TEST REPORT:

NOVUM WALL™ BY REDI-ROCK RETAINING BLOCK

BLOCK TO BLOCK INTERFACE SHEAR CAPACITY
5.2° FACE BATTER

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 Novum Wall™ by Redi-Rock retaining blocks. The testing was performed by Aster Brands personnel, under the supervision of Aster Brands engineers at its testing facility located in Charlevoix, Michigan from October to November 2023. Redi-Rock is an Aster Brands company.

2.0 Purpose

The objective of the test series for this project was to define an interface shear capacity design envelope by investigating the block-to-block interface shear capacity of the Novum Wall™ blocks under varying normal loads using a large testing frame.

3.0 Materials

Novum Wall™ blocks are wet-cast concrete, precast modular block (PMB) units with a consistent height of 9 in (229 mm), and a width of 24 in (610 mm) plus the face texture of variation of 1-1/2 in (38 mm). The length of the block is 46-1/8 in (1172 mm). Standard block dimensions are as shown in **Figure 1** below. The blocks are manufactured from wet-cast, first purpose, air-entrained, non-reconstituted, structural grade concrete mixes 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 610 lb (277 kg) +/- 30 lb (13.6 kg).

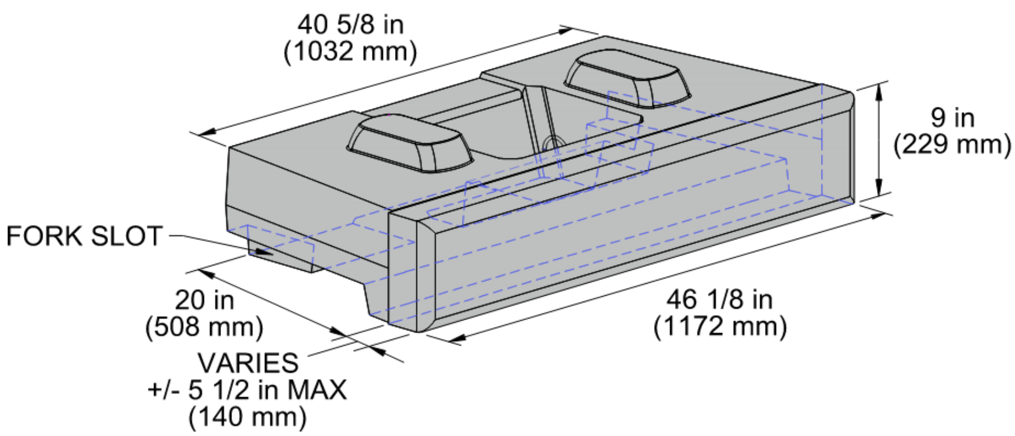

Figure 1 – Novum Wall™ Block Dimensions

Shear engagement between subsequent rows of blocks is achieved by two trapezoidal shaped shear knobs protruding from the top of the block that interlock with a groove cast into the bottom of the block above, as well as friction. The shear knobs also set the wall face batter at a nominal value of approximately 5.2 degrees, so the setback between two rows of blocks is approximately (13/16 in (20 mm). Blocks are designed to be dry stacked in a running bond configuration with the vertical joints offset, or staggered, by half of a block length.

Blocks used for this series of testing were produced by Truemont Materials at its Green Cove Springs, Florida facility. The blocks were produced in August 2023 and cured for 65 to 81 days prior to testing. Average 28-day compressive strength of the concrete that was used to produce the test blocks was 4,220 psi (29.1 MPa), and average compressive strength at the testing date was 5,020 psi (34.6 MPa), as determined by ASTM C39 on 4 in by 8 in (102 mm by 203 mm) field-cured concrete cylinder specimens.

4.0 Test Apparatus

All tests were completed in a high-capacity structural testing frame located at the Aster Brand testing facilities in Charlevoix, Michigan, USA. This testing frame consists of a reconfigurable, steel reaction frame mounted to a 40-inch (1.0 m) 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 at 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 was set on top of two blocks in a staggered, running bond pattern, and an additional block without knobs was placed on top to disperse loading. Base blocks were firmly fixed, and a horizontal load was applied to the back of the middle block. A normal load was applied vertically on top of the top block to simulate varied wall heights. The middle block was then pushed to failure to determine the peak interface shear capacity between the block units. Details of the test set-up are shown in **Figure 2**.

