# Comparative evaluation of hold and release characteristics of various springlock tethering systems allowing one-handed operation

Stéphane Dupont, Ph.D., August 2005

## Abstract

One-hand-operated springlock systems perform better if they release the cord easily when it is pulled by the user (operate mode) and hold it tight when at rest (hold mode). The weights needed to release the cord in both modes were determined for various commercial (A, B, C, F) and experimental (D, E, G) springlock tethering systems. System A used a thin ribbon tether loop threaded through the springlock's eye; B, a thicker cord tether loop also through the springlock's eye; C, a ribbon tether loop though dedicated slots at the bottom of the springlock's barrel; D, a new ribbon cage system developed by the author; E, a variant of system D suitable for use with grommet-protected cord holes (systems D and E are described in detail elsewhere); F, a new integrated springlock and grommet system from ITW Nexus called the SurMount Cordloc; and G, another system developed by the author based on a modification of the springlock allowing it to be tethered from the top. In the hold test, systems A to E released at about the same weight (2148 g, on average). The holding capacity of the SurMount system was higher and that of system G somewhat lower. The release thresholds of systems D, E, G, A, B, F and C in operate mode were 46, 47, 52, 79, 87, 105 and 228 % of the corresponding hold thresholds, making D and E the most effective and C the least effective systems in terms of release characteristics. While offering markedly better performance, systems D and E are somewhat more complicated to install than the commercial systems, although minor modifications in springlock construction could make them much easier to install. Similarly, a modification equivalent to system G could easily be implemented on commercial springlocks. Systems A and B were as easy to install as C but were 2.7 times more effective in operate mode. The SurMount system was the easiest to install. An additional test specific to this system, aiming to mimic an upside-down installation on a backpack drawcord yielded a much lower operate threshold than the standard test (64% of the hold threshold).

## Introduction

Springlock systems that can be operated with one hand are common on elastic drawcord closures of technical garments (jacket hoods, waists and hems, overmitts, etc). They make tightening the drawcord easier, simply by pulling on the cord until the springlock releases. They also simplify opening a drawcord closure. Without a tether, this often requires two motions: one to slide the springlock down the drawcord and another to manually expand the cord casing. With a tether, both actions can be done in a single motion. In addition to offering one-hand operation capability, keeping the springlocks tethered also keeps them from whipping about at the ends of their cords in strong winds and, of course, the user always knows where to find them. With overmitts, one could not have an adjustable cord closure at the cuff without some sort of one-handed tighten-and-release system.

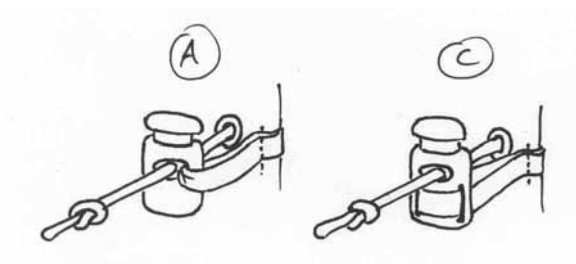



Figure 1: Examples of commercial springlock tethering systems

There are many mentions of one-handed springlock systems in garment descriptions, although web pages rarely provide a detailed view of the mechanism. Based on an extensive tour of outdoor stores in the Montreal (Canada) area in the fall of 2004 and winter of 2005, it appears that most brand-name systems are made of a simple loop of grosgrain ribbon, fabric strip or cord passing either through the springlock's eye or through one or two dedicated slots at or near the bottom of the springlock's barrel. The ends of this loop are typically sewn near the hole or grommet where the drawcord comes out of its casing (Figure 1). In a few cases, the springlock is a very small one. In other cases, it is replaced by some other friction mechanism (rubber cylinder, foam “accordion”, etc.). This tour revealed no one-handed tighten-and- systems on top skirt closures of backpacks or stuffsacks even though the advantages of such a system would be quite significant in these types of applications.

The company ITW Nexus also makes a one-hand operated system where the springlock is permanently attached to a snap-together grommet that provides the anchoring (the SurMount Cordloc). At this point, this system is only available for bulk purchase and has not yet been observed on any commercial equipment or garment.

