BMC Technical Conference 2008

The BMC organised a Technical Conference which was held at Plas Y Brenin in 2006. The event comprised a series of practical morning workshops, which included drop tests on tape slings plus strength testing on a range of old karabiners. In the afternoon the 80 delegates crammed into the lecture theatre for a series of presentations including reports from members of the BMC Technical Committee and a fascinating insight into rope manufacture by Michel Beal, the founder of Beal Ropes.

The conference was such a success that the BMC decided to run a second event this year, and on Saturday 25th October 45 recreational climbers, instructors and industry representatives met again at PYB for the second conference. The format again involved a series of morning workshops followed by afternoon lectures. The account that follows is an attempt to summarise a vast amount of information from pages of notes I scribbled on the day – my apologies in advance for the many necessary omissions!

Workshop 1
Helmet Impact Testing

The first workshop was a practical demonstration of helmet impact tests performed by Dr Mark Taylor of Leeds University. Mark has become a world authority on helmets and he provided a fascinating insight into the current state of play in the helmet world.

Mark started by outlining the studies that have been completed on head injuries and helmet use and it soon became clear that not many statistics are available. The 1986 study by Read et al studied 42 autopsies and head injuries were a major factor in 21 of them. Read concluded that 25% of the deaths could have been prevented if helmets had been worn (although we didn't explore how he came to that conclusion!). Another study in Yosemite (1988) found that 9 out of 13 fatalities were due to head injury and Mark had also studied mountain rescue call out reports from the last 12 years (excluding Scotland). These showed that 25% of injuries were head trauma and, of these, people wearing helmets were less likely to be fatally injured.

The practical workshop session started with us visually inspecting a wide range of helmets and discussing their relative design features. These ranged from the 'Cromptom Climber' (the first commercially available climbing helmet) through to the latest models from many of the main manufacturers and some lesser-known producers too. Comparing some of these older models with something like a Petzl Meteor makes you realise just how reassuringly far helmet design has come in the last few decades

Mark discussed the 2 main helmet types and how they do their job in very different ways. The Meteor style foam helmets (commonly known as lightweight helmets) absorb impact by distributing the force around the foam whilst allowing the foam at the impact site to distort. On the hard shell and strap cradle style helmets (commonly referred to as traditional helmets) the impact force is mostly absorbed by the straps. This creates an interesting situation where the lightweight models will absorb the force from a pointed object better than a blunt one – In this case it really is better to get hit on the head by a sharper object - just not too sharp!

The way traditional helmets absorb the force led to some discussion about the trend some years ago to store food or first aid equipment in the space between the helmet shell and the strapping cradle. While clearly not a good idea Mark had tested helmets with flapjack, Mars Bars and a folded survival bag in the cradle/shell cavity and found the lowest impact force was recorded on the helmet with flapjack in (flapjack was 2.4kn, the survival bag recorded 8.5kn and the helmet with nothing inside recorded 3.5kn). He didn't specify the best type of flapjack though!

Mark outlined the production methods used for the various helmet types and the drop test standards. There are several tests performed on helmets including side impact tests, penetration tests and assessments to ensure helmets can resist being pulled forwards and backwards off the wearer's head. I was interested to hear of this last test due to the recent reported incidents of climbers getting helmets caught on holds in fall or lowering situations. However, Mark pointed out that really the test is only to ensure the helmet won't be pulled off and not to get it to release under load.

There was a limit to what we could perform in the corridor at PYB so our focus was to be a test that mimicked the standard drop test using a blunt weight. The standard for this test is a 5kg weight dropped from 2 metres onto the helmet crown. The EN (European Norm) standard requires the force transmitted to the head to be less than 10kn while the more stringent UIAA standard requires the transmitted force to be under 8kn. Mark pointed out that no-one actually knew how must force was required to cause head injury because tests obviously haven't been performed on people, but he suggested that it is very likely the transmitted force without a helmet would be well over 40kn.

It should also be noted that these tests are normally carried out at a variety of temperatures (-20°c, 35°c and a test on a helmet that had been left in the sun for 400 hours) but our only option was room temperature. We did discuss these temperatures and the whole group predicted that the low temperature test would give the highest reading due to the helmet getting more brittle. In reality the helmet tested at 35°c tends to be weakest.

The tests we completed on the day gave reassuring results with all the helmets passing both the EN and UIAA benchmarks. Here is a brief summary of some of the results on the first drop test on some common helmets*:

Petzl Meteor 3 – 6.9kn
Petzl Elios Class – 7.9kn
Edelrid Ultralight – 4.4kn
Petzl Ecrin – 4.1kn
Carbon Dyneema – 6.5kn

* (Tests made on the day were uncalibrated, and should be taken as indicative only!)

