March 2016

LOAD SAFETY SERIES

Information Sheet

Safe Load Securing of Plant and Machinery

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 the 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].

Plant and Machinery Loads

Due to their size and weight, plant and machinery are considered to be high-risk loads where the consequences of load shift or load shed 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;
- Unloading personnel, if the load has become unstable during the journey and moves uncontrolled 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. Transport of mobile machinery

Selection of Carrying Vehicle

Small vehicles, and mobile equipment may be carried on general freight vehicles.

Loads with a high centre of gravity can seriously affect the vehicle's stability and such machinery should only be transported on vehicles with a low platform height

This will keep the centre of gravity as low as possible to make sure maximum vehicle stability is maintained. Heavy Plant, machinery and mobile equipment can include rubber tyred, solid wheeled and tracked vehicles. They can vary considerably in size and weight.

Load Restraint Methods

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.

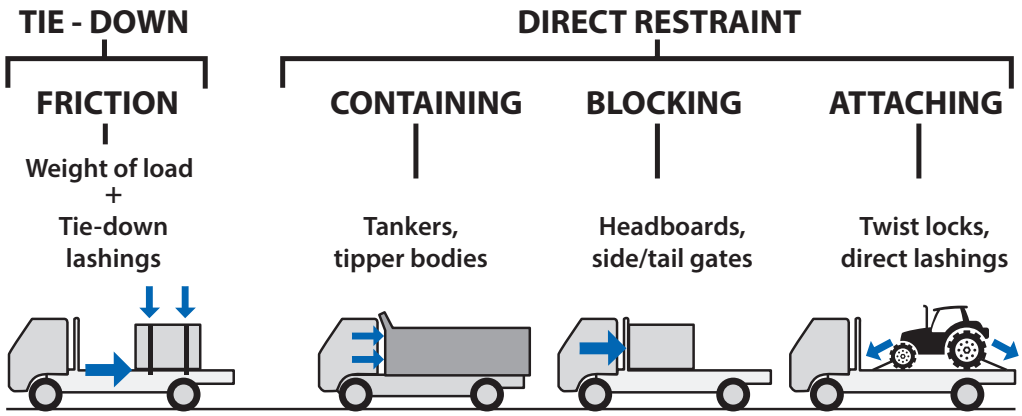

Figure 2. Load restraint methods

Even though these loads are 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 Plant and Machinery loads in place. Rubber tyred and rubber tracked vehicles can be restrained using tie-down in the sideways direction, but not in the forward or rearward directions. The friction between wheels and tracks on loading decks can be extremely low, especially when wet or greasy.

Therefore for these loads, the use of the 'Tie-down' method **only**, 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 appropriate method to secure Plant and Machinery is by using a 'Direct restraint' method. Using **direct lashings**, and/or blocking (to a suitable headboard or gooseneck/swan-neck) wherever possible (Fig 3.).

Tracked and wheeled vehicles should be directly restrained in the forward and rearward directions by suitable lashings. In the case of extremely heavy equipment, the combination of direct restraint and tie-down can be used. Heavy Plant and mobile equipment can also be restrained by containing them within the body structure of the carrying vehicle.

Use of Headboards and/or Gooseneck

Where possible, plant and machinery loads should be loaded so that they are against the headboard or gooseneck of the vehicle/trailer body. 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.

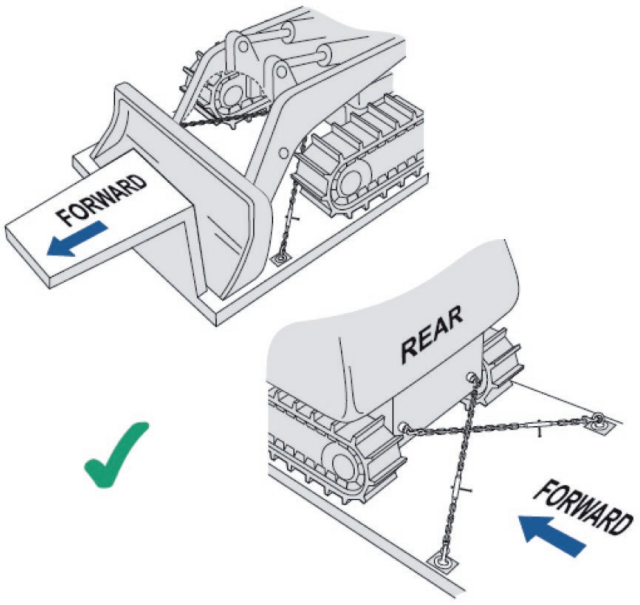

Fig.3 Example Direct restraint and Blocking (Cross lashing also prevents sideways movement)

