

SPACE DEBRIS SYMPOSIUM (A6)  
Hypervelocity Impacts and Protection (3)

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## PIPES VULNERABILITY UNDER MMOD HYPERVELOCITY OFF-CENTERED IMPACT

**Abstract**

HVI (hypervelocity impact) on pipes is different from that on homogeneous plates. In physical tests, off-centered impact on pipes frequently emerges, so anti-debris impact features of pipes are hardly investigated. In order to investigate the influence of the OCD (off-centered distance) on the impact damage results, we used SPH method to calculate the impact damage results about 7 off-centered impact cases, in which the OCD increased uniformly. The same condition in these cases was that the diameter of the aluminum projectile at the velocity 7km/s was 1.05mm, and the outer diameter of the pipes was 18 mm. Computer simulation results show: The crater on cylinder-surface of pipes is not an ellipse as that of an oblique impact on homogenous plates, when OCD exists. It's a figure with unequal semi-minor axes in the circumferential direction and equal semi-major axes in the axial direction. The cause is that the OCD leads to the change of the circumferential impact velocity component, the OCD bigger and the figure more asymmetrical. We had a regression analysis on the impact damage results, established three impact damage equations including a major axis vs. OCD equation, a minor axis vs. OCD equation, and a crater depth vs. OCD equation. The size of the major axis and minor axis decreases with the OCD increasing. But the major axis decreases faster than the minor axis. The off-centered impact could be considered as an oblique impact in the axial section, by analyzing the relation between the impact angle and the impact damage size equations. Impact damage sizes vs. impact angle equations are presented to establish the equivalence relation between the off-centered impact and the oblique impact.

Key Words: off-centered impact , off-centered distance,asymmetrical crater , impact damage equation, oblique impact