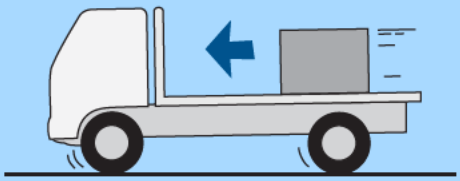
LOAD SHIFT

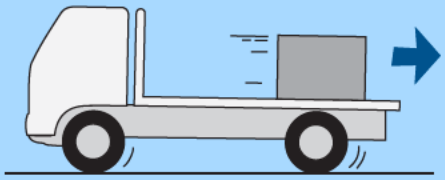
When moving, a vehicle and its load are subjected to forces caused by changes of speed, direction or slope. These forces result from braking, accelerating, cornering or travelling over cambered, undulating or uneven road surfaces and air flow.

GENERAL PRINCIPLES OF LOAD RESTRAINT

The general principles and methods of load restraint are based upon the principle that: Any load-carrying vehicle must be loaded and driven in such a way as to prevent danger to any person, or damage to any property



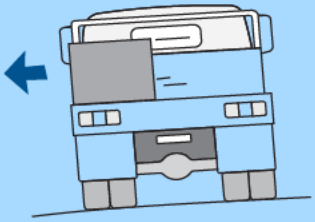
BRAKING
The load can shift forward when driving forward and braking, or accelerating in reverse.



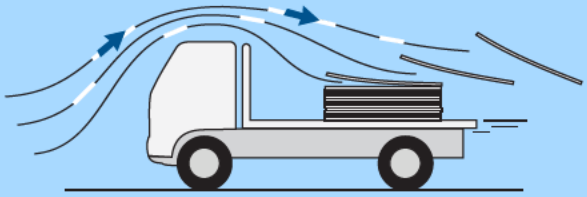
BRAKING IN REVERSE
The load can shift rearwards when braking in reverse, or accelerating forward.

CORNERING
The amount of force needed to prevent the load shifting will increase as the speed increases and as the corner gets tighter.

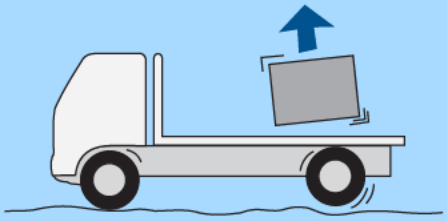
HILLS
The force on the load when traveling over undulating or hilly roads will increase as the slope of the road increases.



CAMBER
The force on the load when traveling over cambered roads increases as the camber of the road increases.



AIR FLOW
When a vehicle is traveling at high speed or in windy conditions, the force caused by air flow can shift a load, especially lightweight objects with large surface areas.



ROUGH ROADS
When a vehicle is traveling over rough surfaces, an unsecured load can shift or fall off the vehicle

The weight of the load alone cannot provide enough friction to restrain it during normal driving. Additional restraint must be used. If the load becomes dislodged from the vehicle and collides with a stationery object, the amount of damage it causes increases as its mass and the speed of the vehicle increases.

HOW TO CARRY A LOAD SAFELY

Choose a Suitable Vehicle.

The vehicle must be suitable for the type and size of load.

Position the Load Correctly.

The load must be correctly positioned on the vehicle.

Use Suitable Restraint Equipment.

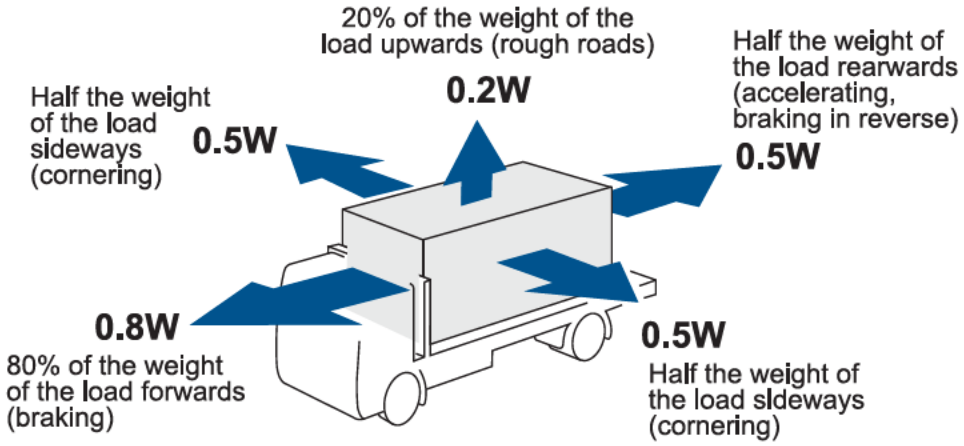
The load restraint equipment and the vehicle body and attachments must be strong enough for each type of load carried and must be in good working condition.

