BCA Equipment and Techniques Committee

Meeting held at My Big Meeting Room, Pinvin on 15 March 2015 commencing at 11:05 am

Present: Roger King (DCUC) RK, Bob Mehew (Rope Test Officer) BM, Stephan Natynczuk (ACI) SN, Gethin Thomas (GT), Nick Williams (Convenor) NW, S Wilson (CNCC) SW

1. Apologies for absence: Vince Allkins and Faye Litherland had sent apologies. Jenny Potts had informed NW that Bob Dearman had been appointed as DCA's Equipment Officer but declined to attend BCA's E&T Committee. It is the intention of DCA to send another person as DCA's representative.

2. Chairman's opening remarks: NW welcomed SW as CNCC's representative to the E&T Committee and GT for his work on North Wales anchors.

3. Notice of Items to be raised under AOB: BM wished to raise the topic of 'Learning from Experience'. SW asked where appointing a trainer for IC anchors would be covered. NW indicated it could be taken under item 9.

4. Minutes of Previous Meeting: The minutes were accepted and signed.

5. Matters arising not covered elsewhere:

5A Actions from Previous Meetings

5/4/14

Action 7.1 NW to pass a copy of the current CSCC anchor documentation onto RK. – yet to be done. NW indicated he had passed a copy to RK during the last meeting. RK confirmed he had a copy. Closed.

2/11/14

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. NW reported that 10 HCR anchors had been supplied by Bolt Products and passed to RK. However he had no update on the supply of 316 anchors. Closed.

Action 11.1 – RK to organise the purchase of a drill. RK reported that a drill had been purchased. Closed.

Action 12.1 – NW to enquire about titanium anchors. NK had purchased 10 anchors from Titan Climbing at a price of £8.45 and passed them onto RK. This was roughly twice the price of a Bolt Product 316 anchor. He had no indication of the price of Bolt Product HCR anchors. NW suggested testing be dealt with under AOB. Closed.

Action 16.2.1 - FL to provide a draft User Requirement Specification for Anchors to NW for circulation within E&T. NW reported that he had not received anything from Faye. Action continues.

5B Other Points Arising:

5B.1 Anchor Puller: NW reported that the anchor puller had required major repair owing to distortion affecting the base. It was not clear if this had arisen from a single event or arose over a period of time. He had replaced the part with a heavier duty material and made several other improvements to the puller. NW asked what the status of the program of anchor testing was. BM reported that some South Wales work was outstanding and that Les Sykes and RK had some testing to do. In addition the load cell had not been calibrated since October 2013 owing to some difficulties with access to the calibration machine. NW noted that the calibration could be easily upset by misuse of the hand held display unit. There was a need to check that the cell was still reasonably OK. He did have a 945kg mass which could be used for such a check. (*Post Meeting Note* – BM has checked the load cell against another load cell and found the indicated output was consistent with the other cell.) It was agreed that following the South Wales work, the puller would be offered to Les Sykes but then handed over to RK at the BCA AGM on 2 June.

5B.2 Resin: NW enquired about stocks. He had 9 tubes of Martyn Price KMR in date. RK reported that he had 5 tubes of KMR.

5B.3 Insurance cover for Anchors: NW asked SW if he was content with the insurance cover for anchor work. SW replied that he was happy with the letter clarifying the situation sent to CNCC in January. NW commented that he had some other concerns but needed to clarify details with SW before seeking clarification from the broker.

5B.4 Static Load Tester: NW asked what progress had taken place with the tester. BM reported none. NW asked that the rig become a standing agenda item.

6. Report on Fischer resin work: BM noted that the report had been posted at http://british-caving.org.uk/wiki3/lib/exe/fetch.php?media=equipment_techniques:bp_anc_fischer_resin_report_141129_issued.pdf . A copy is attached as Appendix 1.

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. BM reported that whilst 33 anchors had been tested in dry holes and 10 anchors placed in flooded holes, the flooded holes work had not been completed. Action closed.

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

In response to a query, BM reported that Table 2 of the report indicated that Fischer resin was stronger than KMR. NW noted that it was more expensive though that should not be taken as a primary consideration. He observed that only Fischer and Hilti provided an 'end to end' understanding of using resin. SW reported that he viewed Fischer resin was better on grounds of the use of parallel tube construction easing checking on trapped air, their easy availability and the quality control.

BM asked about variation in the nozzles for the resin. GT reported he had experienced differences in those supplied with the KMR resin. SW reported that he had had a similar experience with RAWL. He noted that Screwfix supplies of Fischer FIS V 360 S resin cartridges came with 2 nozzles per cartridge. Fischer resin in bulk was also available from Fastco which came with a free dispenser. (*Post meeting note* – for Screwfix see http://www.screwfix.com/p/fischer-fis-v-hybrid-mortar-resin-360ml/88507 , for FastCo see http://www.fastco.co.uk/fixings/resin-fixings/fischer-bulk-red-site-box-of-20-fisv360s-hybrid-resin-injection-cartridges-c-w-40-mixer-nozzles-94405-includes-fisam-dispenser.html NW asked about shelf life but no one could comment.