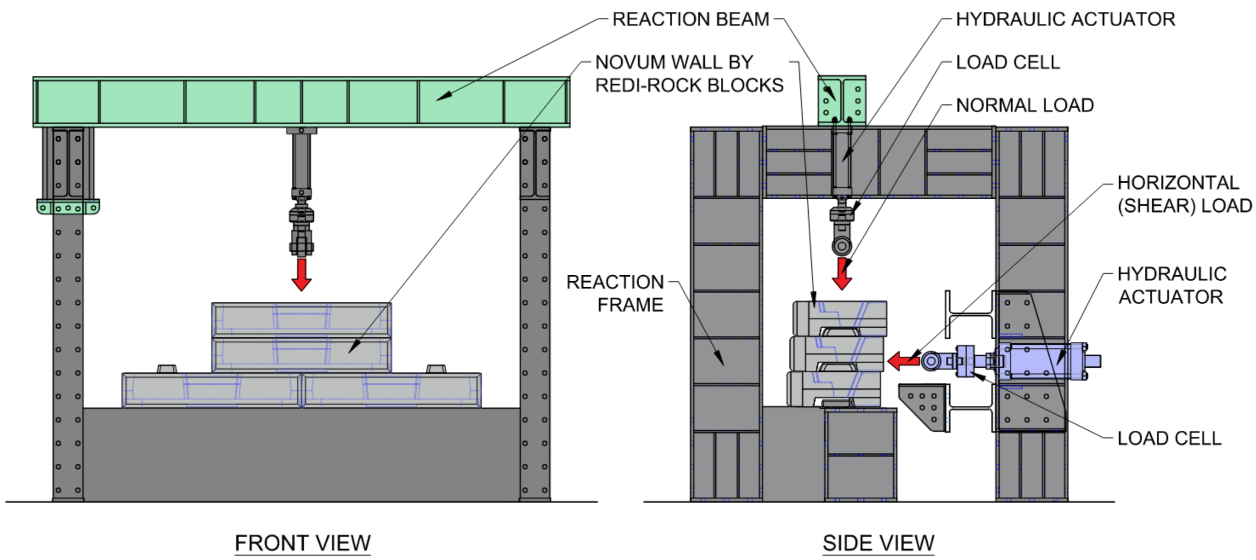

Figure 2 – Schematic test frame set-up

All interface shear tests were taken to the point of maximum shear load to induce failure of the shear knobs or back of the groove, excessive deflection, or visible cracking in the test blocks. The block was moved forward so both of the shear knobs were fully aligned and engaged, and an average initial preload (alignment load) of 511 lb (232 kg) was placed on the block before deflection measurements were recorded. 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 0.26 in/min (6.6 mm/min).

For this testing project, normal load levels varied from 125 to 3,829 lb/ft (1.8 to 55.9 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 15 ft (0.3 to 4.6 m). Additional tests were run at similar nominal normal loads in order to check the repeatability of the testing protocol.

6.0 Laboratory Test Results

Three different failure modes were observed during the testing program. All three failure modes included translation of the top block onto the knobs of the block beneath in varying amounts. For tests imposing lower normal loads, some rotation and lifting of the top block onto the knobs was also observed. The first mode of failure was crushing at the back of the shear groove of the block, but the shear knobs did not break, as shown in **Figure 3**. The second failure mode occurred when the shear knobs, or pieces of the knobs broke, sometimes one or both knobs, as shown in **Figure 4**. The third mode of failure resulted in cracked and/or broken bottom blocks, as shown in **Figure 5**.

Figure 3 – Groove crushing at shear knobs

Figure 4 – Broken shear knob

Figure 5 – Broken bottom blocks

Block displacement plotted against horizontal load for interface shear tests is shown in **Figure 6**. A summary of the peak shear test results is shown in **Table 1**.

