

MODEL MANUAL FOR GENERAL CARGO/CONTAINER VESSEL

BY

DET NORSKE VERITAS

This is an example of a Cargo Securing Manual according to “Guidelines for the Preparation of the Cargo Securing Manual” (IMO MSC/Circ.745) and the “Amendments to the Code of Safe Practice for Cargo Stowage and Securing (IMO MSC/Circ.1026)”.

Accelerations and securing is based on DNV’s IMO LASHCON™, hence it is assumed that the vessel have IMO LASHCON™ installed onboard.

The latest amendments as per the end of May 2002 are covered in this model manual.

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Cargo Securing Manual for M/S TEST VESSEL

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2 General

2.1 Ship Data

General Data

| | |
|-----------------------|--|
| Ship Name: | M/S Test Vessel |
| DNV Id No: | 12345 |
| IMO No: | 67890123 |
| Flag | Flag |
| Class Notation | ✱1A1 General Cargo/ Container Carrier |
| | |

Ship dimensions

| | |
|----------------------------|--------------------|
| Length, Lpp | 155.6 m |
| Beam, B | 21.0 m |
| Depth moulded, D | 12.1 m |
| Draft, T | 7.0 m |
| Speed, V | 17.0 kn |
| GM, range of values | 0.5 - 2.5 m |

Reference documents

| Document/Manual | Issue date | Approval date |
|-------------------------------------|-------------------|----------------------|
| Loading Manual | 96.04.19 | 96.04.20 |
| Trim & Stability Booklet | 96.04.21 | 96.04.22 |
| | | |
| | | |
| | | |

2.2 Definitions

“Cargo Securing Devices” is all fixed and portable devices used to secure and support cargo units.

“Maximum Securing Load” (MSL) is a term used to define the allowable load capacity for a device used to secure cargo to a ship. “Safe Working Load” (SWL) may be substituted for MSL for securing purposes, provided this is equal to or exceeds the strength defined by MSL.

“Standardized Cargo” means cargo for which the ship is provided with an approved securing system based upon cargo units of specific types.

“Semi-standardized Cargo” means cargo for which the ship is provided with a securing system capable of accommodating a limited variety of cargo units, such as vehicles, trailers, etc.

“Non-standardized Cargo” means cargo which requires individual stowage and securing arrangements.

“Cargo transport unit” means a road freight vehicle, a railway freight wagon, a freight container, a road tank vehicle, a railway tank wagon or a portable tank.

“Fixed Securing Devices” means securing points and supports either integral, i.e. welded into the hull structure, or non-integral, i.e. welded onto the hull structure.

“Portable Securing Devices” means portable devices used for lashing, securing or support of cargo units.

2.3 General Information

- 1 The guidance given herein should by no means rule out the principles of good seamanship, neither can they replace experience in stowage and securing practice.
- 2 The information and requirements set forth in this Manual are consistent with the requirements of the vessel's trim and stability booklet, International Load Line Certificate (1966), the hull strength loading manual (if provided) and with the requirements of the International Maritime Dangerous Goods (IMDG) Code (if applicable).
- 3 This Cargo Securing Manual specifies arrangements and cargo securing devices provided on board the ship for the correct application to and the securing of cargo units, containers, vehicles and other entities, based on transverse, longitudinal and vertical forces which may arise during adverse weather and sea conditions.
- 4 It is imperative to the safety of the ship and the protection of the cargo and personnel that the securing of the cargo is carried out properly and that only appropriate securing points or fittings should be used for cargo securing.
- 5 The cargo securing devices mentioned in this manual should be applied so as to be suitable and adapted to the quantity, type of packaging, and physical properties of the cargo to be carried. When new or alternative types of cargo securing devices are introduced, the Cargo Securing Manual should be revised accordingly. Alternative cargo securing devices introduced should not have less strength than the equipment which it replaces.
- 6 There should be a sufficient quantity of reserve cargo securing devices on board the ship.

- 7 Information on the strength and instructions for the use and maintenance of each specific type of cargo securing device, where applicable, is provided in this manual. The cargo securing devices should be maintained in a satisfactory condition. Items worn or damaged to such an extent that their quality is impaired should be replaced.

2.4 Principal sources of danger

Some important sources of danger which can affect the safety of roll on/roll off ships and of persons on them include:

1. Cargo badly stowed or inadequately secured inside or on cargo units.
2. Free surface effects in tank vehicles, tank containers or other bulk units which are slack.
3. Poorly maintained ramps, lifts and stern doors.
4. Poorly maintained or inadequately illuminated decks.
5. Wet decks.
6. Failure to apply brakes correctly.
7. Insufficient or incorrectly applied lashings or the use of lashing equipment of the wrong type or of inadequate strength with respect to mass and centre of gravity of the cargo unit and the weather conditions likely to be encountered during the voyage.

3 Securing Devices and Arrangements

When securing devices are replaced, the inventory lists should, as far as practicable, be updated and relevant certificates inserted in an appropriate place in the manual.

3.1 Specification of Fixed Cargo Securing Devices.

No other attachments to the ship hull structure than those listed below shall be made without the Masters special permission.

Any lashing arrangements imposing loads exceeding the maximum securing loads listed in the inventory list may cause serious structural damage.

Fixed securing devices:

| Type | Manufacturer | Type designation | Quantity | MSL [kN] | Sketch |
|----------------------|-------------------------|------------------|----------|----------|-----------------------------------|
| D-Rings | “Lord of the D-Rings” | D-562 | 18 | 150 | Not included in this Model Manual |
| Twistlock foundation | “Container securing AS” | TW-16-22 | 48 | 250 | Not included in this Model Manual |

3.2 Specification of Portable Cargo Securing Devices.

As a general rule-of-thumb, if doubt about determining the MSL, portable equipment should not be subject to loads exceeding what have been customary usage in the past.

Portable securing devices:

| Type | Manufacturer | Type designation | Quantity | MSL [kN] | Sketch |
|---------------|-------------------------|------------------|----------|----------|-----------------------------------|
| Lashing Chain | “Chain Chain” | B14804 | 15 x 2 m | 74.5 | Not included in this Model Manual |
| Twistlock | “Container securing AS” | TW-1-C | 112 | 250 | Not included in this Model Manual |
| Turnbuckle | “Container securing AS” | TB-15-N | 48 | 250 | Not included in this Model Manual |
| Lashing bar | “Container securing AS” | LB-6-P | 48 | 250 | Not included in this Model Manual |

3.3 Inspection and Maintenance Schemes

Regular inspections and maintenance are carried out under the responsibility of the Master.

Cargo securing device inspections should as a minimum include:

1. Routine visual examinations of components being utilised:
 - Before using any cargo securing device, whether fixed or portable, the equipment must be visually inspected to ensure that there are no defects and that when appropriate, all moving parts have been greased and are operating correctly.
 - After use, and before going into storage, each device should be visually inspected to ensure that the device has not sustained damage, is still in good condition and does not require repair or replacement. Especially after heavy weather voyages the lashing equipment should be carefully examined. Defective portable lashing equipment should be put aside into a suitable separate location, i.e. bins marked "BAD", and any necessary repairs and testing must be carried out prior to re-use. If beyond repair the equipment is to be scrapped.
 - Discarded parts of equipment should be replaced by equivalent parts. Cargo Securing Equipment is only to be renewed by certified equipment.
 - All portable securing devices shall be visually examined and greased as necessary at intervals not exceeding 3 months.
 - Portable equipment not in use should be collected and stored in bins.
 -
2. Periodic examinations/re-testing as required by the Administration. When required, the cargo securing devices concerned should be subjected to inspections by DNV.
 - The welds connecting the fixed cargo securing equipment to the ship's structure should be inspected regularly and any fractures or tearing should be gouged out and rewelded. Welding of the device to the structure should be carried out by approved personnel in accordance with recognised welding practice.
 - If the underlying structure of the deck, tank top, hatch covers, bulkheads or side structure is deformed to such an extent that an uneven stow would result, the structure should be repaired by the most appropriate method. Any significant deformation of the ship's structure in way of securing points is to be reported to DNV at the earliest opportunity.
 - Cargo securing equipment used several times, both loose and fixed, should be re-tested regularly. The equipment to be tested should be selected by random selection, for instance 1 of 50 pieces of each type of equipment. These tests should be to proof strength load.

The following procedures should be followed for accepting, maintaining, repairing or rejecting cargo securing devices, and should be carried out by the ship's crew:

| Cargo Sec. Device | Inspection Check if/for: | Maintenance | Actions to be: |
|---------------------------|--|-------------|---|
| Elephantfoot pots | deformed | | repaired or replaced |
| | corroded | | replaced if top plate is less than 75 % of original |
| Turnbuckle | bent | * see below | straightened |
| | pins damaged or missing | | renewed |
| | hook damaged | | renewed |
| | destructive, thread | | scrapped |
| Lashing chain w/tensioner | link is deformed | | replace if any link is deformed |
| Wire rope lashings | permanent kinks flattening corrosion drying out of the fibre core protrusion of the fibre core | | replaced if any of the listed defects are found |
| Shackles | bolt damaged or missing | | renewed |
| | bent | | scrapped |
| | wear and tear | | scrapped |
| Twistlock | handle damaged/missing | * see below | straightened/renewed |
| | spring/ball/bolts and nuts damaged | | renewed |
| | amount of small cracks | | scrapped |
| Bridgefitting | nuts damaged or missing | * see below | renewed |
| | bent | | straightened |
| | destructive; thread | | scrapped |

* Threads of turnbuckles, twistlocks and bridgefittings should be greased regularly, at least every 3 months.

Inspections and adjustments of securing arrangements during the voyage:

1. The securing devices should be regularly inspected to ensure that the cargo remains safely secured throughout the voyage.
2. The securing arrangement should be adjusted, if found necessary after inspection, during the voyage. Adjustment of securing devices include re-tightening of lashings or remaking the lashing. If necessary additional lashings should be fitted, and if possible the friction could be increased. This is particular important when heavy weather or swell is expected. Moreover, when heavy weather has passed.

Particular attention should also be paid to lashings which may become slack due to the cargo deforming or compacting during the voyage. Lashings may also become slack when cargoes are loaded and secured in conditions of low ambient temperature and the vessel then proceeds to areas of significantly higher ambient temperature.