NW asked if E&T could accept Fischer FIS V 360 S resin as a usable resin. BM indicated that the flooded hole work was still to be completed. SW asked why such a requirement was necessary. BM indicated that placements could not always be guaranteed to be 'dry' or rather damp. Non SRT uses such as hand lines in floors may require working under water. BM reported that he understood that the Fischer resin would cope. (*Post Meeting Note* – Fischer's opinion is attached at Appendix 2. It implies they **do not** recommend it for use under water.) The meeting suggested that testing the existing prepared 10 flooded hole anchors should be sufficient but if need be, a set of 32 should be tested.

Action 6.1 - BM and VA to pull existing 10 BP / Fischer anchors and review if data is sufficient to not need testing a further 23 anchors.

The Committee agreed to adopt Fischer FIS V 360 S resin as an alternative to Martyn Price KMR resin. It was agreed that existing stocks of KMR resin should be used up before moving on.

SW noted that the cartridge design would require new gun / dispenser given the cartridge design. There were two types, an enclosed plastic applicator and an open metal one, see Appendix 3. He intended to carry out trials to find out which worked best under caving conditions.

7. Report on North Wales Anchor work:

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

GT reported that the anchors had been placed in December and extracted in January. Raw data and a rage of images were available at http://www.train4underground.co.uk/bolts-in-slate-testing-project/ along with previous work. The work had been undertaken following initial work on a wider range of anchors which had been used in a number of slate mines in North Wales.

BM tabled a draft document providing some detail on the statistical work undertake on the results and gave a short presentation, see Appendix 4. The detailed analysis was far from complete but initial indications suggested that there were limited differences between types of slate. The data looked as is if was insufficient to show if there were differences between the subsidiary variations. Data analysis was continuing.

The topic of screw in anchors was raised. GT noted the BMC report on heads shearing off because presumably the anchors had been over torqued. NW commented that he understood the manufacturer did not recommend them for use in life support situations. It was accepted that screw in type anchors would not be further considered.

SW expressed concern over aspects of the work with IC anchors. He noted that they had not been placed using the recommended resin and that in some cases it appeared that air may have been trapped within the resin which may have reduced the strength of the anchor. SW was also concerned that neither the Bolt Product nor IC anchors had been recessed. In the case of IC anchors that meant that the load transfer part of the IC anchor was closer to the rock surface, thus bringing into question whether the tests were a true indication of strength. BM accepted that the work did not provide the case for E&T designating the IC anchor for use in slate. SW accepted that the results did show the IC anchor worked well in comparison to the other anchors.

NW noted GT's comment that the variability of slate types and pillar verses cleavage planes did not appear to be as significant as had been feared. NW asked if a summary note could be prepared for

early issue. BM asked that this await completion of detailed analysis. It was accepted that a draft should be prepared, circulated around attendees prior to NW providing final clearance for its issue.

Action 7.1 – GT & BM to produce a brief report summarising the outcome of anchor work in North Wales slate for general publication.

Action 7.2 – BM to produce a full report on the anchor work in North Wales slate.

8. Changes in Anchor Standards: BM had issued a note prior to the meeting on various changes, see Appendix 5. He raised the topic since it did seem that E&T were pressing for more information than was required by the standards. NW said he was happy to see E&T exceeding the requirements of the standards. The information was noted.

9. Request to adopt IC anchor: NW noted the request from CNCC to adopt the IC anchor, see Appendix 6. SW gave a presentation on the anchor. One key learning point from his work was the possible presence of air within either the resin or hardener which would caused the ratio of the two to vary and thus not set. The results of testing 44 anchors in Fischer FIS V 360 S resin are appended (see Appendix 6). The 5% fractile value for the complete set was 33.7kN whilst that for the sub group excluding the first 15 anchors was 34.4kN. He noted that most of the damage seen post extraction was due to the drilling rather than from extraction and holes were reusable. He had gone onto re-drill 4 holes and fit new IC anchors which resulted in similar peak extraction values, see Appendix 6. In addition SW reported that he had drilled two 18mm holes and placed his IC anchors in them. Following extraction he had then placed new anchors in the same holes and repeated the extraction. One hole was then reused for a third time. The results indicate no significant change in peak extraction forces.

SW went onto to note that following UIAA's adoption of a rotational test, he had conducted one such test which resulted in a hairline crack in the resin but no visible difference to the anchor. The anchor had then been used in a radial extraction with a peak extraction force of 52.76kN. (Further details can be found at http://www.resinanchor.co.uk/3.html .)

In response to a query, BM confirmed that the axial tests meet the E&T criteria.

SN enquired about the appearance of metal failure modes. SW reported that whilst some necking was observed around the base teeth, failure had always been between the resin / metal boundary. He also noted that most of the anchors extracted were slightly bent suggesting a slightly off axial axis pull.

NW asked about marking. SW confirmed that anchors are supplied with a unique 3 letter code. SW reported that the manufacturing process is that the anchors were laser cut from a hot rolled sheet of Type 316 stainless steel (confirmation is available), machined on a lathe to place a 3mm radius on the inside edge of the eye and then hand finished to round the exterior edges. Anchors were produced in batches of around 100 a time with a realistic supply rate of some hundreds per year.

BM asked about long term testing. SW responded that with the low damage of extraction and simple extractor tool he had devised, it was reasonable to use anchors placed in cave as a test bed.

SW indicated that a training manual was available. NW indicated he had some comments on the document which he would exchange with SW.