However, we also went on to perform a second drop test on all the helmets and most models gave readings above the EN and UIAA benchmarks. For example, the second drop on a Petzl Meteor recorded 10.5kn and the Petzl Elios was 11.5kn.

A few other issues were discussed in this session that might be of interest. The perennial issue of whether it is safe to put stickers on helmets was raised and Mark pointed out that only stickers specifically authorised by manufacturers can really be deemed completely safe to use. On a similar point we discussed whether the effects of other chemicals have been tested and Mark said there had been a case of a helmet

that had cracked after its owner had sprayed it with DEET based insect repellent a number of times. Also, an outdoor centre that had regularly sprayed their helmets with anti nit spray had reported several cracks in the plastic.

Finally, Mark asked us to inspect a red helmet that had been involved in an impact and we all failed to find any sign of damage until Mark showed us a faint white stress line in the plastic by one of the strap lugs. As Mark pointed out this damage was only visible because the helmet was red – on a white helmet the damage would have been invisible. A good reason to buy a coloured helmet next time?

Mark concluded by saying that because there aren't any bad helmets being produced by the reputable manufacturers the choice comes down to the type of climbing you plan to do, the way it fits and the way it looks. We really are spoilt nowadays!

Workshop 2
Belay Plates

The second workshop I attended was hosted by Graham Desroy from DMM. Graham started by showing us some1960's hawser laid rope and a range of modern ropes of varying diameters. This nicely illustrated the point that belay plates have to keep evolving drastically to keep pace with rope developments and manufacturers are constantly tweaking designs to improve performance and increase their versatility.

The downside of all these variables has meant there is still no agreed standard for belay plates despite ongoing efforts to produce one. A working agreement had been reached to base the standard around the amount of slippage that occurred when a plate was loaded compared to the slippage of an Italian Hitch. Testers could then say the slippage for any rope/belay plate combination must be within a ratio of 0.6 of the slippage of the Italian. Plates that exhibit higher slippage would then be deemed too slippy.

However, although we were thought to be within about 2 years of agreeing this standard, on the day of the conference Graham had heard that a high ranking figure in the testing world had said the testing method was unreliable because it relied on human intervention. Maybe we'll have to wait rather longer for that particular standard to be agreed!

We had a general discussion about the types of plates available and the various materials used in construction. By far the majority of devices are made from aluminium because it is so easy to forge but there are occasional exceptions like DMM's steel V-twin device. Steel offers greater wear resistance and heats up less, but still has similar handling characteristics.

The rest of the session was devoted to testing the frictional differences between a variety of models. The testing method simply involved suspending a person and measuring the amount of friction as the rope was gradually fed through the plate (using a spring balance to give a reading in kilograms). Although by Graham's own admission this was rather unscientific, it did at least allow a comparison to be made between different models*.

The results speak for themselves and all I really need to point out is that the higher reading simply represented lower friction! Oh yes, and on models that could be used in two directions we tested both and that is also shown below;

Italian Hitch – 2.9kg
Sticht Plate (without spring) – 4.4kg
Sticht Plate (with spring) – 8.4kg
Black Diamond ATC – 8.0kg
Petzl Reverso (old model) – 7.0kg
Petzl Reverso 3 (rope running over grooves) – 6.0kg
Petzl Reverso 5 (rope running over smooth side) – 10.0kg
Wild Country SRC – 3.7kg
DMM Bug – 7.6kg

The rope used for all tests was Mammut 10.5mm.

However, I feel we did test enough to allow some general conclusions to be reached. Belay plates that are notoriously quite slick like the ATC were shown to be slick and models that were supposed to offer high and low friction options like the Reverso 3 did indeed perform effectively.

*This test gives a very rough pecking order of devices, it doesn't indicate the actual holding power of any particular device.

Workshop 3
Bolt anchor placement and removal

The bolting workshop was presented by Dan Middleton (BMC Technical Officer and AMI member). Part of Dan's role is to coordinate the BMC Better Bolts Campaign (which began in 2007) and he started by outlining the campaign's 4 key aims;

- To donate good quality bolts to bolt funds around the UK. These are predominantly Fixe glue-ins and Petzl12mm expansion bolts and to date the campaign has distributed 1500 mechanical bolts, 2000 resin bolts and 250 resin belays. The bolt funds bid for bolts and a BMC panel decides which bids will succeed.
- To raise the profile of bolt funds. This is currently done by providing information on the BMC website and informing climbers keen to get involved.
- Educate and inform climbers. The BMC has run several workshops for climbers and more are planned. There is also a lot of information on the BMC website with downloadable documents on using and installing bolts.
- To conduct research into bolts looking particularly at how effective they are, the long term effects on placed bolts and whether repeated loading weakens them. To facilitate this a test area has been set up at Horseshoe Quarry and pull tests will be carried out after 1 week, 1 year, 5 years and 10 years. At the time of the conference only the 1-week test results were available and these are detailed later.

