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TESTING OF ROCK ANCHOR COMBINATIONS FOR VICTORIAN CLIMBING CLUB

R.I. McNamara

September 1999

CSIRO

Building, Construction & Engineering

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EXECUTIVE SUMMARY

Three rock anchor combinations were tested to determine whether or not they complied with the strength requirements of British Standard BS EN 959 : 1997 Mountaineering equipment - Rock anchors - Safety requirements and testing methods [1]. None of the rock anchor combinations tested passed the strength requirements of that Standard.

CONTENTS

TESTING OF ROCK ANCHOR COMBINATIONS FOR VICTORIAN CLIMBING CLUB

1. INTRODUCTION

1.1 General

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Dr Lam Pham - Manager Structural Product and Performance Evaluation

Signed:..... Date:24 Sept 99

Date test specimens received: August 1999

Date tests performed: August 1999

1.2 Aim of Testing

The aim of the testing was to determine whether or not three rock anchor combinations complied with the strength requirements of British Standard BS EN 959 : 1997 Mountaineering equipment - Rock anchors - Safety requirements and testing methods [1].

2. DESCRIPTION OF ROCK ANCHOR COMBINATIONS

2.1 General

All rock anchors i.e. brackets and Ramset masonry fasteners were supplied by the Victorian Climbing Club. The 200 x 200 x 200 mm strength grade N50 concrete blocks used for testing were cast and cured for 28 days by CSIRO Building Construction and Engineering. The requirement for the concrete test blocks under BS EN 959 [1], was for a compression strength of 50 ±10 MPa. The 28 day core test results for the cured concrete blocks fell within this requirement with an average strength of 49.5 MPa. Refer concrete compression test certificate in the Appendix of this report.

2.2 Combination 1

The first test combination consisted of the fixed 2 hole - 3 mm nominal thickness bracket marked AME, fixed to the concrete block with a 10 mm diameter x 75 mm long Ramset 316 stainless steel Dynabolt in accordance with the manufacturers instructions. Note - a 10 mm diameter Dynabolt has an M8 thread. A 10 mm diameter masonry drill was used to drill an 80 mm deep hole in the concrete block. The bracket was placed over the hole in the concrete block and the Dynabolt including washer (supplied with the bracket) under nut was inserted into the bracket/concrete hole and tightened to the manufacturers recommended tightening torque of 20 Nm.

2.3 Combination 2

The second test combination consisted of the fixed 2 hole - 3 mm nominal thickness bracket marked AME, fixed to the concrete block with a 12 mm diameter x 70 mm long Ramset 316 stainless steel Dynabolt in accordance with the manufacturers instructions. Note - a 12 mm diameter Dynabolt has an M10 thread. A 12 mm diameter masonry drill was used to drill an 80 mm deep hole in the concrete block. The bracket was placed over the hole in the concrete block and the Dynabolt including washer (supplied with the bracket) under nut was inserted into the bracket/concrete hole and tightened to the manufacturers recommended tightening torque of 40 Nm.

2.4 Combination 3

The third test combination consisted of the fixed 2.5 mm nominal thickness key hole bracket marked AME, fixed to the concrete block with a 3/8 inch diameter x 3 1/2 inch long 306 stainless steel bolt using a Ramset Chemset hammer in capsule for an M10 bolt in accordance with the manufacturers instructions. A 12 mm diameter masonry drill was used to drill a 90 mm deep hole in the concrete block. The bracket was placed over the hole in the concrete block and the stainless steel bolt NOT including washer was hammered into the bracket/concrete hole to a depth that left the bearing surface of the bolt head 4 to 6 mm clear

of the concrete. The minimum curing time before testing for the Ramset Chemset adhesive was 2 hours.

3 TEST DESCRIPTION

All tests were carried out in accordance with BS EN 959 for axial and radial tests [1]. In addition to recording the maximum load and failure mode, the displacement of the rock anchor combination was monitored using machine head movement. No recommendation for the number of test specimens was given in BS EN 959 [1]. It was considered appropriate to prepare ten specimens of each rock anchor combination. Five of each rock anchor combination were tested in the axial test configuration and five in the radial test configuration.