Action 9.1 – NW to provide comment to SW on IC anchor training manual and then circulate amongst the committee.

RK proposed that the IC anchor be adopted by E&T and that SW be appointed as a trainer for the anchor. BM seconded the proposal which was agreed without comment.

NW indicated that some further discussion as required over aspects of insurance outside of the meeting.

10. Fixed Aids Policy

Action 13.1 - All Committee members to provide contributions of dos and donts 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.

BM proposed that given the lack of activity over several meetings on this topic, the subject be dropped and that the references on the BCA web site to anchor policy be removed. NW accepted he topic be dropped from the business of the committee for the time being. GT noted that some guidance was desirable. NW indicated that whilst the topic was of importance, the topic would take considerable resources to deal with in a suitable manner.

11. Rope Test report: BM reported that due to other work he had nothing to report save that he was behind on testing some samples.

12. AOB

12.1 Bolt Product Extraction techniques: NW asked if anyone had obtained an update on the use of a diamond drill to extract Bolt Product anchors. BM reported that the person who had expressed an interest in the topic was now otherwise engaged.

12.2 IC Anchor Extraction Tool: SW showed the tool he had produced for extracting anchors. It had worked on IC anchors but the nut had proven too short for use on other type of anchors and had stripped its thread. The tool had been made using some M24 fine threaded HT bar borrowed from the anchor puller. BM indicated he was reluctant to release the remaining spare length as it was the reserve piece for the puller. NW suggested that material costs arising from further development of the extractor tool would be funded by BCA. The meeting agreed.

Action 12.2 – SW to obtain M24 fine threaded bar for making up a replacement anchor extractor.

12.3 Titanium & HCR Anchor Testing: NW asked RK about intentions over testing the titanium and HCR anchors. RK proposed to test 5 each of the two anchor types with Fischer resin in limestone and then use the rest.

Action 12.3 – RK to undertake testing of a batch 5 Titanium and 5 HCR / Duplex Bolt Product anchors in limestone.

12.4 Static Load Test: BM reported that he had not undertaken any further work on the rig since its installation at the Bradford Pothole Club's garage. He noted that one outstanding activity was a test proposed by B Dearman and L Sykes on maillons following the unexpected failure of one during

some anchor testing work they did several years ago. NW thought that they had intended to do this using the puller. In response to a query about markings on maillons, NW commented that some were marked under machinery legislation / standards requirements whereas others were marked under PPE legislation / standards requirements. This lead to the use of different terminology of working load limit (safe working load – a load which the maillon could safely and repeatedly withstand) and breaking load (a maximum load which the maillon would take without breaking, though not necessarily be reusable).

12.5 Placing of Anchors by non BCA clubs: RK raised this topic as he was aware of a club in the Devon and Cornwall area which was not a member of BCA and who were starting to place Bolt Product anchors in mines based upon their work experience. NW noted that persons who were not individual members of BCA could not be covered by BCA's insurance policy. He went on to note that BCA would not supply anchors to such persons as they were outside BCA's membership and procedures. RK asked about placing anchors in concrete. BM noted there was no long term data on concrete nor was the quality of concrete used around entrances assured.

12.6 Learning from Experience: BM said that he had asked for this to be discussed as he had been prompted in another meeting about setting up more formal mechanisms for learning from experience. NW indicated that he considered BCA does do it to some extent but that a more formal set up was not required.

12.7 Date and Time of next Meeting: Following discussion, it was agreed to meet on Sunday 15 November at 11am.

The meeting closed at 3pm.

Action List

2/11/14

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

15/3/15

Action 6.1 - BM and VA to pull existing 10 BP / Fischer anchors and review if data is sufficient to not need testing a further 23 anchors.

Action 7.1 – GT & BM to produce a brief report summarising the outcome of anchor work in North Wales slate for general publication.

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Action 12.3 – RK to undertake testing of a batch 5 Titanium and 5 HCR / Duplex Bolt Product anchors.

Report on Testing of Bolt Product Anchors using Fischer Resin at Penwyllt Quarry, South Wales

A set of 33 Bolt Product Type 304 Stainless Steel anchors with 100mm long shafts (Ref no GP8 -100-16A2) were placed in the quarry using Fischer V 360 S resin in two batches. The first in early November 2014 consisted of 5 anchors. The second on 29 November 2014 consisted of 28 anchors. To maintain speed of placing, only anchor 60 in the second batch was placed in a notch; the rest were not. All the anchors in the first batch were placed in notches. The final anchor was placed by 12.50 pm on 29 November.

The placement procedure used was to drill the holes using a 16mm SDS drill, check for depth, blow the holes free of dust, then wash them several times using water and a bottle brush before notionally drying the hole using a chemise cloth. The anchors were degreased using lighter fluid and paper towel. Each hole was filled with resin and the anchor placed into the hole. A small sample of resin was taken in a short length of 15mm OD clear plastic pipe to provide for a reference if required and as a check against poor mixing. Records were also kept of which anchor was placed with which resin. The cartridges of resin were placed upright for approximately 2 hours before use to encourage any air within the two compartments of the cartridge to rise to the top and thus be expelled first. There was no indication of poor resin mixing at any point during the placement of the anchors. (Cartridge B had its nozzle changed since the resin had set in the time gap between placements of anchors 106 and 107.) Surplus resin was wiped away leaving a smooth profile. Two holes were found to have visible quantities of water in them. Owing to time constraints, anchors 110 and 118 were placed in them without removing the water.

