11. SLINGING OF TRUSS

11.1 RELATIVE IMPORTANCE OF SLINGING METHOD

Much can be said about methods and means of slinging and surely we at Prolyte will encourage any user of truss to apply the best and safest methods possible.
Considering this, we also must stress that, in our experience, the slinging method is of little importance when recorded accidents are considered.
There are three main causes of failure of truss structures:

- Overloading the free span; too much dead-load in a certain span, often combined with dynamic forces of life loads (intermittent go-button operation, people, sub-suspended hoists or wind-loading)
- Obstruction of the free span during the lifting of a truss. When the trusses get stuck against structural elements of the building or other obstacles but the chain hoist continues, it creates a vast overload, resulting in permanent damage. The operator must always be able to oversee the complete path of travel of the load and should not be distracted.
- Overloading in between the node points of a truss. Heavy point loads shall only be placed within the node point or directly against it (see the loading tables for allowed loading in between the node points).

Slinging methods become important where shear forces are the limiting factor for a truss structure. Shear is the effect of the non-supported part of the span trying to cut along the supported area. This is best illustrated best with the spigot pin picture shown below, that came from a test situation. If you ever find spigot pins slightly resembling this one, be warned that some truss modules might have been overloaded and need careful inspection.

11.2 SUSPENSION APPLICATION

The difference between temporary and permanent or fixed installations must be considered first in each situation.
For permanent or fixed installations mostly steel or aluminium brackets will be used. These will keep the truss in a fixed position. Fixed shape clamps & brackets can only be used for vertical suspension, not side loading or lateral forces may be applied. Truss bridles are not allowed with this type of suspension equipment.

For temporary installations (such as concerts, where trusses are hung from structural members in a high ceiling to support lighting equipment), the truss is freely suspended. This means the truss can swing freely when horizontal forces are applied. Clamps or sleeved wire ropes with shackles are mostly used in this situation.

11.3 SLINGING WITH WHAT

For support of trusses a series of fixed shaped or flexible lifting equipment tools can be applied. In the entertainment industry flexible slings are predominantly used as lifting tool. Wire rope (steels), chain (clutch-chains) and round-slings (span sets) are very common pieces of lifting equipment.

Round slings
When looking at a lifting sling from an aluminium tube's point of view, it has a preference for supple, soft and non-abrasive slings. A round sling will be the prefect choice. Round slings are made of polyester, which melts at approx. 250°C (~480°F). The allowable temperature for this material to be used at is limited to 100°C (~212°F) Many countries have fire-regulations that don't allow this kind of suspension equipment in situations were hazards from heat sources are present. Think of a light source as a heat generator. Research has shown that 2kW luminair-housings can reach temperatures of about 190°C (~370°F), with the truss-chord straight over it being almost 140°C (~280°F). Not adding a safety in a situation like this will be pure negligence. Accidents have been reported of round slings being melted by spots or the heat of the rays, and as a result trusses have fallen.When round slings are used, a safety backup must be applied such as a wire rope or chain sling.

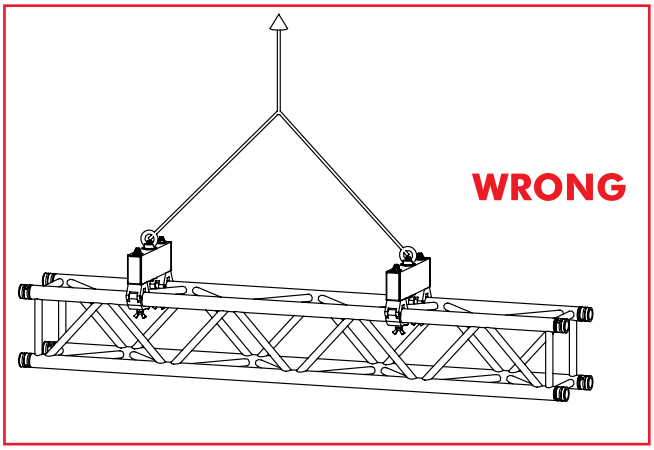
Wire-rope slings
The next best flexible type of thing to use for suspension of trusses is a wire rope, but only one with a good cover or sleeve to protect the aluminium truss-chords from abrasion by the hard and rough wire-rope surface. Wire ropes do resist higher temperatures, but when used as slings this depends partly on the type of termination. Wire ropes with 'return eye' type of termination with an aluminium swage sleeve ('Talurit') are allowed up to 100°C only. But when used with the protective nylon-hose jacket around the steel, this also does insulate the direct heat transfer from lower chord to wire rope, as would any other type of insulating material in between both items. Furthermore heat-dissipation along the wire-rope steel itself reduces the temperature before being transferred into the ferrule, and all of this makes it more acceptable in a risk-analysis, when compared to polyester round slings. Al this is more or less relative as at one point the aluminium of the truss itself