For the practical part of the workshop we started by examining a selection of the10mm (suited to hard rock) and 12mm (suitable for medium to hard rock) mechanical bolts that are commonly used in Britain and Dan detailed their key pros and cons.

The main advantage of mechanical bolts is their ease of placement and the fact that their security doesn't rely on the successful curing of resin. The disadvantages include the expansion system, which is permanently under load, and the many nooks and crannies on the bolt which give lots of places for corrosion to take hold. It is very difficult to remove mechanical bolts so common practice is to drill a longer hold than required so that old bolt stems can be hammered into the hole .

Dan went on to discuss glue in resin bolts and again we examined a variety of models. We looked at some of the older generation of DMM eco bolts, which, although groundbreaking at the time of their release, had the disadvantage of needing an 18mm diameter hole. We also looked at a Fixe model that has been widely used in the UK and fits into a 12mm hole. This model, however, does have some welds along the shaft that may make them prone to rusting. Finally, we looked at some Bolt Products bolts that are available in several finishes such as stainless steel and a shiny alloy which is well suited to salt water environments. Bolt Products supply their bolts in a variety of lengths to suit different rock types.

Following this Dan showed us the 2 common types of resins. Polyester resin is cheapest but not so well suited to wet rock, and epoxy acrylate, which is better for wetter conditions. Resins are stronger than rock when fully hardened although the right type is needed for different bolts (the manufacturer will usually specify the correct type). Some manufactuers claim resin bolts are removable but in tests Dan has had little success in doing this and it certainly seems hard to achieve without damaging the rock around the bolt.

We then moved to a boulder in the Bryn Engan woods to place some bolts and do some pull tests on bolts Dan had placed a few weeks ago. We placed a mechanical bolt first and the process is fairly simple; clean the hole, tap the bolt in and tighten it with the hanger on. We talked about the correct torque setting for mechanical bolts but accepted that in reality climbers don't take torque wrenches on routes and simply tighten bolts until strong resistance is felt on the spanner.

We also placed a resin bolt and again the process simply involves fully cleaning out the hole, filling the hole with resin squirted from a simple compression gun (similar to the ones used for DIY sealants) and pushing the bolt stem into the hole. The resin has 2 parts and these mix in the tube as the gun trigger is squeezed. This mixing is a key requirement for the resin to harden properly and the mixing is then aided further by rotating the bolt as it is pushed into the hole. All the modern staple resin bolts have some form of protrusion or scoring that enables the resin to key in to the bolt effectively – another requirement to effective holding power. After resin bolts are placed it is normal practice to leave them to set for a day before climbing on them although Dan did point out that some climbers feel confident enough to use them after only a few hours.

We went on to test pull test both a mechanical and resin bolt (the resin bolts had been placed 2 weeks before) using a Hilti 2000 Anchor Tester. This machine will pull up to 20kn load (although it only works in an outward orientation) but we couldn't remove either type of bolt before we reached 20kn. There was some deformation of the resin bolt eyelet and some surface cracking of the rock around the mechanical bolt but, as Dan told us it would hard to get over 7kn force loading in a fall, these were very reassuring results! The bolts easily exceeded the EN (European Norm) 959 axial load requirement of 15kn and equalled the UIAA 123 axial load requirement of 20kn.

Dan also shared the results of his 1-week pull tests from the Horseshoe Quarry test site and these were similar to our own findings. In the tests the 3 placed Petzl12mm expansion bolts all tested to 20kn without failure, 2 Petzl 10mm expansion bolts tested to 20kn and 1 pulled out at 19kn, 2 Fixe 10mm resin bolts (set with epoxy acrylate) tested to 20kn and 1 pulled at 19kn (However, upon inspection it was found that the epoxy on the failed Fixe 10mm had not got into the grooves of the bolt stem which probably accounts for the failure – emphasising the need to ensure the resin in is full contact with all the bolt stem).

Tests have also been conducted on resin capsules (an alternative method of deploying resin where the resin is contained in a single use vial) and all these tested to 20kn without failure.

