REPORT
RESULTS
OF
ROSETTA BLOCK
INTERFACE SHEAR CAPACITY TESTING

submitted to

REDI-ROCK INTERNATIONAL

CONFIDENTIAL

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Introduction

This report gives the results of an interface shear testing program carried out to evaluate the mechanical/frictional performance of the shear connection between Rosetta Block™ segmental concrete block units.

The test program was initiated in response to an email authorization to proceed from Mr. Jeremy Manthei of Redi-Rock International, LLC. received 5 December 2006.

The tests were carried out at the laboratories of Bathurst, Clarabut Geotechnical Testing, Inc. in Kingston, Ontario, under the supervision of Mr. Peter Clarabut.

Objectives of test program

The interface shear capacity between Rosetta Block concrete units stacked in a vertical configuration was investigated using a large-scale test apparatus.

The principal objective of the testing was to evaluate the mechanical/frictional performance of the shear connection between successive layers of Rosetta Block units. A second objective was to make recommendations for the selection of interface shear capacities to be used in the design and analysis of retaining wall systems that employ Rosetta Block units.

Materials

Rosetta Block units are solid concrete blocks weighing approximately 580 pounds per unit. The nominal dimensions of the block are 17 inches wide (toe to heel) by 12 inches high by 35 inches long. Construction alignment and wall batter is achieved by means of two concrete keys cast into the bottom surface of the units. The installation arrangement is illustrated in **Figure 1**. A photograph of the Rosetta Block units is shown in **Figure 2**. The blocks used in this series of tests were supplied by Redi-Rock International, LLC. and were received at our laboratory on 6 December 2006 and designated as BIC 06-041, 00-42, and 00-43. The blocks were also identified individually by Redi-Rock International, the blocks used in each test are identifed in **Figure 1** using the Redi-Rock International identification system.

Apparatus and general test procedure

The SRWU-2 method of test as reported in the NCMA Segmental Retaining Wall Design Manual (1993) and ASTM D 6819 was used in this investigation. A brief description of the apparatus and test methodology is presented here. The apparatus used to perform the tests is illustrated in **Figure 1**. The test apparatus allows horizontal loads of up to 35,000 lbf to be applied across the interface between two block layers. The segmental units were laterally restrained at the bottom and surcharged vertically. The blocks were stacked one over the other. Wall heights were simulated by placing a single block over the interface and applying additional normal load using the air bag arrangement shown in **Figure 1**. The horizontal (shear) force

was applied at a constant rate of displacement using a computer-controlled hydraulic actuator. The load and displacements measured by the actuator and displacement transducers were recorded continuously during the test by a microcomputer/data acquisition system. Each test was continued until large shear displacements were achieved. Following each test, the blocks were removed and the units examined to confirm failure modes.

The only variable in this series of interface shear tests was the magnitude of surcharge (i.e. the magnitude of normal load applied to the top segmental unit). The normal loads used in the test program are given in **Table 1**.

Test results

Results of interface shear tests are summarized in **Table 1**. Peak interface shear capacities are plotted against normal load in **Figure 4**. The displacement criterion was calculated to be 0.24 inch based on 2% of the block height. The minimum *peak* shear capacity recorded from the test series was 1412 lb/ft. In all tests, failure was observed as rupture of the shear keys. In all tests peak shear capacity was achieved before 0.24 inches of displacement.

The test results reveal some scatter in shear capacity for tests carried out at nominal similar normal loads. The three tests carried out at a nominal equivalent normal load of about 2057 lb/ft (**Tests 4**, **6**, and **7**) gave peak shear capacity values that ranged from 2530 to 2708 lb/ft with a mean value of 2643 lb/ft. This scatter is less than ± 10% of the mean peak shear criterion required by the NCMA (e.g. maximum variability is 4.3%) and is likely due to small differences in setting up of the blocks and small variations in block dimensions. The trend in data for peak shear loads has been plotted using a linear curve.

Implications to interface shear capacity design and construction with Rosetta block units

The interface shear strength in the field may be less than the values determined in this test series for the same method and quality of construction. The NCMA Segmental Retaining Wall Design Manual (First Edition, 1993) recommends that the design shear capacity at a given normal load for a critical wall structure be the lesser of: a) the peak capacity divided by a minimum factor of safety (not less than 1.5) or; b) the capacity based on the 0.24 inch displacement criterion. The *design* interface shear capacity envelope shown in **Figure 5** is controlled by the peak shear capacity criterion.

