REPORT

results

of

WORLD BLOCK LANDSCAPE BLOCK INTERFACE SHEAR CAPACITY TESTING

submitted to

WORLD BLOCK

CONFIDENTIAL

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 World Block Landscape Block segmental concrete block units.

The test program was initiated in response to a verbal authorization to proceed from Mr. Rod Johnson of World Block received 25 September 2007.

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 World Block Landscape 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 World Block Landscape 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 World Block Landscape Block units.

MATERIALS

World Block Landscape Blocks are solid concrete units weighing approximately 2400 pounds per unit. The nominal dimensions of the block are 24 inches wide (toe to heel) by 24 inches high by 48 inches long. Construction alignment and wall batter is achieved by means of two concrete shear keys cast into the top surface of the units. The installation arrangement is illustrated in Figure 1. A photograph of the World Block Landscape Block units is shown in Figure 2. The blocks used in this series of tests were supplied by World Block and were received at our laboratory on 28 September 2007 and designated as BIC 07-036.

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. A single block was stacked over the under lying blocks. Wall heights were simulated by placing a single block over the interface and applying additional normal load using the air bag arrangement shown in Figure1. 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 or the client specified shear capacity of 3500lb/ft was achieved. Following each test, the blocks were removed and the units examined to confirm failure modes (if applicable).

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.

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TEST RESULTS

Results of interface shear tests are summarized in Table 1. Peak interface shear capacities are plotted against normal load in Figure 3. The displacement criterion was calculated to be 0.48 inch based on 2% of the block height. The minimum peak shear capacity recorded from the test series was 2756 lb/ft. In Test 8, the upper block slid over the shear keys of the lower block units. All other tests were terminated prior to failure when the client specified shear capacity had been achieved.

IMPLICATIONS TO INTERFACE SHEAR CAPACITY DESIGN AND CONSTRUCTION WITH WORLD BLOCK LANDSCAPE BLOCK UNITS

The maximum shear capacity values reported herein are conservative estimates of the peak shear capacity of the World Block Landscape Block system because the tests were terminated prior to failure (except Test 1). Hence, the use of the maximum shear capacity values reported herein will result in an unquantified additional margin of safety for the nominal identical system in the field. 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 0.48 inch displacement criterion. Nevertheless, the design shear capacity envelope inferred from the test data reported herein 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. The design interface shear capacity envelope shown in Figure 4 is controlled by the peak shear (assumed) criterion.

SUMMARY OF CONCLUSIONS

A laboratory testing program was carried out to evaluate the mechanical/frictional performance of the shear connection between World Block Landscape Block segmental concrete units. The actual peak shear capacity of the World Block Landscape Block system may be expected to be greater than the values reported herein since the tests were terminated before shear failure of the blocks could be achieved.

CONCLUDING REMARKS

The test results presented here are applicable to both gravity and geosynthetic reinforced soil segmental retaining wall designs that employ World Block Landscape Block units. However, the inclusion of a layer of geosynthetic reinforcement between the courses may reduce the interface shear capacity to values less than those reported in this investigation.

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REFERENCES

ASTM D6916-03. 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.

TABLE 1:
Test Program:
World Block Landscape Block unit interface shear testing

Test number	approximate wall height (feet)	approximate number of blocks	normal load (lb/ft)	shear capacity (lb/ft) at 0.48 inch displacement	peak shear capacity (lb/ft)
1	16.6	8.3	5006	3668	3668
2	14.2	7.1	4303	3668	3668
3	11.5	5.7	3448	3673	3673
4	8.6	4.3	2576	3690	3690
5	8.7	4.3	2616	3668	3668
6	8.7	4.3	2604	3679	3679
7	5.9	2.9	1761	3656	3656
8	3.2	1.6	956	2756	2756