The anchors were extracted with an axial force on 30 November. The pulling order reflected to a limited extent the placement order such that the resin for every anchor had had at least 24 hours curing time. The temperature was not measured but the day was mild with sunshine. The records for Cross Hands, some 30km to the east and at 170m ASL (compared to the quarry at 350m) indicate the minimum overnight temperature was 6.1C whilst those for Llangorse, some 30km to the west and at 250m ASL indicate the minimum temperature was 9.2C. This level of temperature is not thought to significantly impact on the curing time of the resin (Fischer claim 90 minutes for 5 to 10C) in relation to the 24 hour period.

The peak forces recorded and other related records are given in Table 1. Related photos and movies, together with the spread sheet data calculations can be downloaded from https://drive.google.com/file/d/0B0RTfmWzkLQMMnB5U2NERV9sNUE/view?usp=sharing . (Print outs and electronic copies will be lodged in the British Caving Library.) The results from the two holes found to have water were excluded from the analysis of the data. Anchor 110 which failed at 10.2kN was thought to have not had its hole properly cleaned; the cured resin surface being significantly different to other resin samples in having sub millimetre sized bubbles sunken into the resin (hence reducing the resin to rock contact area). The incorporation of the anchor 110 data point caused the whole data set to fail its normal distribution test and was therefore discounted. Anchor 118 was discounted as it also had water in the hole, even though it failed at a peak force of 39.8kN. This points to care being required in ensuring drilled holes are properly cleaned. Given the test bed situation where two people were working on the holes at the same time, it seems less likely that such a mistake might arise down a cave where work on a pitch is usually limited to one person.

The mean value of the remaining 31 anchors was 38.7kN with a standard deviation of 4.9kN (13% of mean). The data set was found to be normally distributed. The 5% fractile value was thus 28.5kN which is comfortably above the acceptance criterion of 15kN for an axial pull. Table 2 shows summary data for the range of anchors placed under the NCA and BCA schemes. Fischer V 360 S resin gave a better performance than KMR resin, assuming the difference in rock has no impact.

Several observations were made whilst pulling the anchors. The first was that the twisted shaft causes the anchor to turn on being extracted, as had been noted before. The design of the BCA anchor puller is such that this twisting force is transmitted through the U bolt and up the threaded bar shaft to the joint between it and the load cell. What was noticeable was that in many cases it was clear that the resin metal bond had broken and that the anchor was initially being extracted whilst leaving the resin in place. But part way out this mode of extraction suddenly changed and some, perhaps half of the resin in the hole was then pulled out, seemingly attached to the anchor. From memory, this change in mode was often around the same time that spalling of the rock became significantly. A few anchors came out and left the hole clear such that one could see down the hole. These showed the resin in place and with a neat imprint of the anchor. It would thus seem that a significant failure mode was first the metal / resin bond failed. However the anchor was still held well in place by the mechanical interference between metal and resin. But after part extraction of the anchor, the remaining extraction would cause the resin / rock bond to fail in the top half of the hole whilst also causing the rock in the top 2 to 5 centimetres to spall.

The second set of observations related to the degree of spalling occurring on extraction and the extent to which the hole was reusable for placing another anchor. The BCA puller was specifically designed to place the reaction force back into the rock well away from the zone of potentially affected rock. It is not clear if an extractor placing this reaction force back into the rock close to the anchor would substantially reduce the degree of spalling. Around 50% of the holes suffered sufficient spalling to make the location not reusable. This would make the anchor unattractive on conservation grounds.

The third observation is that failure to properly clean a hole before placing the resin can cause the anchor to system to significantly reduce its strength.

Part of a test bed using Bolt Product Type 304 Stainless Steel anchors using Fischer V 360 S resin in wet holes was placed but the work was not completed due to lack of time. The planned return was cancelled owing to a weather forecast predicting near zero temperatures. This work to determine the influence of leaving a hole full of water and displacing it using the resin remains to be completed. But Fischer V 360 S resin was found to be satisfactory in notionally dried holes.

The permission of the South Wales Caving Club to use the Penwyllt quarry for testing these and other anchors is gratefully acknowledged.

Vince Allkins
Bob Mehew
January 2015

Table 1 - Type 304 BP anchors using Fischer V 360 S resin Penwyllt 29 & 30 November 2014										
Pulling order	BP no.	kN								
		force	comment	notched	resin sample	resin	reusable location		photos	
1	60	36.46		yes	before & after	B	no	0	2568, 2571 to 76	
2	58	26.84		no	after	A	no	0	2568, 2577 to 79, 81	
3	59	41.01		no	after	A	no	0	2568, 2582 to 85	
4	56	41.78		no	after	A	no	0	2568, 2586 to 93	
5	57	36.51		no	after	A	yes	1	2568, 2594 to 98	
6	101	25.26		no	after	B	yes	1	2570, 2599 to 2604	photos show 111 incorrectly numbered
7	102	43.87		no	after	B	yes	1	2570, 2605 to 09	
8	103	37.61		no	after	B	yes	1	2570, 2610 to 12	note 12 shows resin at bottom of hole
9	104	36.53		no	after	B	yes	1	2569, 2613 to 16	
10	105	30.02		no	after	B	yes	1	2569, 2617 to 21	
11	106	37.24	1st movie from note made at time, shows time in sync between cameras	no	after	B	yes	1	2569, 2622 to 26	
12	127	44.46	2nd movie based on times of cameras, placed preceding week	yes	no	A	?	0	2627 to 30	
13	128	39.93	placed preceding week	yes	no	?	?	0	2631 to 36	
14	107	40.93	3rd movie based on times of cameras	no	after	B new nozzle	?	0	2637 to 42	note 42 shows resin at bottom of hole
15	109	39.84		no	after	B new nozzle	?	0	2644 to 55	
16	125	43.12	placed preceding week	yes	no	A	?	0	2656 to 60	
17	108	37.36		no	after	B new	no	0	2661 to 83	

