

## TECHNICAL COMMITTEE NOTE TCN 17/01

### Anchor Test Report – 2017 Update

#### SUMMARY

Following the publication of the interim test results of the BMC Anchor Testing program in TCN 11/01, the majority of the remaining tests were completed with the results published in this update. The final remaining tests will be performed and added in due course. Some additional tests were made of newly available bolts. Future plans for coastal test locations are described.



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## 1. INTRODUCTION

As part of the long term anchor tests at Horseshoe Quarry, further destructive testing was undertaken of a number of anchor systems. In addition, some newly available bolts from Titan Climbing were installed and tested. These Eterna bolts are made from a titanium alloy, and used with an epoxy resin are claimed by the manufacturer to be the most corrosion resistant anchor on the market.



*Fig.1 Titan Climbing Eterna anchor*

## 2. ANALYSIS

Test anchors were loaded axially using the BMC pull test rig, which has a maximum load of 20kN. Above this, the attachment maillons become deformed and impossible to undo. For more detail on the test rig and procedure, refer to the original anchor test report TCN 11/01.

Test results are compiled below:

Anchor type	Material	Time installed	kN	Comments
DMM Ecobolt/Hilti HY150	316	10y	20 <sup>+</sup>	No failure
Fixe/Hilti HY150	304	10y	18.8	Resin/anchor pullout
Fixe/Hilti HY150	304	10y	15.7	Resin/anchor pullout
Fixe/MM Capsule	304	10y	20 <sup>+</sup>	No failure
Fixe/MM Capsule	304	10y	15.2	Resin/anchor pullout
Petzl 12mm Expansion	316	10y	20 <sup>+</sup>	No failure
Petzl 12mm Expansion	316	10y	20 <sup>+</sup>	No failure
BP 8mm/Fischer VT380	316	5y	20 <sup>+</sup>	No failure
BP 8mm/Fischer VT380	316	5y	20 <sup>+</sup>	No failure
Staple	316	10y	8.0*/19.5	Resin/anchor pullout
Staple	316	10y	8.0*/20 <sup>+</sup>	No failure
Titan Eterna/EpoPlus RE385	Ti	1w	20 <sup>+</sup>	No failure
Titan Eterna/EpoPlus RE385	Ti	1w	20 <sup>+</sup>	No failure

\* 20kN figure indicates that the test rig maximum load was achieved without failure of the anchor other than distortion of the eye or hanger.

\* First result is a yield load, where load dropped off with an audible noise coming from the anchor, assumed to be one anchor leg bond failing, second result is the subsequent load achieved.

### **3. DISCUSSION**

Looking at the 10 year tests, there is no indication of any failure or strength reduction from corrosion of the anchor material over the 10 year test program. Any failures are due to the anchor pulling out leaving the resin behind – in other words, either the resin has failed mechanically or there has been insufficient mechanical keying. This affected the Fixe anchors, and has been noted in previous tests.<sup>1</sup>

The staples again showed interesting behaviour, with a loud popping sound and sudden release of the load as one leg appeared to fail at around 8kN. The anchors then subsequently held considerable load, indeed one exceeded the test rig parameters and could not be extracted. A possible reason for this might be that an applied load may cause a “camming” effect in which one leg of the anchor jams against the side of the hole.

Once again the Petzl 12mm and DMM Ecobolts performed well, reaching the test rig maximum. The Bolt Products 8mm anchors also performed well in their 5 year tests, and now await their final 10 year tests. The Titan Eterna bolts also gave good results in our initial test after 1 weeks installation.

So far then, it appears that AISI 316 anchors of all types tested are not noticeably weakened by corrosion in this particular inland location.

### **4. CONCLUSIONS**

The results suggest that for inland, non-coastal use, anchors made from AISI 316 are not noticeably affected by corrosion over a 10 year lifespan, whether they are expansion or resin anchors.

Fixe anchors do appear to suffer from poor keying of the resins used in the slots, leading to lower than expected pull-out forces.

Staples also have some problems, typically with one leg failing, leading to a drop in load, which then often increases up to the recorded failure point. In any case, with suitably priced commercially produced anchors now available, there is now no longer such a need as there was previously for climbers to use these home-made anchors.

DMM Ecobolts, Bolt Products 8mm, Petzl 12mm expansion and Titan Eterna anchors all gave good results in testing.

### **5. RECOMMENDATIONS**

Staples and Fixe anchors are not used for any future BMC bolting projects.

Petzl 12mm expansion and BP 8mm resin anchors are used and recommended for future BMC bolting projects.

A coastal testing program is set up to compare the long term performance of anchors made using different materials. This will include Bolt Products 8mm anchors in AISI 316 and EN 1.4462, and titanium Eterna anchors from Titan Climbing. Two locations on the Great Orme in N.Wales have been earmarked for use as test locations.

## **6. REFERENCES**

1. TCN 11/01 Anchor Test Report (BMC 2011)