Head Games

The BMC helmet testing programme- Part 1

by Andy MacNae and Mark Taylor

The helmet is back. For alpinists and ice climbers it never went away but for nearly twenty years rock climbers have decided that the risk of being fashionably challenged out weighed that of a head plant and so went bareheaded. But times are changing, witness Bentley on Equilibrium or Gresham on Meshuga, and the helmet is once again cool.

What brought about this change in mind set? Well, for one, climbing helmet technology has finally started to catch up with that of cycling and of course the hard grit revolution brought home the dangers of head injury to its leading exponents in no uncertain fashion. So where are we now? There is no doubt that lightweight helmet technology is in its infancy and in the future we will see better and better protection for the climbers vulnerable head. What also seems to be evolving is an increasing specialisation both of design and use. In a recent article in Climber magazine Andy Kirkpatrick (a member of the BMC Technical Group) referred to the current generation of lightweight helmets as Rock Helmets, both in terms of the way they are designed and the way in which they are increasingly being used. This specialisation of design and use has left the standards process behind. Originally helmets were designed essentially to protect against rock fall in a mountain environment and the standard was written accordingly. This means we have a problem. If you want a helmet solely for rock climbing you are buying one designed to meet a standard written with the Alps in mind, whereas what you really want is something which will protect the head in the event of an impact while falling. If you are buying a helmet for the mountains you want lots of protection but minimal weight, but with so many designs about, how do you know what you are getting? Will the lightweight generation really stand up to the rigours of the Alps? If you want an all rounder what should you be looking for?

It was to address these problems, and to gather evidence for a rethink of the standard, that the BMC's helmet testing programme was initiated early this year. At first only the new lightweight helmets were tested but it soon became clear that for a useful comparative study as many helmets as possible should be examined and so in the end a total of 15 models were included. In part 1 of this article we look at the test results, in part 2 we shall examine the tecnical attributes of the helmets in greater detail.

The tests

The tests were carried out by Mark Taylor, a researcher at Leeds University Textile Department. The Leeds facility is acknowledged as a leading authority in the field and new testing equipment has increased the reliability of the testing method still further. Manufacturers and importers were asked to support the tests by providing samples. In the majority of cases support was excellent and where it was not possible to obtain complimentary samples the BMC purchased the required helmets.

Initial tests were carried out as stipulated by EN12492 "Helmets for mountaineers", although the helmets were not temperature conditioned. Such conditioning would not greatly affect the results but would cause small differences in the force/ time curves.

The helmet standard (EN12492)

As already stated the helmet standard was written with the dangers of alpine climbing in mind. When designing a helmet for use in the mountains the designer is concerned with two main factors related to protecting the wearer's head from falling stones – the peak impact force transferred via the helmet to the climbers neck, and the penetration of the helmet (and the head) by sharp-edged stones. Additionally, the retention system (chin-strap) has to be designed to retain the helmet on the wearer's head. A helmet's performance in these areas is examined in the key parts of the helmet test. In essence seven tests are carried out on a helmet which is firmly mounted upon a wooden headform. One helmet sample is used for each test. These tests are:

Vertical energy absorption: A 5kg striker with a 50mm radius hemispherical end is dropped 2m onto the top of the helmet, and the peak force transmitted to the 'neck' measured. The CEN standard requires that the force must not exceed 10kN.

Penetration: A 3kg conical striker is dropped from 1m to test two points of impact. The striker may penetrate the helmet shell but must not impact the headform.

Front, side and rear energy absorption: Three tests are made with the headform tilted at 60º in the appropriate direction, using a 5kg flat striker but only dropped from 0.5m. Again the peak transmitted force should not exceed 10kN. In practice this is not a demanding test and all helmets pass relatively easily.

Retention system: Checks (1) that the chinstrap will not release under a load of 0.5kN, and (2) that the helmet is retained on the headform when an impulsive load is applied to the front edge (also rear edge) of the helmet in a direction to roll it off the headform.

There is an additional UV test stipulated in the new standard but as all helmet materials are UV stabilised, and have been for many years, this is felt by many to be an expensive and unnecessary extra test and it was not carried out during the BMC program.

The UIAA standard uses the same tests but requires that the peak transmitted force shall not exceed 8kN in the four energy absorption tests (compared with 10kN for the CEN standard).

The helmets

The following helmets were tested. This is not meant to be a comprehensive review of all available in the shops. It is as complete as possible in the lightweight category (c400g and below) with additional helmets selected to typify a given design or material.

