Long Term Rope Test Results

This is an extract from a lecture I gave on the results and other matters some while ago. What follows were my slides and speaking notes. If you want more information or clarification then feel free to contact me.

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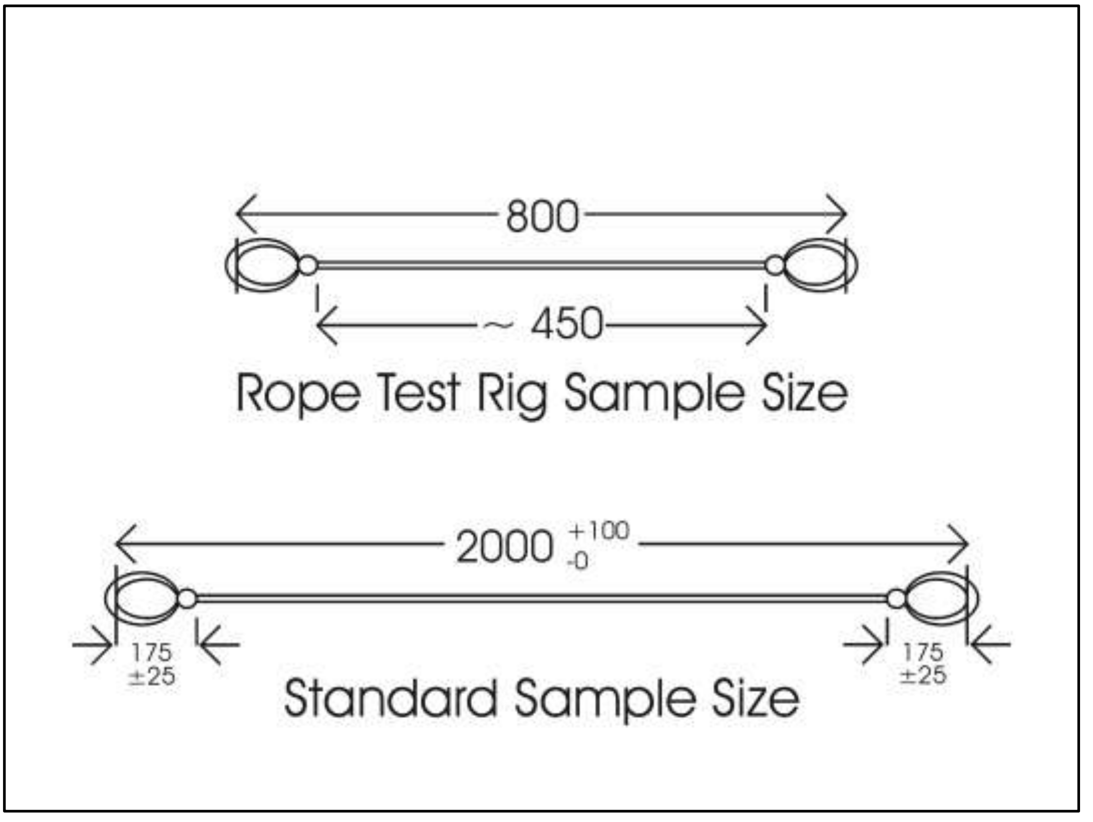
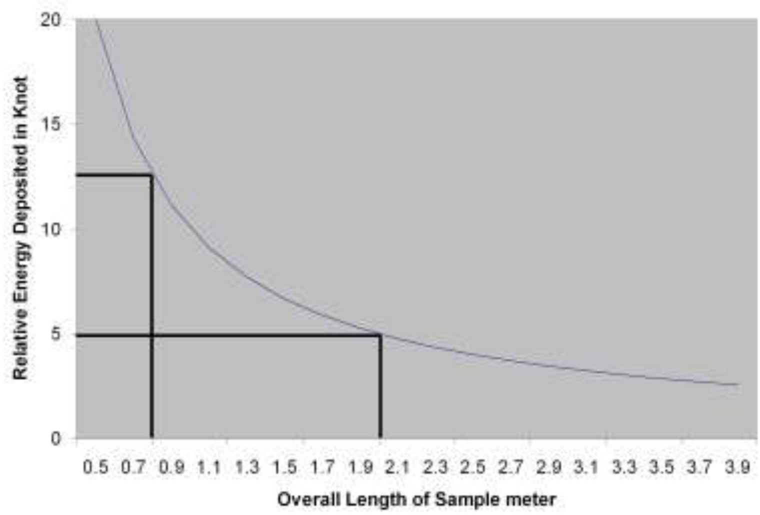
work started by Owen NCA's Long Term Rope Test NCA purchased a 230m of 10mm SRT rope.
rope was be thoroughly washed/rinsed and stretched and prepared as per manufacturers recommendations.
cut alternately into seven 2.5m lengths and seven 30m lengths and labelled so as to be able to identify each length. The 2.5 m lengths were then tested by Owen.
Testing done of BCA Rope Test Rig which is different from the British Standard.