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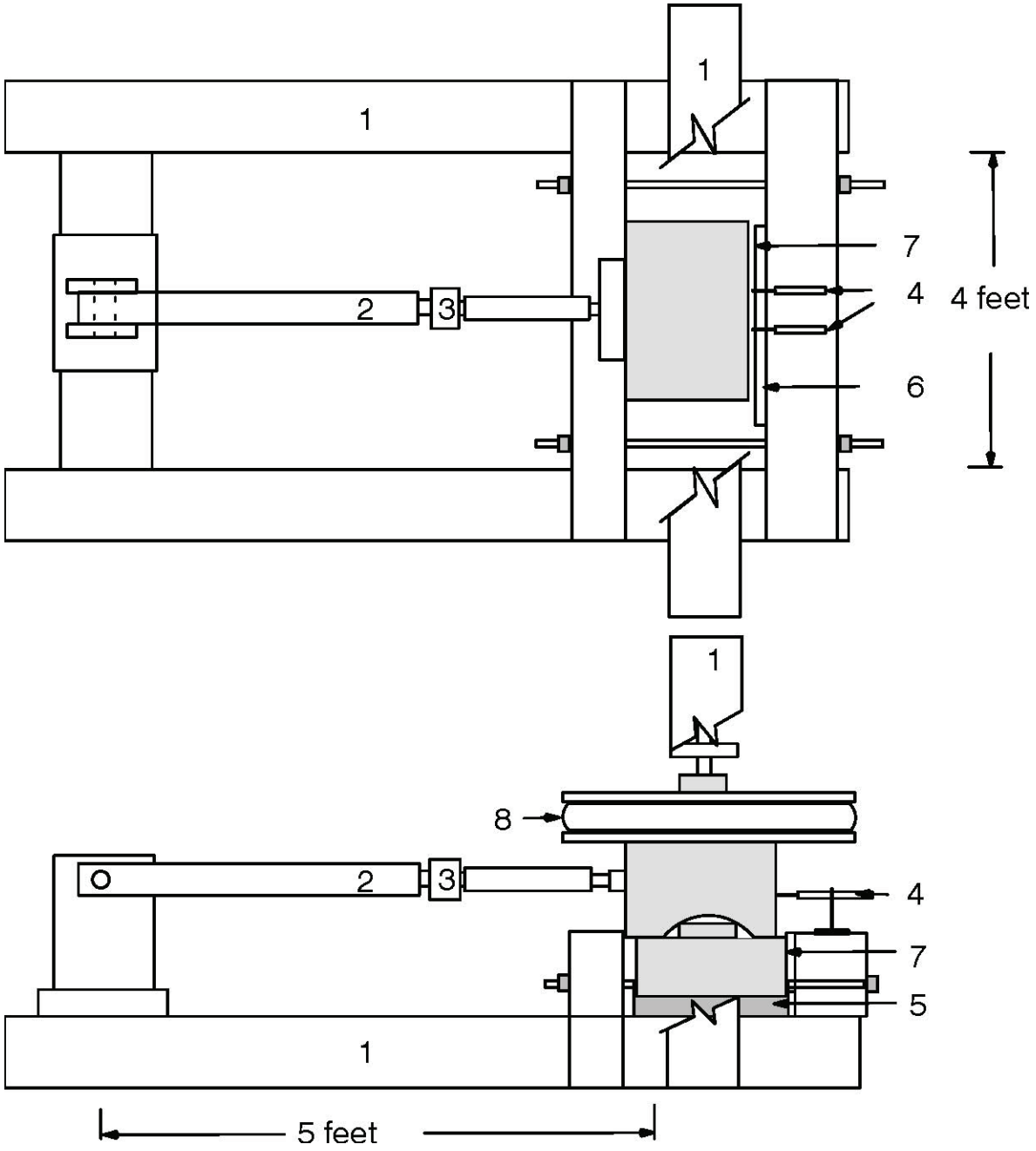
FIGURE 1:
Schematic of shear capacity test apparatus showing World Block Landscape Block segmental concrete units



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

FIGURE 2:
Photograph of the World Block Landscape Block configuration used in the shear test apparatus

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FIGURE 3:
Interface shear versus normal load for World Block Landscape Block tests