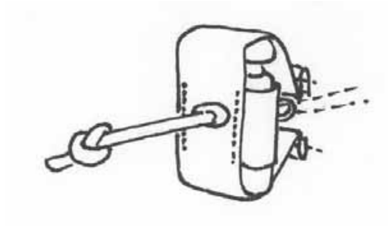


**Figure 2 : Springlock cage system**

Starting in the spring of 1998, the author developed different one-handed springlock systems, some that aimed to more closely mimic the action of the user's fingers when releasing a springlock (the springlock "ribbon cage" system, as shown in Figure 2), others that take advantage of the position adopted by the springlock when the cord is being pulled to facilitate its release (e.g. system G, shown in Figure 4). Both appeared to function better than the existing commercial systems. The springlock cage system is described in greater details in the springlock cage instructions document also available on the web site http://www.kiddiesgames.com/jacketinserts/. The new designs appeared to allow the release of the springlock at much lower pull forces than the standard systems. The cage system was originally conceived for the elastic hood closure of an anorak but was also successfully installed on static cord closures on other equipment (insulated water bottle holder, backpacks, etc.). This paper reports on a series of tests run to evaluate the hold and release characteristics of various one-handed springlock tethering systems in controlled, side-by-side comparisons, looking particularly at the standard commercial systems, the new SurMount Cordloc from ITW Nexus (the larger of the two sizes available), two variants of the springlock cage system, and the top-tethering system, developed by the author.

## Materials and Methods

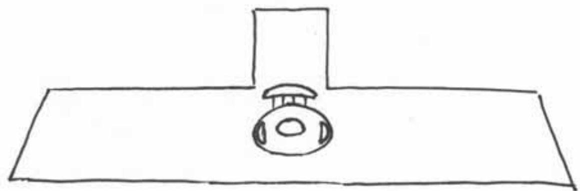


**Figure 3**

Tethering systems A to E and G were sewn onto strips of polyurethane-coated nylon packcloth, 4 X 17 cm with a 5-6 mm diameter hole burned in the middle with a hot nail. In systems A, C and G, the tether was made of 9 mm (3/8 in.) grosgrain ribbon. In system B, the tether was made of 3 mm climbing accessory cord. Cage systems D and E were made with 13 mm (1/2 in.) grosgrain ribbon, as described in the springlock cage instructions document mentioned above. The large SurMount system was clipped directly on wider, oval holes on inverted T-shaped pieces of packcloth, as shown on Figure 3. The different fabric shape was used to perform both the standard hold and operate tests described below as well as an additional operate test specific to the SurMount system.

