Belay Device Friction Test

	Overall	8mm Rope	10mm Rope	11mm Rope	Weight
Trango Jaws	8.9	8.9	8.3	9.6	8.5
Metolius BRD Belay Rappel Device	8.9	9.6	9.0	8.6	5.9
Black Diamond ATC XP	8.7	9.2	8.6	9.0	4.1
Omega Pacific SBG II	8.7	9.3	8.0	8.9	8.2
Petzl Reverso Belay Device	8.7	8.6	9.2	8.7	6.5
Black Diamond ATC Guide	8.6	9.2	8.5	8.8	2.6
DMM V-Twin Belay Device	8.5	8.3	9.4	8.0	5.7
Petzl Reverso 3	8.5	8.6	7.3	9.8	7.7
DMM Bug	8.2	7.2	9.5	8.1	6.4
Black Diamond ATC	8.2	8.5	7.6	8.3	10
Trango Pyramid	7.3	7.3	7.1	7.1	9.6
Trango B52	7.1	7.9	6.8	6.4	9.6

How the test was performed?
A locking carabiner was clipped to a bolt and each belay device was attached to the biner. The rope was passed through the belay device. The slack on the “climber” side of the device went around a pulley and was attached to a 50 lbs weight. The weight and the pulley allowed the belay device to feed and settle naturally. The “hand” side of the belay device was attached to a spring scale to measure the force.

The force on the spring scale was recorded. This test was repeated 10 times (resetting the slack on the “hand” side between each test). After doing ten feed tests, the spring scale was moved to the lower lock-off test position and ten more tests were performed.

We also measured the weight of each device.

12 comments have been added to this test. Read / Add Comments.

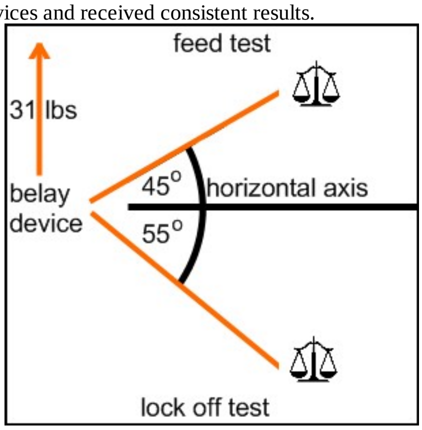
More than a dozen “tube style” belay devices are on the market. Each device is safe, at a similar price point, and lighter than a Big Mac. So the question is, what sets them apart? We believe two key factors that distinguish belay devices are the range of friction the device can provide as well as the maximum friction it can achieve. You want low friction when feeding the rope and high friction when locking-off. If you are new to belay devices please read our Belay Devices 101 article first.

Method
We measured the friction each device creates at 45 degrees above the horizontal axis (feed test) and 55 degrees below it (lock-off test). These measurements were taken on 8, 10 and 11mm ropes. Ten results were taken for each scenario (60 total tests per belay device: each of the three ropes was tested at two angles, 10 times per angle).

What we tested?
We tested all "popular tube style belay devices". This is defined by belay devices that are sold by at least 5 online retailers. All belay devices were purchased from retailers (not the manufactures) at full price.

Tester Comments
This test does not give belay devices any credit for auto-blocking or dual friction features which should be considered especially for multipitch climbers. For multipitch climbers, I strongly recommend an auto-blocking device predominately for use as an emergency ascender. Dual friction devices are especially useful at the local sport crag.

Details
- The same section of rope was used for each test.
- The tests were weighted for 20 seconds before the scale was read.
- 50 lbs of weight (two-25lbs plates) was used but was passed through a pulley, decreasing the direct weight (to the belay device) to 31 lbs.
- The belay slot (all the belay devices that we tested have 2 slots) farthest from the wood backdrop (closest to the tester) was always used.
- For each test the weight was lifted, 2 inches of slack was pulled through the device towards the scale, then the weight was dropped and allowed to settle naturally.
- We re-tested the belay device that was tested first after ten other belay devices and received consistent results.
- If the device had multiple friction modes, the high friction mode was used.



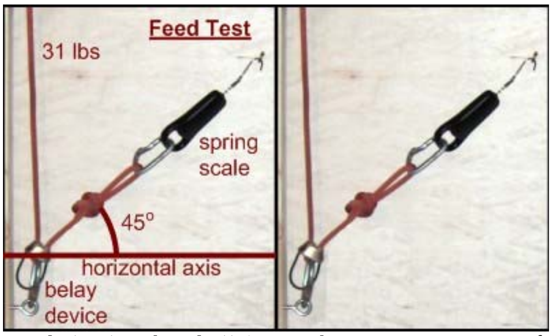
Equipment

- 11mm Rope – Bluewater Enduro; 10mm - Edelweiss Flashlight 10; 8.1mm – Beal Ice Line.
- Pulley - Petzl Swing Side pulley.
- Locking Carabiner - Black Diamond Rocklock Twistlock. We used the twistlock model so all carabiners were shut the same way.