Provide Adequate Load Restraint.

Every load must be restrained to prevent unacceptable movement during all expected conditions of operation.

The load restraint system will meet the Regulation Performance Standards, if the load doesn't shift when subjected to forces illustrated below.

LOAD RESTRAINT FORCES



(W = Weight of the load)

Use Appropriate Driving Methods

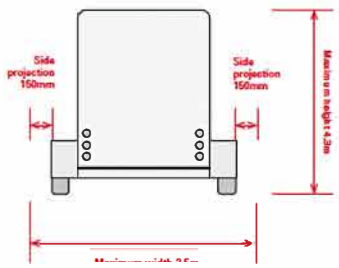
If the load is correctly restrained it will not shift or fall off in all expected driving conditions, including a full braking stop. Because a loaded vehicle might drive differently, the driver must take into account any changes in the vehicle's stability, steering and braking caused by the size, type and position of the load. The driver should check the load and its restraint during the journey. Loads that can settle must be checked regularly.

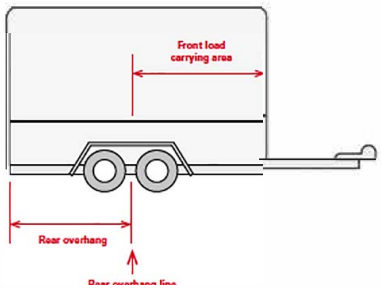
KEY MAXIMUM LEGAL LOADED MASS AND DIMENSIONS OF VEHICLES

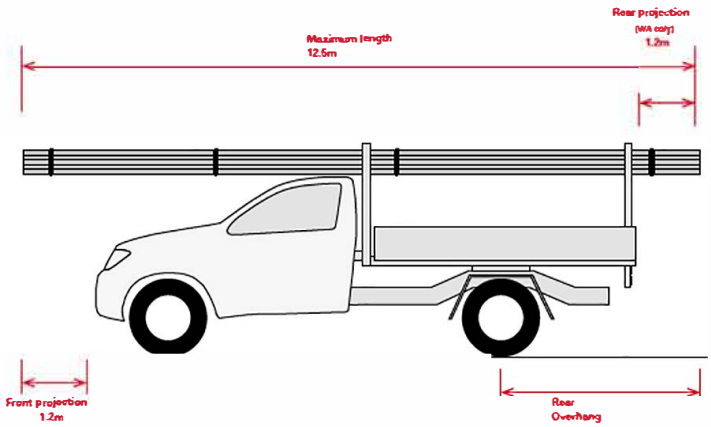
Dimension	Maximum	Notes
Mass	The maximum mass of the vehicle is set by the manufacturer and is known as the **gross vehicle mass**	The gross vehicle mass includes the vehicle and everything in or on it including the driver, the passengers and the goods, etc
Length	12.5 metres	This includes the light vehicle and any projections to the back or front of the vehicle
Width	2.5 metres	
Height	4.3 metres	Drivers need to consider the stability of the vehicle and any restrictions enroute

