

## **KNOTS AND OTHER TERMINATIONS**

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Terminations made with natural or synthetic ropes are almost always temporary, while terminations made with wire rope are more likely permanent.

Two of the most common knots used in theatre are:

### **The Bowline**



Commonly used for hoisting or hauling.

Termination Efficiency 60%

### **The Clove Hitch**



Commonly used to tie to an anchor point or batten.

Termination Efficiency 75%

Rope of all types have a **Tensile Strength (TS)** and a **Working Load Limit (WLL)**.

For natural and synthetic ropes, the **WLL** is the **TS** divided by ( / ) 5. ¼" Nylon Double Braid Rope 1700lbs./5 = 340lbs.

Some authorities recommend dividing by 10 and others, to be safe, by 15 (NFPA 1983)

### **Wire Rope Clips**



Use only forged wire rope clips.

Follow manufacturers guidelines for assembly and use.

Know how many clips are required and the proper torque for each application.

Wire rope clips can be used again, however, do not reuse wire rope.

The live/long end of the wire rope must be resting in the saddle.

When done correctly, the termination is 80% efficient.

### **Wire Rope**

The designated wire rope for theatre rigging is 7x19 Galvanized Aircraft Cable. There are 7 bundles of 19 strands of wire.

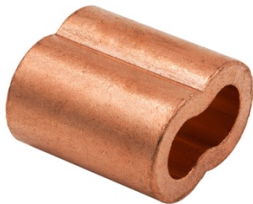


## Swaged Fittings

Swaged fittings in rigging require the use of a swaging tool:

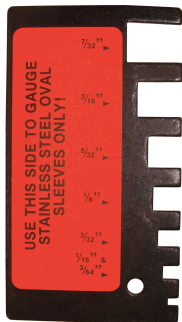


and copper ovals or sleeves:



Only copper fittings are approved for theatre rigging.

The swage is checked with a GO NO GO GAUGE.



When done correctly, swaged fittings are 95-100% efficient.

## De-Rating Terminations

As described, all terminations require we derate the strength of the rope based on the termination's efficiency. For natural or synthetic rope, start with the WLL.

Multiply the WLL by the termination percentage:  $100\text{lbs.} * 60\% = 60\text{lbs.}$

## De-Rating Based on Application

How the terminated rope (wire, natural or synthetic) will be used also requires derating. This calculation is known as the **Design Factor**.

Types of Design Factors:

5:1 Static/un-moving (a static scenic element)

8:1 Moving (a batten or scenic element)

10:1 Live load (a performer flying effect.)

**Never to be done without using a professional company.**

### Calculation:

*Media:*

1/8" Wire Rope (**2000lbs.** Ultimate Breaking Strength)

*Termination Type:*

Wire Rope Clip: **80%** Efficiency

*Application Type/Design Factor*

Moving Load: **8:1** Design Factor

1. Derate the termination:  
 $2000 * 80\% = 1600\text{lbs}$
2. Derate the application:  
 $1600\text{lbs.}/8 = 200\text{lbs.}$   
(200lbs. is the allowable load)

### Resources:

[www.usitt.org/backstage-resources-study-guides](http://www.usitt.org/backstage-resources-study-guides)

**Stage Rigging Handbook**; Third Edition.  
Jay O. Glerum, Southern Illinois University Press, Carbondale IL, 2007

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