

## TECHNICAL NOTE

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### Bullet Ricochet from Gypsum Wallboard

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**REFERENCE:** Jordon, G. E., Bratton, D. D., Donahue, H. C. H., and Rowe, W. F., "Bullet Ricochet from Gypsum Wallboard," *Journal of Forensic Sciences*, JFSCA, Vol. 33, No. 6, Nov. 1988, pp. 1477-1482.

**ABSTRACT:** In a criminal case, police alleged that a gouge in a plaster wall was the result of a bullet ricochet. Experimental studies showed that it is possible to obtain bullet ricochets from gypsum wallboard if the bullets are fired at a very low angle of incidence into the wallboard. The resulting ricochet marks, however, did not resemble the gouge alleged to have been caused by a bullet ricochet. When the angle of ricochet was determined, it was in all cases greater than the angle of incidence. While these results differ from those obtained in studies of ricochets from concrete and metal plates, they are similar to the results obtained in studies of bullet ricochet from soil and water.

**KEYWORDS:** criminalistics, ballistics, bullet ricochets, plaster

As a result of a criminal case in which the defendant was charged with assault with a deadly weapon, we became interested in whether or not bullets will ricochet from plaster or wallboard. The complainant alleged that the defendant had fired a pistol at him during an altercation in the defendant's home. No weapon could subsequently be found; moreover, although the shooting allegedly occurred indoors, no bullet or expended cartridge could be found. Police investigators did note, however, an irregular, horizontally elongated 6.0- by 3.6-cm (2.4- by 1.4-in.)<sup>3</sup> gouge in the wall at the top of the stairs leading to the second floor of the house. (A later inspection of the scene by one of the authors [W. F. R.] revealed that the wall in question consisted of plaster over lathe.) The police investigators subsequently testified that in their opinion this gouge was the result of a bullet ricochet.

Two of the authors (H. C. H. D. and W. F. R.) were retained as defense consultants in this case. Our survey of the forensic science literature did not reveal any published studies of bullet ricochets from plaster or wallboard. Although we were skeptical that bullets traveling

Received for publication 24 Oct. 1987; revised manuscript received 29 Jan. 1988; accepted for publication 11 Feb. 1988.

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<sup>3</sup>These measurements were derived from an unscaled, oblique photograph taken by police and from on-scene measurements of objects shown in the photograph made by one of the defense consultants (W. F. R.). The mark was repaired and repainted before the defense retained its consultants.

at normal velocities would ricochet from plaster or wallboard, we were reluctant to express an opinion without first conducting test-firings. Our experiments were intended to determine if pistol bullets traveling at normal velocities would ricochet from plaster or wallboard at some angle of incidence. Furthermore, if bullets did in fact ricochet from such surfaces, we were also interested in comparing the resulting marks in the plaster or wallboard with that alleged by police investigators to have been caused by a ricochet.

### Materials and Methods

Two series of experiments were undertaken. In the first, both .38 and .22 caliber handguns were fired into 30.5- by 30.5- by 0.95-cm (12- by 12- by  $\frac{3}{8}$ -in.) pieces of new gypsum wallboard. This target material was used because of its ready availability and because it was the only available facsimile of plaster-over-lathe wall construction. Unfortunately, plaster-over-lathe construction was replaced with gypsum wallboard over a quarter of a century ago [1]. We realized that gypsum wallboard might differ significantly from plaster-over-lathe construction in such properties as compressive strength, tensile strength, impact hardness, elasticity, and mass per unit area. Because these factors would mainly affect the angle of incidence at which ricochet would occur and the resulting angle of ricochet, differences between plaster-over-lathe construction and gypsum wallboard would have been significant only if we had failed to obtain bullet ricochet from the gypsum wallboard.

