Q: Are sleeved steels fit to be used in all occasions ?

Answer:

No, certainly ***not*** everywhere. Finally a clear answer to a question. We will explain why use of these on RSJ's[i] or steel 'I-beams' is not very clever.

'Sleeved steel' - the word

In the Netherlands there is this constant tendency to use English where we have proper words in Dutch. And that resultant "*Dutchlish*" sometimes messes things up quite considerably, where the Dutch word for 'hose' ('*slang*') was not translated and used in conjunction with the English 'steel' a monster was born that should be discussed at the Language departments of the Universities. A '*slang*' is Dutch for 'a flexible hollow cilinder of rubber or plastic'. Where the Anglo-Saxons use 'steel' [ii] as abbreviation for 'steel wire rope sling' in Dutch we have '*staalkabelstrop*' or '*staalstrop*' in short. So a '**hose steel**' should be translated with '***slang-staalstrop***' but both are hypothetical only. The oldest English encounted with the subject was the term 'sleeved steel' (early 80-ies) and came from Mike Crisp in his user manual for the TAS-stage trusses.

'*Sleeved steel*' - the product

In those days the idea was of a steel surrounded with a thickwalled (rubber) hose. It was meant to prevent the cutting (sawing) effect of the (hard) steelwire in the (soft) aluminium chords of the truss. Even if the '*spanset*' (a brandname having become a product name, but the offcial term is 'round sling') was already known since it's invention around 1972, it was also known that it had limited resistance to high temperatures in those days of PAR-64 "ceilings and walls of light". So in order to keep the trusses alive several things have been attempted throughout the years: 1) burlap or other textiles, twisted around the steel and fixed with Gaffa tape, 2) sections of fire hose slided over each other as they would still fit around the end terminations, 3) rubber or plastic hoses without or with a kind of 'armour net' designed for garden of pneumatic use, and 4) short sections of PVC rainpipe cut open for ¼ and clicked around the chords where protection was needed. But group 3) has started to make a life for it self, and is now abused on the RSJ of the main structural support members.

Part 2: Why not on other things beside trusses?

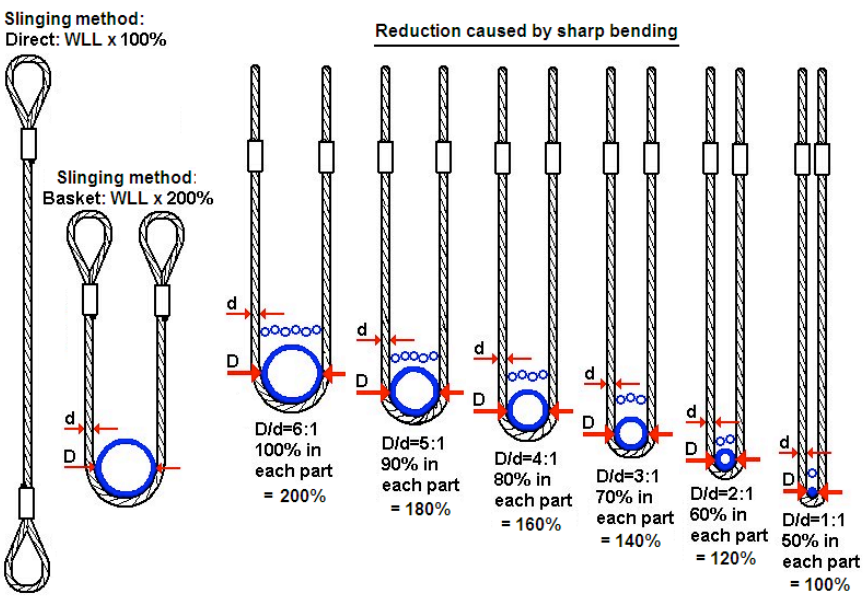
2: What else needs protection, next to truss?

The function of the hose is to protect the *soft aluminium tubes*. But when a steel beam is protected with a layer of paint, powdercoat or even a thin layer of zinc, there are obvious reasons to protect this protection.... As often, it starts out with some minor damage to the rust-protector, but once the corrosion sets in it doesn't stop anymore. That's one infamous charcteristic of iron and in most alloys of structural steel. Where rust comes in the strength is leaving.

The wire rope sling itself !

But also the steel sling itself need protection, to be precise agaist turnig around a sharp bent. Because sharp bents make the steel loose part of its strength, and the shraper the turn, the more loss of strength.