						nozzle				
18	110	10.24	found with water in hole, now ? If properly cleaned	no	after	C	yes	1	2684 to 89	85, 6 & 7 show curious surface to resin indicative of poor bonding to rock
19	123	46.16	placed preceding week	yes	no	A	yes	1	2690 to 93	
20	111	42.04		no	after	C	yes	1	2694 to 98	note these photos are correctly labelled
21	112	38.49		no	after	C	?	0	2699 to 702, 04 & 05	note 705 shows resin at bottom of hole
22	115	38.5		no	after	C	?	0	2706 to 14	
23	114	41.91		no	after	C	yes	1	2722 to 28	
24	113	37.19		no	after	C	no	0	2729 to 37	
25	118	32.85	water logged hole	no	after	C	yes	1	2739 to 41	
26	122	47.36		no	no	A	no	0	2742 to 45	
27	117	37.52		no	after	C	no	0	2747 to 51	note 51 shows resin at bottom of hole
28	116	37.17		no	after	C	no	0	2752 to 57	
29	129	35.75	placed in vertical face	no	after	C	no	0	2758 to 64	
30	130	35.42	placed in vertical face	no	after	C	yes	1	2765 to 67	
31	119	39.26	placed in vertical face	no	after	C / D	yes	1	2768 to 70	
32	120	44.27	placed in vertical face	no	after	D	yes	1	2771 to 74	
33	124	41.14	placed in vertical face into notch, placed preceding week	yes	no	A	yes	1	2776 & 77	
							sum	16		
									2793 to 99	photos of field note book records
									2790	photo of all anchors
									2792	photo of all resin samples
									2563	location of work

Table 2 Summary Data for all resin placed anchors used in the NCA & BCA Scheme						
Anchor Type	*No. tested*	*mean kN*	*SD kN*	*% SD*	*k*	*5% fractile value kN*
DMM Eco	*23*	*39.8*	*9.5*	24	*2.16*	*19.4*
Pico trial batch	*33*	*33.6*	*5.2*	15	*2.08*	*22.8*
Pico batch 2 Horseshoe Quarry #	*30*	*27.9*	*4.1*	15	*2.08*	*19.4*
Pico batch 2 Ingleton #	*30*	*34.9*	*6.2*	18	*2.08*	*22.0*
Bolt Products / Rawl resin	*33*	*35.2*	*4.7*	13	*2.08*	*25.4*
Bolt Products / KMR resin	*32*	*44.9*	*8.7*	19	*2.08*	*26.8*
S Wilson early concrete work	*6*	*42.5*	*1.2*	3	*3.09*	*38.8*
S Wilson field work RAWL	*25*	*34.9*	*3.5*	10	*2.13*	*27.4*
S Wilson field work using Fischer	*36*	*35.7*	*1.1*	3	*2.04*	*33.5*
BP / Fischer resin Penwyllt quarry &	*31*	*38.7*	*4.9*	13	2.08	28.5
# excluded metal failure results & excluded wet hole results						

Appendix 2

Text of E Mail from Fischer re resin

The FIS V resins will work in damp hole that do not have water flowing over them at the time of installation.
Once cured they can be fully immersed.
If there is laying water, and this can be mostly removed using a blow out pump or sponge, the FIS V is suitable.
For installation under the water, FIS VT 380 C resin is suitable.
In wet or damp conditions doubling of the curing times is required.