The ammunition used in the first series of test firings is shown in Fig. 1. Four Winchester 38 Special rounds with 158-grain lead bullets were fired from a .38 caliber Smith & Wesson Model 10 revolver having a 10.2-cm (4-in.) barrel at a range of 40.5-cm (16 in.) into the targets at angles of incidence of 80, 60, 30, and 10° (measured from the target surface). Four Remington .22 caliber rounds with 40-grain lead bullets were fired from a .22 caliber High-Standard Supermatic Trophy Model semi-automatic pistol at a range of 42 cm (16.5 in.) into

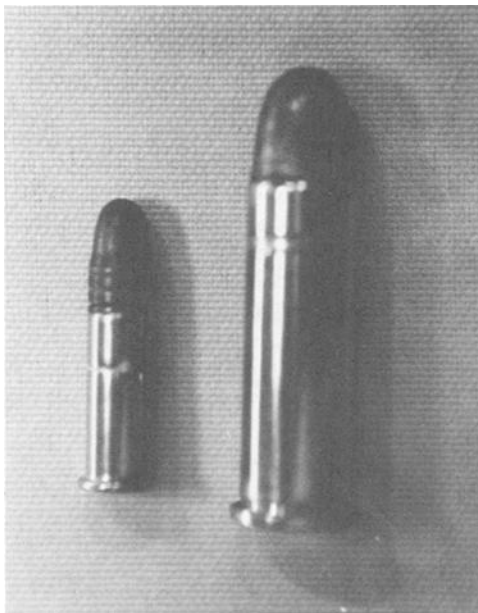


FIG. 1—Ammunition used in ricochet study: Remington .22 caliber (left); Winchester .38 Special (right).

the targets at the same angles. The final shot fired in the first series of experiments was a .38 Special round fired tangentially (angle of incidence approximately 1 to 2°) along the target surface. This shot was fired because the other shots fired in this first series completely perforated the targets, without ricocheting. We hoped that with a very low angle of incidence a ricochet could be produced.

Following the resolution of the criminal case, a second series of experiments were undertaken. In this series of experiments, rounds were fired from a Baretta Model M9 9-mm semi-automatic pistol and from a .357/.38 caliber Ruger Security Six revolver into two sheets of 1.2-m by 1.2-m by 1.3-cm (4-ft by 4-ft by 1/2-in.) gypsum wallboard. One sheet of wallboard served as the initial target and was nailed vertically to 5.1- by 10.2-cm (2- by 4-in.) supports; the other sheet of wallboard served as the final target and was mounted vertically at a right angle to the first sheet. All shots were fired from a range of approximately 4.9 m (16 ft). The following measurements were made for each shot: perpendicular distance of pistol muzzle from initial target surface, distance from muzzle to point of impact on initial target parallel to surface of the initial target, perpendicular distance of impact point in final target from initial target surface, and distance from impact point in final target to impact point in initial target parallel to the surface of the initial target. The angles of incidence and ricochet were then calculated trigonometrically. The following types of ammunition were used: Federal 9-mm, 115-grain, copper-jacketed hollow point; Winchester .38 caliber, 158-grain, semi-wadcutter; and Winchester .38 caliber, +P+ 110-grain, semi-jacketed hollow point. These rounds are shown in Fig. 2. These rounds have nominal muzzle velocities of 355 m/s (1165 ft/s), 230 m/s (755 ft/s), and 311 m/s (1020 ft/s), respectively, when fired from a 10.2-cm (4-in.) barrel [2].

### Results and Discussion

All of the rounds fired in the first series of test-firings completely perforated the gypsum wallboard targets, with the exception of that round fired almost tangentially along the target surface. This round ricocheted off the surface of the wallboard, leaving a gouge approximately 20 cm (8 in.) long. The entrance holes produced by the remaining rounds were ellipti-

