PETROK SS
Consultaion & Training

Load Securing & Cargo Handling

Introduction

•**Basic Principles**

The load in a vehicle must at all times be in no danger to any person in or on the vehicle or on the road.
The load carried must at all times be secured totally, so that no danger to any person.

Introduction

What is the Safe Loading

For any type of cargoes, that:

✓Must be contained or secured, and safely placed in / onto the vehicles

✓Properly & adequately secured on vehicles

✓Shall not cause danger to any persons, including the driver

✓Shall not cause danger to the public

Introduction

What is the Unsafe Loading

Inadequately secured cargo could fall off the vehicle cause traffic congestion and others could be hurt or killed.

- Inadequately secured cargo could hurt or kill the driver during strong braking or a crash.

- The steering of a vehicle can be affected by how the cargo is distributed and/or secured on the vehicle, making it more difficult to control the vehicle

Introduction

Vehicles for different cargo loads

- Different types of vehicles are used according to the types of loads
- The vehicle must be designed for the load, i.e. anchor points , platform , headboard .

Laws and Regulation

- BSEN 12195-22001

Ten Commandments for Safe Loading

1. Check the vehicle before loading
2. Determine the securing method
3. Check the blocking equipment
4. Check the securing equipment
5. Check the load distribution / Centre of Gravity as low as possible
6. Check the cargo securing regularly
7. Use equipment which supports cargo securing
8. Ensure securing arrangements cause no damage to the goods
9. Drive smoothly, avoid sudden turn and heavy breaking
10. Ensure body conditions are fit for driving and/or working

Terminology

- Blue label
- • Preferred option.
- • Polyester (PES) webbing.
- • Resistant to mineral acids.
- • Attacked by alkalis.
- Green label
- • Polyamide (PA) webbing.
- • Virtually immune to effects of alkalis
- • Attacked by mineral acids.
- Brown label
- • Not to be used on steel products.
- • Polypropylene (PP) webbing.
- • Little affected by mineral acids and alkalis.
- • Low lashing capacities.

Ratchet Strap Device

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

Terminology

LASHING CAPACITY

The allowable loading capacity of webbing.

LIFTING EQUIPMENT

An item of work equipment used for lifting /lowering loading e.g crane, forklift, loader, chain block ,..etc.

Terminology

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

Center of Gravity

The center of gravity is the exact point on which the entire load will balance.

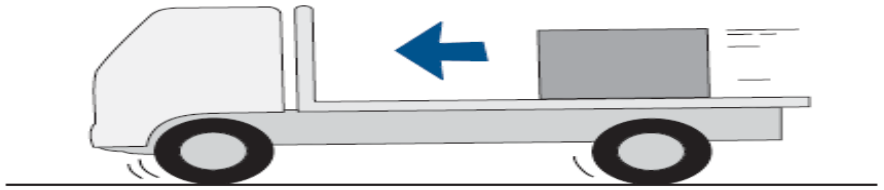
For loads of consistent material, this point will always be near the center of the load.

If a load contains materials with different weights or densities, the load center will be on the side containing the heavy material.

For example: If a pallet contains bricks on one side and pillows on the other, the center of gravity will obviously be closer to the side of the pallet containing the bricks.

Load Shift

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



BRAKING

BRAKING IN REVERSE

The load can shift sideways when cornering. The amount of force needed to prevent the load shifting will increase as the speed increases and as the corner gets tighter (see Figure A.3).

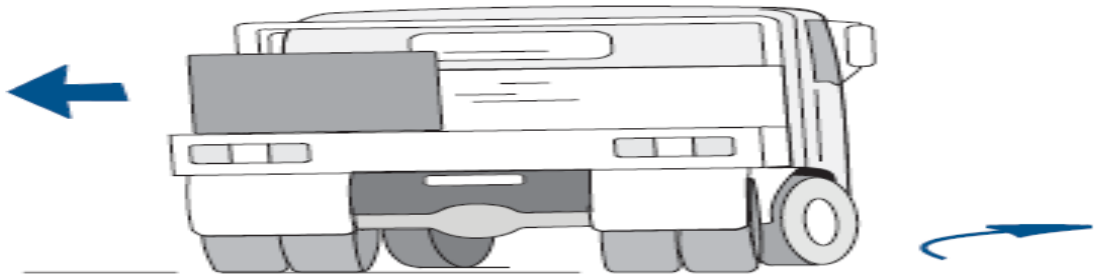


Fig. A.3 CORNERING

The force on the load when travelling over undulating or hilly roads will increase as the slope of the road increases (see Figure A.4)

Fig. A.4 **HILLS**

When a vehicle is travelling at high speed or in windy conditions, the force caused by air flow can shift a load, especially lightweight objects with large surface areas (see Figure A.6).

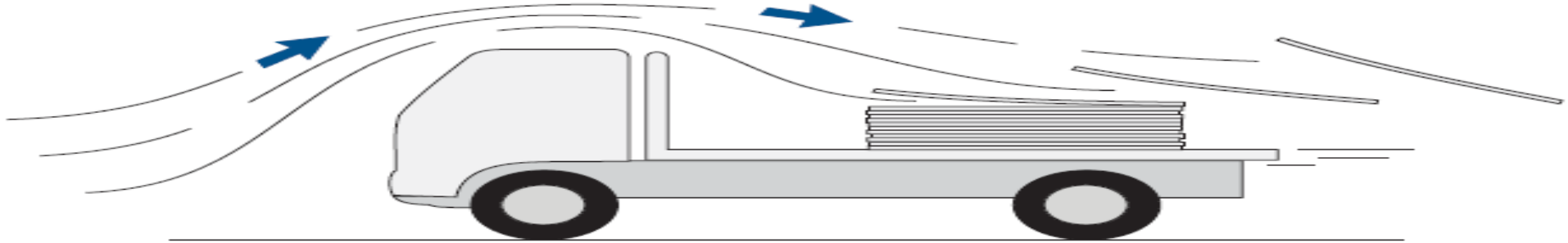


Fig. A.6 **AIR FLOW**

When a vehicle is travelling over rough surfaces, an unsecured load can shift or fall off the vehicle (see Figure A.7).

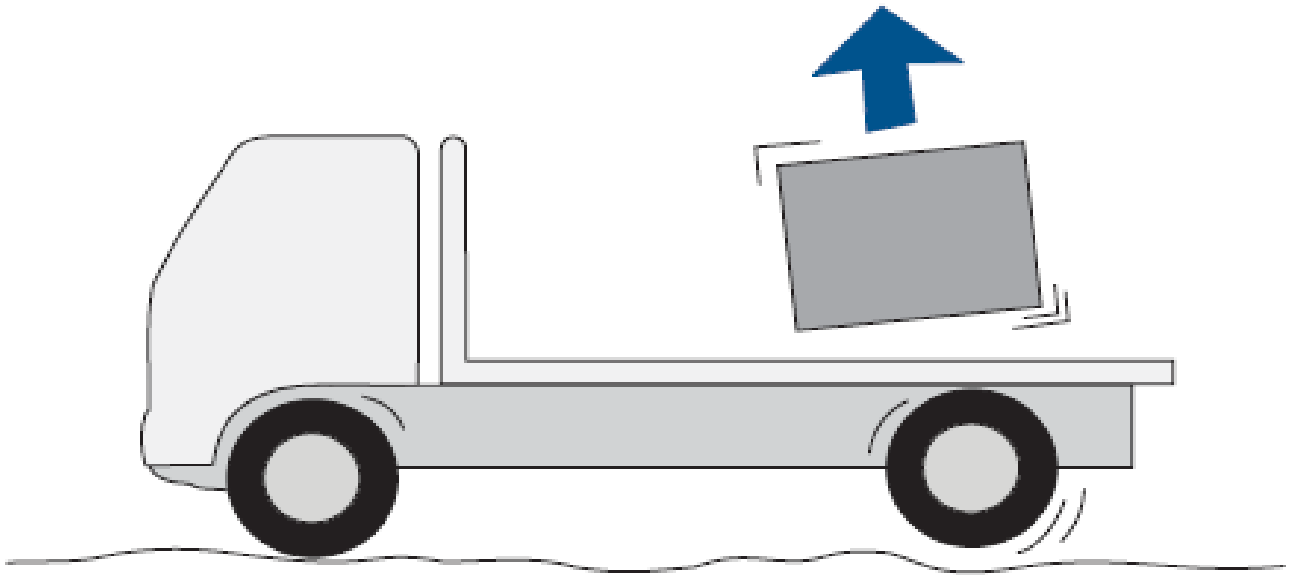


Fig. A.7 **ROUGH ROADS**

2 HOW TO CARRY A LOAD SAFELY

The following is a summary of the principles outlined in Sections B, C, D, E, F, G, and H.

2.1 Choose a Suitable Vehicle.

The vehicle must be suitable for the type and size of load (see Section B).

2.2 Position the Load Correctly.

The load must be correctly positioned on the vehicle (see Section B).