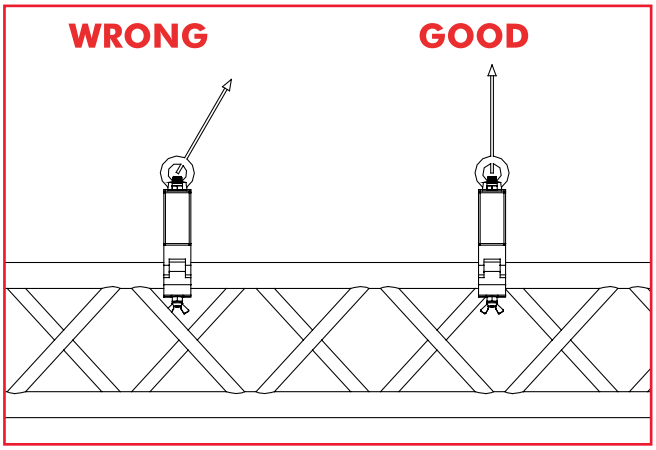
starts loosing strength. At 75°C (167°F) about 95% of the original tensile strength remains, at 100°C (212°F), this is already reduced to 85%, and at 150°C (302°F) only 70% and finally at 200°C (392°F) only 50% of the original strength remains. It must be stressed that in tropical areas with lots of generic lights, or in Film or TV-studio's these temperatures are easily reached! Wire ropes are more difficult to apply in the preferred slinging methods of chokes and wraps, thus leave fewer possibilities for best support action.

Chain-slings
Chain slings do allow for use at high temperatures but also need protective cover and are difficult to apply in the preferred slinging methods. When chain-slings are preferred as truss slinging equipment the specific arguments must come from the users themselves as other types of slinging material are just as good or even better in most applications.

Wire rope filled round-slings (soft-steel®)
The soft steel® has a normal outside webbing for soft slings, but instead of the polyamide core, the soft steel® has a core made of steel wires. Which makes it resistant to high temperatures. The steel wires within the soft steel® are as flexible as a normal soft sling, but have a much better fire resistance. The soft steel® can be used in circumstances where the normal soft slings are not allowed.
The outside webbing is black, including an identification label and a hidden inspection window to inspect the steel wires within the soft steel®. The soft steel® applies to all CE regulations.
When looking at this product from the point of view of an aluminium tube, this type of sling is surely to be preferred over the single 10mm diameter "sleeved wire-rope slings". The supported area is at least 4 or 5 times that of a regular wire rope and when choked even better.
he wire-rope core has better heat resistance than the truss itself. Prolyte Products endorses all innovations that add to greater safety in the entertainment industry and this is definitely on of them.

Fixed shape support brackets
Last items to consider are the fixed-shape lifting brackets, generally using clamps of the types CLP-535 or CLP-587. These are produced for most truss-series and have in common that horizontal forces between the chords are absent and that fireproofing is never a problem.
Depending on the type of truss there are steel or aluminium versions (or both). A small disadvantage is the fact that they can never be placed right at the node-point, but must always be as close to it as possible, and they definitely do take more time to put into place, certainly when to be fitted tot the lower chords. For permanent (or semi-permanent, like a TV-show running a couple of years) installations, these types of considerations are less important and thus fixed brackets more often found there. As far as the standardized slinging methods are involved these do not compare fully and are not take into further consideration.
Lifting brackets should not be used to make truss bridles.





Lifting eyes
Eye bolts or nuts are often used. Eye bolts/nuts can mostly be loaded in a vertical plane only, although there are types that allow horizontal forces as well. Details on the allowable loading of eye bolts/nuts can be found in local or national standards.
All eye bolts/nuts must be secured against rotating (unforeseen loosening), which may cause the load to drop.