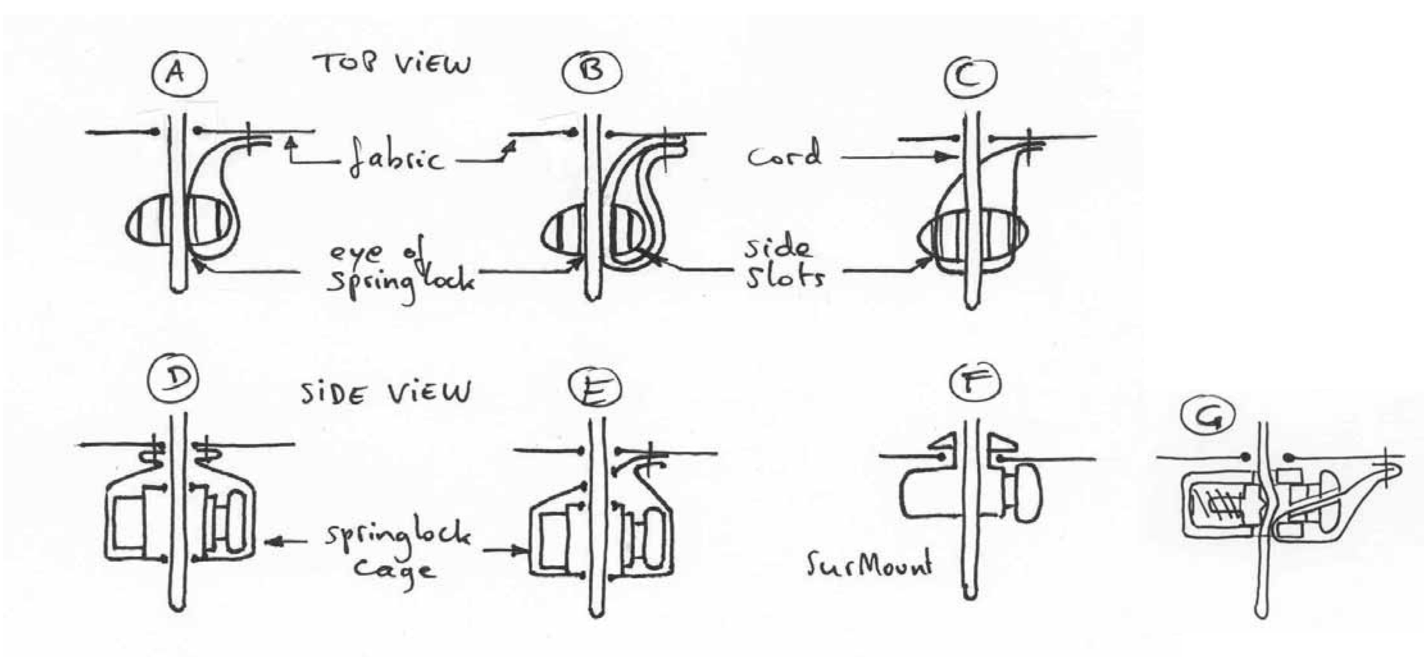



**Figure 4 : Schematic representation of the various one-handed springlock systems**

System G required cutting and filing a diagonal slot through the top of the springlock's piston, wide enough for the grosgrain ribbon tether to pass through, as shown in Figure 4. The other systems tested are also described in Figure 4. All systems except the SurMount used regular springlocks purchased at the same time from the Mountain Equipment Co-op (MEC) store in Montreal. Although information concerning their manufacturer could not be obtained from the MEC, the springlocks look identical to the ITW Nexus Toaster model (see http://www.itwnexus.com/cord-locks.html) but are apparently manufactured in Canada. MEC calls them "Toaster Ellipse", which is reminiscent of the ITW Nexus nomenclature. Like the Toaster, they are shipped in the locked-open configuration from which they are permanently released with the first squeeze. The springlocks used for this test had been released from their locked shipping configuration (i.e. their spring was left fully extended) for at least 2 months prior to the test. Each springlock was fully squeezed and released 10 times just prior to the experiment. In order to try and account for possible unit-to-unit differences in holding capacity, two springlocks were tested for each system except for system G for which only one springlock was made.

