BCA Equipment and Techniques Committee

Meeting held at My Big Meeting Room, Pinvin on 2 November 2014 commencing at 11:10 am

Present: V Allkins (CCC) VA, Roger King (DCUC) RK, Faye Litherland (FL), Bob Mehew (Rope Test Officer) BM, Jenny Potts (DCA, observer) JP, Stephan Natynczuk (ACI) SN, Nick Williams (Convenor) NW, S Wilson SW.

1. Apologies for absence: None.

2. Chairman's opening remarks: NW welcomed SW.

3. SUI membership of Committee: The committee affirmed SUI becoming a member of E&T Committee. In response to a query, there was a negative view by members to the 'electronic' presence of members by phone or video links.

4. Notice of items to be raised under Any Other Business: NW noted that SW's continued work on anchors would be raised in AOB if not before.

5. Minutes of the previous meeting: The sentence "Furthermore by using hot rolled material he had a higher strength metal." in item 16.1 was amended to read "Furthermore hot rolled plate is a more suitable material.". The minutes were accepted and signed.

6. Matters arising:

Action 6.1 BM to draft a proposal for a program of work to demonstrate Rawl resin was suitable for use in caves with BP anchors and circulate to members and others for comment. – see item 7. Closed

Action 6.2 NW to order 10 tubes of KMR resin. – done and available for issue. Closed

Action 7.1 NW to pass a copy of the current CSCC anchor documentation onto RK. – yet to be done.

Action 10.1 NW to contact SUI to sort out which anchor installation procedures they were adopting. – Tim Fogg had confirmed they had adopted the CNCC procedure and were using their own trainers. Closed.

Action 13.1 All Committee members to provide contributions of dos and don'ts for the items listed (Anchors, Ropes, Ladder, Chain, Wire cable). - see item 13.

Action 13.2 NW to issue an invite to cavers for contributions to the process of producing a Dos and Don'ts list. – see item 13.

7. Replacement Resin – program and potential problems with RAWL resin: BM noted he had issued a proposal to clear action 6.1, see Appendix 1. NW asked if there was a need to adopt a new resin. RK reported that he had experienced one poor resin mixed placement in his testing program with a peak force of only 8kN.

SW reported that he found there were significant problems with mixing of resin, often due to air in the tube. He noted that the RAWL cartridge was coaxial and translucent so one could not see if air was present in the cartridge. Fischer cartridges were two tubes in line and transparent. Thus one could see air bubbles if one removed the label. He also noted that Fischer resin and hardener were

less viscous than RAWL which made getting entrapped air to the discharge point slightly easier. He was of the opinion that some of the reported RAWL mixing problems were down to entrapped air.

VA enquired if air being expelled might be heard. SW indicated that it might be possible to either hear the air but one could also getting air being expelled from the hole. One might also feel the difference in the trigger but this was a skill.

SW had also found it useful to check on resin mix before and after filling each hole. He had also experienced a problem in a Fischer cartridge nozzle where a thin line of unmixed resin was clearly present. The only way to deal with it was to discard the nozzle. Taking samples of resin was discussed. It was agreed that the focus had to be on the installer checking the quality of mixing rather than requiring samples to be kept.

NW noted that this pointed to a lack of understanding of the challenges associated with resin but RK's reported 8kN experience was a clear failure to achieve the 15kN threshold. This raised the question if post placement tests should be conducted, as is the practice in Derbyshire. VA pointed out testing every placed anchor would create an enormous work load. BM noted that a 10kN load would distort the head and crack any resin linked to the head. FL noted that users were expected to use two anchors to protect against a single failure.

BM noted that his proposal suggested nearly 100 anchors were required to cover all the identified parameters. SW pointed out that not all parameters were covered which would extend the program.

SW endorsed using Fischer resin because of the packing features. He emphasised that this was the Fischer V 360 S resin as the VT resin came in a coaxial cartridge. It was noted that KMR resin was packed in a similar manner to RAWL. NW stated that cost was not a significant parameter.

It was agreed that Fischer V 360 S resin should be tested. FL proposed that the tests should be done on both dry and flooded holes to check the influence of the gross presence of water. NW stated he preferred testing 30 anchors of each. It was agreed that the tests should be conducted with 304 SS anchors. VA & BM volunteered to undertake the testing. NW agreed to organise the supply of the resin.