The design shear capacity envelope illustrated in **Figure 5** should be used with caution. The actual design capacity envelope should be lower if the quality of construction in the field is less than that adopted in this controlled laboratory investigation and/or lower quality concrete is used in the manufacture of the blocks. In addition, the interface concrete surfaces should be free of aggregate particles in order to maximize the frictional resistance that is developed between the concrete surfaces.

Summary of conclusions

A laboratory testing program was carried out to evaluate the mechanical/frictional performance of the shear connection between Rosetta Block segmental concrete units. The following conclusions can be drawn:

1. The minimum *peak* shear capacity recorded from this test series was 1412 lb/ft (height above interface equal to 1.0 block unit).
2. Variability in shear capacity was observed between nominal identical tests due to small differences in setting up of the blocks and small variations in block dimensions.
3. The design envelope in **Figure 5** is based on interpretation of test data as recommended in the NCMA Segmental Retaining Wall Design Manual (First Edition, 1993). The choice of design interface shear capacity may vary with quality of construction in the field and hence lower design values than those taken from **Figure 5** may be appropriate.

Concluding remarks

The test results presented here are applicable to conventional and geosynthetic reinforced-soil segmental retaining wall designs that employ Rosetta Block units. The inclusion of a layer of geosynthetic reinforcement may reduce the interface shear capacity to values less than those reported in this investigation.

P. Clarabut

R. J. Bathurst, Ph.D., P. Eng.

Table 1:
Test Program:
Rosetta block unit interface shear testing

Test number	approximate wall height (feet)	approximate number of blocks	normal load (lb/ft)	shear capacity (lb/ft) at 0.24 inch displacement	peak shear capacity (lb/ft)
1	4.2	4.2	823	1527	1527
2	1.0	1.0	198	1412	1412
3	7.3	7.3	1440	2808	2808
4	10.4	10.4	2050	2530	2530
5	13.5	13.5	2675	2785	2785
6	10.4	10.4	2057	2692	2692
7	10.4	10.4	2065	2708	2708
8	17.0	17.0	3369	3255	3255
9	19.8	19.8	3924	3065	3063

REFERENCES

ASTM D 6916-03. Standard Test Method for Determining Shear Strength between Segmental Concrete Units (Modular Concrete Blocks), American Society for Testing and Materials, West Conshohocken, PA 19428-2958 USA.

Simac, M.R., Bathurst, R.J., Berg, R.R. and Lothspeich 1993. *NCMA Segmental Retaining Wall Design Manual* (First Edition, 1993), National Concrete Masonry Association, 2302 Horse Pen Road, Herndon, VA 22071−3406, 250 p.

1	loading frame	2	horizontal actuator
3	horizontal load cell	4	displacement transducers
5	platform	6	spacers
7	Rosetta Block	8	air bag load arrangement