3. If adjustment to the cargo securing arrangement has to be carried out at sea under adverse weather and sea conditions adequate precautions have to be taken to avoid dangerous situations for the crew. Good seamanship is necessary.
4. During a voyage, partial discharge may result in an exposed cargo face. This should preferably be secured while loading to avoid hazards while discharging other cargo.

5. Sufficient reserve securing devices should be carried to deal with unexpected circumstances.
6. Entries of all examinations and adjustments to lashings should be made in the ship's record book.

Inspections and maintenance carried out are to be entered into the "Log for Maintenance of Cargo Securing Equipment", see Appendix 1.

4 Stowage and Securing of cargo

4.1 Handling and safety instructions

4.1.1 General principles of cargo securing

1. Cargo shall be secured according to recognised principles, taking into account the dynamic forces that may occur during sea transport and the most severe weather condition expected. Ship handling decisions should take into account the type of cargo and stowage position of the cargo and the securing arrangements.
 - Care should be taken to distribute the forces as evenly as possible.
 - If in doubt the lashing arrangement should be verified using an acceptable calculation method.
 - The securing gear should be adapted to the cargo to be carried.
 - Lashings are to be kept as short as possible.
2. Prior to loading cargo, the following should be checked:
 - Relevant deck areas are, as far as practicable, to be clean, dry and free from oil and grease.
 - Cargo, cargo transport unit or vehicle to be suitable for transport.
 - Necessary securing equipment is to be found onboard.
 - See item 5.
3. The securing equipment should be:
 - available in sufficient quantity including reserves
 - suitable for the purpose**
 - of adequate strength*
 - practical and maintained**

* The required strength, which depends on the lashing forces, can be calculated based on methods for evaluating forces as outlined in this manual.

** Specific handling and safety instructions are provided in sub-chapter 4.1.2 along with instructions to suitable areas, while the maintenance are dealt with in chapter 3.3.
4. Securing operations shall be completed before the ship leaves the berth and the securing should be based on proper planning, execution and supervision. Relevant personnel should be properly qualified and experienced and should have a sound practical knowledge of the application and content of this Cargo Securing Manual.
 - The master shall take care in planning and supervising the stowage and securing of cargoes based on information about the cargo.
 - The cargo is to be distributed with attention to the ship stability so that the hazards of excessive accelerations are reduced as far as practicable.
 - Due attention to the ship's structural strength should be taken.

Excessive accelerations are expected to occur in the far forward and aft part of the ship, but can also occur in general as a result of a high GM value.

5. Where practicable, cargo units shall be provided with a Cargo Stowage and Securing Declaration, stating that the cargo has been properly stowed and secured, taking into account the

IMO/ILO Guidelines for Packing Cargo in Freight Containers or Vehicles. In general, cargo carried in containers, road vehicles, ship borne barges, railway wagons and other transport units should be properly packed and secured within these units. Relevant expertise should be called for, if found necessary, when considering the shipment of a cargo with unusual characteristics, i.e. cargo which may require special attention to location, stowage/securing and weather conditions.

- Different commodities should be compatible with each other or suitable separated
 - Cargo must be suitable for the ship and vice versa
6. If the duty officer considers that a cargo is not safely secured to a cargo unit, measures shall be taken to avoid shifting of the cargo. If adequate measures are not possible, due to the nature of the cargo or lack of securing points, the cargo unit shall not be taken on board. Reference in this respect is made to TFK Report 1990:6E "Loading and Securing Cargo on Load Carriers, Advice and instructions".
 7. The securing arrangements shall be adequate to ensure that there will be no movement which will endanger the ship. Slackening of the securing gear due to cargoes which have a tendency to deform or to compact during voyage shall be avoided. Cargoes with low friction coefficient should also be tightly stowed across the ship to avoid sliding. Suitable material such as soft boards or dunnage should be used to increase friction, ref. paragraph 7.2.1 of the CSS Code.
 8. Cargo units containing hanging loads (e.g. chilled meat, floated glass) and very high cargo units are, because of the relatively high position of the centre of gravity, particularly prone to tipping. Whenever possible they should be located in positions of least movement i.e. on the centre line, towards amidships and on a deck near the waterline.
 9. Safe means of access to securing arrangements, safety equipment, and operational controls shall be provided and properly maintained. Stairways and escape routes from spaces below the vehicle deck shall be kept clear. The cargo spaces should be, as far as practicable, regularly inspected during voyage.
 10. Lashings shall not be released for unloading before the ship is secured at the berth, without the Masters express permission.
 11. Cargo shall not obstruct the operating controls of stern doors, entrances to accommodation and/or fire fighting equipment.
 12. Dangerous goods shall be segregated, stowed and secured according to the IMDG code and valid instructions for this ship.

4.1.2 Safe handling of cargo securing devices

This subchapter should contain clear and specific handling and safety instructions for all the cargo securing devices used on board. The instructions should be based on the manufacturer's guidance literature. In order to be effective and simple to use, the instructions should be visualized by means of sketches, figures or photos.

4.1.3 Evaluation of forces acting on cargo units

Lashing forces are derived from accelerations of the cargo due to ship motions. The largest accelerations, and therefore the most severe forces, can be expected in the furthest forward, the furthest aft and the highest stowage positions on each side of the ship. Special consideration should be given to the securing of vehicles stowed in these positions. Generally the forces which have to be

taken by the securing devices are composed of components acting relative to the axes of the ship, i.e. longitudinal, transverse and vertical direction. The two first are the most important to consider with respect to lashing since the main function of lashings are to prevent cargo units from tipping and/or sliding, in the transverse or longitudinal direction.

The transverse accelerations increase directly with the GM value, and care should be taken when stowing and distributing cargo to avoid excessive accelerations, ref. sub-chapter 4.1.1 “General principles of cargo securing”.

If cargo is stowed in positions where loads from wind pressure and/or sea sloshing may be expected, this shall be taken into consideration when securing the cargo.

Due to uncertainties as to the actual weights and locations of the centre of gravity of cargo units, the lashing forces may vary considerably. It is not possible to specify exactly the maximum forces which may be exerted in the most severe conditions. A general rule is that an adequate number of lashings of sufficient strength to meet the worst weather that could be encountered during the voyage should always be fitted. If very heavy weather is expected, appropriate operational measures, such as delaying sailing or altering course or speed, should be taken to minimise the forces.

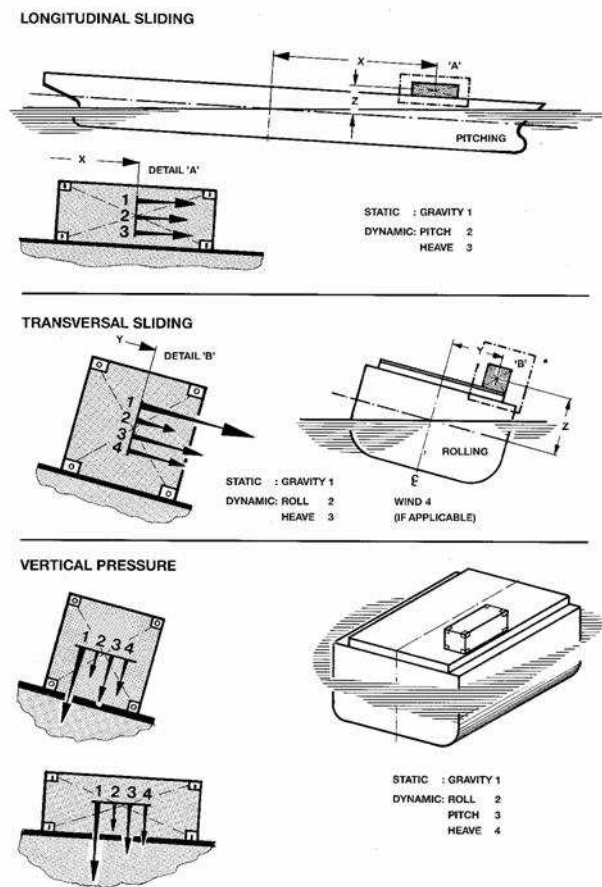
Due to the difficulty in predicting dynamic accelerations and the complexity of dynamic calculations, the lashing forces apply to rigid and unsprung cargo. Additional lashings will be required to resist dynamic forces due to sprung or non-rigid cargoes.

The lashings are in general most effective on a cargo unit when they make an angle with the deck of between 30° and 60°. When these optimum angles cannot be achieved, additional lashings may be required.

The forces can be estimated based on the calculation methods outlined in this Cargo Securing Manual. The effect of anti roll devices should not be taken into account when planning the stowage and securing of cargoes.

4.1.4 Forces acting on typical cargo units

Cargo units/cargo transport units on a ship will in principles be subjected to the forces given on the drawing below.



Source: Mac Gregor Conver

4.1.5 Calculation of forces in semi- and non-standardised lashing arrangements

We have used IMO LASHCON™ for all the calculations in the Cargo Securing Manual for M/S Test Vessel, and M/S Test Vessel have also IMO LASHCON™ installed onboard. As an alternative to use IMO LASHCON™, a calculation procedure based on Annex 13 to the CSS Code and Amendments to the Code of Safe Practice for Cargo Stowage and Securing (IMO MSC/Circ.1026) is included in Appendix II.

4.1.5.1 MSLs for different securing devices

MSLs for different securing devices are given in table 1 if not given else where.

The MSL of timber should be taken as 0.3 kN/cm² normal to the grain.

| Material | MSL |
|---|--------------------------|
| Shackles, deckeyes, twistlocks, lashing rods, D-rings, stackers, bridge fittings, turnbuckles of mild steel | 50% of breaking strength |
| Fibre rope | 33% of breaking strength |
| Wire rope (single use) | 80% of breaking strength |
| Wire rope (re-useable) | 30% of breaking strength |
| Steel band (single use) | 70% of breaking strength |
| Chains | 50% of breaking strength |
| Web lashings | 50% of breaking strength |

Table 1 - Determination of MSL from breaking strength

For particular securing devices (e.g. fibre straps with tensioners or special equipment for securing containers), a permissible working load may be prescribed and marked by authority. This should be taken as the MSL.

When the components of a lashing device are connected in series (for example, a wire to a shackle to a deckeye), the minimum MSL in the series shall apply to that device.

4.1.5.2 Safety factor

When using balance calculation methods for assessing the strength of the securing devices, a safety factor is used to take account of the possibility of uneven distribution of forces among the devices or reduced capability due to the improper assembly of the devices or other reasons. This safety factor is used in the formula to derive the calculated strength (CS) from the MSL and shown in the relevant method used.

$$CS = MSL / \text{safety factor}$$

Notwithstanding the introduction of such a safety factor, care should be taken to use securing elements of similar material and length in order to provide a uniform elastic behaviour within the arrangement.

