MATERIAL DEFLECTION AND BULLET RICOCHET DETERMINATIONS FOR DIFFERENT ANGLES OF FIRING ON A CONCRETE PLATE

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***Abstract**:Tests for determining the material deflection and projectile ricochet when firing small caliber ammunitions at a concrete plate target were conducted. The target is inclined relative to the weapon line of sight at different angles (perpendicular; inclination of 30, 45 and 60 degree angles). Using high-speed camera and witness panels, different measurements were conducted to determine fragments velocity and the radius of dispersion.*

***Keywords**: small caliber weapons, ammuniton, projectile, ricochet, fragmentation.*

Introduction

The research conducted on the determination of material deflection and projectile ricochet for a number of small caliber weapons is part of the authors work concerning the evaluation of firing range ballistic protection when firing in different conditions small caliber ammunitions.

The tests consisted of shooting series, with different weapons for a number of distances to the target (16 m, 92.5 m, 144.5m, 234.5m and 314.5m) and for five angles of inclination of the target (90, 60, 45, 30 degrees).

The concrete deflector target was placed in a specially arranged location within the firing range, on it's right side being mounted the witness cardboard panels. This panels are grided and their position is centered related to the target material. This allows determining the ricochet velocity and the angle of dispersion.

1. Test Procedure Description

The scheme for the conducted tests is shown bellow in Figure 1. Ammunitions of 9 x 19 mm, 7.62 x 39 mm, 7.62 x 51 mm NATO and 7.62 x 54 mmR calibers were tested. Thorough inspections of the weapon-ammunition system and firing range conditions were performed before each set of tests (when requiring a different type of weapon-ammunition system).

The high-speed camera was placed in a designated location suitable chosen to capture the firing event and assure protection of the operator. Using the PHOTRON specialized software, frame-by-frame analysis of the recordings produced the results. The mass of the ricochet elements was determined weighing with a SCALTEC precision balance (measuring error of 0.0001g).

Figure 2 presents the assumptions used to determine the vertical and horizontal values for the ricochet elements.

After each set of tests, the coordinates of the points of impact on the witness panel were determined and were utilized to create the distribution charts of the impacts.