Manufacturer	Helmet	Measured Weight(g)
Grivel	The Cap	359
Petzl	Meteor	253
	Ecrin Roc	472
Black Diamond	ABS Half Dome	454
HB	Carbon/Dyneema	305
	El Cap	534
	El Cap (Kevlar/Carbon)	529
	Olympus	384
	Blue Water	402
	JB Lightweight	573
Edelrid	Ultralight	405
Cassin	Mercury	342
Camp	Rock Star	386
	High Star	421
	New StarTech	397

The results

Firstly we must state that the program did not aim to verify a helmets' performance against the CEN or UIAA standard. However where the results suggested that a helmet was unlikely to meet the standard the BMC has of course taken the matter up

with manufacturers (see end of article). In order to avoid too great a focus on numbers the results for each impact test, are presented within a comparative chart. These results are discussed and some important conclusions reached. In part 2 of this article a range of force/time curves will show the ways in which different types of helmet react to an impact and a brief review of each helmet's attributes will be given.

So what do we find?

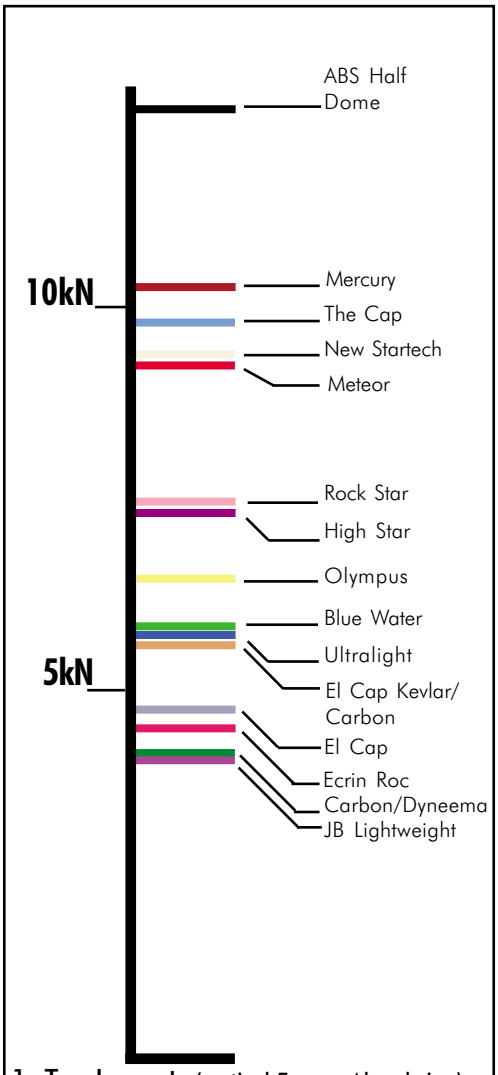
Without beating around the bush several lightweight helmets failed to meet the requirements of the EN standard and several more failed to meet the requirements of the stricter UIAA standard. Is this a surprise? In the case of the marginal failures, no! Without going into excessive detail a recent redraft to the standard changed the shape of the weight that impacts the helmet. This new test is harder on lightweight helmets than the old version against which the helmets would have originally been certified. In addition it has already been stated that the current standard does not really test the lightweight 'rock' helmets against the way in which they will be used and so marginal results were always likely. But that's marginal failures. One helmet was well outside the range of acceptability and another model gave cause for concern, these are discussed later.

What else do we learn?

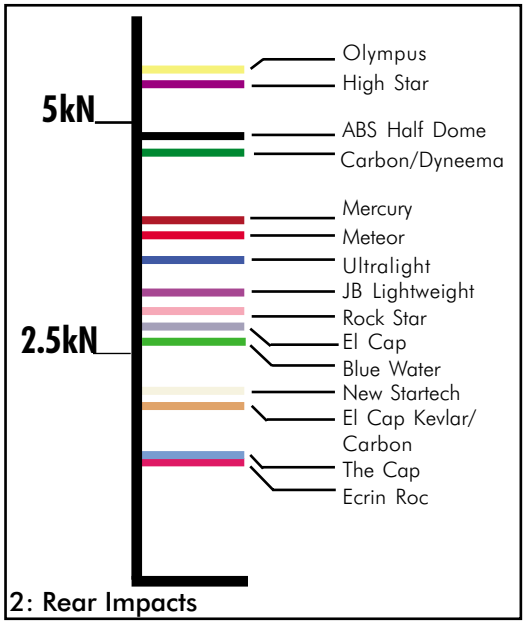
- In general helmets of the new lightweight foam type absorb less energy during an impact from above than more 'traditional' designs. This is to be expected and demonstrated a difference in design emphasis.
- The order is not repeated with front, side and rear impacts. Here results seem dependent on other design factors. How helmets would perform under more severe impacts is an issue to be explored, and ideally should be something examined within an updated standard.
- Although all helmets pass the penetration test, it should be noted that this pass can be marginal in the case of soft foam helmets, where localised pressures can build up.
- Having compared the Leeds results with those from other test centres several inconsistencies were found. It is clear that the tests are not being carried out in the same way and the BMC and UIAA will be asking test centres to re-examine and harmonise their methodologies.
- After testing, some helmets show little physical evidence of having sustained damage. This may be a matter of concern for managers of equipment pools.

