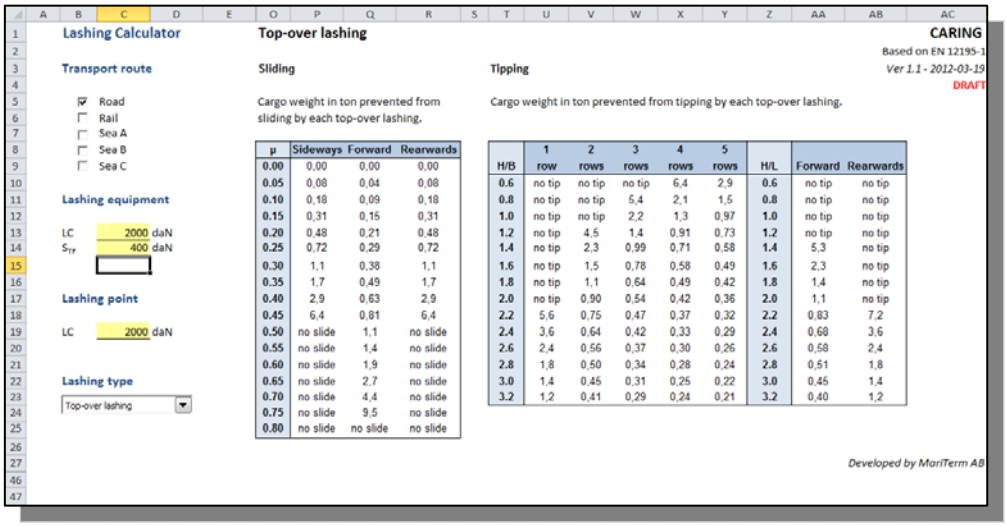
Guide to the Caring Cargo Calculator



Lashing Calculator

Transport route

- [x] Road
- [ ] Rail
- [ ] Sea A
- [ ] Sea B
- [ ] Sea C

Lashing equipment

LC 2000 daN

S_{TF} 400 daN

Lashing point

LC 2000 daN

Lashing type

Top-over lashing

Top-over lashing

Sliding

Cargo weight in ton prevented from sliding by each top-over lashing.

μ	Sideways	Forward	Rearwards
0.00	0,00	0,00	0,00
0.05	0,08	0,04	0,08
0.10	0,18	0,09	0,18
0.15	0,31	0,15	0,31
0.20	0,48	0,21	0,48
0.25	0,72	0,29	0,72
0.30	1,1	0,38	1,1
0.35	1,7	0,49	1,7
0.40	2,9	0,63	2,9
0.45	6,4	0,81	6,4
0.50	no slide	1,1	no slide
0.55	no slide	1,4	no slide
0.60	no slide	1,9	no slide
0.65	no slide	2,7	no slide
0.70	no slide	4,4	no slide
0.75	no slide	9,5	no slide
0.80	no slide	no slide	no slide

Tipping

Cargo weight in ton prevented from tipping by each top-over lashing.

H/B	1 row	2 rows	3 rows	4 rows	5 rows
0.6	no tip	no tip	no tip	6,4	2,9
0.8	no tip	no tip	5,4	2,1	1,5
1.0	no tip	no tip	2,2	1,3	0,97
1.2	no tip	4,5	1,4	0,91	0,73
1.4	no tip	2,3	0,99	0,71	0,58
1.6	no tip	1,5	0,78	0,58	0,49
1.8	no tip	1,1	0,64	0,49	0,42
2.0	no tip	0,90	0,54	0,42	0,36
2.2	5,6	0,75	0,47	0,37	0,32
2.4	3,6	0,64	0,42	0,33	0,29
2.6	2,4	0,56	0,37	0,30	0,26
2.8	1,8	0,50	0,34	0,28	0,24
3.0	1,4	0,45	0,31	0,25	0,22
3.2	1,2	0,41	0,29	0,24	0,21

H/L	Forward	Rearwards
0.6	no tip	no tip
0.8	no tip	no tip
1.0	no tip	no tip
1.2	no tip	no tip
1.4	5,3	no tip
1.6	2,3	no tip
1.8	1,4	no tip
2.0	1,1	no tip
2.2	0,83	7,2
2.4	0,68	3,6
2.6	0,58	2,4
2.8	0,51	1,8
3.0	0,45	1,4
3.2	0,40	1,2

CARING

Based on EN 12195-1

Ver 1.1 - 2012-03-19

DRAFT

Developed by MariTerm AB

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Education and Culture DG
Lifelong Learning Programme

GUIDE TO THE CARING CARGO CALCULATOR

The CARING Cargo Calculator is based on the principles in the standard EN 12195-1 (2010). The purpose of the calculator is to enable the user to produce costume made Quick Lashing Guides, based on preferred equipment capacities, routes and securing methods.

