

## Proper Construction of Eye Splices & Lap Splices Using Multiple Compression Sleeves

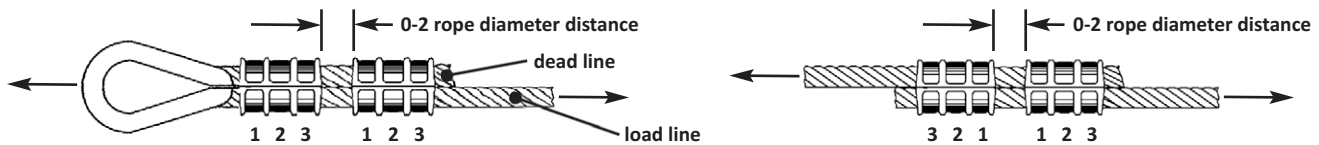
### Spacing is Important When Using Multiple Sleeves

**Foreword:** Eye splices normally require one sleeve for a full-strength solution, however, with some custom applications, eye splices and lap splices are fabricated with more than one compression sleeve for the purpose of achieving more grip capability and/or to add redundancy in an application critical to safety. Nicopress is often asked about the proper positioning and press sequences when it is necessary to utilize **multiple** oval sleeves for a termination. This question arises for eye splice terminations and more often for lap joint sleeve connections. This subject can be confusing since some literature suggests not to use more than one sleeve in a termination because one sleeve may fail first which produces a “domino” effect on the remaining sleeves. While this is possible, it can occur only if all three of the following conditions are true:

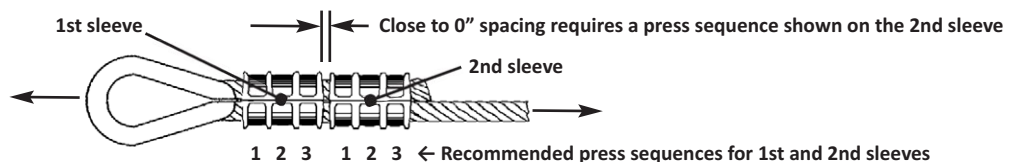
1. A special application rope splice **requires** the use of more than one sleeve to achieve the tension requirement. In other words, one sleeve will not provide enough grip strength for the custom application so two sleeves **must** be used; and,
2. The two sleeves have been spaced too far apart from each other (significantly more than two rope diameters’ distance); and,
3. If after swaging both sleeves, one of the two intermediate ropes (i.e. ropes between the sleeves) is longer than the other.

We have found that when the gap space between any two sleeves is no more than 0 to 2 diameters’ distance apart, the intermediate ropes **cannot** differ in length enough to cause unequal sharing of the rope tension, thus, eliminating premature failure to one of the sleeves in the termination. The intermediate ropes will share the load equally if they are the same length between sleeves. If the “dead line” is longer, the sleeve nearest the eye will fail first; if the “load line” is longer, the sleeve with the rope end will fail first. Refer to the reverse side for additional theory on double sleeve terminations as a result of Nicopress testing.

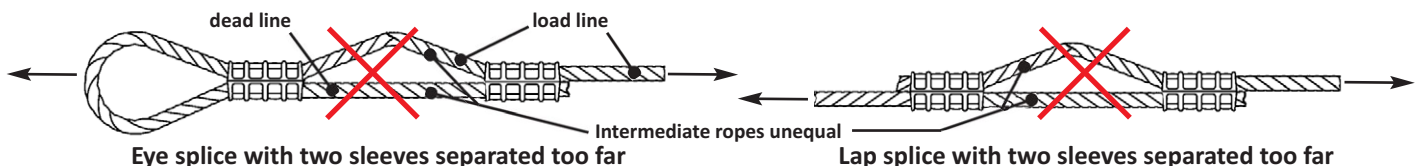
### Recommended: Eye splice and lap splice with correct sleeve spacing between sleeves & press sequence



If it is desired to install the second sleeve in contact with the first, the second sleeve must be pressed in the sequence as shown below so that the sleeve material flows outward, away from the interface during swaging. For eye splice with two sleeves and near 0” spacing, follow this pressing sequence:



### NOT Recommended: Excessive sleeve spacing allowing one intermediate rope to differ in length



**Final Word:** When it is necessary to use multiple sleeves for special eye splices or lap splices, it is always better to keep the sleeves as close as possible to prevent one intermediate rope from becoming longer than the other. If the above recommended procedure for multiple sleeve installations is used, the terminations will act additively and perform reliably and consistently.