And exactly these **two types of protection** (a) *the vulnerable materials under the steel* and (b) *the sharpness of bending in the steel wire rope* are lumped together on one pile. So if we look at a truss chord we see a 'short turn' in th wire rope bending round a 48-51mm tube-diameter. Is that considered 'sharp'? A nice smooth bend around a big round object shows to not weaken the wire rope, but a tight turn makes the cable to break right there. Bending around it's own diameter (as in a 1 ton shackle) results in only 50% of the original wire rope strength even if that is on a round cross section. The ratio between diameter of object (D) and that of the steel (d) plays a major role. In standards it is agreed to call it a ***sharp edge*** when the object (D) and the steel (d) have the same diameter (thus D:d = 1:1). In that case (and worse) the wire rope itself needs to be protected: against that tight bending.

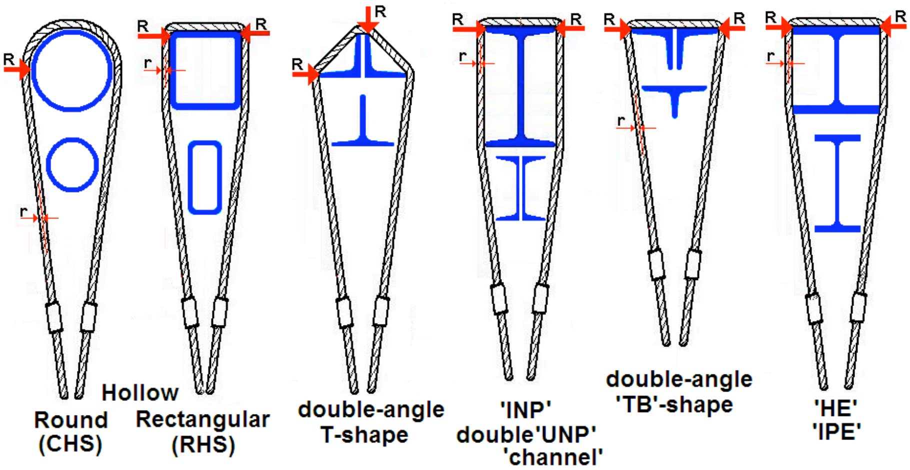


Picture 1: Various bendings of a wire rope sling in a 'basket' method

Part 3: And what about bending around a straigh turn?

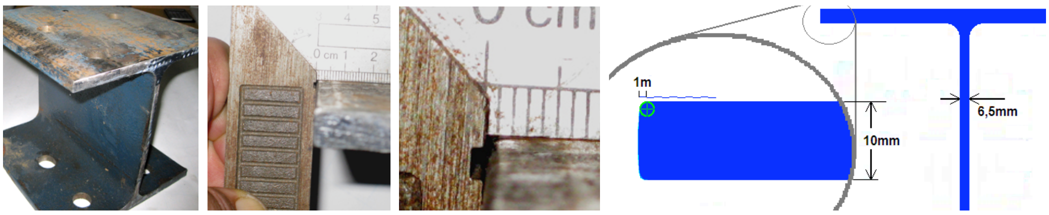
3: Bending around a straight (90 degree) turn

In picture 1 it shows that between D:d = 6:1 and 1:1 the amount of reduction due to decrease of bending radius is close to lineair. In tests we have done similar results were found: on a 50mm truss chord (D=50:d=10) indeed a 'steel-weakening' of ca. 10% was found. Not really a problem, when the steel in used in basket method: a 1 ton steel in a basket can be loaded to 0,9 x 2 x 1000kg = 1800 kg. Meaning half of that obviously, in 'our' type of business. [iii]
But in a turn smaller than the own diameter (very sharp) it is mandatory to take precautions against that sharp edge to prevent the risk of premature breaking of the steel wire rope. It is common practise to use steels for suspending the chain hoists from steel hollow sections (CHS and RHS), double-angle, double channel, T, and RSJ's in INP, IPE and HE shapes.



Picture 2: Rolled steel joists with steel slings in the 'basket' method

In rectangular hollow section the sharpness of the radius 'R' is not that bad. For example: 50x50x4mm: R=4-8mm and 250x250x8mm: R=12-20mm. The RHS members of a main structure often have a (R) equal to that (r) of a steel, what reduces it's capacity to 50% at max. But is the last three rolled beams the corners surely are very sharp, with ofen no more than 0,5 a 1 mm, see fig. 3. So the wire rope does need protection when bent around it.

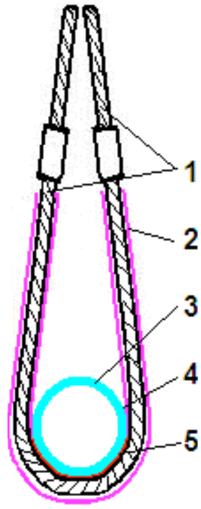


Picture 3: HE A 200, steel rolled beam with a flange radius (r = 1mm).

Part 4: Protection, how and with what?

4: Protection: with more than hose thickness!