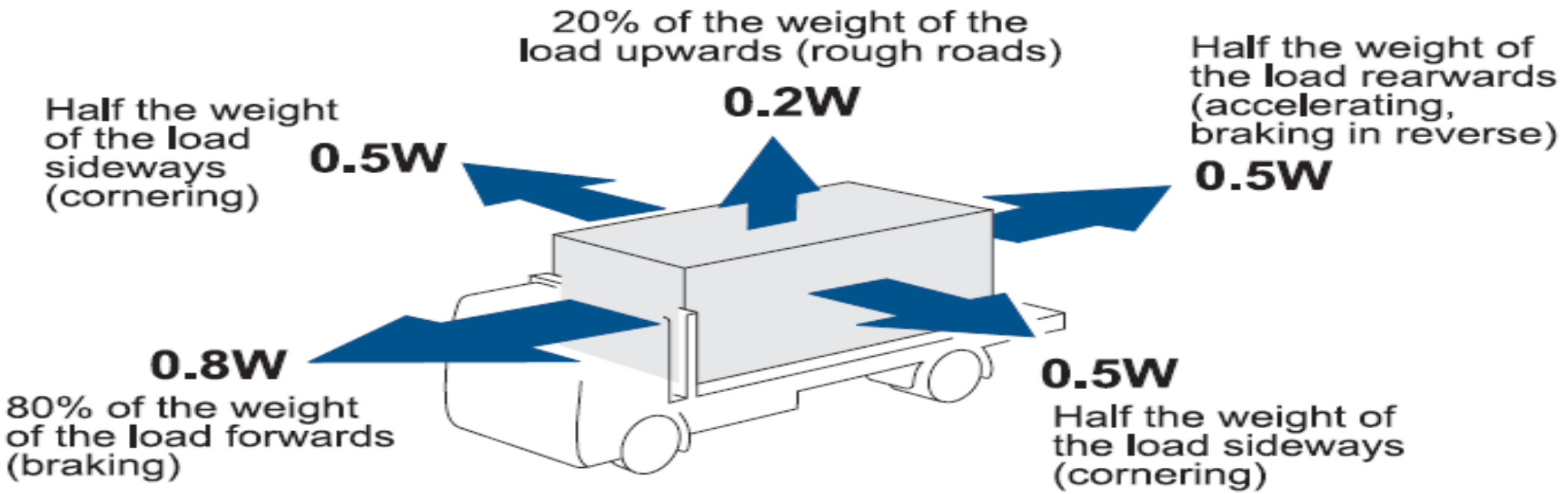
2.3 Use Suitable Restraint Equipment.

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 (see Sections C, G and H).

2.4 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 (see Section F), if the load doesn't shift when subjected to forces illustrated below in Figure A.8.



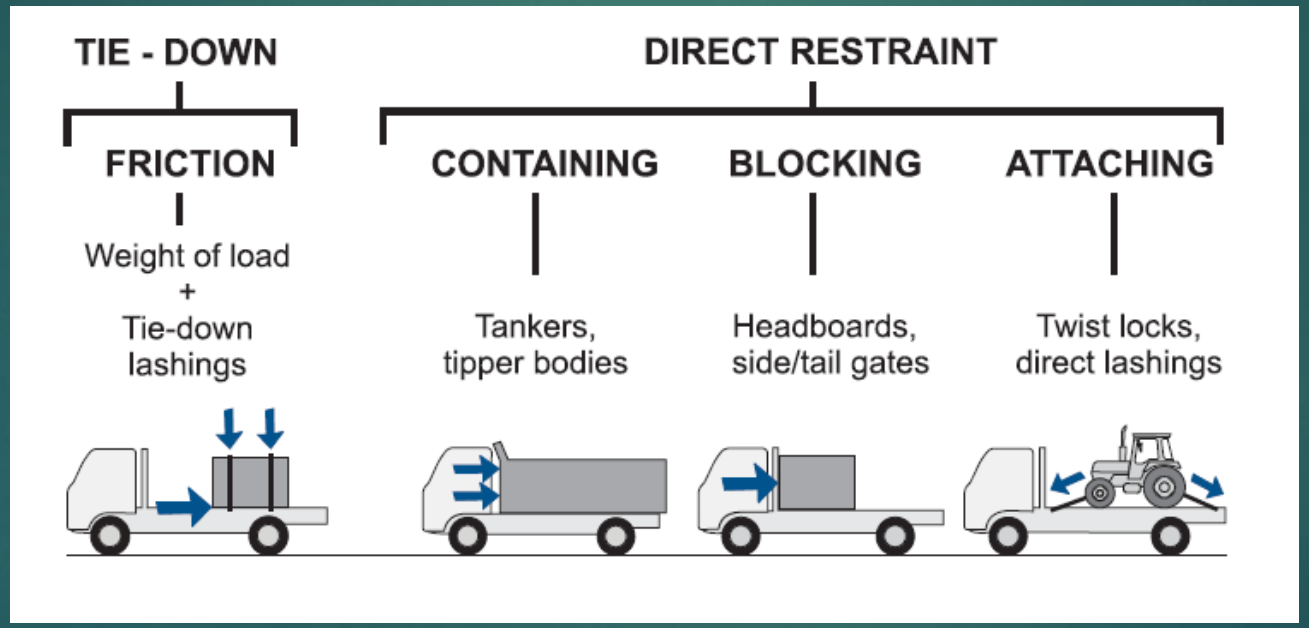
2.5 Use Appropriate Driving Methods

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 (see Section D). Loads that can settle must be checked regularly.

3 LOAD RESTRAINT METHODS



3.1 Tie-down Method

Tie-down restraint is the most common form of load restraint and involves the use of lashings.

The load is prevented from moving by friction between the load and the vehicle.

The friction force prevents the load moving forward, rearward and sideways. The lashings are tensioned to clamp the load to the vehicle and to prevent the load from moving upwards.

The friction force comes from both the weight of the load and the clamping force of the lashings. When the surfaces are slippery, the friction forces can be very low.

Lashings that clamp the load onto the vehicle are called 'tie-down lashings' (see Figure

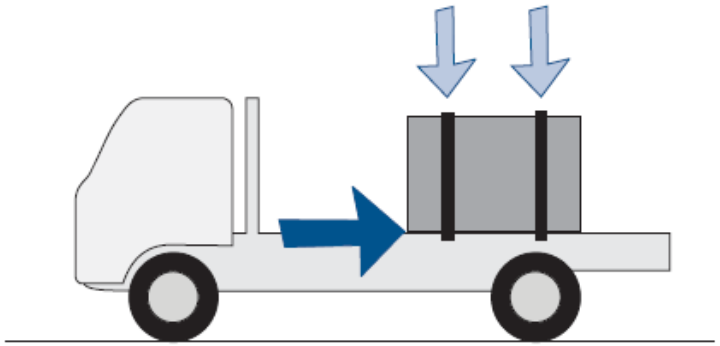


Fig. A.10 **LOAD RESTRAINED USING TIE-DOWN LASHINGS**

3.2 Direct Restraint Method

A load can be directly restrained by containing, blocking or attaching without any assistance from friction.

3.2.1 Contained loads

Contained loads can be directly restrained without any securing devices. These include liquids in tanks, bulk solids in tanks or rigid sided bodies and mixed loads of various items in rigid sided bodies or containers (see Figure A.11). See also Section E.7, page 140.

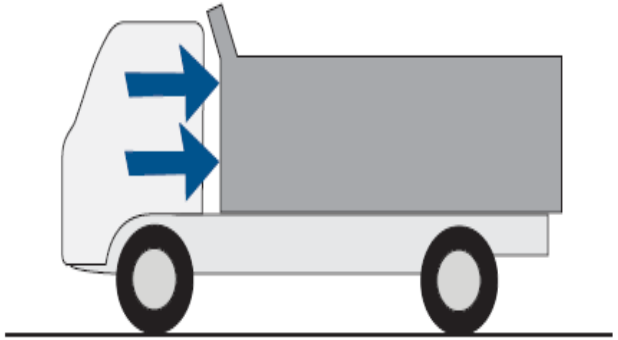


Fig. A.11 **LOAD CONTAINED IN TIPPER**

3.2.2 Blocked loads

Loads can be directly restrained by blocking against vehicle structures or other items of load or packing in contact with the structures. These structures include headboards (see Figure A.12), braced loading rack, drop-sides and bulkheads. The load in Figure A.12 is blocked from moving forwards by the headboard, but requires additional sideways, rearward and vertical restraint.

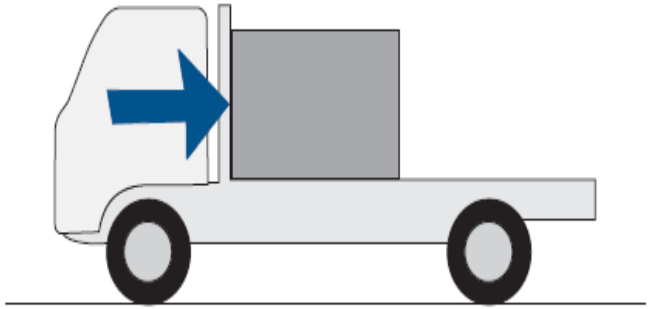


Fig. A.12 **LOAD BLOCKED AGAINST HEADBOARD**

3.2.3 Attached loads

Attached loads can be directly restrained by lashings that provide all the necessary restraint (see Figure A.13).

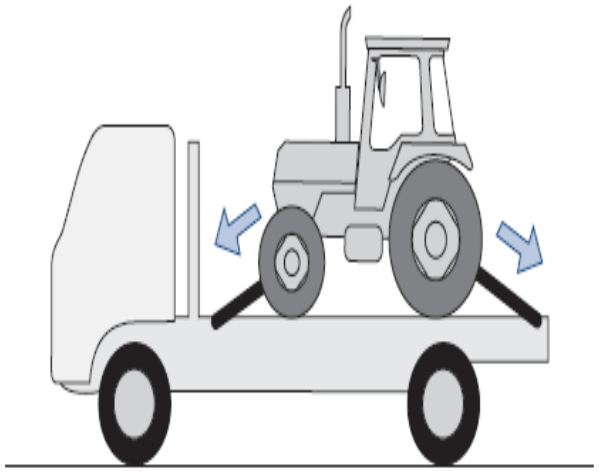


Fig. A.13 **LOAD ATTACHED USING DIRECT LASHINGS**

Attached loads can be directly restrained by mechanical locking devices that provide all the necessary restraint. Figure A.14 shows a shipping container restrained by twist locks. The twist locks do not rely on friction between the load and the deck.