4.1.5.3 Simplified method – Rule of thumb

The total of the MSL values of the securing devices on each side of a unit of cargo (port as well as starboard) should equal the weight of the unit. (The weight of the unit should be taken in kN).

This method, which implies a transverse acceleration of $1g$ (9.81 m/s^2), applies to almost any size of ship, regardless of the location of stowage, stability and loading condition, season and area of operation. The method, however, takes into account neither the adverse effects of lashing angles and non-homogeneous distribution of forces among the securing devices nor the favourable effect friction.

Transverse lashing angles to the deck should not be greater than 60° and it is important that adequate friction is provided by the use of suitable material. Additional lashings at angles of greater than 60° may be desirable to prevent tipping but are not to be counted in the number of lashings under the rule-of-thumb.

4.1.5.4 Ship Specific Example based on Alternative Method – using IMO LASCHON™

Input to IMO LASCHON™:

Lpp = 155.6 m
 B = 21.0 m
 Speed = 17.0 kn
 GM = 2.5 m

Cargo mass: 55 t
 Dimensions: L = 6.0 m, B = 4.0 m, H = 4.0 m
 Stowage: 0.6 L on deck high.
 MSL of lashings: 110 kN
 μ : 0.3 (steel – timber)

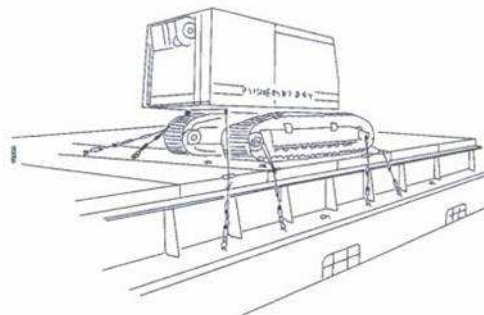
Lever arm of tipping: $a = 1.8 \text{ m}$
 Lever arm of stability: $b = 2.0 \text{ m}$
 Horizontal distance from securing to tipping axis: $d_1 = 4.1 \text{ m}$
 $d_2 = 7.0 \text{ m}$

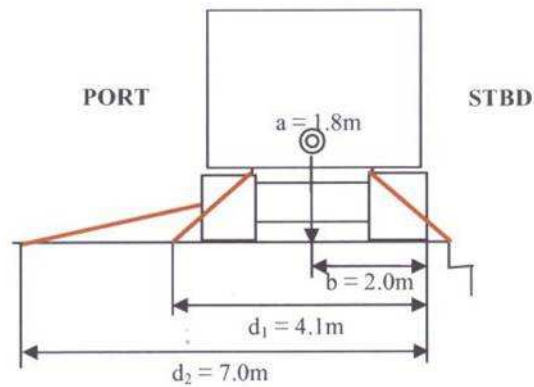
Force by wind pressure:

Longitudinal direction = $F_W = 4 \text{ m} \times 4 \text{ m} \times 1 \text{ kN/m}^2 = 16 \text{ kN}$
 Transverse direction = $F_W = 6 \times 4 = 24 \text{ kN}$

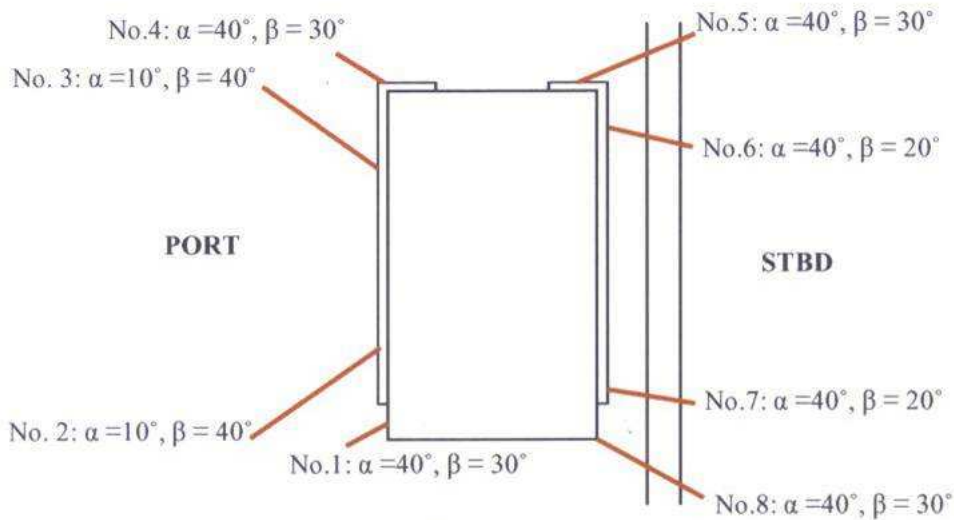
Force by sea pressure:

Longitudinal direction = $F_S = 4 \times 2 = 8 \text{ kN}$
 Transverse direction = $F_S = 6 \times 2 = 12 \text{ kN}$







Front view



Top view

Print outs from IMO LASHCON™:

| | | | | | | | | | | | | | | | | | |
|--|--|----------|--|---------|--|--------------|----------|----------|--------|---------|---------|-----------------|--|-------|------|------|-----|
|  | Code of Safe Practice for Cargo Stowage and Securing 2003 Edition, Annex 13 | | LASHCON IMO Version 9.0 December 2003 | | Sign: _____ Time: 11:07 Date: 04.02.12 | | | | | | | | | | | | |
| | <p>About LASHCON™: LASHCON is a MS EXCEL based calculation tool for control of lashing-arrangements for semi- and non-standardised cargo. The program is developed by Det Norske Veritas, and is based on the calculation procedures outlined in Annex 13 to the Code of Safe Practice for Cargo Stowage and Securing, 2003 Edition.</p> <p>Program assumptions: Reference is made to the User Manual.</p> | | | | | | | | | | | | | | | | |
| <p align="center">Input of main vessel data:</p> <table border="1"> <tr> <td>Vessel Name:</td> <td>Ship Id:</td> <td>Lpp [m]:</td> <td>B [m]:</td> <td>V [kn]:</td> <td>GM [m]:</td> </tr> <tr> <td>M/S Test Vessel</td> <td></td> <td>155,6</td> <td>21,0</td> <td>17,0</td> <td>2,5</td> </tr> </table> | | | | | | Vessel Name: | Ship Id: | Lpp [m]: | B [m]: | V [kn]: | GM [m]: | M/S Test Vessel | | 155,6 | 21,0 | 17,0 | 2,5 |
| Vessel Name: | Ship Id: | Lpp [m]: | B [m]: | V [kn]: | GM [m]: | | | | | | | | | | | | |
| M/S Test Vessel | | 155,6 | 21,0 | 17,0 | 2,5 | | | | | | | | | | | | |
| <p>NOTES:</p> | | | | | | | | | | | | | | | | | |

| | | | | | | | | | | | | | | | |
|---|--|---|-----|---|-----|--|-----|----------------------------|-----|-----|-----|-----|-----|-----|-----|
|  | | Code of Safe Practice for Cargo Stowage and Securing 2003 Edition, Annex 13 | | LASHCON IMO Version 9.0 December 2003 | | Sign: Time: 11:07 Date: 04.02.12 | | | | | | | | | |
| Input of cargo unit data | | | | Give cargo unit stowage position | | | | | | | | | | | |
| Cargo unit specification: Mass of cargo unit: Coefficient of friction: | | Full track vehicle m 55,00 ton μ 0,30 (-) | | Vertical: Deck, high Longitudinal: 0,6 L | | | | | | | | | | | |
| Wind exposed area: Sea exposed area: Lever arm of tipping: Lever arm of stability: | | Aw 24,00 16,00 m ² As 12,00 8,00 m ² a 1,80 m b 2,00 m | | Calculation method: <input checked="" type="radio"/> Alternative calculation <input type="radio"/> Advanced calculation | | Recommended | | | | | | | | | |
| Input of lashing data | | | | | | | | | | | | | | | |
| Max securing load [kN]: | | MSL | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 |
| Transverse lashing direction | | | PS | PS | PS | PS | SB | SB | SB | SB | SB | SB | SB | SB | SB |
| Longitudinal lashing direction | | | Aft | Aft | Fwd | Fwd | Aft | Aft | Fwd | Fwd | Aft | Aft | Fwd | Fwd | Aft |
| Vertical securing angle [degr]: | | α | 40 | 10 | 10 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 |
| Vertical securing angle [degr]: | | β | 30 | 40 | 40 | 30 | 30 | 20 | 20 | 30 | 30 | 30 | 30 | 30 | 30 |
| Horizont. securing point distance: | | d [m] | 4,1 | 7,0 | 7,0 | 4,1 | 4,1 | 4,1 | 4,1 | 4,1 | 4,1 | 4,1 | 4,1 | 4,1 | 4,1 |
| RESULTS: | | | | | | | | | | | | | | | |
| Actual forces | | Securing capacity [kN / kNm] | | | | Accelerations | | | | | | | | | |
| Transverse sliding force [kN]: 441,3 | | Transv. capacity: | | PS [kN] 433 Not OK | | Transverse: | | $a_t = 7,37 \text{ m/s}^2$ | | | | | | | |
| | | | | SB [kN] 450 OK | | Vertical: | | $a_v = 4,02 \text{ m/s}^2$ | | | | | | | |
| Longitudinal sliding force [kN]: 192,0 | | Long. capacity: | | Fwd [kN] 282 OK | | Longitudinal: | | $a_l = 3,06 \text{ m/s}^2$ | | | | | | | |
| | | | | Aft [kN] 282 OK | | | | | | | | | | | |
| Cargo tipping moment [kNm] 794,4 | | Tipping capacity: | | PS [kN] 1728 OK | | | | | | | | | | | |
| | | | | SB [kN] 1898 OK | | | | | | | | | | | |

Conclusion:

One extra lashing in port side direction is needed, or change β angle to be similar as for starboard side.

