel plate, the failure mode of the steel plate and the missile and the advantages and disadvantages of Lagrang algorithm and SPH algorithm in the simulation of high-speed collision problem are analyzed and compared, which provides a reference for the study of simulation collision problem.

## 1. Preface

In the past few years, computer simulation technology has been developing rapidly in China, and the simulation software has been developed. Computer simulation is not only low cost, but also can analyze and observe the whole process of response. Especially in the study of high-speed collision problem, Simulation has a very good advantage. The problem of penetrating steel plate is a typical high-speed collision problem, its action time is very short, the experiment is not easy to control, the measured physical quantity is also very limited, can not get space, time continuous results, can not fully reflect the penetration Structural response process and deformation mechanism, and computer simulation technology is able to solve such problems. Therefore, the choice of computer simulation is the best choice. In this paper, the Lagrang algorithm and SPH algorithm in LS-DYNA software are used to simulate the whole process of high-speed projectile penetrating steel plate, which provides reference and reference for projectile penetrating steel plate.

## 2. Introduction the LS-DYNA software

LS-DYNA is the most comprehensive analysis software developed by American companies. Because LS-DYNA program has powerful numerical simulation function, it has a wide range of applications in civil and defense industry. Mainly involved in the safety analysis of blasting engineering; fluid structure interaction; penetration process and explosion into the pit simulation analysis; military equipment and structural facilities by collision and explosion impact loading structural dynamic analysis; ultra-high-speed collision simulation analysis. Therefore, LS-DYNA is recognized as the leading element of the display finite element, which is the base code for all display solvers.



### 3. Establishment of Projectile Penetration Model

The design of this article is a cylindrical metal with a spherical shape, the radius is 2cm and the length is 12cm. Round armor plate radius of 20cm, thickness of 1cm, the projectile to 1500m / s speed vertical impact metal target center. Both the missile and the target material are steel. Using 3D graphics software solid works drawing penetration model is as follows:

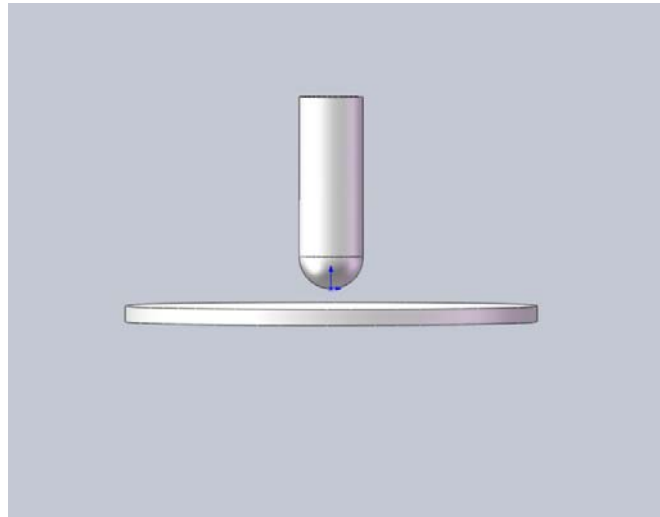


Figure 1. 3D graphics software solid works drawing penetration model

### 4. Simulation calculation

#### 4.1. mesh Lagrange algorithm

The Lagrange method is usually used to analyze the stress and strain of a solid structure, and its grid and structure are coincident, and the nodes in the model are the material points. The advantage of this method is that it can describe the structural boundary motion very well, and the calculation time is fast. Most of them are used in the problem of small deformation and medium deformation. The finite element mesh is consistent with the change of material structure. In the calculation of structural deformation and fluid-structure coupling problems, due to the material will flow, will make the grid a great deformation, resulting in numerical simulation is difficult, even the solver cannot be calculated. For the penetration model, the model is simplified when the grid is divided in ls-dyna, the projectile is cut into 1/2 projectiles, and the circular steel plate is cut into rectangles so that it can be faster in the post-treatment Calculation, and does not affect the simulation results, in order to more clearly see the penetration effect, in the penetration of more than a piece of steel.