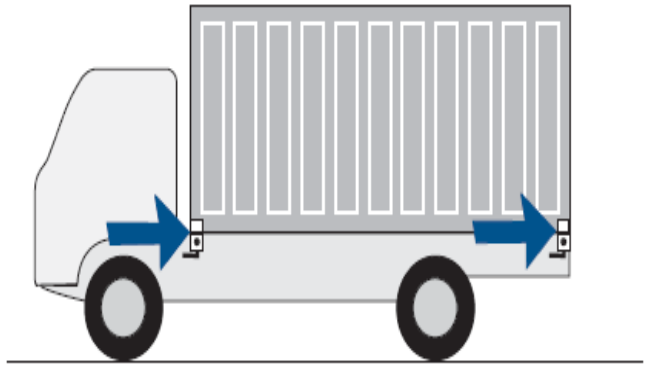


Fig. A.14 **LOAD ATTACHED USING TWIST LOCKS**

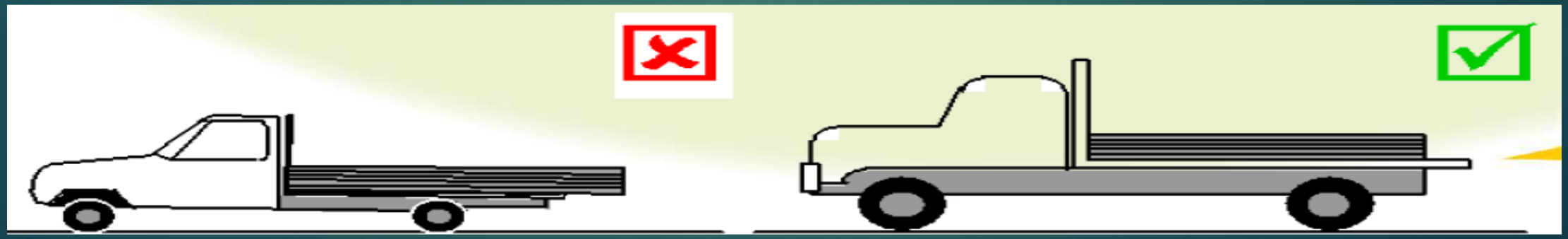
ARRANGING LOADS ON VEHICLES

CONTENTS

Selecting the Vehicle

A vehicle that is appropriate for each load to be carried shall be selected, taking into consideration characteristics including:

- the design and materials of construction of the vehicle;
- the maximum carrying capacity of the vehicle in relation to the weight of the load and any mobile equipment (such as forklifts) that will be used on the vehicle for loading
- the length, height and width of the vehicle in relation to the load, so that a load can be contained within the vehicle if possible and avoid the need for an escort.



Selecting the Vehicle

Special precautions must be taken when carrying a load with a high centre of mass. The load should be carried on a vehicle with a low platform height (e.g. drop frame trailer or low loader) or on a vehicle with good roll stability (see Figure B.3).

Fig. B.3 DROP DECK TRAILER FOR MAXIMUM STABILITY

2 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 comering. This can be achieved by loading heavy objects first and placing them close to the centre-line of the vehicle (see Figures B.4 & B.5).

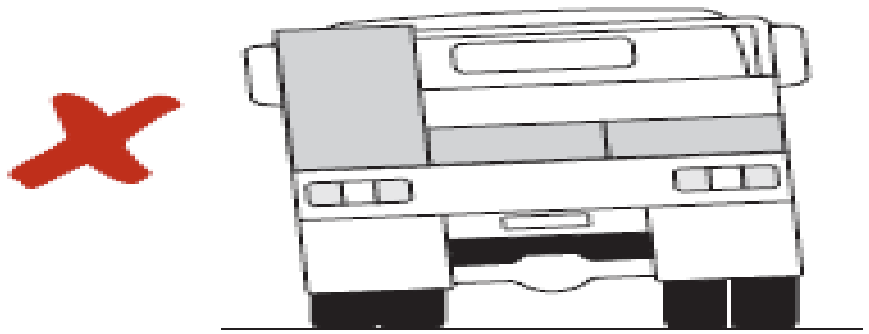


Fig. B.4 INCORRECT POSITION

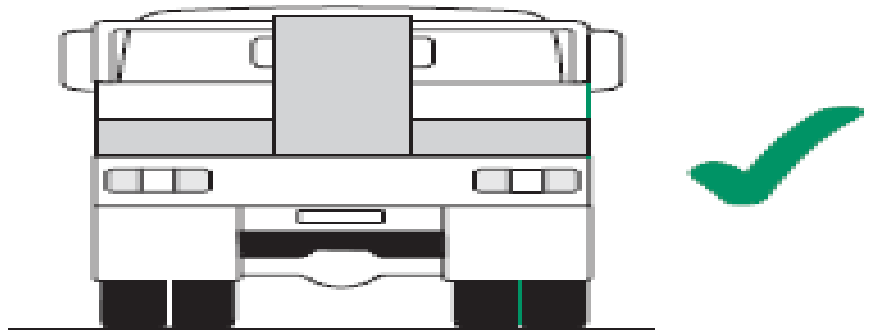


Fig. B.5 CORRECT POSITION

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 (see Figure B.6).

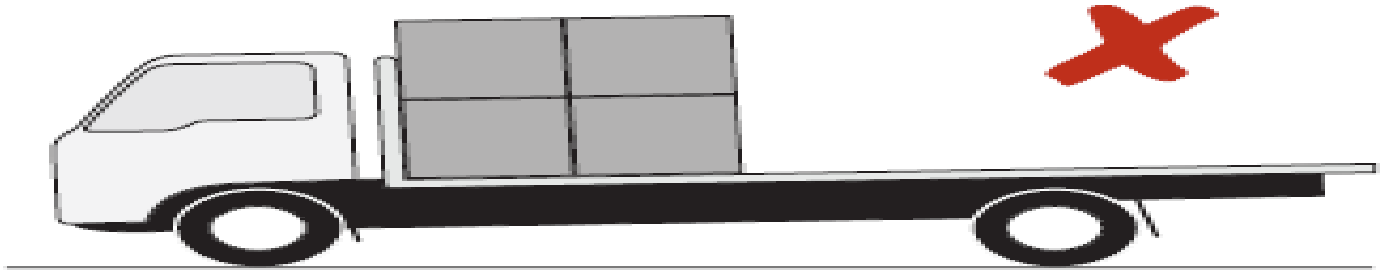
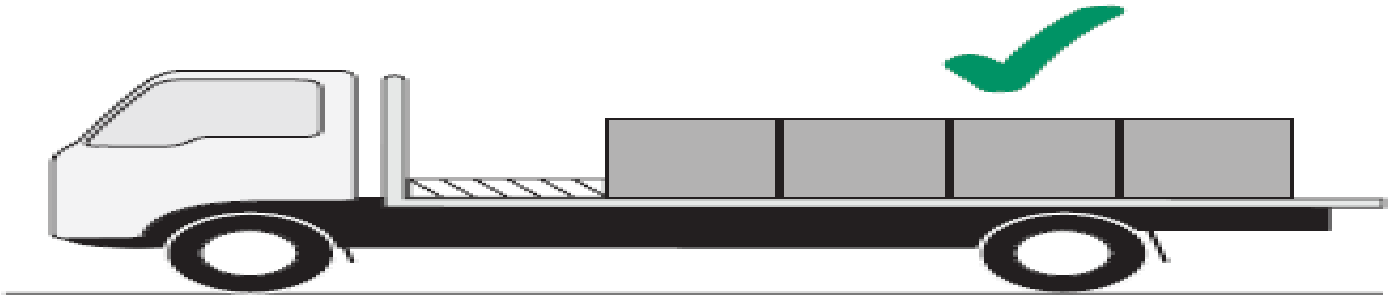


Fig. B.6 **INCORRECT LOAD POSITION** (overloads front axle)

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 (see Figure B.7).



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 (see Figure B.8).

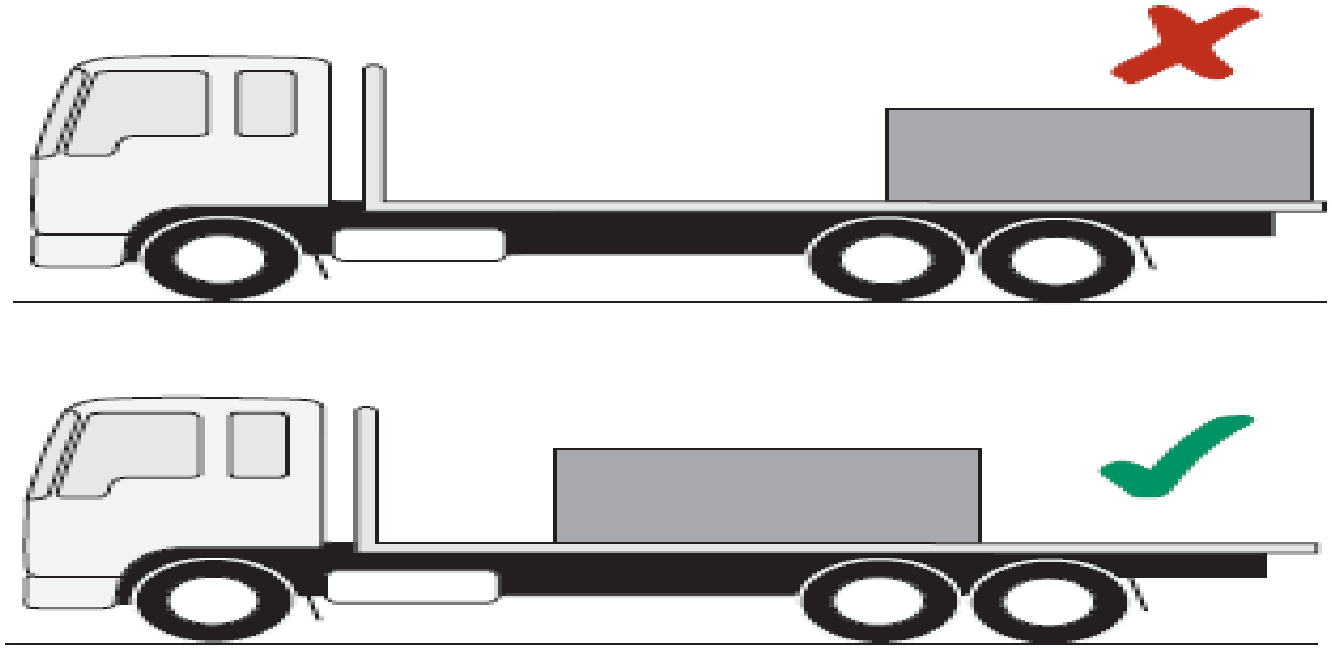


Fig. B.8 KEEP WEIGHT ON STEER AXLES

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 (see Figures B.10 & B.12).

