Cercorp Initiatives

NCFI - FlexLock®
Foam Suitability Test

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1.0 INTRODUCTION

This report describes the results of tests using a low-density polyurethane foam in the cavity of a FlexLock® wall segment. The FlexLock® Wall System is a complete load-bearing masonry structure designed as a mortarless alternative to standard concrete block construction. The test was conducted in-house by Cercorp Initiatives Inc. of Steubenville, Ohio with materials provided by North Carolina Foam Industries (NCFI) of Mount Airy, North Carolina.

1.1 UNDERSTANDING THE PROBLEM

In order to successfully dry-stack masonry, a certain amount of clearance is required between the male and female head joints to allow for jamb-free assembly. While this facilitates construction, it does permit the entry of water beyond the exterior face shell. To address this problem, a water diversion strategy was devised. This strategy led to modifications employing channels formed in the interior of the units. These channels diverted water down through the wall cavity to weep holes at the base of the wall. An ASTM E-514 water penetration test was performed by the National Concrete Masonry Society (NCMA) to observe the effectiveness of the modifications (Project #02-269) . The test panel was subject to sustained winds at 62.4 mph, 5.5" of water per hour for a duration of four hours. The water diversion modification stopped 93.3% of the water from migrating beyond the interior face shell. While this was promising, another strategy needed to be devised to stop 100% of the water.

A barrier method was envisioned using a foam product to completely exclude water from entering the wall cavity. Another ASTM E-514 water penetration test was performed (Project #02-269) by the NCMA lab using a urea formaldehyde product provided by the FOM Company. This product proved unstable and allowed 4.8% of the water to migrate through the interior shell.

1.2 OBJECTIVE

The primary objective of this test is to determine the suitability of NCFI foam for use in the FlexLock® Wall System as a means to:

(1) Completely Stop the Flow of Water to the Wall Cavity The polyurethane material is waterproof thus the test need only fill the wall cavity blocking the head and bed joints. Once this is established, an ASTM-E514 will be performed on a foamed wall segment to verify the watertight integrity of the system

(2) Ensure That the Units Are Not Stained by the Foam Architectural block such as split-face and brick-face require a consistent look. Accidental contact by foam with these surfaces could alter the appearance resulting in an unattractive and inconsistent look. The test will consider a strategy to remove accidental contact thereby maintaining the consistence of appearance.

2.0 MATERIALS

2.1 CONCRETE MASONRY UNITS

All of the concrete masonry units used in the research program were hollow 8x8x16-inch FlexLock® concrete masonry units (Figure 1). All of these units were manufactured at the same time to reduce any possible variations due to batching, mixing, or molding of the FlexLock® units. The units were delivered to Cercorp in ready-to-build condition.

Figure 1

Figure 2

2.2 POLYURETHANE FOAM

NCFI 42-6 is a two part component (Figure 2) with a nominal 2.1 pcf density. It is designed for void filling applications which require a high degree of flow. NCFI 42-6 component viscosities make the system suitable for either mechanical mix machines, impingement high pressure (over 600 psi) mixing machines or hand mixing. Mixing and metering equipment must accommodate the 1:1 by volume mix ratio.

3.0 WALL PANEL CONSTRUCTION AND TESTING PROCEDURES

3.1 PANEL CONSTRUCTION

The test wall panel was constructed in three courses with three units in each course (Figure 3). The course were banded to simulate the confined area of a typical wall and reduce any expansion of the units caused by the foam. The sides were stuffed with fiberglass insulation to prevent foam from escaping. The wall segment was not post-tensioned.

Figure 3

3.2 TESTING PROCEDURES

3.2.1 WALL SEGMENT

After reviewing the SPI "Guide for the Safe Handling and use of Polyurethane and Polyisocyanurate Foam Systems" and the manufacturer's safety instructions, two equal parts of "A" and "R" were measured out in clean plastic containers. Each component measured 32 fluid ounces. They were transferred to a single five gallon bucket and mixed with a 4" stirrer at between 1,500 and 2,000 R.P.M. in accordance with the manufacturer's instruction. The combined material was then poured into the wall cavity from the top course at two equidistant points (Figure 4).