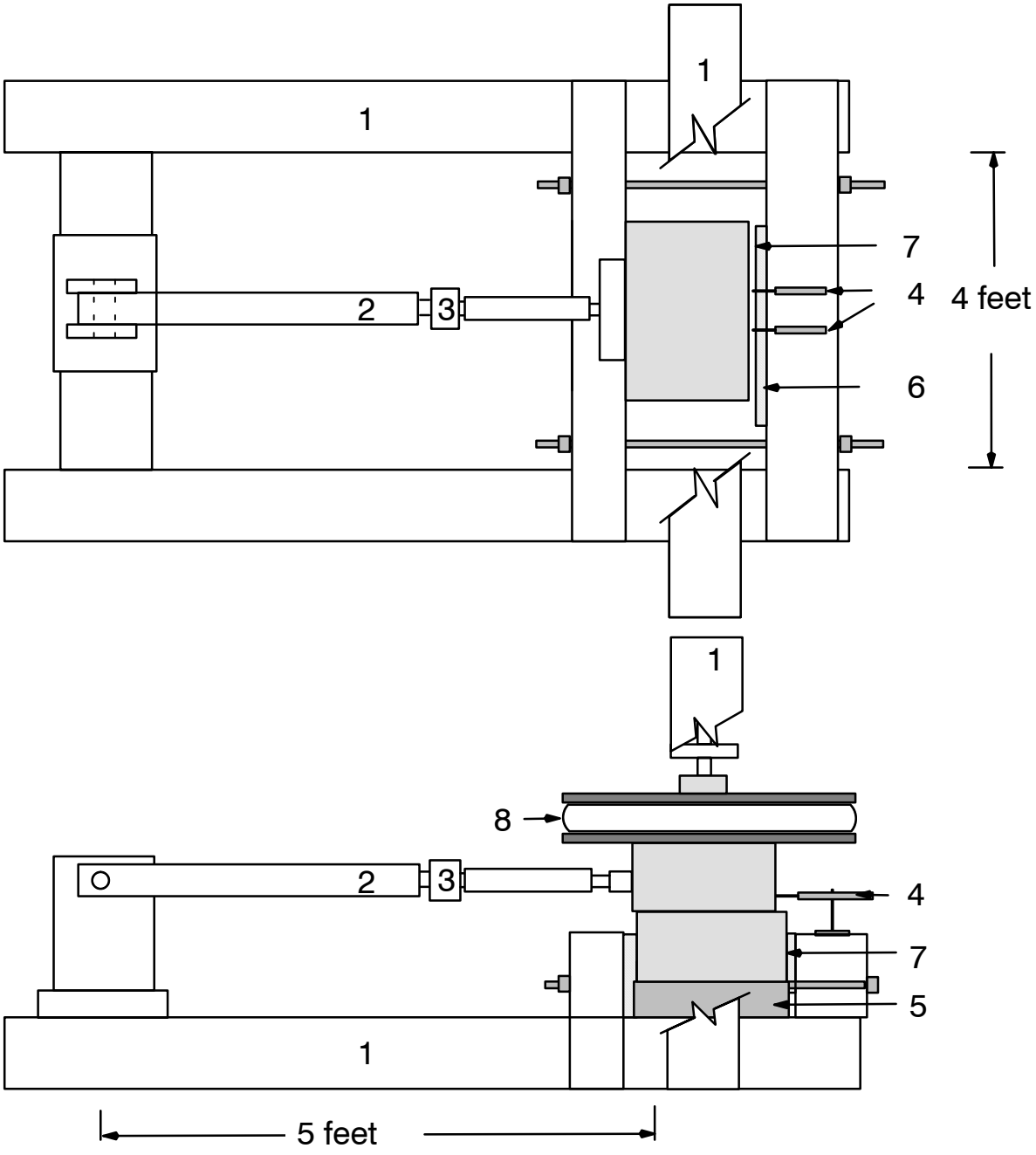

Figure 1: Schematic of shear capacity test apparatus showing Rosetta segmental concrete block units

