The Proving Mortar

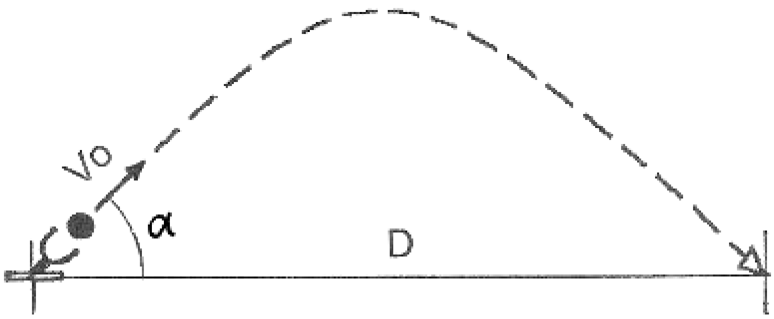
Testing Black Powder with a Mortar

As a practical shooter, I usually test my powder by means of a muzzle loading rifle and/or pistol. I measure the muzzle velocity of the bullet. (See my "recipe" section). But that requires a chronograph, for measuring bullet speed, which costs a small fortune. And I have shot to pieces two of them already. An alternative is the ballistic pendulum, a somewhat clumsy instrument.
During the days when only black powder firearms were available, powder was usually tested by the manufacturer, as well as by merchants, by means of a proving-mortar.
According to the contract between the Swiss Powder Administration and the powder mill, Art. 20, dated Aug.12th 1849, this French model proving mortar had to shoot this very ball at least 715 Swiss feet (210 meter) by a charge of 98 grams of powder. Then the powder was accepted by the federation.

Fig. 1:
Proving mortar of the Swiss powder mill in Aubonne. No longer used, since the barrel cracked some 20 years ago while demonstrating it to a visitors group.

Fig. 2:
A glimpse into the barrel , cal. 19 cm, length 25 cm. Clearly outlined is the powder chamber at the bottom of the bore.

This method of powder testing takes advantage of the fact that the distance(D) of the projectile fired from a mortar is directly proportional to the powder's energy (E).



Calculation of ball/powder energy:

$$D = \frac{Vo^2 \cdot \sin 2\alpha}{g} \quad (m)$$

$$E = \frac{m \cdot D \cdot g}{2 \cdot \sin 2\alpha} \quad (Joule)$$

where:

Vo = muzzle velocity (m/s)

m = bullet mass (kg)

α = muzzle elevation

g = gravity (9.81 kg m/s^2)

E = energy (Joule)

<u>And note:</u> At an elevation of 45°, sin 2α =1.000

For example:

A 40 millimeter bearing ball used for a projectile weighs 0.272 kg. The load used is 1.00 grams of powder. Assuming, the ball travels 100 meters, - a reasonable distance to measure. Then the bullet/powder energy is:

$$E = \frac{0.272kg \cdot 100m \cdot 9.81}{2 \cdot 1.000} = 133 Joule \text{/g powder}$$

<u>My Method:</u>

Since a ball of a ball bearing is usually ground and polished to within a100th of a millimeter, I have drilled the barrel with a tolerance of one tenth of a millimeter. As such,
a patch is not required. The breech face of the mortar is contoured to match the shape of the ball having a radius of 20 mm. (Round head drill bits are readily available).

Fig. 2:
This is the mortar that I have used for many years. Made of stainless steel 18/8, with a bore of 40 mm at an elevation of 45°. It has three feet and a base plate that can be levelled out by means of two screws (at the rear). Level is found by means of a spirit-bubble (fixed at the left front corner)
A bright red cord attached to the projectile is helping to facilitate its recovery. The ball usually burrows some inches deep into the earth upon impact.

Ignition is by means of slow match. To minimize pressure loss, the touch hole is drilled very small, only 1.0 millimeter diameter. For reliable ignition there was used a mixture of barium-peroxide and zirconium as priming powder, a very hot flash.

Fig 3:

Firing the proving mortar near my home.
There is a large flat meadow, usually with no pedestrians or cattle on it.
The flying ball is barely visible in the blue sky, so I outlined it by the white circle.

Some major results:

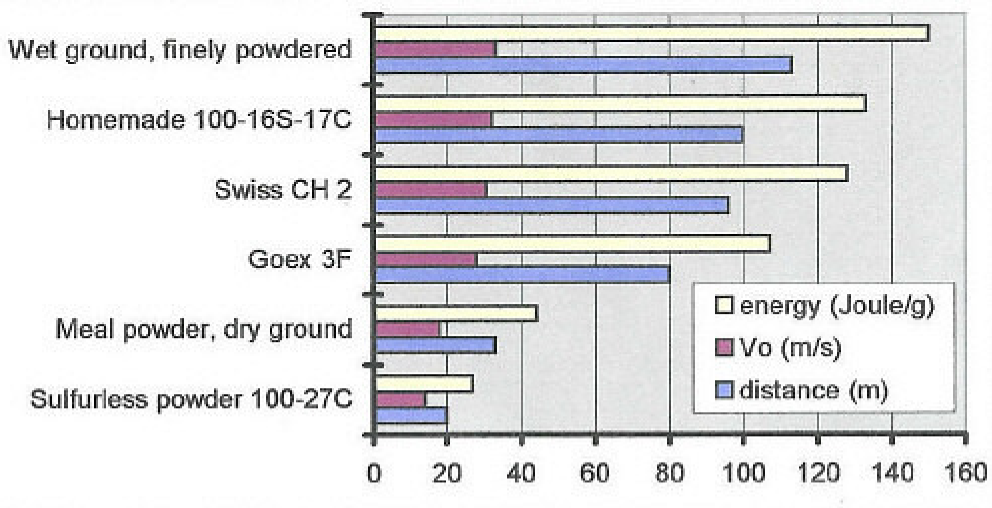


Fig. 4: Results fired with 1.00 gram of different powders

Conclusion

Ballistics measured with a mortar are not comparable with those determined by a rifle. For example, an Enfield rifle, loaded with 2,0 grams of Swiss black powder CH2 yields 400 Joule/g, where as the mortar yielded only 128 Joule/g. Even more disappointing are the results of sulfurless powder. Here, the rifle showed 370 Joule/g while the mortar only showed 27 Joule/g.

So, the mortar predominantly demonstrates the explosivity power of a powder, while the rifle will demonstrate its performance as a propellant.

Ulrich Bretscher,
Uznach, Switzerland
Dez. 12th 2009