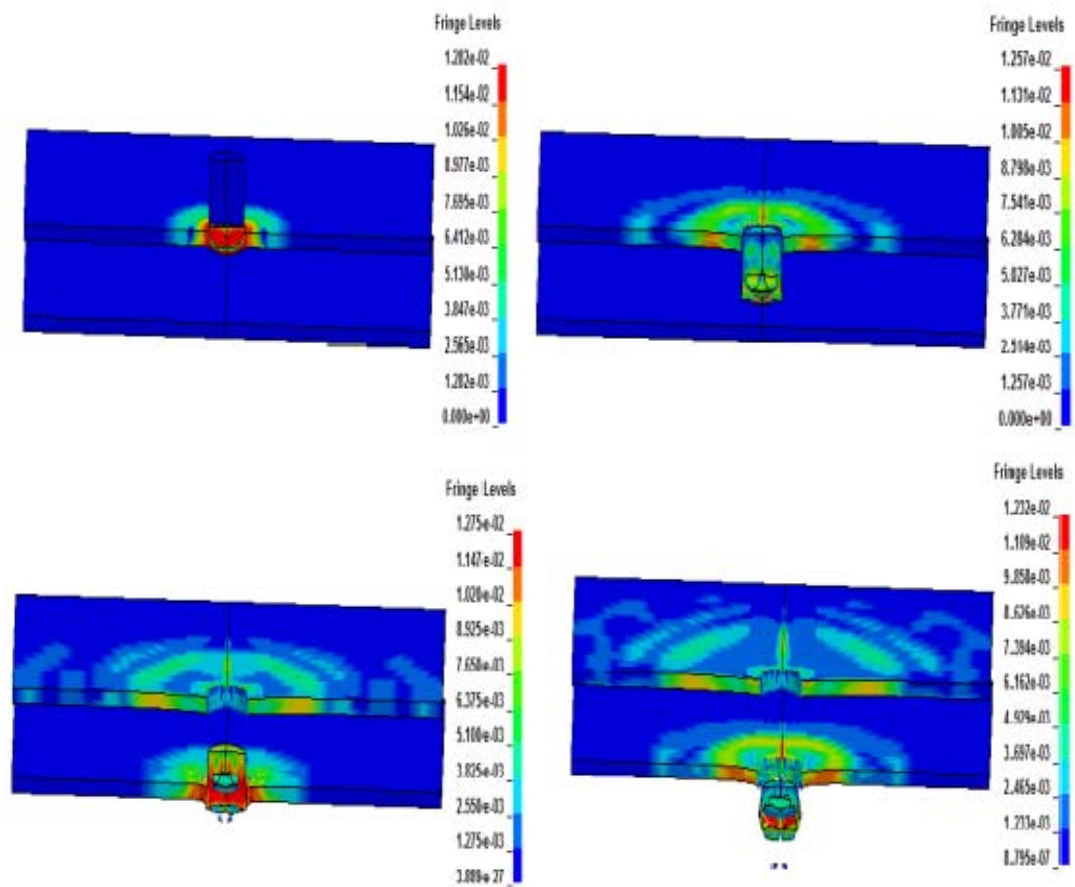


Figure 2. LS-DYNA drawing the process of penetration model

The Von-mises stress-time curves of the different parts of the projectile are shown. From the figure can be seen when the penetration, the deformation of the warhead to the extent of steel damage. In the high-speed penetration, the steel plate damage gap is very regular, but the second piece of steel can be seen when the speed down, the gap is rough, but also fragments fly out.

