March 2016

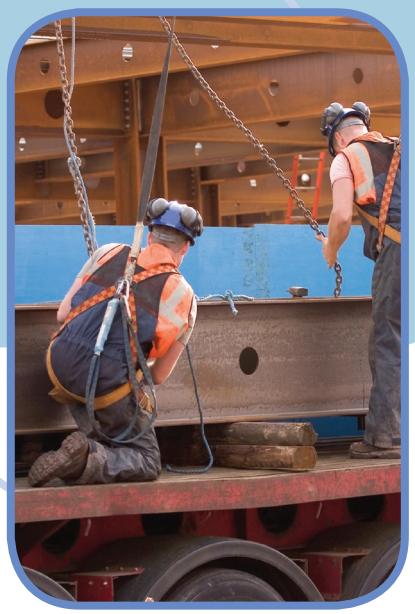
LOAD SAFETY SERIES

Information Sheet

Safe Load Securing of Structural Steel Loads

What the Law requires

Under Health and Safety Legislation, a vehicle is a place of work. The law requires that workplaces are maintained in a condition that is safe and without risk to safety and health. Employers have duties under the Safety, Health and Welfare at Work Act 2005 to ensure, so far as is reasonably practicable, the health and safety of their employees and others who may be affected by their work activities (other road users). This includes providing systems of work that are planned, organised, performed, maintained and revised.



Road Traffic law requires

Every load carried by a vehicle in a public place shall be of such a weight and size and so distributed, packed, adjusted and attached to the vehicle that, so far as can reasonably be foreseen, no danger is liable to be caused and that there is no interference with the stability of vehicle. In the case of mechanically propelled vehicles and trailers, no load carried shall exceed a reasonable weight, having regard to the engine capacity, brakes, tyres and general construction of the vehicle[1].

Structural Steel Loads

Steel is a high-density; high-risk load and the consequences of load shift can be extremely serious. Loads that are not firmly anchored to the load bed can shift during transport. This can make them unsafe. Movement of the load endangers:

- the driver, if the load slides forward during the journey or shifts sideways and causes the driver to lose control of the vehicle;
- other road users or pedestrians, if the load shifts sideways or slides backwards and falls off the vehicle; and
- unloading personnel, if the load has become unstable during the journey and collapses during unloading.

[1] *S.I. No. 190/1963: ROAD TRAFFIC (CONSTRUCTION, EQUIPMENT AND USE OF VEHICLES) REGULATIONS, 1963, Reg 96*

HEALTH AND SAFETY AUTHORITY
www.hsa.ie

www.garda.ie

RSA
Údarás Um Shábháilteacht Ar Bhóithre
Road Safety Authority
www.rsa.ie

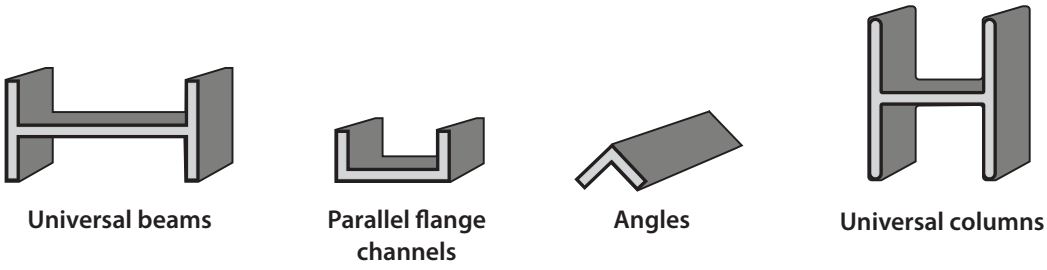


Figure 1. Examples of structural steel sections

Loads can be restrained by two basic methods, 'Tie-down' or 'Direct restraint'.

Tie-down is when the load is prevented from moving by friction only, also called a 'frictional lashing'. It is an indirect method of restraint.

Direct restraint is when the load is prevented from moving by containing, blocking or attaching it to the vehicle.

Even though steel is heavy, **the weight of the load alone cannot not be relied on to hold it in place**. If the load lifts off the bed, even momentarily, static friction is lost. Therefore friction alone cannot be relied upon to hold a steel load in place. For steel loads the use of the 'Tie-down' method which relies on the combined friction generated by the weight of the load and the 'Tie-down' force of the lashings is **not recommended.**

The most appropriate approach to secure steel loads is using a combination of the Tie-down and Direct restraint methods. The use of 'Anti-slip' load matting between the load and the load bed will ensure maximum coefficient of friction values can be achieved for the calculation of the number of lashings, and reduce the number of lashings needed.