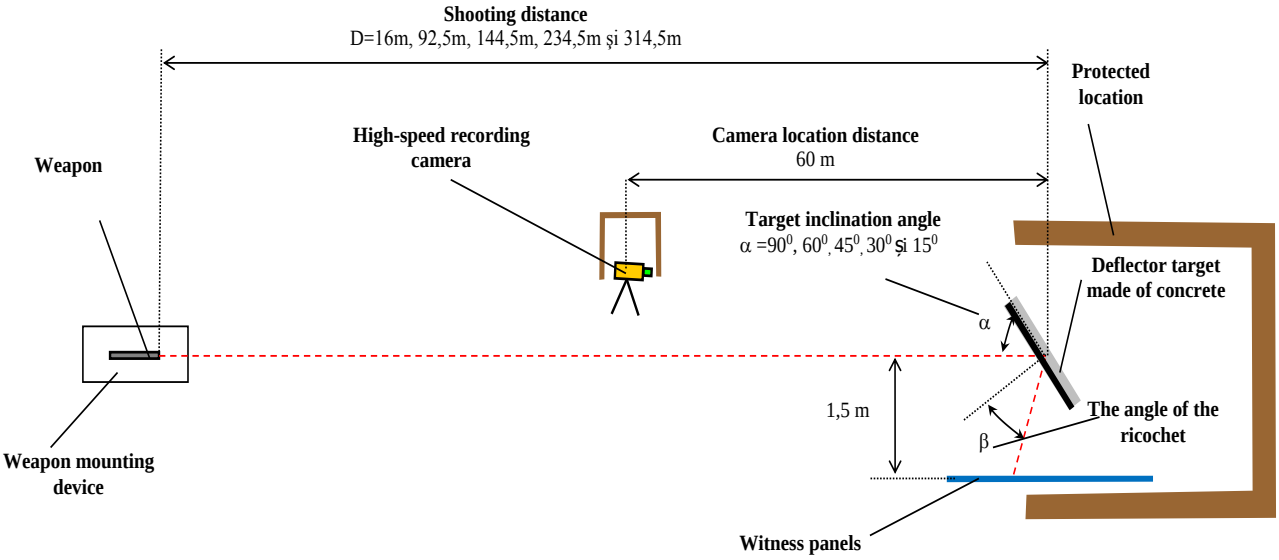


Figure 1: Testing Configuration Schematic

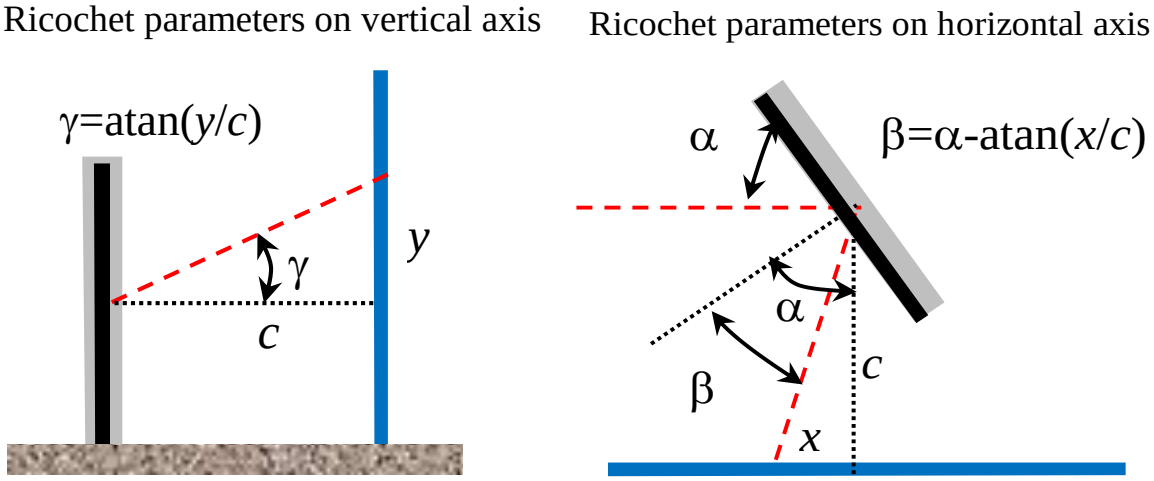


Figure 2: Ricochet Angles on Orthogonal Axis System

2. Test Results Obtained

Results obtained were comparable for the calibers considered. Therefore, next will be detailed only the values obtained for the 7.62 x 39 mm AKM assaul rifle.

The worst case scenario for the material displacement and the appearance of the ricochet phenomenon is validated for an inclination of the target with an angle α of 60°. These are the cases considered when creating the dispersions represented in Figure 5.

For the three firings at each distance considered, values obtained from the measurements are shown in Table 1.

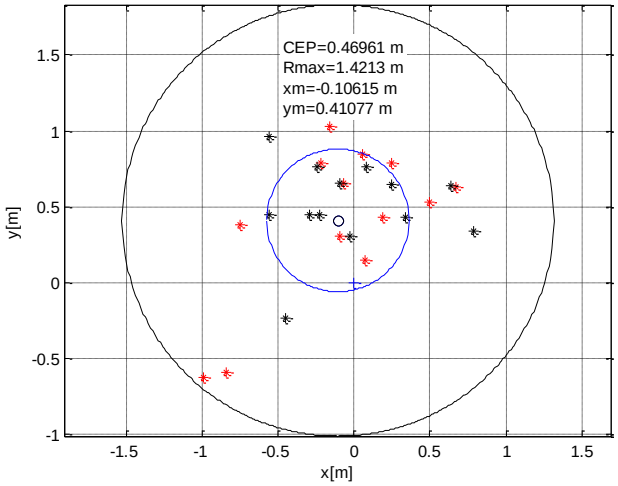
D [m]	α [degree]	CEP [m]	Std(x) [m]	Std(y) [m]	β_{med} [degree]	Δβ [degree]	γ_{med} [degree]	Δγ [degree]
16	**60**	**0.4696**	**0.4996**	**0.5109**	**63.50**	**57.49**	**14.55**	56.93
16	**45**	**0.3111**	**0.1368**	**0.4856**	**25.89**	**14.01**	**9.74**	49.61
16	**30**	-	-	-	-	-	-	-
92.5	**60**	**0.4166**	**0.7783**	**0.2118**	**103.09**	**47.20**	**2.64**	27.33
92.5	**45**	**0.3269**	**0.4769**	**0.1931**	**53.60**	**55.51**	**7.26**	26.75
92.5	**30**	**0.5781**	**0.4789**	**0.4198**	**24.82**	**58.65**	**8.07**	51.10
144.5	**60**	**0.3163**	**0.4571**	**0.1920**	**89.32**	**33.84**	**1.03**	29.50
144.5	**45**	**0.3202**	**0.2981**	**0.3113**	**54.09**	**41.92**	**7.94**	42.56
144.5	**30**	**0.3081**	**0.3115**	**0.2179**	**34.44**	**43.53**	**4.58**	31.52
235	**60**	**0.3944**	**0.4299**	**0.1684**	**58.99**	**33.16**	**2.48**	21.81
235	**45**	**0.2071**	**0.2059**	**0.2332**	**48.83**	**25.33**	**-0.43**	32.17
235	**30**	**0.3436**	**0.4265**	**0.3419**	**24.54**	**59.54**	**7.86**	45.21
314.5	**60**	**0.3529**	**0.2507**	**0.3516**	**88.95**	**27.19**	**-2.32**	39.85
314.5	**45**	**0.4495**	**0.2312**	**0.4616**	**43.89**	**32.25**	**7.28**	51.34
314.5	**30**	**0.5981**	**0.4950**	**0.5566**	**26.02**	**61.63**	**1.27**	51.99

