SECTION H

Load-Restraint Equipment

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Section H - Load Restraint Equipment

This Section contains general design and selection information for load restraint equipment. It is intended for equipment manufacturers and suppliers, and vehicle owners and operators.

Load restraint equipment includes ropes, webbing, strapping, nets, chains and associated fittings, and attachments such as hooks, clamps, turnbuckles, tensioners and winches.

To avoid confusion with strength ratings assigned for lifting purposes, the term 'Lashing Capacity (LC)' is used to define load restraint capacity in preference to any of the following terms, viz. Maximum Working Load (MWL), Working Load Limit (WLL), and Rated Assembly Strength (RAS).

The lashing capacity of load restraint equipment is defined in the relevant Australian Standards.

Section B *'Arranging Loads on Vehicles'* and Section C, *'Restraining Loads on Vehicles'* contain the requirements which should be taken into account when considering the suitability, serviceability and use of load restraint equipment.

Section F *'Calculating Restraint Requirements'* contains the methods of selecting the load restraint equipment based on strength requirements.

1 SYNTHETIC ROPE

The selection of the appropriate rope for restraining loads is very important because there are a number of unsuitable ropes on the market, of unknown strength and quality that are not intended to be used as transport lashings.

Only fibre ropes that comply with *Australian Standard AS/NZS 4345 'Motor vehicles - Cargo Restraint Systems - Transport Fibre Rope'* (see Section J) should be used.

Sisal and manila ropes do not comply with the above requirements and should not be used for restraining loads on vehicles.

When assessing the serviceability of ropes in relation to the Australian Standard, they must be examined at about every metre of their length, both externally and between the strands.

If any of the following conditions exist, the rope must be replaced:

(i) Ropes weakened by 10% or more of their original minimum breaking strength by wear or mechanical damage caused by excessive loading, knotting and bending.

(ii) Ropes weakened by 10% or more of their original minimum breaking strength by exposure to chemicals, including acid and alkaline solutions and organic solvents. The chemicals weaken or soften the rope fibres, which can then be easily rubbed or plucked off.

(iii) Ropes weakened by 10% or more of their original minimum breaking strength by exposure to high temperatures.

(iv) Ropes weakened by 10% or more of their original minimum breaking strength by prolonged exposure to sunlight or ultraviolet light.

This damage can be recognised by the hairy appearance of the fibres.

2 WEBBING ASSEMBLIES

Webbing assemblies with either attached or in-line ratchet winches should be manufactured to comply with *Australian Standard AS/NZS 4380, 'Motor vehicles - Cargo Restraint Systems - Transport Webbing & Components'* (see Section J).

When selecting webbing equipment it is important to ensure that the assembly components have an adequate lashing capacity for the application.

Webbing assemblies include load rated webbing material with specified stitching and sewing patterns, together with end fittings and tensioning devices.

When assessing the serviceability of webbing and attachments in relation to the Australian Standard, if any of the following conditions exist, the webbing or attachment must be replaced:

(i) Webbing weakened by 10% or more of its original minimum breaking strength, by wear, damage, or stitching failure caused by excessive loading, knotting and bending.

(ii) Webbing weakened by 10% or more of its original minimum breaking strength by exposure to chemicals, including acid and alkaline solutions and organic solvents.

(iii) Webbing weakened by 10% or more of its original minimum breaking strength by exposure to high temperatures.

(iv) Webbing weakened by 10% or more of its original minimum breaking strength by prolonged exposure to sunlight or ultraviolet light. This damage can be recognised by the hairy appearance of the fibres.

(v) Webbing repaired in a manner not approved by the manufacturer.

(vi) Any attachments (tensioner, hook and keeper, etc.) weakened by 10% or more, or, prevented from functioning by wear, damage or corrosion.

Note: Wear caused by chafing over rough surfaces causes a furry appearance on the webbing, and may lead to broken load-bearing fibres.

Damage caused by cuts and abrasions, resulting in broken load-bearing fibres is often localised to areas where the webbing contacts the load and coaming rails.

