Ballistics Testing

of

Verticrete Precast Ledgestone Wall Panels

UL 752, Level 4

for

Hawk Construction

5002 U.S. Highway 380

Princeton, Texas

By

Carr Consulting, Inc.

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Ballistic Testing

Hawk Construction requested Carr Consulting to perform ballistic tests on two of their products. Both products are precast fence panels. These panels are required to pass a UL 752, Level 4 ballistics test. Two patterns were tested: Ashlar, and Ledgestone. Since each pattern has a different depth and thickness each was tested separately. This report applies only to the Ledgestone pattern.

Each panel is made of solid, precast concrete. Panels have raised patterns with the thinnest areas being the mortar joints. These joint areas are typically approximately 4 inches thick. Each test was performed at a mortar joint. Testing the thinnest section gave conservative results. . Although UL 752 only requires a 12 inch square sample, we tested an actual panel. Testing a full size product matches an installed condition better than a limited size sample. A smaller 2 foot tall sample was used in Ledgestone to determine in a smaller size decreased the resistance.

Testing Method
Precast panels are required to pass a level 4, UL 752 ballistics test. The requirements for the test is a as follows:

A. UL 752 Requirements
    a. Test Method:
        i. UL 752, Level 4 (Part 1)
        ii. Version = UL752-Rev. October 5, 2005
    b. Testing Requirements:
        i. Munitions:
            1. Caliber = 30-06
            2. Cartridge Type = 180 grains JSP
            3. Projectile = Soft Core
            4. Velocity = 2540 – 2794 fps
    c. Allowable Test Temperatures = 55, 72, 95, 120^{o}F
    d. Firing Distance = 15 feet
    e. Witness Board Distance = 18 inches
    f. Witness Board Thickness = 0.125”, Corrugated Cardboard
    g. Shots Required = 1
    h. Criteria for Passing:
        i. Projectile may not penetrate sample

Testing

Testing was performed at Hawk Construction's facility in Princeton, Texas.

B. Test Conditions:
   a. Date: December 29, 2014
   b. Outdoor
   c. Temperature = 55°F
   d. Winds = Calm
   e. Clear Skies

C. Test Equipment
   a. Munitions:
      i. Sellier & Bellot 30-06
      ii. 11.7g, 180 grains
      iii. Soft Point
      iv. No. 2937 (See Figure 1 & 2)

Figure 2

Figure 1

a. Weapon:
   v. Remington
   vi. Model 703, 30-06 (See Figure 3 & 4)

Figure 4

Figure 3

b. Mount:
   vii. Caldwell Lead Sled Plus
   Straps were added to improve the stability during firing.
   viii. Manual Remote Trigger
   The trigger was pulled 25 feet behind the weapon. The operator stood behind another 5" thick concrete panel with a concrete cover.
   ix. The sled and stand was stabilized by 90 lbs. of concrete weights

Figure 5

Figure 6

Figure 8

Figure 7

Figure 9

D. Safety
   a. All shots were discharged against a precast concrete structure behind the witness plate. The weapon was protected by 5 inches of concrete to prevent damage to the weapon or the engineer. A 25' long pull cord was extended behind another concrete barrier and lid for added operator safety. Hearing and eye protection was worn during all firing events.

E. Sample
   Figure 12 shows the untested sample.
   a. Verticrete Fence Panel
      i. Ledgestone Pattern
      ii. Concrete, f_c = 4,000 psi
      iii. +30 days curing time
      iv. Not temperature sensitive. The test was carried out at ambient temperature.

Figure 11

Figure 10

Figure 12 shows the Ledgestone pattern on a 2’ height sample. Figure 11 shows the original state of the witness board for the Ledgestone Shot 1.

Figure 12

Shot distance of 15 feet is verified in Figure 12.

F. Shot 1

For Level 4 protection, the panel needs to resist only one shot. The red laser mark in Figure 15 shows the target area. Firing at the thinnest section was chosen to give conservative results.

Figure 13

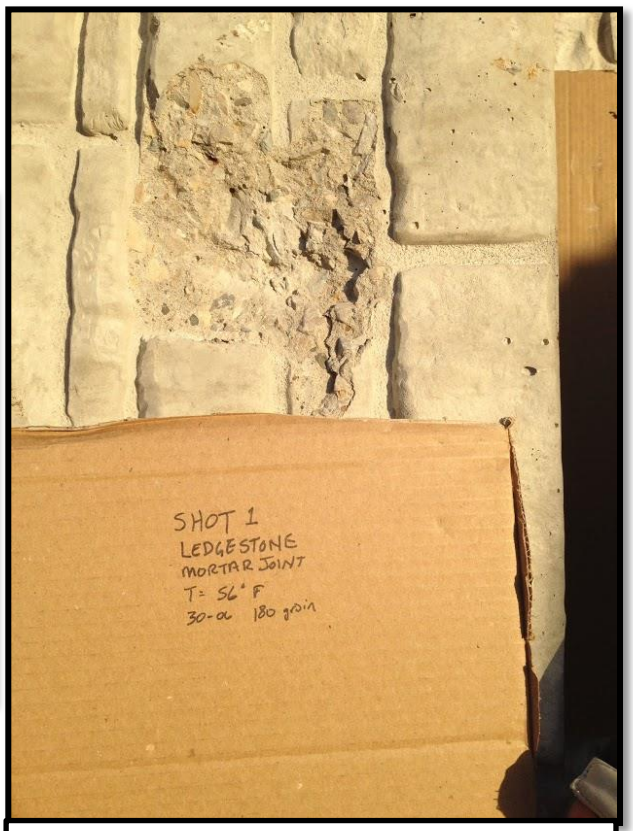


Figure 14

Figure 13 was taken after the first shot. The front shows no signs of penetration through the sample. Material ejected from the surface is limited to a 4" x 3" area. There is no indication any part of the projectile remained in the panel. The rear of the panel shows no signs of damage, see Figure 14. No part of the witness board shows any signs of projectile penetration or debris damage.