MAXIMUM LENGTH OF PROJECTIONS STICKING OUT OF THE VEHICLE

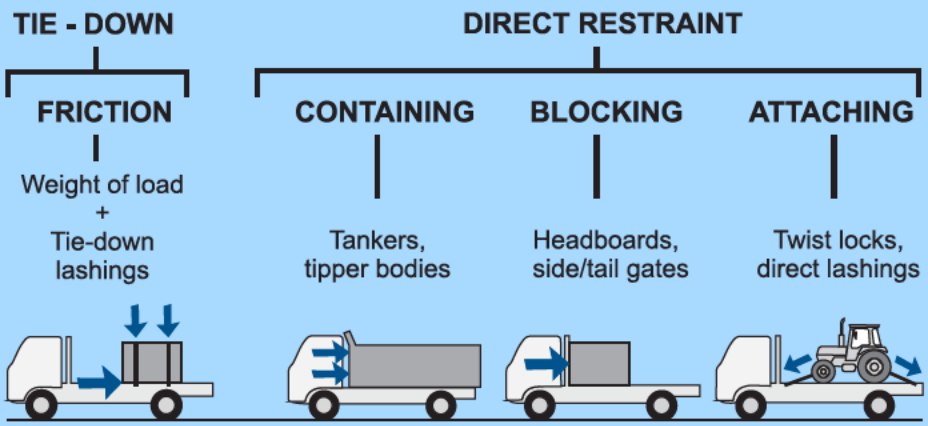
Projection direction	How length is calculated	Maximum	Notes
Sideways	From the edge of the vehicle to the end of the projection	150 mm from the outermost part of the vehicle on either side	Total width including projections must not exceed 2.5 metres
Rear overhang – singl axle group trailer	From the rear axle to the end of the projection	Either the front load carrying area (measured from axle to front of trailer), or 3.7 metres – whichever is lesser	
Rear	From the end of the vehicle	1.2 metres	Applicable in Western Australia only.
Forward	From the front of the vehicle	1.2 metres	







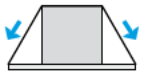
LOAD RESTRAINT METHODS



Tie-down Method

- Tie-down – i.e. using lashings to tie down the load – is a common method of load restraint.
- The load is prevented from moving by the friction between the load and vehicle, created by the weight of the load and pressure from the tie-down lashings.
- Tie-down lashings include webbing straps, chains and ropes. These are tensioned to clamp the load down.

- Tie-down lashings are most effective if they are vertical and tight. **The more a lashing is angled away from the load, the less effective it is.**

	APPROX. ANGLE	TIE-DOWN ANGLE EFFECT	TIE-DOWN EFFECTIVENESS
	90°	1.00	100%
	60°	0.85	85%
	45°	0.70	70%
	30°	0.50	50%
	15°	0.25	25%

TIE-DOWN ANGLE EFFECT

Direct Restraint Method

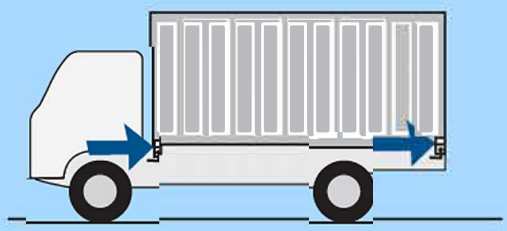
Direct restraint can be used for most loads, especially those that are difficult to tie down, such as:

- unstable loads
- crushable/fragile loads - offset loads
- slippery loads.

A load can be directly restrained by:

- **Attaching** – direct lashings such as webbing straps, chains and twist locks directly attach the load to the vehicle; attaching is especially suitable for slippery loads and loads on wheels
- **Blocking** – headboards, side gates and tailgates, etc., block the load from moving in each direction respectively
- **Containing** – the vehicle structure restrains the load, e.g. a load in a tipper truck, or equipment in a ute.

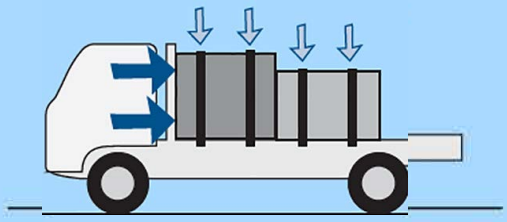
LOAD ATTACHED USING TWIST LOCKS



Attached loads can be directly restrained by mechanical locking devices that provide all the necessary restraint. The figure to the left shows a shipping container restrained by twist locks. The twist locks do not rely on friction between the load and the deck.

