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Destructive Testing and Field Experience with HDPE Mortars

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In an earlier article on High Density Polyethylene (HDPE) mortars, results from an initial series of tests were published (*Pyrotechnics Guild Int'l. Bulletin*, No. 54, p 5). Those results will not be repeated here. This article continues by presenting the results from an additional test, a summary of the author's field experience since the first article, and comments on HDPE mortar use in England by Rev. Ron Lancaster.

Destructive Mortar Tests

Three tests were performed in which a 22" long 3" diameter HDPE mortar (SDR = 13.5, resin type PE3408) was staked above ground and a 3" salute was exploded in the bottom of the mortar. Approximate determinations were made of: 1) the percent weight loss of the mortar due to fragments leaving the mortar, 2) the radius and area through which fragments were found to have been propelled, and 3) the shape and weight of typical fragments. In the three tests, the mortars were at three different temperatures (5, 40, and 80 °F); however, no temperature dependence was observed in these very limited tests. On average, 6% of the mortar's weight was lost as fragments (not counting the loss of the wooden mortar plug). The fragments were found to have been propelled to a maximum distance of approximately 100 feet, which corresponds to an area of about 30,000 square feet. A typical fragment was stretched to about 1/3 its original thickness, was roughly leaf-like in appearance, and weighed about ½ ounce. Judging from the shape and weight of the fragments, it is estimated the serious injury to a properly clothed and positioned shooter, even if struck by one of the few fragments, was unlikely.

As a comparison, two similar tests were performed using 24" long 3" diameter PVC mortars (Sch. 40). In this case, nearly the same range of mortar temperatures were used (10 and 80 °F). As above, no temperature dependence was observed. On average, 80% of the mortar's weight was lost as fragments. Those fragments were frond to have been propelled to a maximum diameter of approximately 175 feet, which corresponds to an area of about 100,000 square feet. A typical fragment retained it original thickness, had sharp edges and jagged points, and weighed one or two ounces. Judging from the shape and weight of the fragments it is estimated that serious injury to a properly clothed and positioned shooter was likely if struck by any of the large number of fragments.

The stretching thin of HDPE mortar fragments causes them to be slowed more rapidly after being thrust into the air from a bursting mortar (they are more like a feather than a rock). However, this stretching has an additional safety benefit. The mechanical energy that is consumed in thinly stretching the fragment is, in the process, converted into thermal energy, raising the temperature of the fragments. Calculations suggest that the stretching will result in a temperature rise of about 40 °F. The HDPE fragments are somewhat flexible to begin with, but they become more flexible as their temperature rises.

From these limited tests, it seems fairly clear that HDPE mortars present less danger to nearby persons and equipment in the event of a shell detonation within them, than PVC mortars similarly stressed.

Limited Field Experience

During the recent season, HDPE mortars were used by the author on four displays in which approximately 800 three to six inch shells were fired. (The equipment used to fire the shows positions the mortars in very close proximity to each other in steel racks. The so-called dense-pack set-up was described in a

paper appearing in *Pyrotechnica XI*.) Although several flower pots were observed to have occurred, only two mortars were damaged. In one case the plug blew out and the bottom of the mortar split for about three inches. In the other case, the plug blew out and a bulge occurred about half way up the mortar. In neither case were any fragments generated (except for the mortar plugs) and there was absolutely no damage to the rack or to adjacent mortars.

Lancaster's Comments

The following is an abridged quote from a recent letter from Rev. Ron Lancaster, a noted author and pyrotechnician.

"I notice that you were asking a question about polyethylene mortars and really do know quite a bit about this and think I can say that I have pioneered the use of these materials in this country. ... Quite near to us we have one of the two principal manufacturers of high density polyethylene pipe and I bought material from them over ten years ago and can say that we are still using the original tubes that we bought from them then. We have many hundreds of these now and we buy a few more each year. ... So far we have never had a serious accident with any of them and I have often wondered what would happen if, for example, a three-inch salute went in such a tube. It did, in fact, happen last year and it burst roughly half-way up the tube and I am happy to say that it 'belled' the tube in the centre ... and at one point the heat was sufficient to actually melt the plastic in the bell portion to let the gas come out. This piece of information was really quite useful to us and really I was quite gratified to see what had happened. ...

I think that you will find that these mortars are very useful indeed and much superior to paper.

With every good wish,

Yours sincerely,

Ron Lancaster

P.S. Needless to say we never use PVC."