It is a simple mobile rig, some 3.4 metres high and uses a sample of rope around 800 mm long under a load from the test weight of 100 kg.

First major difference is test rope soaked minimum 2 hours. Known rope is weaker when wet – not investigated



It uses a sample of around 800 mm length.
Standard specifies a test sample which is 2 meters long, or more precisely between 2.0 and 2.1 meters long
whilst under a load of 100 kg.
The BS specifies that each rope is terminated with a figure of eight knot such that the length between the inner edge of the loop and the outside of the knot is between 150 and 200 mm under load. We don't have a similar specification for the rope test, but typically the length of this dimension is between 200 and 175 mm.
three different parts of the rope sample which can absorb the energy of the falling test mass.
First there are the loops were clearly the two sides of the loop are able to absorb the energy.
Then there are the knots.
inner length of single rope which roughly means that the BS has 2 meter less 2 times 175 mm, ie 1700 mm
as against the rope test rig's length of around 500 mm.
hypothesis was that because the rope test rig's shorter length of single rope meant that proportionally more energy is being deposited in the knots and loops than is the case for the BS test.
modelling it one actually gets the reverse, due to the fact that as the sample length increases, so there is more energy to be deposited in the increasing inner single length of rope.
This model which I won't reproduce here as it is just a set of mathematical statements does however, show that the difference between a sample length of 800 mm and 2 m is actually more that the difference between 2 m and 100 m.
I can only conclude at this moment that I am confused and I feel the only way forward is to test it.
Unfortunately, the rope test rig can't take overall sample lengths of much more than 800 mm.

