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THE BLAST AND FRAGMENT RESISTANT CONSTRUCTION SYSTEM (BFR) for AMMUNITION QUICKLOAD PROGRAM

The DOD

EXPLOSIVE SAFETY BOARD SYMPOSIUM

St. Louis Missouri

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THE ASP CONSTRUCTION SYSTEM
for
AMMUNITION QUICKLOAD PROGRAM

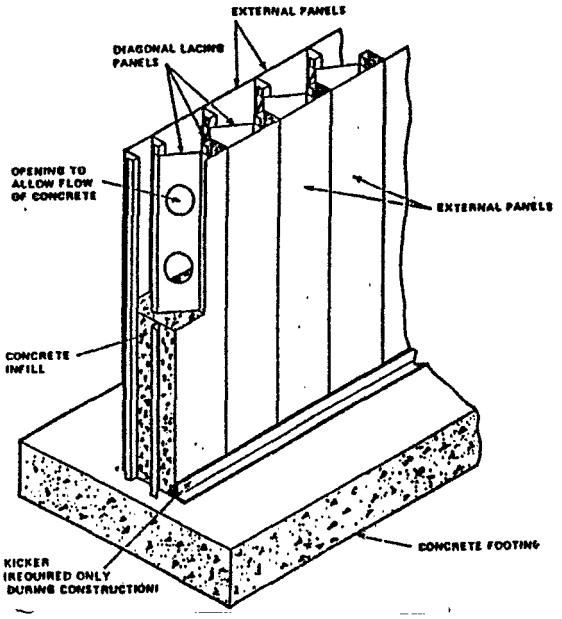
Yaakov Yerushalmi

1.0 INTRODUCTION

The patented blast and Fragment Resistant construction system (BFR), known as the ASP, was developed for use in structures to resist the effects of accidental explosins, protective structures for the military and against acts of terror. The system has been tested extensively, and these tests show a significant price and cost performance advantages of the BFR system, as compared to reinforced concrete alternatives, in a wide range of accident and malevolent threat scenarios. This paper will briefly describe the system, its applications, main tests performed and recent tests, performed by the Ballistics Research Laboratory (BRL) for Ammunition Quickload Program. The purpose in the BRL test was to assess whether BFR movable panels can prevent chain detonation of trucks loaded with ammunition at a distance of 15 ft.

2.0 SYSTEM DESCRIPTION

The wall element of the BFR system, is a composite structure of interior and exterior steel panels and diagonal internal steel lacing panels, filled with a special concrete mix. (See figure 1). The BFR wall is erected on conventional concrete foundations, Roof slabs are constructed using a bottom BFR exterior panel in a similar manner to floor decking.
Reinforcement bars are used to tie the walls to the foundation, to the roof, or to intermediate slabs. BFR beams and columns cab be utilized to strengthen structures. Almost any exterior or interior finish can be applied to BFR walls and buildings. Standard BFR walls are 8", 10", or 12" thick. When a single BFR wall cannot supply the required protection, a layered or "sandwich" design in utilized. A representative BFR sandwich wall consists of two sepratate 8" thick BFR walls, separated by 16" void. The 16" void is filled with 2" diameter stones. (See Figure 1).



BFR Panel Assembly (ASP)