Appendix 3

Fischer FIS V 360 S resin cartridge and dispensers

FIS V 360 S

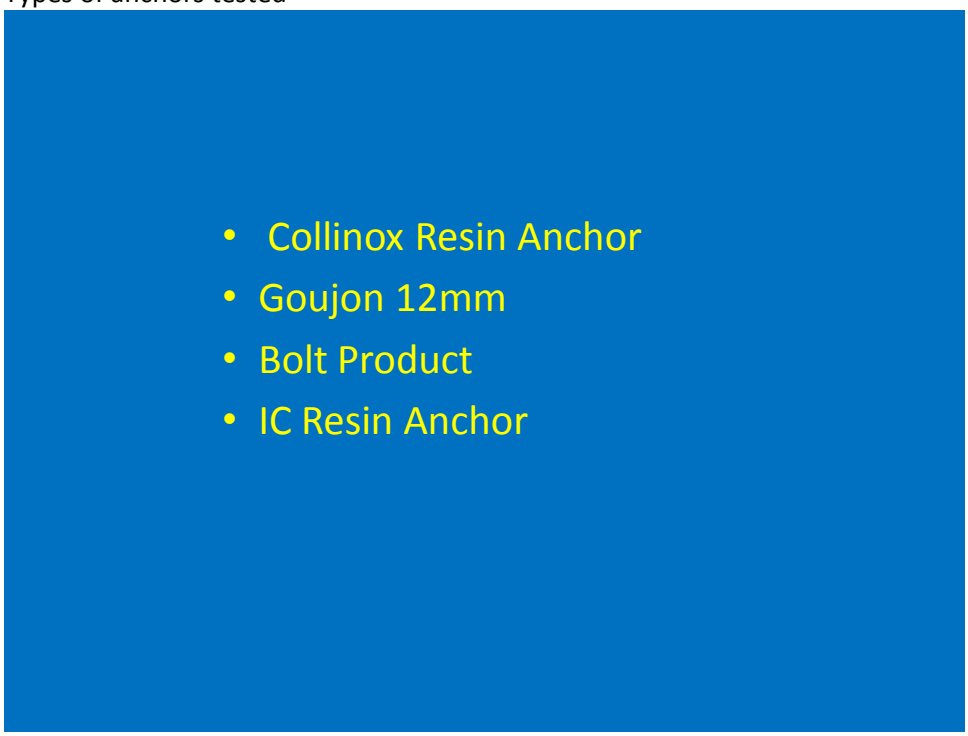
FIS DM S

FIS AM

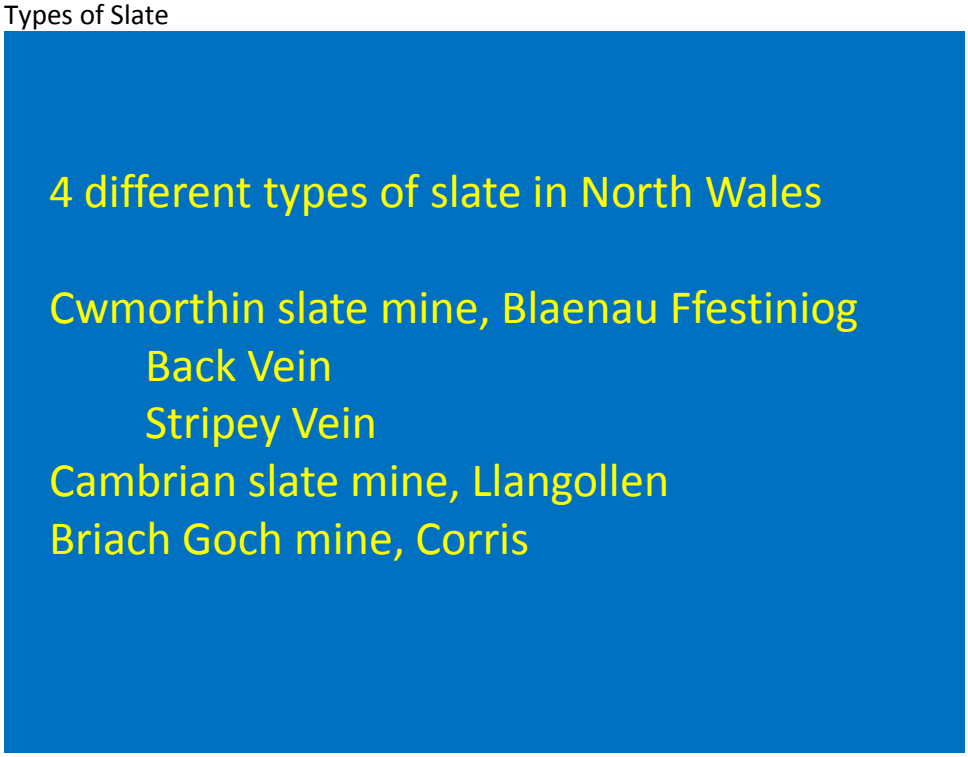
Appendix 4

Extract from Presentation on North Wales Anchor Testing

Types of anchors tested



Types of Slate



Anchors were placed in both cleavage and pillar planes.