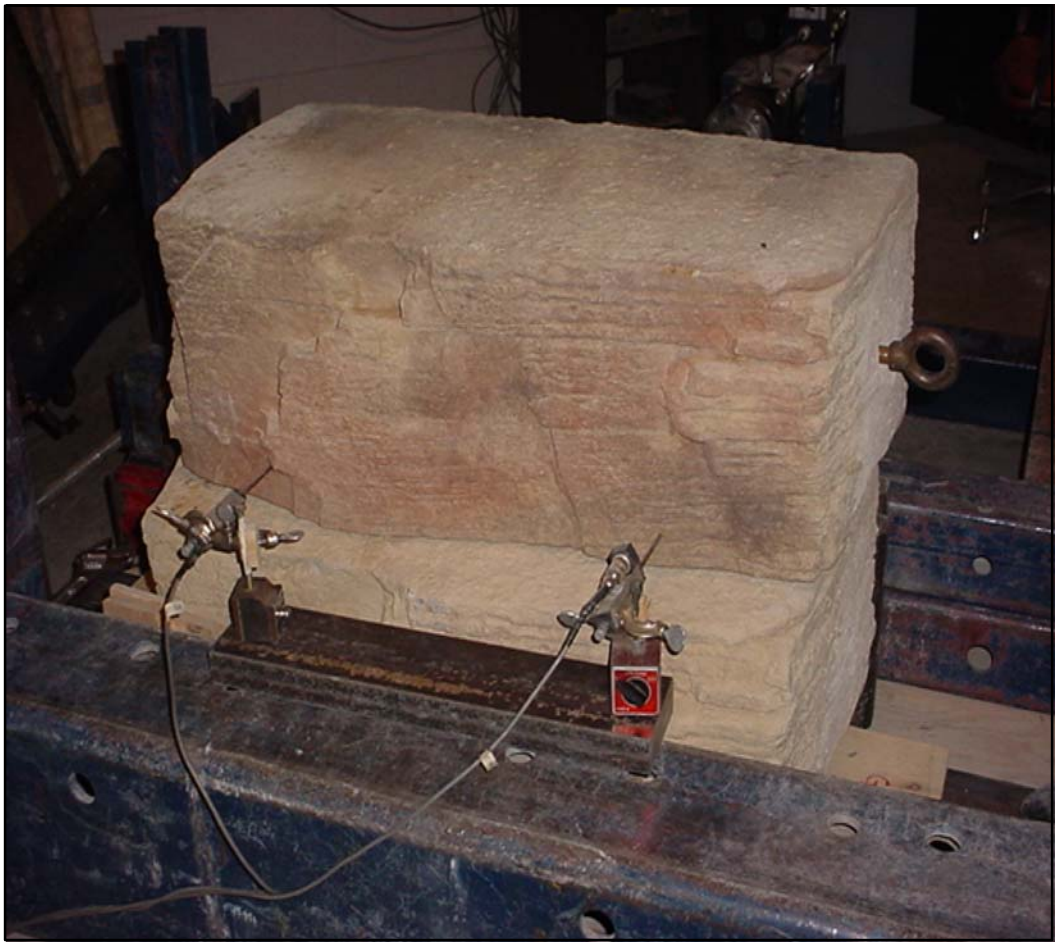

Figure 2: Photograph of the Rosetta block configuration used in the shear test apparatus

