Paper ID: 52728
student

17th IAA SYMPOSIUM ON SPACE DEBRIS (A6)
Impact-Induced Mission Effects and Risk Assessments (3)

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BALLISTIC LIMIT EQUATIONS FOR CYLINDER PROJECTILES IMPACTING WHIPPLE SHIELD

Abstract

Ballistic limit equations (BLEs) are used for the damage prediction of spacecraft in a meteoroid and space debris environment. Traditional BLEs are typically developed using hypervelocity impact tests with spherical projectiles. However, research shows that most orbital debris are not spherical and cylinder projectiles can be more damaging than equal mass spherical projectiles. If spacecraft shield is designed using spherical projectile-based BLEs, the design will be non-conservative. This paper presents a new BLEs for cylinder projectiles impacting a typical whipple shield through modifying the Cour-Palais/Christiansen damage equations with shape factor based on dimensionless ratio of length to diameter. Numerical simulation methods and hypervelocity impact tests were used in developing the modified BLEs. It is found that the shape factor of the cylindrical projectile changes significantly with the ratio of length to diameter(L/D), while under the same L/D, shape factor is basically the same at different impact speeds. Cylinder projectiles with large L/D have a higher penetrating capability than small L/D Cylinder projectilesincluding spherical projectiles. The results obtained in this study also show the need to incorporate effects of shape and orientation in the damage prediction of cylinder projectiles.