TEST REPORT:

ROSETTA HARDSCAPES GRAND LEDGE RETAINING WALL BLOCKS

BLOCK-TO-BLOCK INTERFACE SHEAR

WITH MIRAGRID 5XT GEOGRID INCLUSION

Tested By:
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1.0 Introduction

This report presents the results of a laboratory testing project that was performed to evaluate the block-to-block interface shear capacity between Rosetta Hardscapes Grand Ledge retaining wall block units with Miragrid® 5XT geogrid. The testing was performed by Aster Brands personnel, under the supervision of Aster Brands engineers at its testing facility located in Charlevoix, Michigan from February 2021 to April 2021. Rosetta Hardscapes is an Aster Brands company.

2.0 Purpose

The objective of the test series for this project was to investigate the block-to-block interface shear capacity of full-size Rosetta Hardscapes 12-in by 20-in (305 mm by 508 mm) by 3-, 4-, 5-, and 6-ft (0.91, 1.22, 1.52, and 1.83 m) Grand Ledge retaining block units with geogrid inclusion under varying normal loads using a large testing frame.

3.0 Materials

Rosetta Hardscapes Grand Ledge blocks are wetcast concrete, precast modular block (PMB) units with a consistent height of 12 in (305 mm), and a width (perpendicular to the wall face) of 12 in (305 mm) plus the face texture of about 8 in (203 mm), for a total width of approximately 20 in (508 mm). The length (in parallel with the wall face) of the blocks varies in even 12-in (305 mm) increments from 3 ft (0.91 m) to 6 ft (1.83 m). Standard block dimensions are shown in **Figure 1**.

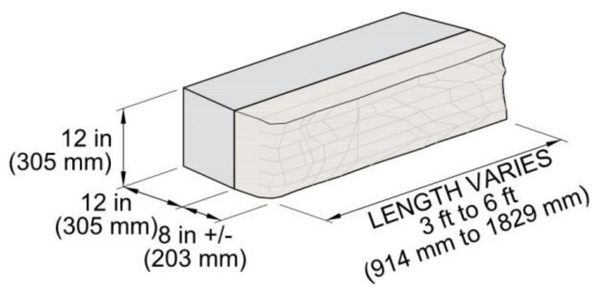

Figure 1 – Grand Ledge Block Dimensions

The blocks are manufactured from wet cast, first purpose, air-entrained, concrete in accordance with ASTM C94 or ASTM C685. They have a minimum specified 28-day compressive strength of 4,000 psi (27.6 MPa) and weigh approximately 660 lb (300 kg) to 1,350 lb (612 kg) per unit.

Shear engagement between subsequent rows of blocks is achieved by two shear heels protruding from the bottom of the block that interlock with the back of the top of the blocks below, and friction. The shear heels also set the wall batter at 2 ¼ in (57 mm) per course, or approximately 10.6 degrees. Blocks are designed to be dry stacked in a running bond configuration with the vertical joints offset, or staggered.

Blocks used for this series of testing were produced by High Format at its Charlevoix, Michigan facility. The blocks were produced in January 2021 and cured for 39 to 85 days prior to testing. Average compressive strength of the concrete that was used to produce the test blocks was 4,570 psi (31.5 MPa), as determined by ASTM C39 testing on 4-in by 8-in (102 mm by 203 mm) field-cured concrete cylinder specimens. All test blocks had compressive strength values at the time of testing above the minimum specified 28-day value for Rosetta Hardscapes Grand Ledge blocks of 4,000 psi (27.6 MPa). No adjustments were made to the test results presented in this report.

The geogrid reinforcement used for these tests consisted of TenCate Mirafi® Miragrid® 5XT, manufactured from high molecular weight, high tenacity polyester multifilament yarns woven in tension and finished with a PVC coating. Individual samples were cut from Lot #20201205-1-2 to fit the interface area between the blocks. Published values for the physical and design properties of this product are available on the manufacturer's website.

4.0 Test Apparatus

All tests were completed in a high-capacity structural testing frame located at the Aster Brands testing facilities in Charlevoix, Michigan, USA. This testing frame consists of a reconfigurable, steel reaction frame mounted to a 40-in (1015 mm) thick solid concrete "strong floor".