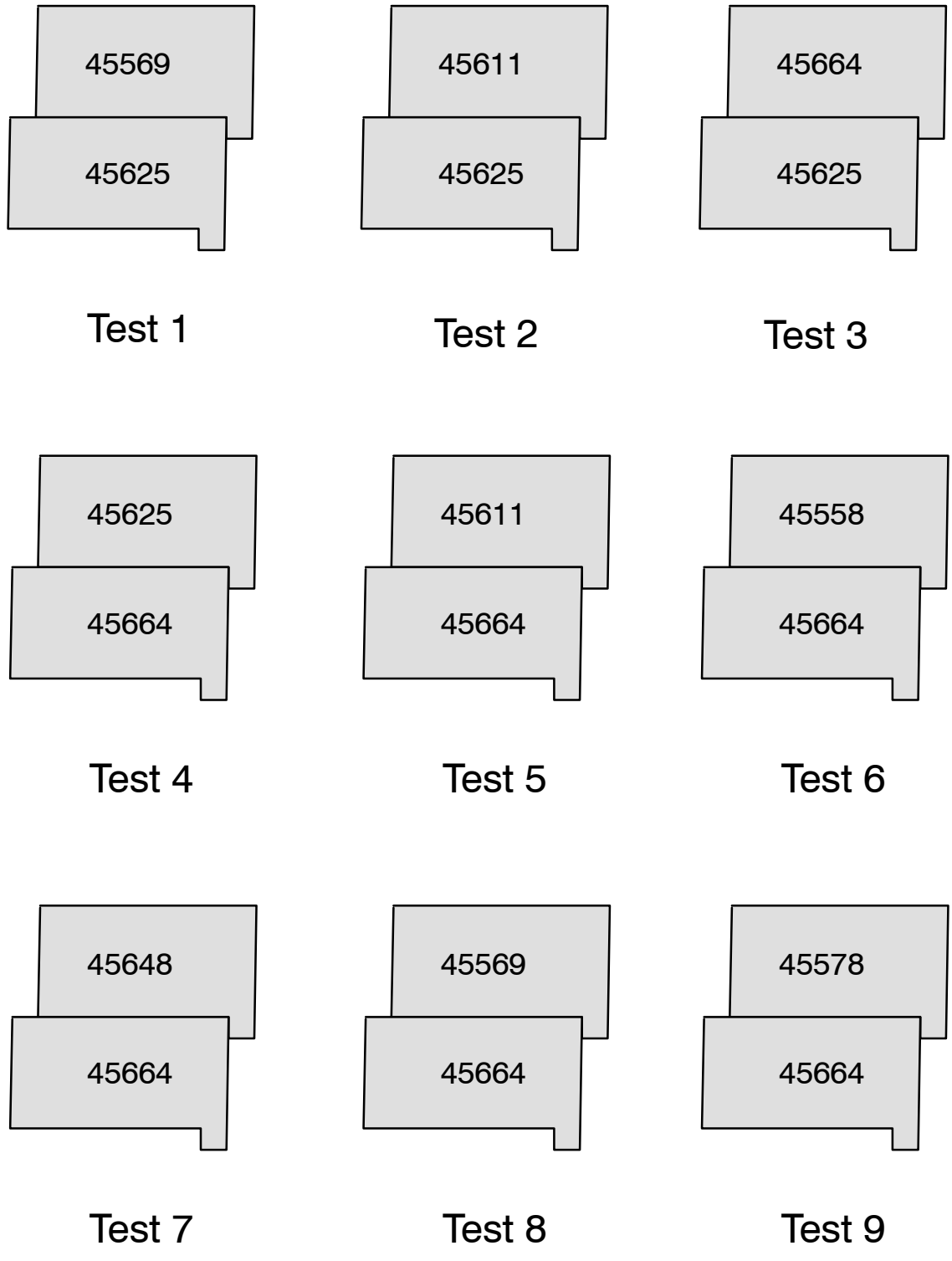

Figure 3: Rosetta Block identification and configuration

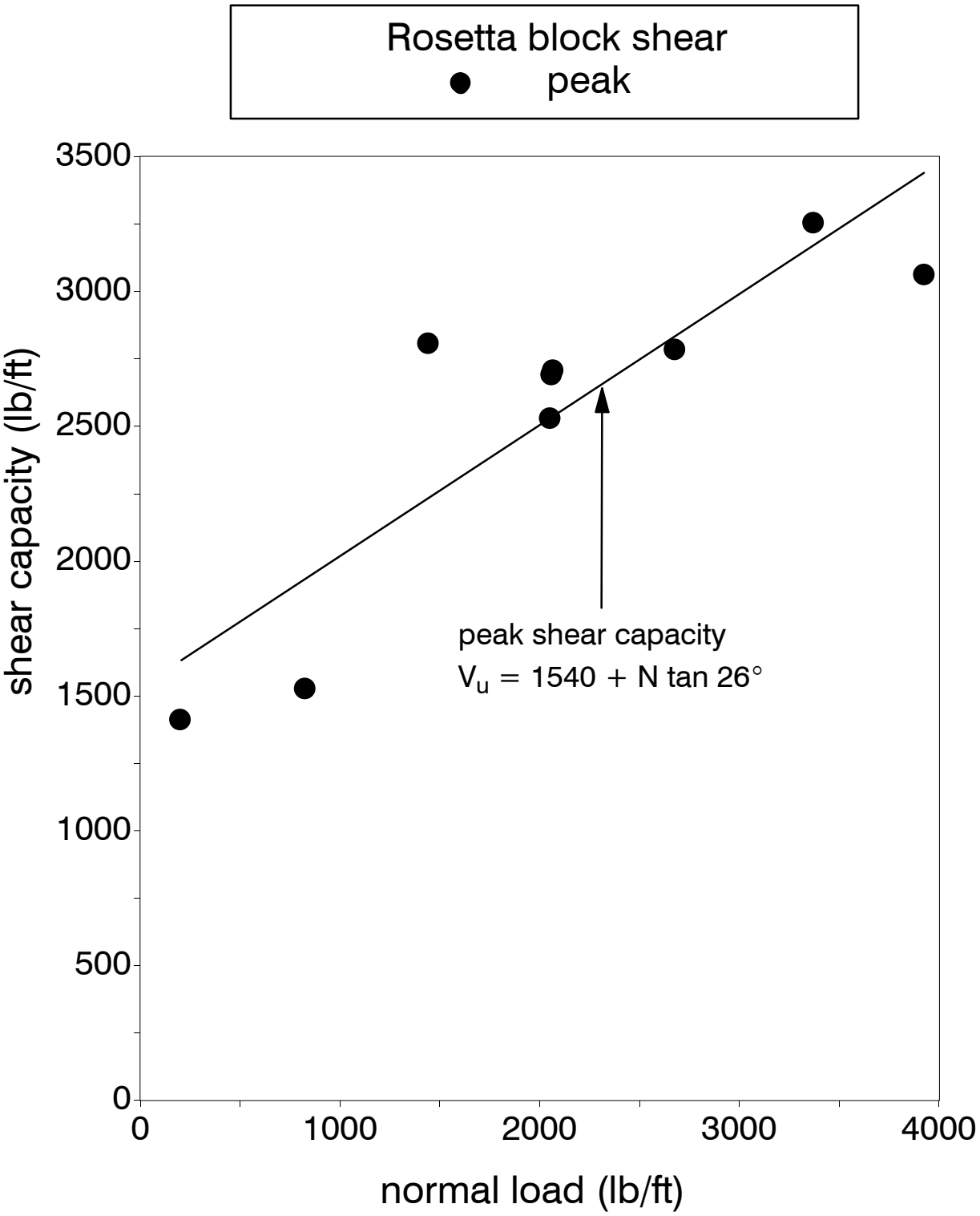

Figure 4: Interface shear versus