Fig. B.10 **INSUFFICIENT WEIGHT ON DRIVE AXLES**

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 (see Figures B.11 & B.12).

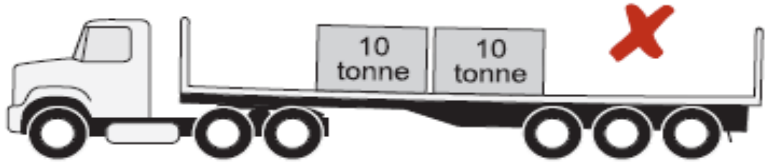
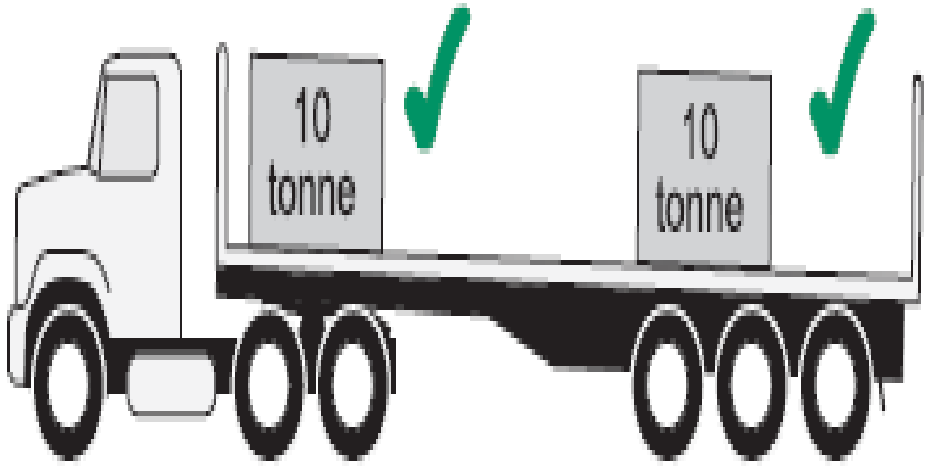


Fig. B.11 **EXCESSIVE TRAILER FLEXING**



.12 GOOD WEIGHT DISTRIBUTION

A load which has any potentially dangerous projection should be placed to minimise the risk to the driver or any other person, in the event of the load shifting during braking or a collision (see Figures B.14 & B.15).

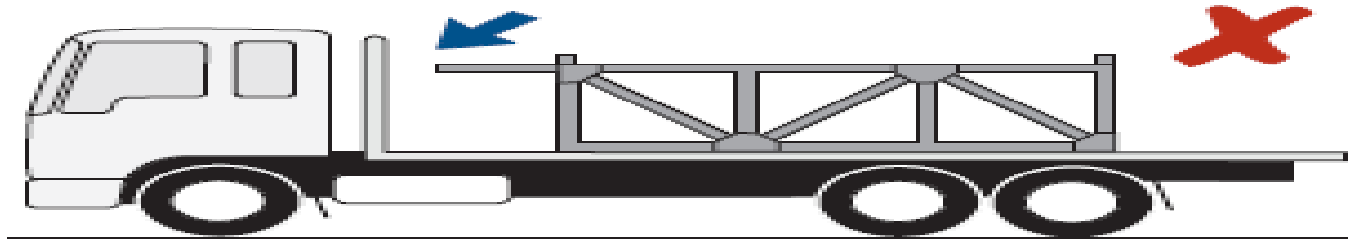


Fig. B.14 DANGEROUS POSITION

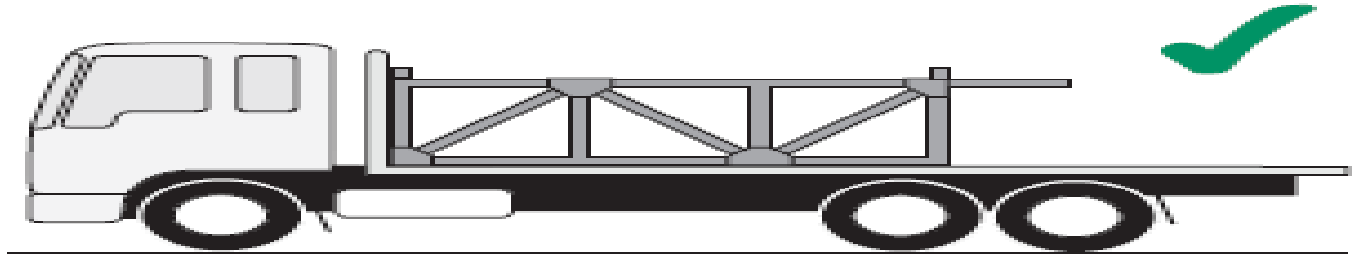


Fig. B.15 CORRECT POSITION

3 RECOGNISING UNSTABLE LOADS

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) (see Figure B.16). This applies to evenly shaped loads of the same material throughout such as paper rolls, 205 litre drums, or gas cylinders.

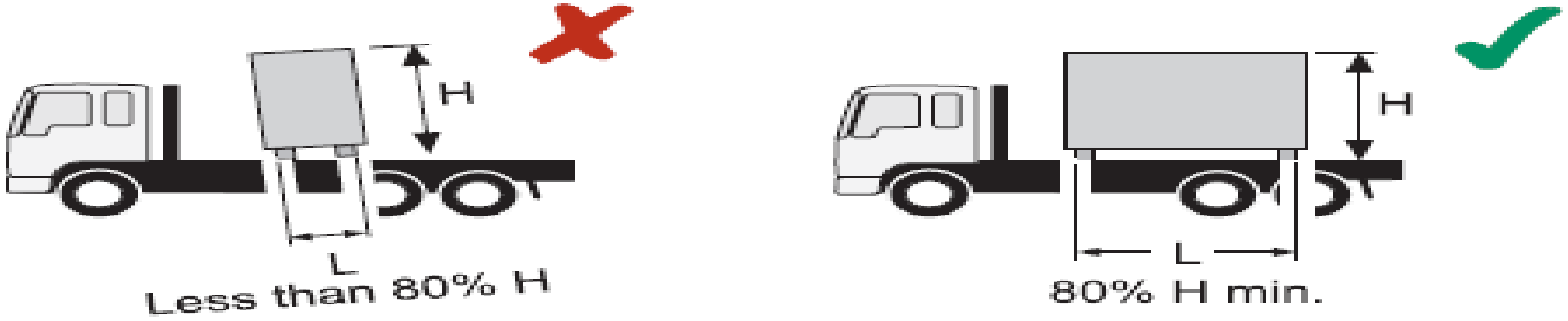


Fig. B.16 UNSTABLE FORWARDS

Tall loads are unstable sideways if the width (W) measured across the vehicle, is less than 50% of the height (H) (see Figure B.17).

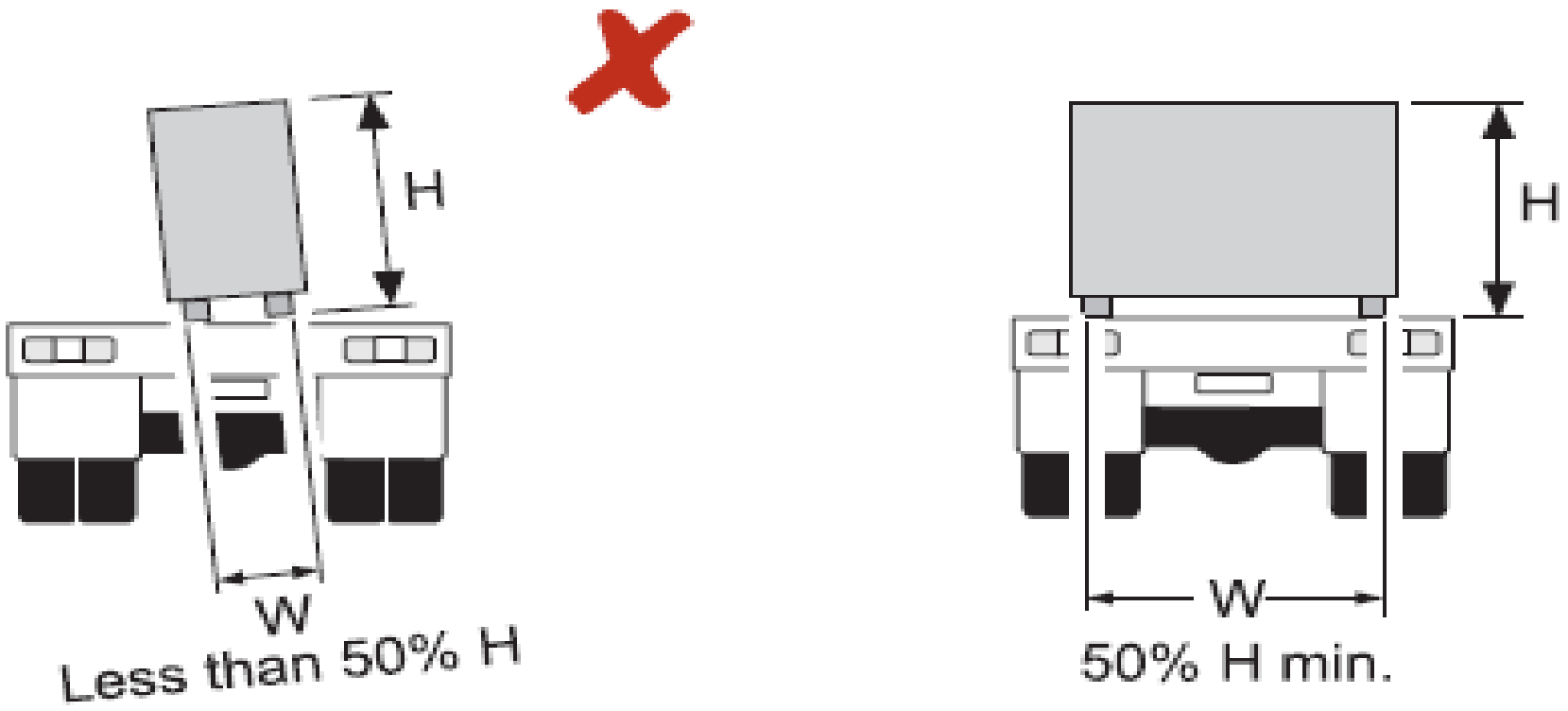


Fig. B.17 **UNSTABLE SIDEWAYS**

Unstable loads can be placed against a rigid structure, such as a headboard, to prevent them from tipping (see Figure B.19).

