A new approach towards the numerical modelling of ballistic impact on concrete targets

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The development of realistic numerical tools to efficiently simulate the response of concrete structures to projectile impacts or near field explosions has been one of the major quests in defense research for decades. Under these extreme loading conditions, dynamic pressure waves are locally transmitted to the target leading to complex failure modes, such as: (*i*) compaction, associated with pore collapse and comminution (i.e. fragmentation, crushing and pulverization) of the material in front of the impactor (front face); (*ii*) spalling (tensile fracturing) at the rear face, upon reflection of the induced pressure wave; and (*iii*) radial cracking around the penetration tunnel [1]. So, the constitutive model used to simulate the dynamic response of concrete to impulsive impact loads must be able to cover all these failure mechanisms.

Modelling comminution of concrete has proven to be particularly challenging. In spite of the vast literature on impact and the subsequent dynamic fracture of quasi-brittle and brittle materials, most models used for macroscopic dynamic FEM analysis are inadequate to simulate the phenomenon as it is observed in front of the impactor. In this study, the material comminution and compaction under high pressure is phenomenologically represented by an additional (hydrostatic) damage mode linked with a confinement criterion. This new concept is combined with a recently developed effective rate-dependent damage model and used to simulate a series of experiments conducted by Beppu et al. [2]. This model reproduces the major phenomena associated to the dynamic failure of concrete under ballistic impacts. As a direct consequence of the stress-based nonlocal regularization scheme used, the results are mesh independent.

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