

Knot Strength

A hitch is a knot that is used to secure a line to a fixture, such as a boat line to a vertical pole on a dock. There are numerous hitches that can be used to successfully achieve this objective, most notably the clove hitch. Figure 1 illustrates the clove and two of its variations, the modified clove hitch and the double clove hitch.

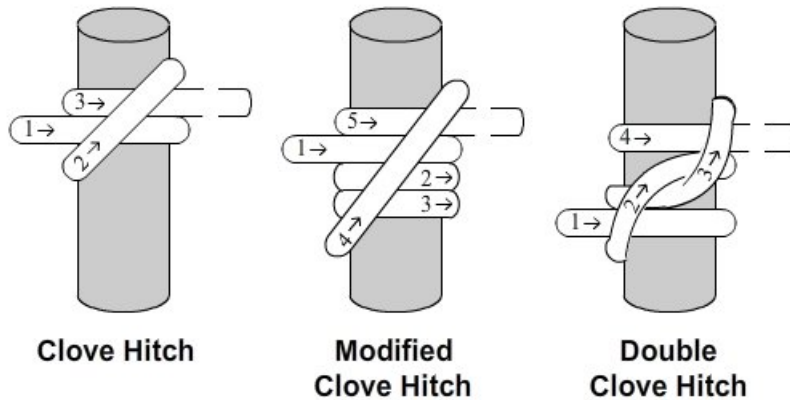


Figure 1 – Clove Hitch, Modified Clove Hitch and Double Clove Hitch

The clove hitch is characterized by two key foundational elements, the wraparound and the wrapover. A wraparound is defined by a rope passing around the pole to which it is tied. A wrapover is defined by the rope passing over itself. Figure 2 illustrates a wraparound (left illustration) and a wraparound with a wrapover (right illustration) which is a clove hitch.

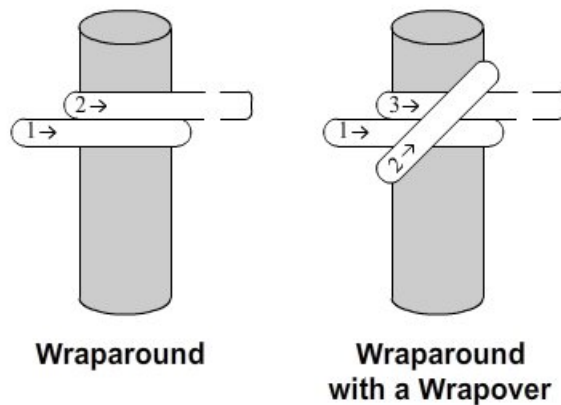


Figure 2 – Wraparound and Wrapover

The strength of a knot is determined by the amount of friction within the knot. This will vary greatly based on the rope diameter, rope coarseness and rope material as well as the hold rod parameters (including size, diameter and surface). However, given the three hitches illustrated in Figure 1, the primary source of friction are in the wraparounds and wrapovers.

As the rope is pulled (e.g. by the boat drifting from the dock), tension is applied uniformly along the rope back to the knot. Figure 3 illustrates the tension on the knot in both directions (the pull of the boat and the hold of the pole). For the knot to hold, the applied tension (T_2) must not exceed some multiple of the tension of the knot (T_1). The multiple is an exponential function of the angle the rope is wrapped and the coefficient of friction between the pole and rope. The multiple will be referred to as e and the knot will hold as long as $T_2 \leq eT_1$.

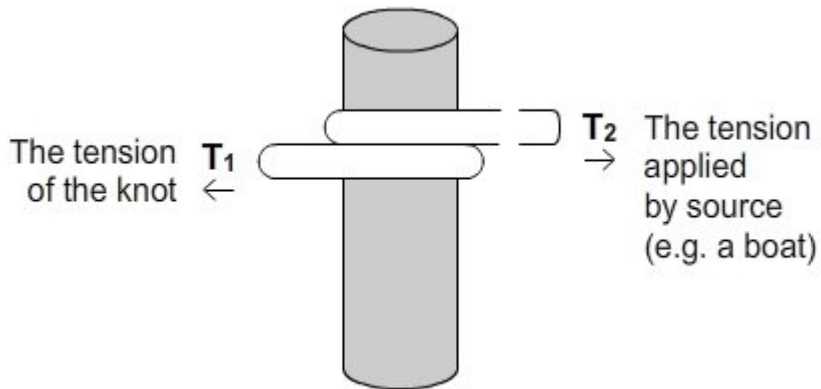


Figure 3 – Knot Tension