Testing forces were induced by a precision hydraulic actuator system. The system is capable of providing up to 12 in (300 mm) of travel movement and a maximum of 150,000-lb force (670 kN) simultaneously in two directions using two separate hydraulic pump systems. This allows for precise control of both horizontal and vertical loading. The hydraulic systems are controlled by high-precision directional flow control, needle, and pressure relief valves.

Forces, pressures, and displacements were recorded with electronic sensing devices. Forces were measured with load cells mounted to the ends of the hydraulic cylinders and pushing directly on the block. Displacements were measured with an integral LDT sensor mounted inside the horizontal hydraulic cylinder.

All measurements were recorded with a National Instruments cDAQ data acquisition module and Labview data acquisition software. Data was recorded a minimum of one datum per sensor per second.

5.0 Methodology

Interface shear capacity testing was completed in general accordance with ASTM D6916 "Standard Test Method for Determining the Shear Strength Between Segmental Concrete Units (Modular Concrete Blocks)." In this test method, one block is placed on top of two blocks in a staggered, running bond pattern with a piece of geogrid reinforcement inserted between the two layers of blocks. The base blocks are firmly fixed, and a load is applied to the back of the top block. A normal load is applied vertically on top of the top block to simulate varied wall heights.

The upper block is then pushed horizontally to failure to determine the peak interface shear capacity between the block units with geogrid inclusion. Steel beams and plates with rubber pads are used to spread the loads evenly across the surfaces of the blocks. Tests are run until there is a significant reduction in the applied load and/or excessive deflection. An overview of the test set-up and the configuration of some of the components is shown in **Figure 2**.

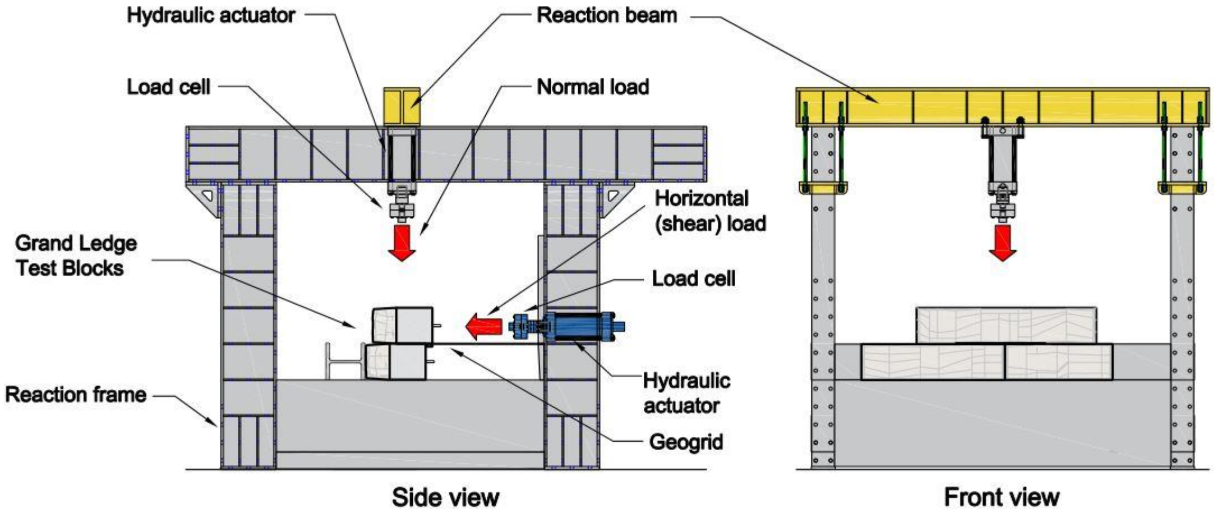

Figure 2: Schematic test frame set-up

All interface shear tests were taken to the point of maximum shear load to induce failure of the shear heels, whenever possible. The top block was moved forward until both of the shear heels were fully aligned and engaged, and an initial load (alignment load) was placed on the block before deflection measurements were recorded. Data for friction tests with geogrid inclusion was also collected. However, that data is not presented as part of this report.