Action 7.1 – VA & BM to test 30 Bolt Product type 304 anchors in dry holes and 30 in flooded holes using Fischer V 360 S resin.

Action 7.2 – NW to purchase Fischer resin and ship it to VA.

8. Anchor Testing in Devon: RK issued a report of his work, see Appendix 2. As previously commented on one anchor in limestone gave a very poor result of 8kN. Inspection of the extracted anchor suggested poor mixing of the resin. The mainly poor results in Killas were possibly due to it being a boulder. Although there was a problem in that the owner did not want to have an anchor test bed within the mine, it was considered necessary to do some more test on Killas to resolve what was the expected capacity. RK asked for 24 more Bolt Product type 304 anchors to continue testing.

9. Further Anchor Testing:

9.1 North Wales: NW introduced a request from North Wales to fund the testing of some anchors that had been used in slate in various mines, see Appendix 3. FL queried whether the focus should be on slate variability rather than anchors. BM noted that the proposal did cover several quarries and thus different slate types. VA suggested the test set should include Bolt Product anchors. BM suggested that given the only difference between Collinox and Batinox were the length and diameter of the shaft (70mm long by 10mm OD for Collinox verses 100mm long by 14mm OD for Batinox), one could argue that testing Batinox was not necessary if Collinox gave an acceptable performance. If the Collinox did not achieve a satisfactory performance, then a follow up request for funding Batinox should be submitted. It was also suggested that the test program should be expanded to cover Bolt Product anchors. The committee agreed to fund a program involving Collinox, Coeur plus Goujon and Bolt Product anchors. The committee also agreed that if the Collinox results were poor, then a decision on funding Batinox anchors would be taken by email in advance of the next meeting.

Action 9.1 – NW to inform North Wales of E&T's agreement to fund the work.

9.2 Use of Anchor Puller: BM reported that he understood there were now several demands for the puller. This included SW's desire to radial pull IC anchors for which he required a higher range load cell and L Sykes work in Yorkshire. Following a short discussion it was agreed that the priority list for use would be:

1st IC radial tests
2nd Fischer resin tests
3rd North Wales range of anchor tests
4th L Skyes Yorkshire anchor work
5th RK's Devon work

The meeting adjourned for lunch at 1.05pm and restarted at 1.30pm.

10. Anchor Placement – demands / stock & placements: FL indicated that Mendip was currently OK but would need some more resin in due course. RK noted that there was a request to use anchors in concrete at a mine head. He also had an outstanding request for some HC anchors and wanted 12 type 316 anchors. NW estimated there were roughly 200 type 316 anchors in stock. JP indicated that DCA might need some more in due course but she had not had any specific request. NW agreed to chase up Bolt Products for information on HC anchors and the outstanding type 316 order.

Action 10.1 - NW to contact Bolt Products to obtain some HC anchors and information on delivery of the outstanding part of the type 316 order.

11. Use of BCA Drills etc: NW reported that he had a request from a DCUC based club for E&T to help them purchase a drill for anchor placement. RK indicated that he felt DCUC should deal with this. NW asked if DCUC and CCC had BCA supplied drills. VA indicated whilst he had not, he had his own so did not consider there was a need for one. RK indicated it would be useful if DCUC did have a drill. The committee agreed to E&T purchasing a drill for DCUC.

Action 11.1 – RK to organise the purchase of a drill.

12. BMC Chloride Stress Corrosion Cracking Work: BM reported that UIAA were considering doing some work on Chloride Stress Corrosion Cracking but their focus was on conditions not overly relevant to caves. NW noted a recent discussion on ukCaving referring to titanium anchors. RK noted this would be of interest to some Devon located caves. NW agreed to look into them.

Action 12.1 – NW to enquire about titanium anchors.

13. Fixed Aids: NW Reported that he had not progressed the topic. It was agreed to carry the topic forward.

Action 13.1 - All Committee members to provide contributions of dos and don'ts for the items listed (Anchors, Ropes, Ladder, Chain, Wire cable).

Action 13.2 - NW to issue an invite to cavers for contributions to the process of producing a Dos and Don'ts list.

14. Rope Test report: BM apologised for not issuing a report but he had been busy with other matters and there was little to report. He was on top of testing submitted samples.