The thickness of the (garden- or compressor-) hose material is not more than 1,5 to 3mm. And it is susceptible for damages such as cuts. Tests we have done on truss, using a 'armoured' hose on a 10mm steel in a 'basket' around a 50x4mm diameter aluminium tube – revealed that at ca. 1 ton (10kN) the 'plastic' of the hose had fully disappeared. It was completely pressed away in between the two metals, even though the pressure was neatly distributed all along half of the circumfrence. So even on truss there is a limit to the use of hose in 'sleeved steels'.



Picture 4: 'Sleeved steel':

1) *10mm (r=5mm) steel with* 2) *armoured polyester hose 2,5mm thick*
3) *truss chord 50x4mm* 4) *25mm radius* 5) *compression squeeze zone*

Sleeved steel on beams?

Use of '*sleeved steels*' for slinging steel structural beams only is making sense on large diameter CHS, or (cold rolled) RHS types with wall thickness of ca. 10mm, where R=25mm. On all other types of RSJ's the wall of the sleeve, or hose, will be cut almost immediately, leaving a hole in the material at that particular spot. Worse is that the plastic (or rubber) sleeve hides any possible damage to the steel sling body. Even a transparant hose only remains so for a couple of months.

In a test with '100% overload' [iv] on a HE B 140 section the hose was clearly cut in two places. After the hose was fully removed it turned out that the steel itself was also seriously damaged: the shape and lay of the strands was badly disrupted as shown in picture 5. A lasting deformation obviously. Such places are the source for breaking wires, and thus a potential threat for the safety. Discard!

Picture 5: 'Sleeved steel' after overlaoding on HE-beam and removal of sleeve/hose.

A similar test on the same steel sling, after that hose was removed, was carried out on a ⊥ TB-section, but now with a proper padding of burlap. The result was a minor flattening only of the steel in that position.

Part 5: NOT on structural beams, possible on truss, but there is a better thing!

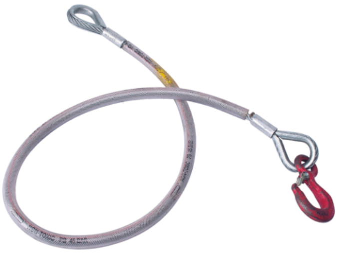
5: Conclusions

1) For lifting of truss a '*sleeved steel*' is one of the options. Certainly where a temperature-risk is apparent (pyrotechnics, heat from spot-houses or focal points in the bundles of light) it is not wise (in some regions outrights not allowed) to only use polyester round slings. A steel slings must be added as '*safety*' next to the polyester. But when such a '*back-up steel*' has to be used any way, it might as well become the primary means of suspension. Providing some sort of protection is added for the soft chords of the aluminium truss, for example by adding some sort of hose as a protective sleeve around the steel. Another remark must be made: in Germany steel slings covered (in plastic etc.) are even more limited in their use, as the requirement there is that any wire rope must allow for inspection all along it's length.[v] So the sleeve can be only half of the length of the sling body it sits around. And with that we are back to at least some sawing action again to the truss chords.

2) For slinging of structural steel beams these 'jacketed' steel-slings are NOT an option, with the exception for the CHS and RHS types. The material thicktness contributes hardly to increase the bending radius, and after a first use the material in that position is permanently cut, thus opt for a discard.

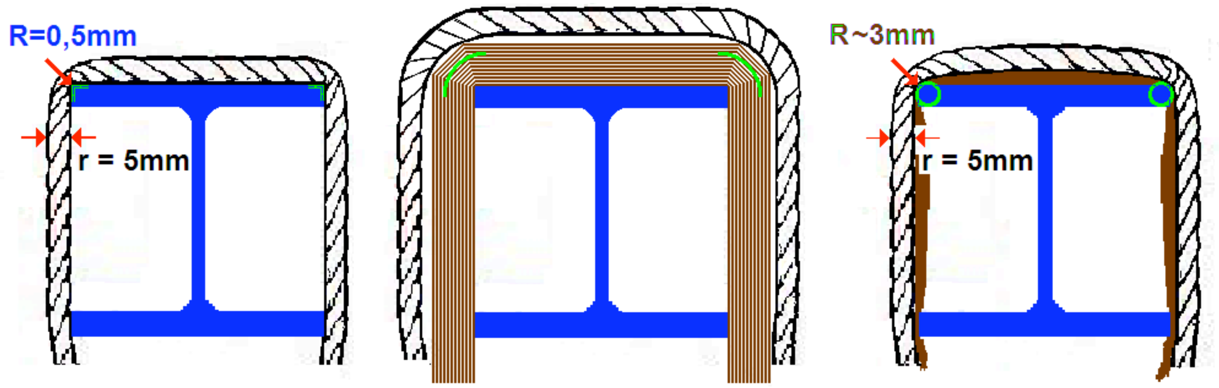
3) The unwritten rule that damage to a sleeve (analog to the jacket of a polyester round sling) should be a reason for discard is almost systematically neglected [vi]. The types of damage points in the direction of a serious knowledge gap, both in users and manufacturers alike. The last group should provide better information for use for instance in the CE or IIA-declaration(s) of conformity, and warn against misuse in user manuals.