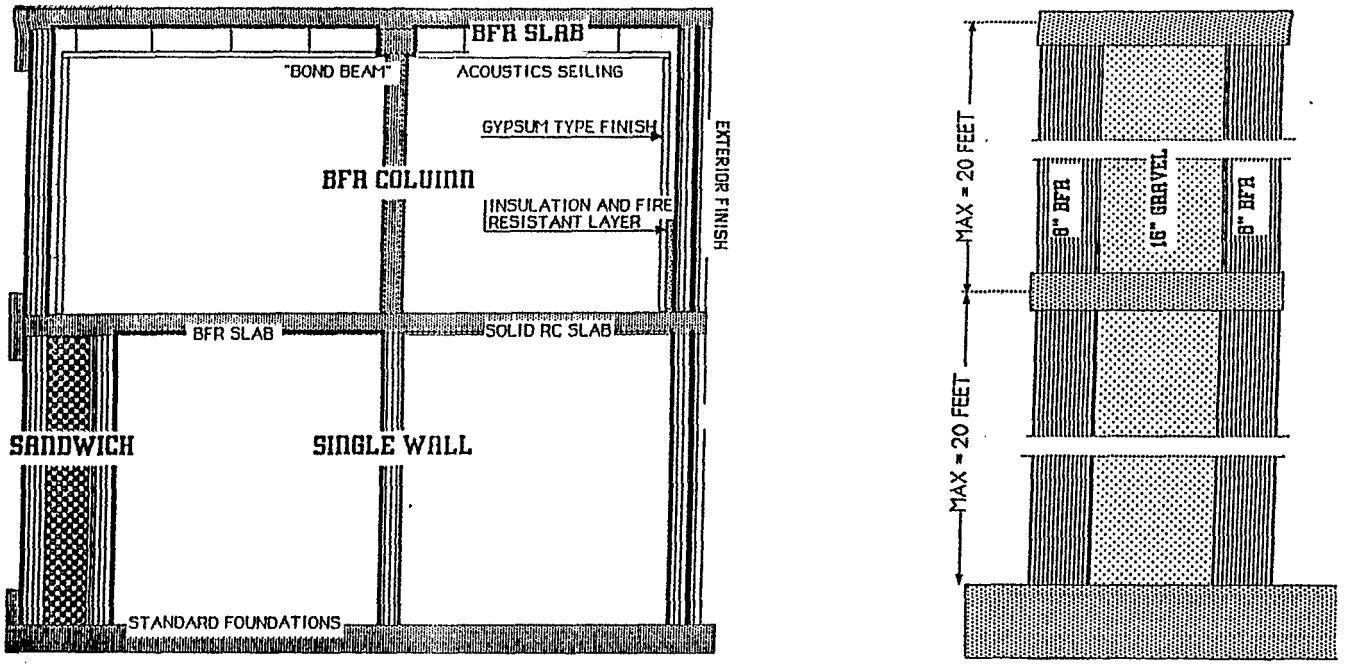


Figure 1

The system is in use for the following applications.

(a) SAFETY - Ammunition and explosives magazines. Separation walls for upgrading the protection levels in exsisting explosive facilities, utilizing minimal space, enabling quick and clean construction. Production and testing chambers for confined or semi-vented explosions. Protected control rooms and bare cubicles.

(b) MILITARY - Structures and separation walls designed to withstand near miss of air bombs.

(c) ANTI-TERROR - Structures, such as computer centers or embassy buildings, designed to withstand terrorist and demolition attacks using car bombs, direct hit of shaped charges, and heavy placed charges. Upgrading protection levels of exsisting buildings.

(d) SHIELDING - Protective structures with requirements for RF or EMP shielding.

(e) BARRIERS-US standard for protection of sensitive facilities (Reference 1).

3.0 GENERAL TESTS PERFORMED ON THE BFR SYSTEM

Four different tests of buried and above ground BFR box structures (wall thickness 10") subjected to near miss of MK-82, MK-83 and MK-84 aerial bombs. Tests established that for a near miss criteria a 10" BFR wall section is equivalent to 20" RC. The high resistance to fragmentation is achieved due to the well anchored back and front plates eliminating back spalling, front cratering and edge effects. The back and front plate together with the diagonal panels confines the concrete, having a higher strength compared to standard RC.

The Naval Surface Weapons Center test (Reference 2) was intended to assess the resistant capabilities of the BFR sandwich construction against repeated direct hits of RPG-7 warheads. Five rockets were detonated on a circumscribed target area of wall (1.65 sf). The sample tested was a sandwich section consisting of 8" BFR wall, a 16" gap filled with 2" size granite stones, and a rear wall of 8" BFR. Maximum penetration was 19"; average penetration of the five rockets was 16". Penetration in the BFR section is about half of the penetration of the RPG-7 warhead in solid RC section. The measured results of this test are similar to the result of two different tests performed outside the USA. The conclusion is that the 32" thick layered BFR sandwich section is equivalent to a 50" solid RC section.

