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Experimental study of plain and reinforced concrete targets subjected to impact loading

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Abstract

In order to study the influence of the plain concrete and reinforced concrete on ballistic performances. Penetration tests were conducted on different thicknesses of plain concrete and reinforced concrete plates having 40 Mpa unconfined compressive strength and reinforcement of 8mm diameter steel mesh in reinforced concrete plates is incorporated. The plates were 450mm of diameter and 60mm, 80mm, 100mm thicknesses are studied. The plates were subjected to an impact of hard steel projectile with ogive nose weighing 1kg with diameter 19mm and length of 450mm. The projectiles were accelerated by the laboratory pneumatic gun to velocities range between 28m/s to 102m/s. impact and residual velocities were measured by the high speed digital camera system. Ballistic resistance of plain concrete and reinforced concrete at different thicknesses had been find out in the experiments and compared with already proposed analytical formula. The results thus obtained are presented and influences there on due to the variation in the concrete plate thicknesses to the projectile impact are discussed. The ballistic limit was found to increase with an increase of target thickness.

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Keywords: Ballistic limit; scabbing; residual velocity; impact velocity

1. INTRODUCTION

Concrete structures have been widely used in construction of civilian structures and important structures such as bunkers, nuclear power plants, buildings, brides, dams, tunnels etc. for those structures important criteria is to with stand against impact load produced by projectiles. So many researchers did perforation experiments on high strength

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concrete slabs, beams, grouts etc. Hanchak and Forrestal's [1-4] have done projectile impact on different grade of concrete and varying diameters of concrete plates and grouts they found striking velocities corresponding to maximum depth of penetration, effect of concrete target diameter on depth of penetration. Shirai and ohno [5] presented a method to improve the impact resistance of reinforced concrete plates against projectile impact they reported to reduce local damage due to impact load provide steel plate lining at impacted and rear surface, double layered RC plates can be expected to have higher impact resistance than the standard one.Damage evaluation of concrete plates at higher impact velocities was also studied by Beppu and ohno [7]. The launch acceleration in the gun bore and the deceleration during the perforation event was recorded with an acceleration transducer. Several perforation tests using concrete targets of different thicknesses were conducted with a nominal striking velocity of 400 m/s. The residual velocity and kinetic energy consumed versus the target thickness was analysed. The perforation limit was also obtained by Li Jinzhu and Lv Zhongjie [8]. In this study perforation experiments have been done on varying thicknesses 80mm, 100mm of low strength concrete having compressive strength of 40Mpa with hard steel projectile of 1 kg and 19mm diameter validated with already proposed formulae. The projectiles were accelerated by the laboratory pneumatic gun to velocities range between 28m/s to 102m/s. impact and residual velocities were measured by the high speed digital camera system. Ballistic resistance of plain concrete and reinforced concrete at different thicknesses had been find out in the experiments. Damage pattern of concrete also discussed.

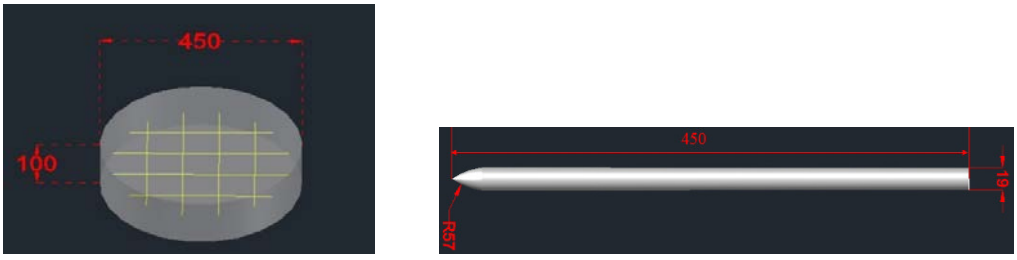
2. CONCRETE TARGETS

In previous studies many researchers have studied with high strength concrete and low strength concrete and also normal strength concrete but they have found that there is very minor effect in performance of the concrete targets with respect to their compressive strengths. The target materials used were M40 plain concrete see Table 1, Different thicknesses of 80mm and 100mm of M40 grade concrete had been casted, and 5 cube of dimension (150*150*150) mm also casted. The samples for the compressive strength tests were allowed to cure for at least 28 days. After curing of concrete cubes had been tested on compression testing machine which gives unconfined average compressive strength of 48 Mpa.

Table 1. Constituents of concrete

Cement	water	Aggregate (10mm)	Sand	admixture
437.9	166.4	1040.92	720	0.25%

Diameter of concrete plates was taken constant 450mm and different thickness concrete plates were casted, 80mm, 100mm. Geometry of the concrete plate is shown in Fig 1(a). The experiments were conducted on a pneumatic gun with 1 kg projectile as shown in Fig 1(b), was launched up to an incidence velocity 200 m/s. The length of the barrel was considered 18 m to enable adequate acceleration of the projectile for obtaining the required velocity see Fig 2. The angle of incidence was considered normal to the target.



a) Circular concrete plates b) projectile

Fig. 1. Geometry of concrete plate and hard steel projectile