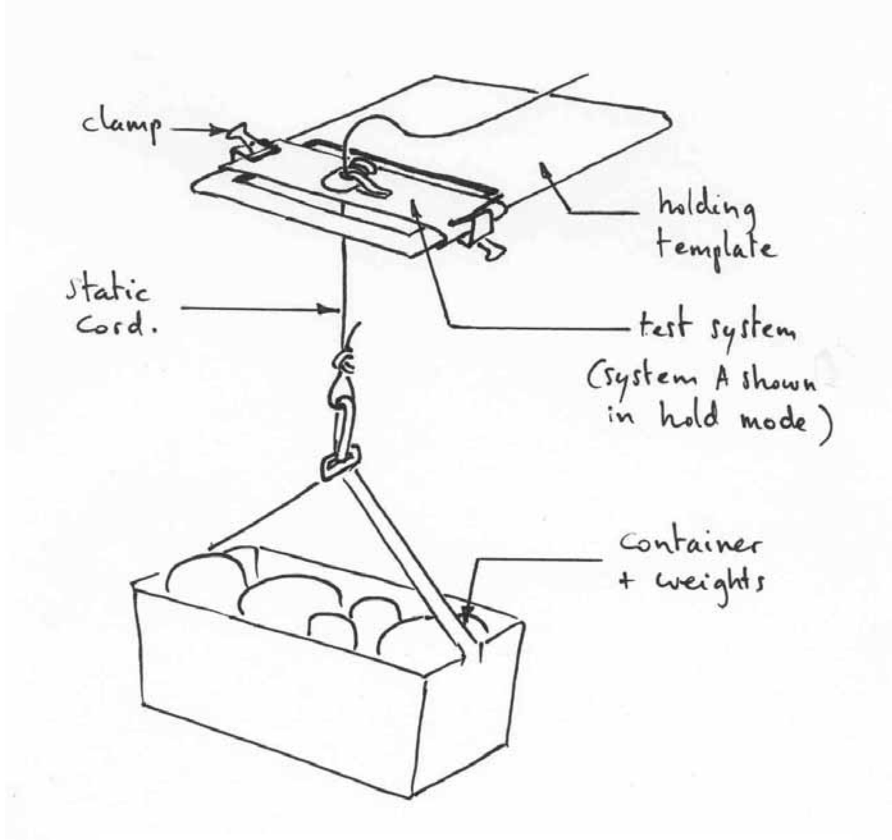



**Figure 5 : Schematic diagram of test system**

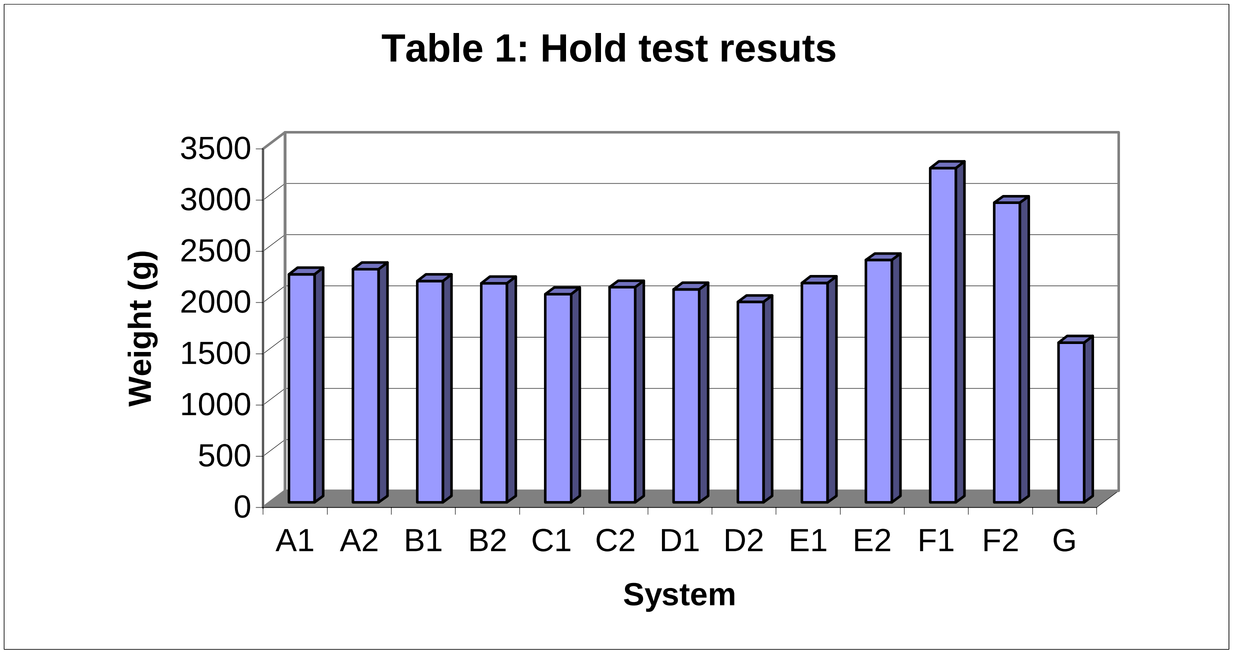
In the standard experiments, the fabric strips were stretched and clamped over a horizontal holding template, with the springlock either on the underside for an "operate" test or on the top side for a "hold" test. The springlocks were then threaded through the eye (and, in the case of systems D and E, also through the appropriate holes in the cage systems) with the same length of 3 mm static climbing accessory cord, as shown in Figure 5. A plastic container attached to the cord was progressively loaded with weights until the springlock released and the container dropped. The final addition of weight was done with grains of dry corn. After each release, the container was weighed. Three replicate release-and-weighings were performed for each springlock/tether system in both the operate and hold configuration, in random order.

The static cord was used in preference to an elastic one to minimize variability factors due to stretch (of core and of sheath), softness (or "squeezability"), etc.

