Critical impact velocity of a cemented carbide projectile penetrating a water target

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Abstract

During rigid body penetration, the contact load between the target material and the penetrating projectile is concentrated to the tip of the projectile. At high penetration velocities, the loading will generate stresses within the projectile body which can reach the limiting strength of a typical projectile material. Since an intact tip shape is critical for a stable penetration process, especially during penetration into low strength target materials like liquids, it is essential that the projectile material is strong enough to withstand the loading during the complete penetration process.

In order to assess the strength of different materials to be used for rigid body penetration into low strength materials an impact test methodology has been developed. Projectile materials to be evaluated are launched at different velocities into a small cylindrical tank filled with the target material. Four X-ray flashes are used to depict the interaction between the target and the frontal part of the projectile. The flash X-rays make it possible to see through the target material and offers the possibility to study the projectile response in detail. By launching the projectile at different velocities and determine the maximum possible impact velocity without damaging the projectile material; it will be possible to assess materials with suitable strength properties.

The paper presents the test methodology applied on two different grades of cemented carbide, CC-1 and CC-2 penetrating a water target. The critical velocity for these two materials has been determined within ± 2 m/s and ± 28 m/s, respectively. Results from the impact experiments as well as hardness and fracture toughness data of the two materials together with numerical simulations of the contact load and resulting stress at the critical impact velocity will be presented.