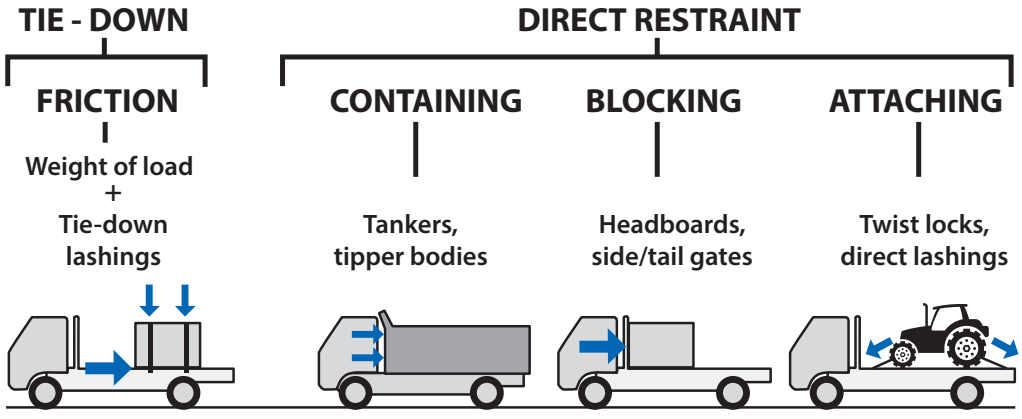
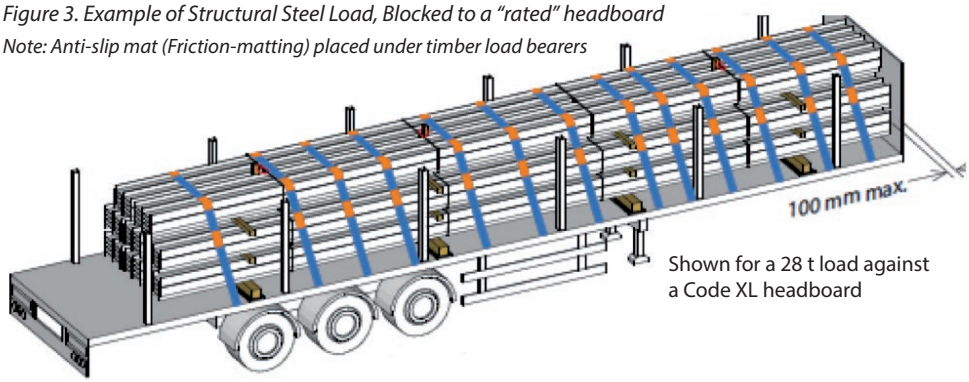


Figure 2. Load restraint methods (To control forward motion)

Figure 3. Example of Structural Steel Load, Blocked to a "rated" headboard
Note: Anti-slip mat (Friction-matting) placed under timber load bearers



Use of Headboards

Where possible, steel should be loaded so that it is against the headboard of the vehicle. This enables the headboard to become part of the load securing system by blocking the load from moving forward under braking or emergency conditions. This will also allow for fewer lashings being required, than for a load loaded away from the headboard. The headboard should be strong enough to prevent the load from moving[2]. The headboard offers critical protection to the driver, therefore the load should not be loaded above the height of the headboard unless precautions have been taken to stop it moving forward.

If it is not possible to load to the headboard or:

- there is no headboard in place
- there is inadequate headboard strength, or
- the load is designed for loading away from headboard

then there is a need to ensure that the load is secured adequately to stop it sliding forward uncontrollably.

This will usually result in need to use more lashings on the load or in conjunction, use alternatives such as blocking, loop lashings, or construction of an intermediate bulkhead at front end of load to stop it moving forward.