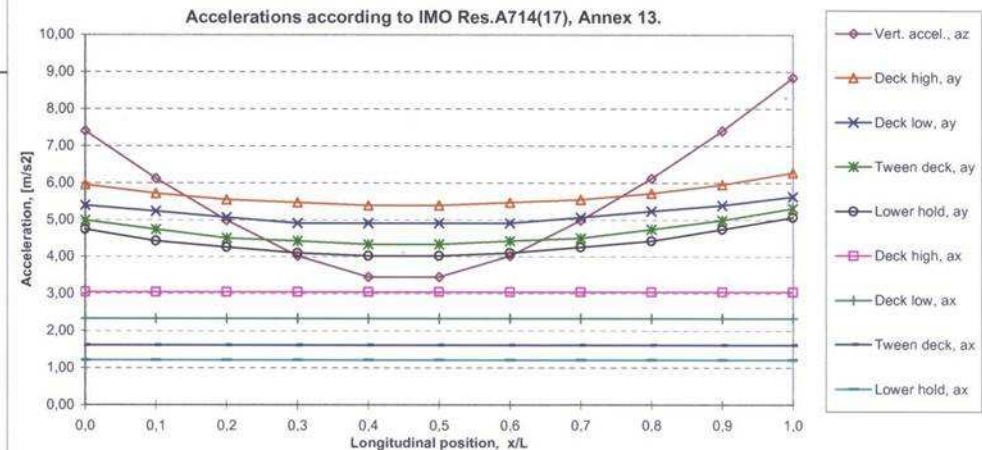
4.1.5.5 Ship Specific Accelerations from IMO LASCHON™

Print out of accelerations for GM = 0.5, GM = 1.5 and GM = 2.5:

| Vessel Name: M/S Test Vessel | | | | | | | | | | | Ship Id: |
|--|--|------|------|------|------|------|------|------|------|------|------------------------------|
| Accelerations according to Annex 13 to IMO Res. A714(17) | | | | | | | | | | | |
| Long. position: | Transverse acceleration a_y in m/s^2 | | | | | | | | | | Long acc a_x in m/s^2 |
| | 0,0 | 0,1 | 0,2 | 0,3 | 0,4 | 0,5 | 0,6 | 0,7 | 0,8 | 0,9 | 1,0 |
| Deck, high | 5,95 | 5,71 | 5,55 | 5,47 | 5,39 | 5,39 | 5,47 | 5,55 | 5,71 | 5,95 | 6,27 |
| Deck, low | 5,39 | 5,23 | 5,06 | 4,90 | 4,90 | 4,90 | 4,90 | 5,06 | 5,23 | 5,39 | 5,63 |
| Tween-deck | 4,98 | 4,74 | 4,50 | 4,42 | 4,34 | 4,34 | 4,42 | 4,50 | 4,74 | 4,98 | 5,31 |
| Lower hold | 4,74 | 4,42 | 4,26 | 4,10 | 4,02 | 4,02 | 4,10 | 4,26 | 4,42 | 4,74 | 5,06 |
| | Vertical acceleration a_z in m/s^2 | | | | | | | | | | |
| | 7,40 | 6,11 | 4,98 | 4,02 | 3,46 | 3,46 | 4,02 | 4,98 | 6,11 | 7,40 | 8,84 |

Note !

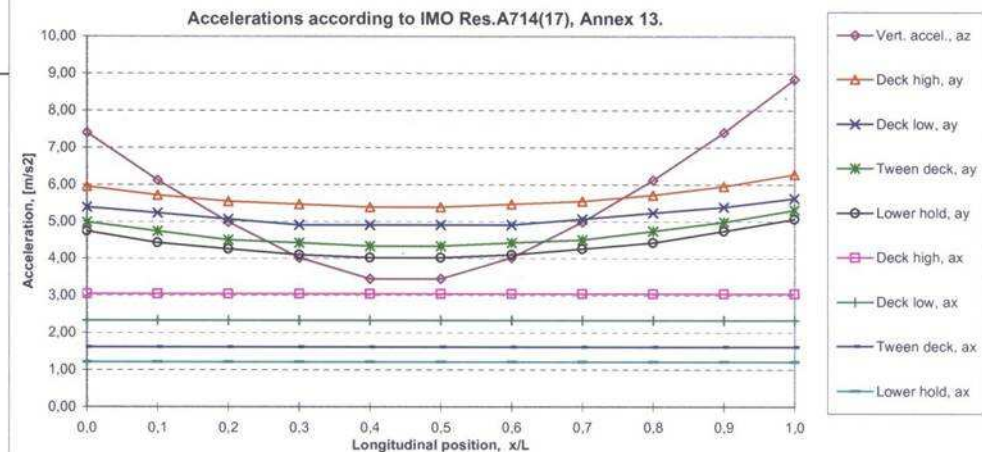
These accelerations
apply only
for GM=0,50m



| Vessel Name: M/S Test Vessel | | | | | | | | | | | Ship Id: |
|--|--|------|------|------|------|------|------|------|------|------|------------------------------|
| Accelerations according to Annex 13 to IMO Res. A714(17) | | | | | | | | | | | |
| Long. position: | Transverse acceleration a_y in m/s^2 | | | | | | | | | | Long acc a_x in m/s^2 |
| | 0,0 | 0,1 | 0,2 | 0,3 | 0,4 | 0,5 | 0,6 | 0,7 | 0,8 | 0,9 | 1,0 |
| Deck, high | 5,95 | 5,71 | 5,55 | 5,47 | 5,39 | 5,39 | 5,47 | 5,55 | 5,71 | 5,95 | 6,27 |
| Deck, low | 5,39 | 5,23 | 5,06 | 4,90 | 4,90 | 4,90 | 4,90 | 5,06 | 5,23 | 5,39 | 5,63 |
| Tween-deck | 4,98 | 4,74 | 4,50 | 4,42 | 4,34 | 4,34 | 4,42 | 4,50 | 4,74 | 4,98 | 5,31 |
| Lower hold | 4,74 | 4,42 | 4,26 | 4,10 | 4,02 | 4,02 | 4,10 | 4,26 | 4,42 | 4,74 | 5,06 |
| | Vertical acceleration a_z in m/s^2 | | | | | | | | | | |
| | 7,40 | 6,11 | 4,98 | 4,02 | 3,46 | 3,46 | 4,02 | 4,98 | 6,11 | 7,40 | 8,84 |

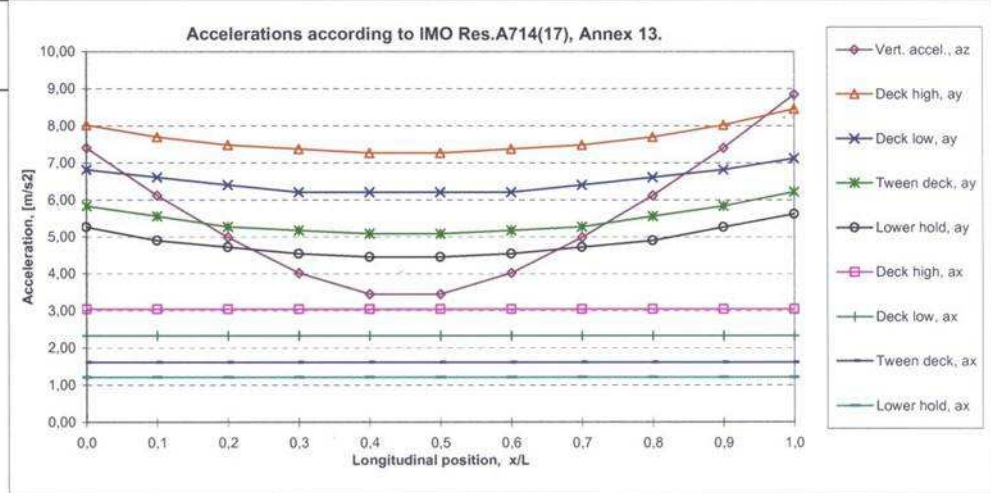
Note !

These accelerations
apply only
for GM=1,50m



| | | | | | | | | | | | |
|--|------|------|------|------|------|------|------|------|------|------|------------------------------|
| Vessel Name: M/S Test Vessel | | | | | | | | | | | |
| Ship Id: | | | | | | | | | | | |
| Accelerations according to Annex 13 to IMO Res. A714(17) | | | | | | | | | | | |
| Transverse acceleration a_y in m/s^2 | | | | | | | | | | | Long acc a_x in m/s^2 |
| Long. position: | 0,0 | 0,1 | 0,2 | 0,3 | 0,4 | 0,5 | 0,6 | 0,7 | 0,8 | 0,9 | 1,0 |
| Deck, high | 8,02 | 7,69 | 7,48 | 7,37 | 7,26 | 7,26 | 7,37 | 7,48 | 7,69 | 8,02 | 8,45 |
| Deck, low | 6,81 | 6,61 | 6,40 | 6,20 | 6,20 | 6,20 | 6,20 | 6,40 | 6,61 | 6,81 | 7,11 |
| Tween-deck | 5,83 | 5,55 | 5,27 | 5,17 | 5,08 | 5,08 | 5,17 | 5,27 | 5,55 | 5,83 | 6,21 |
| Lower hold | 5,26 | 4,90 | 4,72 | 4,54 | 4,45 | 4,45 | 4,54 | 4,72 | 4,90 | 5,26 | 5,61 |
| Vertical acceleration a_z in m/s^2 | | | | | | | | | | | |
| | 7,40 | 6,11 | 4,98 | 4,02 | 3,46 | 3,46 | 4,02 | 4,98 | 6,11 | 7,40 | 8,84 |

Note !
These accelerations
apply only
for GM=2,50m



4.2 Application of portable securing devices

- 1 duration of the voyage;
- 2 geographical area of the voyage with particular regard to the minimum safe operational temperature of the portable securing devices;
- 3 sea conditions which may be expected;
- 4 dimensions, design and characteristics of the ship;
- 5 expected static and dynamic forces during the voyage;
- 6 type and packaging of cargo units;
- 7 intended stowage pattern of the cargo units; and
- 8 mass and dimensions of the cargo units.

5 Supplementary Requirements for General Cargo/Container vessel

5.1 Bulk Carriers

5.1.1 Extracts from various Timber Deck Codes

The following text is quoted from the “Code of Safe Practice for Ships carrying Timber Deck Cargoes”, 1991, chapter 2.1-6.4. The original numbering in the Code is maintained.