For this testing program, normal load levels were varied from 207 to 6,487 lb/ft (3.0 to 94.7 kN/m) to simulate the performance of block-to-block interface shear at different vertical locations in a wall cross-section. These values correspond to wall heights ranging from approximately 1 to 29 ft (0.3 to 8.8 m). Additional tests were run at the same nominal normal load near the middle of the range of normal loads to check the repeatability of the testing protocol.

Blocks were preloaded with horizontal loads ranging from approximately 200 to 500 lb (0.9 to 2.2 kN) to set and align the blocks. Displacement was measured at the point of load by the integral LDT sensor mounted inside the horizontal hydraulic cylinder. The displacement rate (velocity) at which the load was applied to the blocks as they were tested was manually controlled with an average displacement rate of 0.20 in per min (5.1 mm/min), which is within the tolerance of the rate specified in ASTM D6916 of 0.197 in per minute +/- 0.04 in per min (5 mm/min +/- 1mm/min). A side view of the test setup is shown in **Figure 3**.

Figure 3 – Interface shear test setup

6.0 Laboratory Test Results

Interface shear with geogrid inclusion testing resulted in a shear failure through one or both of the shear heels, as shown in **Figures 4 and 5.** Two of the tests, (Test Nos. 11 and 12) using 6 and 5 ft blocks with normal loads of 6,521 and 3,284 lb/ft (95.2 and 47.9 kN/m) exhibited block cracking. The observed cracks were generally perpendicular to the length of the block, running through the block face as shown in **Figure 6**.

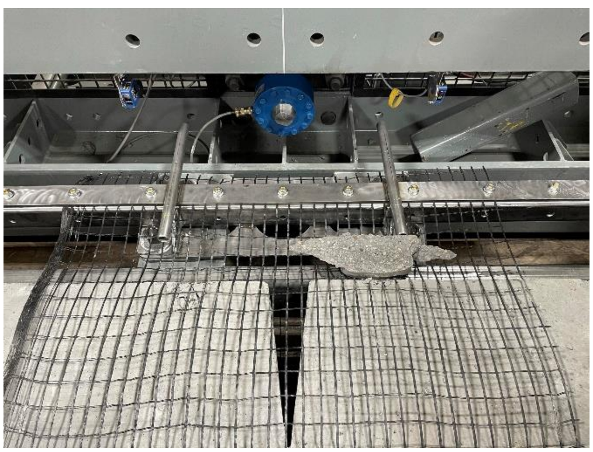

Figure 4 - Shear heel sheared off

Figure 5 - One shear heel failed, one intact

Figure 6 – Block cracked under high load

Test results for peak interface shear with geogrid inclusion are provided in **Table 1**. Block displacement plotted against horizontal load for interface shear tests is shown in **Figure 7**.

Table 1 – Summary of Peak Interface Shear Test Results

Test No.	Geogrid Type	Block Size (ft)	Concrete Strength (psi)	Concrete Strength (Mpa)	Normal Load (lb/ft)	Peak Shear (lb/ft)	Normal Load (kN/m)	Peak Shear (kN/m)
1	5XT	3	4564	31.47	202	1228	2.9	17.9
2	5XT	4	4564	31.47	641	1294	9.4	18.9
3	5XT	5	4569	31.50	3205	1832	46.8	26.7
4	5XT	6	4569	31.50	1101	1006	16.1	14.7
5	5XT	3	4574	31.53	3256	2811	47.5	41.0
6	5XT	4	4574	31.54	2160	2088	31.5	30.5
7	5XT	5	4578	31.57	3236	1946	47.2	28.4
8	5XT	6	4578	31.56	3247	1955	47.4	28.5
9	5XT	3	4585	31.61	4345	3097	63.4	45.2
10	5XT	4	4594	31.67	5406	3701	78.9	54.0
11	5XT	5	4602	31.73	6521	3931	95.2	57.4
12	5XT	6	4602	31.73	3284	2104	47.9	30.7

