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Numerical Simulation and Analysis of Engraving Process with Serial Launch Method

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Abstract: In order to study the mechanical mechanism and movement characteristics of the projectile's dynamic engraving rifling with serial launch method at different initial velocities, the internal ballistic physics process with serial launch method was analyzed based on the 30 mm caliber artillery. The finite element models of the projectile and barrel were established and the finite element simulation of the engraving process was carried out with LS-DYNA. The results show that the initial engraving velocity has no influence on the deformation of the ammunition belt. The ammunition belt is grooved by the rifling gradually and the plastic deformation occurs. When the initial engraving velocity increases from 5 m·s^{-1} to 400 m·s^{-1}, the equivalent stress of the ammunition belt increases from 611.8 MPa to 717.5 MPa, the plastic strain peak of the ammunition belt decreases from 0.89 to 0.75, the engraving resistance peak increases from 20.3 kN to 22.9 kN and the friction resistance after the engraving process is completed increased from 0 to 3.5 kN. When the initial engraving velocity increases, the strain rate of the ammunition belt material, the plastic flow stress and the engraving resistance change, which have great influence on the following ballistic process of the projectile after the engraving process. When three projectiles are launched with serial method in turn, the standard deviation of axial velocity of the first projectile is 8.3 m·s^{-1}, and the subsequent two are 18.2 m·s^{-1} and 26.7 m·s^{-1} respectively. The vibration shock effects of the subsequent projectiles are more significant than the first one at high engraving velocity.

Key words: serial launch method; ammunition belt; initial engraving velocity; finite element analysis; engraving resistance

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《含能材料》“损伤与点火”专栏征稿

含能材料的损伤特征与点火过程有密切的联系,炸药、推进剂的内部损伤及其对力学特性、安全特性和点火行为的影响规律受到了含能材料学界的高度重视,为推动这一重要研究方向的学术交流,本刊特设立“损伤与点火”专栏。专栏主要征集炸药、推进剂等含能材料的损伤观测与多尺度表征技术、含损伤的本构方程、准静态与动态损伤演化规律、损伤与破坏的宏(细)观模式、损伤对起爆、爆炸、爆轰成长以及非冲击起爆行为的影响等方向的原创性研究论文。来稿请注明“损伤与点火”专栏。

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