CHAPTER 2 - STABILITY

- 2.1 The ship should be supplied with comprehensive stability information which takes into account timber deck cargo. Such information should enable the master, rapidly and simply, to obtain accurate guidance as to the stability of the ship under varying conditions of service. Comprehensive rolling period tables or diagrams have proved to be a very useful aid in verifying the actual stability conditions.
- 2.2 The stability of the ship at all times, including during the process of loading and unloading timber deck cargo, should be positive and to a standard acceptable to the Administration. It should be calculated having regard to:
 - .1 the increased weight of the timber deck cargo due to:
 - .1.1 absorption of water in dried or seasoned timber, and
 - .1.2 ice accretion, if applicable;
 - .2 consumables;
 - .3 the free surface effect of liquid in tanks; and
 - .4 the weight of water trapped in broken spaces within the timber deck cargo and especially logs.
- 2.3 The master should:
 - .1 cease all loading operations if a list develops for which there is no satisfactory explanation and it would be imprudent to continue loading;
 - .2 before proceeding to sea, ensure that:
 - .2.1 the ship is upright;
 - .2.2 the ship has an adequate metacentric height in both departure and arrival conditions; and
 - .2.3 the ship meets the required stability criteria.
- 2.4 Ships carrying timber deck cargoes should operate, as far as possible, with a safe margin of stability and with a metacentric height which is consistent with safety requirements but such metacentric height should not be allowed to fall below the recommended minimum.
- 2.5 However, excessive initial stability should be avoided as it will result in rapid and violent motion in heavy seas which will impose large sliding and racking forces on the cargo causing high stresses on the lashings. Operational experience indicates that metacentric height should preferably not exceed 3% of the breadth in order to prevent excessive accelerations in rolling provided that the relevant stability criteria are satisfied. This recommendation may not apply to all ships and the master should take into consideration the stability information obtained from the ship's stability manual.

CHAPTER 3 - STOWAGE

3.1 General

3.1.1 Before timber deck cargo is loaded on any area of the weather deck:

- .1 hatch covers and other openings to spaces below that area should be securely closed and battened down;
- .2 air pipes and ventilators should be efficiently protected and check-valves or similar devices should be examined to ascertain their effectiveness against the entry of water;
- .3 accumulations of ice and snow on such area should be removed; and
- .4 it is normally preferable to have all deck lashings, uprights, etc., in position before loading on that specific area. This will be necessary should a preloading examination of securing equipment be required in the loading port.

3.1.2 The timber deck cargo should be so stowed that:

- .1 safe and satisfactory access to the crew's quarters, pilot boarding access, machinery spaces and all other areas regularly used in the necessary working of the ship is provided at all times;
- .2 where relevant, openings that give access to the areas described in 3.1.1.1 can be properly closed and secured against the entry of water;
- .3 safety equipment, devices for remote operation of valves and sounding pipes are left accessible; and
- .4 it is compact and will not interfere in any way with the navigation and necessary working of the ship.

3.1.3 During loading, the timber deck cargo should be kept free of any accumulations of ice and snow.

3.1.4 Upon completion of loading, and before sailing, a thorough inspection of the ship should be carried out. Soundings should also be taken to verify that no structural damage has occurred causing an ingress of water.

3.2 Height and extent of timber deck cargo

3.2.1 Subject to 3.2.2, the height of the timber deck cargo above the weather deck on a ship within a seasonal winter zone in winter should not exceed one third of the extreme breadth of the ship.

3.2.2 The height of the timber deck cargo should be restricted so that:

- .1 adequate visibility is assured;
- .2 a safe margin of stability is maintained at all stages of the voyage;
- .3 any forward-facing profile does not present overhanging shoulders to a head sea; and
- .4 the weight of the timber deck cargo does not exceed the designed maximum permissible load on the weather deck and hatches.

3.2.3 On ships provided with, and making use of, their timber loadline, the timber deck cargo should be stowed so as to extend:

- .1 over the entire available length of the well or wells between superstructures and as close as practicable to end bulkheads;
- .2 at least to the after end of the aftermost hatchway in the case where there is no limiting superstructure at the after end;

- .3 athwartships as close as possible to the ship's sides, after making due allowance for obstructions such as guardrails, bulwark stays, uprights, pilot boarding access, etc., provided any area of broken stowage thus created at the side of the ship does not exceed a mean of 4% of the breadth; and
 - .4 to at least the standard height of a superstructure other than a raised quarterdeck.
- 3.2.4 The basic principle for the safe carriage of any timber deck cargo is a solid stowage during all stages of the deck loading. This can only be achieved by constant supervision by shipboard personnel during the loading process.
- 3.2.5 Appendix A provides general advice on stowage practices which have proved to be effective for various types of timber deck cargoes.

CHAPTER 4 - SECURING

4.1 General

- 4.1.1 Every lashing should pass over the timber deck cargo and be shackled to eyeplates suitable and adequate for the intended purpose and efficiently attached to the deck stringer plate or other strengthened points. Such arrangements will be specially considered by class. They should be installed in such a manner as to be, as far as practicable, in contact with the timber deck cargo throughout its full height.
- 4.1.2 All lashings and components used for securing should:
- .1 possess a breaking strength of not less than 133 kN;
 - .2 after initial stressing, show an elongation of not more than 5% at 80% of their breaking strength; and
 - .3 show no permanent deformation after having been subjected to a proof load of not less than 40% of their original breaking strength.
- 4.1.3 Every lashing should be provided with a tightening device or system so placed that it can safely and efficiently operate when required. The load to be produced by the tightening device or system should not be less than:
- .1 27 kN in the horizontal part; and
 - .2 16 kN in the vertical part.
- 4.1.4 Upon completion and after the initial securing, the tightening device or system should be left with not less than half the threaded length of screw or of tightening capacity available for future use.
- 4.1.5 Every lashing should be provided with a device or an installation to permit the length of the lashing to be adjusted.
- 4.1.6 The spacing of the lashings should be such that the two lashings at each end of each length of continuous deck stow are positioned as close as practicable to the extreme end of the timber deck cargo.
- 4.1.7 If wire rope clips are used to make a joint in a wire lashing, the following conditions should be observed to avoid a significant reduction in strength:
- .1 the number and size of rope clips utilized should be in proportion to the diameter of the wire rope and should not be less than four, each spaced at intervals of not less than 15 cm;

- .2 the saddle portion of the clip should be applied to the live load segment and the U-bolt to the dead or shortened end segment;
- .3 rope clips should be initially tightened so that they visibly penetrate into the wire rope and subsequently be re-tightened after the lashing has been stressed.

4.1.8 Greasing the threads of grips, clips, shackles and turnbuckles increases their holding capacity and prevents corrosion.

4.2 Uprights

4.2.1 Uprights should be fitted when required by the nature, height or character of the timber deck cargo.

4.2.2 When uprights are fitted, they should:

- .1 be made of steel or other suitable material of adequate strength, taking into account the breadth of the deck cargo;
- .2 be spaced at intervals not exceeding 3 m;
- .3 be fixed to the deck by angles, metal sockets or equally efficient means; and
- .4 if deemed necessary, be further secured by a metal bracket to a strengthened point, i.e. bulwark, hatch coaming.

4.3 Loose or packaged sawn timber

4.3.1 The timber deck cargo should be secured throughout its length by independent lashings.

4.3.2 Subject to 4.3.3, the maximum spacing of the lashings referred to above should be determined by the maximum height of the timber deck cargo in the vicinity of the lashings:

- .1 for a height of 4 m and below, the spacing should be 3m;
- .2 for heights of above 4 m, the spacing should be 1.5m.

4.3.3 The packages stowed at the upper outboard edge of the stow should be secured by at least two lashings each.

4.3.4 When the outboard stow of the timber deck cargo is in lengths of less than 3.6 m, the spacing of the lashings should be reduced as necessary or other suitable provisions made to suit the length of timber.

4.3.5 Rounded angle pieces of suitable material and design should be used along the upper outboard edge of the stow to bear the stress and permit free reeving of the lashings.

4.4 Logs, poles, cants or similar cargo

4.4.1 The timber deck cargo should be secured throughout its length by independent lashings spaced not more than 3 m apart.

4.4.2 If the timber deck cargo is stowed over the hatches and higher, it should, in addition to being secured by the lashings recommended in 3.4.1, be further secured by:

- .1 a system of athwartship lashings (hog lashings) joining each port and starboard pair of uprights near the top of the stow and at other appropriate levels as appropriate for the height of the stow; and

- .2 a lashing system to tighten the stow whereby a dual continuous wire rope (wiggly wire) is passed from side to side over the cargo and held continuously through a series of snatch blocks or other suitable device, held in place by foot wires.

4.4.3 The dual continuous wire rope, referred to in 3.4.2.2, should be led to a winch or other tensioning device to facilitate further tightening.

4.4.4 The recommendation of 4.4.2.2 should apply to a timber deck cargo of cants.

4.5 Testing, examination and certification

4.5.1 All lashing and components used for the securing of the timber deck cargo should be tested, marked and certified according to national regulations or an appropriate standard of an internationally recognized standards institute. Copies of the appropriate certificate should be kept on board.

4.5.2 No treatments which could hide defects or reduce mechanical properties or strength should be applied after testing.

4.5.3 A visual examination of lashings and components should be made at intervals not exceeding 12 months.

4.5.4 A visual examination of all securing points on the ship, including those on the uprights, if fitted, should be performed before loading the timber deck cargo. Any damage should be satisfactorily repaired.

4.6 Lashing plans

One or more lashing plans complying with the recommendations of this Code should be provided and maintained with this Cargo Securing Manual for carrying timber deck cargo.

CHAPTER 6 ACTION TO BE TAKEN DURING THE VOYAGE

6.1 Tightening of lashings

6.1.1 It is of paramount importance that all lashings be carefully examined and tightened at the beginning of the voyage as the vibration and working of the ship will cause the cargo to settle and compact. They should be further examined at regular intervals during the voyage and tightened as necessary.

6.1.2 Entries of all examinations and adjustments to lashings should be made in the ship's log-book.

6.2 Voyage planning and ship handling

6.2.1 The master should plan the voyage so as to avoid potential severe weather and sea conditions. To this effect, weather reports, weather facsimiles or weather routing agencies should be consulted.

6.2.2 In cases where severe weather and sea conditions are unavoidable, masters should be conscious of the need to reduce speed and/or alter course at an early stage in order to minimize the forces imposed on the cargo, structure and lashings. The lashings are not designed to provide a means of securing against imprudent ship handling in heavy weather. There can be no substitute for good seamanship.

6.3 Listing during voyage

If a list occurs that is not caused by normal use of consumables (water and fuel), such a list can probably be attributed to one of three causes, or possibly a combination of same.

