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Investigation of High-Velocity Projectile Penetrating Concrete Blocks Reinforced by Layers of High Toughness and Energy Absorption Materials

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Abstract

Recently, the need to protect people and structures against attacks of terrorists are of a high increase. The main objective of this paper is to enhance the concrete resistance against ballistic impact of high velocity projectile by using different combination layers from different materials as reinforcement for concrete and investigate their effect on the penetration depth of projectile and the resulted damage of concrete. The investigation presents the development of a finite element accurate models using AUTODYN 3D. The Lagrangian formulation numerical techniques is used to model the projectile and concrete target. The investigated models are reinforced using different layers combinations of several materials such as ceramics, fiber composite, polymer and metal: (AL_2O_3 - 99.7% and Kevlar- epoxy, Teflon and aluminum alloy 6061-T6) .Those materials were chosen because of their high thermal shock resistance or their great capability in energy absorption. The main findings showed a significant enhancement in the reduction of penetration depth compared to the concrete resistance without reinforcement, which demonstrate the great performance of the used combinations in the shock wave propagation. Hence from the findings of this work we can say that the concrete reinforced by ceramics or aluminum alloy with fiber composite or polymer can be used for several applications as it represents a successful anti-penetration composite structure.

Keywords: Impact; Ballistic; Penetration; Concrete; Energy Absorption Materials.

1. Introduction

In civilian and military applications, the reinforced concrete has been used as an effective construction material for protective structures. The response of concrete structures to impact loading which results from terroristic attacks or high-velocity fragments due to accidental explosions and causes penetration and perforation that lead to failure of the structure, has become of great importance.

In the last decay, many empirical and numerical models as well as experimental studies were conducted to analyze the behavior of normal reinforced concrete subjected to impact loading with different ranges of velocities. Some of these empirical models were based on experiments and described the penetration depth, such as NDRC (1945) and ACE (1946) [1, 2]. Others described the penetration resistance first, then used it to derive the penetration depth, such as the

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