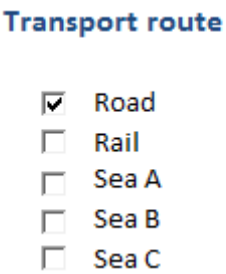
This guide has the following content:

1. **Lashings tab** – Guide on using the calculator sheet "Lashings"
2. **Washers and nails tab** – Guide on using the calculator sheet "Washers and nails"
3. **Transport route** – Definitions on the available modes of transport
4. **Friction factors** – list of friction factors from the standard EN 12195-1 (2010)
5. **Example** – Example on how to use the tables in the calculator to determine the required number of lashings

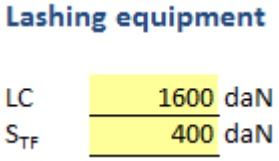
1. Lashings tab

1.1. Calculation procedure

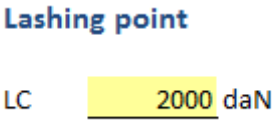
1. Under the "transport route section", select the modes of transports which are to be included in the calculation.



2. Insert lashing capacity (LC) and Standard Tension Force (STF) for the current lashing equipment under the "lashing equipment" section.



3. Insert lashing capacity (LC) for the cargo lashing point under the "lashing point" section.



4. Select which lashing method the calculation shall be based on under the "lashing type" section. The following lashing methods can be used:

   - Top-over lashing
   - Spring lashing
   - Loop lashing
   - Straight/cross lashing

1.2. Results

When all information above has been entered, the calculator presents the cargo weight prevented from sliding and tipping in sideways, forward and rearward directions, in two different tables.

Sliding

Cargo weight in ton prevented from sliding by each top-over lashing.

μ	Sideways	Forward	Rearwards
0,00	0,00	0,00	0,00
0,05	0,08	0,04	0,08
0,10	0,18	0,09	0,18
0,15	0,31	0,15	0,31
0,20	0,48	0,21	0,48
0,25	0,72	0,29	0,72
0,30	1,1	0,38	1,1
0,35	1,7	0,49	1,7
0,40	2,9	0,63	2,9
0,45	6,4	0,81	6,4
0,50	no slide	1,1	no slide
0,55	no slide	1,4	no slide
0,60	no slide	1,9	no slide
0,65	no slide	2,7	no slide
0,70	no slide	4,4	no slide
0,75	no slide	9,5	no slide
0,80	no slide	no slide	no slide

Tipping

Cargo weight in ton prevented from tipping by each top-over lashing.

H/B	1 row	2 rows	3 rows	4 rows	5 rows	H/L	Forward	Rearwards
0,6	no tip	no tip	no tip	5,8	2,9	0,6	no tip	no tip
0,8	no tip	no tip	4,9	2,1	1,5	0,8	no tip	no tip
1,0	no tip	no tip	2,2	1,3	0,97	1,0	no tip	no tip
1,2	no tip	4,1	1,4	0,91	0,73	1,2	no tip	no tip
1,4	no tip	2,3	0,99	0,71	0,58	1,4	5,3	no tip
1,6	no tip	1,5	0,78	0,58	0,49	1,6	2,3	no tip
1,8	no tip	1,1	0,64	0,49	0,42	1,8	1,4	no tip
2,0	no tip	0,90	0,54	0,42	0,36	2,0	1,1	no tip
2,2	4,5	0,75	0,47	0,37	0,32	2,2	0,83	7,2
2,4	3,3	0,64	0,42	0,33	0,29	2,4	0,68	3,6
2,6	2,4	0,56	0,37	0,30	0,26	2,6	0,58	2,4
2,8	1,8	0,50	0,34	0,28	0,24	2,8	0,51	1,8
3,0	1,4	0,45	0,31	0,25	0,22	3,0	0,45	1,4
3,2	1,2	0,41	0,29	0,24	0,21	3,2	0,40	1,2

Sliding

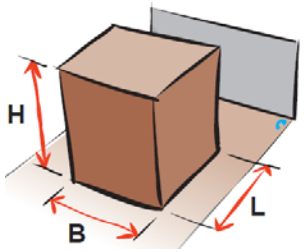
In the first table, the cargo weight in ton prevented from sliding by each lashing is given for different friction factors.

