A New Ballistic Limit Equation of Projectiles Hypervelocity Impacting on Dual Wall Structures

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The potential threat from meteoroid and orbital debris particles impacting on pressurized spacecraft prompted a study of ballistic limit equations. The ballistic limits can be subdivided into three phases: ballistic, shatter, and melt/vaporization. The present paper is devoted to a new ballistic limit equation of sphere projectiles impacting on dual wall structures. Compared with existed equations, the proposed equation has clearer theoretical bases and more convenient form for engineering design. In ballistic phase, forward velocity of projectiles after impacting bumpers is presented as a non-dimensional function from results of numerical simulations by a multivariate linear least squares regression analysis. Materials used for bumpers in these numerical simulations consisted of aluminum, copper and steel. Because of little effect, the spacing between the walls was not considered in ballistic phase. The response of rear walls is modeled following a single wall crater equation. In shatter phase, the approach for obtaining the equation is similar to that in ballistic phase. The forward velocity of the biggest fragments of chattered projectiles after impacting bumpers was analyzed in shatter phase. In melt/vaporization phase, since accelerated facilities can hardly reach so high velocity, experimental data are relatively less than the other two phases. An initial equation form based on dynamic mechanics analysis was assumed firstly and the equation was obtained by a regression analysis for a single variable lastly. Tresca criterion was used to define the critical penetration. With this approach, ballistic limit equations satisfying engineering application can be obtained with less data. The proposed equation has been checked with data of experiments and ballistic limit curves of existed equations. Agreement observed between existed and proposed results confirmed the validity of the new equation.