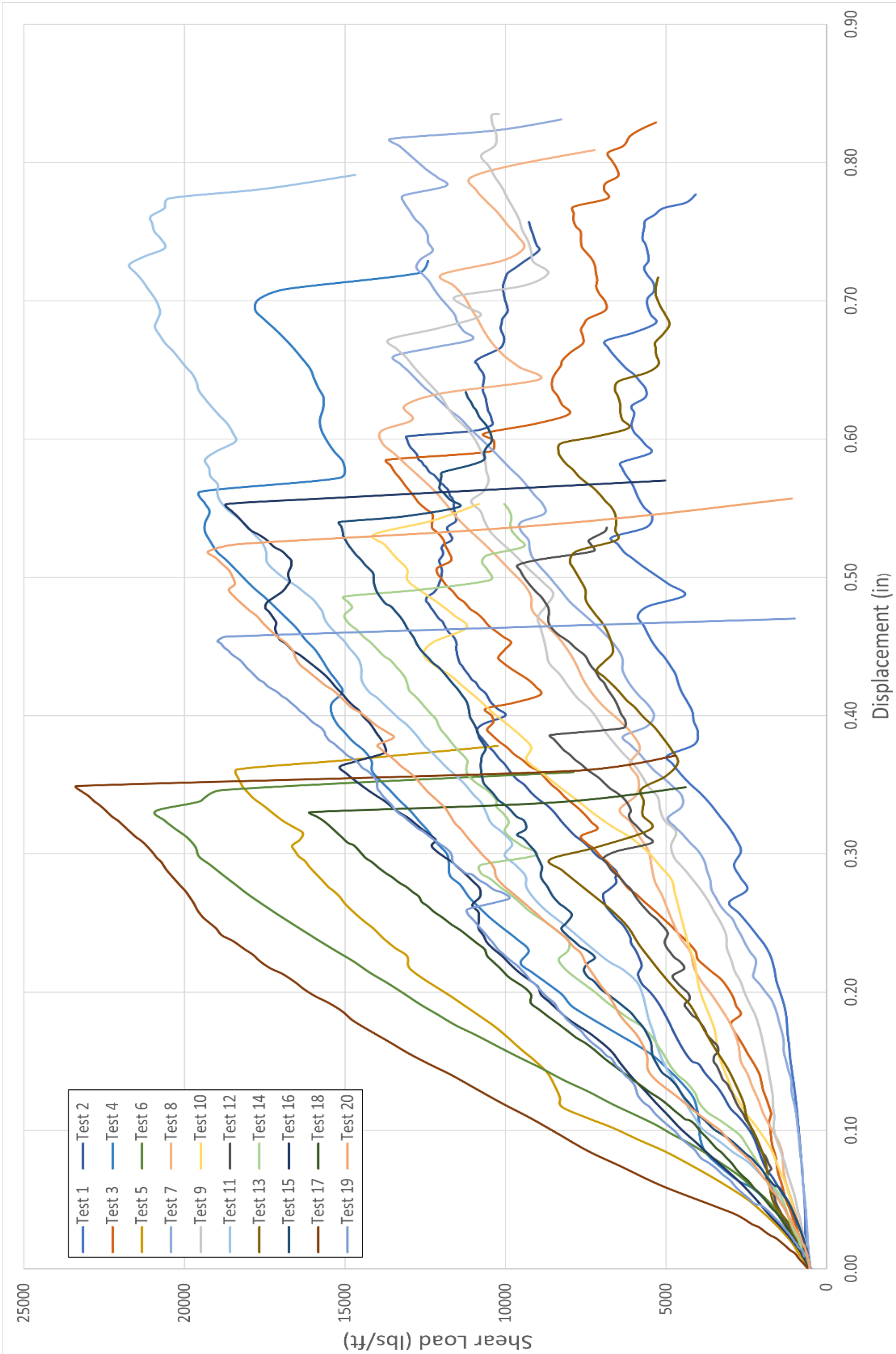

Figure 6 – Horizontal Interface Shear Force versus Horizontal Displacement

Table 1 – Summary of Peak Interface Shear Test Results

Test Number	Normal Load lb/ft	Normal Load kN/m	Peak Shear lb/ft	Peak Shear kN/m	Observed Failure
1	125	1.8	1,790	26.1	Crushed Groove
2	571	8.3	3,401	49.6	Broken Knob
3	272	4.0	3,565	52.0	Broken Knobs
4	1,277	18.6	5,079	74.1	Broken Knobs
5	2,464	36.0	4,775	69.7	Broken Blocks
6	3,829	55.9	5,433	79.3	Broken Blocks
7	125	1.8	3,533	51.6	Broken Knobs
8	248	3.6	3,606	52.6	Broken Knobs
9	367	5.3	3,546	51.7	Broken Knob
10	854	12.5	3,681	53.7	Crushed Groove
11	1,253	18.3	5,650	82.5	Broken Knobs
12	127	1.9	2,499	36.5	Broken Knob
13	252	3.7	2,239	32.7	Broken Knobs
14	378	5.5	3,911	57.1	Broken Knob
15	500	7.3	3,947	57.6	Broken Knob
16	1,060	15.5	4,861	70.9	Broken Block