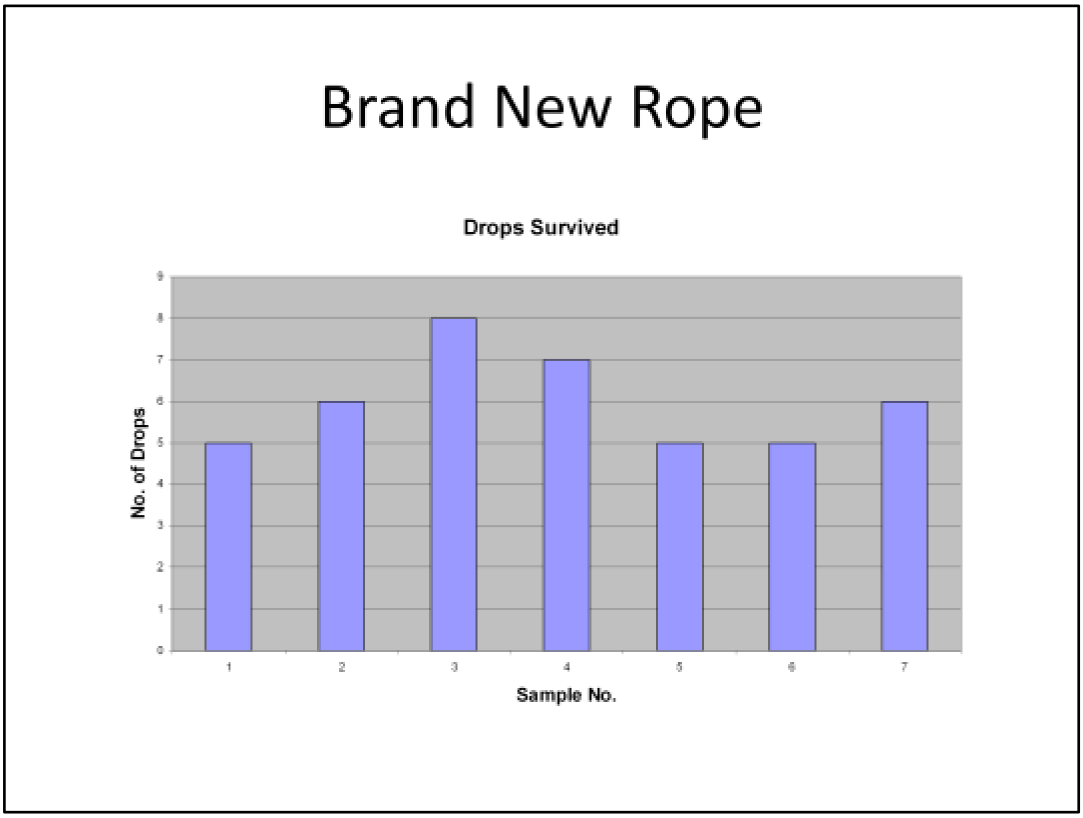


Result from model shows much greater significance of knot in rope test rig

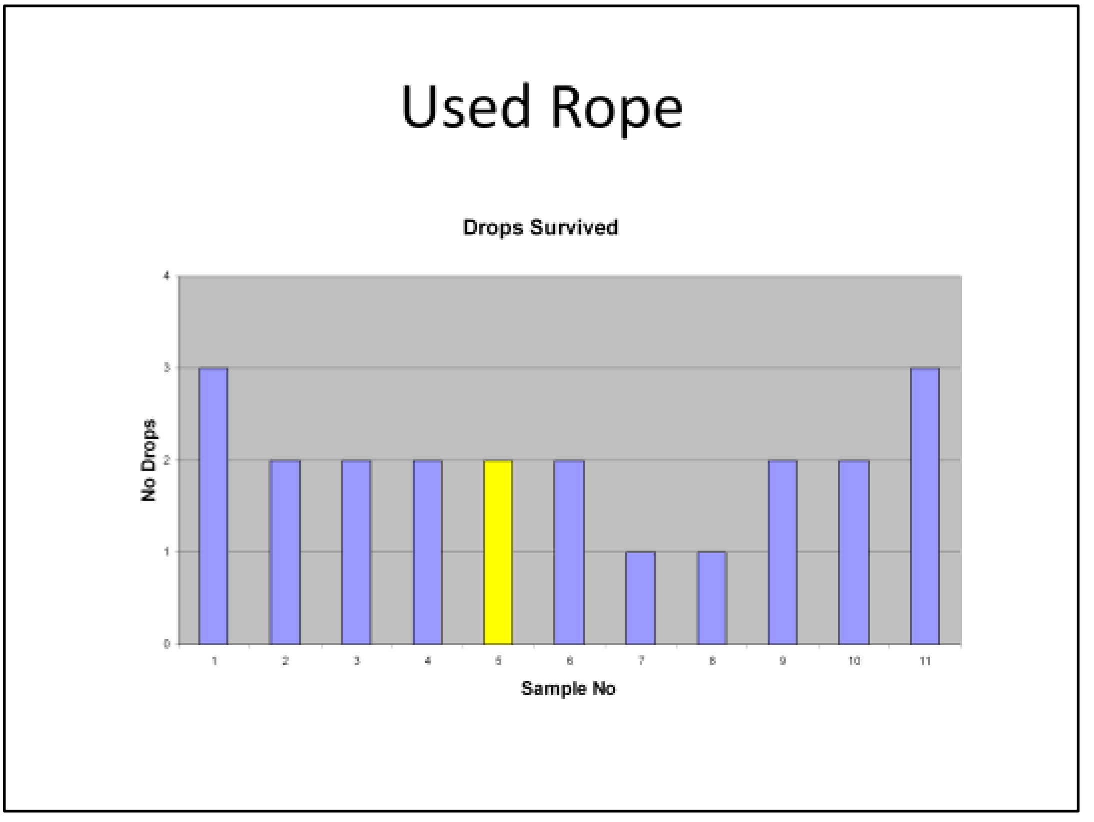
I have subsequently done some work with different rope lengths and the length of the sample appears to make a difference to the number of drops survived. A 0.4m sample of used 9mm rope survived 8 drops, a 1m sample survived 2 drops and a 1.5m sample survived 1 drop.

