CASE 7:
DIRECT RESTRAINT USING CALCULATIONS OR LOAD TABLES

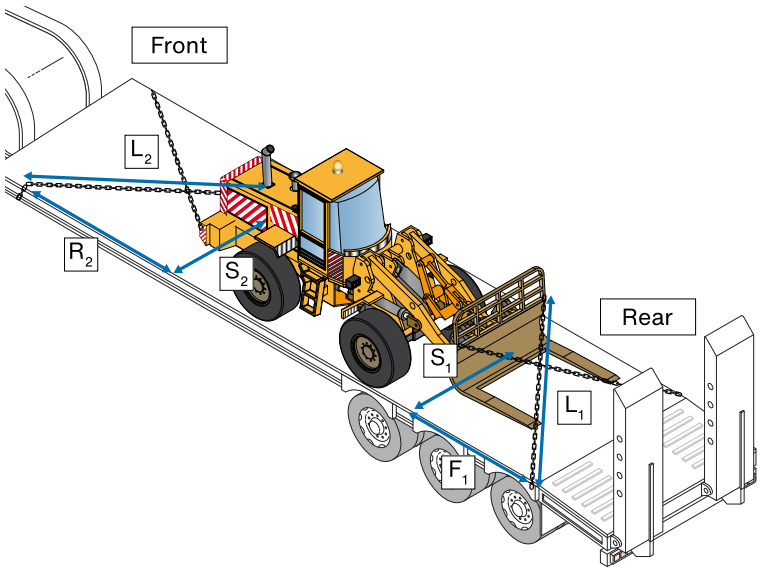
Load:

- 15 tonne front-end loader – *Figure 500*.

Direct lashing angles:

- For this example, we will determine the direct lashing angle effect using a simple calculation. To do this we need to know the following information.

Figure 500 Front-end loader



	FRONT	REAR
Lashing (chain) length* *longer chains used to cross the deck	4,000 mm (L2 in diagram)	4,000 mm (L1 in diagram)
Distance between the tie points along the trailer	3,400 mm (R2 in diagram)	3,400 mm (F1 in diagram)
Distance between the tie points across the trailer	2,000 mm (S2 in diagram)	2,000 mm (S1 is diagram)

Step 1:
What is the mass of the load?

The total mass of the load is **15,000 kg**.

Step 2:
What is your direct lashing angle effect in the forward direction?

The **rear** chains provide the forward restraint.

To determine the **forward direct angle effect** divide the **distance between the tie points along the truck (F1)** by the **lashing length (L1)**:

3,400 (F1) ÷ 4,000 (L1) = 0.85 (forward direct angle effect)

For more information see Lashing angles.

Step 3:
What is your direct lashing angle effect in the sideways direction?

Both the **front and rear** chains provide the sideways restraint.
To determine the **sideways direct angle effect** divide the **distance between the tie points across the truck** by the **lashing length** for both chains:

Front chain	**2,000 (S2) ÷ 4,000 (L2)** = 0.5 (sideways direct angle effect)
Rear chain	**2,000 (S1) ÷ 4,000 (L1)** = 0.5 (sideways direct angle effect)

For more information see Lashing angles.

Step 4:
What is your direct lashing angle effect in the rearward direction?

The **front** chains provide the rearward restraint.

To determine the **rearward direct angle effect** divide the **distance between the tie points along the truck (R2)** by the **lashing length (L2)**:

3,400 (R2) ÷ 4,000 (L2) = 0.85 (rearward direct angle effect)

For more information see Lashing angles.

Step 5:
What strength lashings is needed to restrain the load? CALCULATION

To restrain a **15,000 kg** load the following strength lashing is needed:

DIRECTION	RESTRAINT REQUIRED		REQUIRED LASHING STRENGTH (PER LASHING)	FOR EXAMPLE (FROM TABLE 4)
Forwards (80% of the weight)	12,000 kg (6,000 kg per lashing)	0.85	6,000 kg ÷ 0.85 = 7,059 kg	13 mm transport chain with claw hooks or winged grab hooks
Sideways (50% of the weight)	7,500 kg (3,750 kg per lashing)	0.50	3,750 kg ÷ 0.50 = 7,500 kg	13 mm Grade 'T' chain hooks or winged grab hooks
Rearwards (50% of the weight)	7,500 kg (3,750 kg per lashing)	0.85	3,750 kg ÷ 0.85 = 4,412 kg	10 mm transport chain with claw hooks or winged grab hooks

Note: *Chain capacity is reduced by 25% due to contact with coaming rail.*

Taking the highest lashing strength required (7,500 kg), a 13 mm Grade 'T' chain with claw hooks or winged grab hooks is necessary in **all directions** to restrain the load.

For more information see Table 4 Typical lashing capacity – chain or Table 3 Typical lashing capacity – ropes and webbing straps.

The lashing strength is the lashing capacity or manufacturer's rating, which should be marked on the lashing.

Chains should be of the same length and at the same angle to be considered working together.

Step 5 (ALTERNATIVE):
What strength lashings is needed to restrain the load? USING LOAD TABLES

Once you know the direct angle effect for each direction, you can also use the load tables to determine the lashing strength you need.

For **forward direction restraint**, see Table 9 Minimum lashing capacity – direct restraint forwards (80% of load weight) using 2 chains.

For **sideways and rearward** direction restraint, see Table 10 Minimum lashing capacity – direct restraint sideways or rearwards (50% of load weight) using 2 chains.

The **forward direct angle effect is 0.85** (see Step 2). To restrain a **15,000 kg** load in the forward direction a lashing strength of **7.1 tonne** is needed. For example (from Table 4), **a 13 mm Grade 'T' transport chain with claw hooks or winged grab hooks**.

MINIMUM LASHING CAPACITY – DIRECT RESTRAINT FORWARDS (80% OF LOAD WEIGHT) USING 2 CHAINS

Mass of load (kilograms) (tonnes)	Angle effect AE = >0.85	Angle effect AE = >0.70	Angle effect AE = >0.50
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

The **sideways direct angle effect is 0.50** (see Step 3). To restrain the **15,000 kg** load in the sideways direction a lashing strength of **7.5 tonne** is needed. For example (from Table 4), a **13 mm Grade 'T' transport chain with claw hooks or winged grab hooks**.

MINIMUM LASHING CAPACITY – DIRECT RESTRAINT SIDEWAYS OR REARWARDS (50% OF LOAD WEIGHT) USING 2 CHAINS

Mass of load (kilograms) (tonnes)	Angle effect AE = >0.85	Angle effect AE = >0.70	Angle effect AE = >0.50
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

The **rearwards direct angle effect is 0.85** (see Step 4). To restrain a **15,000 kg** load in the rearwards direction a lashing strength of **4.5 tonne** is needed. For example (from Table 4), a **10 mm transport chain with grab hooks or edge contact**.

Taking the highest lashing strength required (7.5 tonne), a 13 mm Grade 'T' transport chain with claw hooks or winged grab hooks is necessary in **all directions** to restrain the load.

For more information see Table 4 Typical lashing capacity – chain or Table 3 Typical lashing capacity - ropes and webbing straps.

The lashing strength is the lashing capacity or manufacturer's rating, which should be marked on the lashing.

Chains should be of the same length and at the same angle to be considered working together.

MINIMUM LASHING CAPACITY – DIRECT RESTRAINT SIDEWAYS OR REARWARDS (50% OF LOAD WEIGHT) USING 2 CHAINS

Mass of load (kilograms) (tonnes)	Angle effect AE = >0.85	Angle effect AE = >0.70	Angle effect AE = >0.50
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