The purpose of the French Corps of Engineers test (Reference 3) was to apply reflected pressures with relatively long duration on BFR gable wall, simulating scenarios of accidental explosion of ammunition magazines. (See Figure 2).
A BFR wall panel 11.5 feet long, by 10 feet wide, was constructed on a heavy steel frame. The steel frame was bolted to an existing heavy concrete structure. The BFR wall was bolted to the top and the bottom of a steel frame. Sliding or movement of the BFR wall was precluded.
The blast loads were generated by detonation of 1750 lbs of TNT at various distances. Free field and reflected blast parameters were measured, as well as strains, accelerations, and displacements. Four detonations were done starting with a peak reflected pressure of 7 psi up to peak reflected pressures of about 200 psi with positive duration of about 15 msec.
The conclusin from this test is that 10" thick BFR wall can serve for the construction of front gable wall of ammunition magazines.

4.0 THE AMMUNITION QUICKLOAD PROGRAM

The "Quickload" tests used large quantities of ammunition on flat-bed trailers. Ammunition for USA millitary units are stored on flat-bed trailers in compounds near inhabited buildings. Most of the ammunition consists of mass-detonating munitions. If one trailer load detonates there is currently no fully satisfactory method to prevent detonation propagation of munitions on other trailers.
The purpose of the test was to assess whether BFR movable panels can prevent chain detonation of ammunition trucks. Five movable BFR panels 12" thick and 8' high were placed between two trucks loaded with ammunition. Distance between the side line of the ammunition stored on the trucks was 15'. The Donor trailer contained 160 M107 projectiles (155mm) and 160 staggered M3A1 propellant charge cans. The Acceptor trailer contained 96 projectiles and 96 M3A1 propellant charges.
The test took place in March 1988 (Reference 4). Accidental detonation was simulated by simultaneous detonation of four rounds on the Donor truck. All the projectiles of the Donor truck were detonated. A crater of 58" deep x 25 feet x 24 feet was left by the explosin.