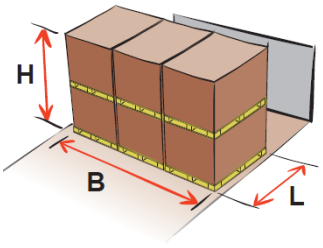
Tipping

The second table gives the cargo weight in ton prevented from tipping by each lashing.

For sideways tipping, the secured cargo weight is given for different height to width ratios (H/B) of the cargo section. There are different columns for different number of cargo rows, i.e. the number of collies abreast in each section.

For tipping forward and rearward the secured cargo weight is given for different height to length ratios (H/L). Only the foremost or rearmost section has to be considered.

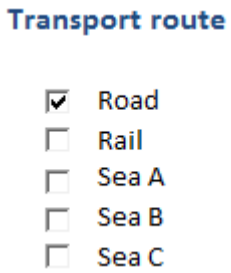




2. Washers and nails tab

2.1. Calculation procedure

1. Under the “transport route section”, select the modes of transports which are to be included in the calculation.



2.2. Results

Tag washers

Cargo weight in ton prevented from sliding by each tag washer.

Tag washers should only be used in combination with lashings.

	Dimension [mm]						
	ϕ 48	*ϕ 62*	*ϕ 75*	*ϕ 95*	*30 x 57*	*48 x 65*	*130 x 130*
μ	**Sideways**						
0,20	0,42	0,58	0,75	1,00	0,42	0,58	1,3
0,30	0,63	0,88	1,1	1,5	0,63	0,88	1,9
0,40	1,3	1,8	2,3	3,0	1,3	1,8	3,8
μ	**Forward**						
0,20	0,21	0,29	0,38	0,50	0,21	0,29	0,63
0,30	0,25	0,35	0,45	0,60	0,25	0,35	0,75
0,40	0,31	0,44	0,56	0,75	0,31	0,44	0,94
μ	**Rearwards**						
0,20	0,42	0,58	0,75	1,00	0,42	0,58	1,3
0,30	0,63	0,88	1,1	1,5	0,63	0,88	1,9
0,40	1,3	1,8	2,3	3,0	1,3	1,8	3,8

The friction factor should be chosen based on the material combination for the tag washer and the cargo or the platform.

Cargo weights prevented from sliding are presented for tag washers of different dimensions and various coefficients of friction.

Note
The friction factor should be chosen based on the material combination for the tag washer and the cargo or the platform.

Tag washers should only be used in combination with lashings.

Nails 4"

Cargo weight in ton prevented from sliding by each 4" nail.

	Sideways		Forward		Rearwards	
μ	*Smooth*	*Galvanized*	*Smooth*	*Galvanized*	*Smooth*	*Galvanized*
0,15	0,31	0,46	0,17	0,25	0,31	0,46
0,20	0,37	0,53	0,18	0,27	0,37	0,53
0,25	0,44	0,64	0,20	0,29	0,44	0,64
0,30	0,55	0,80	0,22	0,32	0,55	0,80
0,35	0,73	1,1	0,24	0,36	0,73	1,1
0,40	1,1	1,6	0,28	0,40	1,1	1,6
0,45	2,2	3,2	0,31	0,46	2,2	3,2
0,50	no slide	no slide	0,37	0,53	no slide	no slide
0,55	no slide	no slide	0,44	0,64	no slide	no slide
0,60	no slide	no slide	0,55	0,80	no slide	no slide
0,65	no slide	no slide	0,73	1,1	no slide	no slide
0,70	no slide	no slide	1,1	1,6	no slide	no slide
0,75	no slide	no slide	2,2	3,2	no slide	no slide
0,80	no slide	no slide	no slide	no slide	no slide	no slide

Cargo weights prevented from sliding are presented for smooth and galvanized nails with a length of at least 4", for various coefficients of friction.

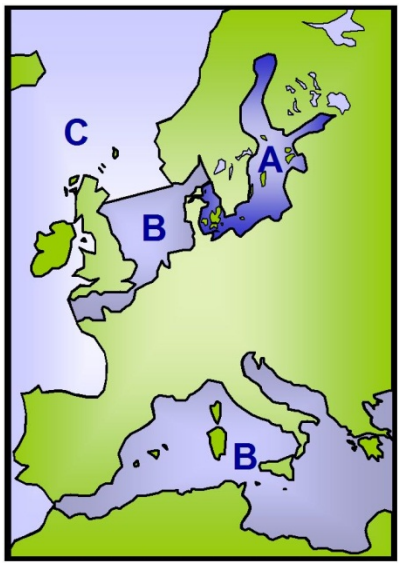
3. Transport route

The lashing calculator can be used for the following modes of transports:

- Road transports
- Railway transports
- Sea transports

Sea transports are divided into three different traffic areas, A, B, and C, each having individual requirements on cargo securing. The areas are illustrated in the figure to the right but are also defined as follows:

- Sea area A = The Baltic Sea
- Sea area B = The North & Mediterranean Seas
- Sea area C = Unrestricted area



4. Friction factors

The coefficients of friction for different material combinations are presented in the table below. The table is extracted from the EN 12195-1 standard.