Fig.4 Example of Direct Lashing

[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*

Direct lashings

Once loaded, the load should be secured with a suitable number of direct lashings. It is very important to make sure that all parts of the load are secured. All moveable assemblies such as jibs, brackets, booms and cabs etc. must be left in the position recommended for transportation by the manufacturer and must be secured to prevent movement relative to the main body of the machine.

The machine should be restrained against forward, backward and sideways movement by chain or webbing lashings[3] attached to anchorage points on the vehicle. All lashings should incorporate some form of tensioning device.

In deciding the number of anchorage points to be used when arranging a restraint system, the following factors should be considered:

- The need to position the machine to achieve the correct load distribution to meet the legal axle load requirements and to ensure that the vehicle's handling is not impaired.
- The extent to which other load restraint features is incorporated in the design of the vehicle.
- Whether the machine has wheels, tracks or rollers.
- The weight of the machine to be carried.
- A minimum of four lashings should be used.
- A minimum of four separate anchorage points should be used.
- Top-over lashings placed over the top of the driver cabin or covers of mobile machines are not recommended.

WARNING: Vehicles should never be driven, no matter how short a distance, with any equipment extended or in an unlocked position.

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 identified by means of a label on the web lashing which shows the rated capacity 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[4].
- 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 5. Webbing strap with label description

[3] *Lashing Steel Wire ropes complying with EN12195-4 may also be used, but are not covered in this information sheet.*

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

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, which shows the rated capacity.
- 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 6 and 7).
- The end fitting of the chain must be suitable for the type of securing point used.

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.

Strength of Lashings (Capacity) needed

A minimum of 4 lashings are needed, The following load tables allow selection of the minimum size of chain required when two chains are used to prevent movement in a particular direction. The lashing capacity is listed for loads from 100 kg to 30 tonnes. Heavier loads and poor lashing angles[5] will require a higher capacity chain. A recommended angle for direct lashings is a slope of 1 in 2 or approximately 25 degrees to the horizontal.

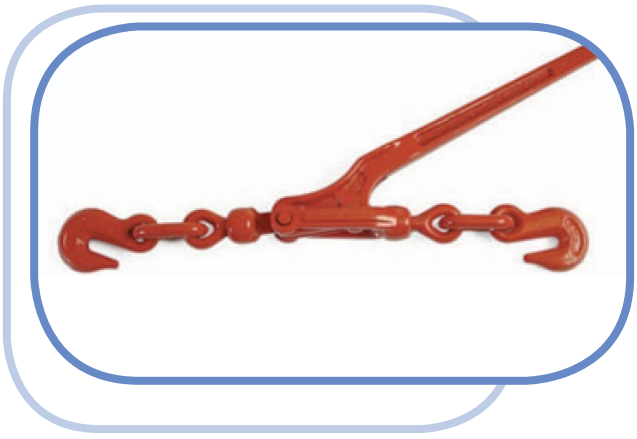

Figure 6. Over center load binder (Not Recommended)

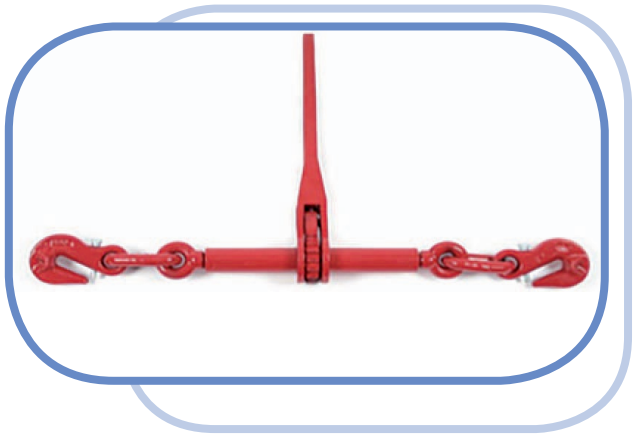

Figure 7. Bottle tensioner (Recommended)

[5] See lashing angle effect footnote 6.