11. SLINGING OF TRUSS

11.4 HOW TO SLING TRUSS

There are 3 basic principles of slinging recognized all over the world:

- Direct hitch
- Choke hitch
- Basket hitch

Almost all standards about slinging anywhere in the world do only recognize these three essential methods, with some variation in defining the additional wrapping.

For any aluminium round-tube truss chord it would be best if the load pressing against the tube were evenly spread on a large area. Contact (bearing) stresses on the tube wall surface are larger when resting on the tip of a nail (covering e.g. 1 mm2) than when resting in a 50mm wide clamp that allows for an area of approx. 1/3 of the tube to be supported. Nobody will use a nail, but wire ropes and chains have much less surface contact-area with the aluminium tube and therefore can easily damage the chords surface, an attention point for all relatively thin-walled X-series truss.

Results from experimental research at Prolyte show that even the best types of 3mm thick fibre-reinforced nylon hoses, used as protective sleeves around the 10mm diameter wire-ropes have a limit to their use. Support loads of approx. 1800kg (900kg/chord) made the nylon layer fully disintegrate in between wire rope and truss-chord, only leaving the armour fibres in place. The protective effect towards the aluminium of the tube, not being 'eaten' by the steel of the wire rope, however was lost.
When using sleeved wire ropes for slinging of truss this is certainly a matter of systematic inspection.
When wire ropes are used for slinging another possible method for aluminium chord protection is the use of plastic C-shaped tubes of about 100mm long that are 'clicked' over the truss-chords at the required suspension point.
These can be made from any regular type of rainwater pipes. In that case any regular wire-rope steel can be used to sling-support the truss, and discard of such inexpensive pieces of equipment cannot be a serious topic when safety comes to mind.
Chain slings are much less likely to be used because of pricing and weight, but truss-chord protection is again an issue to keep into consideration.

In general the slinging of truss has an effect on the lateral shear-force in the truss cross-section.
There is almost no influence on the safety of the free spans of the truss with respect to the bending moment. In continuous spans however, the inversion of the bending stress at the centre supports leads to tension in the top chord and compression in the lower ones.
Here careful application of the slinging material is essential, supporting also the lower chords.

Direct hitch ('straight vertical pull' hitch)
This method is only found where an extra piece of suspension equipment is used, such as a bracket with an eyebolt or lifting ring fitted onto the truss-module. The sling (round sling, wire rope or chain) can then be attached to this by means of a hook or shackle.
When all safety aspects are considered it is obvious that use of only one single suspension sling is less favourable.

Choke hitch
This method should only be undertaken using pairs of round-slings or soft steels in each support-point. Each one of this pair supports one side of the truss beam-cross-section. These slings can be choked to the bottom chords, and then wrapped once around the top chords before attaching the hook or a shackle. Wire rope or chain slings are impossible to use with this method. Furthermore, this method degrades the slinging factor to 0.8 times the WLL (workload limit) of the sling. Even when using two slings, the net result will only remain at 1.6 times a single sling WLL. When all safety aspects are considered it is obvious that use of only one single suspension sling is less favourable.

Basket hitch
This is the most used method for suspending truss-beams. The slings, no matter what type, are placed underneath the bottom chords and are wrapped, or are run straight up, on each side of the truss bottom chords, next they are wrapped around the top chords before attaching the hook or shackle. This method improves the slinging factor by 1.4 to 2 times the WLL of the sling, dependent on its outer angle. Angles over 45° are not allowed under the new European Standards, thus the inclined angle of a basket-truss-wrap is never more than 90°. Please ensure that the sling is attached next to a horizontal cross brace, so that it is able to absorb the compressive force between the chords.
In general, a truss could be slung from just the top chords, but this could reduce the 'shearing' capacity by 50%. If, for some reason, this needs to be done, make sure that the total loading of the truss is not in excess of 50% of the relevant figure given in the loading tables (see part 2).
Suspension of any type of truss from just one chord is never acceptable, unless this would be for decorative purposes only, and no load is attached to the truss.
When all safety aspects are considered it is obvious that use of only one single suspension sling is less favourable.