March 2016

LOAD SAFETY SERIES

Information Sheet

Safe Load Securing of Precast Concrete 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 vehicles capability; brakes, tyres and general construction of the vehicle.[1]

So, vehicle owners and operators need to ensure compliance with both health and safety and road traffic legislation if they are involved in loading, unloading or transporting loads of any type on their vehicles.

Pre-cast Concrete Loads

Precast Concrete products are high-risk loads and the consequences of load shift can be extremely serious. Loads that are not firmly anchored to the load bed may 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 including pedestrians, if the load shifts sideways or slides backwards and falls off the vehicle.
- Unloading personnel, if the load has become unstable during the journey and collapses during unloading.

Load Restraint Methods

Loads can be restrained by two basic methods, either indirectly or directly using 'Tie-down' or 'Direct restraint' methods respectively.

Tie-down is when the load is prevented from moving by friction only, also called a 'frictional lashing'.

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

Figure 1. Example of correctly secured Precast Concrete load using chains

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

Even though concrete 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 the load in place. For Precast Concrete 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 alone is **not recommended**.

The most appropriate approach to secure Precast Concrete Loads is using a **combination** of the 'Tie-down' and 'Direct restraint' methods. Combining these methods to use suitable lashings (to increase friction), suitable headboard (to provide blocking) and side stanchions (to provide containment) is the optimal approach to secure the load. The use of 'Anti-slip' load matting between the load and the load bed can ensure maximum coefficient of friction values are achieved for the calculation of the number of lashings, and reduce the number of lashings required.

Use of Headboards

Where possible, Precast Concrete components should be loaded so that they are positioned 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. The **headboard** should be strong enough to prevent the load from moving.[2] The headboard gives critical protection to the driver, so the load should not be loaded above the height of the headboard unless precautions have been taken to stop it moving forward.

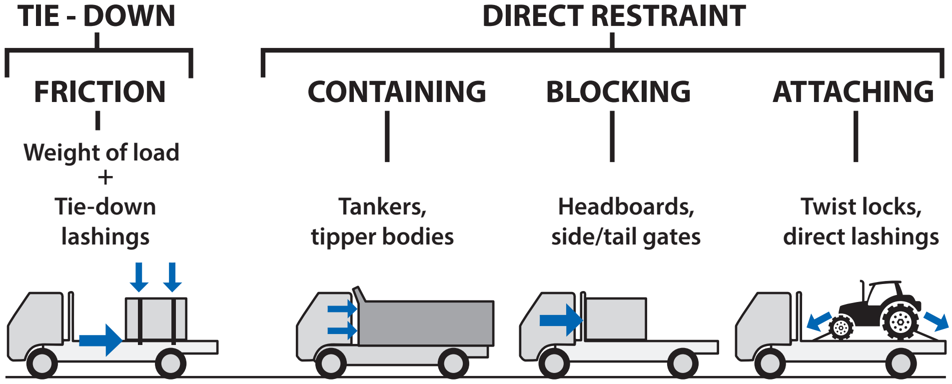

Figure 2. Load restraint methods (To control forward motion)

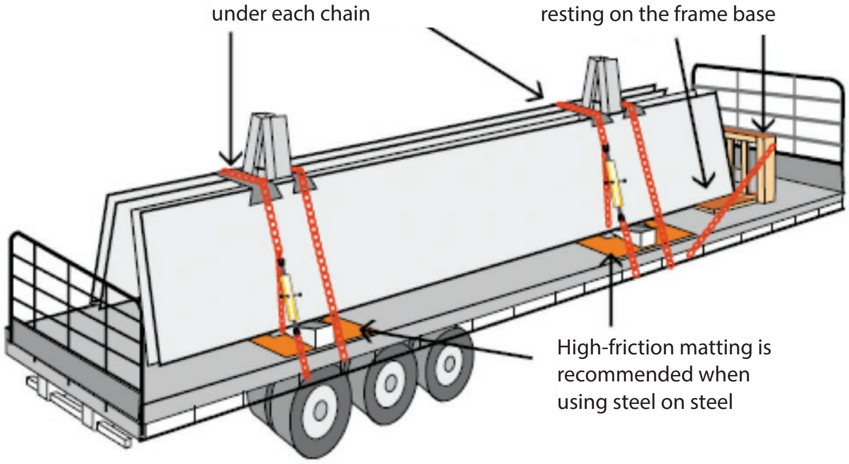

Figure 3. Example of a Concrete Panel Load, Blocked to a "temporary" headboard

Anti-slip mat (Friction mat) placed under timber load bearers

[2] Best practice suggests that 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

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

- there is no headboard in place,
- the headboard strength is inadequate, 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 lead to the requirement to use more lashings on the load or, in conjunction, use alternatives such as blocking, loop lashings, or construction of an intermediate bulkhead at the front end of the load to stop it moving forward.

Figure 4. No Blocking Capacity

Figure 5. Example of moveable Blocking Frame to prevent forward movement

Lashings

Very rigid loads, such as pre-cast floor sections and concrete beams, should be supported in only two positions to allow the vehicle to flex. If the lashings are placed between the dunnage[3] positions they can break or loosen when the vehicle and/or the load flexes. This could allow the load to move. **Note: In these cases the Lashings (x2) must be of sufficient capacity to prevent the load from moving or alternatively be supplemented by use of Headboard, Side stanchions, End protection or moveable blocking frame.**

Once loaded, the load should be secured with a suitable number of lashings. It is very important to ensure that all parts of the load are secured. Building the load into a 'pyramid' shape can help to ensure that the lashings remain in contact with the whole load and prevent individual items from sliding or toppling.

