BLC Derivation of a Stuffed Whipple Shield Based on Numerical Simulations

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Key Words: Hypervelocity Impact, Smoothed Particle Hydrodynamics (SPH), Ballistic Limit Curve (BLC), Stuffed Whipple Shield.

ABSTRACT

Research of a shield to protect electronic equipment and crew of a space station from hypervelocity impact from space debris and meteoroids has been actively conducted. Recently, not only a Whipple shield consisting of two aluminum plate but also a shield containing advanced materials has been developed as an enhanced shielding. In general, impact tests using two-stage light-gas gun are mainly performed to evaluate the protective ability of a shield. The experimental results are used to derive ballistic limit curve (BLC) which represents the diameter and the velocity of a projectile where the failure of the shield has been occurred. However, it is possible to obtain only the result of the velocity region below 7km/s because the size and impact velocity of the projectile are limited in experiments [1]. Therefore, numerical simulations are required in order to obtain BLC in the whole velocity region of 1~15km/s.

In this study, we derive the simulation based ballistic limit curve of a stuffed Whipple shield that is used in the International Space Station (ISS) European Columbus module. The stuffed Whipple shield is composed of an aluminium bumper, a rearwall and intermediate bumpers consisting of advanced materials such as Nextel and Kevlar-epoxy. Numerical simulations are implemented by the commercial hydro-code package, AUTODYN-2D. In simulating the hypervelocity impact, the smoothed particle hydrodynamics (SPH) is used to represent debris cloud generated when the projectile collides with the bumper.

Acknowledgment

This work was supported by Defense Acquisition Program Administration and Agency for Defense Development (UD090090AD) and also supported by the National Research Foundation of Korea (NRF) grant funded by the Korea government (MEST) (No. 2011-0017512).

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