Cargo shift

- 6.3.1 A major shift of deck cargo will obviously be immediately apparent. Deck cargo may however have shifted imperceptibly or there may have been a shift of cargo below decks. An immediate examination should determine whether or not cargo has shifted and if this is the case the master will have several remedies available to him depending upon the exact circumstances.
- 6.3.2 The ballasting and transferring of ballast or fuel to reduce or correct a list caused by a shifted cargo should, however, be carefully considered since this action would, in all probability, result in a far greater list if the cargo should subsequently shift to the other side.
- 6.3.3 As any cargo shift will in most cases occur in adverse weather conditions, sending crew to release or tighten the lashings on a moving or shifted cargo may well represent a greater hazard than retaining an overhanging load. A moving or shifted timber deck cargo should only be jettisoned after careful consideration; jettisoning is unlikely to improve the situation as the whole cargo stack would probably not fall at once. Severe damage may also be sustained by the propeller if it is still turning when timber is jettisoned.

Water ingress

- 6.3.4 The possibility of water ingress should immediately be determined by sounding throughout the ship. In the event that unexplained water is detected, all available pumps should be used to bring the situation under control. Subsequent actions will obviously depend upon whether or not such ingress of water can be controlled by use of pumps.

Angle of roll

- 6.3.5 If the rolling of the ship prior to the detection of the list has been exceptionally slow and the ship has returned to the upright position in a sluggish manner, this will indicate that the ship has little or no metacentric height remaining. The list is therefore due to the ship lolling to one side and having no righting arm to return it to the upright position. This situation may be rectified by either adding weight to the low part of the ship (ballasting double bottom tanks) or removing weight from the high part (deck cargo). Of the two options, ballasting is usually preferable and if empty divided double bottom space is available, the tank on the lower side should be ballasted first in order to immediately provide additional metacentric height-after which the tank on the high side should also be ballasted. However, special care should be taken in ballasting and deballasting to rectify the situation since this may cause a far greater list to the other side.

The following is quoted from the "Code of Safe Practice for Ships carrying Timber Deck Cargoes" 1991, Appendix A. The original numbering in the Code is maintained.

Advice on stowage practices

1 GENERAL

- 1.1 The stowage practices described in this appendix have been found to achieve satisfactory results, provided that account is taken of the recommendations of chapters 1-6. Although specific conditions may dictate a departure from these guidelines, the basic principles as detailed in 1.2 should nevertheless be adhered to.

- 1.2 The basic principle for the safe carriage of timber deck cargo is, as indicated earlier, to make the stow as solid and compact as practicable. The purpose of this is to:
 - .1 prevent slack in the stow which could cause the lashings to slacken;
 - .2 produce a binding effect within the stow; and
 - .3 reduce to a minimum the permeability of the stow.
- 1.3 Lashings prevent deck cargo from shifting by increasing the friction due to pre-stress forces and counteracting forces on the stow in the direction of possible shifting. The lashings should meet the following criteria:
 - .1 the strength of all lashing elements should be at least equal to that recommended in the Code; and
 - .2 the necessary tension should be maintained during the whole voyage.
- 1.4 The shifting of timber deck cargo is due mainly to the following causes which may occur singly or together:
 - .1 lashings becoming slack due to compaction of the cargo during the voyage, unsuitable devices for tightening the lashing systems and/or inadequate strength of the lashings;
 - .2 movement of the cargo across the hatch covers due to insufficient friction, particularly in ice and snow;
 - .3 inadequate strength of the uprights due to poor material properties and/or excessive forces;
 - .4 heavy rolling or pitching of the ship;
 - .5 impact from heavy seas.
- 1.5 Great care should be taken to keep the ship in an upright condition during loading as even a slight list will impose a considerable load on the retaining uprights. The necessity for prudent ship handling during the voyage cannot be overstressed; imprudent ship handling can nullify even the best of stowages.
- 1.6 The lashings should be in accordance with chapter 4 of the Code and may comprise the following types:
 - .1 Hog lashings are normally used over the second and third tiers and may be set "hand tight" between stanchions. The weight of the upper tiers when loaded on top of these wires will further tighten them (see figure 1).
 - .2 Wire rope lashings which are used in addition to chain lashings. Each of these may pass over the stow from side to side and loop completely around the uppermost tier. Turnbuckles are fitted in each lashing to provide means for tightening the lashing at sea (see figure 2).
 - .3 Wiggle wires which are fitted in the manner of a shoelace to tighten the stow. These wires are passed over the stow and continuously through a series of snatch blocks, held in place by foot wires. Turnbuckles are fitted from the top of the footwire into the wiggle wire in order to keep the lashings tight at sea (see figures 3 and 4).
 - .4 Chain lashings which are passed over the top of the stow and secured to substantial padeyes or other securing points at the outboard extremities of the cargo. Turnbuckles are fitted in each lashing to provide means for tightening the lashing at sea (see figure 5)
- 1.7 Systems for securing timber deck cargoes are shown in figures 3, 4, 5, 6, and 7

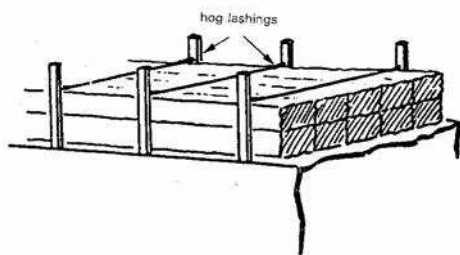


Figure 1

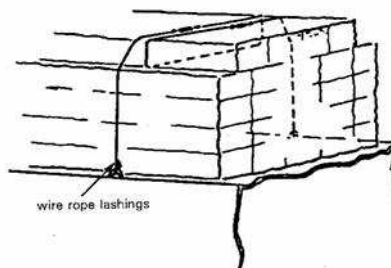


Figure 2

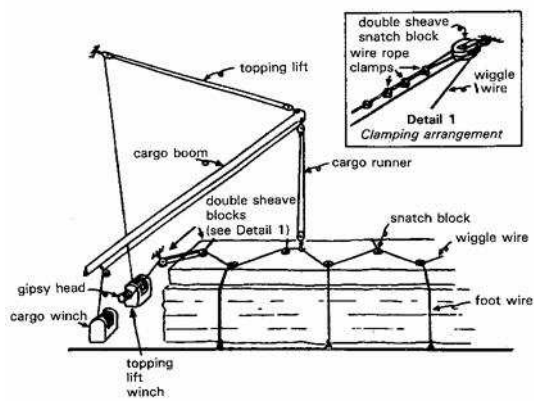


Figure 3

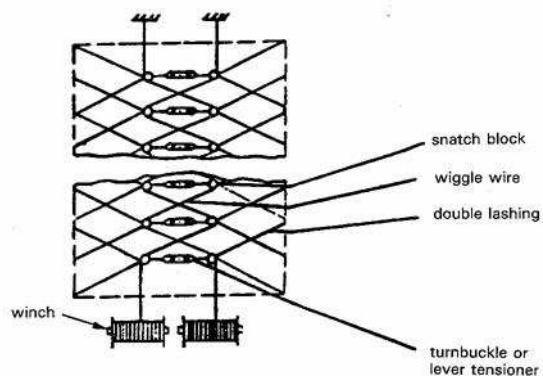


Figure 4

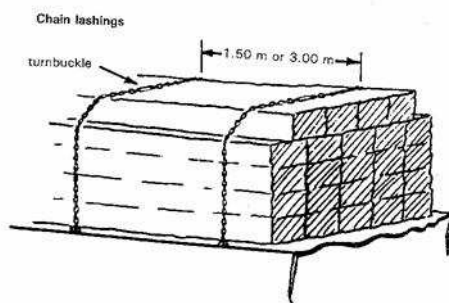


Figure 5

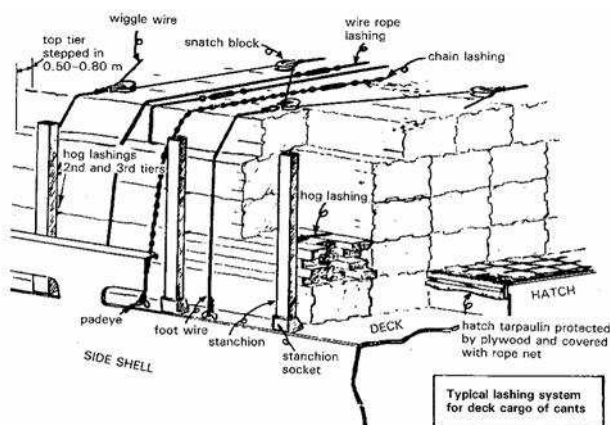


Figure 6

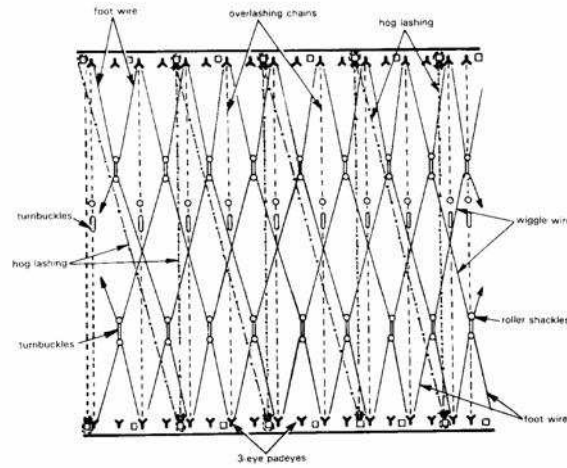


Figure 7

2 PACKAGED TIMBER AND CANTS

- 2.1 Timber packages are usually bundled by bandings fastened mechanically (hard bundled) or by hand (soft bundled). The packages may not have standard dimensions and they are not always flush at both ends. The stowage problem is compounded by differences in the lengths of packaged timber when the packages are stowed on board the ship. Moreover, the master of the ship often has no influence on the order in which the packages are delivered.
- 2.2 Packages which contain random lengths likely to disrupt the compaction of the stow should not be loaded on deck. Other packages of random lengths capable of compact stowage may be loaded on deck in a fore-and-aft direction but not on exposed surfaces or in the stowage outboard of the hatch coamings (see figures 8 and 9).