3 CHAIN ASSEMBLIES

The suitability of chain is determined by its size, strength, hardness and elongation. Chains manufactured from low strength materials are heavier, bulkier and more prone to damage and wear than higher tensile chain.

Chain assemblies should be manufactured to comply with *Australian Standard AS/NZS 4344, 'Motor vehicles - Cargo Restraint Systems – Transport Webbing & Components'* or *AS 2321 'Short-link Chain for Lifting Purposes',* (see Section J).

Some chain tensioning systems, which can 'kickback' are dangerous and can cause injury to the operator. Alternative tensioners are available.

When assessing the serviceability of chains and attachments in relation to the Australian Standard, if any of the following conditions exist, the chain or attachment must be replaced:

(i) Any link weakened by wear, damage or corrosion which reduces its diameter by more than 10%.

(ii) Any bent, twisted, stretched or collapsed link.

(iii) Any link repaired by welding (except when approved by the original manufacturer) or any unsuitable repair link or joined by a bolt or wire.

(iv) A knot in any portion of the chain.

(v) Any attachment (turnbuckle, load binder, grab hook, etc.) weakened or prevented from functioning by wear, damage or corrosion.

Chains should be joined using a joining link rated with a rating at least equal to the lashing capacity of the chain.

4 WIRE ROPE AND ATTACHMENTS

Steel wire rope with appropriate end fittings and tensioning winches can be used to effectively secure certain loads. Its greater elasticity makes it more suitable than chain for loads which settle during transport.

Australian Standard AS 3569 'Steel Wire Ropes' (also see Section J) specifies requirements for steel wire ropes for all purposes and also specifies materials, manufacture, marking, packing and test requirements.

The manufacturers' rating of wire rope manufactured in accordance with *Australian Standard AS 3569 'Steel Wire Ropes'*, or other equivalent International Standard, should be no greater than one-third of its specified minimum breaking strength.

When assessing the serviceability of wire ropes and attachments in relation to the relevant Standards (see Section J), if any of the following conditions exist, the rope or attachment must be replaced:

(i) Any rope length equivalent to 3 rope diameters containing more than 4 broken wires.

(ii) Any rope length equivalent to 6 rope diameters containing more than 6 broken wires.

(iii) Any rope length equivalent to 30 rope diameters containing more than 16 broken wires.

(iv) Any rope where the diameter is reduced by more than 10% by abrasion.

(v) Any rope which has been crushed or flattened by more than 15% of its nominal diameter.

(vi) Any rope which is significantly notched or kinked.

(vii) Any rope weakened by corrosion.

(viii) Any attachment (shackle, thimble, turnbuckle, hook, etc.) weakened or prevented from functioning by wear, damage or corrosion.

5 STRAPPING

Strapping can be effectively used to restrain some loads. Steel strapping has a high-tensile strength and can be highly pre-tensioned using manual or power operated tensioners.

For example, 32 mm wide strapping with 0.8 mm minimum thickness has a minimum breaking strength of 2.32 tonnes and can be readily tensioned to 650 kg force. The typical joint strength of 1.6 tonnes is lower than the strapping strength and determines the breaking strength of the lashing assembly.

Loads with low frictional surfaces require high clamping forces for effective restraint. Steel strapping is therefore very suitable for unitising and lashing 'heavy and slippery' loads on container flats or bases.

The manufacturers' rating of a steel strapping assembly for lashing purposes should be no greater than half of its specified minimum breaking strength.

Further requirements for strapping are contained in *Australian Standard AS 2400.13 'Packaging - Tensional Strapping'* (see Section J).

6 LASHING TENSIONERS AND CONNECTORS

Webbing, chain and wire rope lashing assemblies all require mechanical tensioners and connectors, which should be manufactured and marked to recognised standards (see Section J). The marking will ensure traceability in case of product failure.

The lashing capacity of tensioners and connectors manufactured from steel should be no greater than half of their specified minimum breaking strength.