15. BCA Static tester: BM noted that work on the static test rig had not progressed due to other demands.

16. Any other business

16.1 DCA Anchor Work: JP provided a report on work undertaken by DCA on anchors over the past months, see Appendix 4.

16.2 User Requirement Specification for Anchors: FL led a discussion on her partly drafted document with the aim of obtaining information to help complete it. FL agreed to update the draft and send a copy to NW for circulation within E&T.

Action 16.2.1 - FL to provide a draft User Requirement Specification for Anchors to NW for circulation within E&T.

16.3 Insurance cover for anchors: SW sought advice on whether anchors installed in caves but not under the BCA scheme were covered by BCA's insurance. NW responded that they could be but it was difficult to give a definitive answer. For example he felt it was likely that the commercial production of anchors would not be covered nor would homemade untested anchors. FL suggested that if there had been a problem involving a commercially produced anchor, then surely the injured party would sue the manufacturer. BM suggested SW and NW discuss the problem outside the meeting so NW could get clarity on what advice might need to be sought from the underwriter.

16.4 Testing to BS EN 959:2007: BM asked if the IC anchors needed to be tested to BS EN 959. NW indicated there was a significant difference between claiming an anchor was "independently certified to BS EN 959" and that an anchor "complied with BS EN 959" as is often found. He considered that it was in E&T's gift to accept results from tests done in stone rather than concrete.

16.5 Date/location for next meeting: The Committee agreed to Sunday 15 March 2015 at 11am. SN noted that he might have moved to somewhere else but it would be in the same locality.

The meeting closed at 1515.

Action List

5/4/14

Action 7.1 NW to pass a copy of the current CSCC anchor documentation onto RK. – yet to be done.

2/11/14

Action 7.1 – VA & BM to test 30 Bolt Product type 304 anchors in dry holes and 30 in flooded holes using Fischer V 360 S resin.

Action 7.2 – NW to purchase Fischer resin and ship it to VA.

Action 9.1.1 – NW to inform North Wales of E&T's agreement to fund the work.

Action 10.1 - NW to contact Bolt Products to obtain some HC anchors and information on delivery of the outstanding part of the type 316 order.

Action 11.1 – RK to organise the purchase of a drill.

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Action 13.1 - All Committee members to provide contributions of dos and donts for the items listed (Anchors, Ropes, Ladder, Chain, Wire cable).

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Action 16.2.1 - FL to provide a draft User Requirement Specification for Anchors to NW for circulation within E&T.

Appendix 1 Alternative Resins

I accepted an action at the last meeting to "*draft a proposal for a program of work to demonstrate Rawl resin was suitable for use in caves with BP anchors and circulate to members and others for comment*". Having been somewhat slow off the mark, I have subsequently had some difficulties in producing a program due to some results obtained by Simon Wilson in the development work he is undertaking on his new anchor design. The information can be best summarised in the following table

Anchor Type	*No. tested*	*mean kN*	*SD (1) kN*	*% SD*	*k (2)*	*5% fractile value kN (3)*
DMM Eco (4)	*23*	*39.8*	*9.5*	24	*2.15*	19.5
Pico trial batch (4)	*33*	*33.6*	*5.2*	15	*2.33*	21.5
Pico batch 2 Horseshoe Quarry (4, 5)	*30*	*27.9*	*4.1*	15	*2.33*	18.4
Pico batch 2 Ingleton (4, 5)	*30*	*34.9*	*6.2*	18	*2.25*	20.9
Bolt Products / RAWL resin (6, 7)	*33*	*35.2*	*4.7*	13	*2.40*	23.9
Bolt Products / KMR resin	*32*	*44.9*	*8.7*	19	*2.23*	25.5
S Wilson field work / Fischer (8)	*36*	*35.7*	*1.1*	3	*2.04*	33.5

Notes

(1) SD - Standard Deviation

(2) k is a parameter to convert mean and standard deviation into 5% fractile value, see (3), taken from Owen's "Handbook of Statistical Tables" page 126 using the 95% confidence values.

(3) Assuming the data is normally distributed, then the 5% fractile value is the value above which 95% of the population is predicted to achieve in the test.

(4) Although the badge on the resin has changed, the resin used in these all of these tests is understood to be the equivalent to the modern day Martyn Price KMR resin.