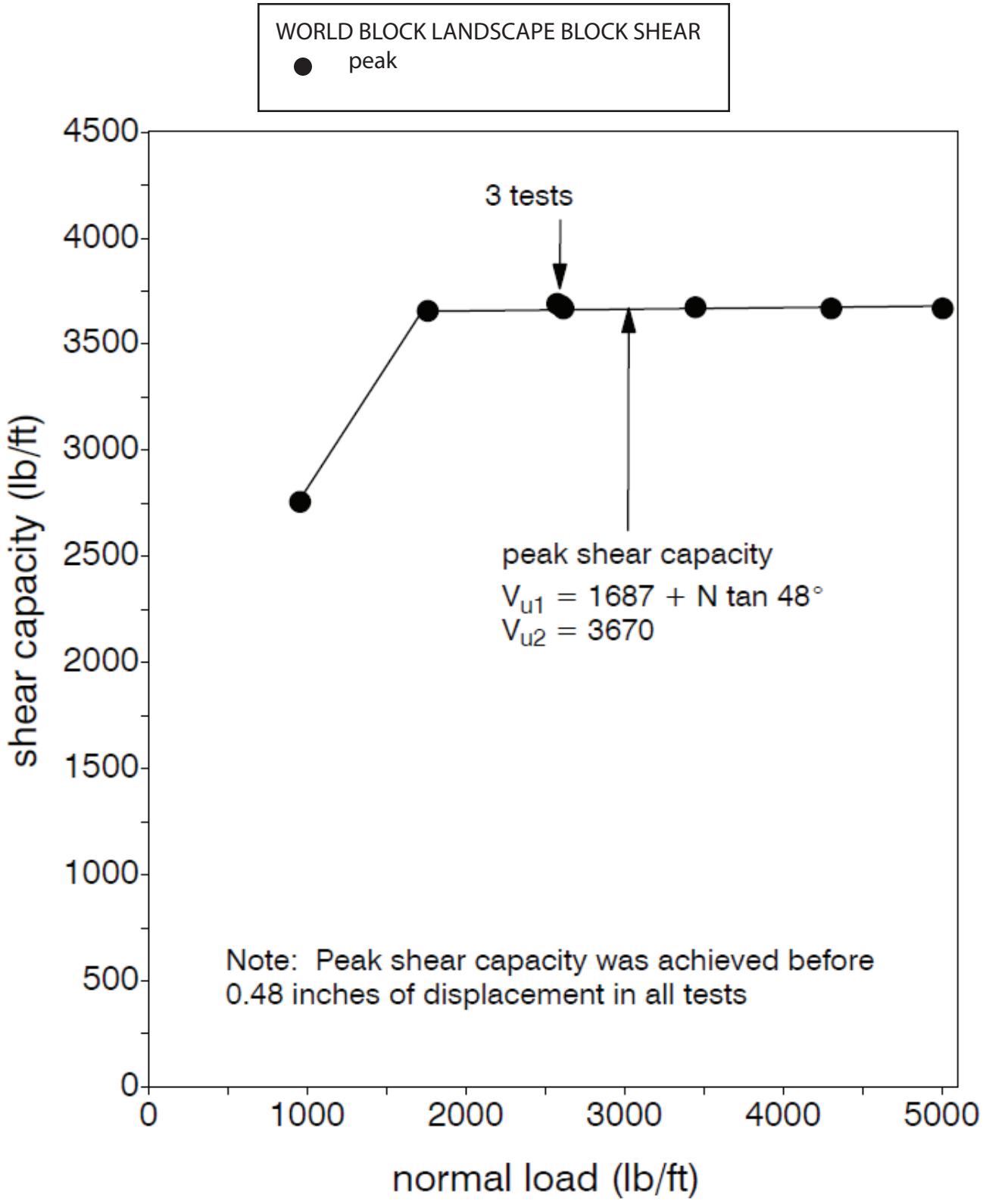
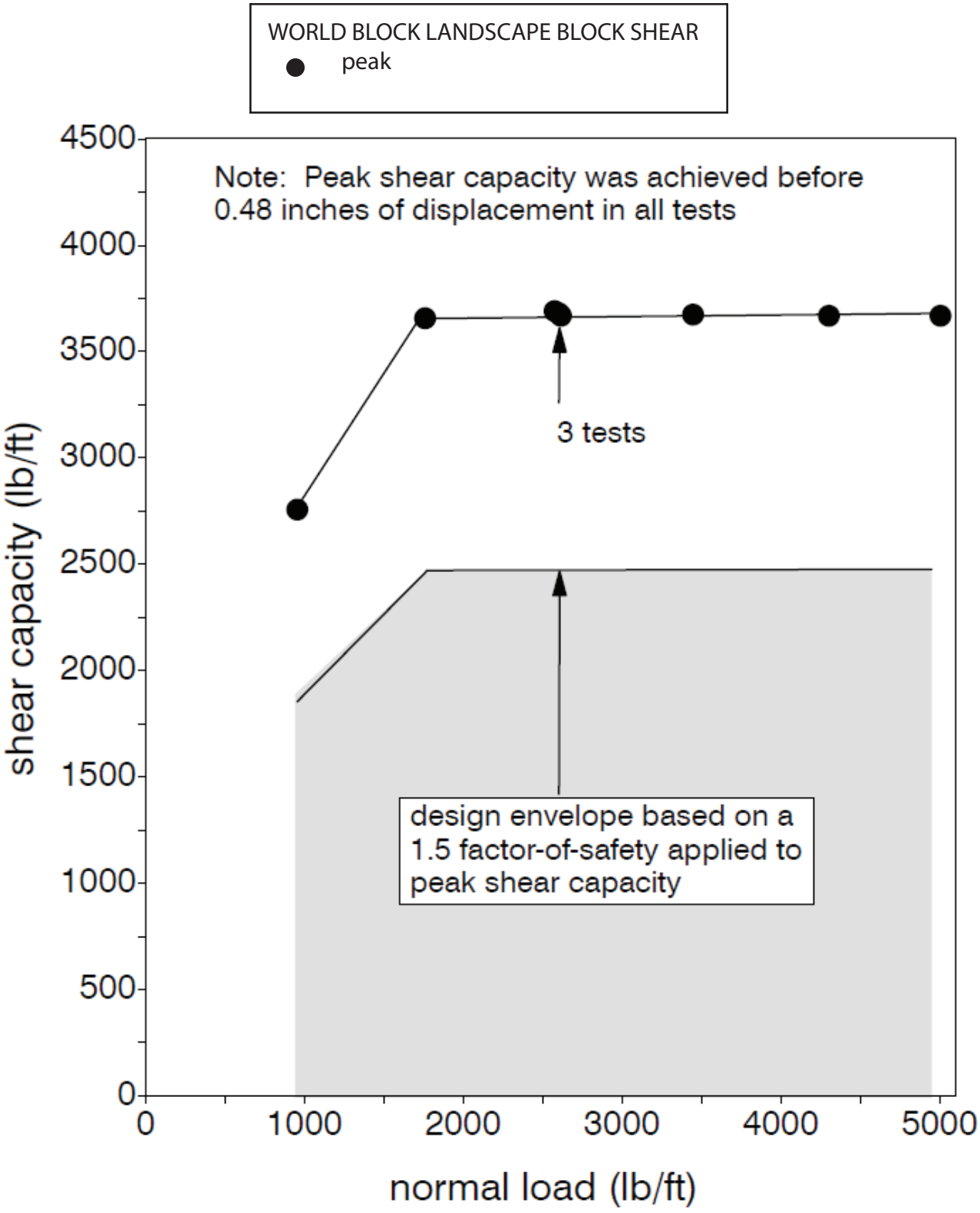


FIGURE 4:
Preliminary design curve for shear capacity versus normal load for World Block Landscape Blocks



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