Drop Number	Fall Factor
1	1.0
2	1.0
3	1.1
4	1.2
5	1.3
6	1.4
7	1.5
8	1.6

The next major difference is that the BS requires the dynamic test to maintain the fall factor at 1.0.
withstand five falls of Fall factor 1.0 without releasing the mass.
In fact many ropes go on well beyond 5, some citing as many as withstanding 40 falls. I have even tested one to 100 drops survived and gave up.
Owen recognised that the task of conducting even up to only 15 drops would take a large amount of time.
He argued that one could more quickly take the rope to breaking point by increasing the fall factor between drops.
He has used a range of increments, but the current approach is to use the following sequence
The rig is limited by how high the weight can be raised and is around Fall Factor 1.8.
two arguments about this approach.
first is that you can never get a fall in use above Fall Factor 1. The response to this is that there are some circumstances where a caver will clip onto a rope above the anchor point and if the caver fell from that position, then there would be a fall factor of above one. I agree it is not a very common situation, but it does exist. Also whilst it may be good practice to avoid being above anchor points, good practice is not always achieved in a caving situation.
second relates to the fact that you are placing a different load on the rope by using increasing fall factors compared with maintaining the fall factor constant. I have to admit that I have no idea as to what the difference is. It is another one of those things which I would like to conduct some work on. But this time it can be undertaken on the rope test rig.
first two drops in the NCA test are at Fall Factor 1.0, so to that extent we start off the same, albeit ignoring the sample length difference.
I will come back to the question of a standard for further use of a rope later on in this talk.
As an aside, it is also worth remembering that the Standard requires the tester to first conduct a peak force test on the same sample of rope with the test weight dropping from 600 mm, that is Fall factor 0.3, before then going on to conduct the dynamic performance tests. In addition, the rope has been conditioned before testing in an atmosphere with a relative humidity of 65% at 20 degrees C. The rope test rig conducts tests with the ropes wet as this is nearer to actual use conditions that 65% humidity.