Conclusion

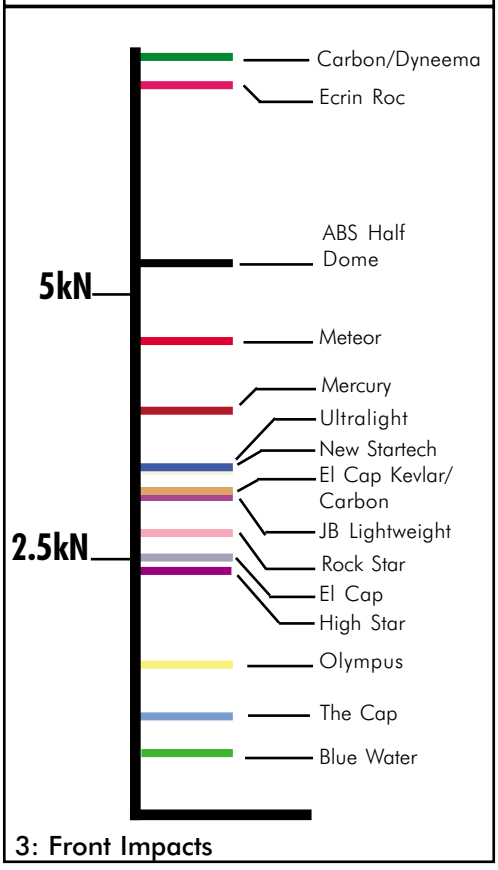
With increasing specialisation in climbing and mountaineering, it is good to see that helmet design is beginning to reflect specific uses. At present the design of helmets for rock climbing, where the main concern is protecting the head during a fall, is judged by a standard that does not primarily address this concern. In addition it is apparent that variations in test laboratory practice might allow sub-standard helmets on to the market. Taking these factors into account it is the



1: Top Impacts (vertical Energy Absorbsion)

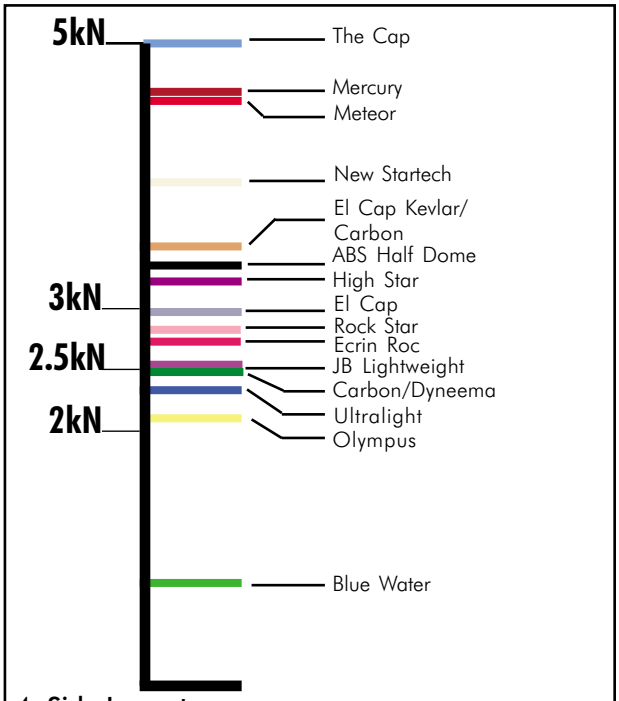


2: Rear Impacts



3: Front Impacts

PTO for front impacts



4: Side Impacts

opinion of the BMC Technical Committee that a major re-think and restructuring of the standard is called for. BMC representatives have taken this position to the UIAA Safety Commission which has initiated a programme of work to review and revise the standard. It is to be hoped that in a few years we will see a more realistic standard(s) and an increasing range of cleverly designed helmets for rock climbing and mountaineering that we can wear with comfort and confidence. In the meantime full marks to the designers of the lightweight generation and we look forward to further innovation.

