## Soft/Hard Shackle Comparison Data

**Table 1:** Soft shackle testing for different knot styles using 3/16 in Amstel Blue rated at 5400 lbf) was preloaded to 2000 lbf and increased between two hard 5/8in shackles until failure (BalanceCommunity Slackline Outfitters).

| Group | Sample 1 | Sample 2 | Sample 3 | Sample 4 | Sample 5 | Average | % Line Strength |
|---|---|---|---|---|---|---|---|
| **Spliced Loop** | 5,150 lbf (22.9 kN) | 4,796 lbf (21.3 kN) | 5,708 lbf (25.4 kN) | 6,124 lbf (27.2 kN) | 5.874 lbf (26.1 kN) | **5,530 lbf (24.6 kN)** | **102.41%** |
| **Diamond Knot** | 8,000 lbf (35.6 kN) | 8,200 lbf (36.5 kN) | 6,800 lbf (30.2 kN) | 7,800 lbf (34.7 kN) | 6,900 lbf (30.7 kN) | **7,540 lbf (33.5 kN)** | **139.63%** |
| **Better Diamond Knot** | 8,800 lbf (39.1 kN) | 6,800 lbf (30.2 kN) | 8,700 lbf (38.7 kN) | 7,400 lbf (32.9 kN) | 8,200 lbf (36.5 kN) | **7,980 lbf (35.5 kN)** | **147.78%** |
| **Button Knot** | 13,500 lbf (60.1 kN) | 12,100 lbf (53.8 kN) | 12,000 lbf (53.4 kN) | 10,000 lbf (44.5 kN) | 13,000 lbf (57.8 kN) | **12,120 lbf (53.9 kN)** | **224.44%** |
| **Big Overhand Knot** | 11,300 lbf (50.3 kN) | 13,500 lbf (60.1 kN) | 11,500 lbf (51.2 kN) | 13,000 lbf (57.8 kN) | 7,000 lbf (31.1 kN) | **12,325 lbf (54.8 kN)** | **228.24%** |

The soft shackle producer, BalanceCommunity Slackline Outfitters recommended diameters between ¼ in (6mm) and 5/16 in (8mm) using Amsteel Blue line. The strength of the soft shackle "relies heavily on the knot and the diameter of the body where the noose wraps around" (BalanceCommunity). Further info regarding pros/cons of each type was listed on the link found in **Table 1**. The first three tests used only a single loop while the last two involved two loops as shown in **Figure** 2.

**Figure 1***:* A single loop soft shackle with a standard Diamond Knot (left) and a double loop Big Overhand Knot (right)

These tests provided limited statistical certainty regarding each knot type, however do establish an increasing trend in failure load uncertainty with larger theoretical failure loads as shown in **Table 2**.

**Table 2***:* The data from **Table 2** yielded larger uncertainties and standard deviations for higher rated shackles.

| Type | Uncertainty | Standard Deviation |
|---|---|---|
| Spliced Loop | 734 | 487 |
| Diamond | 740 | 578 |
| Better Diamond | 1180 | 770 |
| Button | 2120 | 1199 |
| Big Overhand | 4260 | 2291 |

These tests also showed that higher rated soft shackle types increased in failure load. The fifth test for the Big Overhand shackle shown in **Figure** 2 was described as having a problem in the setup process which may account for the low data point creating the much higher uncertainty in **Table 2**.

