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14. ABSTRACT
There is an occasional requirement to perform soft recovery of small caliber munitions in order to examine the condition of the bullets after they have been fired. A simple method using commercially available urethane foam has been successfully implemented. The details of the foam recovery technique are fully documented for future reference.

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1. Introduction

A recurring requirement in the small caliber test community is the ability to gently recover projectiles fired at full velocity so that they can be examined in order to determine the condition of the rounds that were fired.

This report documents a simple and inexpensive technique that yields excellent results. The technique consists of firing a projectile into an array of urethane foam blocks. The purpose of this report is to serve as a reference for future testing by describing the technique in sufficient detail so that the test set-up can be easily replicated.

2. Soft Recovery Requirements

The initial requirement was to recover 5.56-mm M855 projectiles fired from the M16A2 rifle at a nominal velocity of 927 m/s (3060 ft/s). It was desired that the projectiles not be deformed in any way during the recovery.

The technique needed to be inexpensive and simple to use. Previous soft recovery of these projectiles utilized ballistic gelatin blocks. In order for the bullets to remain undeformed, the gelatin had to be positioned 600-m downrange. Gelatin blocks are expensive, difficult to handle (heavy), and have a limited useful life, particularly at a warm ambient temperature. A simpler, less expensive technique was needed.

3. Soft Recovery Concept

3.1 Foam Parameters

The basic soft recovery concept was to use an array of urethane foam blocks to stop the bullet. Parameters that needed to be determined were:

- Foam density
- Foam stiffness
- Foam block dimensions
- Foam block array depth

Foam density and stiffness were the primary concern. If the foam was too hard, it could potentially damage the bullet. A foam that was too soft would take a long distance to stop the bullet. The foam block lateral dimensions are determined by the bullet trajectory into the foam. If the bullet continues to travel in a straight line once it enters the foam, then relatively small blocks of foam can be used. If the bullet veers off course, larger blocks of foam would be needed. The bullet trajectory in the foam would most likely be affected by the foam properties (density and stiffness).

3.2 Foam Selection

It was initially desired to use the soft recovery technique on a firing test scheduled three weeks from the time the concept was proposed. This allowed very little time for determination of optimum foam parameters. Initial telephone inquiries revealed several local foam suppliers. The one that was closest to the test center also had the best prices. Due to the short timeline, a "buy it and try it" approach was chosen. Although exact prices vary for different grades of foam, it was found that a volume of 3 × 3 × 20 ft of foam would cost on the order of $2,000. This meant a credit card purchase could be used and the purchase processed within the required schedule. The local supplier also allowed for picking up the foam rather than having it delivered, thus avoiding the additional costs and delays of shipping and receiving.

An initial visit to the supplier allowed for examination of numerous foam samples. Engineering judgment was used to select a candidate foam. The plan was to setup and test the candidate foam and then to possibly purchase additional foam depending on the test results. If the bullet was damaged during recovery, a softer foam would be used. If it required too much distance to stop the bullet, a stiffer foam would be used. The use of foam blocks of different stiffnesses in various combinations was also considered.

3.3 Foam Description

The foam that was initially purchased was:

Super Firm Angel Foam, Density 1.8, Compression 55, cut to 36 × 36 × 12-in blocks
Qty: 20 blocks
Unit Cost: $98.57 per block ($1971.40 total)
(Note: pricing is subject to change and is included for reference only.)

The supplier used was:

Houck's Upholstery Shop
239 Hopewell Road
Churchville, MD 21028
POC: Don Houck 410-836-2066

Subsequent purchases included 6-in thick blocks to facilitate bullet extraction from the foam as described below. Foam price is nominally proportional to volume and the foam blocks can be cut to size as desired (within reason). Therefore, two 6-in thick blocks cost essentially the same as one 12-in block.

4. Testing and Evaluation

4.1 Test Description

The initial test setup consisted of 20 blocks of 3 × 3 × 1-ft foam blocks, arranged to create a structure 3 ft high × 3 ft wide × 20 ft long. Kraft paper sheets were placed between the foam blocks in order to easily determine the trajectory of the bullet through the foam. The first foam block was located 80 ft from the muzzle of an M16A2 rifle. A standard charge M855 projectile was fired into the center of the foam at a nominal velocity of 927 m/s (3060 fps). The nominal projectile weight is 62 gr.

A typical test setup is shown in figure 1. Unfired and soft recovered M855 projectiles are shown in figure 2.

Figure 1. Test setup.

Figure 2. Unfired (left) and soft recovered (right) 5.56-mm M855 projectiles.

The M855 projectile was stopped after penetrating approximately 14 ft into the foam with a sideways trajectory deviation on the order of several inches. The recovered projectile appeared to be in good condition with no physical damage. The most notable differences are the rifling marks where the bullet engraved in the barrel, and the polishing effect of the foam which removed the green paint and black sealant from the projectile.

Since the preliminary test showed satisfactory results, additional tests were performed with different projectiles and weapons. In all cases the projectiles were recovered in good condition and were stopped within a reasonable distance. Some sample projectile recovery descriptions follow.

Figure 3 shows unfired and recovered 223 Remington Match projectiles which have an open tip. It can be seen in the figure that the tip has not expanded. These projectiles were fired at a nominal velocity of 2860 ft/s, and the nominal projectile weight was 69 gr. Stopping distance was again approximately 14 ft.

Figure 3. Unfired (left) and soft recovered (right) 0.223
Remington Match projectiles.

Figure 4 shows unfired and recovered 7.62-mm M118LR projectiles. These projectiles were fired at a nominal velocity of 2660 ft/s, and the nominal projectile weight was 175 gr. Stopping distance was ~22 ft. For these tests, the foam was located 240 ft from the muzzle due to other test constraints.

Additional testing was also performed with 40-mm grenades fired from the M203 launcher. The projectiles were inert M433 simulators, weighed 185 g, and were fired at a nominal velocity of 240 ft/s. The projectiles stopped ~12 in into the foam.

Figure 4. Unfired (left) and soft recovered (right) 7.62-mm M118LR projectiles.

It was also found that damage to the foam from individual shots was minor, and that the foam could be re-used numerous times. Figure 5 shows a foam block that has been impacted numerous times.

One occasional difficulty with the foam was extraction of a bullet that had lodged deep into the foam without excessively damaging the foam. The testing showed that for a particular projectile/velocity, the stopping distance was fairly consistent (±2 ft). It was thus decided to purchase additional foam blocks that were 6 in thick. These thinner blocks were then placed in the region where the projectile was expected to stop in order to simplify bullet extraction.

Testing has not been performed to evaluate the effects of a denser foam. This type of test would be of interest to see if the stopping distance could be reduced without inducing projectile damage. The current test requirements have been met, and there is no active research effort geared towards optimization of the foam recovery system.

Figure 5. Foam block showing minimal damage from multiple impacts.

5. Summary

A simple method for soft recovery of small caliber ammunition has been developed, implemented, and documented. The method uses relatively inexpensive commercial off-the-shelf foam blocks. The method has been successfully used for projectiles ranging from 5.56 to 40-mm diameter.

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