## Theory:

### Force analyses when intermediate ropes are equal lengths

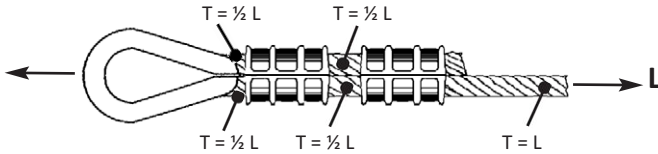


Fig A – Eye splice with equal length intermediate ropes

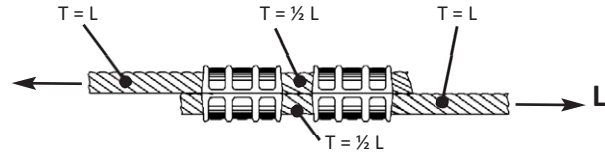


Fig B – Lap splice with equal length intermediate ropes

In **Figures A and B**, “T” is the line tension and “L” the line load (force) applied to the termination. The intermediate ropes share the load equally with each rope tension equal to approximately half of the load. This is unlike an unequal intermediate rope pair which shifts the entire load to the shortest length intermediate rope thus causing a single sleeve to handle the full load rather than both sleeves.

### Force analyses when initially loaded and intermediate ropes are unequal lengths

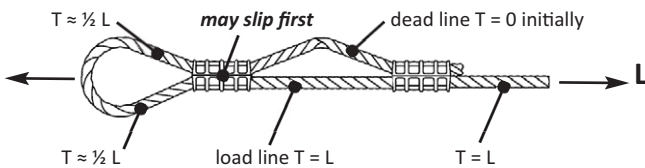


Fig C – Force analysis when dead line is longer

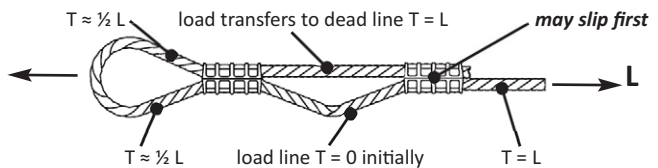


Fig D – Force analysis when load line is longer

When an application **requires two sleeves to achieve a full strength termination** and the intermediate ropes are unequal, then:

- If the dead line is longer, the sleeve nearest the eye (or “eye splice sleeve”) will fail first;
- If the load line is longer, the sleeve with the rope end (or “end sleeve”) will fail first.

**Fig C** – The dead line is longer, so the load “L” remains the same on the intermediate load-line rope which transfers the entire load to the single eye splice sleeve. As the load increases, the eye splice sleeve cannot hold the entire load so it begins to slip. This action will draw the end sleeve closer to the other sleeve and either hold the load or cause both sleeves to fail.

**Fig D** – Since the intermediate load line is longer, the load immediately transfers to the dead intermediate rope and then to the single eye splice sleeve. As the load increases the eye splice sleeve holds stronger than the end sleeve, since, the end sleeve acts like a single lap splice with the entire load on each rope entering and exiting it. This causes the end sleeve to slip first with either the rope end ejecting or the end sleeve being drawn toward the eye sleeve. This action either will hold the load or cause both sleeves to fail.

**Final Comments:** If a rigger wishes to add redundancy to a termination by doubling sleeves (when only one sleeve is necessary for a full-strength connection), it is advised to follow the recommended procedure for close spacing. This is necessary since:

- If the **Fig D** configuration occurs, the load is transferred to the deadline and the right sleeve will act as a single lap splice initially, which is not as strong as the left sleeve with an eye splice. This right sleeve likely would slip initially, then the left sleeve eye splice would take the full load since it is a full strength connection. In this configuration, only one sleeve will act with full strength capability and the anticipated redundancy is lost.
- If the **Fig C** configuration occurs, the load transfers to the eye splice, which will hold, since it is a full-strength connection, however, the anticipated redundancy is still lost.
- Per **Fig A**, when the recommended close spacing is used, the two sleeves will act in series to double the grip capability and either sleeve will act with full strength capability, thus the anticipated redundancy is realized.