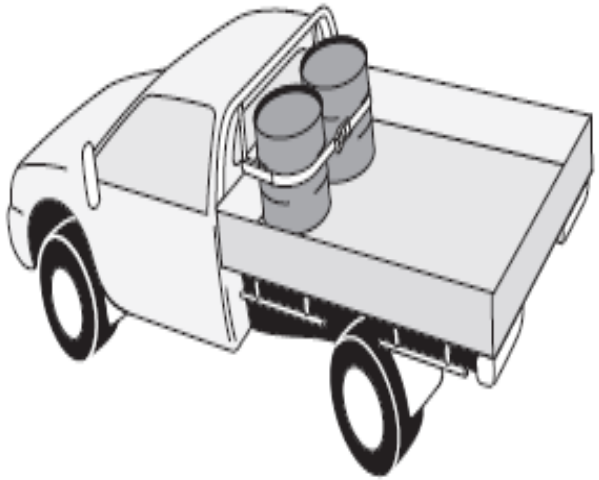


Fig. B.19 STABILISED LOAD

Alternatively, several unstable items of load can be strapped together to form a stable pack (see Figure B.20).

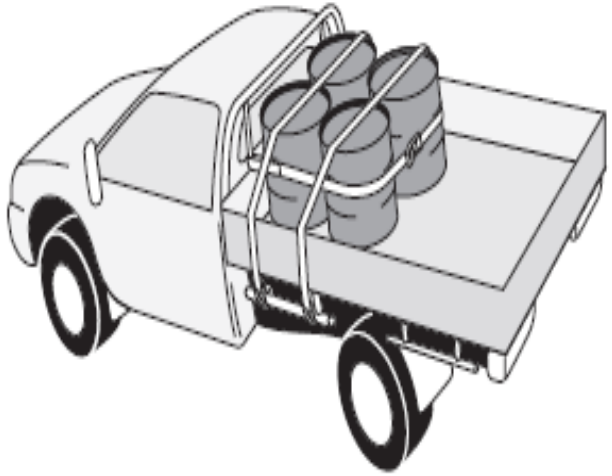


Fig. B.20 STABLE PACK

4 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.

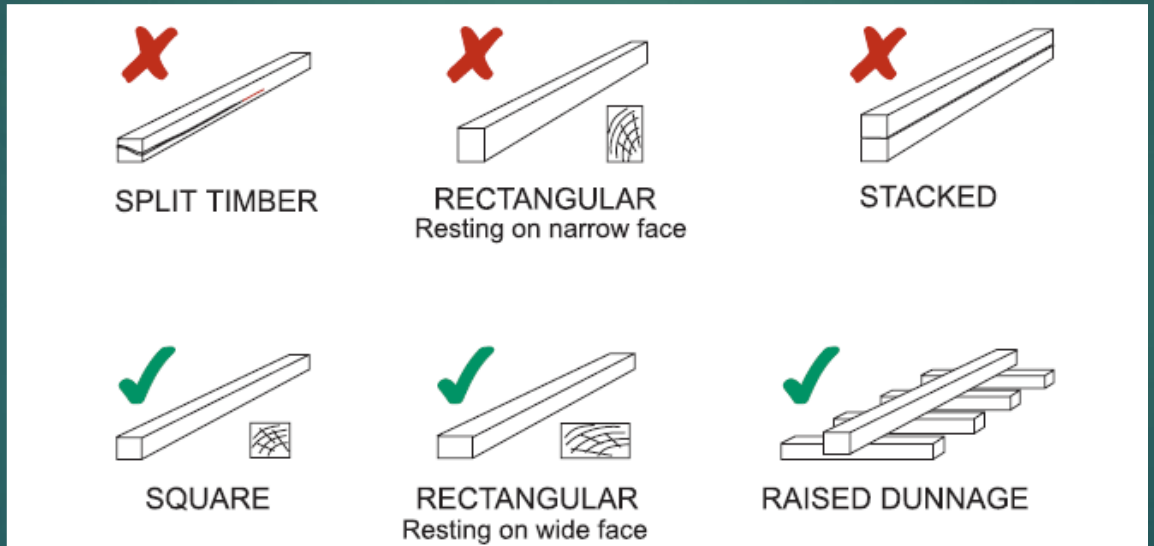
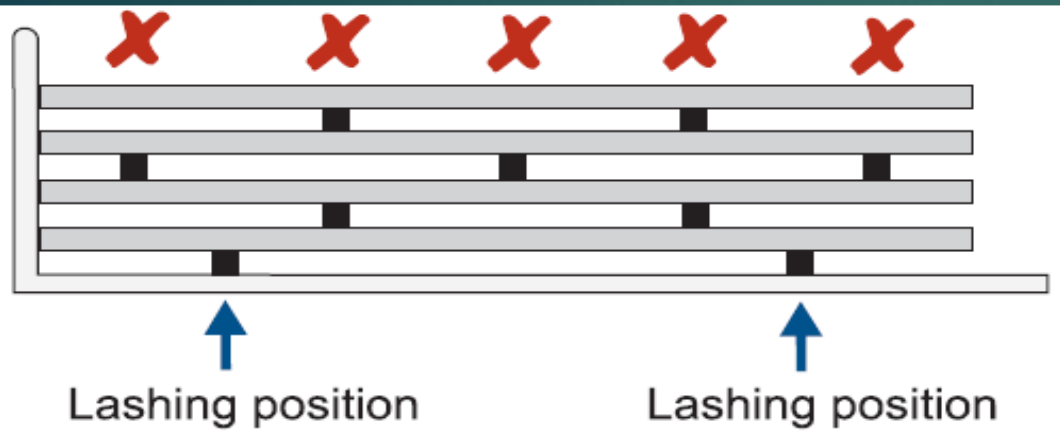


Fig. B.21 **DUNNAGE DO'S & DON'TS**



POSITIONING DUNNAGE

The base of the load broke from the strapping tie-down force. The strap should have been positioned above the dunnage supporting the load. *(Photo courtesy Queensland Transport).*

5 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.

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6 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.

1 HOW MUCH LOAD RESTRAINT?

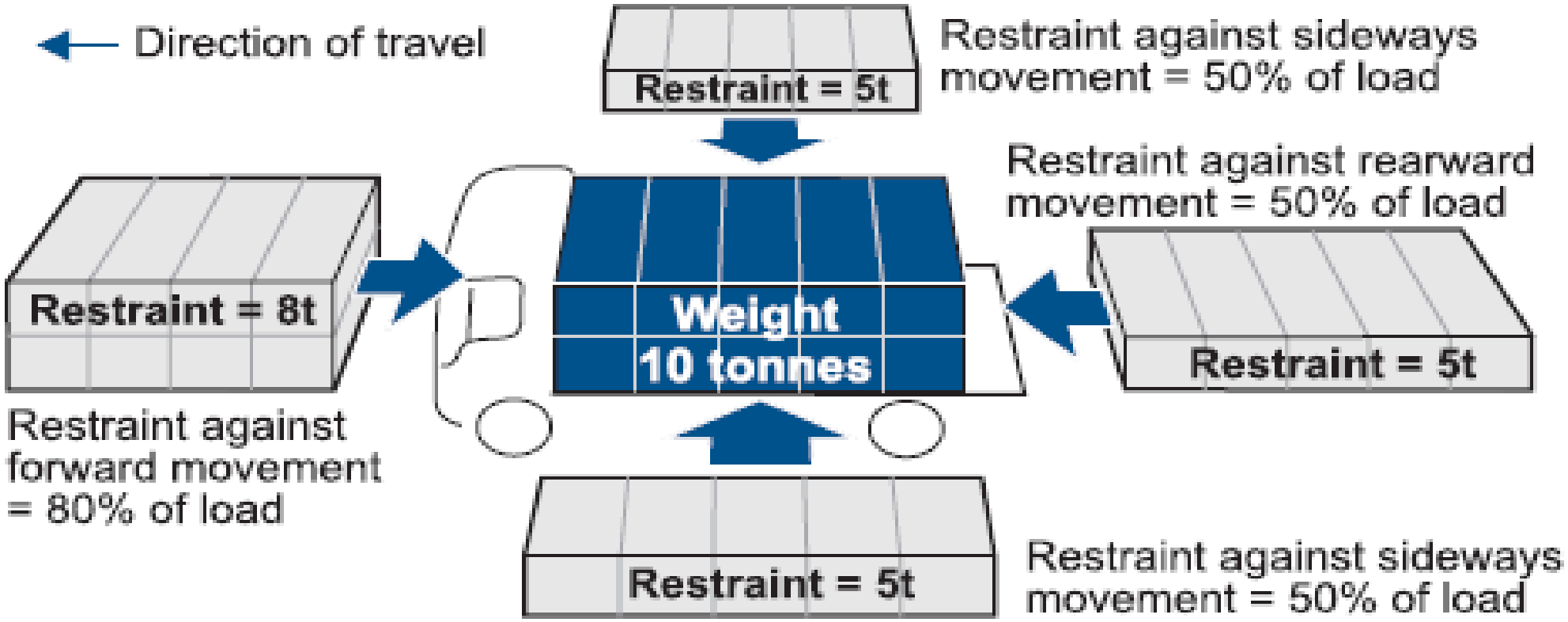


Fig. C.1 MINIMUM HORIZONTAL RESTRAINT REQUIRED

2 TIE-DOWN METHOD

Tie-down is load restraint using friction. The pre-tension in a tie-down lashing gives the same effect as holding the load with a 'giant' G-clamp. The friction stops the load moving.