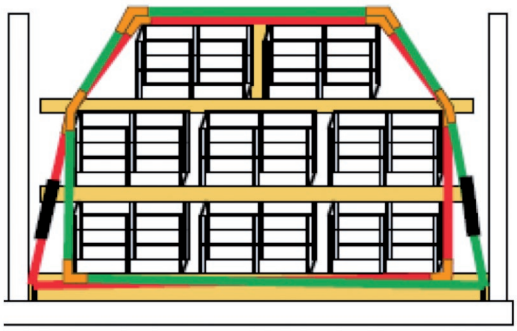
Figure 4.
Integrated System employed as a temporary headboard

Figure 5. Inadequate headboard: No Blocking capacity

[2] *Best practice suggests the strength of the superstructure should meet the requirements laid down in EN 12642 (L-XL). In addition, the end wall should be able to withstand 40% of the payload, up to a maximum of 50 KN*

Lashings

Once loaded, the load should be secured with a suitable number of lashings. It is very important to make sure that all parts of the load are secured. Building the load into a 'pyramid' shape can help to make sure that the lashings remain in contact with the whole load and prevent individual items from sliding or toppling. Loop lashing ('belly wrapping') is particularly useful in securing bundled steel products.



A pair of opposing loops using webbing straps and tensioners

Figure 6. Pyramid load configuration using loop web lashings

- ✓ Opposing loops must be applied in pairs.
- ✓ Opposing loops should be placed around the full load.
- ✓ A pair of opposing loops needs two tensioners; one for each webbing strap.
- ✓ Avoid any excess slack in the lashing.

Webbing straps and ratchets

When designing a restraint system and determining the required number of restraints, it is the lashing capacity and not the breaking force which must be taken into account.

- Lashing capacity = *Maximum allowable tension in the lashing.*
- Breaking force = *Maximum force the web lashing withstands when tested complete with ratchet and end fittings.* The breaking force of the lashing assembly will be twice the lashing capacity.
- Lashing capacity is NOT to be mistaken for the allowable weight of product the lashing can safely restrain.
- A 2-tonne lashing capacity webbing strap will be denoted by LC 2000daN.

Requirements

- Straps should comply with the **EN12195-2** standard, by means of a label on the web lashing and a classification on the ratchet.
- The strap must have a hand-operated ratchet tensioner.
- The length of the straps has to be sufficient for the securing method.
- Straps should be visually inspected before every journey.
- The end fitting of the strap (Web Lashing) must be suitable for the type of lashing point used[3].
- Web lashings must not be attached to rope hooks.

Lashing capacity	**LC.... daN**
Standard hand force* Standard tension force	**S_{HF} 50 daN** **S_{TF} .... daN**
Webbing material	**POLYESTER**
Length	**...m**
	"NOT FOR LIFTING"
Name of manufacturer or supplier	
Manufacturer's traceability code	**CODE NR #### ####**
Year of manufacture	**DD MM YYYY**
Standard	**BS EN 12195-2**

Figure 7. Webbing strap with label description

[3] *The lashing points should comply with EN 12640 and must be attached to the vehicle at approximately 50 cm intervals.*

Edge protection is needed to protect the strap from sharp or abrasive edges of the product or trailer. Failure to apply appropriate edge protection to the strap introduces the risk of cutting the strap and losing some or all of the restraint on the product. Edge protection also reduces the stress on the outer fibres of the strap by increasing the radius of the corner. Using the strap over a tight corner without edge protection will reduce strap strength significantly.

Figure 8. Correct use of edge protectors on web lashings

Transport chains and tensioners

When designing a restraint system and determining the required number of restraints, it is the lashing capacity and not the breaking force which must be taken into account.

- Lashing capacity = *the maximum allowable tension in the chain.*
- Lashing capacity is NOT to be mistaken for the allowable weight of product the lashing can safely restrain.
- A 4-tonne lashing capacity chain will be denoted by LC 40kN.

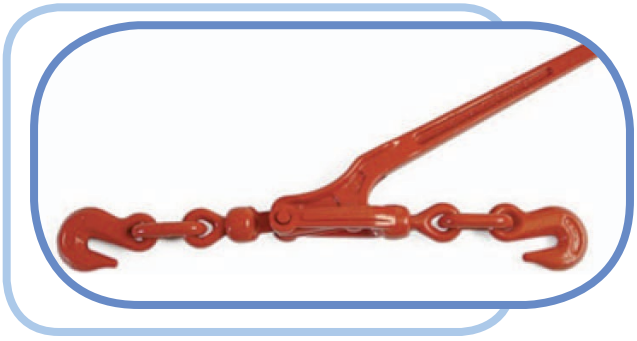


Figure 9. Over center load binder (Not Recommended)

Breaking force = *Maximum force the complete chain lashing, including load binder and connection components, can withstand.* The breaking force of the lashing assembly will be twice the lashing capacity.