(5) The data excludes those samples which involved metal failure (2 in each test bed).

(6) RAWL resin used was the R-KER 380 expoy acrylate cartridge based.

(7) Post test observation indicated some parts of the resin had not cured.

(8) Fischer resin used was the FIS V 360 S (not winter) cartridge based.

Also of note is that all bar the Bolt Products / RAWL resin data set was normally distributed. Other unreported work indicates a similar problem. The table shows that there can be substantial variation in the percentage standard deviation. The causes of these variations are varied and probably not fully understood.

One major variable is the process of measuring the extraction force. Put simply, the expectation is that an axial pull (that is directly outwards along the axis of the shaft of the anchor) requires less force than a radial pull (that is at right angles to the axis of the shaft of the anchor). So if the pull is slightly off the axis, then the extraction force is expected to go up.

A second anticipated variable is the resin but this can be subdivided. We have no real data on the 'strength' of resin by which we can compare between all of the three resins mentioned above.

One sub variable of resin is mixing. Clearly an unmixed resin which perforce has no strength is a serious concern. The Bolt Product RAWL work has shown small parts of the cast resin failing to cure. In addition, it was noted during the Fischer work that one nozzle failed to achieve a consistent mix and had to be replaced. (Because the nozzle was replaced, the poorly mixed resin was not therefore tested.)

It was noted that the Fischer resin showed air spaces in the unmixed resin within the cartridge which if not expelled during initial set up could lead to poor mixing. This problem is claimed to occur with other resins and it has been reported that one should both store and transport cartridges in the upright (nozzle up) position; a statement not apparently recorded in either RAWL or Fischer documentation.

Other possible variables includes the hole cleanliness and the degree of dryness of the hole. I am assuming we can ignore variations in strength of the metal anchor since we don't see metal failure.

One feature of the all the data is that none have produced what I would term a "mission failure" result, in that no 5% fractile value has come below the agreed criterion of 15kN.

One observation of Fischer and RAWL application sheets is that they recommend remarkably small annuluses between bolt outside diameter and hole internal diameter of 1mm. To emphasise that is the annulus is only 0.5mm wide. In comparison, DMM Eco anchors required a large hole so the tangs could be inserted into it and hence had a considerable thickness of resin between metal and rock.


Photo by L Sykes

The strength of the rock substrate may have some influence, even though from most extracted anchors the degree of spalling or perhaps rock breaking is not that great. It is thought that using limestone in quarries could well influence the strength by being heavily impacted from shot blasting creating micro fractures. There is some anecdotal information that anchors placed in water worn limestone faces perform better than anchors placed in limestone faces in quarries. (There is a potential related topic as to whether naturally faults and joints in limestone also have micro fractures associated with them due to the earth movement.) Images of the holes from which the Bolt Products anchors have been extracted indicate more than surface spalling has occurred.

Whilst the use of concrete to the appropriate standard would be challenging to acquire, alternative rock such as granite could be a suitable alternative, though this would not cover long term rock / resin potential concerns.

There is also a subsidiary concern that the hole internal diameter is so tight on the anchor external diameter that there may be an insufficient thickness of resin between the anchor and the rock to provide for a good bond. This concern becomes more significant if the resin is poorly mixed.

The original choice of resin was in part dictated by having a resin which could cope with greasy anchors. Although the task of degreasing an anchor is simple, it is one which could easily be overlooked.

An experiment to obtain information on resin performance with respect to potential variables would have to cover

- Poor mixing
- Cleanliness of the hole
- Wetness of the hole
- Rock quality
- Greasy anchor

The industry method for testing for poor mixing is to undertake cube crush tests as per BS 6319 Part 2 using 40mm cubes. This would not only be costly as one will only get 5 cubes from each resin cartridge, would require setting up a crush rig and more importantly, not reflect the concern over the relatively minimal amount of resin used in the placing of anchors. It would also not give information related to impact on the strength of anchors.

