B120 Critical Angles for 9mm Parabellum Bullets

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The goal of this presentation is to introduce attendees to the angle at which a ricochet will no longer occur when a bullet strikes some common substrates.

This presentation will affect the forensic science community by providing data that can be used as background when assessing a ricochet at a shooting scene.

Determining the angle at which a bullet will successfully ricochet is essential information when a shooting investigation involves indirect fire. This information provides the forensic scientist with fundamental data required for the scientific reconstruction and assessment of a shooting scene. Depending upon the substrate, the bullet's design, velocity, construction, and its angle of impact, a bullet may fail to ricochet upon impact or the bullet will successfully ricochet. Knowledge of bullet behavior with common substrates provides valuable information for scientific investigations of shooting scenes where bullets have impacted intermediate surfaces. A timely and accurate scene reconstruction is imperative in both the investigative and the adjudicative stages of a shooting incident.

Bullets discharged from firearms have a considerable amount of kinetic energy and achieve high velocity during the very short time they are accelerating down the bore of the firearm. Even accounting for some frictional losses as it is forced through the bore, the once-stationary bullet emerges as a fast-moving energetic projectile.

A bullet that is discharged from a firearm can ricochet off of the many different surfaces present at a typical shooting scene. Although bullets will behave differently depending upon the material they encounter, they are nevertheless bound by the laws of physics.

Potential ricochet surfaces may be categorized based on how the bullet interacts with the substance. Hard surfaces traditionally remain intact after low-angle bullet ricochet because they will not yield to the bullet's impact energy. Materials such as concrete, marble, granite, and steel are just a few examples that fall into this category. Bullet ricochets off of hard unyielding surfaces consistently have ricochet angles (the angle created between a line designating the bullet path and a line designated by the substrate surface) that are less than the bullet's angle of impact (the acute angle at which the bullet approaches the substrate surface).[1] Soft surfaces will not remain intact but instead will deform, deflect, or fail entirely, yielding to the bullet's impact energy. Materials such as wood, turf, sand, paneling, wallboard, thin automobile sheet metal, and water are just some examples of surfaces that fall into this category. Bullet ricochets off of relatively soft yielding surfaces routinely have ricochet angles that are greater than the impact angle of the bullet.[2] When a bullet is fired at either of these types of materials, whether hard or soft (i.e., unyielding or yielding, respectively), there is an angle at which a ricochet will no longer occur. At (and above) this "critical angle" the bullet may break apart into fragments after hitting the surface in the case of a hard unyielding substrate or it may remain intact, to either penetrate (embed but not exit) or perforate (enter and exit) the material in the case of a soft yielding substrate

The critical angle for the 9mm full metal jacket bullet used in this study was determined to be between 7° and 8° for gypsum drywall, between 5° and 6° for automotive sheet metal, between 11° to 15° for sand, and approximately 15° for heavy steel plate, marble, and modular concrete block. For the purposes of determining the critical angle for the unyielding substrates, the retained weight of the bullet was used as the criterion to decide whether the angle had been reached. Once the recovered bullet lost more than 5% of its original mass, the critical angle was considered achieved; however, it must be appreciated that a fast-moving bullet with 95% of its original mass must still be treated with respect.

References:

1. Haag, L. Shooting incident reconstruction. *New York: Academic Press*, 2006: 123
2. Ibid. 131

Ricochet, Critical Angle, Shooting Reconstruction