17	3,137	45.8	6,076	88.7	Broken Block
18	2,172	31.7	4,186	61.1	Broken Block
19	1,252	18.3	4,934	72.0	Broken Block
20	1,877	27.4	5,008	73.1	Broken Blocks

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 7**.

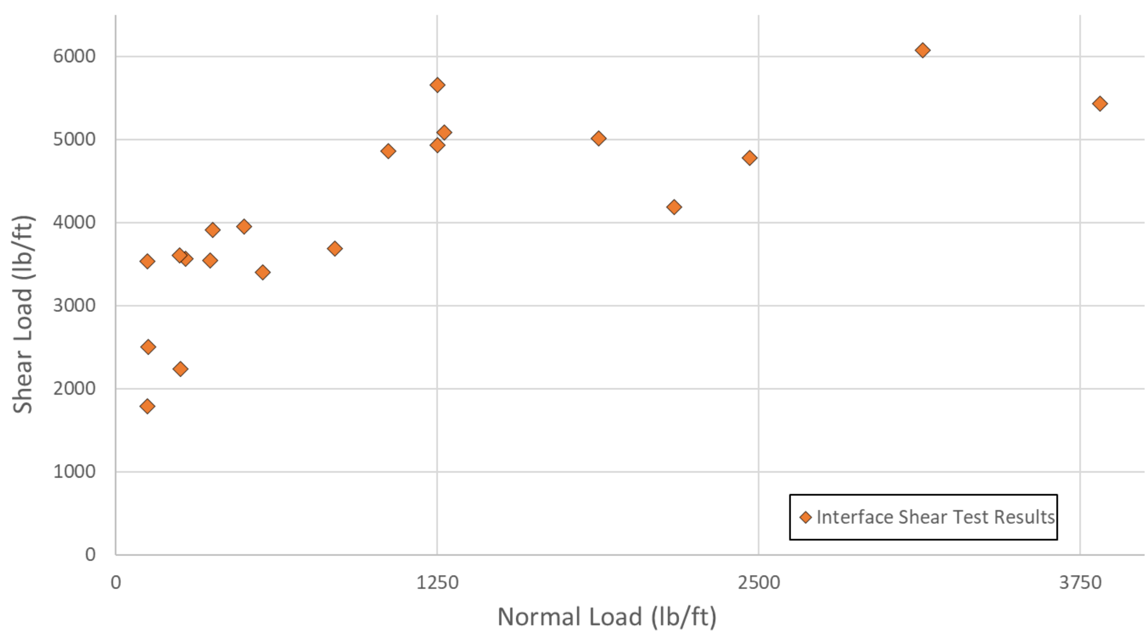

Figure 7 – Peak Shear Load versus Normal Load

The Novum Wall™ block to block interface shear capacity tests were conducted in general accordance to ASTM D6916. Small deviations from the standard can be further elaborated upon request.

The recommended interface shear capacity envelope for use in design and analysis can be found in the design resources for Novum Wall™ by Redi-Rock.

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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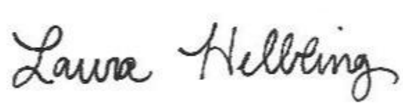

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