MINIMUM LASHING CAPACITY - DIRECT RESTRAINT FORWARDS (0.8W) USING TWO CHAINS			
MASS OF LOAD	MINIMUM LASHING CAPACITY		
(KILOGRAMS)	E = 0.85 to 1.0	E = 0.70 to 0.84	E = 0.50 to 0.69
100	48	53	80
200	95	115	160
300	142	172	240
400	189	229	320
500	236	286	400
750	353	429	600
1000	471	572	800
1500	706	953	1200
2000	942	1143	1600
(TONNES)			
3	1.5	1.8	2.4
4	1.9	2.3	3.2
5	2.4	2.9	4.0
6	2.9	3.5	4.8
7	3.3	4.0	5.6
8	3.8	4.6	6.4
9	4.3	5.2	7.2
10	4.8	5.8	8.0
11	5.2	6.3	8.8
12	5.7	6.9	9.6
13	6.2	7.5	10.4
14	6.6	8.0	11.2
15	7.1	8.6	12.0
16	7.6	9.2	12.8
17	8.0	9.8	13.6
18	8.5	10.3	14.4
19	9.0	10.9	15.2
20	9.5	11.5	16.0
21	9.9	12.0	16.8
22	10.4	12.6	17.6
23	10.9	13.2	18.4
24	11.3	13.8	19.2
25	11.8	14.3	20.0
26	12.3	14.9	20.8
27	12.8	15.5	21.6
28	13.2	16.0	22.4
29	13.7	16.6	23.2
30	14.2	17.2	24.0

Table1. Shows the minimum strength (lashing capacity) required for each of two chains directly restraining forward movement.[6]

MINIMUM LASHING CAPACITY - DIRECT RESTRAINT SIDEWAYS (0.5W) USING TWO CHAINS			
MASS OF LOAD	MINIMUM LASHING CAPACITY		
(KILOGRAMS)	E = 0.85 to 1.0	E = 0.70 to 0.84	E = 0.50 to 0.69
100	30	36	50
200	59	72	100
300	89	108	150
400	118	143	200
500	148	179	251)
750	221	268	375
1000	295	358	500)
1500	442	536	750
2000	589	715	1000
(TONNES)			
3	0.9	1.1	1.5
4	1.2	1.5	2.0
5	1.5	1.8	2.5
6	1.8	2.2	3.0
7	2.1	2.5	3.5
8	2.4	2.9	4.0
9	2.7	3.3	4.5
10	3.0	3.6	5.0
11	3.3	4.0	5.5
12	3.6	4.3	6.0
13	3.9	4.7	6.5
14	4.2	5.0	7.0
15	4.5	5.4	7.5
16	4.8	5.8	8.0
17	5.0	6.1	8.5
18	5.3	6.5	9.0
19	5.6	6.8	9.5
20	5.9	7.2	10.0
21	6.2	7.5	10.5
22	6.5	7.9	11.0
23	6.8	8.3	11.5
24	7.1	8.6	12.0
25	7.4	9.0	12.5
26	7.7	9.3	13.0
27	8.0	9.7	13.5
28	8.3	10.0	14.0
29	8.6	10.4	14.5
30	8.9	10.8	15.0

Table 2. Shows the minimum strength (lashing capacity) required for each of two chains directly restraining sideways or rearwards movement

Load Securing Standards

The European Standard **EN 12195 (1-4)** "Load restraint assemblies on road vehicles" is accepted as giving a safe level of cargo securing for road transport operations. These need to be read in conjunction with other applicable standards[7].

Further information and Guidance

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

www.loadsafe.ie

[6] E = Lashing angle effect = ratio of horizontal distance between lashing points & length of lashing (0.5 -1.0)

[7] *See www.loadsafe.ie for further information on standards*