Poor mixing could be simulated by placing low strength bodies (such as nylon fishing line or sheet nylon) in the hole of differing sizes to simulate either air spaces or the extreme of poor mixing. As such one could thus obtain a set up where the body could occupy say 10% of the space normally filled by the resin. It is not clear if this would work, so some initial tests would have to be undertaken to show appropriate distribution. Trials would have to be conducted with varying displacement and also to determine the size of air gap or poorly mixed resin that one could realistically expect to experience. These could be done by simulating the rock with say an 18mm ID pipe. Both plastic and steel 18mm diameter pipes are easily available. The anchors could be placed and then the pipe cut open along the shaft axis and prised off. The resin could then be cut away to determine if the body has remained in position. In qualitative terms, poor mixing could be tested by say three set ups representing 0, 10 and 25% reduction in resin. In addition the concept will not work with using the normal 16mm diameter hole as experience indicates the Bolt Product anchor requires some force to be inserted in a 16mm hole. This work would have to be done with say a 18mm hole.

This variable also suggests that different larger hole sizes should be tested to reduce the potential for this concern. The expectation is that increasing hole size in the rock should not change the strength though it will increase the volume of resin required per hole. The obvious alternative hole size is 18mm to allow for reuse of Eco anchor holes and perhaps 20mm to allow for excessively cleared holes being reused from either Eco or Bolt Product anchors.

Cleanliness of the hole can only be realistically checked by using dry drilled holes which have either been not cleaned what so ever, or cleaned solely by blowing and brushing or cleaned by water and brushing. There is also the variant of a damp drilled hole where the dust can result in a paste remaining in the hole.

Wetness of the hole can be checked by washing the hole and then either drying it with a cloth or blowing water out so as to leave it damp or leaving the hole full of water which is displaced by the resin.

Rock quality can be checked by using say either a granite outcrop (which is of much higher compressive strength than limestone or 50N/mm^2 concrete) or a limestone outcrop or a limestone surface in a quarry.

Greasy anchors is probably best done on either as delivered or as degreased.

These ideas reflect a sizeable range of tests to test each parameter individually, let alone in combination. The reference state would be 0% body, 16mm hole, cleaned by water, dried, limestone outcrop and degreased.

Parameter	range
Poor mixing	2
Hole diameter	2
Cleanliness	3
Wetness	2
Rock Quality	2
Greasy anchor	1
Total	12

To have some confidence in the results one would have to repeat each range test say 5 times making 60 anchors. Each of the above tests would be compared against the reference case which would require some 30 anchors tested to ensure the system is performing according to a normal distribution. Data analysis would include calculating mean, standard deviation and 5% fractile value for each test. If we allow say 5 pre test trials for poor mixing, that implies 95 tests.

It is suggested that such tests are based on using the spare 304 anchors with a subsequent five 316 anchors being tested to assure no difference between resin 304 and resin 316 stainless steel interactions. That gives 100 anchors in total. The number of holes per cartridge is a bit of a guess. If we assume the anchor metal conservatively occupies two lengths of 8mm OD by 110mm long volume and we drill a conservative 18mm ID hole 110mm deep, then the volume of resin required per anchor in cm^3 is $11*\pi*(0.9^2 - 0.4^2)$ which is 23cc. Cartridges usually come in 360cc or 380cc size. If say we eject 40cc to achieve adequate pre mixing, then that leaves 320cc which is roughly 13.9 anchors, say 14 per tube. That means we require some 8 or 9 cartridges.

If we use RAWL KER resin despite its poor mixing experience, then typically that will cost £15 per 380cc cartridge from Metro Fixings or £120 for 8. Tool Net charge £83 for a box of ten. Fischer FIS V costs £12 per 360cc cartridge or £108 for 9. Assuming £2 per anchor this will require around £300, neglecting other costs such as drill bits and travel expenses.

In a short consultation with Fischer over the use of resin in wet conditions, they recommended FIS VT which cost around £8 per 380cc cartridge from Sealants &Tools. A brief comparison of data sheets suggests the two resins have similar strengths though Fischer's sales literature suggests it performs slightly less well but presumably more than well enough for our application, given its added ability to cope with wet conditions.

This document has been written to promote a discussion on the way forward rather than make a proposal. I must record my thanks to both Les Sykes and Simon Wilson for their helpful contributions to this document.

However one point does probably require a recommendation. That is amendments should be made to training documentation to include a reference to the need to store and transport resin cartridges nozzle upright so as to minimise the possibility of air remaining within the bulk resin causing poor mixing.