Requirements

- Lashing chains must comply with the **EN12195-3 standard,** identified by means of a metal tag attached to the chain.
- Lashing chains should be visually inspected before every journey.
- The use of spring links (over centre load binders) is not advised due to kick back hazard. (Figures 9 and 10)
- The end fitting of the chain must be suitable for the type of securing point used.

Number of Lashings needed

The number of lashings needed can be calculated using the procedures outlined in the EN 12195 standard[4]. This will depend on the nature of the load (weight, dimensions, centre of gravity), the static friction between the load and the load bed, the securing method used (Direct, Indirect or combination of both) and the rated capacity of the lashings employed. The following tables give an indication[5] of lashings required when using selected chain and web lashings using two different friction values when the load is blocked and unblocked in the forward direction.

WARNING: Because of different behaviour and elongation under load conditions, chain lashings and web lashings must not be used to secure the same load. Consideration shall also be given to ancillary fittings (components) and lashing devices in the load restraint assembly, to ensure compatibility with the lashings being used.

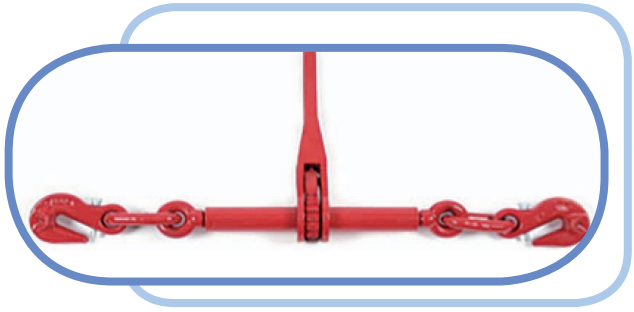


Figure 10. Bottle tensioner (Recommended)

[4] The European Standard **EN 12195 (1-4)**, *"Load restraint assemblies on road vehicles"*

[5] For detailed calculations refer to **EN 12195** and associated guidance

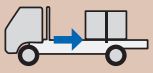
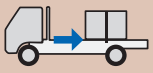
MAXIMUM WEIGHT EACH 50mm WEBBING STRAP CAN RESTRAIN					
FRONT OF LOAD BLOCKED?		NO		YES	
HOW MUCH FRICTION?		MEDIUM μ = 0.4 (Smooth Steel on Timber)	HIGH μ = 0.6 (Rubber Load Mat)	MEDIUM μ = 0.4 (Smooth Steel on Timber)	HIGH μ = 0.6 (Rubber Load Mat)
Minimum average strap tension 300kg					
STRAP ANGLE	ANGLE EFFECT (E)				
90°	1.0	600kg	1800kg	2400kg	3000kg
60° to 90° approx.	0.85 to 1.0	510kg	1530kg	2040kg	2550kg
45° to 60° approx.	0.70 to 0.84	420kg	1260kg	1680kg	2100kg
30° to 45° approx.	0.50 to 0.69	300kg	900kg	1200kg	1500kg
15° to 30° approx.	0.25 to 0.49	150kg	450kg	600kg	750kg

Table 1. Max load restrained by one 50mm Web lashing

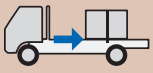
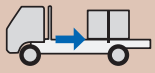
MAXIMUM WEIGHT EACH 8mm CHAIN CAN RESTRAIN					
FRONT OF LOAD BLOCKED?		NO		YES	
HOW MUCH FRICTION?		MEDIUM μ = 0.4 (Smooth Steel on Timber)	HIGH μ = 0.6 (Rubber Load Mat)	MEDIUM μ = 0.4 (Smooth Steel on Timber)	HIGH μ = 0.6 (Rubber Load Mat)
Minimum average chain tension 750kg					
CHAIN ANGLE	ANGLE EFFECT (E)				
90°	1.0	1500kg	4500kg	6000kg	7500kg
60° to 90° approx.	0.85 to 1.0	1275kg	3825kg	5100kg	6375kg
45° to 60° approx.	0.70 to 0.84	1050kg	3150kg	4200kg	5250kg
30° to 45° approx.	0.50 to 0.69	750kg	2250kg	3000kg	3750kg
15° to 30° approx.	0.25 to 0.49	375kg	1125kg	1500kg	1875kg

Table 2. Max load restrained by one 8mm chain

Load Securing Standards

The European Standard **EN 12195 (1-4) as amended**, "Load restraint assemblies on road vehicles" is accepted as giving a safe level of cargo securing for road transport operations.

Further information and Guidance

The following website contains links to further information, including European Community "Best Practice" and International Industry guidelines: **www.loadsafe.ie**