The additional experiment with the SurMount system was designed to determine its release characteristics in the operate mode when the system was held at a specific angle to the cord, as shown in Figure 7a. This position was used to approximate a situation where the system would be installed in an inverted position on a backpack drawcord closure (Figure 7b).

## Results and Discussion

Ideally, a one-hand-operated springlock system would require a low activation tension for operating (i.e., the tension that, when applied to the cord, will cause the springlock to release it) while letting the springlock apply the highest possible holding force to the drawcord when it is at rest. Therefore, the most effective systems, as determined by the tests reported here will be the ones with the lowest "operate" weight thresholds combined with the highest "hold" weight thresholds. Table 1 shows the weight (mean of 3 replicates) causing the release of each springlock system in hold mode. These weights were equivalent in systems A to E (1900-2300 g, with an average of 2148 g). The SurMount system had a greater holding capacity (about 3100 g), owing to a slightly different springlock design and construction. In system G, the holding capacity of the springlock was only 73% of the average normal capacity seen on systems A - E (1560 g). This was likely due to threading the tether through the springlock's eye, which reduced the friction applied to the cord.




Important variations were observed in the weights causing the release of the cord in the operate tests. To allow comparison between all the systems, the release thresholds in operate mode were expressed as percentage of the corresponding hold thresholds (Table 2). The percentages for systems D, E, G, A, B, F and C were 46, 47, 52, 79, 87, 105 and 228 %, respectively. Therefore D and E were the most effective systems in terms of release characteristics, with an average operate threshold of 927 and 1050 g, respectively. System E was developed as an alternative to D for applications where a grommet is used to reinforce the hole in the fabric (see springlock cage instructions document for details). Systems A and B, with an average operate threshold of 1790 and 1866 g, respectively, were only marginally easier to release in the operate mode than in the hold mode. The SurMount system was marginally harder to release in the operate mode. However, its operate threshold of 3238 g cannot be compared directly with those of the other systems because the springlock component of the SurMount system holds significantly tighter by design than the standard springlocks used in these systems.

System C had a very high release threshold in the operate mode, at and average of 4715 g, or over twice as much as the normal release threshold of the standard springlocks in the hold mode and five times as much as the release threshold of system D in the operate mode. This is likely due to the tether loop holding the springlock's barrel near its bottom. When the cord is under tension, the springlock aligns itself in the direction of the pull, adopting an angle that forces the cord to pull against the top edge of the eye of the barrel, thus greatly increasing the weight required for release (see Figure 6a). Several other springlock models have also been observed on commercial garments and in suppliers' catalogues that are specifically designed to allow the springlock to be tethered from the bottom. These could be expected to behave in the same manner as system C, displaying very high release thresholds in the operate mode.

While system G was essentially as effective as D and E in the operate mode, its lower holding capacity would probably reduce its usefulness in applications where the springlock needs to resist a high tension (e.g. backpack closures). This capacity should still be high enough for garment applications where the cord tensions are typically lower. However, the main point demonstrated by system G is that low operate release thresholds can be easily achieved when the springlock is tethered from the top instead of the bottom. In these situations a pull on the cord translates as a pull down on the lower edge of the piston's eye, which helps release it, as shown in Figure 6b.