FAQ
- Does this test tell you if a belay device is safe or not? No. Other organizations test if gear is safe. Spadout's goal is not to replicate these tests. Our goal is to help climbers determine which device is optimal for their equipment.
- Why wasn't 90 degrees or -90 degrees recorded? 90 degrees (both ropes perfectly vertical) removes almost all friction provided by the belay device. Therefore results are not dependent on the belay device. -90 degrees would require you to lock off between your legs. We don't recommend this. Also as an interesting side note, almost all the belay devices could hold the entire weight if we just allowed the 3 ounce scale to hang at -90 degrees (when the 10 or 11mm rope was used).
- Why was 45 degrees selected for the feed test? Most climbers belay the majority of the time with their palm down. This is a common maximum feed angle that would be used with your palm down. Exceptions do exist including belaying with an auto-locking belay device on stiff gym ropes but that is beyond the scope of this test.
- Why was 55 degrees selected for the lock-off test? The majority of climbers belay by connecting the device to a carabiner connected to their belay loop. A typical climber who brings the rope all the way to their side will achieve approximately 55 degrees. Exceptions include extending your belay loop with slings, but this is mainly used while rappelling long distances.

- Why were 8,10 and 11mm ropes selected? 11mm ropes are still common in gyms. 9.8-10.5mm ropes are common at crags. 8mm ropes are common for alpine.

Converting the Raw Data



For readability we wanted to convert all the raw data (available at the bottom of the page) into one value per rope diameter. Therefore, all the lock-off test values were converted to a relative value by (11-[value]/[minimum value]). All the feed test values were converted to a relative value by ([value]/[maximum value]*10). We weighted the lock-off test value 3 parts and the feed test value 1 part (easily stopping a fall is more important than feeding rope). The final overall value was ([lock off relative value] * 3 + [feed relative value] * 1) / 4.

To calculate the overall value we gave each of the diameters values a weight of 8 and the device's weight's value a weight of 1. So therefore it was (8*(8mm value + 10mm value + 11mm value) + (weight value)) / 25. With a maximum variance of 41 grams we decided that the overall value should be minimally affected by the device's weight.

Raw Data
Columns with an "L" are lock-off values. "F" is for feed values. All values are in pounds except weight which is grams.

	11mm L	11mm F	10mm L	10mm F	8mm L	8mm F	Weight (g)
Black Diamond ATC	1.74	10.3	2.29	9.18	6.59	16.51	60
Black Diamond ATC Guide	1.27	9.65	1.72	9.28	5.16	16.42	101
Black Diamond ATC XP	1.21	9.86	1.68	9.36	5.17	16.48	93
DMM Bug	1.45	7.21	0.96	9.76	6.21	13.02	83
DMM V-Twin	1.51	6.96	0.78	8.7	6.13	15.44	86
Metolius BRD	1.37	9.07	1.18	8.91	4.57	16.69	85
Omega Pacific SBG II	1.63	8.98	1.56	9.94	5.25	13.63	77
Petzl Reverso	1.34	9.31	1.58	10.9	6.21	16.31	82
Petzl Reverso 3	0.6	9.13	2.37	7.74	5.93	15.99	78
Trango B52	3.69	15.66	3.94	11.56	6.14	17.67	70
Trango Jaws	0.68	9.15	1.03	6.44	5.64	16.31	76
Trango Pyramid	2.41	9.36	2.69	8.24	7.34	14.5	71

Post-Test Analysis

Though lifting a 50 lbs weight 720 times in one 11 hour testing marathon got old I'm very pleased with the results. The final goal was to narrow the results down to one relative value for each rope diameter. The reasoning for this is that new climbers can look at this data an easily determine which devices are optimal for their rope. In any test setup simplification is obviously necessary to make the data quickly readable. I would strongly encourage more experienced climbers to analyze the data in greater detail.

I have made all the raw data easily available in CSV (opens in Excel or any similar application): Download Raw Data (right click, "save as").

Don't forget when interpreting the raw data that these values are in pounds and are measurements displayed by the spring scale. So a higher lbs value means lower friction and vice versa (because lower friction will transfer more of the force to the spring scale).

Our equation gives the lock off force lots of weight, the feed force very little and the device's weight almost nothing. These numbers are optimal for a new climber because feeding the rope extremely fast isn't necessary and an easy lock-off is critical. Experienced climbers who are confident catching falls may be interested in lower friction when feeding rope (so they can aggressively feed and take in slack) and therefore may be willing to trade some lock-off friction for a lower feed friction.

I'd also like to re-emphasize that this test gives no value to auto-blocking and dual friction devices. The reasoning for this is that I only wanted to test values that could be calculated and truly unbiased. You could argue that for dual friction devices we should have measured the lock-off mode in high friction mode and feed mode in low friction mode. My counter argument is that this setup is impossible during one belay / rappel making it an unrealistic setup. So weight these elements as you see fit.

My personal opinion: I'm a sucker for simplicity. The ultra-simple Metolius BRD (shown on the right) was really a shocking find and I'm adding this to my personal collection. With no “teeth” or “high friction modes” it locked off as well as most of the “decorated” models while still allowing a low friction feed.