Startech

Many readers will have followed the story 'Concern over Startech Helmets' in the press over the past few months. The Leeds testing program gave top impact figures for the pre May 2000 Startech ranging beween 18.6 and 20+kN. The Technical Committee insited that Camp must rectify this situation and as a result Camp, via their UK agents Allcord, are now offering to upgrade all old Startech to the standard of the new post May 2000 model. If you own an old Startech please contact Allcord 0191 284 8444 for an upgrade.

Black Diamond Half Dome

The Leeds results indicated a top impact force some 20% above that allowed by the CEN standard, whilst the notified body CRITT had measured a top impact force of less than 2kN during certification testing. When notified of this anomaly BD commented as follows:

Thank you for notifying Black Diamond of discrepancies in test results discovered at the LEEDS laboratory. Black Diamond is concerned by the findings suggesting that our Halfdome helmet does not meet the CEN standard for mountaineering helmets. The Halfdome helmet has been tested and certified by the Notified Body, C.R.I.T.T.

The wide variation in data between two reputable organizations is a serious concern to us.If our helmet is truly found to not meet the requirements of the CEN standard we will take all actions necessary to achieve conformance and, more importantly, to ensure the safety of all our customers worldwide. Our preliminary recommendation, which we have begun, is to establish communications between BMC/ LEEDS and CRITT to determine the root cause of the discrepancy and to correct it. Once this is complete all organizations should collectively evaluate if further action is required. We look forward to working with BMC/LEEDS to resolve these issues.

The Technical Committee is in discussion with Black Diamond and will undertake further tests.

A rough guide to helmets

How do helmets protect the head?

When either a rock hits your head, or your head hits the rock the only way that you are going to escape serious injury is if the energy of the impact is absorbed by the helmet. It must do this in such a way that the force transmitted to the head is not localised such as to fracture the skull, and not high enough to fracture the neck or damage the brain. This is the helmet's job and several elements of its structure play a part in this.

The Cradle: Made from nylon webbing, keeps the shell away from the head, spreads the load, allows the helmet to distort and absorbs some energy. Foam based helmets do not have cradles and so the helmet sits closer to the head; also the load is not distributed so uniformly.

The Shell: Distorts and distributes the impact energy. Some shell materials absorb energy as they delaminate.

Foam: Both soft and hard foam are found in modern lightweight helmets. The foam absorbs energy as it is compressed. For a given foam, energy absorbing capability is directly related to thickness.

Which one?

There is no doubt that comfort is a crucial factor and regardless of this technical appraisal you should try and buy a helmet that fits well and feels good. If this is so you are more likely to wear it and that's what it's all about. What you look for beyond this depends on the end use:

Rock only: Good energy absorption all round, particularly at the rear. Light with good ventilation. Sits close to head (but this conflicts with energy absorbing ability). Unfortunately the current standard tests do not give enough information to really help make a choice between helmets just for cragging. It is to be hoped this can be rectified in the future.

Ice/Alpine: The top impact and penetration performance is key and should take precedence over any other factors. Ability to take multiple impacts is important. For many, weight will also be a key factor and so it really is a question of looking for the best test figures and minimal weight. Among the currently available models, some traditional shell and cradle designs give better protection for the same weight.

Centre/group use: Value for money, long life, obvious signs if damaged.

A note on lifetime: Regardless of the material from which a helmet is made its performance will deteriorate with age. It is reasonable to consider a helmet to be at the end of its life when it can no longer pass the standard. The degradation rate varies from material to material and is dependent on conditions of use, but in general the greater a helmet's initial energy absorbing capacity the longer it will be usable.

When to wear?

Every year the BMC's Equipment Investigation Panel examines several helmets which have saved the wearers life, following a fall or a rock strike. At the same time we hear of incidents where a climber not wearing a helmet has suffered serious or fatal head injuries. The message seems clear. Take a helmet to the crag and presume you are going to wear it. Only if you can justify why not should you do without. During use, check that the chin-strap is tight enough to retain the helmet on your head in the event of an impact (or series of impacts in a bad fall).