CASE 3:
TIE-DOWN RESTRAINT WITH CHAINS

Load:

- A stack of 2-tonne precast concrete panels (4 panels) – *Figure 492*.
- Each panel weighs 2 tonnes. The total mass is 8 tonnes.

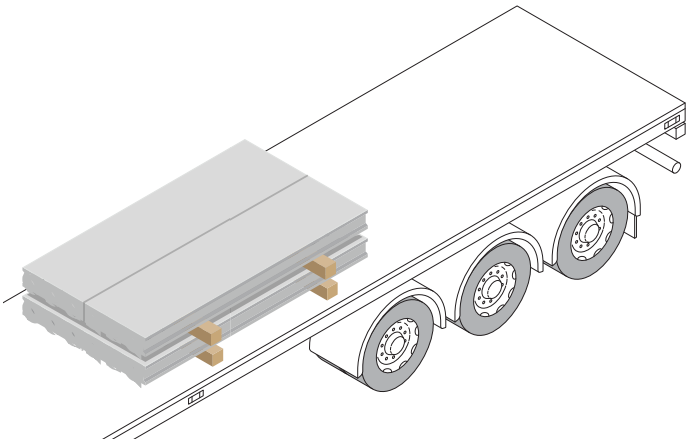
Vehicle:

- A prime mover and flat-tray semitrailer combination.

Equipment:

- Chain: 8 mm transport chain.
- Tensioner: standard load binder (average pre-tension 750 kgf).

Figure 492 Precast concrete panels on a flat tray



IDENTIFY THE LOAD, VEHICLE AND EQUIPMENT:

Step 1:
Which part of the load do I want to restrain?

I want to restrain the entire stack of precast concrete panels.

Step 2:
What vehicle will I use?

A prime mover and flat-tray semitrailer combination.

Step 3:
What restraint equipment will I use?

Transport chain (8 mm) and standard load binder (average pre-tension: **750 kgf**).

✓ Check what level of tension you can get with your equipment.

✓ Check your equipment is rated.

⚠ Unrated equipment should not be used for restraint purposes.

CHOOSE A SENSIBLE RESTRAINT METHOD:

Step 4:
What restraint methods may be suitable for my combination of load, vehicle and equipment?

For this example, **tie-down restraint** is a suitable restraint method based on the load type, the vehicle and the equipment available.

✔ Check the load type.

This is a load of precast concrete panels.

See the Loads module for information on other load types.

✔ Check how to use the equipment correctly.

See the Vehicle and equipment module for more information.

Step 5:
Can I block the load?

In this case, it is impractical to block the load. As the load is **UNBLOCKED** tie-down needs to provide all the restraint.

⚠ Unblocked loads will need a lot more lashings because the tie-downs need to resist the potential forward forces (equivalent to 80% of the weight).

WORK OUT THE NUMBERS:

Step 6:
What is the mass of the load?

The mass of the load is 8 tonnes **(8,000 kg)**.

⚠ If you underestimate the mass, you are likely to put yourself and others at risk due to insufficient restraint. Double-check your calculations!

Step 7:
How much friction?

The load is precast concrete panels on **timber** dunnage on a **steel** flat-tray truck. The friction level is **MEDIUM**.

ℹ For a list of typical friction levels see Table 1: Typical friction levels.

⚠ Friction levels within a load can vary. You need to design your tie-down restraint system for the lowest friction level. This is where the load is most likely to fail.

Tips:

- If your friction level is low you can improve the friction by using higher friction rubber/ load mats or interlayer packaging material.
- ℹ See Interlayer packaging for more information.

Step 8:

How many lashings do I need?

EASY OPTION – USE THE TABLES

Recheck the following to make sure the calculation is correct:

Lashing pre-tension amount **(Step 3)**	**750 kgf**
Blocking **(Step 5)**	**UNBLOCKED**
Load weight **(Step 6)**	**8,000 kg**
Friction level **(Step 7)**	**MEDIUM**

For this example, assume a **lashing angle greater than 60°**.

The table below outlines the number of lashings needed to restrain the **load weight** when using 8 mm transport chains with a lashing pre-tension of **750 kgf** if the load is **UNBLOCKED** and a **MEDIUM** level of friction.

Lashings:	**Tensioner:**	**Pre-tension:**
8 mm transport chain	Over-centre tensioner	750 kgf

UNBLOCKED (RESTRAINED TO 0.8G)

	Number of lashings	**Lashing angle (from horizontal)**				
		At least 75° AE > 0.95	**At least 60° AE > 0.85**	**At least 45° AE > 0.70**	**At least 30° AE > 0.50**	**At least 15° AE > 0.25**
MEDIUM FRICTION	**Static friction:** 0.4		**Example:** Smooth steel on timber			
	1	1,400 kg	1,200 kg	1,000 kg	750 kg	380 kg
	2	2,800 kg	2,500 kg	2,100 kg	1,500 kg	770 kg
	3	4,300 kg	3,800 kg	3,100 kg	2,200 kg	1,100 kg
	4	5,700 kg	5,100 kg	4,200 kg	4,200 kg	1,500 kg
	5	7,200 kg	6,400 kg	5,300 kg	5,300 kg	1,900 kg
	6	8,600 kg	7,700 kg	6,300 kg	6,300 kg	2,300 kg
	7	10,000 kg	9,000 kg	7,400 kg	7,400 kg	2,700 kg
	8	11,000 kg	10,000 kg	8,400 kg	8,400 kg	3,100 kg
	9	13,000 kg	11,000 kg	9,500 kg	9,500 kg	3,400 kg
	10	14,000 kg	12,000 kg	10,000 kg	10,000 kg	3,800 kg

The load weight is **8,000 kg**. Based on a **lashing angle greater than 60°**, when a load is **UNBLOCKED** and the friction level is **MEDIUM**, 7x 8 mm transport chains can restrain **9,000 kg**. Therefore, **7 chains** are needed to restrain this load.

This stack needs 7 chains. At least half of these chains needs to be placed over the top layer. The top layer needs at least 4 chains (enough to restrain that layer, with the "extra" tension contributing to restraining the bottom layer) and the other lower layer could use the other 3 chains. Alternatively all 7 chains could be over the whole stack.

7 chains per stack seems a lot, but this is what is required if the front of the load is not blocked.

To calculate the restraint requirements for different equipment and friction levels see the tie-down lashing tables.

Tips:

- Reduce the number of chains by blocking.
- You can block with direct restraint crossover chains or by placing the load against a step deck or rated headboard.