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INVESTIGATION OF ALUMINIUM WHIPPLE SHIELD RESPONSE TO HYPERVELOCITY IMPACTS CLOSE TO BALLISTIC LIMIT BETWEEN 2.5 AND 5 KM/S

Abstract

For impact velocities larger than a threshold velocity of 3 km/s, aluminium Whipple Shields present an enhanced protection capability with respect to monolithic protections with the same areal density. In particular, in the range between 3 and 7 km/s the projectile partially fragments and melts after impacting the bumper; modelling this transition might be complex due to the high number of parameters affecting the collision. In particular, limited data is available in literature with a systematic evaluation of such parameters.

In this context, a campaign of 22 experiments was performed to assess the response of Whipple Shields to normal impacts in the transition range up to 5 km/s. In the tests, the projectile diameter was fixed at 2.9 mm and the bumper thickness and impact velocity were systematically varied respectively at 1, 1.5, and 2 mm and between 2.6 and 5 km/s. Collected data included high-velocity videos of the debris cloud generated by the impacts at both low resolution (for all shots) and high resolution (for 19 out of 22 tests); in addition, for 10 experiments high-resolution images of both the bumper and the wall were acquired after the tests.

In this paper, the experimental campaign is described and the main collected results are presented; in particular, qualitative and quantitative assessments on the debris cloud geometry and of the damage on the bumper and the wall are included; the influence of the different impact parameters is also discussed. Experimental results are finally compared with numerical simulations performed with a coupled finite element-discrete element method on LS-DYNA.