Bob Mehew

21 October 2014

Appendix 2 DCUC Resin Anchor testing Summer 2014

This testing took place in South Devon during the Summer & Autumn of 2014. The testing was organized by Roger King. Richard Vooght and Alex Heath assisted in the installation & testing, Thanks to the Landowners Bruce & John Bolton from Chudleigh, Humphrey Walters of Great Rock & Earl of Bradford (Tavistock Woodlands) through the help of Dave Warne, Chairman of DCUC.

The system of the Bolt Products Anchors & KMR resin has already been proved in a variety of locations in other areas of the UK. This was for comparison with the three common Rock types found in Caving & Mining areas in the South West.

Devonian Limestone.
The site was a Chudleigh in Gardens of Rock House on the North side of the main outcrop. On a small exposure by the camping area. NGR SX 86443 78787

Four anchors were initially places when they were extracted one failed at a low level. This was the first placed and it would seem that the resin had not mixed properly. Another bolt was placed in the undamaged hole and extracted later. The resin used was at the last of a tube and did not mix properly; the resin had a granular texture.

Serial Number	Force	Comments
558	33.10 kN	No damage to rock
557	32.80 kN	No damage to rock
559*	18.00 kN	No damage to rock
556	26.40 kN	No damage to rock
551*	8.00 kN	See above

Granite
The site was on the Launder level of the Great Rock mine complex. This was a boulder at the side of the track. NGR SX 81976 81868

Serial Number	Force	Comments
555	31.30 kN	No damage to rock
554	25.30 kN	No damage to rock
553	31.50 kN	Boulder cracked on extraction + some spalling
552	32.50 kN	Spalling around hole

Killas
The site was at the Devon Great Consols Complex. This was by the entrance of Wheal Fanny. NGR SX 42205 73690

Serial Number	Force	Comments
560	20.08 kN	Cracking around bolt
316 - 321	12. 80 kN	Cracking around bolt
316 - 323	12.90 kN	Cracking around bolt
316 - 328	13.45 kN	Cracking around bolt

560 was installed on a shelf in the entrance to the adit; the remainder on a boulder. One bolt (316-328) also had some coning.

Dave Warne suggested that the low readings might relate to the fact that they were in a boulder.

Appendix 3 North Wales Anchor Testing Proposal

From: Gethin Thomas [mailto:redacted] !
Sent: 19 October 2014 23:18!
To: richard hill; Vince Allkins; CCC Access Conservation; Robert Mehew!
Cc: conservationofficer@cambriancavingcouncil.org.uk; BERNIE WOODLEY !

Subject: Bolts in slate

Hi All,
Finally had a chance to pull together a proposal (as to Stuarts request a few months ago!) about extending the bolts in slate project….

Bolts in slate

Over the last few years we've seen a significant increase in the number of bolts placed in the slate mines of North Wales as, I suspect, battery powered drills are becoming more affordable and people more adventurous!

Unfortunately not all the anchors placed are PPE bolts conforming to the UIAA 123 or EN959 standard, with several significantly cheaper anchors being commonly used, but difficult to identify in use. The question had to be asked are these cheaper DIY bolts up to the job? Our original tests confirmed many of these bolts are not appropriate(http://www.train4underground.co.uk/lmla-level-1-training/bolts-inslate-testing-project/), further supported by the catastrophic failure of several "thunderbolts" on some limestone crags in North Wales (https://www.thebmc.co.uk/bolt-failures-on-north-wales-limestone)

The UIAA and EN standards are both based on, in part, an axil (that is directly out, at a right angle to the rock face) pull from from concrete with a compressive strength of 50Nmm2 (http://atv.hamradio.si/~s51kq/photo_album/Climbing_and_Mountaineering/pdf_climbing/UIAA/PictUIAA123-EN959RockAnchors.pdf), slate measures up around 24-36Nmm2. So another question worth asking is do anchors perform as well in slate as they do in concrete?

Recently there's been observations of expansion anchors on several bolted rock climbs within the slate quarries in North Wales wobbling (https://www.thebmc.co.uk/warning-issued-over-slate-bolts). Although none have failed in use it has highlighted concern with the appropriateness of expansion anchors (particularly 10mm expansion anchors) in slate. A theory is circulating that the repeated loading of expansion anchors crumble the slate around the operative parts of the expansion anchor reducing its function, which begs the question does repeated loading of expansion anchors in slate effect their reliability?

