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Excuse the pun !

Decoding Impact:

"The Critical Role of TERMINAL BALLISTICS in Forensic Science"

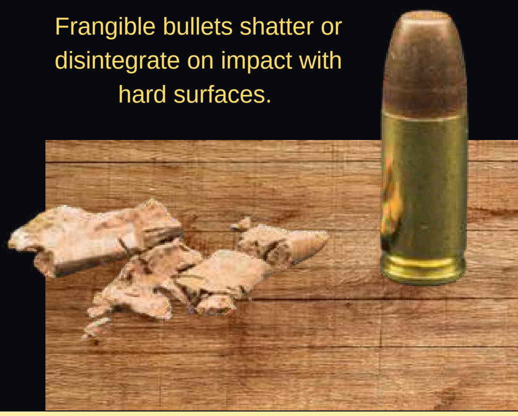
Part Three

Frangible Bullets

The last category of expanding bullets is frangible bullets. These are designed to break upon impact, which results in a huge increase in surface area. The most common of these bullets are made of small diameter lead pellets, placed in a thin copper shell, and held in place by an epoxy or similar binding agent. On impact, the epoxy shatters, and the copper shell opens up, the individual lead balls then spread out in a wide pattern, and due to their low mass-to-surface area ratio, stop very quickly. Similar bullets are made out of sintered metals, which turn to powder upon impact. These bullets are usually restricted to pistol cartridges and rifle cartridges intended for use at very short ranges, as the nonhomogeneous cores tend to cause inaccuracies that, while acceptable at short ranges, are not acceptable for the long ranges at which some rifles are used.

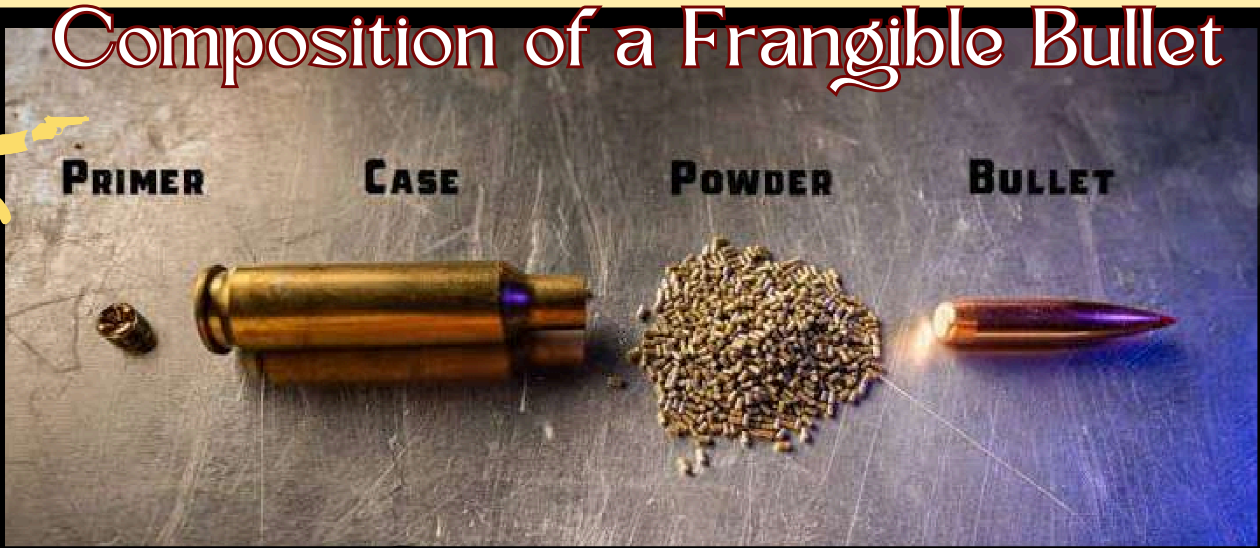
By far the most common use of frangible ammunition is for training by shooting steel targets at close ranges, while one may be at risk of being injured by fragments of standard solid lead bullets at close ranges when shooting steel, the powder that frangible bullets disintegrate into upon impact poses a very low risk to the shooter. This becomes irrelevant when shooting at longer ranges because it is unlikely that fragments created by the impact of any type of bullet on a steel target will travel more than 50-100yds, in these long-range cases it is of more value to use bullets that fly identically to those to be used in real situations than to mitigate the possible risks of bullet fragments and ricochets so frangible bullets are typically not used.

Frangible bullets shatter or disintegrate on impact with hard surfaces.



One interesting use of the sintered metal rounds is in shotguns in hostage rescue situations; the sintered metal round is used at near-contact range to shoot the lock mechanism out of doors. The resulting metal powder will immediately disperse after knocking out the door lock and cause little or no damage to the occupants of the room. Frangible rounds are also used by armed security agents on aircraft. The concern is not depressurization (a bullet hole will not depressurize an airliner), but over-penetration and damage to vital electrical or hydraulic lines, or injury to an innocent bystander by a bullet that travels through a target's body completely instead of stopping in the body.