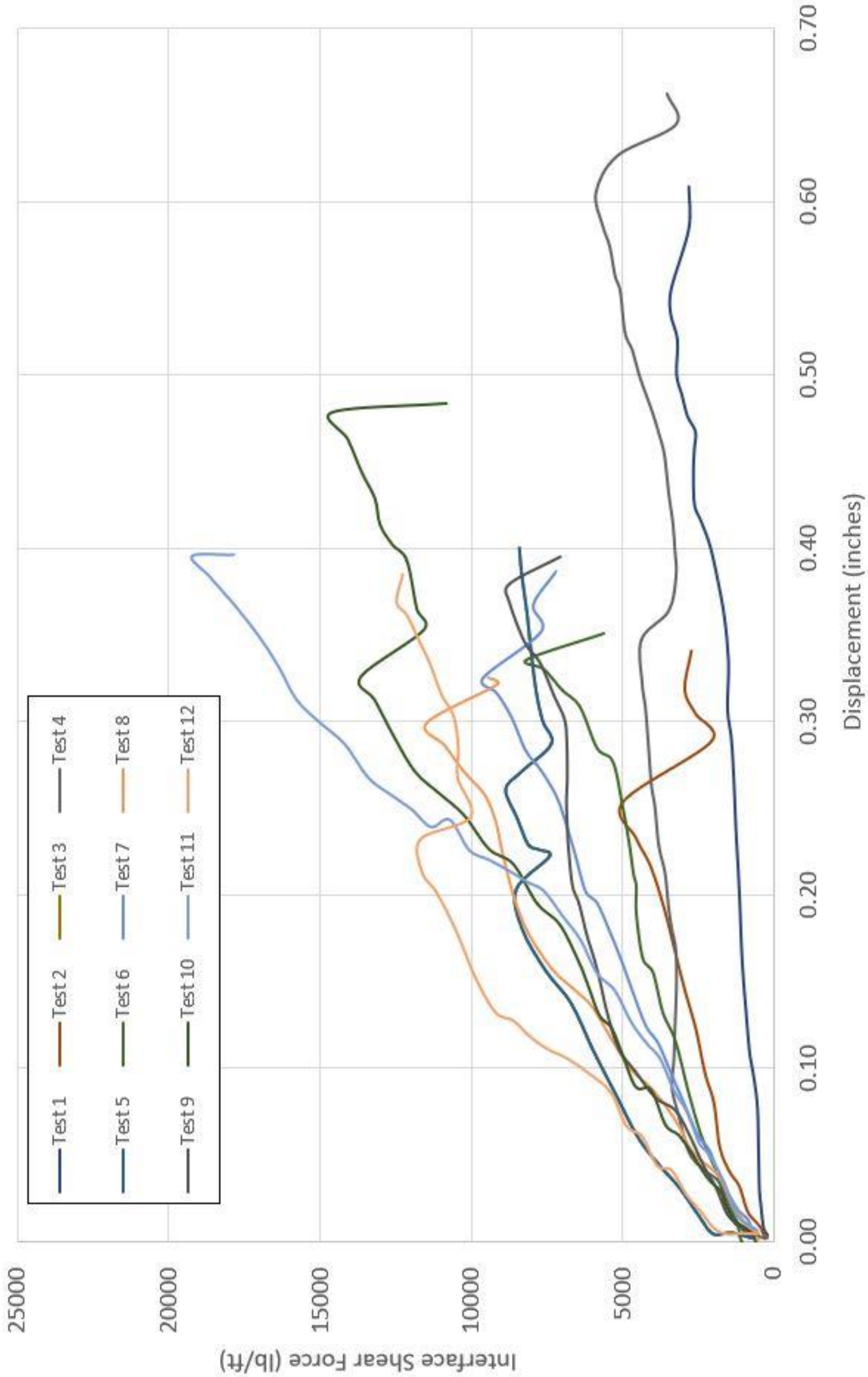

Figure 7 - Horizontal Interface Shear Force versus Horizontal Displacement

Peak interface shear loads were taken as the maximum measured load during each interface shear test. Peak loads plotted against normal loads are shown in **Figure 8**.