If the load does not shift, it is not the strength of the lashing that determines the holding ability of a tie-down lashing. It is determined by the amount of tension in the lashing from initially tightening the knot, or operating the ratchet, winch or dog, in conjunction with the amount of friction present.

Tie-down should not be used on slippery loads because too many lashings are needed.

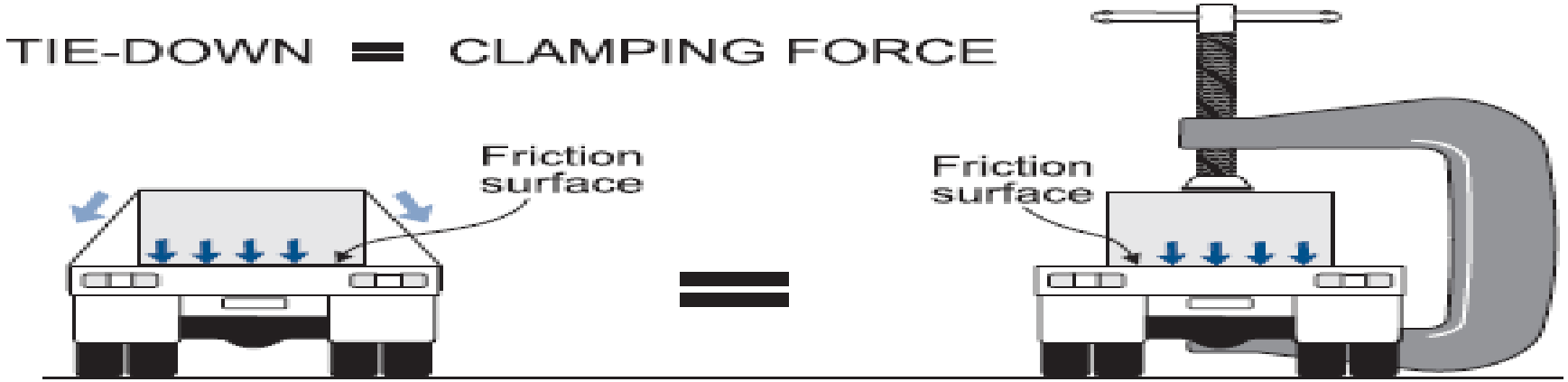


Fig. C.3 CLAMPING THE LOAD

2.2 Applying Tie-Down Lashings

Tie-down lashings are used to help restrain a load using friction.

Tie-down lashings are ropes, straps or chains which normally pass over the top of a load and are attached to the vehicle on either side (see Figure C.6). They may also pass through or be attached to a load. They are pre-tensioned using knots or mechanical tensioners to increase the clamping force under the load.

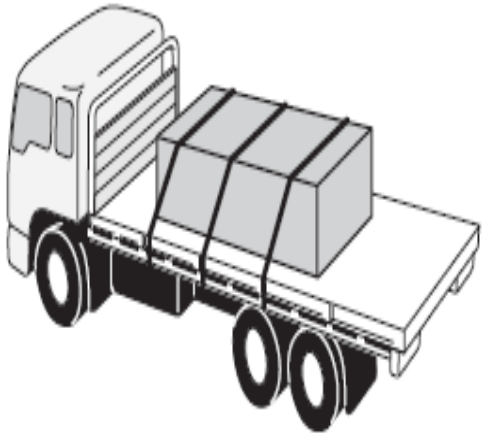


Fig. C.6 TIE-DOWN LASHINGS

Tie-down lashings used on offset loads can loosen if the load shifts sideways (see Figure C.7). Such movement can be sudden and without warning. Offset loads should be blocked or directly restrained to prevent sideways movement.

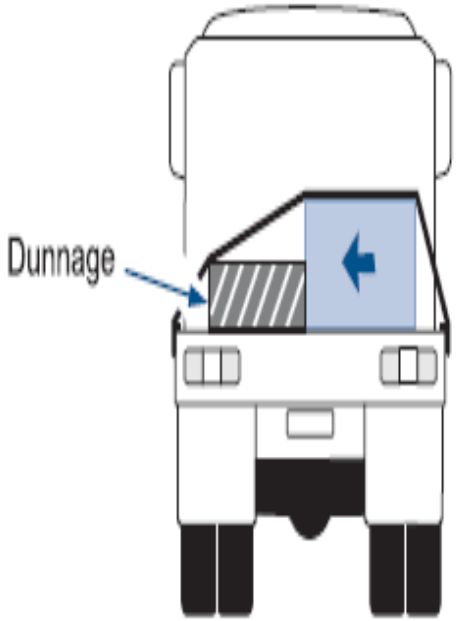
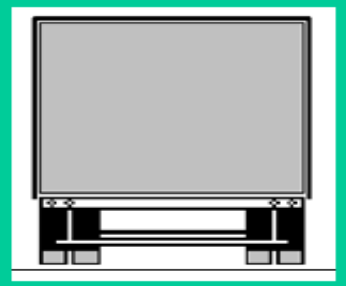
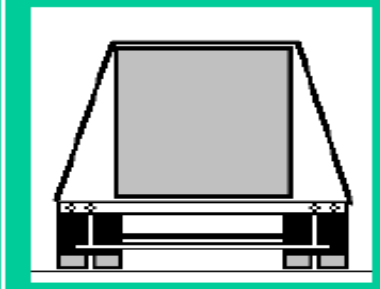
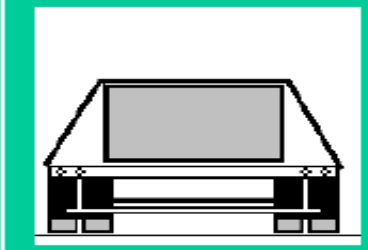
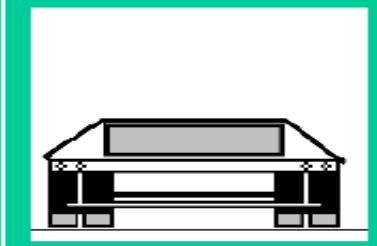
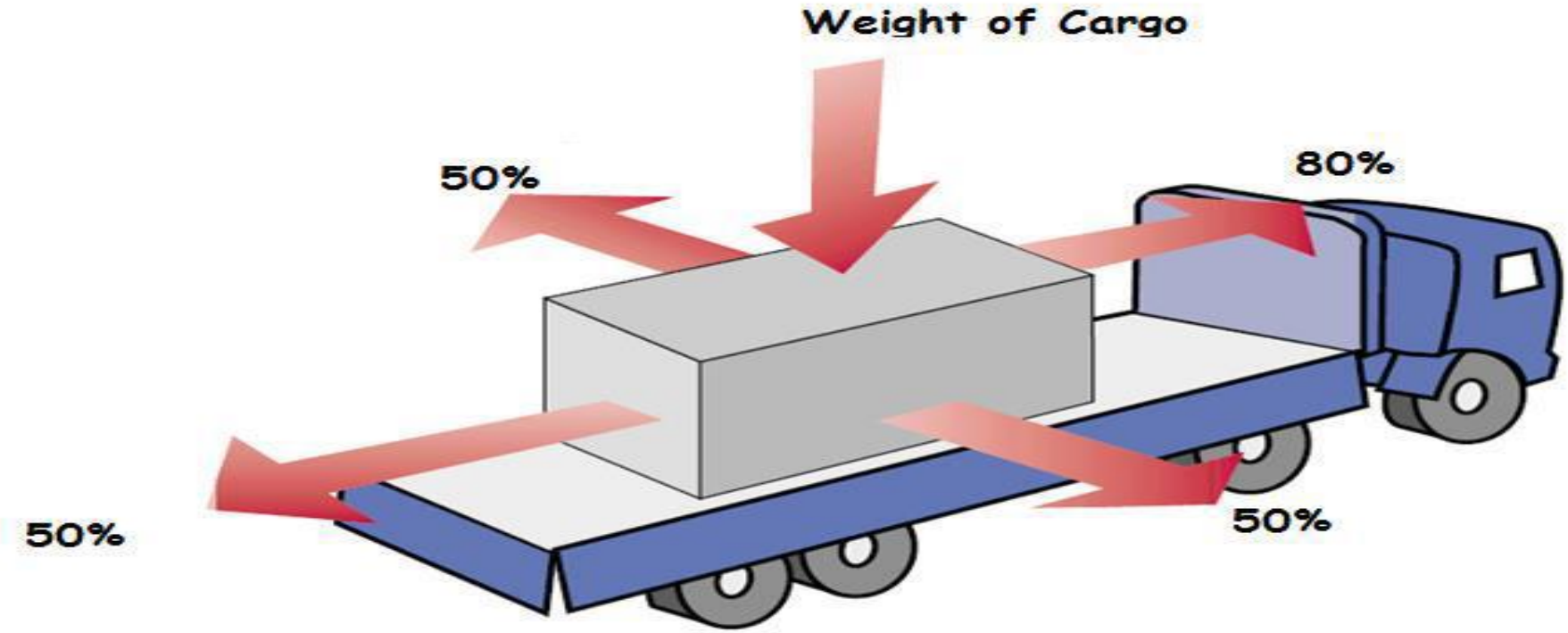


Fig. C.7 OFFSET LOAD (slippage loosens lashings)