Composition of a Frangible Bullet



Large Caliber Projectile

"The purpose of firing a large caliber projectile is not always the same. For example, one might need to create disorganization within enemy troops, create casualties within enemy troops, eliminate the functioning of an enemy tank, or destroy an enemy bunker. Different purposes of course require different projectile designs."

Many large caliber projectiles are filled with a high explosive which, when detonated, shatters the shell casing, producing thousands of high-velocity fragments and an accompanying sharply rising blast overpressure. More rarely, others are used to release chemical or biological agents, either on impact or when over the target area; designing an appropriate fuse is a difficult task that lies outside the realm of terminal ballistics.

Other large-caliber projectiles use bomblets (sub-munitions), which are released by the carrier projectile at a required height or time above their target. For US artillery ammunition, these projectiles are called Dual-Purpose Improved Conventional Munition (DPICM), a 155 mm M864 DPICM projectile for example contains a total of 72 shaped-charge fragmentation bomblets. The use of multiple bomblets over a single HE projectile allows for a denser and less wasteful fragmentation field to be produced. If a bomblet strikes an armored vehicle, there is also a chance that the shaped charge will (if used) penetrate and disable the vehicle. A negative factor in their use is that any bomblets that fail to function go on to litter the battlefield in a highly sensitive and lethal state, causing casualties long after the cessation of conflict. International conventions tend to forbid or restrict the use of this type of projectile.

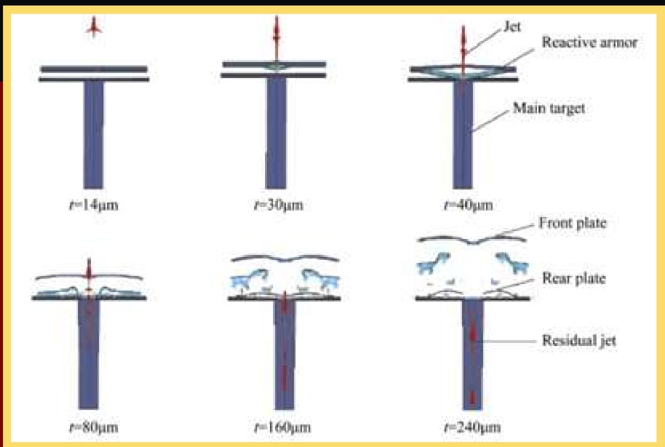
Some anti-armor projectiles use what is known as a shaped charge to defeat their target. Shaped charges have been used ever since it was discovered that a block of high explosives with letters engraved in it created perfect impressions of those letters when detonated against a piece of metal. A shaped charge is an explosive charge with a hollow lined cavity at one end and a detonator at the other.

They operate by the detonating high explosive collapsing the (often copper) liner into itself. Some of the collapsing liners go on to form a constantly stretching jet of material traveling at hypersonic speed. When detonated at the correct standoff to the armor, the jet violently forces its way through the target's armor.

Contrary to popular belief, the jet of a copper-lined shaped charge is not molten, although it is heated to about 500 °C. This misconception is due to the metal's fluid-like behaviour, which is caused by the massive pressures produced during the detonation of the explosive causing the metal to flow plastically. When used in the anti-tank role, a projectile that uses a shaped-charge warhead is known by the acronym HEAT (high-explosive anti-tank).

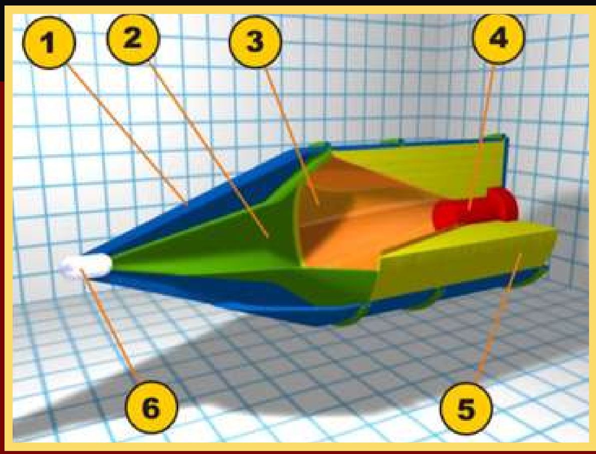
Shaped charges can be defended against by the use of explosive reactive armor (ERA), or complex composite armor arrays. ERA uses a high explosive sandwiched between two, relatively thin, (normally) metallic plates. The explosive is detonated when struck by the shaped charge's jet, the detonating explosive sandwich forces the two plates apart, lowering the jets' penetration by interfering with, and disrupting it. A disadvantage of using ERA is that each plate can protect against a single strike, and the resulting explosion can be extremely dangerous to nearby personnel and lightly armoured structures.

Explosive Reactive Armor (ERA)



Predicted results of demonstrated penetration process (normal impact).