Combination of materials in the contact surface [a]	Friction factor μ
Sawn wood	
Sawn wood – fabric base laminate/plywood	0,45
Sawn wood – grooved aluminium	0,4
Sawn wood – shrink film	0,3
Sawn wood – stainless steel sheet	0,3
Plane wood	
Plane wood – fabric base laminate/plywood	0,3
Plane wood – grooved aluminium	0,25
Plane wood – stainless steel sheet	0,2
Plastic pallet	
Plastic pallet – fabric base laminate/plywood	0,2
Plastic pallet – grooved aluminium	0,15
Plastic pallet – stainless steel sheet	0,15
Steel and metal	
Steel crate – fabric base laminate/plywood	0,45
Steel crate – grooved aluminium	0,3
Steel crate – stainless steel sheet	0,2
Concrete	
Concrete rough – sawn wood battens	0,7
Concrete smooth – sawn wood battens	0,55
anti-slip mat	
Rubber	0,6 [b]
Other material	as certified [c]

[a] Surface, dry or wet but clean, free from oil, ice, grease.

[b] May be used with f_μ = 1,0 for direct lashing.

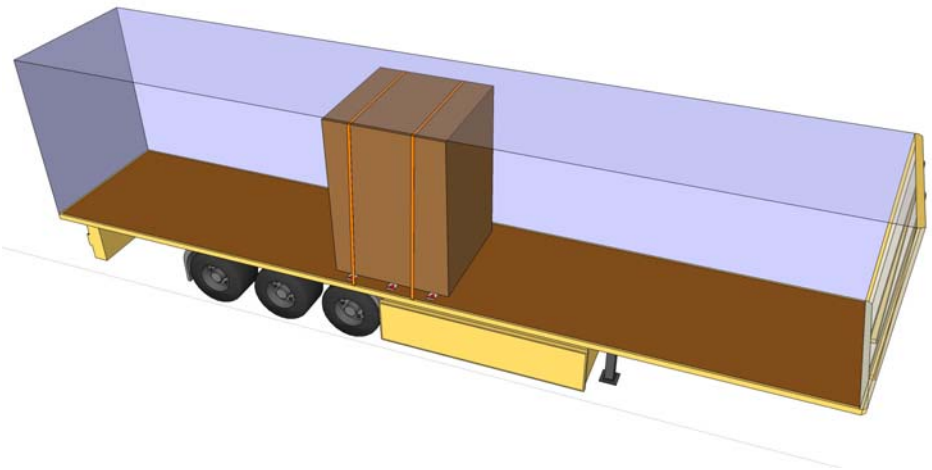
[c] When special materials for increased friction like skid-inhibiting mats are applied, a certificate for the friction factor μ is required.

It has to be ensured that the used friction factors are applicable to the actual transport. If the surface contacts are not swept clean, free from frost, ice and snow a friction factor larger than μ = 0,2 (for sea transport μ = 0,3) shall not be used. Special precautions should be taken for oily and greasy surfaces.

5. Example

A wooden box shall be transported on road. The box is stowed in a trailer with wooden floor and has a weight of 5 ton, length = 2.0 m, breadth = 2.0 m, height = 2.8 m and center of gravity in the center of the box.

The box is secured by 2 top-over lashings of webbing, with LC = 1600 daN (1 600 kg) and pre-tension 400 daN (400 kg). In addition to these lashings, the box is prevented from sliding by 6 tag washers (∅95 mm), which are placed symmetrical under the box. The arrangement is illustrated in the figure below.



Is this cargo securing arrangement sufficient to prevent sliding and tipping in all directions?

The cargo securing arrangement is evaluated through the Lashing Calculator, for capability to prevent sliding and tipping in all directions, according to the following:

5.1. Sliding

μ	Sideways	Forward	Rearwards
0,00	0,00	0,00	0,00
0,05	0,08	0,04	0,08
0,10	0,18	0,09	0,18
0,15	0,31	0,15	0,31
0,20	0,48	0,21	0,48
0,25	0,72	0,29	0,72
0,30	1,1	0,38	1,1
0,35	1,7	0,49	1,7
0,40	2,9	0,63	2,9
0,45	6,4	0,81	6,4
0,50	no slide	1,1	no slide
0,55	no slide	1,4	no slide
0,60	no slide	1,9	no slide
0,65	no slide	2,7	no slide
0,70	no slide	4,4	no slide
0,75	no slide	9,5	no slide
0,80	no slide	no slide	no slide

Lashings
According to the table on page 5 of this manual, the coefficient of friction is 0.4 for sawn wood against tag washers (steel) as there is no risk for frost ice or snow during this voyage.