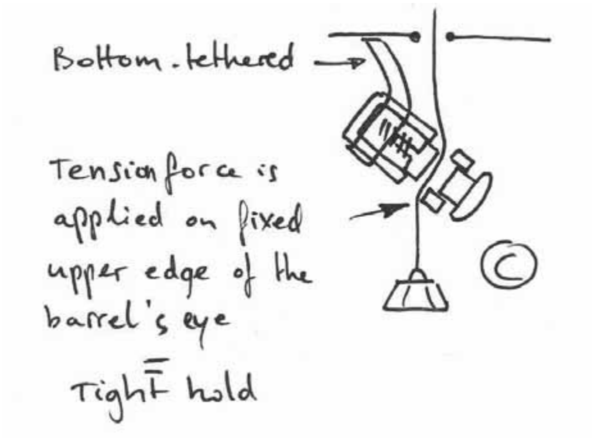



Figure 6a

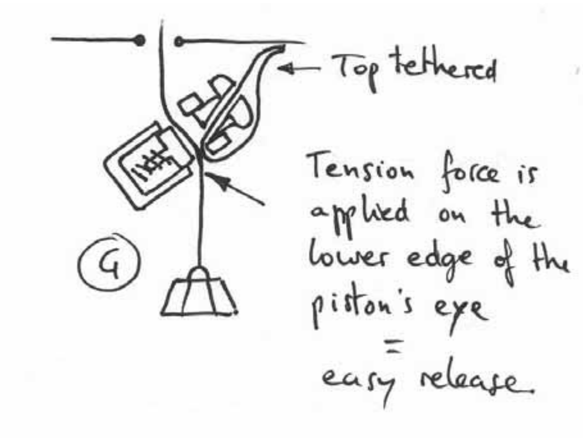
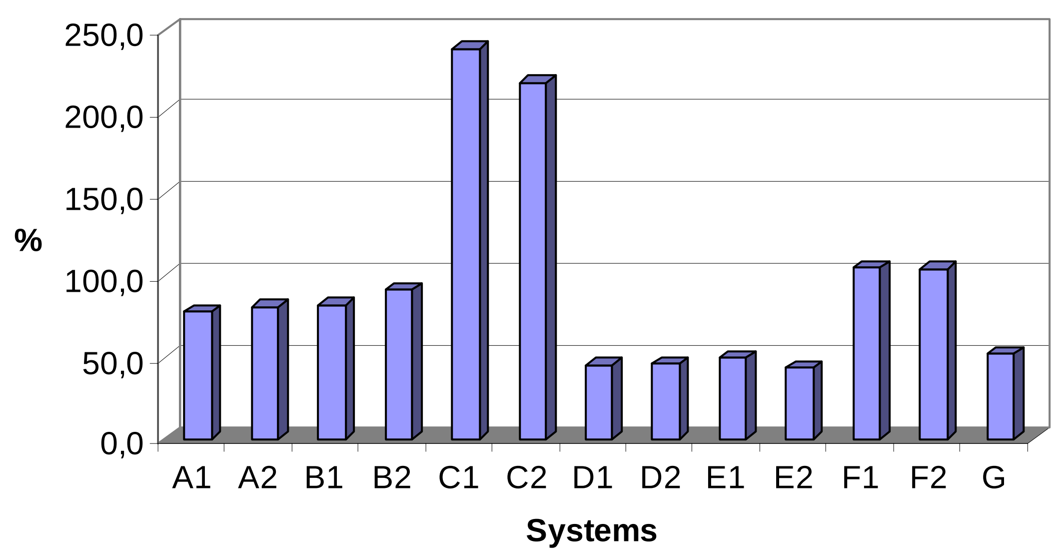



Figure 6b

The additional test performed on the large SurMount systems in the configuration shown in Figure 7a aimed to take advantage of the rigid grommet attachment to place the springlock in a position resembling that of system G. This position is more easily achievable on more “rigid” or “taut” applications such as backpack drawcord closures where the weight and shape of the pack will help keep the system in the correct position. In “softer” applications, such as jacket hood drawcords, pulling on the cord will typically align the system perpendicular to the cord, as in the standard tests. It should also be noted that in a commercial application, the oval shape of the clip-on grommet would be insufficient to keep the SurMount system pointing down as shown on figure 7b if clipped only to a single layer of fabric. Stitches or some sort of reinforcement would probably be needed to keep the unit from swiveling. The forced angled configuration of this additional test did yield lower operate release thresholds than in the standard configuration (61 and 66 % of the corresponding hold thresholds for F1 and F2, respectively). This helped validate the single result obtained for system G and indicated that in certain applications, attention should be paid to the orientation of the SurMount's springlock. For example, on a backpack drawcord that will normally be pulled up when used one-handed, installing the SurMount system in an inverted position, with the piston pointing down would generally yield better release characteristics, wherereas installing it right side up will yield a configuration resembling system C and the release characteristics will likely be much poorer.

**Table 2: Operate thresholds as % of hold thresholds**



Genuine Toaster springlock samples were later obtained from ITW Nexus. Close visual inspection revealed no appreciable difference with the springlocks used in the main tests. Toaster units were installed in a system C configuration and in a system D cage. Hold and operate tests run on these confirmed the main findings of the equivalent tests run on the MEC-purchased units.