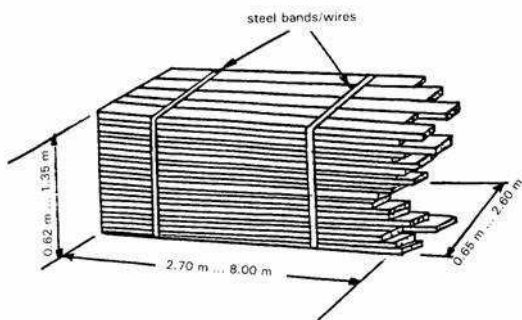


Figure 8

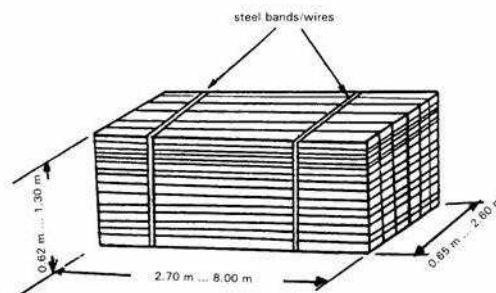


Figure 9

- 2.3 Packages for deck stowage should be solidly made up. They should have bands adequate to prevent slackening or disintegration of the package during the voyage, which could cause a loosening of the stow as a whole. Slack bands on the top surface of the deck cargo are dangerous foot traps.
- 2.4 Cants are usually bundled by banding, but the irregularities caused by varying thicknesses and curved sides make compact bundling very difficult to achieve. Because of these factors, considerable broken stowage is encountered as well. The tendency is for the packages to assume a rounded cross-section within the bands due to the curved sides of the individual pieces (see figure 10).

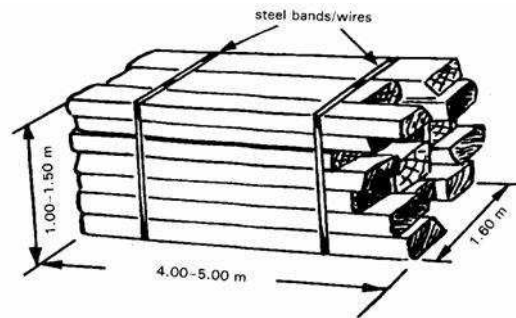


Figure 10

- 2.5 A solid stow of packaged timber is not always possible as the packages of timber have different measurements, may be partially soft bundles, and gaps may exist between the packages. It is essential, however, that the upper tier and outboard packages be stowed as compactly as possible and the upper tiers chocked as necessary.
- 2.6 The methods used to stow cargoes of loose timber for transport cannot always be applied to the transport of packaged timber as:
- .1 packaged timber cannot be stowed to give a compactness as tight as that achieved with loose timber, and lashings may therefore be less effective;
 - .2 packaged timber cannot be stowed between the uprights as densely and with so few gaps as loose timber. The uprights may consequently have to sustain greater loads when packaged timber is being carried and may absorb the forces generated by the cargo when it is moving.
- 2.7 Before commencing to load on the deck or hatches, a firm and level stowage surface should be prepared. Dunnage, where used, should be of rough lumber and should be placed in the direction which will spread the load across the ship's underdeck structure and assist in draining.
- 2.8 Due to the system of athwartship lashing, the stowage of packages should generally be in the fore-and-aft direction; the wings of the upper two tiers should always be in the fore-and-aft direction. It is advisable to have one or more non-adjacent tiers stowed athwartships when above the level of the hatches in order to produce a binding effect within the cargo. Also, athwartship packages should be carried above the hatches to interlock the load. If packages with great differences in length are to be loaded, the longest packages should be stowed fore and aft outboard. Short packages should be confined to the inner portions of the stowage. Only packages flush at both ends can be stowed athwartships (see figures 11,12 and 13).

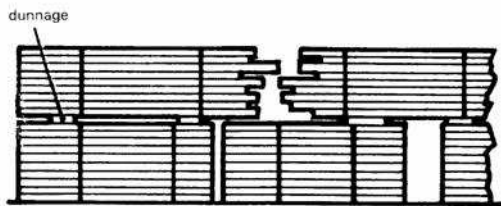


Figure 11

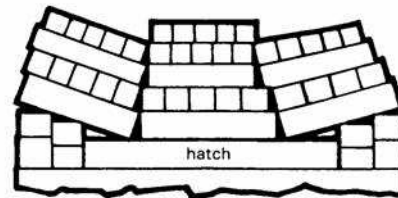


Figure 12

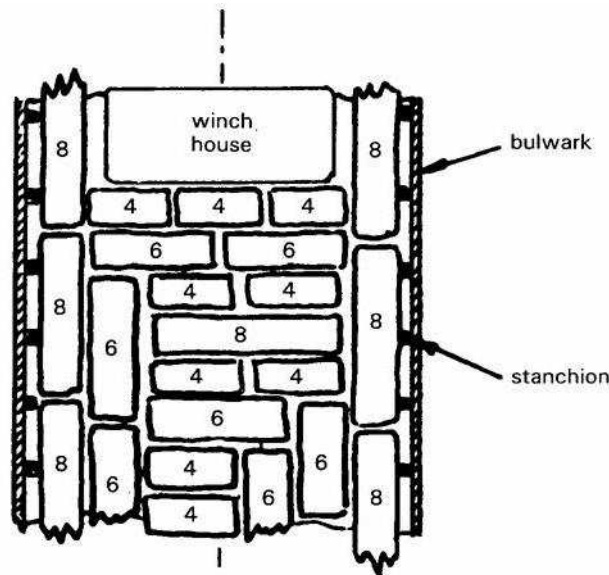


Figure 13

- 2.9 The timber should be loaded to produce a compact stow with a surface as level as practicable. Throughout the loading, a level and firm stowage surface should be prepared on each working tier. Rough dunnage, if used, should be spread over at least three adjacent packages to produce a binding effect within the stow, particularly in the wings.
- 2.10 Any gaps occurring around packages in which the cargo may work at sea, such as in the vicinity of hatch coamings and deck obstructions, should be filled with loose timber, efficiently chocked off or effectively bridged over. For this purpose a supply of timber chocking material should be made available to the ship.
- 2.11 Packages at the outboard edges of the stow should be positioned so that they do not extend over the padeyes and obstruct the vertical load of the athwartship lashings. The end of each deck stow should be flush in order to minimize overhangs to resist the influence of green seas and to avoid the ingress of water.
- 2.12 Large heavy boards and squares of timber, when loaded on deck in combination with packages, should preferably be stowed separately. When placed in upper tiers, heavy pieces of timber tend to work loose at sea and cause some breaking of packages. In the event that boards and squares are stowed on top of packages they should be efficiently restrained from movement.
- 2.13 When the final tier is loaded on a large number of tiers, it may be stepped in from the outer edge of the stow about 0.5-0.8 m (a half package).

3 LOGS

- 3.1 If logs are loaded on deck together with packaged timber, the two types of timber should not be intermixed.
- 3.2 Logs should generally be stowed in a fore-and-aft direction to give a slightly crowned top surface such that each log is adequately restrained from movement when the system of securing is in place and set up taut.
- 3.3 In order to achieve a compact stow, the butt of each log or sling of logs should not be in the same athwartship plane as those adjacent to it.

- 3.4 In order to achieve a more secure stowage of logs when stowed on deck, a continuous wire (hog wire) should be utilized at each hatch meeting the specifications of chapter 4 of the Code. Such hog wire should be installed in the following manner:
- .1 At approximately three quarters of the height of the uprights, the hog wire should be rove through a padeye attached to the uprights at this level so as to run transversely, connecting the respective port and starboard uprights. The hog lashing wire should not be too tight when laid so that it becomes taut when overstowed with other logs.
 - .2 A second hog wire may be applied in a similar manner if the height of the hatch cover is less than 2m. Such second hog wire should be installed approximately 1 m above the hatch covers.
 - .3 The aim of having the hog wires applied in this manner is to assist in obtaining as even a tension as possible throughout, thus producing an inboard pull on the respective uprights.

4 PULP WOOD AND PIT-PROPS

- 4.1 When these items are stowed in the manner described below, good compaction of the deck cargo can be obtained.
- .1 In the deck area clear of the line of hatches, the cargo should be stowed in the athwartship direction, canted inboard by some cargo laid fore and aft in the scuppers.
 - .2 At the centre of the stow, along the line of hatches, the cargo should be laid in the fore-and-aft direction when the wing cargo has reached hatch height.
 - .3 At the completion of loading, the cargo should have a level surface with a slight crown towards the centre.
- 4.2 To prevent the cargo from being washed out from below its lashings, it is recommended that nets or tarpaulins be used as follows:
- .1 the ends of each continuous section of deck cargo, if not stowed flush with the superstructure bulkhead, may be fitted with a net or tarpaulin stretched and secured over the athwart-ship vertical surface;
 - .2 over the forward end of each continuous section of deck cargo and in the waist of the ship the top surface may be fitted with a net or tarpaulin stretched and secured across the breadth of the cargo and brought down the outboard vertical sides to securing points at deck level.

The following text is quoted from the International Conference on Loadlines 1966.

Annex I - Regulations for determining loadlines.

Regulation 44

Stowage General

- (1) Openings in the weather deck over which cargo is stowed shall be securely closed and battened down. The ventilators shall be efficiently protected.
- (2) Timber deck cargo shall extend over at least the entire available length which is the total length of the well or wells between superstructures. Where there is no limiting superstructure at the after end, the timber shall extend at least to the after end of the aftermost hatchway. The timber shall be stowed as solidly as possible to at least the standard height of the superstructure.

- (3) On a ship within a seasonal winter zone in winter, the height of the deck cargo above the weather deck shall not exceed one-third of the extreme breadth of the ship.
- (4) The timber deck cargo shall be compactly stowed, lashed and secured. It shall not interfere in any way with the navigation and necessary work of the ship.

Uprights

- (5) Uprights, when required by the nature of the timber, shall be of adequate strength considering the breadth of the ship; the spacing shall be suitable for the length and character of timber carried, but shall not exceed 3 metres (9.8 feet). Strong angles or metal sockets or equally efficient means shall be provided for securing the uprights.

Lashings

- (6) Timber deck cargo shall be efficiently secured throughout its length by independent over-all lashings spaced not more than 3 metres (9.8 feet) apart. Eye plates for these lashings shall be efficiently attached to the sheer strake or to the deck stringer plate at intervals of not more than 3 metres (9.8 feet). The distance from an end bulkhead of a superstructure to the first eye plate shall be not more than 2 metres (6.6 feet). Eye plates and lashings shall be provided 0.6 metres (23 inches) and 1.5 metres (4.9 feet) from the ends of timber deck cargoes where there is no bulkhead.
- (7) Lashings shall be not less than 19 millimetres (1 inch) close link chain or flexible wire rope of equivalent strength, fitted with sliphooks and turnbuckles, which shall be accessible at all times. Wire rope lashings shall have a short length of long link chain to permit the length of lashings to be regulated.
- (8) When timber is in lengths less than 3.6 metres (11.8 feet) the spacing of the lashings shall be reduced or other suitable provisions made to suit the length of timber.
- (9) All fittings required for securing the lashings shall be of strength corresponding to the strength of the lashings.