HEAT (High-Explosive Anti-Tank)



1: Aerodynamic cover;
2: Air-filled cavity;
3: Conical liner (Often copper);
4: Detonator;
5:Explosive;
6: Piezo-electric trigger

Tank fired HEAT projectiles are slowly being replaced for the attack of heavy armour by so-called "kinetic energy" penetrators. It is the most primitive (in-shape) projectiles that are hardest to defend against. A KE penetrator requires an enormous thickness of steel, or a complex armour array to protect against. They also produce a much larger diameter hole in comparison to a shaped charge and hence produce a far more extensive behind armour effect. KE penetrators are most effective when constructed of a dense tough material that is formed into a long, narrow, arrow/dart like projectile.

Tungsten and depleted uranium alloys are often used as the penetrator material. The length of the penetrator is limited by the ability of the penetrator to withstand launch forces whilst in the bore and shear forces along its length at impact.

Limitations of materials and construction: LEAD

Malleable lead alloy or jacketed lead core projectiles conducive to expansion have been shown to be capable of exhibiting between 98 and 100% weight retention at velocities up to 2000 feet per second, however measures approaching an ideal weight retention in practice would generally be realized at lower velocities due to inconsistencies of impacted targets in the real world. According to various experience and methodology, the limit at which expanding lead projectiles of appropriate alloy can be launched with minimal contamination upon impact may be contended more or less within the vicinity of mach 2 speeds.

Several methods have been developed to improve performance under the stress of high velocities. Hard cast lead alloys have been utilized which are resistant to expansion and deformation of any kind. These hard cast varieties may be more brittle than softer alloys, but within their limitations are capable of exhibiting greater weight retention at velocities up to around 2500 feet per second. Whether or not they are of sufficient construction, cast lead bullets are typically not pushed at significantly higher velocities, as accuracy is subject to degrees of degradation, with relation to the type of alloy, form of the bullet, lubricants or coatings, and design of the barrel.

Bullets with an exposed lead tip which are designed to fire in excess of 2400 feet per second are typically made of a jacketed variety, encased in copper, brass, or iron/steel. There is less tolerance for gaps in understanding brought by research and development above the ordinary threshold of velocity for lead bullets. To mitigate significant material loss, the jacket of bullets may be bonded intricately to the lead core at a molecular level, typically by thermal adhesion or electrochemical processes.

It is generally acknowledged that bonded bullets are capable of increased resilience under severe stress. Depending on experience and methodology exemplary bullets can be observed which are theoretically capable of optimal weight retention under the hydraulic forces of impact velocities roughly in the vicinity of 2300 to 2700 feet per second. Designs with more reactive expansion characteristics may exhibit optimal weight retention at much lower velocities. Above their optimal threshold, bonded bullets with resilient alloys and construction may perform diminishing yet remarkable returns for weight retention, where standard jacketed varieties circumstantially exhibit the risks brought by severe loss of integrity, which manifests to various effect.

Additionally, the shape of the jacket material may be designed to mechanically retain a lead core to prevent the bullet from severely separating. This can be accomplished either by completely compartmentalizing separate sections of the bullet, or by a retaining shelf on the interior meant to lock the lead core into place to ensure a sufficient degree of the softer core can be reinforced by a stronger metal as it deforms. Such construction does not alter the limitations of a given alloy, but can allow for designs with highly reactive expansion characteristics in a given circumstance to retain sufficient mass for some length of penetration, even when significant loss of material is to be expected.

Conclusion: Understanding Terminal Ballistics for Practical Application

In exploring terminal ballistics, we've uncovered the science of projectile impacts and their practical implications. From the initial impact to the final resting point, understanding these dynamics is crucial for applications like law enforcement, hunting, and forensic science.

Key takeaways

Impact Dynamics: The velocity, angle of entry, and material properties of both the bullet and target dictate the nature of the impact, affecting energy transfer and deformation.

Wound Ballistics: Studying wound channels and cavitation helps design ammunition for specific purposes, ensuring the right balance of penetration and stopping power.

Material Response: Different materials react uniquely under ballistic stress, informing the design of protective gear and aiding forensic investigations.

Ammunition Design: Insights from terminal ballistics influence bullet design, ensuring effectiveness for military, law enforcement, and hunting applications.

Forensic Ballistics: Analyzing bullet impacts aids in reconstructing shooting incidents, determining firearm types, and providing critical evidence in legal cases.

"Understanding terminal ballistics extends beyond theory to impact life-and-death decisions in law enforcement and military contexts, ensures ethical hunting practices, and aids forensic scientists in uncovering truths. Advancements in materials science and bullet design continue to refine this field, promising more effective and specialized ammunition. As we conclude this series, it's clear that terminal ballistics remains essential for progress in safety, justice, and tactical efficiency."

Wessie van der Westhuizen, the CEO and founder of Wesco Forensic Services, is a distinguished expert in the field of forensics, particularly known for his extensive knowledge of terminal ballistics. With a career dedicated to advancing forensic science, Wessie has played a pivotal role in understanding how projectiles behave upon impact, contributing significantly to crime scene investigations and the pursuit of justice. His innovative approaches and deep insights have established him as a leader in the industry. We extend our sincere thanks to Wessie for sharing his invaluable expertise and shedding light on this critical aspect of forensic science.