Subsidiary variations

Other Variables

wet - washed and then dried

dry - brush and pump

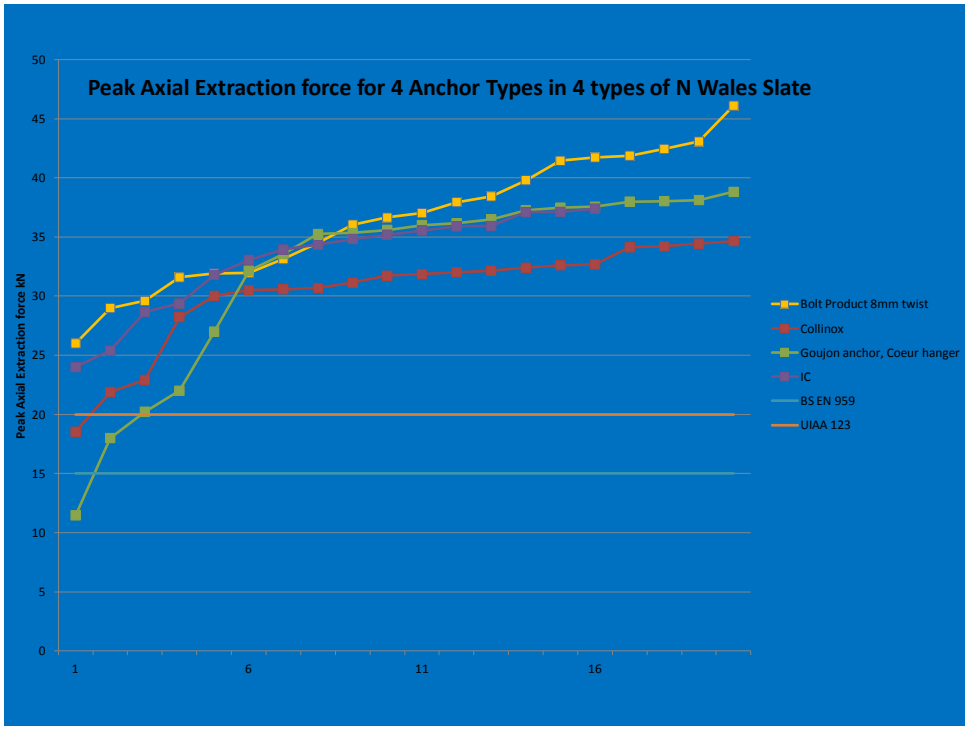
Exercised or not

six applications of 6kN axial force

Problems which arose

Information from	Reason
placement	Resin error
placement	soft rock
placement	very soft rock
placement	anchor not recessed
extraction	rock damaged
extraction	rig problem

Results



Questionable results

Data set of anchors	Test Result	Excluded Pull No.s	Potentially Pre identified	Potentially post identified	Not identified
All 76	Norm	11, 43 & 47	43 & 47		11
Bolt Product	Norm	none			
Collinox	Norm	43, 48 & 66	43 & 48	48 #	66
Goujon	Norm	11, 12, 44, 47 & 60	44,47		11, 12 & 60
IC	Norm	25 & 49	49	49 #	25

was also rock damage

Results

Data set of anchors	Mean kN	Standard Deviation kN	5% fractile value kN
All 76	33.0	6.1	21.4
Bolt Product	36.5	5.4	24.5
Collinox	30.4	4.4	20.7
Goujon	32.2	8.0	14.6
IC	33.1	4.2	23.5

Possible differences between Anchors

Anchor Groups		Result from t test
Bolt Product	Collinox	is a difference
Bolt Product	Goujon	no discernible difference
Bolt Product	IC	is a difference #
Collinox	Goujon	no discernible difference #
Collinox	IC	no discernible difference #
Goujon	IC	no discernible difference

Sub groups which appear to be different

Bolt Product		
Cambrian	Cwmorthin, Back Vein	Is a difference #
Cwmorthin, Back Vein	Cwmorthin, Stripey Vein	is a difference #
Braich Goch, Corris cleavage	Braich Goch, Corris pillar	is a difference #
Collinox sub groups		
Cwmorthin, Back Vein	Cwmorthin, Stripey Vein	is a difference #
Goujon sub groups		
IC sub groups		
Cwmorthin, Back Vein cleavage	Cwmorthin, Back Vein pillar	is a difference #

Appendix 5

Recent Changes to Anchor Testing

As noted at the last meeting UIAA had changed their standard for mountaineering anchors in 2013. The key changes cover the deletion of the radial (shear) test, the increasing of the value for the axial test from 15 to 20kN and the inclusion of a new test which requires the anchor to withstand a torque of 150Nm for 60 seconds; see http://www.theuiaa.org/upload_area/Safety/Standards/Safety-Standards/UIAA_123_Rock_anchors_March_2013.pdf .

A discussion with D Middleton, BMC's Technical Officer, has confirmed that the testing requirements in BS EN 959:2007 for Mountaineering anchors are based on testing only one sample of the anchor in axial to exceed 15kN and one in radial mode to exceed 25kN. It does not require testing a group and undertaking a statistical analysis.

For information, BS EN 795:2012, the PPE anchor standard requires three tests. The deformation test requires that if an anchor is intend to deform, then the anchor does not deform by more than 10mm under a load of 0.7kN for 1 minute. The dynamic test uses a 2m long lanyard made from 11mm dynamic mountaineering rope with bowline knots with a 100kg rigid mass. The drop distance is adjusted to achieve a 9kN (+0.5kN / -0.0kN) and the anchor should not release the test mass. (The 1997 issue used a 2m long hawser laid rope with spliced loops and a 100kg mass dropped through 2.5m.) The static test requires the anchor to hold a 12kN (+1kN / -0kN) load (it was 10kN in the 1997 issue) for 3 minutes.

Given this information, E&T is invited to review its current requirement of

> *The standard for acceptance of an anchor type on the basis of an axial load is based on the 15kN axial load value as cited in Section 4.3.1 of the Mountaineering Equipment – Rock Anchors – Safety requirements and test methods BS EN 959 : 2007, as computed as the 5% fractile value as specified in Section 4.2 (3) of the Euro Code Basis of Structural Design Standard BS EN 1990 : 2002 from the results of a batch test of a minimum of 5 anchors provided there is supplementary information showing the distribution of results follows a normal distribution, else the minimum size of the batch test should be 32.*

Bob Mehew
21/2/2015

Appendix 6

COUNCIL OF NORTHERN CAVING CLUBS

British Caving Association

48 Burtree Avenue
Skelton
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30th January 2015

To the BCA Equipment and Techniques Committee C/O Nick Williams

Are you are aware, the IC anchor designed by Simon Wilson has come up for discussion with the CNCC committee. This was in response to a proposal by Sam Allshorn for the CNCC to ask the BCA E&T committee to consider approving the IC anchor. For the full proposal, please refer to the 17th January 2015 committee meeting agenda (Appendix C) which is available on our website

I would like to inform you that the CNCC committee have voted to accept the proposal.

