Every once in a while we get a question like: “Is this OK to use for my aerial exercise?”, which an accompanying picture similar to the below:

There will be lots of answers, mostly different versions of “NO!”, but with little detail as to *why* it is not safe.

This post will explain some of the reasons why the rig in the above picture is not safe for aerial activities.

Design Goals

A lot of experienced aerial riggers, when designing a rig, will assume the maximum weight of a performer is 200 lbs. An experienced aerialist can generate 10 times their body weight when executing certain moves. This means that point must be able to hold 2,000 lbs. without failing. We will apply a safety factor of 2.5, meaning that the rig point should have a Minimum Breaking Strength (MBS) of about 5,000 lbs., or about 22 kiloNewtons.

Our equipment does not always meet that standard, but that is our goal.

Withdrawal Resistance

For the sake of example, we will use several reasonable assumptions:

The “eye bolt” is a ½” lag eye screw, 6 inches long, with the shaft fully threaded. There is 4 inches of thread engaged in the wood beam. The beam is a variety of Douglas Fir.

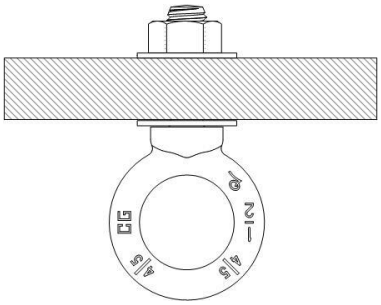
There are online calculators available, but again, using several assumptions, the withdrawal resistance of this type of fastener, in this type of wooden beam is around 600-700 lbs.

That is, if the wood is consistent all the way thru; that it doesn’t have a hidden knot hole part way up, or an internal crack weakening the beam. There is usually no way to tell.

A 100 lb. aerialist can easily generate a downward force of 600 lbs., and some aerialists can generate 900-1000 lbs., resulting in the lag screw pulling out of the wood beam, probably resulting in a fall.

Additionally, the eye screw can “un-screw” itself from the beam when doing a spinning move.

It is much better to use a bolt, with a lock washer and a nut on the other side of the beam.



A ½” diameter eye bolt has a Working Load Limit (WLL) of about 2,600 lbs. with a 5:1 safety factor, giving a breaking strength of about 13,000 lbs. This is well over our design goal of 5,000 lbs.

Forged eye vs. Bent eye bolts

Forged Eye Bolt Bent Eye Bolt

The lag screw shown above does not have a forged eye, but rather a bent eye. This type of eye is made by bending the eye around a mandrel. However whatever can be bent, can also be 'un-bent'. This is the primary danger of using 'bent eye' fasteners: the eye can open up upon repeated stress, like from normal aerialist activities, probably resulting in a fall.

The WLL of a ½" bent eye bolt is about 200#, with a safety factor of 4:1. This means the bent eye will fail at about 800 lbs.; far under our design goal of 5,000 lbs.

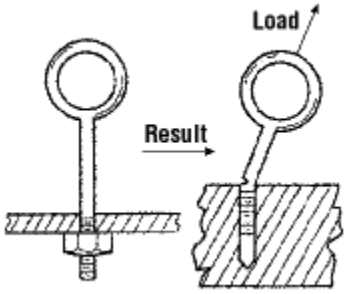
Shoulder vs non-shoulder eye bolts.

Shouldered Eye Bolt

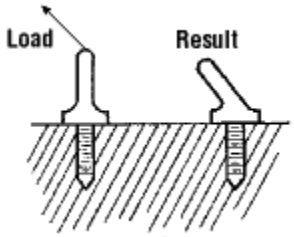
Non-Shouldered Eye Bolt

In aerial activities, we use only shouldered eye bolts. Here's why…

A non-shoulder eye bolt is designed for in-line loads only; they do not resist lateral forces very well. They can fail at relatively small loads:



The shoulder on a shoulder bolt is meant to resist those lateral forces, to a degree. But only if loaded properly.



The load must be "in-line" with the axis of the eye, not perpendicular.

The best option when installing an eye bolt for aerial activities is probably a "swivel eye" bolt.

This type of eye bolt will both swivel and hinge, so that the load rating is always maintained at 100%.

The swivel eye bolt is immune to swinging and other ‘non-straight down’ activities.

So the rig pictured above fails on several counts:

1. The fastener appears to be a lag screw rather than a bolt.
2. The bolt is likely not all the way thru the beam with a washer/nut on top.
3. The lag screw has a bent eye rather than a forged eye.
4. The lag screw has no shoulder to resist lateral loads.