Combined Tie-down and Direct Restraint Method

Combined tie-down and direct restraint uses both friction and direct restraint, as shown below.



FRICTION + BLOCKING

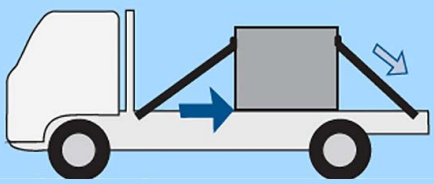
Offers load restraint provided by:

- friction force from the weight of the load, plus
- friction force from tie-down lashings, plus
- blocking (the front part of the load is blocked by the headboard and the rear part of the load is then blocked by the front part).

The load is prevented from moving forwards by a combination of friction force from the weight of the load and the lashing tension, and also blocking against the headboard. The load is prevented from moving rearwards and sideways only by friction. The load is prevented from moving upwards by the lashings.

Offers load restraint provided by:

- friction force from the weight of the load, plus
- friction force from the downward force from the lashings, plus
- direct restraint from lashings that are attached to the load.



FRICTION + DIRECT RESTRAINT

There are five important aspects in ensuring the safe carriage of any load, which are:

- Selecting The Vehicle;
- Positioning The Load;
- Recognising Unstable Loads;
- Using Dunnage;
- Loading and Unloading;
- Do's and Don'ts

SELECTING THE VEHICLE

VEHICLE TOO SMALL

CORRECT CHOICE OF VEHICLE

A vehicle must be of a design suitable for the type of load carried. It must have adequate load-carrying capacity and sufficient space for the load. When a vehicle is loaded, the manufacturer's tyre and axle load capacity, the Gross Vehicle Mass (GVM) or Aggregate Trailer Mass (ATM) and, where applicable, Gross Combination Mass (GCM) must not be exceeded. The carrying capacity of a vehicle (or trailer) is its GVM (or ATM) less its Tare mass.
Federal, State and Local Government regulations must be complied with.

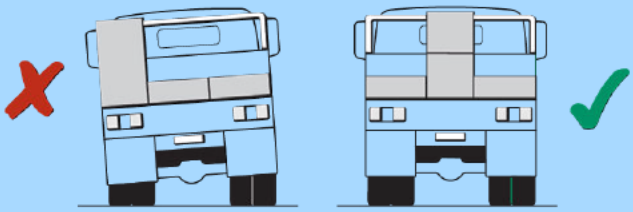
POSITIONING THE LOAD

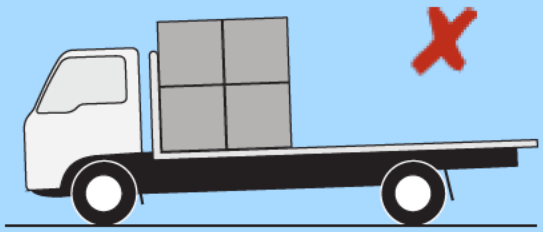
Incorrect positioning of the load on a vehicle can result in a significant safety risk.

The load must be positioned to maintain adequate stability, steering and braking, and not overload tyres and axles.

A load should be positioned so that its centre of mass is as low as possible and not offset to one side of the vehicle. Positioning the load in this way will reduce the vehicle's tendency to overturn when cornering. This can be achieved by loading heavy objects first and placing them close to the centre-line of the vehicle.

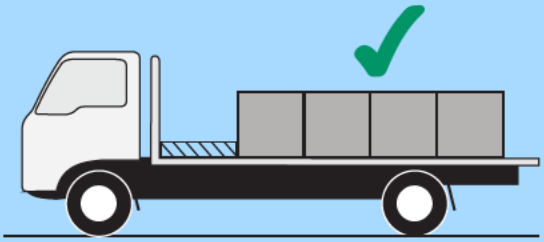
Where mixed loads are 'contained' on a vehicle, weak crushable items should be placed behind (or on top of) strong items to prevent damage during heavy braking.





INCORRECT LOAD POSITION
(overloads front axle)

A load placed against a headboard is easier to restrain, but it can place too much weight on the steer axle and can have a high centre of mass. Heavy loads should not be carried this way.