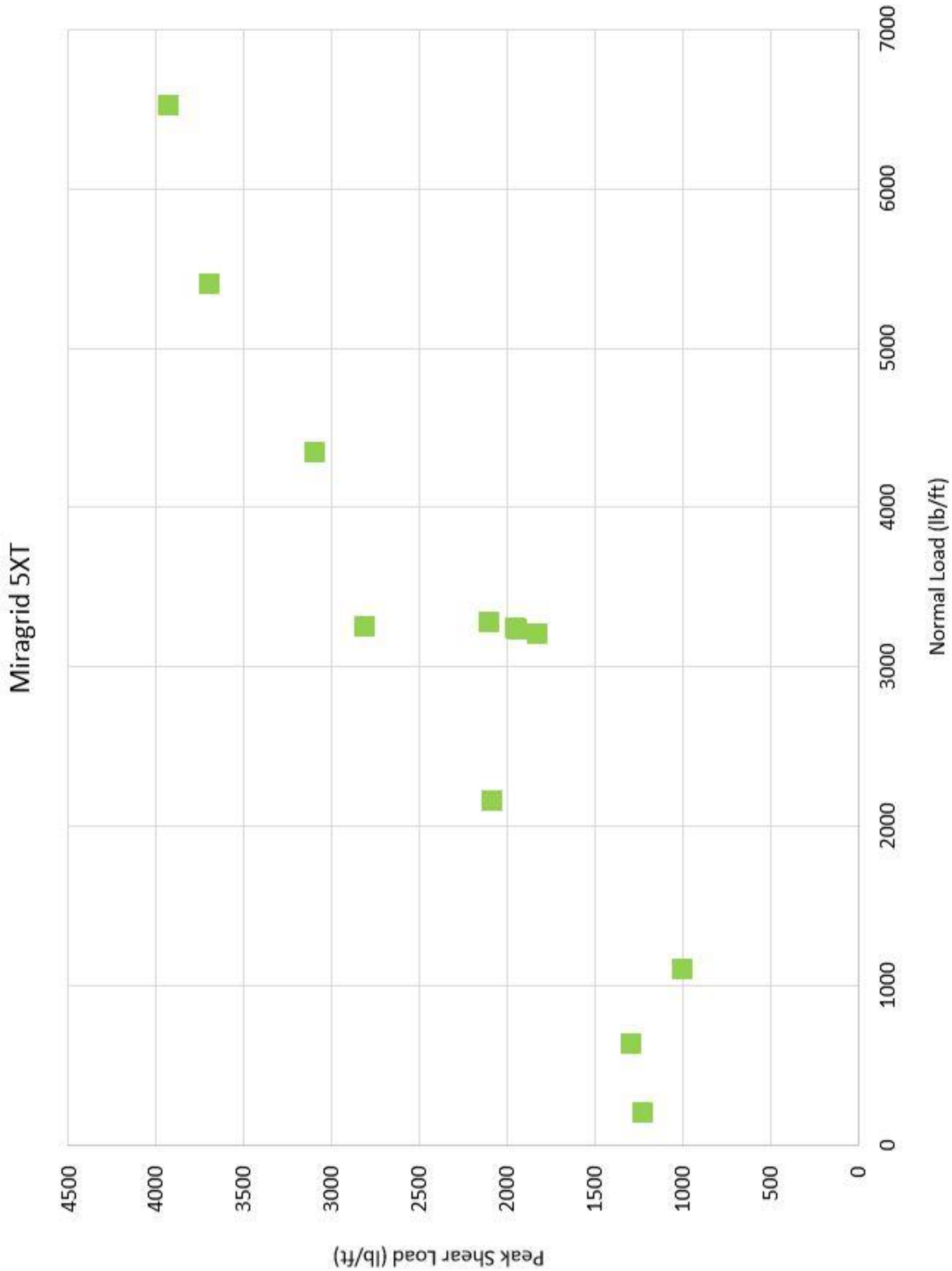

Figure 8 – Peak Interface Shear Load versus Normal Load

Additional tests were run at approximately 3,200 lb/ft (46.7 kN/m) normal load to check repeatability of the testing protocol. ASTM D6916 indicates a value of ±10% variation for each test from the mean as a measure of repeatability. Upon review of the data, the high value was 32% above the mean, and the low value was 14% below the mean. The remainder of the values fall within 8 to 9% of the mean of the test results.

7.0 Closure

The data and conclusions contained herein should be used with care. The user should verify that project conditions are equivalent to laboratory conditions and should account for any variations.

This test data is accurate to the best of our knowledge and understanding. It is the responsibility of the end user to determine suitability for the intended use.

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