

TECHNICAL COMMITTEE NOTE TCN 18/02

Rock Anchor Testing – Sea Cliffs

SUMMARY



Rock anchors manufactured from three different materials were placed at two locations which are influenced by coastal weather and conditions. Load testing and a visual inspection were performed on these anchors, with the aim of detecting whether stress corrosion cracking (SCC) had developed. After one year of exposure, testing found no evidence of SCC being present. One set of anchors showed signs of staining on the surface. This was only evident with AISI 316 stainless steel anchors installed at the site which was exposed to damp sea air but was not directly adjacent to the water. Further tests will be performed after a total of 5 and 10 years of exposure.

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1. INTRODUCTION

The BMC has performed a long term test of various anchor systems at an inland location, which found no detectable reduction in strength over a 10 year trial period.^[1] The anchors tested were manufactured from either 304 or 316 series stainless steel. It was decided to follow up this work by investigating the performance of anchors at a coastal location, in particular to see if stress corrosion cracking (SCC) might be a risk.

In order to limit the numbers of test anchors placed, given any installation would be on land not owned by the BMC, it was decided to design a test protocol which would detect SCC if present whilst avoiding damaging the anchors if it was not present and thus allow continual retesting.

Fortunately, if SCC is present, it tends to manifest itself by causing affected components to fail at very low loads when load tested. A test load of 6 kN was chosen as this would be anticipated to be towards the upper end of a normal service load for a rock anchor, but unlikely to lead to plastic deformation of the anchor. If such loading did result in the formation of residual stresses in the anchor, which are known to encourage SCC formation, this would be similar in any case to any residual stresses caused by normal use.

The tests were performed using a portable Hydrajaws anchor tester, the test load of 6 kN was applied and held for 1 minute before being released. The anchor was also given a visual inspection and any comments noted.

Two locations were selected for the test, both on the Great Orme near Llandudno. Test site 1 was around sea level, facing seawards on a boulder on the landward edge of the boulder beach used to approach the climbing at Lower Pen Trwyn. This location will sometimes be sprayed and submerged by seawater but in general it is above sea level and faces E.



Test site 1 on the boulder beach approach to Lower Pen Trwyn.

Test site 2 is above the Marine Drive past Chain Gang Wall. Facing W, it is on a small wall of limestone. This location is exposed to the prevailing weather but is well above sea level.



Testing at site 2 which is well above the sea but facing the prevailing wind direction.

Test anchors placed at each location consisted of 3 each of the following:

- A) Bolt Products 8mm x 100mm twisted leg in AISI 316 using Fischer FIS VL, a vinyl ester hybrid mortar.
- B) Bolt Products 8mm x 100mm in 1.4462 using the same resin as (A).
- C) Titan Climbing Eterna 900mm length in grade 2 Titanium using G&B Gebofix Epo Plus RE, an epoxy resin.

Anchors were installed and tested one year after installation using a portable load tester. Notes were made on the visual condition of the anchors.

2. ANALYSIS

Test results and comments summarised in the table below, each test being performed on the three anchors of that type at the location.

Location	Anchors tested	6 kN test passed?	Comments
1	A	Y	
1	B	Y	
1	C	Y	
2	A	Y	Visible staining
2	B	Y	
2	C	Y	

All of the anchors tested passed the load test without failure. Visual inspection found all anchors to look in good condition, with the exception of the AISI 316 Bolt Products (A) anchors at site 2, which all had some surface staining present. Similar staining was not noted at site 1. Of note was that staining was visible on the side of the anchor orientated towards the sea rather than the landward side.



AISI 316 anchor at site 2 showing visible staining, shot taken facing landwards.



Same anchor as above with no staining, viewed facing seawards.



1.4462 anchor at site 2.



Titanium anchor at site 2.

3. DISCUSSION

The results so far are as expected. The main point of interest is that staining of the AISI 316 anchors appears to be present at the location which would be assumed to be less hostile. Damp, salty air from sea spray carried by the wind will often be present at site 2, but at site 1 there should be much greater amounts of chloride ions present due to the immediate proximity of the water. It is possible that at site 1 any deposited ions are washed off regularly and the actual amount of chloride ions on the surface is less than at site 2, but this is speculation.

4. CONCLUSIONS

After 1 year of exposure, SCC has not been detected at any of the locations with any of the different materials. AISI 316 anchors at site 2 on the cliffs above the Marine Drive show signs of staining.

5. RECOMMENDATIONS

No recommendations. The test programme will continue as planned, to include further testing after a total of 5 and 10 years exposure time, which shall mean testing in the summer of 2022 and 2027.

6. REFERENCES

[1] TCN17/01 Anchor test report – update. *BMC Technical Committee Note*