Loss of tension

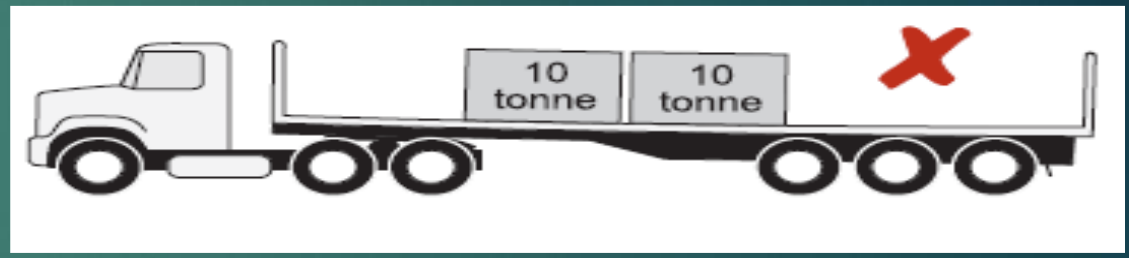
				
Angle	90°	60°	45°	30°
Effectiveness	100%	85%	70%	50%
Chain	3,000 Kg	2,550 Kg	2,100 Kg	1,500 Kg
Webbing	700 Kg	595 Kg	490 Kg	350 Kg

Forces on the Cargo



- Insufficient weight on drive axle

- Excessive trailer flexing



- Good weight distribution

Equipment for Cargo securing

- Chains & webbing

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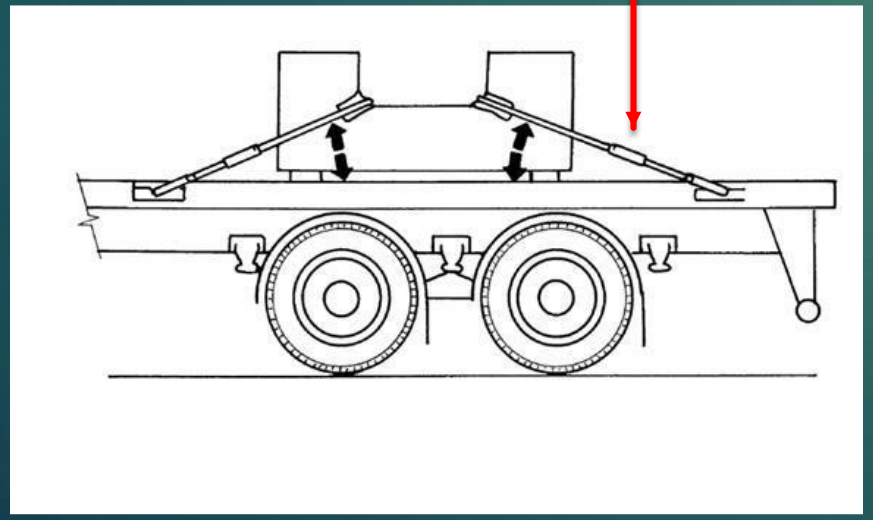
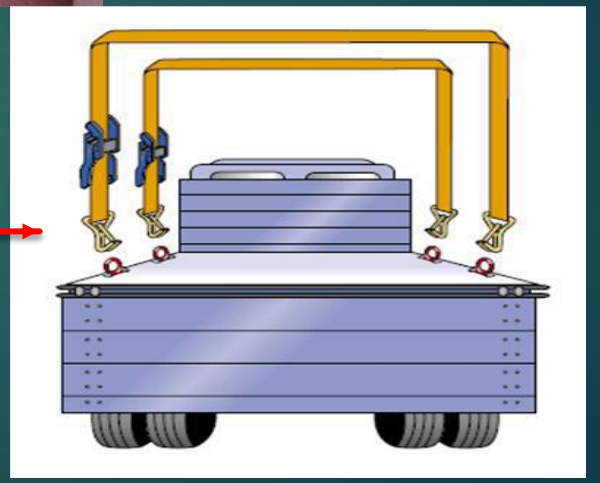
LC = Lashing Capacity

Stf = Tension Force





Tie-down principle

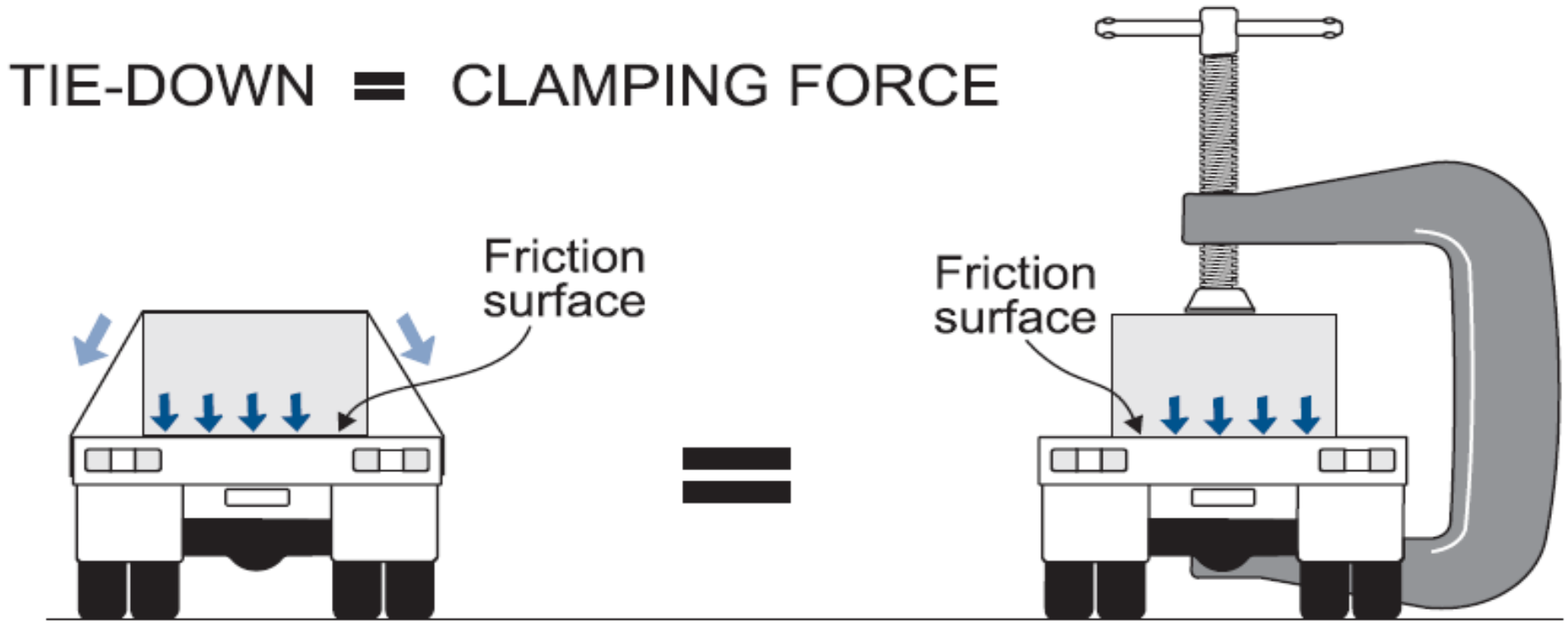


Fig. C.3 **CLAMPING THE LOAD**

Securing of Gas Cylinders

- Try to limit the number of cylinders that you are transporting.
- Ensure the cylinder contents are clearly labeled.
- Ensure the cylinder valve is in the fully closed position.
- Use valve protection caps before moving.
- A pressure relief device must be in communication with the vapor space of the cylinder.
- Use cylinder dollies or other mechanical lifting devices to move the cylinders to the vehicle.
- Never drop the cylinders or allow things to bang into them.
- An open vehicle or trailer is preferred.

Securing of Gas Cylinders

- Transporting the cylinders in an upright position is always preferred.
- Cylinders should be placed only on flat floors or platforms.
- If the cylinders are secured to a pallet, the pallet must be able to transport 3500 lbs per pallet, and the cylinders must be secured by a web strap rated at 10,000 lbs.
- Secure the cylinders in the vehicle or trailer to prevent movement during transit. Cylinders should not be allowed to shift relative to each other or the supporting structure.
- When transporting hydrogen or cryogenic liquid cylinders, the vehicle must have an open body with a support capable of holding the cylinder upright when subjected to 2g of acceleration, and the vehicle may not enter a tunnel.

Forces on Cargo

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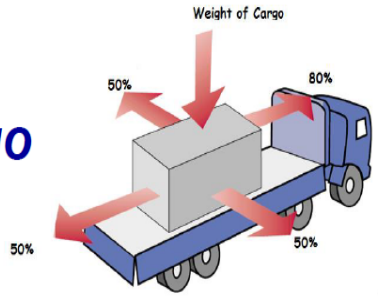
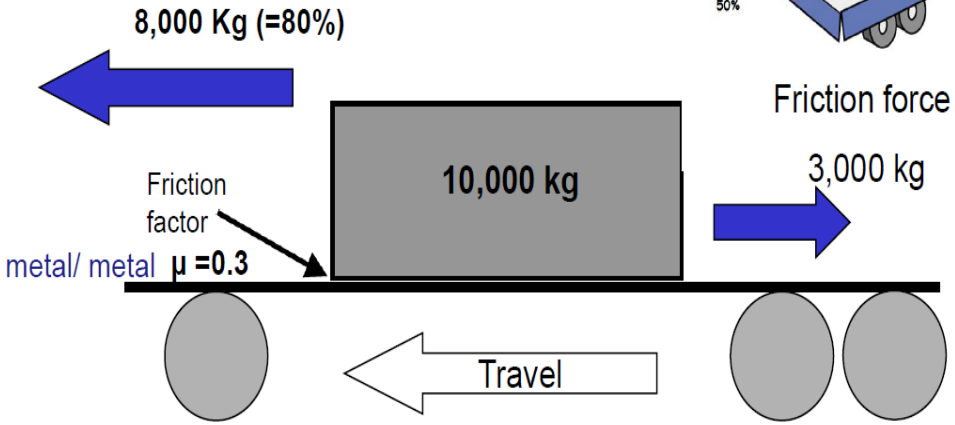
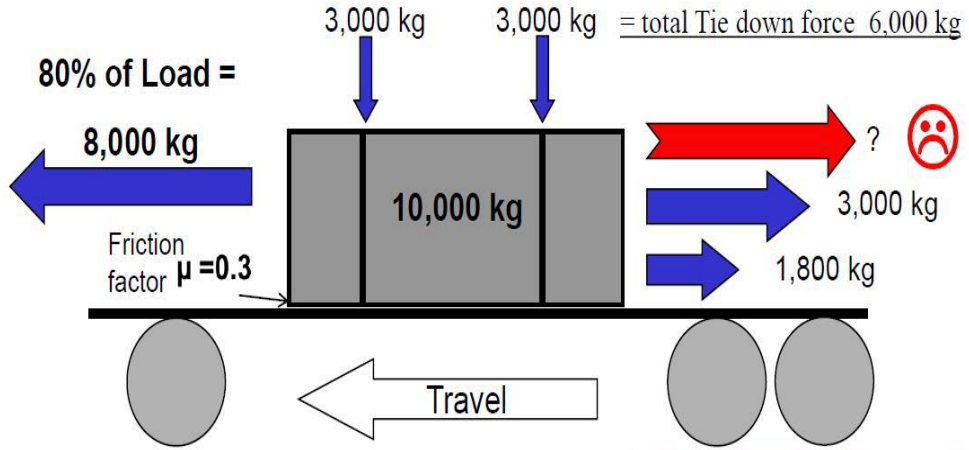
Forces on Cargo