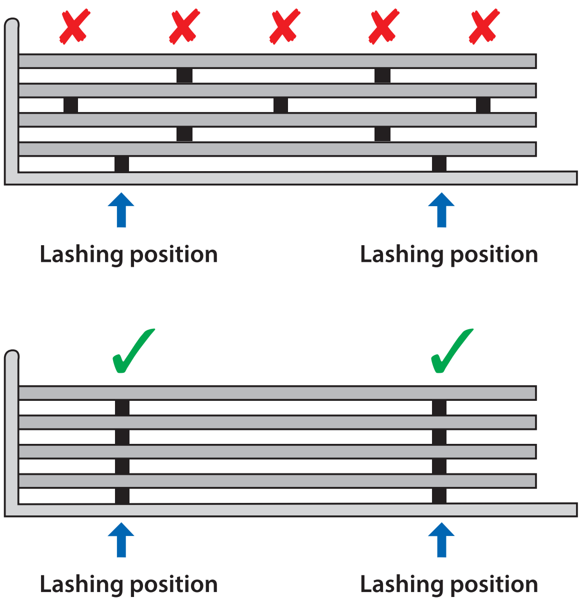

Figure 6. Positioning of Dunnage

[3] loose wood, matting, or similar material used to support and/or keep a cargo in position.

Webbing straps and ratchets

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

When designing an indirect (tie-down) restraint system, it is the standard tension force (STF), not the lashing capacity of the strap, which is relevant for the calculation of the number of straps needed.

Lashing capacity = *Maximum allowable tension in the strap.*

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.
- A 2-tonne lashing capacity webbing strap will typically allow an STF of between 300 – 600kg[4].

Requirements for webbing straps

- Straps must comply with the **EN12195-2 standard**, by means of a label on the web strap 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[5].
- They must not be attached to rope hooks.

Edge protection is required 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.

Lashing capacity	LC.... daN
Standard hand force* Standard tension force	SHF 50 daN STF .... 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

Figure 8. Load secured with chain and tensioners

[4] See Table 1 for examples using an STF of 300kg at differing strap angles, friction coefficients and presence of blocking.

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

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 or LC 4000dan

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,** confirmed by means of a metal tag attached to the chain containing details.
- 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. (Figure 9 and 10).
- The end fitting of the chain must be suitable for the type of securing point used.

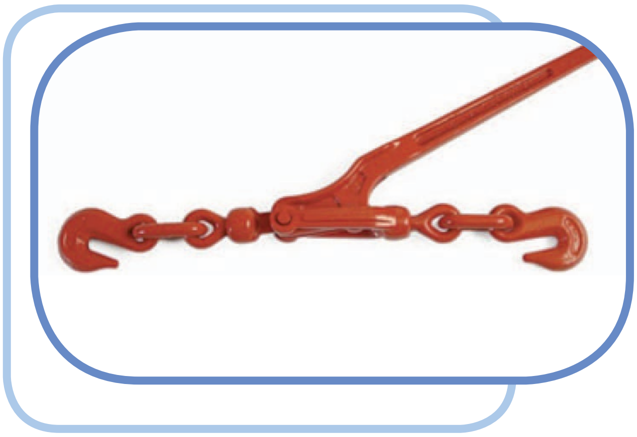

Figure 9. Over centre load binder (Not Recommended)

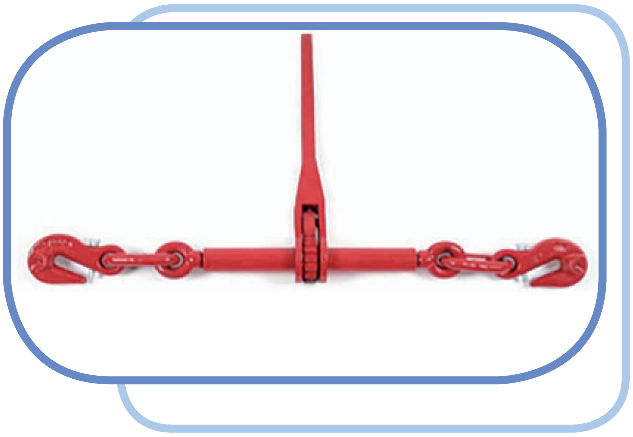

Figure 10. Bottle tensioner (Recommended)

Number of Lashings required

The number of lashings required can be calculated using the procedures outlined in the EN 12195 standard[6]. 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 employed (Direct, Indirect or combination of both) and the rated capacity of the lashings employed. The following tables give an indication[7] 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.

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

[7] 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 $\mu = 0.4$ (Smooth Steel on Timber)	HIGH $\mu = 0.6$ (Rubber Load Mat)	MEDIUM $\mu = 0.4$ (Smooth Steel on Timber)	HIGH $\mu = 0.6$ (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 Strap Web lashing; Tie-down system

MAXIMUM WEIGHT EACH 8mm CHAIN CAN RESTRAIN					
FRONT OF LOAD BLOCKED?		NO		YES	
HOW MUCH FRICTION?		MEDIUM $\mu = 0.4$ (Smooth Steel on Timber)	HIGH $\mu = 0.6$ (Rubber Load Mat)	MEDIUM $\mu = 0.4$ (Smooth Steel on Timber)	HIGH $\mu = 0.6$ (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; Tie-down system

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