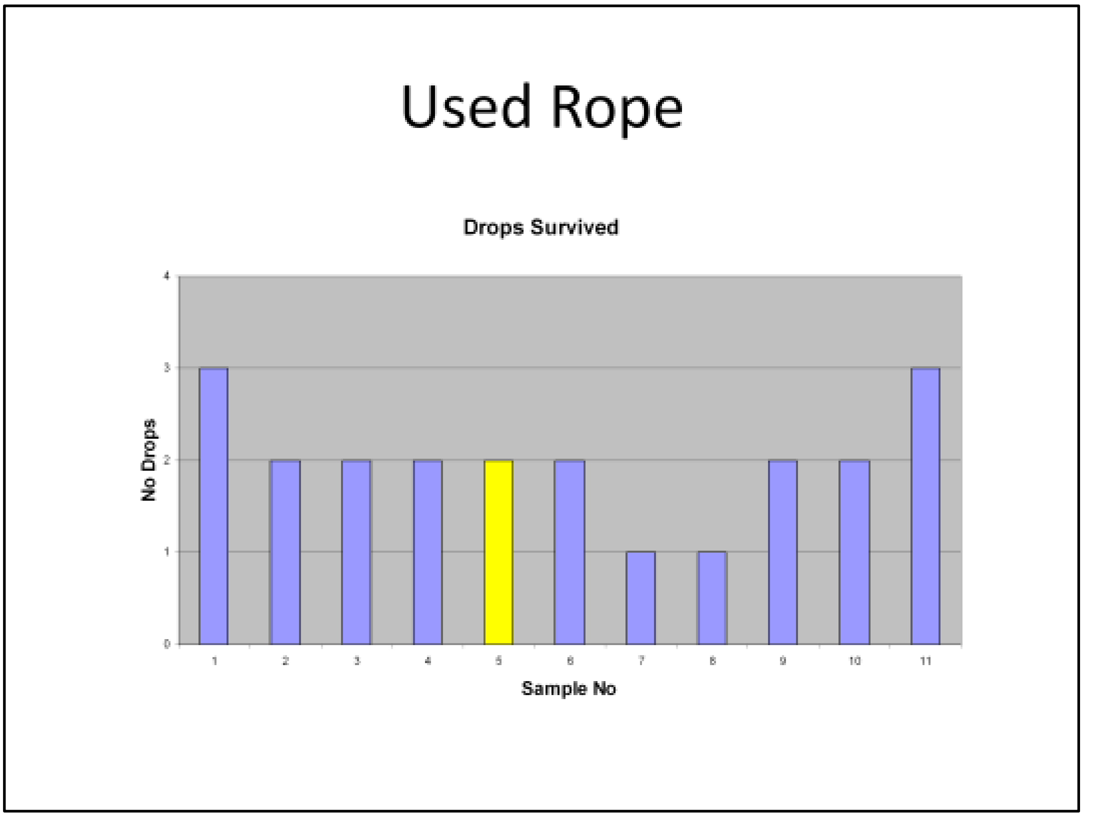
So we have a single length of rope with 7 samples taken at 30 meter distance along it. you can see that for what should be 7 identical pieces of rope, we found a variation in survivability of between 5 and 8 drops survived.
To emphasise the point this means that say the first sample survived 5 drops, but broke on the sixth.
This variability is another reason why I think it is not prudent to use the simple test for continued use of a rope based on it surviving 2 drops at fall factor 1.0 I will come back to this point again.



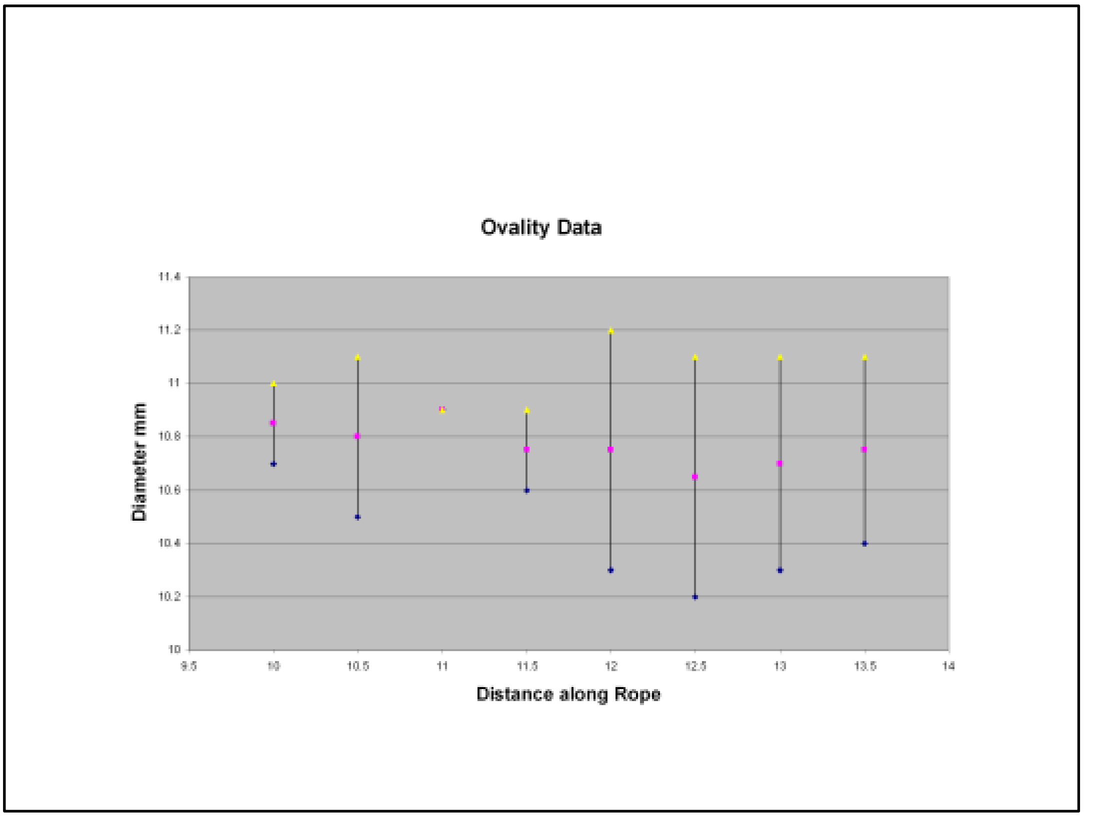
First note variability along length of rope. Shows taking sample from end is unlikely to reflect performance of rope