Finally, tests were carried out on home made staple bolts (with Hilti resin) of the type commonly use by certain well-known bolting activists (no names were shared!) and they pulled at 16.5kn, 13.5kn and 13.5kn. It was noted that the bolt that failed at 16.5kn had a splayed end where the metal had been unevenly cut and this again supports the evidence that the resin works best if it has something to grip on to.

Finally, we discussed the issue of sustainable bolting. This is an area that is still developing and new techniques will need to be found to make bolting truly environmentally sustainable. At present old expansion bolts can be removed by drilling out the stem using a core drill. This leaves an oversize hole that can then be replaced with a resin bolt. Unfortunately, at present there is no way to remove resin bolts without damaging the rock around the placement.

Afternoon Lectures

The afternoon comprised a number of lectures. Dan Middleton's lecture broadened the information provided in the morning's bolting workshop and so I have incorporated it into the bolting workshop summary above. Similarly, Dr Mark Taylor's lecture information on helmets has again been incorporated into the helmet workshop account. The other afternoon lectures were given by Oliver Milling (chairman of the BMC Technical Committee) who outlined recent recalls and equipment failure investigations, Charlie Thwaites from W.L.Gore talked about 'Understanding Garment Protection' and Ken Ledward (founder and owner of the legendary KLETS equipment testing service) discussed 'Real World Product Testing'.

Four hours of information packed lectures are hard to condense into a few paragraphs so I have just summarised some of the key points provided by each speaker.

BMC Technical Committee incident report
Oliver Milling

Oliver reported a few recent incidents investigated by the Technical Committee.

Firstly, a broken flexible cam had been sent for analysis. Although as far as I know no conclusive evidence has been found to explain its failure the breakage was significant because it had failed at the point where the cable enters the cam unit and this fracture point was covered by the outer plastic sleeve. This damage would not have been identified during routine inspections.

The committee has also investigated several carabiners which have snapped at the point where the back bar starts to curve round to the nose. All these crabs are thought to have failed at only around 3kn. Markings on the biner and laboratory simulations have led to the conclusion that the failure was caused by the quickdraw sling catching on the nose of the crab causing very high leverage in a fall. It is obviously essential to make sure quickdraws are seated probably.

Finally, Oliver drew attention to the BMC's online head injuries survey. This currently has 400 respondents and will hopefully continue to build up into a very valuable resource and can be found on the BMC website.

Understanding Garment Protection
Charlie Thwaites

Charlie Thwaites provided a very detailed analysis of Gore's fabric testing procedures and showed some of the companies test facilities. There was a lot of statistical information and photographs that I can't reproduce here but I did note a few points that I thought may be of particular interest.

- Gore work on around a 7-year fabric development programme - so as we all invest in Pro-Shell they are already testing the next generation of fabrics. These tests involve 4 phases including a range of laboratory tests before controlled wearer tests are performed in the field. Inevitably these tests are also very expensive. For example a single chamber test series with a human tester costs around £80,000 – and that's just one of many many tests!

- From Gore's tests it has been shown that heat loss in wet shell clothing is about 3 times greater than in dry.

- I was surprised to hear that tests have shown that there is very little difference in vapour transmission rate between a regular fleece worn under a shell and a windproof fleece worn under a shell.

- Finally, pressure on breathable fabrics means your breathable membrane works better when compressed under something like a rucksack shoulder strap!

Real World Product Testing
Ken Ledward

The final speaker of the day was Ken Ledward. Ken founded KLETS (Ken Ledward Equipment Testing Services) many years ago and the company has become an industry leader in the field. Ken's tests are carried out on the hill and give manufacturers the hard data that only 'getting out there' can really provide.

Many of the techniques Ken has developed have led the way for others and he outlined the testing procedure used to test some fabrics in the winter wilds of the Cairngorm Mountains. Again it is hard to document some of the information because it was presented very visually, but certainly no one listening could fail to notice Ken's passion for his work and the contribution his testing has made to the standard of equipment we currently have available. It was even better to hear his son is now following in his footsteps (literally, it seems, as his son is an expert on testing boot soles!).

Conclusion

The 2008 BMC Technical Conference was a great success and I would like to extend my thanks to everyone involved in the planning and execution of the event. It would be great if the conference can become a firm bi-annual event and that it continues to be well supported. I also hope this summary accurately portrays the quality of the event and the information is useful both to mountaineering instructors and other readers of AMI News.

This report was written by Paul Lewis, a member of the AMI Committee. Many thanks for allowing us to use it.