This was also supported by the CNCC Technical Group.

Therefore, on behalf of the CNCC I would like to request the following;

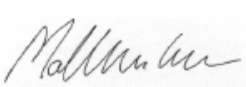
(1) That the BCA E&T Committee consider approving the IC anchor for use alongside the Bolt Products anchor under your policy on 11th March 2015.

(2) That Simon Wilson, as the manufacturer of the anchor, is recognised as an approved trainer for the installation of these anchors.

I would also like to make you aware that Simon Wilson has been accepted by the CNCC Committee to represent us at future BCA E&T meetings.

There were a number of discussions surrounding this matter. One matter raised was that the expertise of the CNCC Technical Group could be put to good use to provide additional ongoing testing of these anchors in much the same way that they have done for other anchors over many years. I appreciate that these anchors have already been tested and met the required criteria, but extra data (in particular, ongoing testing post-installation) is always welcome. The CNCC Technical Group has offered to do this, and it would be wise to take advantage of this, given their prominent role in anchor safety assessment over many years. As Secretary, it is my belief that you should take advantage of this in any way possible, although I am obligated to emphasise that this is a personal request, reflecting my own thoughts and those of some of the individuals present at our meeting, but is not a directive that was voted upon or agreed by the CNCC Committee.

Yours sincerely



Matt Ewles

Secretary, Council of Northern Caving Clubs
secretary@cncc.org.uk www.cncc.org.uk

Appendix 7

Results of IC anchor testing

Number	Peak load kN	Tube	Installed	Pulled
1	35.94	A	9/9/14	10/9/14
2	34.98	A	9/9/14	10/9/14
3	34.09	A	9/9/14	10/9/14
4	35.83	A	9/9/14	10/9/14
5	32.46	A	10/9/14	11/9/14
6	34.71	A	10/9/14	11/9/14
7	33.52	A	10/9/14	11/9/14
8	35.22	A	10/9/14	11/9/14
9	34.69	A	10/9/14	11/9/14
10	35.04	A	10/9/14	11/9/14
11	36.97	A	10/9/14	11/9/14
12	36.34	A	10/9/14	11/9/14
13	38.01	A	11/9/14	12/9/14
14	36.67	A	11/9/14	12/9/14
15	35.61	A	11/9/14	12/9/14
16	34.29	B	12/9/14	14/9/14
17	34.31	B	12/9/14	14/9/14
18	36.53	B	12/9/14	14/9/14
19	35.26	B	12/9/14	14/9/14
20	35.42	C	14/9/14	17/9/14
21	35.73	C	14/9/14	17/9/14
22	35.63	C	14/9/14	17/9/14
23	36.95	C	14/9/14	17/9/14
24	35.18	C	14/9/14	17/9/14
25	36.32	C	14/9/14	17/9/14
26	36.93	C	14/9/14	17/9/14
27	36.37	B	12/9/14	17/9/14
28	36.76	B	12/9/14	17/9/14
29	35.74	B	12/9/14	17/9/14
30	36.35	B	12/9/14	17/9/14
31	36.56	B	12/9/14	17/9/14
32	35.84	B	12/9/14	17/9/14
33	35.46	D	17/9/14	18/9/14
34	35.82	D	17/9/14	18/9/14
35	36.74	D	17/9/14	18/9/14
36	35.47	D	17/9/14	18/9/14
37	36.29	E	1/10/14	14/10/14
38	36.22	E	1/10/14	14/10/14
39	36.95	E	1/10/14	14/10/14
40	36.32	E	1/10/14	14/10/14
41	35.21	E	1/10/14	14/10/14
42	36.85	E	1/10/14	14/10/14

43	36.31	E	1/10/14	14/10/14
44	35.24	E	1/10/14	14/10/14
Mean	35.8	Numbers 1 to 44		
SD	1.0			
5% fractile	33.7			
Mean	36.0	Numbers 15 to 44		
SD	0.7			
5% fractile	34.4			
2nd use		1st test kN		
5.2	36.56	32.46	25/10/14	16/11/2014
13.2	36.03	38.01	25/10/14	16/11/2014
16.2	34.91	34.29	25/10/14	16/11/2014
29.2	35.55	35.74	25/10/14	16/11/2014
Mean	35.8	35.1		
18mm holes				
1st use				
801.0	35.14		9/11/14	16/11/2014
802.0	33.13		16/11/14	23/11/2014
2nd use				
801.2	34.47		16/11/14	23/11/2014
802.2	32.35		23/11/14	30/11/2014
3rd use				
801.3	33.64		23/11/2014	30/11/2014

NB ‘5.2’ number means hole number 5 used for second time and similar for others. Likewise for ‘801.0’.