Marks on rope

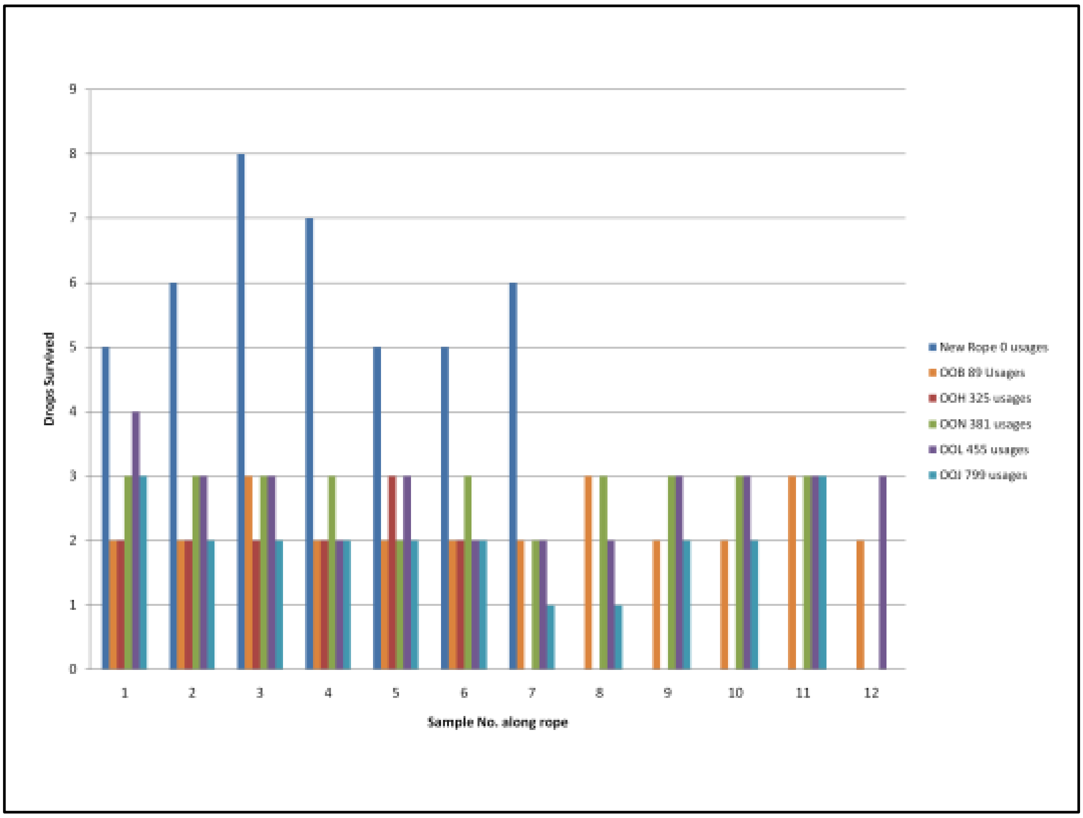
First I have to say that although one might say the rope was well looked after, one area was slightly glazed
as you can see from the bottom rope in this picture. There was also a brown stain.