In 2012 a group of us, having between us placed several hundred bolts in slate, looked to conduct some simple tests in a block of slate in Cwmorthin Slate Mine. The initial tests were conducted with a Hydradraw test rig which can only pull bolts to 20kN. The results for PPE bolts were promising, however the DIY bolts did not fair so well with several failing, some even during placement!

A year later with the support of the BCA, in particular Bob Mehew, we returned to the site with the BCA test rig (and a wheelbarrow to get it in!) and tested the bolts to destruction. Again this round of testing gave us comfort with several of the expansion anchors holding beyond 35kN and resin anchors beyond 30kN (the UIAA standard is for 20kN in an axial pull).

In all 19 bolts were tested to destruction, 3 donated by the NWCRO, but the others funded by ourselves. 2 days were taken up placing the bolts (2 people each day) and another 2 days testing (3 and 4 people each day), we also funded the hire of a calibrated Hydrajaw test rig for the initial 2012 tests.

Although the testing has given us some comfort in the reliability of some anchors in slate (and highlighted the inappropriateness of one particular design of anchor which had been marketed as a soft rock anchor, something we've highlighted to the manufacturer and fed back to the NWCRO) it's been pointed out that this small test bed does not constitute a statistically sound test. Neither did our initial round of tests look at the possibility of anchors deteriorating in use.

Following discussions with Bob Mehew it has been suggested that we expand the tests to a number of different sites, and test 5 of each anchor type at each site. I've identified 2 sites, one in Corris another in Cwmorthin where we could set up 2 test beds in different veins of the slate to conduct further tests. I also have permission from the owners to conduct these tests.

I would propose 2 tests for the anchors, the first, to repeatedly take the anchors up to 6kN 20 times in succession to emulate repeated falls on the anchor, followed by a test to destruction. The first round of tests could be completed with a Hydrajaw which could either be rented locally or if available borrowed from the BCA. To test the anchors to destruction we'd need the BCA hydraulic test rig. Time wise I suspect we'll need at least 1, possibly 2 days to bolt each site, then at least 2 days per site for the pull testing. I have time during December and January to complete the work if the resources can be made available.

As I understand the BCA E & T group have agreed to support the project, but are reluctant different anchors other than the BP. Given there are no BP bolts in use within the slate mines in North Wales I would suggest it is of greater benefit to the mining exploration fraternity to test the anchors most commonly used in the mines, and am looking for support from the CCC to fund the extension of this project.
I'd be looking at around funding for the following

22 x 10mm Collinox at £7.29 each. Total: £160.38
22 x 14mm Batinox at £13.02 each. Total: £286.44
22 x Collinox resin ampules at £1.04 each. Total: £22.88
22 x Batinox resin ampules at approx. £2 each. Total: £44
22 x Coeur & Goujon 12mm anchors at £4 each. Total: £88
Grand total: £601.70

Gethin Thomas
19th October 2014.

Appendix 4 DCA Equipment Officer's Report

Around the middle of September it was reported by Chris Porcheret that there was a loose DCA P anchor at the top of the alternative route down Leviathon in JH mine. It turned out that the loose anchor was not installed by DCA but was one of a series of stainless steel resin set and expansion anchors installed by persons unknown. This anchor (possibly Raumer) could be moved with the fingers and only took a small amount of force to remove with a short bar. When inspected the anchor had a minimal amount of resin on the shaft. The substrate around the existing 12mm hole was inspected and deemed structurally sound, the hole drilled out to 16mm and a new BP anchor installed. Subsequently the anchor was successfully Hydrajaws tested to EN959. This episode highlights the dangers of anchors being installed by untrained persons and the need to rigorously check all anchors to the BCA approved guidelines whilst rigging. It should also be noted that both BP and Eco anchors have been on sale commercially and that just because an anchor of these designs has been used does not necessarily mean that it was installed by DCA. DCA is not responsible for any anchors except those designated on the approved topos. I would like to encourage a discussion on whether this alternative route down JH should be re-bolted by DCA as it seems to be quite popular.