normal load for Rosetta block tests

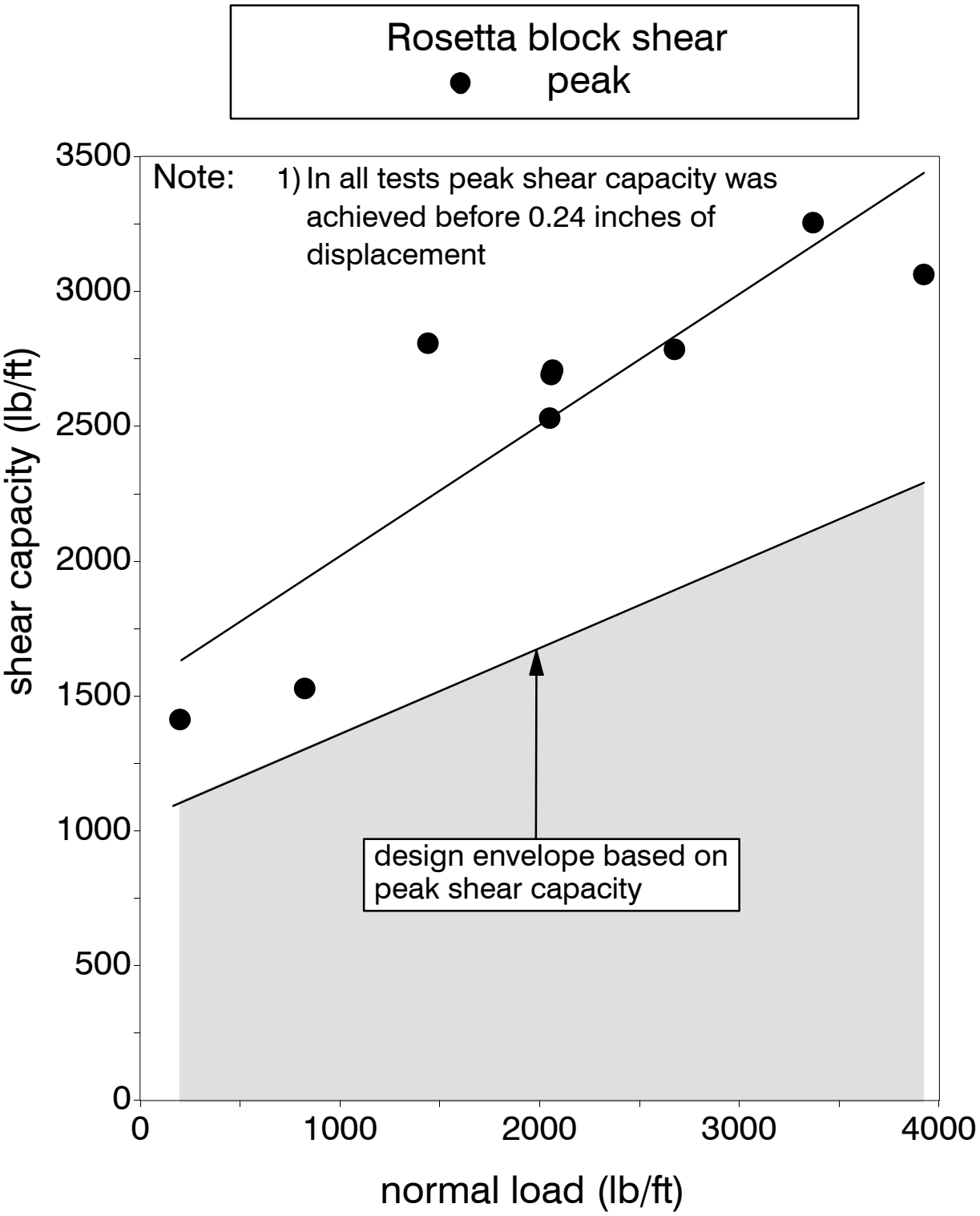

Figure 5: Preliminary design curve for shear capacity versus normal load for Rosetta Block units