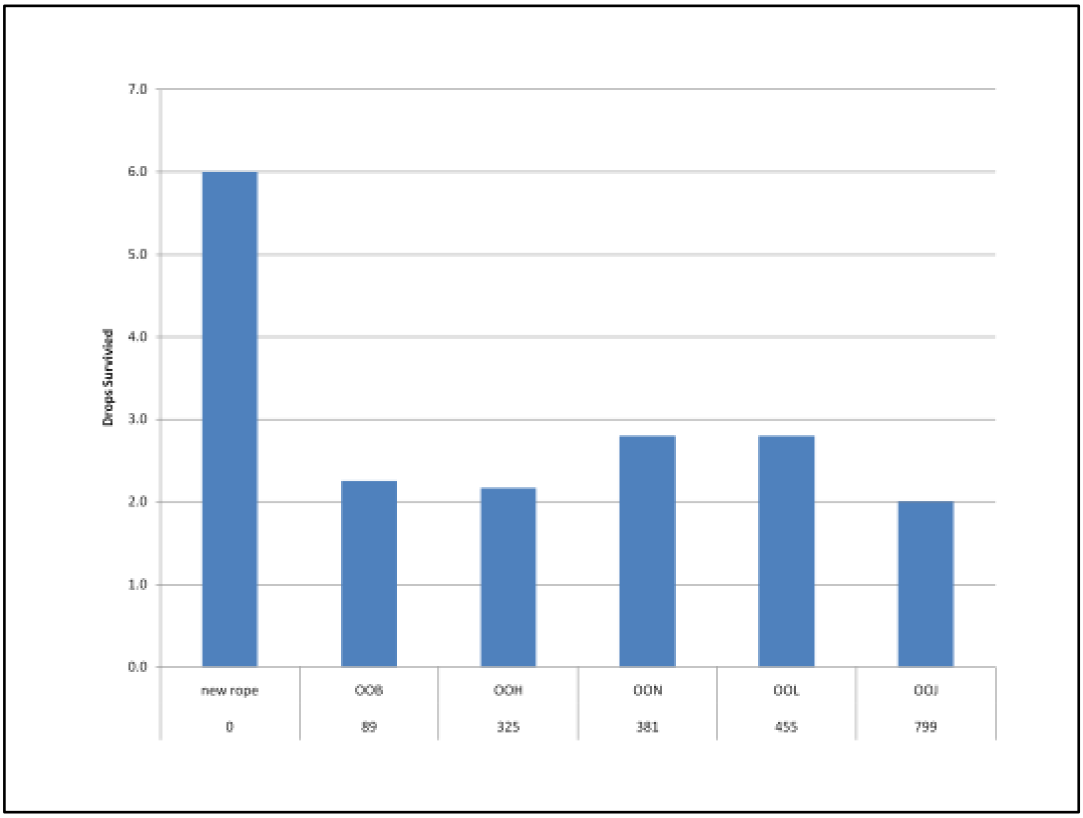
Marks on rope These did not seem to make any difference to the survival rating as the sample with the glaze is number 5.
I also noted this same sample when looking and feeling the rope felt slightly oval.