Sideways
In sideways direction each top-over lashing prevents 2.9 ton from sliding.

Forward
In forward direction each top-over lashing prevents 0.63 ton from sliding.

Rearward
In rearward direction each top-over lashing prevents 2.9 ton from sliding.

	Dimension [mm]						
	ϕ 48	ϕ 62	ϕ 75	ϕ 95	30 x 57	48 x 65	130 x 130
μ	**Sideways**						
0,20	0,42	0,58	0,75	1,00	0,42	0,58	1,3
0,30	0,63	0,88	1,1	1,5	0,63	0,88	1,9
0,40	1,3	1,8	2,3	3,0	1,3	1,8	3,8
μ	**Forward**						
0,20	0,21	0,29	0,38	0,50	0,21	0,29	0,63
0,30	0,25	0,35	0,45	0,60	0,25	0,35	0,75
0,40	0,31	0,44	0,56	0,75	0,31	0,44	0,94
μ	**Rearwards**						
0,20	0,42	0,58	0,75	1,00	0,42	0,58	1,3
0,30	0,63	0,88	1,1	1,5	0,63	0,88	1,9
0,40	1,3	1,8	2,3	3,0	1,3	1,8	3,8

Tag washers

Sideways
In sideways direction each tag washer prevents 3.0 ton from sliding

Forward
In forward direction each tag washer prevents 0.75 ton from sliding

Rearward
In rearward direction each tag washer prevents 3.0 ton from sliding

Since tag washers and top-over lashings are used in combination, the following cargo weights are prevented from sliding:

	Sideways	Forward	Rearward
Top-over lashing	2 x 2.9 = 5.8 ton	2 x 0.63 = 1.3 ton	2 x 2.9 = 5.8 ton
Tag washer	6 x 3.0 = 18.0 ton	6 x 0.75 = 4.5 ton	6 x 3.0 = 18.0 ton
TOTAL	**= 23.8 ton**	**= 5.8 ton**	**= 23.8 ton**

Since the cargo weighs 5 ton, the lashing arrangement is sufficient to prevent sliding in any direction.

5.2. Tipping

H/B	1 row	2 rows	3 rows	4 rows	5 rows	H/L	Forward	Rearwards
0,6	no tip	no tip	no tip	5,8	2,9	0,6	no tip	no tip
0,8	no tip	no tip	4,9	2,1	1,5	0,8	no tip	no tip
1,0	no tip	no tip	2,2	1,3	0,97	1,0	no tip	no tip
1,2	no tip	4,1	1,4	0,91	0,73	1,2	no tip	no tip
1,4	no tip	2,3	0,99	0,71	0,58	1,4	5,3	no tip
1,6	no tip	1,5	0,78	0,58	0,49	1,6	2,3	no tip
1,8	no tip	1,1	0,64	0,49	0,42	1,8	1,4	no tip
2,0	no tip	0,90	0,54	0,42	0,36	2,0	1,1	no tip
2,2	4,5	0,75	0,47	0,37	0,32	2,2	0,83	7,2
2,4	3,3	0,64	0,42	0,33	0,29	2,4	0,68	3,6
2,6	2,4	0,56	0,37	0,30	0,26	2,6	0,58	2,4
2,8	1,8	0,50	0,34	0,28	0,24	2,8	0,51	1,8
3,0	1,4	0,45	0,31	0,25	0,22	3,0	0,45	1,4
3,2	1,2	0,41	0,29	0,24	0,21	3,2	0,40	1,2

Sideways
The height H of the box is 2.8 m and the width B is 2.0 m and thus H/B = 1.4.

There is no risk of tipping sideways.

Forward/rearward
The height H of the box is 2.8 m and the length L is 2.0 m and thus H/L = 1.4.

In forward direction each lashing prevents 5.3 ton from tipping. Together the 2 lashings prevents 10.6 ton of cargo from tipping, which is more than enough.

There is no risk of tipping rearwards.

5.3. Conclusion

The calculations above show that the cargo securing arrangement, consisting of 6 tag washers and 2 top-over web lashings, is sufficient to prevent sliding and tipping in all directions.