Report on the

Practical destructive tests on some items of caving personal protective equipment

Conducted during the

12th European Cave Rescue Meeting

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Introduction

Investigations into the items of personal protective equipment against falls from a height have a long standing history. As soon as adventurers started to secure at heights with various expedients they were questioning their efficiency. Means of testing were initially basic, but gradually evolved and procedures and methods gained their formal character and consequent reliability with supposed reproducibility.

To note clearly here is that due to time constraints the described tests lack replication that would lead to conclusions funded in statistical inference and consequently have more an informative and exploratory character than a scientific one.

The Cave rescue meeting hosted by the Corpo Nazionale Soccorso Alpino e Speleologico in Casola was not centred around testing of equipment but had a broader goal. The Cave rescue meeting being nested within the general cavers' meeting led ECRA's Technical commission to think about possible ways of presenting their work to the wider caving public. Casola where the meeting was taking place is one of the few gypsum karst areas in Italy. Gypsum is typically a soft and friable rock where anchoring with expansion bolts is unreliable. They consequently developed a technique of anchoring with 8 mm x 80 mm concrete screws. There seem to thrive quite a few assumptions within the local caving community on the rules of placing concrete screws. Among them:

- Never place a screw in the same hole as another screw was already unscrewed from. Always use fresh holes where the thread will bite into the rock.
- Only use one screw for few placings. After that the thread is consumed to the point of non-reliability.

The first part of the tests therefore served the local community with an attempt to show extraction strength differentials of the new, and old screws used in new and used holes.

We collected nice big chunks of massive gypsum rock without evident cracks from a local quarry and drove them to the meeting place. There we got 3 new and 3 2-years used 8 mm x 80 mm concrete screws. A set of 6 holes was drilled. In pairs (new and old screw) we placed the screws: once, twice and four times in the same hole. Extraction results are as shown in table 1.

Table 1: Results on the concrete screws test.

	Just screwed in	Once re-screwed	4 times re-screwed
New	10 kN	18 kN	17,5 kN
2 years	17 kN	14 kN	17 kN

If we briefly dare to comment the results obtained, we might conclude that most effects on anchor strength are not attributable to either age or status of the hole. During testing we mostly felt that the way placement was done (re-drilling the hole and initial bite of the screw) and rock quality were paramount.

The second part of the testing was more cave rescue oriented. It is well known CNSAS technicians carry as part of their personal equipment a length of 5 mm double braid aramid core and polyester sheath cord. They use it for either anchor equalization or even temporary suspension of the stretcher during transfers between two hauling ropes. These techniques stirred up a lot of scepticism among some fellow rescue technicians from other countries. Very high tenacity, yet low elongation are some of the very well known characteristics of aramid fibres. A bit less known are their sensitivity to UV light and bending. Ageing might, therefore, prove problematic. Especially with some sloppy technicians not updating their equipment regularly. Stemming from these premises, we confronted in a breaking strength test new and used aramid cords typically used by CNSAS cave rescue. The results are shown in table 2.

Table 2: Results of the aramid cords breaking strength test.

	New	**Used**
Overhand knot	12 kN (knot slipped)	8 kN (knot slipped)
Fig. 9 in a loop	20 kN (broken carabiner)	15 kN (broken on knot)

From the meagre results it might be deduced that regularly checked and exchanged aramid cords hold static forces very well. Even after about 2 years of cave rescue use, the cord still held a solid 15 kN of static load in a loop. It has to be emphasized at this point that reliability of all ultra-static materials changes radically in dynamic loads. Those, however, are **supposed not to occur!?** in cave rescue work.