The axial test was carried out by applying a load perpendicular to the concrete block, via the hole at the end of the bracket opposite the masonry anchor. The radial test was carried out by applying a load parallel to the concrete block, via the hole at the end of the bracket opposite the masonry anchor.

The axial and radial test configurations were as shown in BS EN 959 Figures 3 and 4 respectively.

4 RESULTS AND DISCUSSION

The results of testing are given in the table below:

Rock Anchor Combination No.	Test Direction	Specimen No.	Max. Load (kN)	Displ. at Max. Load (mm)	Failure Mode
1 (3 mm thick bracket, 10 mm dia. Dynabolt)	axial	1/10 A	20.01	~25.00	bolt failure
		2/10 A	21.59	38.41	bolt failure
		3/10 A	21.65	42.83	bolt failure
		4/10 A	23.33	45.53	bolt failure
		5/10 A	21.46	39.68	bolt failure
	radial	1/10 S	24.63	43.61	bolt failure
		2/10 S	22.22	31.84	bolt failure
		3/10 S	26.35	36.25	bolt failure
		4/10 S	28.81	40.44	bolt failure
		5/10 S	27.64	38.54	bolt failure
2 (3 mm thick bracket, 12 mm dia. Dynabolt)	axial	1/12 A	8.41	16.57	Thread failure / nut
		2/12 A	25.12	46.58	concrete failure
		3/12 A	26.60	47.00	bolt failure
		4/12 A	25.60	44.82	concrete failure
		5/12 A	22.95	37.03	bolt failure
	radial	1/12 S	26.48	28.43	bolt failure
		2/12 S	31.79	41.11	concrete failure
		3/12 S	31.95	43.02	bolt failure
		4/12 S	31.72	39.40	concrete failure
		5/12 S	28.34	~ 28.00	concrete failure
3 (2.5 mm thick bracket, 3/8 inch bolt Chemset into concrete)	axial	1C A	9.99	17.74	clip failure (tension one side)
		2C A	10.71	21.24	clip failure (tension one side)
		3C A	12.26	26.45	clip fail (pulled past bolt head)
		4C A	9.90	19.01	clip failure (tension one side)
		5C A	12.47	23.45	clip fail (pulled past bolt head)
	radial	1C S	19.30	32.80	clip failure (tension one side)
		2C S	16.21	21.65	clip failure (tension one side)
		3C S	16.42	20.70	clip failure (tension one side)
		4C S	17.51	28.66	clip failure (tension one side)
		5C S	19.41	23.22	clip failure (tension one side)

The minimum load required in BS EN 959 [1] for the axial test is 15 kN. The minimum load required in BS EN 959 [1] for the radial test is 25 kN. Interpreting the Standard, it is assumed that for a rock anchor to meet the requirements of the Standard, tests must not yield results below the required minimum values for both the axial and radial tests. On this basis none of the rock anchor combinations tested pass the BS EN 959 [1] strength requirements.

If it were not for one axial test result, combination 2 using the 12 mm diameter Dynabolt may have passed the requirements. There was not apparent reason why the nut thread failed in the axial test 1/12 A.

5 CONCLUSION

None of the rock anchor combinations tested passed the strength requirements of BS EN 959 [1] as stated above in Section 4 of this report.

6 REFERENCE

British Standards Institute. Mountaineering equipment - Rock anchors - Safety requirements and test methods. British Standard BS EN 959 : 1997

APPENDIX

Concrete compression test certificate

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CONCRETE FOR TESTING OF ROCK ANCHORS 26-08-99

ORDERED – N 50

COMPRESSIVE STRENGTH

7 DAY FOG CURED - 48.3 Mpa

28 DAY FOG CURED - 66.8 Mpa

28 DAY CORES - 49.5 Mpa **

** TEST BLOCKS WERE CAST OUTSIDE AND COVERED WITH POLYETHELENE SHEET FOR 28 DAYS AFTER CASTING. CORES WERE THEN TAKEN AND TESTED WET.

STRENGTH REQUIRED FOR TEST WAS 50.0 Mpa +/- 10%

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