A report came in from the instructors at Stanley Head that the high anchors on the 1st pitch of P8 were oozing water around the resin. They were inspected by DCA and were found to be perfectly structurally sound by Hydrajaws testing. It turned out that these were not the anchors in question and that the complaint pertained to the anchors at the high level old iron ladder bypass to Pitch 2. It would save a lot of time and effort if persons reporting defects in placements could accurately describe where the offending anchors are positioned. As it was, an unnecessary trip was made by the installers. In future all complaints of defective anchors should be emailed directly to myself by the complainant giving precise details and a telephone number so I can ratify first hand their exact position. Any complaints by other routes will be ignored until accurate positioning of the offending placements is defined. Whilst I would always encourage cavers to bring defective anchors to DCA's attention the installers have a hard enough job without being sent on pointless errands. I have been unable to contact the installers to check whether the old iron ladder pitch bolts have been checked and would advise that they are best avoided until further notice.

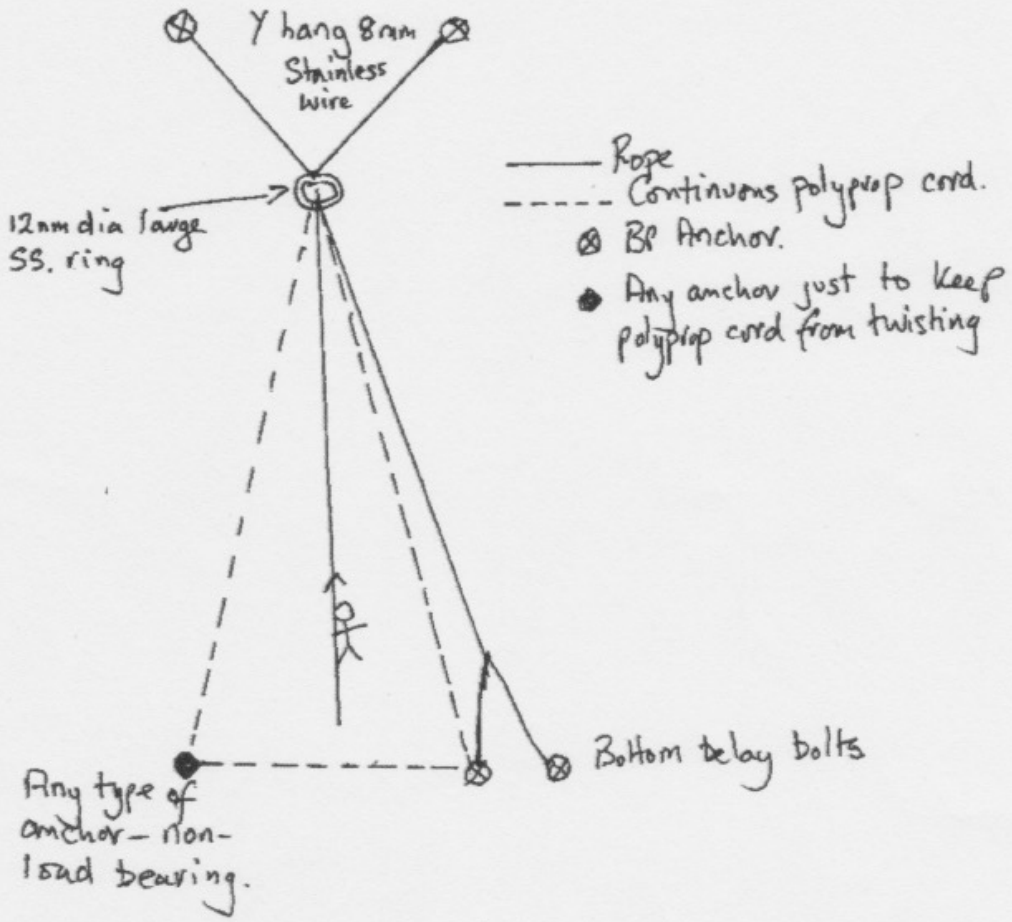
To protect the very expensive 36 volt Hilti drill I have obtained a Pelicase courtesy of the BCA E&T Committee. This will no doubt prove its worth when it is dragged back and forth through St. Valentines sump during the re-bolting of the Filthy Five pitches planned for this winter.

I am also in the process of having two 8mm Y hangs manufactured for the pull-throughs in the Far Flats in Nettle Pot (see beneath for design).

Bob Dearman

Pull-through system.

Developed by DCA



Made to order to suit each installation site.