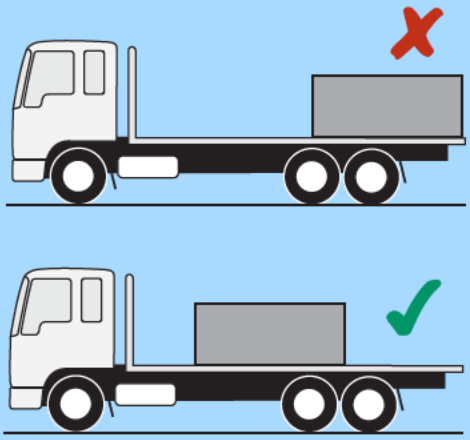
CORRECT LOAD POSITION

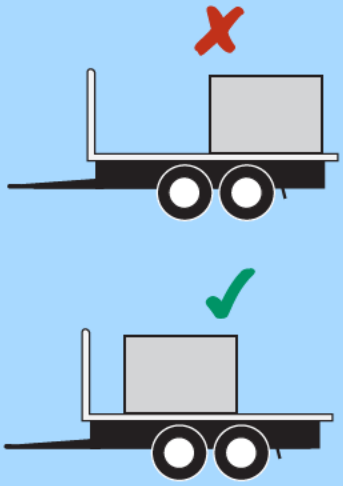
If the front axle is overloaded, the load must be placed further back for better weight distribution and arranged so its centre of mass is as low as possible.

KEEP WEIGHT ON STEER AXLES

A load should be arranged so its centre of mass is in front of the centre of the rear axle or rear axle group on utilities, trucks and trailers.

This will ensure sufficient weight on steer axles to ensure safe steering and not overload the rear axle.





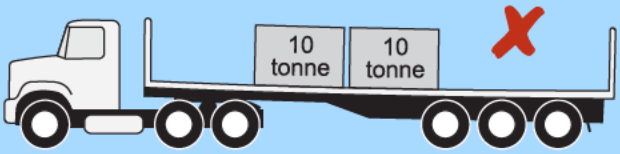
PREVENT TRAILER SWAY

When loaded, the centre of mass of a drawbar trailer, including its load, must be in front of the centre of the axle group, to minimise trailer sway. This means that the trailer coupling should push down on the towbar, not exceeding the manufacturer's ratings of the coupling and towbar.

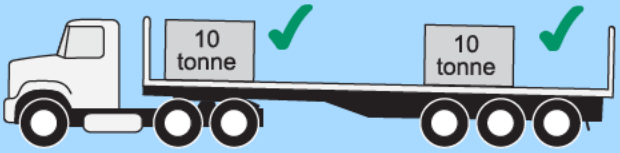
The centre of mass of the load should be in front of the rear axle of a semi-trailer to provide enough weight on drive axles of the prime mover for traction and stability.

Heavy objects should be loaded first and positioned to provide even loading across the deck and shared loading between axles. To prevent excessive flexing of the middle of long trailers, heavy items or the dunnage supporting long lengths should be placed over the axle groups, where possible.

INSUFFICIENT WEIGHT ON DRIVE AXLES

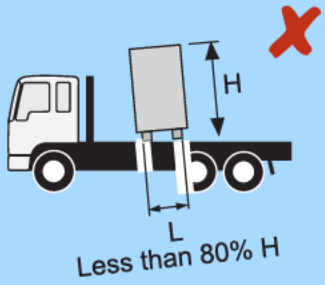


EXCESSIVE TRAILER FLEXING

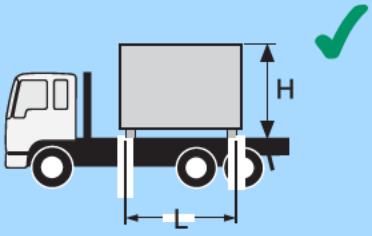


GOOD WEIGHT DISTRIBUTION

RECOGNISING UNSTABLE LOADS



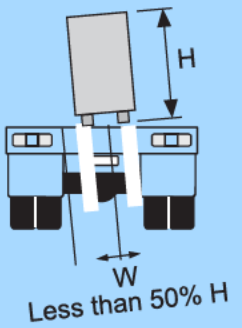
Less than 80% H

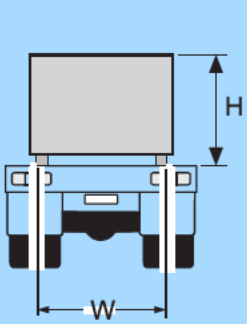


80% H min.