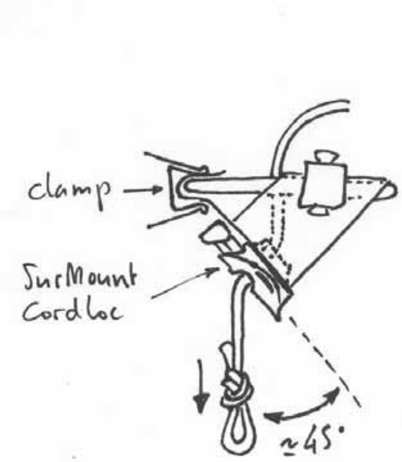



Figure 7a

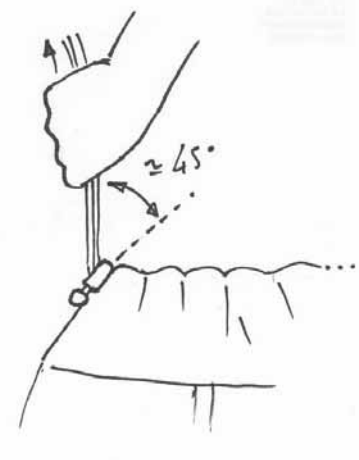



Figure 7b

## Conclusion

Based on these results, it appears that tethering a springlock with a loop through a dedicated slot or anchor point located below the eye is a relatively ineffective way to hold it in place for one-handed operation. Since there appears to be no time or material savings involved in installing this system on commercial garments, compared to systems whose tether loops are threaded through the eye of the springlock (e.g. systems A and B), it is difficult to see any advantage to using bottom-tethered systems.

Top-tethered systems could easily be designed by springlock manufacturers. One such option was demonstrated by system G although in this system, repeated friction from the cord may result in accelerated wear of the ribbon. Another option would be to add a horizontal tether anchor bar at the top edge of the springlock's barrel (Figure 8). This should provide low operate release thresholds without reducing the holding capacity of the springlock.

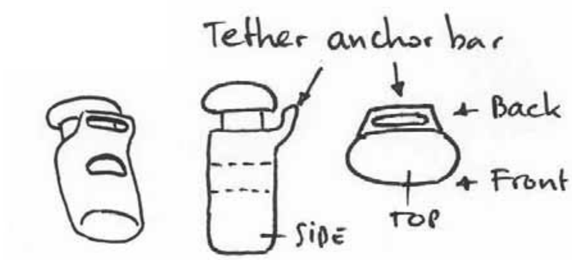



Figure 8

Systems D and E, while the most effective, are also somewhat more complex to install than the other systems when the full cage system must be sewn. This would probably act as a disincentive to garment and pack manufacturers. Again, simple modifications of the standard springlock design could greatly increase ease of installation while maintaining optimum operate release characteristics (e-mail me if you wish to discuss these modifications). Other tests not reported here indicated that systems D and E also work well with many other kinds of springlocks (rectangular ones, cylindrical barrel-locks, etc.) on a wide variety of applications. Based on the author's field experience, their use on jacket hoods and backpack closures makes opening and closing them much faster and easier.

In terms of ease of installation, system F is the easiest of the systems tested, provided the cord can be installed and threaded though it before finishing the cord casing. The raised profile of the grommet clip on the inside, combined with the fixed springlock on the outside, would make it somewhat difficult to thread the cord through this system after the cord casing has been closed up, particularly with narrow casings. Given that the overall holding capacity of this system is relatively high, there would probably be advantages to adopting this new system, particularly for static cord closures requiring a high resistance to cord slippage in hold mode, such as backpack drawcord closures. However, in such applications, different orientations of the system may result in large differences in the release characteristics. Care should be taken to install the SurMount system so as to facilitate, rather than hinder, the release of the cord in operate mode.

One aspect that has not been tested here is the rate of wear caused by the various springlock systems on the cord itself. However, it may be expected that systems displaying lower operate thresholds would also cause less wear on the cord than those displaying higher thresholds, which may be seen as another advantage for systems with low operate thresholds.

**Acknowledgement:** I thank ITW Nexus for providing free samples to test.