Figure 4

Figure 5

3.2.2 STAIN TEST

After pouring the foam into the wall cavity, a small portion was poured on to the shell face of a standard CMU to create a "pancake" of approximately 8" in diameter (Figure 5). The face of the unit was untreated and contained no integral water repellent. The pancake was left to cure for 48 hours.

4.0 TEST RESULTS AND OBSERVATIONS

4.1 WALL SEGMENT RESULTS AND OBSERVATIONS

Within seconds of being poured, the polyurethane compound began to rise. As it filled one cell (Figure 6), it flowed over and down-filled the adjacent cells of the same course. When these were filled, it continued to rise and filled the second and third courses in a similar fashion until the excess overflowed the entire wall segment. A slight amount of foam could be observed leaking through the head joints at the very bottom course (Figure 7). This is likely the result of the initial liquid state of the foam. Since the first course is at the base of the wall, and no leakage was observed in the second and third course, the leakage is not likely to adversely effect wall appearance.

Figure 6

After 48 hours, the segment was dissected. The adhesion of the foam to the interior cavity was considerable and the effort to remove the units from the wall segment resulted in breakage of the masonry units. It is believed that this strength could add greater structural performance to the system particularly in shear resistence

The foam penetrated every observable area of the cavity creating a solid interlocking membrane. Although an ASTM E-514 will need to be conducted, it is believed that the foam created a watertight/airtight barrier.

Figure 7

Figure 8

4.2 STAIN RESULTS AND OBSERVATIONS

Within seconds of being poured on to the shell face, the polyurethane compound began to rise. After curing for 48 hours, a trowel was used to remove the majority of material from the shell face (Figure 8). This took little effort. A semi-sticky residue was observed after the pancake was removed (Figure 9).

A commercially available 100% acetone was then poured on the residue and scrubbed in with a hard bristle brush. This resulted in significantly reducing the residue leaving only a slight yellow shadow (Figure 10). Depending on the size of the spill, the color of the units and the type of solvent, the stain would likely be imperceptible.

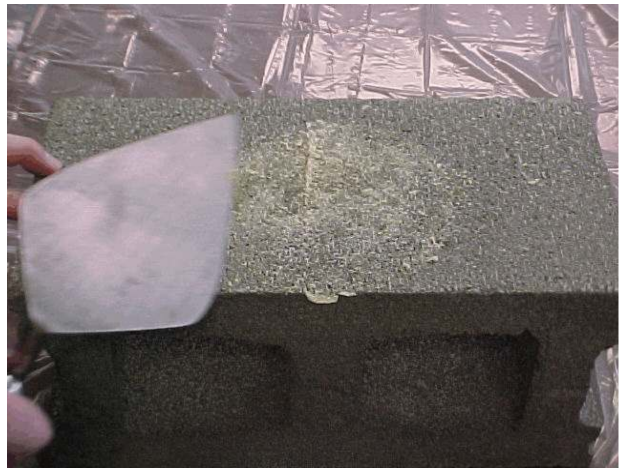

Figure 9

Figure 10

5. 0 CONCLUSION

The primary objective of this test was to determine the suitability of NCFI foam in the FlexLock® Wall System as a means to:

(1) <u>Stop the Flow of Water to the Wall Cavity</u> The waterproof polyurethane material filled the wall cavity completely blocking the head and bed joints and created a solid interlocking membrane. It is recommended that an ASTM-E514 water penetration test be performed to verify the watertight integrity of the system

(2) <u>Ensure That the Units Are Not Stained by the Foam</u> While the foam did stain the face shell, the stain was significantly reduced with the introduction of 100% acetone. This reduction still left a slightly yellow shadow. Though the shadow may not be perceptible from a short distance, especially if the stain is small, it is recommended that other solvents be tried to completely remove it.

Overall the suitability was deemed positive and the tests successful.