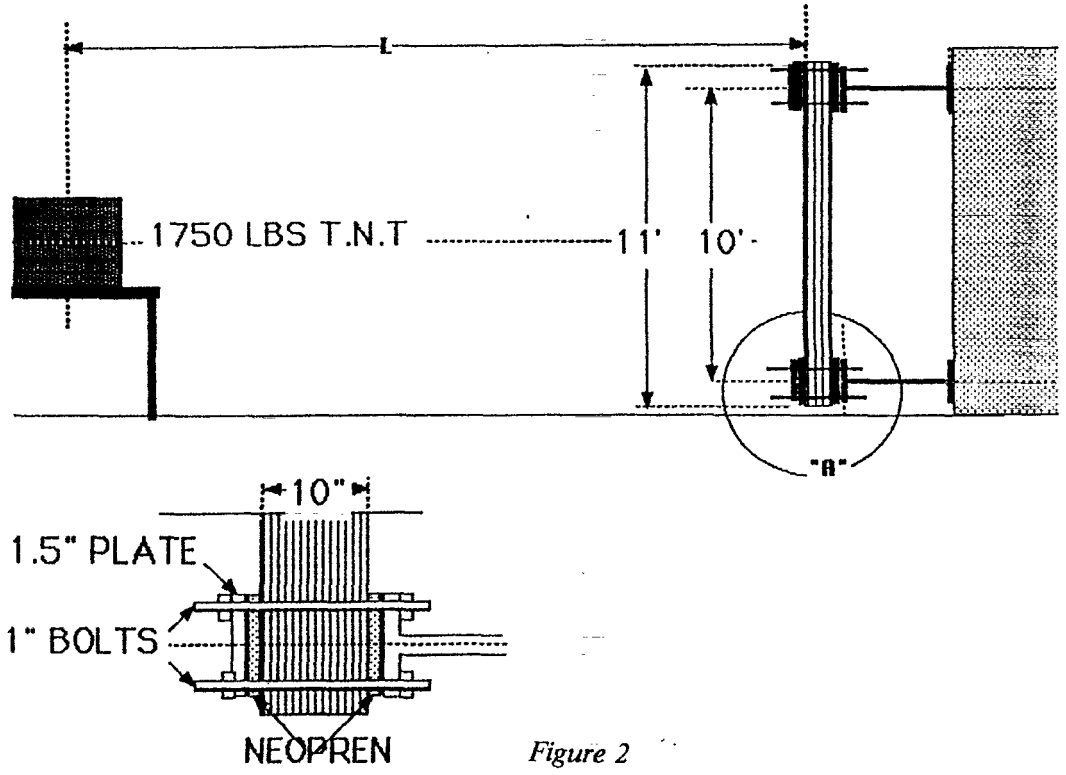


Figure 2

The test has revealed success since a chain detonation was prevented (Figure 3). The overpressure at a distance of 450 feet was 1.72 psi at 550 feet, 0,89 psi and at 650ft 0.74 psi. Two additional tests (Refernce 5) which had identical setups to the test described above, were carried out in FEB 1989. Both tests were successful, with similar results.
Based on three successful tests the recommendation of BRL is that the specific BFR movable wall can be used to separate truckloads of ammunition which have a Net Equivalent Weight of 2500 lbs with a minimum separation distances of 15 feet. For Basic load Ammunition Holding Areas (BLAHA), shielded with the BFR system, the Q-D requirement for publick traffic routes is 600 feet and unhabited building distance is 900 ft regardless of the number of loaded trucks.

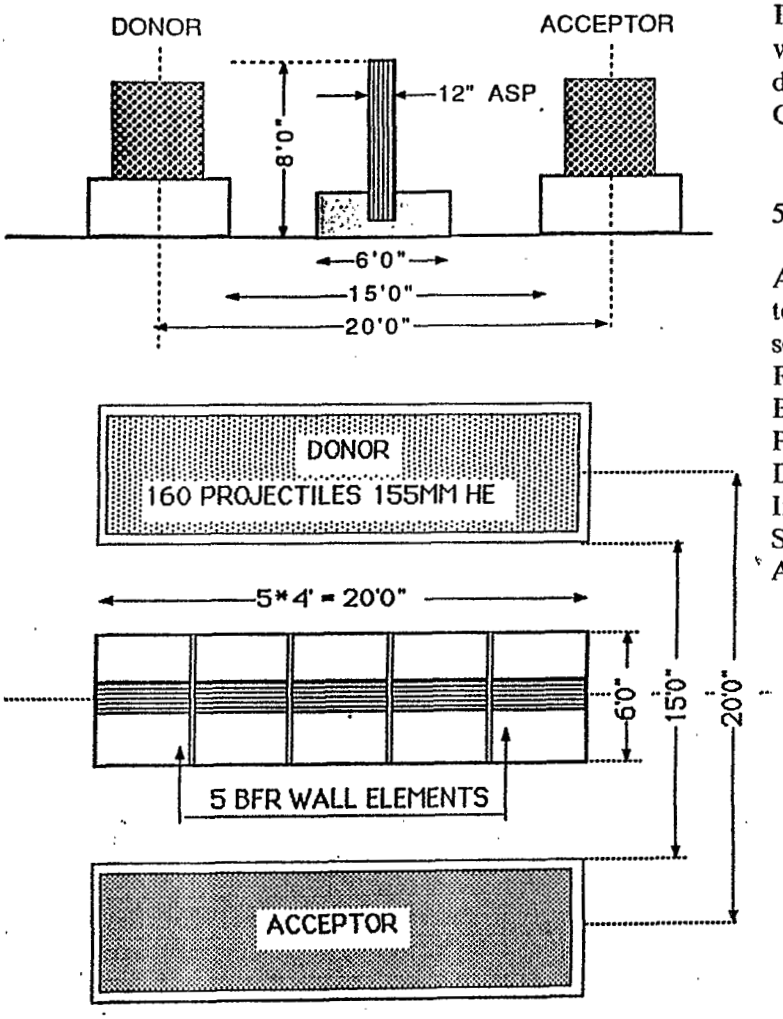


Figure 3

5.0 LIST OF REFERENCES

5.1 Reference 1

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5.2 Reference 2

Testing of the ASP sandwich barrier with shaped-charges (RPF-7) warheads by H.M. DeJarnette Research and Technology Department, 19 February 1986. Naval Surface Weapons Centers, White Oak, Silver Spring, Maryland 20903-5000.

5.3 Reference 3

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5.4 Reference 4 & 5.

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