Carabiner Wear and Strength Reduction in Old Carabiners
Anecdotal Test Results

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Abstract: *Seven old and severely worn or abraded carabiners (four oval and three HMS type) were tested to failure. Each of the carabiners had been retired from active service 13 years prior to testing due to obvious signs of external wear. Given the extent of wear, each of the carabiners retained a surprisingly high breaking strength. Although the results are interesting, no conclusions regarding carabiner wear or retirement should be drawn from these tests.*

Tests were conducted at the Surety Manufacturing And Testing Ltd. test facility in Edmonton, Alberta on a Lucker Custom test bed using ADMET digital force measuring equipment. The test equipment was calibrated and certified in June 1999 to tolerance levels of + / - 1%. Test materials and carabiners were provided by Cyril Shokoples. Tests were supervised by Morgan Neff. Test were conducted on seven carabiners on March 29, 2000.

Four of the carabiners were non - locking oval types and three were locking HMS or "Munter" types. The HMS carabiners were of a UIAA certified design. In July 1987, these carabiners were subjected to a wet, highly abrasive environment during a four day rappel exercise at a Boy Scout Jamboree. It is estimated that each carabiner had approximately 250 cycles of rope run over them during this event with 25% percent of those while the ropes were wet and abrasive. Ropes containing large quantities of imbedded sand particles were run over the carabiners while under load. This resulted in deep scoring or abrasion of each carabiner. Immediately following this event, the carabiners were retired from active service and had been stored for nearly 13 years.

Four tests were done on SMC brand aluminum oval carabiners that were purchased in the mid to late 1970s. Due to minor but noticeable design differences, it was evident that the carabiners were from at least three different batches or production runs and of different ages. The carabiners had never sustained any falls and other than the obvious wear where the rope had abraded, appeared to be in good condition. It is difficult or impossible at this point to ascertain (with any certainty) the exact age of any of the carabiners or their original rated strength, although similar carabiners of the era were rated with "minimum" breaking strengths of from 3500 to 4000 lbs.

Thickness or "diameter" of an undamaged section of each carabiner was measured with calipers and compared to thickness of material in the most deeply worn area. A very rough approximate wear percentage was estimated from these figures.

Breaking Strength	rod diameter (inches)	worn thickness	% wear	comments	test #
3930 lbs.	.406	.373	9%	gate failure then carabiner bent open, newest design, least wear	50246
3880 lbs.	.433	.353	18%	gate failure followed by spine failure	50243
3850 lbs.	.418	.344	18%	gate failure followed by spine failure	50244
3540 lbs.	.409	.312	24%	gate failure followed by spine failure, worst overall wear	50245

It is interesting to note that none of the carabiners failed at the actual site of the wear. Similarly it is of interest that the greater the amount of wear, the lower the breaking strength. Since gate failure is the precursor to overall failure in all of these tests, one may speculate that the greater the wear on the carabiner, the quicker the carabiner deformed and placed load on the gate, leading to premature failure. Unfortunately, since the carabiners would appear to have come from different production batches and the sample size is minute, it is truly speculative that this correlation exists. Without a control group as a standard of comparison, it is impossible to relate these breaking forces to what would be expected of an undamaged carabiner.

The final three tests were done on locking aluminum HMS or "Munter" carabiners that were purchased in the early 1980s. Two of the carabiners were Grivel brand and one was Kong - Bonaiti brand. Despite the different brand markings, it externally appeared that all three carabiners were of "identical" design. All were stamped as being UIAA approved. All had ratings of 2250 kg in the major axis and 700 kg in the minor axis stamped on the body. (This correlates with approximately 4900 and 1540 lbs. respectively.) The carabiners had never sustained any falls and other than the obvious wear where the rope had abraded, appeared to be in good condition. It is impossible to ascertain the true age of the carabiners.

Each of the two most worn carabiners were tested in the major axis with the load being applied in the centre of the large radius where the Munter hitch would run, so as to load the spine and gate of the carabiner relatively equally (insofar as possible). The least worn carabiner was tested along the minor axis.

Breaking Strength	**rod diameter (inches)**	**worn thickness**	**% wear**	**comments**	**test #**
4800 lbs.	.483	.427	12%	gate failed then carabiner bent open	50247
5220 lbs.	.465	.443	9.5%	gate failed then carabiner bent open	50248
2290 lbs. (+/- 5%)	.468	.447	4.5%	gate failure, least wear, load applied along minor axis	50249

As with the oval carabiners, none of the HMS carabiners failed at the actual site of the wear. Once again, anecdotally, the greater the amount of wear, the lower the breaking strength. Failure in all cases was at forces very near those stamped on the carabiner, however, that is not to say that the carabiners would not have withstood an even greater load had they not been damaged.

Summary: Seven heavily worn carabiners were tested to determine breaking strength after significant local abrasion. Although a common - sense pattern seems to emerge of "greater wear = lower breaking strength", it should be stressed that the small sample size and lack of a control group of undamaged carabiners of the same type and vintage makes proper statistical treatment impossible! It is premature to guess what amount of wear may be acceptable based on these tests alone. A prudent suggestion would be that once wear becomes easily palpable and visually noticeable a carabiner should be retired, even though it may still retain a significant portion of it's rated strength. These tests should be used for general interest and entertainment value only, not to form recommendations upon which your life may depend. They would best be published in the "Journal of Irreproducible Results". Climb safe! cS