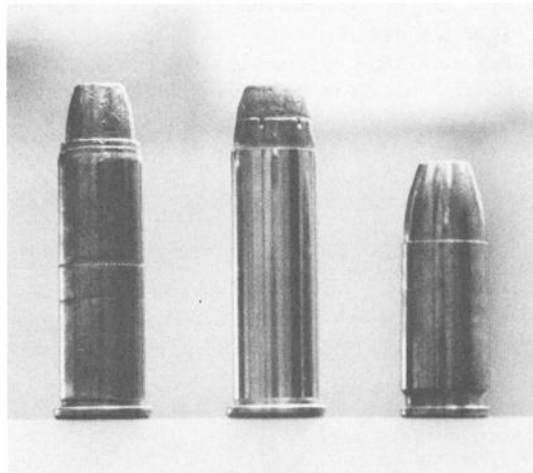


FIG. 2—Ammunition used in ricochet study: Winchester .38 caliber semi-wadcutter (left); Winchester .38 caliber semi-jacketed hollow point (middle); and 9-mm Federal copper-jacketed hollow point (right).

cal; the minor axes of the ellipses were approximately equal to the diameters of the impacting bullets. All of the rounds left readily visible bullet wipe at the point of initial impact. Traces of bullet wipe were not observed in photographs of the gouge mark on the wall; unfortunately, no microchemical tests for bullet constituents or other trace materials were performed by police investigators on the original mark.

Table 1 summarizes the results of the second series of test-firings. All but one of the rounds fired ricocheted from the initial target. One intriguing observation is that the angles of ricochet were larger than the angles of incidence. This is very different from the results obtained by Jauhari [3,4] for the ricochet of bullets from metal plates, by McConnell et al. [5] for the ricochet of shotgun pellets from concrete surfaces, and by Hartline et al. [6] for the ricochet of shotgun pellets from steel plates. However, studies of bullet ricochet from soil [7] and water [8] have obtained angles of ricochet greater than the angles of incidence. Readily cratered targets seem more likely than other targets to produce angles of ricochet greater than the angles of incidence.

Figure 3 shows the typical mark produced in the initial target by a ricocheting bullet. These marks varied in length from 13.3 up to 18.4 cm (5.25 up to 7.25 in.). All of the ricocheting bullets produced bulges in the rear surface of the initial target, and in two instances, the bullets penetrated the full depth of the wallboard before rebounding.

Jauhari [3,4] has noted that when bullets ricochet from metal plates, they may become unstable. "Keyhole" perforations (such as that shown in Fig. 4) were produced in the final target by four of the ricocheted bullets. These bullets were clearly tumbling after leaving the final target.

The marks left on the gypsum wallboard by the ricocheting bullets were quite different from the slightly elongated gouge alleged by police investigators to have been caused by a bullet ricochet. Because of this and because of a lack of any hole resulting from the final impact of the ricocheting bullet, one author (W. F. R.) testified for the defense that in his opinion the gouge was not the result of a bullet ricochet. The prosecution ultimately stipulated to this opinion; the defendant was acquitted following brief jury deliberations.

## Summary

Experimental studies have shown that it is possible to obtain bullet ricochets from gypsum wallboard if the bullets are fired at a very low angle of incidence into the wallboard. When the angle of ricochet was determined, it was in all cases greater than the angle of incidence. While these results differ from those obtained in studies of ricochets from concrete and metal plates, they are similar to the results obtained in studies of bullet ricochets from soil and water.

TABLE 1—*Angles of incidence and ricochet for ricochet from gypsum wallboard.*

Weapon	Type of Ammunition	Angle of Incidence, (deg)	Angle of Ricochet, (deg)
Baretta (9 mm)	115-grain copper-jacketed hollow point	5.0	none; bullet perforated target
	115-grain copper-jacketed hollow point	3.4	6.3
Ruger (.357/.38)	158-grain semi-wadcutter	5.1	7.8
	158-grain semi-wadcutter	5.1	18.4
	158-grain semi-wadcutter	4.8	17.5
	158-grain semi-wadcutter	3.3	6.1
	158-grain semi-wadcutter	3.3	6.6
	110-grain semi-jacketed hollow point	3.7	6.1