4) Companies that drag around with '<u>*basket-steels*</u>' [vii] or <u>sleeved steels of 3m or more</u> show that they basically have no clue on what they are doing anyway. Manufacturers will not ask why you want that sh*t.



Picture 6: 'Basket steel – with hose'

5) The most *low-tech* (or even '*no-tech*') material for protecting steels from the sharp corners remains the 16 layers (= 8 x folded) burlap bag, a scheme is shown pict. 7. The thickness of that is about 10-12mm, and even in compression much more than 3mm will remain. Similar (over-)load tests we have done on HE-sections, but with this amount of burlap, they proved to be free of the damage that was found in the 'sleeved steel' as described earlier.



Picture 7: Steel HE RSJ's without (L) and with (M, R) burlap as corner protection.

6) Next to burlap one can think of strips, cut from carpet tiles (~5-7mm thick) or rubber conveyor belts (~8-12mm) as a means for corner protection, but the risk of a such a piece falling is much bigger. Certainly the conveyor belt strip can strike a seriuos blow.

6: And finally there's this: . . . . '*soft steels*' !

This complete discussion however is somewhat obsolete, as since about one decade there is a new product in the marketplace: a wire-rope-filled roundsling that we know as '***soft steel***' or '***steel flex***', that can easily replace both the "*sleeved steel*" as the polyester '*spanset*'. In the past already some articles were published on that 'new sling on the block'. When sharpness is considered we also notice a clear advantage: the 2 ton version of a '***soft steel'*** has an indication by the manufacturer (Roodenberg Staalkabels) that the radius (r) is to be taken as 2,5mm. That comes from the assumption that when goiing around the corner two layers of wire will be lying on top of each other. Compare this to a 2 ton steel that has a radius of at least 6mm. So with a safe bending ratio of 6:1 the 'soft steel' means that it can take corners with a radius of (6 x2,5=) 15mm without loss of strength. Lets agree to not use this tubesize to lift a truss from, and than all the rest is bigger anyway.
And finally about structural steel beams. Because even soft steel do not get by without any corner protection. The 1mm radius of an RSJ still is sharp for a '*soft steel*' but it requires less burlap to deal with that problem. Even a couple of folds in a T-shirt can do that, and riggers always have a decent supply of those.

Rinus Bakker – June 1, 2009

[i] RSJ = 'Rolled Steel Joist', a traditional expression for (hot) rolled structural steel beam sections, which covers all types from angle-iron to HE.

[ii] Anglo Saxon riggers can be confusing in their wording as well using '*steel*'. Because referring to the upper chord of a big steel truss structure there are still those that talk about the 'high steel' then, in stead of something like '*top beam*'. Similarly 'low steel' is used, where '*lower beam'* or '*bottom chord*' would be better and more clear.

[iii] A 'WLL' is always indicated based upon the rules in the EU Machinery Directive, and we in our trade are used to double the 'coefficient of use', so we take WLL / 2 at max.

[iv] 2 ton on a 1 ton steel sling. This is within the "normal industrial" regulations, provided the sling is around a 60 mm outer diameter object. But it would not go without corner protection on a HE- of IPE type of RSJ. A hose as protection showed to be very much insufficient.

[v] In this case our 'neighbours from the East' again proved their obsession for regulation fetishism. A hose or sleev proves to be damaged way before the wire rope itself. So when the 'rule of damage to covers or jackets' – as in round slings – was followed consistently any (possible) damage to the steel wire rope itself would become apparent immediatley with the removal of the sleeve, hose or other type of cover.

[vi] With that in mind we could expect some statistics on accidents caused by this. However those are not known. Partly because the entertainment business is not particularly well known for keeping accidents records at all, but part of that is of course that in this business the maximum load is never applied to the material anyway. Many companies tend to stick to the 'doubled Factor of Safety' standards (like e.g. BGV-C1 [=D], NPR 8020-10 [=NL] and CWA 15902 [=EU]). Many other companies might not even know of such a standard, but they often do stock 1 ton steels in combination with 0,5 ton hand hoists as the highest load lifting capacity.

[vii] 'Basket steel' is a term well established in the Low Countries, indicating a short steel ssling with a eye-hook fixed to one end. In combination with an 'oversized' shackle, this is a very effective and safe way of connecting a steel sling in a 'basket' methode onto a structural beam.