UNSTABLE FORWARDS

Tall loads can tip over under heavy braking or cornering. This can happen even if they are restrained properly at the base. A load will be less stable if it is placed on a base such as timber dunnage that is narrower than the base of the load. Tall loads are unstable in the forward direction, if the length (L) measured along the vehicle, is less than 80% of the height (H). This applies to evenly shaped loads of the same material throughout such as paper rolls, 205 litre drums, or gas cylinders.





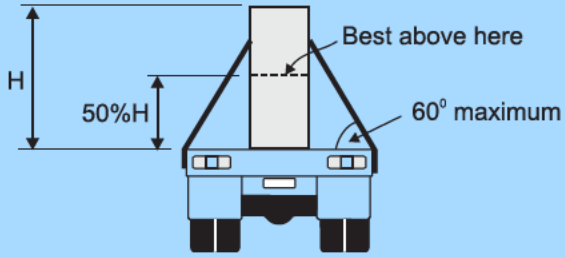
UNSTABLE SIDEWAYS

Tall loads are unstable sideways if the width (W) measured across the vehicle, is less than 50% of the height (H).

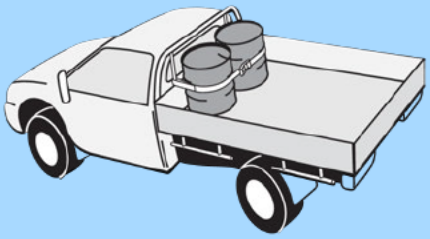
Fully tensioned tie-down lashings will increase the stability of the load. Care should be taken when using rope or webbing straps to stablise a load, because of the amount that these lashings can stretch. Ropes may stretch up to 20% and some webbing straps may stretch up to 13% of their length, before reaching their Lashing Capacity. This amount of stretch may allow the load to tip over. Chains are much more effective in preventing unstable loads tipping, because they don't stretch as much (about 1% of their length, up to their Lashing Capacity).

Lashings can be attached directly to the load to prevent tipping. These lashings are most effective if attached to the upper half of the load and angled no more than 60 degrees to the horizontal, in the opposite direction to tipping.

Where a tall, unstable load is fragile or of uneven shape such as a transformer, it may not be possible to stabilise or prevent it tipping by attaching direct lashings. In such cases the load should be supported by a specially constructed frame and the frame restrained.

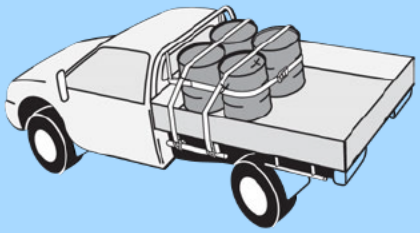


ATTACHING DIRECT LASHINGS TO UNSTABLE LOADS



STABILISED LOAD

Unstable loads can be placed against a rigid structure, such as a headboard, to prevent them from tipping.



STABLE PACK

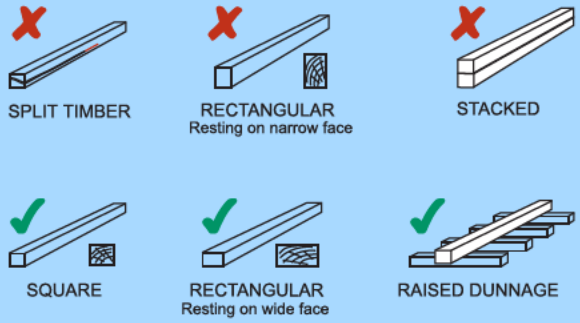
Alternatively, several unstable items of load can be strapped together to form a stable pack.