Tensioners and connectors should exhibit no permanent deformation and should be fully functional after being subjected to a force equal to 1.25 times their lashing capacity.

Tensioners should be designed so that the tension in the lashing cannot be inadvertently released and so that any 'kickback' which could cause injury to the operator is minimised.

Powered winches can be utilised for many applications. They can offer continuous automatic self-tensioning of the load during transport.

7 INTER-LAYER PACKING

Parts of a load can be separated by inter-layer packing. The inter-layer packing can take various forms including protective wrapping, cardboard, carpet, 'anti-slip' mats rubber matting, plywood and timber dunnage.

High friction inter-layer packing can increase friction between most surfaces and significantly reduce the number of tie-down lashings required to restrain a load.

Some inter-layer packing such as plastic wrapping, can be very slippery. This can significantly increase the number of tie-down lashings required.

Rubber matting can be natural or synthetic rubber plain sheet, or 'honey-combed' mat made from recycled tyres (anti-slip load mat). Anti-slip mat is very effective in increasing friction between loads and vehicles, especially when dry and hot. Conveyor belt material is generally not suitable for use as an anti-slip mat because it is made for wear resistance and can be too slippery.

The friction coefficient obtained with most loads on anti-slip rubber matting is usually more than 0.6, but can be lower than 0.45 with slippery loads such as some coated pipe.

8 DUNNAGE, BLOCKING TIMBER, CHOCKS, AIR BAGS AND TYRES

8.1 Timber

Timber used as dunnage, chocks, cradles or for blocking loads, should be carefully specified for each application. It should be strong enough to withstand being split or crushed by the load.

The timber selected should be relatively free of knots and splits.

Where steel strapping passes over sharp corners on the end of timber dunnage, these corners should be rounded or bevelled to prevent the timber being crushed. If the timber crushes the strapping will loosen.

8.2 Dunnage

The size selected should be based on the load and the maximum span between support points.

Square dunnage may be adequate for some purposes however rectangular dunnage is preferred, as long as the dunnage rests on a wide face (See Section B.4, page 46).

Where timber is used for dunnage, it is important to select the appropriate dunnage timber (the variety of hardwood/softwood, dressed/rough sawn) to maximise the friction between it, the load and the vehicle.

8.3 Inflatable Dunnage (Air Bags)

Inflatable air bags (disposable or reusable) are available in a wide variety of sizes and can be used to effectively restrain and separate loads contained in van bodies and shipping containers.

Air bags, also referred to as 'pneumatic load control systems' should be used strictly in accordance with the manufacturers' instructions.

8.4 Tyres

Rubber tyres can be used to separate contained loads. They can be used as wheel chocks on vehicles and mobile equipment restrained with tie-down lashings. Rubber tyres or parts of tyres can be used under heavy loads to increase friction for tie-down.

Typial damaged webbing straps (see Section H.2 for allowable wear).

The steel straps on this 15 tonne steel coil broke allowing the centre of the coil to spear outwards, causing the trailer to roll over.

This photo is a close-up of a tyre wedged between a large steel tipping body (see below) and the steel gooseneck of a trailer. The rubber tyre will act in a similar way to a rubber load mat and considerably reduces the amount of tie-down and/or additional direct restraint needed.

The plastic wrapping on the palletised cartons failed and allowed the cartons to dislodge. The ropes and cap tarpaulin are not suitable for restraining this load.

1 The red items are lugs and fittings for direct restraint. They are bolted or welded to the load and the carrying vehicle. Some are designed to weld on a flat surface and others on a 90 degree edge or corner.

2 The pink items are chain gauges. They are used to determine if a chain is stretched or worn. They measure the link length, diameter and internal width. They are normally brand specific. Check with the manufacturer of the chain you use.

3 The black items are rubber snubbing blocks. They act as shock absorbers for chains to stop them breaking under impact loads. They usually consist of a circle of six chain links set in rubber. Half a link protrudes from each end to connect the rest of the chain.