For same rope; showed moderate variation, more than expect from new rope



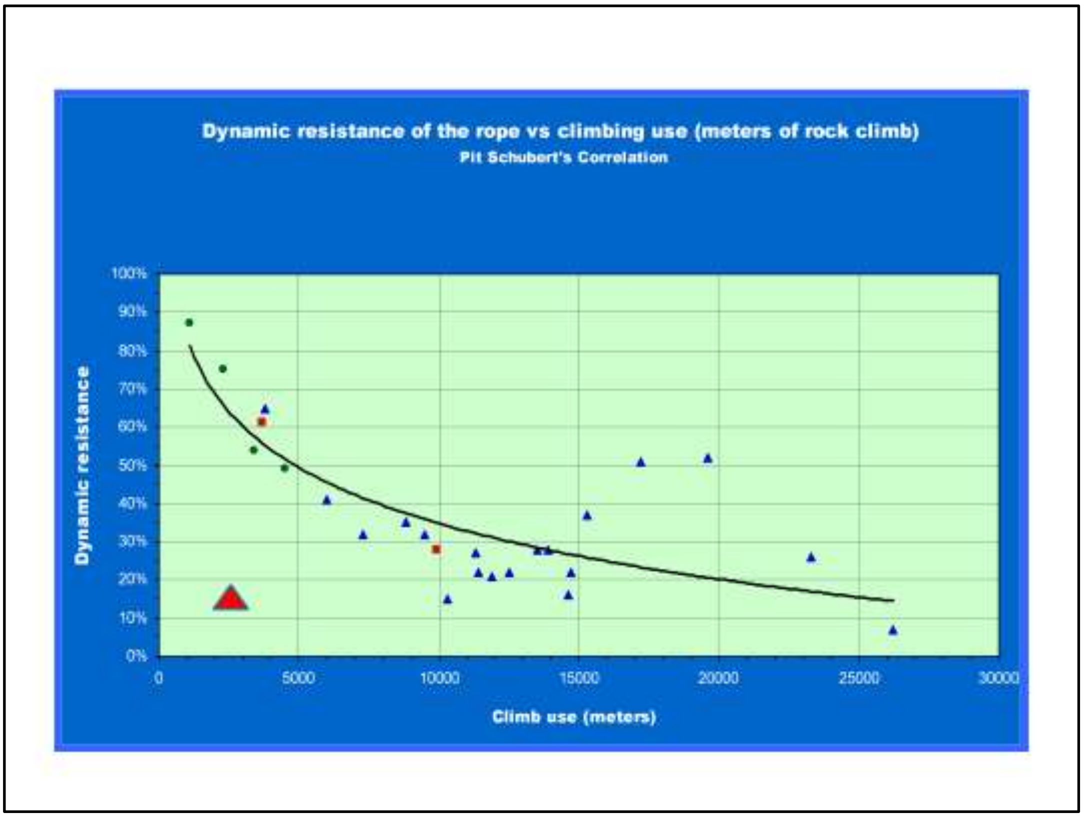
Loaned out seven ropes one not traced, another lost. So have 5 returns. Variable length as one rope returned in 3 parts, another lost part following being cut by dropped boulder.
This is plot of all samples returned
Note wide span of usages from new ie zero to 799



This is the average of the drops survived shown in increasing level of usage
Startling all used ropes down to around 2 drops survived on average

Comment about time from purchase in Sept 2000 being around 8 years in all
Note usage within two & half years.
Ropes stored in dark loft until tested

So some concern that only 80 usages in albeit 8 year old rope causes ropes capacity to survive drops reduced to 2.



This is Pat Schubert's & Giuliano Bressan's work on climbing ropes which also shows precipitous drop at start of life.
Note believe the horizontal climb use is essentially if one used a 50m rope on a 50m climb, then climbing use is 50m.
By comparison our 80 usages of 30m long rope means 2400m or just half way along first interval.
The vertical Dynamic Resistance parameter is based how the rope reduces in capacity to survive FF 1.0 drops.
So if when new it survives say 20 drops, and then after so much use it survives say 10 drops,
its dynamic resistance has dropped to 50%

Difficult to equate our incremental FF approach to this.
Based on an old data sheet that rope was good for at least 12 drops,
Then we are looking at dynamic resistance of around 15% and probably less
Where red triangle is located

So our work shows much worse impact than Pit's work .