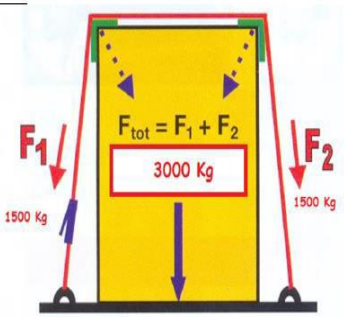
Required Force:	8,000 Kg.
Trailer deck friction force:	3,000 Kg.
(0.3 x 10,000 kg)	
Shortage:	5,000 Kg.

2* 10 mm Chains – metal / metal



Required Force:	8,000 Kg
Force due to friction:	3,000 Kg
Extra friction force due to tiedown: 2 Chains =	
6,000 kg * Friction μ (0.3) =	1,800 Kg
Friction force Total =	3,000 + 1,800 = 4,800 Kg

Shortage = 3,200 kg (8,000 – 4,800 Kg)



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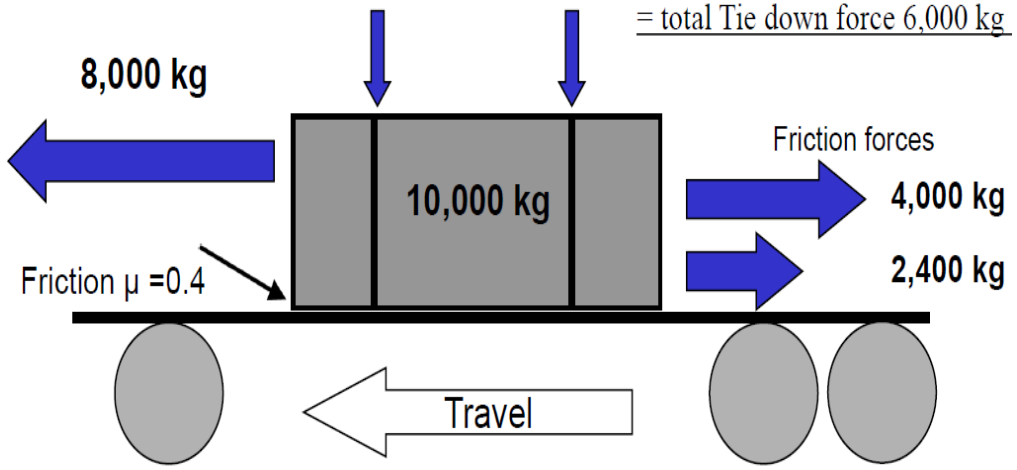
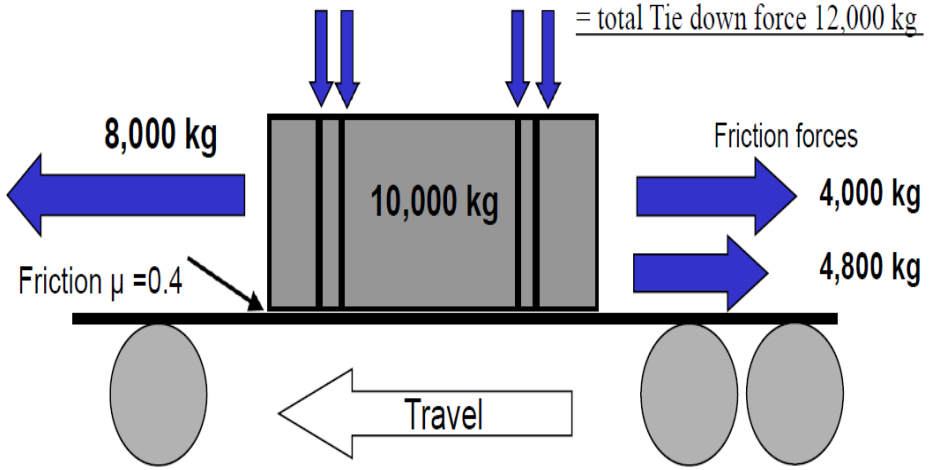
2* 10 mm Chains metal/wood (μ=0.4)



Required Force:	8,000 Kg
Restraint due to friction:	4,000 Kg
Restraint due to tiedown: 2 Chains =	
6000 Kg * Friction μ (0.4)	2,400 Kg
Restraint Total	4,000 + 2,400 = 6,400 Kg

Shortage = 1,600 kg (8000 – 6400)

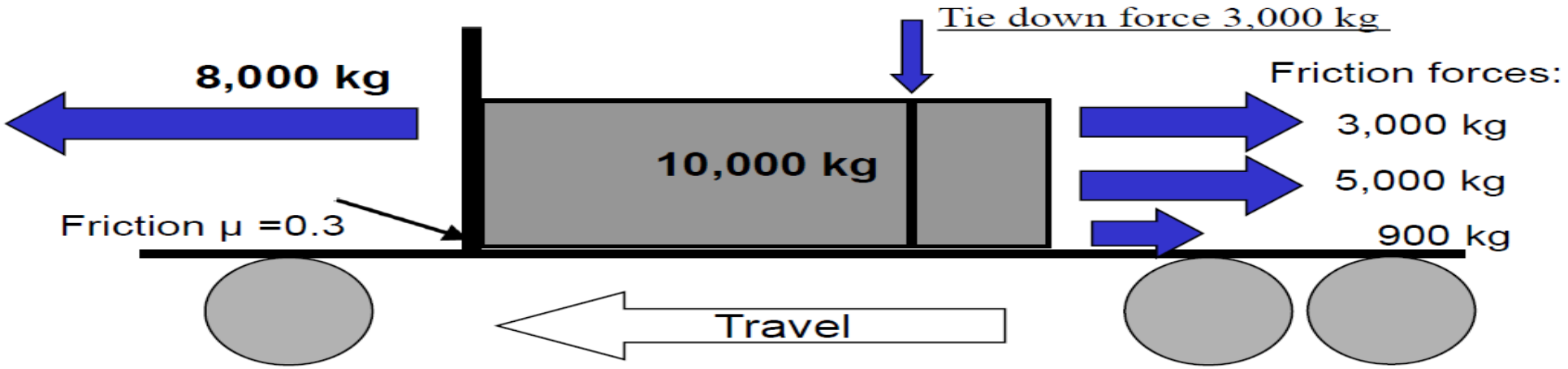
4* 10 mm Chains metal/wood (μ=0.4)



Required Force:	8,000 Kg
Restraint due to friction:	4,000 Kg
Restraint due to tie down: 4 Chains =	
12,000 Kg * Friction μ (0.4) =	4,800 Kg
Restraint Total =	4000 + 4800 = 8,800 Kg

Friction forces > Required force 8,800 > 8,000

Use of Head board and 1* 10 mm Chain metal / metal (μ=0.3)



Required Force:	8,000 Kg
Restraint due to friction:	3,000 Kg
Restraint due to Headboard:	5,000 Kg
Restraint due to tie down:	900 Kg

1 Chain = 3000 Kg * Friction μ = 0.3Kg)

Restraint Total = = 3,000 + 5,000 + 900 = 8,900 Kg

Friction forces > Required force 8,900 > 8,000

Metal Deck // μ=0.3

Ch --> Stf=1,500kg / We --> Stf=350kg					5000 kg	
Cargo weight	We	Ch	We	Ch	We	Ch
1,000	1	1	2	1	1	1
2,000	2	1	5	1	1	1
3,000	3	1	7	2	1	1
4,000	4	1	10	2	1	1
5,000	5	1	12	3	1	1
6,000	6	1	14	3	1	1
7,000	7	2	17	4	1	1
8,000	8	2	19	4	1	1
9,000	9	2	21	5	1	1
10,000	10	2	24	6	1	1
11,000	10	2	26	6	2	1
12,000	11	3	29	7	5	1
13,000	12	3	31	7	7	2

Bopetco RSMT - LS Field checklist - Source: European Best Practice on Cargo s

Bopetco RSMT - LS Field checklist - Source: European Best Practice on Cargo s

On Wood // μ=0.4

Ch --> Stf=1,500kg / We --> Stf=350kg					5000 kg	
Cargo weight	We	Ch	We	Ch	We	Ch
1,000	1	1	1	1	1	1
2,000	1	1	3	1	1	1
3,000	1	1	4	1	1	1
4,000	1	1	6	1	1	1
5,000	2	1	7	2	1	1
6,000	2	1	9	2	1	1
7,000	3	1	10	2	1	1
8,000	3	1	11	3	1	1
9,000	3	1	13	3	1	1
10,000	4	1	14	3	1	1
11,000	4	1	16	4	1	1
12,000	4	1	17	4	1	1
13,000	5	1	19	4	1	1