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File: 3.5-1

January 11, 1966

22 CALIBER BULLET IMPACT TESTS OF FIBERGLASS REINFORCED THERMOPLASTICS - REPORT #1

On January 7, 1966 I tested two samples of our compression molded, glass fiber reinforced thermoplastic materials by mounting them firmly on a 2"x 6" pine plank and then shooting them at point blank range - 10 feet - with a rifle using Winchester super-speed 22 caliber long rifle bullets. The samples were crescent shaped and five inches along the straight edge.

One sample was a 30% Lexan - 70% glass fiber ($\frac{1}{2}$ inch long, randomly distributed fibers). It was 3/8" thick. The bullets were stopped when the shots were fired perpendicular to the target. When at an angle, the bullets ricocheted off, ripping up some of the fibers. It appeared that as the bullet entered the material it mushroomed and was stopped by the glass fibers. The bullet itself was spread out and imbedded in between layers of fiber. There were large mounds, about five times the diameter of the bullet, on the back of the sample behind the bullet entry holes.

The other sample was 30% high molecular weight polyethylene - 70% glass fiber. It was $\frac{1}{4}$" thick. Again, the fibers were $\frac{1}{2}$" long and randomly distributed in the compression molded blank. The results of this test were better. There appeared to be less penetration of the bullets. The final shape of the bullet was much flatter and in one case was waffer thin. Again, angled shots were ricocheted resulting in ripped fibers and a shallow groove.

Conclusions

From this simple test I conclude that the high density polyethylene sample stopped comparable impacts from bullets more effectively than the Lexan sample.

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22 CALIBER BULLET IMPACT TEST OF FIBERGLASS REINFORCED THERMOPLASTICS - REPORT #2

On January 8, 1966 I tested five samples of glass fiber, reinforced thermoplastic materials. These samples were not supported against a flat backing surface but were supported only by two outside edges, leaving only airspace behind the bullet impact areas. I shot the samples at a range of ten feet using a rifle and Winchester super-speed 22 caliber long rifle bullets. The samples were crescent shaped of various sizes but were all cut from 5 inch diameter discs of varying compositions.

Sample Composition	Thickness	Results
70% Lexan 30% ½" glass fibers randomly distributed.	3/8"	The bullet went right through the sample, then through a piece of 3/8" plywood and finally imbedded itself in a thick plywood board.
50% Lexan 50% tightly woven glass cloth - layered silicone sizing treated.	3/16"	The bullet was retained in the sample about one-half way through. The Lexan was shattered and broken on the surfaces and parted from the glass cloth easily.
30% Lexan 70% tightly woven glass cloth - layered silicone sizing treated.	1/8"	The bullet was completely retained, but the sample was ripped apart. The bullet penetrated about one quarter of the way through the material making a nice, clean round hole. Then it mushroomed out and forced the remaining 3/4 of the material back away from the first quarter. Thus, the material was separated layer-wise from itself with a ½" airspace between the 2 sections. The bullet was found mushroomed against the back layer but not penetrating it.
30% Lexan 70% tightly woven glass cloth - layered silicone sizing treated.	1/4"	Three shots were fired. All three were contained and the piece showed little material damage except for bumps on both sides of the shots. Two of the shots were fired so that their bullet holes overlapped. The second shot thus entered material damaged by the first shot but was nevertheless very adequately contained. Their was no evidence of failure of the glass cloth on the rear side of the sample.

Sample Composition	Thickness	Results
50% Diamond 3010 Cat. #10474 50% ½" glass fiber randomly distributed.	1/4"	The bullet penetrated the piece but the piece was only 3/4" wide and 3½ inches along the straight edge. This test was not too valid.

Conclusions

I conclude that:

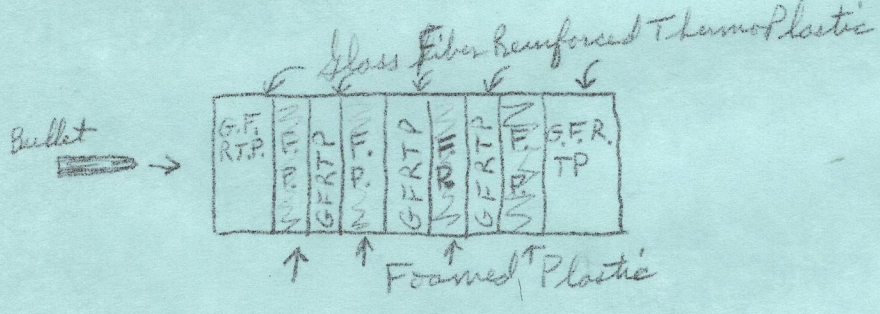
1) Fiberglass cloth appears to be more effective than randomly spaced short length glass fibers. However, long length glass fibers 4-8 inches long must be evaluated and compared with these results.

2) A very thin section of material (1/8") is sufficient to stop a 22 caliber bullet at a range of 10 feet.

Recommendations

1) These materials be fully investigated when full military testing procedures are known.

2) A composite layered material be evaluated for armor plating purposes. The first layer penetrated should be one that would begin mushrooming the bullet. Then there should be a soft foam layer about 1/8 to 1/4 inches thick. Next, these should be a series of 1/8 to 1/4 inch pieces of fiberglass reinforced thermoplastic materials interspaced with soft layers. Finally, there should be a relatively thick layer of fiberglass reinforced thermoplastic. An edge view of this would be as follows:



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