#### 4.2. SPH algorithm

The SPH method is discretized by separate particles and nodes, rather than the use of cells, which are fixed and fixed points of mass, that is, particles and nodes whose quality is attached to their coordinate system, The SPH method is also a kind of Lagrangian method. Because this method does not need to divide the grid, especially for large deformation problem simulation, therefore, from the theory and logic, SPH method is naturally able to simulate ultra-high-speed collision, penetration and other physical phenomena.

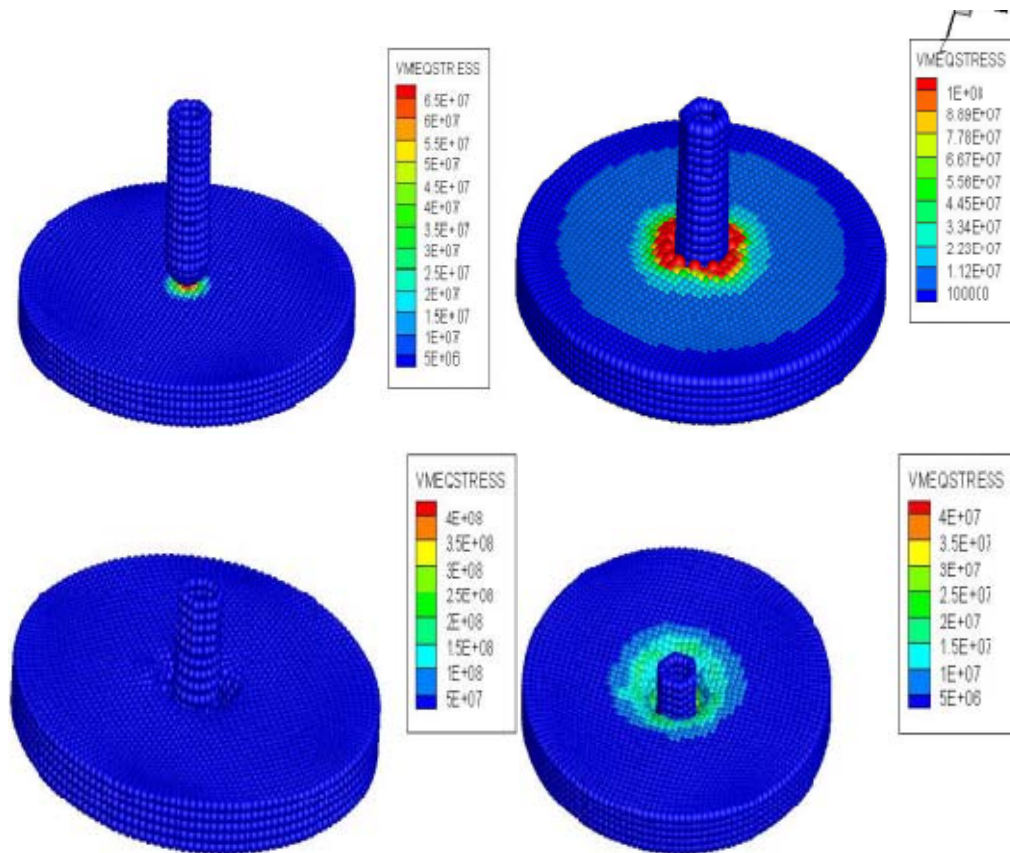


Figure 3. SPH drawing the process of penetration model

SPH with the particle approximation method will be equivalent to the grid particles, which is the biggest difference between finite element method, we can see from the figure, the use of SPH simulation can clearly see the whole process of local changes, and steel in the whole penetration the degree of deformation is very clear, the gap between the damage and the experiment is very similar to the gap.

## 5. Conclusion

In this paper, the Lagrang algorithm and the SPH algorithm are used to simulate the problem of penetrating steel plate. The two algorithms have their advantages from the whole process and the result. The traditional grid method is easier in the pre-treatment stage, because there are more mature procedures, so the simulation can save a lot of time. SPH in the preparation of the program more difficult, but from the simulation results, SPH simulation results more accurate, and the damage effect is more obvious.

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