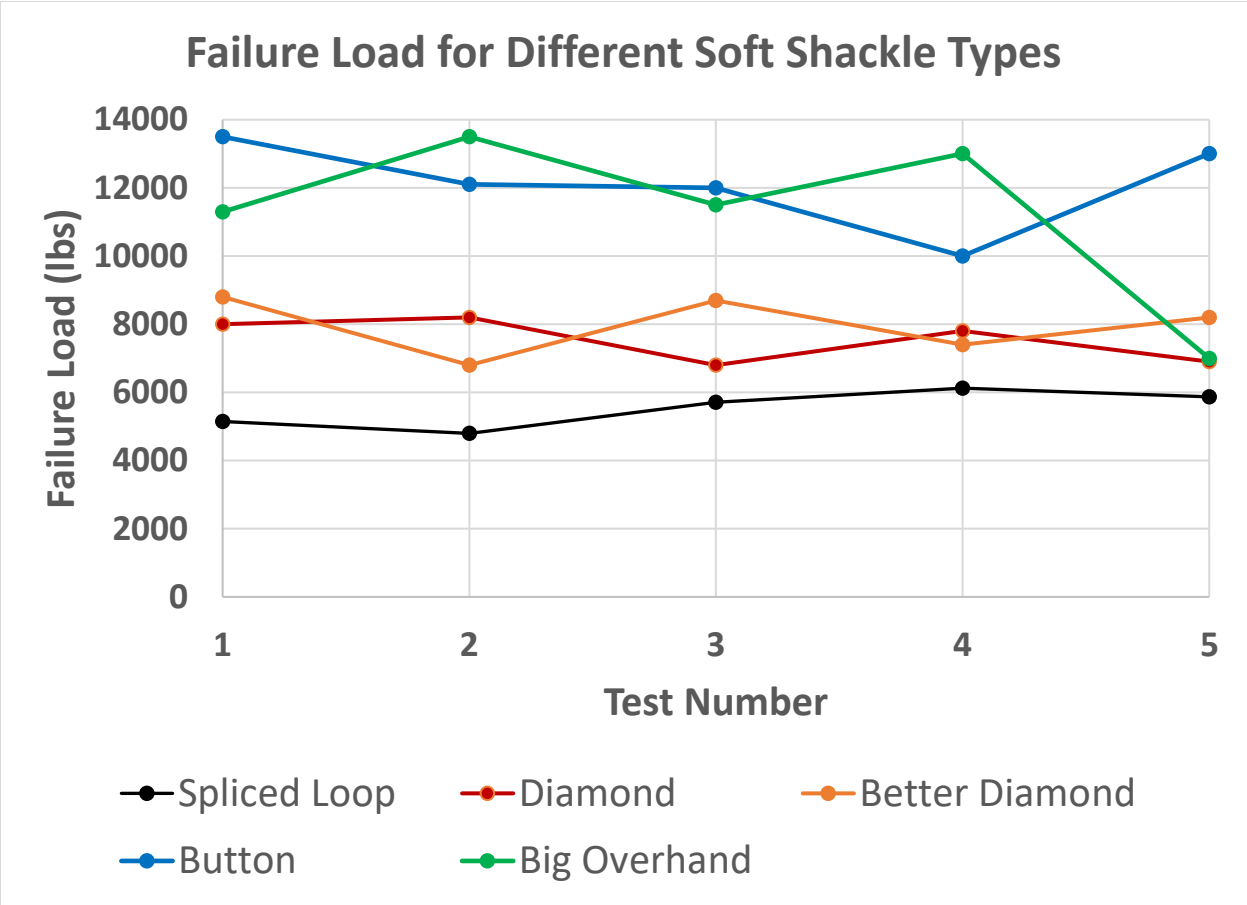


**Figure 2***:* Data from **Table 1** was plotted to show the increase in failure load with use of higher rated shackles.

The Button and Big Overhand knots on the shackles yielded the best failure strengths. The Better Diamond and Diamond knots had the best consistency on failure strengths. Overall, the BalanceCommunity data showed that an increase in diameter/knot quality of 2mm can increase the failure load by a maximum of 8704 lbs. Higher rated shackles also failed less consistently with uncertainty as high as 4260 lbs and as low as 734lbs. The higher rated shackles did consistently fail above shackle failure loads of lower ratings.

The company L-36 also performed testing which yielded that soft shackles with two loops achieved at lowest, 33% of the theoretical failure loads. The single loop shackles achieved percentages in the low 20's of theoretical failure loads (L-36).