Figure 15

G. Shot 2
Although only one shot is required to comply with the standard, we were curious what a second shot would do. The weapon was reloaded. The aim was checked and adjusted to hit the same place as the first shot.

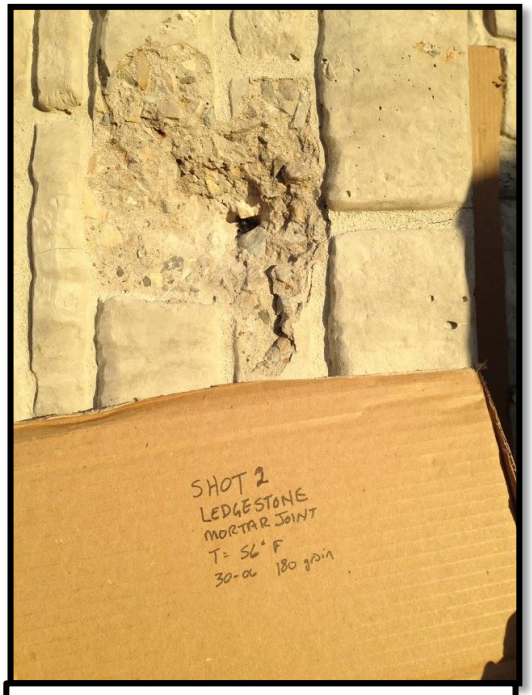


Figure 17

Figure 16

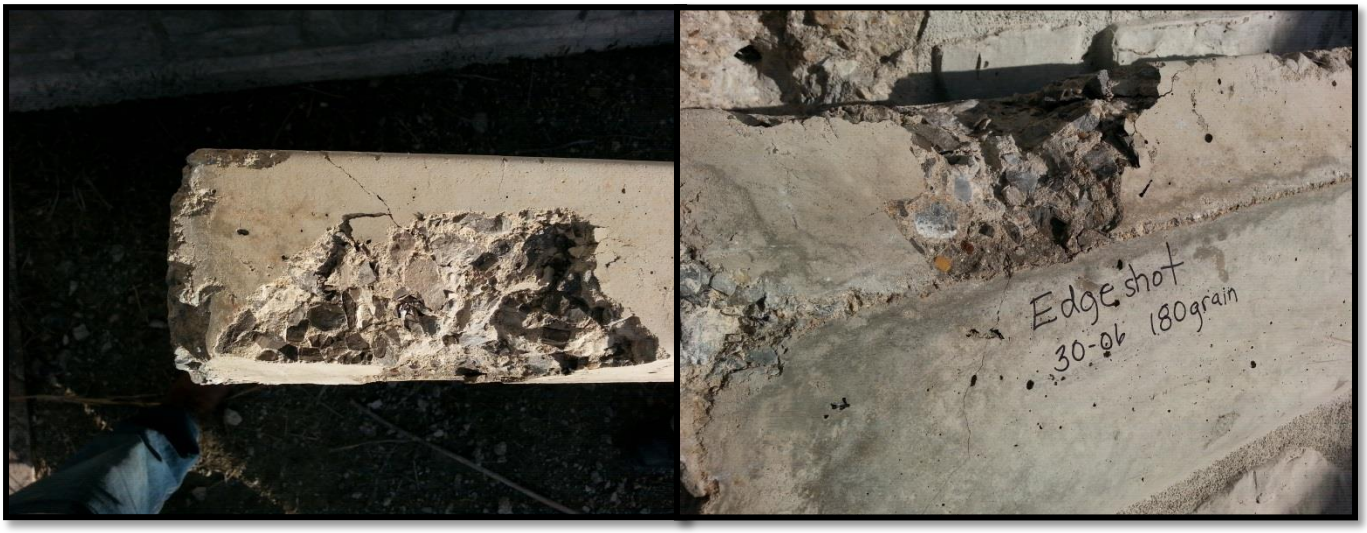
Figure 18

Figure 19

Shot 2 lodged in the panel. It didn't penetrate. However, the shot damaged the rear side of the panel. Debris can be seen on the ground. The witness board shows minor damage from concrete fragments hitting it.

UL 752, Level 4, Part 2

Part 2 of this standard is meant to ensure a shot along the edge will not penetrate the product.



Spalling on the edge shot was worse than on a center shot. However, the projectile didn't penetrate through the sample. Only one shot is required.

Results and Discussion

Verticrete's Ledgestone pattern, concrete panel was tested as per UL 752, Level 4 for ballistic protection. Since all of these products are outdoors, the product was tested as it would be installed. The result of this test was clear. Verticrete's Ledgestone pattern concrete panel EXCEEDS UL 752, Level 4 for ballistic protection. The UL 752, Level 4 standard is used by Homeland Security as a requirement for all fencing around electrical substations, as well as many other venues. These panels meet the requirements set by Homeland Security to protect electrical substations and ancillary equipment.

If you have any questions or comments, feel free to contact me at 972-786-5401.

Sincerely,

John P. Carr, P.E.