Table 1: Results obtained for AKM assault rifle

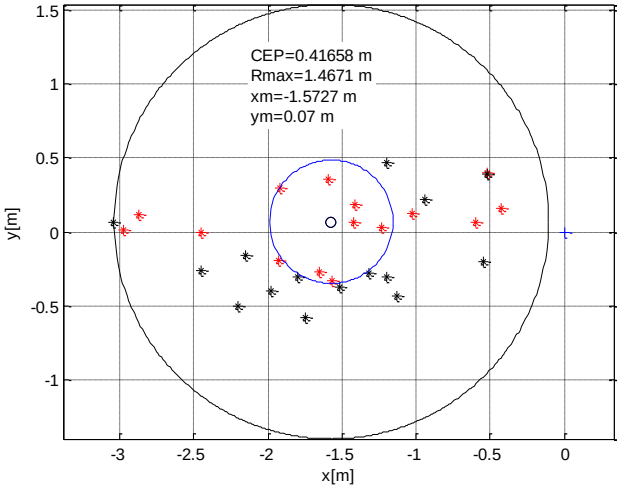
Figure 3: Material deflected from concrete target on witness panel

Figure 4: Bullet ricochet towards the panel

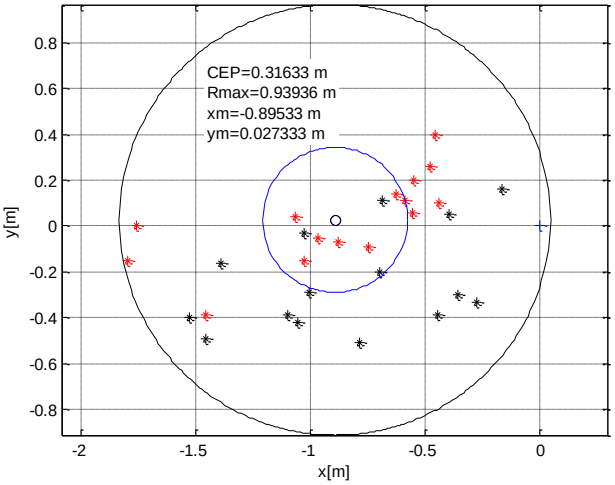
Having the results, next, the dispersion of the fragments and ricochet bullets could be realized. One tool useful to determine the biggest concentration of ricochets and target material fragments grouped on the smallest portion of the witness panel is the circular error probable.



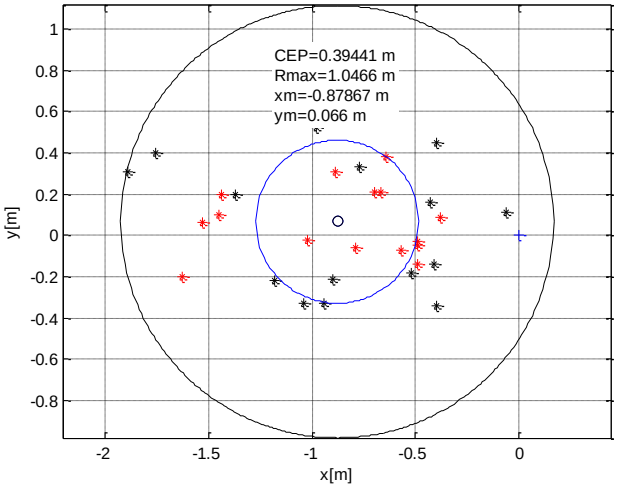
Distribution of impact points on the witness panel, when firing at a target inclined at 60°, from 16m



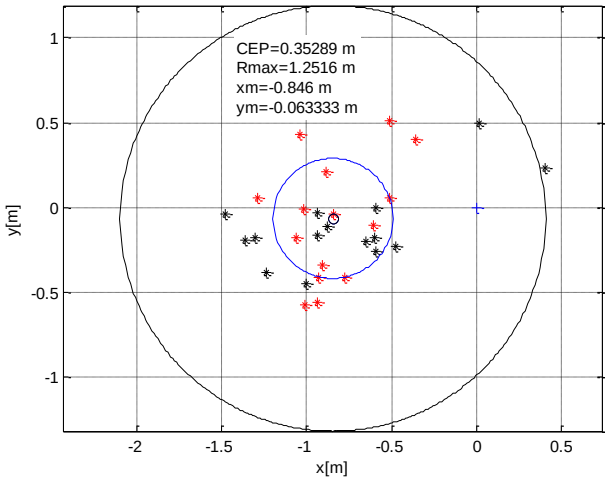
Distribution of impact points on the witness panel, when firing at a target inclined at 60°, from 92.5m



Distribution of impact points on the witness panel, when firing a target inclined at 60°, from 144.5m



Distribution of impact points on the witness panel, when firing at a target inclined at 60°, from 235m



Distribution of impact points on the witness panel, when firing at a target inclined at 60°, from 314.5 m

Figure 5: Impact point distribution on witness panel for the cases considered

Acknowledgments

Tests to determine the appearance of the ricochet phenomenon and material displacement from the targeted object when firing a number of small caliber weapons were conducted. Results obtained are usefull in creating a tool evaluating the ballistic protection of a specific firing range.

References

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