USING DUNNAGE

Dunnage is the packing placed under or between parts of the load. It is used to allow loading and unloading using forklifts or lifting slings.
Some loads require inter-layer packing. The use of slippery plastic wrapping means that more tie-down lashings are required than with timber alone, whilst the use of anti-slip rubber matting usually means that fewer lashings are required.
It is dangerous to place dunnage on its narrow face or stacked directly on top of itself because the dunnage can roll under heavy braking. If the dunnage rolls, the lashings can loosen and all restraint can be lost.
To prevent rectangular dunnage from rolling, it can be placed on its wide face.
Dunnage that is placed directly on the deck can be bolted to the deck or fitted with special stablising brackets.

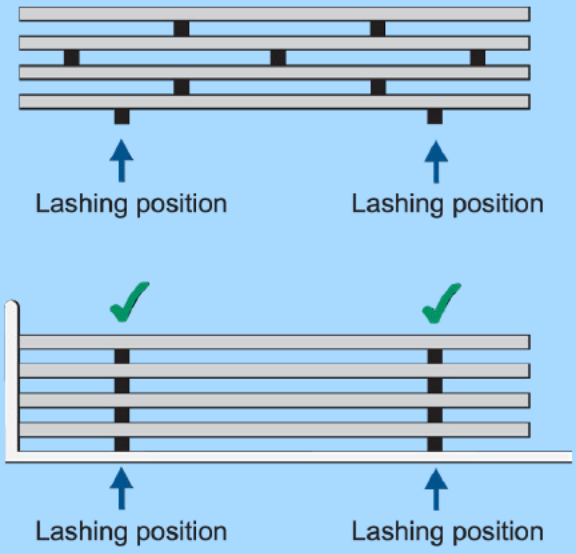
If the height of the dunnage needs to be raised (for uneven loads) it should be stacked alternatively at right angles to keep it stable.

If the dunnage spans between support points it must be strong enough to support the weight of the load, the tie-down clamping forces and the shock from bumps. If the dunnage is not strong enough, additional supports should be added or stronger dunnage used or, alternatively, the load rearranged.



Most dunnage is made from square or rectangular hardwood or softwood timber. Timber which is used for dunnage should be relatively free of knots and splits. For heavy loads, such as large steel sections that are supported on small areas of contact, the dunnage should be strong enough to prevent it crushing or splitting.

If the load has multiple layers of lengths of rigid sections, the upper rows of dunnage should be placed directly above the bottom dunnage (see Figure B.22). If the dunnage is placed between lashing positions it can work loose when the vehicle and load both flex during a journey. If the dunnage works loose and falls out it could cause an accident.



LOADING AND UNLOADING

The load should always be packed, located and restrained in a way that allows its safe loading and unloading.

When throwing lashings over the vehicle, be careful that no-one is standing on the other side. Before throwing the lashings, check there is no obstruction above the vehicle and electric cables that could come into contact with the lashings.

When opening doors, gates, sides and side curtains and when removing lashings and tarpaulins take care that loads that may have shifted during a journey, do not dislodge and cause injury. When releasing the tension in lashings, be careful of any sudden uncontrolled movement of handles, cheater bars, sharp steel strapping and hooks on lashings and elastic straps.

Forklift operations are a major cause of injury to drivers and loaders. When a vehicle is being loaded or unloaded by forklift, make sure that you are always in full view of the forklift driver. Do not approach a forklift whilst it is moving.

Do not stand or work on one side of the vehicle if the other side is being loaded or unloaded. Part of the load may be pushed onto you during the loading or unloading operations.

DOs AND DON'Ts

DO: make sure that the vehicle's load space and loading deck are suitable for the type and size of the load.
DO: check the weight of the load to be carried.
DO: check the positioning of the load along the vehicle.
DO: consider the positioning of the load after partially loading or partially unloading the vehicle.
DO: position the load evenly across the vehicle.
DO: provide extra restraint for tall loads.

DON'T: overload your vehicle or its individual axles.
DON'T: load your vehicle too high.
DON'T: overload the steer axle by placing the load too far forward.
DON'T: reduce the weight on the steer axle by placing the load too far back.
DON'T: allow the load to project dangerously towards the cabin or outside the vehicle.
DON'T: place rectangular dunnage on its narrow face.