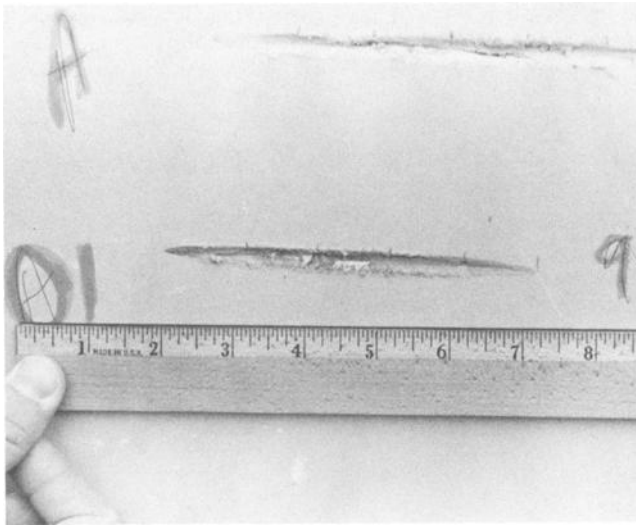


FIG. 3—Ricochet mark made by 9-mm, 115-grain copper-jacketed hollow point bullet in gypsum wallboard.

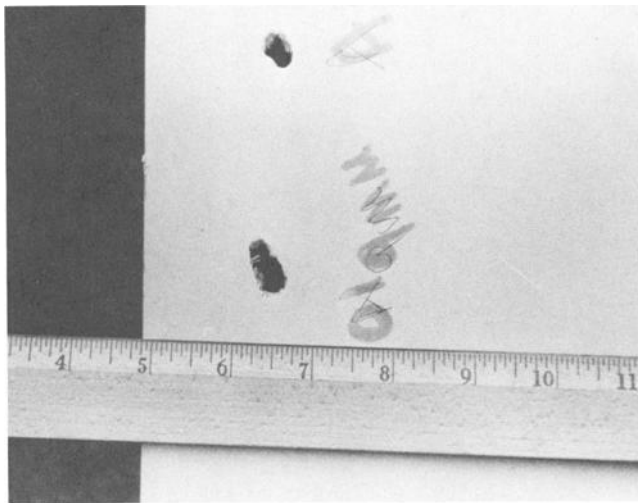


FIG. 4—Bullet hole in final target made by 9-mm, 115-grain copper-jacketed hollow point bullet after ricochet.

### References

- [1] Wenk, R. J. and Henkels, P. L., "Calcium Compounds," *Kirk Othmer Encyclopedia of Chemical Technology*, Vol. 4, John Wiley and Sons, New York, 1978.
- [2] Murtz, H. A., *Guns Illustrated 1986*, 18th ed., DBI Books, Northbrook, IL, 1986.
- [3] Jauhari, M., "Bullet Ricochet," *Indian Police Journal*, Vol. 16, No. 3, Jan. 1970, pp. 43-47.
- [4] Jauhari, M., "Bullet Ricochet from Metal Plates," *The Journal of Criminal Law, Criminology and Police Science*, Vol. 60, No. 3, Sept. 1969, pp. 387-394.

- [5] McConnell, M. P., Triplett, G. M., and Rowe, W. F., "A Study of Shotgun Pellet Ricochet," *Journal of Forensic Sciences*, Vol. 26, No. 4, Oct. 1981, pp. 699-709.
- [6] Hartline, P. C., Abraham, G., and Rowe, W. F., "A Study of Shotgun Ricochet from Steel Surfaces," *Journal of Forensic Sciences*, Vol. 27, No. 3, July 1982, pp. 506-512.
- [7] Birkhoff, G., "Ricochet Off Land Surfaces," Ballistic Research Laboratory Report 535, Aberdeen Proving Ground, MD, 21 March 1945.
- [8] Haag, L., "Bullet Ricochet from Water," *AFTE Journal*, Vol. 11, No. 3, July 1979, pp. 26-34.

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