Stability

- (10) Provision shall be made for a safe margin of stability at all stages of the voyage, regard being given to additions of weight, such as those due to absorption of water and icing and to losses of weight such as those due to consumption of fuel and stores.

Protection of Crew, Access to Machinery Spaces, etc.

- (11) In addition to the requirements of Regulation 25 (5) of this Annex guard rails or life lines spaced not more than 330 millimetres (13 inches) apart vertically shall be provided on each side of the deck cargo to a height of at least 1 metre (39 inches) above the cargo.

Steering Arrangements

- (12) Steering arrangements shall be effectively protected from damage by cargo and, as far as practicable, shall be accessible. Efficient provision shall be made for steering in the event of a breakdown in the main steering arrangements.

The following text should be regarded as DNVs interpretation of Regulation 44 in order to harmonise this Regulation with the Code of Safe Practice for Ships Carrying Timber Deck Cargoes (Resolution A.287 (VIII)).

Stowage

General

Openings in the weather deck over which cargo is stowed should be securely closed and battened down. The ventilators and air pipes should be efficiently protected. Timber deck cargoes should extend over at least the entire available length which is the total length of the well or wells between superstructures. Where there is no limiting superstructure at the after end, the timber should extend at least to the after end of the aftermost hatchway. The timber deck cargo should extend athwartships as close as possible to the ship side due allowance being given for obstructions such as guard-rails, bulwark stays, uprights, etc. provided any gap thus created at the side of the ship does not exceed 4 per cent of the breadth (b). The timber should be stowed as solidly as possible to at least the standard height of a superstructure other than a raised quarter deck. On a ship within a seasonal winter zone in winter, the height of the deck cargo above the weather deck should not exceed one-third of the extreme breadth of the ship. The timber deck cargo should be compactly stowed, lashed and secured. It should not interfere in any way with the navigation and necessary work of the ship.

Uprights

Uprights, when required by the nature of the timber, should be of adequate strength considering the breadth of the ship; the strength of the uprights should not exceed the strength of the bulwark and the spacing should be suitable for the length and character of timber carried, but should not exceed 3 metres. Strong angles or metal sockets or equally efficient means should be provided for securing the uprights. Lashings for timber deck cargo should be efficiently secured throughout its length by independent overall lashings. The spacing of the lashings should be determined by the maximum height of the cargo above the weather deck in the vicinity of the lashing:

- 1) for a height of 4 metres and below the spacing should be not more than 3 metres;
- 2) for a height of 6 metres and above the spacing should be not be more than 1.5 metres;
- 3) at intermediate heights the average spacing should be obtained by linear interpolation.

Where the height of timber deck cargo exceeds 6 metres the strength of the lashings should be to the satisfaction of the Society. Eye plates for these lashings should be efficiently attached to the sheer strake or to the deck stringer plate. The distance from an end bulkhead of a superstructure to the first eye plate should not be more than 2 metres. Eye plates and lashings should be provided 0.6 metre and 1.5 metres from the ends of timber deck cargoes where there is no bulkhead. The lashings should be capable of withstanding an ultimate load of not less than 13,600 kg. They should be fitted with sliphooks and turnbuckles, which should be accessible at all times. Wire rope lashings should have a short length of long link chain to permit the length of lashings to be regulated. When timber is in lengths of less than 3.6 metres, the spacing should be reduced or other suitable provisions made to suit the length of timber. Shackles, stretching devices and all other ancillary components incorporated into a chain or wire rope lashing and its securings should have a minimum ultimate load of 14,100 kg. Each component should be proof loaded to 5,600 kg. No part should be damaged or permanently deformed after proof loading.

Stability

Provision should be made for a safe margin of stability at all stages of the voyage, regard being given to additions of weight, such as those due to absorption of water and icing and to losses of weight such as those due to consumption of fuel and stores.

Protection of Crew, Access to Machinery Spaces, etc.

In addition to the requirements of Regulation 25(5) (Ch.1 Sec.10 E) of this Annex, guard rails or lifelines not more than 330 millimetres apart vertically should be provided on each side of the cargo deck to a height of at least 1 metre above the cargo. In addition a lifeline, preferably wire rope, set up taut with a stretching screw, should be provided as near as practicable to the centre line of the ship. The stanchion supports to all guard-rails and lifelines should be spaced so as to prevent undue sagging. Where the cargo is uneven, a safe walking surface of not less than 600 millimetres in width should be fitted over the cargo and effectively secured beneath or adjacent to a lifeline.

Steering Arrangements

Steering arrangements should be effectively protected from damage by cargo and, as far as practicable, should be accessible. Efficient provision should be made for steering in the event of a breakdown in the main steering arrangements.

5.2 Container Carriers

5.2.1 Handling and Safety Instructions

1. Instructions on the proper handling of the securing devices on containers (and other standardized cargo):
 - All loose securing elements have to be applied according to this Cargo Securing Manual.
 - It is recommended to have only one type of twistlock on board. If more than one type of twistlocks, the different types should be clearly identified.
 - All twistlocks in use have to be locked.
 - Twistlocks must be inserted so that opening devices are accessible for opening.
 - Adjustable pressure- or tension / compression elements have to be set with a minimum clearance to the longitudinal bulkhead in order to reduce the movement within the container block.
 - Damaged containers are not allowed to be loaded.
 - Cargo carried within the standardized cargo units should be packed and secured within these units. The same principles to stowage and securing of cargo inside the containers should be applied as the same cargo being stowed conventionally onboard.
 - The skirts of the bottom rails of the container should not be allowed to come in contact with the underlying dunnage. These structures are not strength members, and will buckle and give way if placed on dunnage.
2. Safety instructions related to handling of securing devices and to securing and unsecuring of containers (or other standardized cargo by ship or shore personnel):
 - People working in the cargo area are always to wear a protective helmet and protective shoes.
 - Any securing or unsecuring of containers must be carried out during the ship's stay at berth or safe anchorage.
 - Dropping of container fittings from above is forbidden.
 - Work on top of container stacks is generally to be avoided. If work on top of containers is not avoidable, an approved fall protection system must be used. Access to the top of a container stack for inserting, locking, unlocking or collecting securing devices is only allowable by means of an approved lashing cage.
 - A fall hazard shall exist whenever employees are working within 0.9 meters of the unprotected edge of a work surface and 0.3 meters or more, horizontally, from the adjacent surface. Weather conditions may impair vision or sound footing of workers on top of containers.
 - Fall protection systems must be inspected and maintained prior to each day's use.

- Each fall protection system shall be rigged to minimize the free-fall distance.

5.2.2 Stowage and Securing Instructions

Possible consequences from misuse of securing devices or misinterpretation of instructions given might result in the following:

- Exceeding the maximum stack mass may result in:
 - overstressing hatch cover construction
 - overstressing stowage and securing devices
 - damaging containers or loss of containers overboard
- When twistlocks are not locked properly this may result in:
 - overstressing stowage and securing devices
 - damaging containers or loss of containers overboard
- When lashings are not applied in the relevant places this may result in:
 - overstressing of twistlocks
 - damaging containers or loss of containers overboard
- When the weight distribution in the stack is not like prescribed in this manual this may result in:
 - overstressing stowage and securing devices
 - damaging containers or loss of containers overboard
- If the maximum GM - value in the stowage plan is exceeded this may result in:
 - higher transverse accelerations
 - overstressing stowage and securing devices
 - overstressing the ship structure
 - damaging containers

5.2.2.1 Stowage and Securing Plan (*not included in this model manual*)

Appendix I – Log for maintenance of cargo securing equipment

LOG FOR MAINTENANCE OF CARGO SECURING EQUIPMENT

[illegible]

CARGO SECURING MANUAL FOR M/S TEST VESSEL

LOG FOR MAINTENANCE OF CARGO SECURING EQUIPMENT

[illegible]

Appendix II – Manual procedure for calculation of lashings

Annex 13 to the CSS Code and Amendments to the Code of Safe Practice for Cargo Stowage and Securing (IMO MSC/Circ.1026).

Assumption of external forces

External forces to a cargo unit in longitudinal, transverse and vertical directions should be obtained using the formula:

$$F_{(x,y,z)} = ma_{(x,y,z)} + F_{w(x,y)} + F_{s(x,y)}$$

where

- $F_{(x,y,z)}$ = longitudinal, transverse and vertical forces
- m = mass of unit
- $a_{(x,y,z)}$ = longitudinal, transverse and vertical accelerations (see table 2)
- $F_{w(x,y)}$ = longitudinal and transverse forces by wind pressure
- $F_{s(x,y)}$ = longitudinal and transverse forces by sea sloshing

The basic acceleration data are presented in table 2.

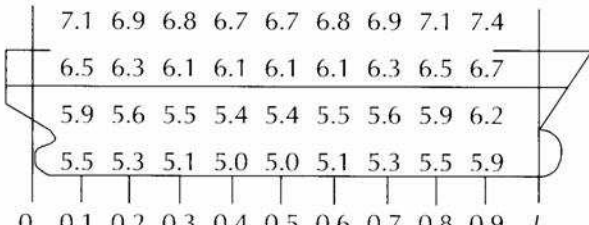
| Transverse acceleration a_y in m/s^2 | | | | | | | | | | Longitudinal acceleration a_x in m/s^2 |
|--|-----|-----|-----|-----|-----|-----|-----|-----|-----|--|
| on deck, high | 7.1 | 6.9 | 6.8 | 6.7 | 6.7 | 6.8 | 6.9 | 7.1 | 7.4 | 3.8 |
| on deck, low | 6.5 | 6.3 | 6.1 | 6.1 | 6.1 | 6.1 | 6.3 | 6.5 | 6.7 | 2.9 |
| 'tween-deck | 5.9 | 5.6 | 5.5 | 5.4 | 5.4 | 5.5 | 5.6 | 5.9 | 6.2 | 2.0 |
| lower hold | 5.5 | 5.3 | 5.1 | 5.0 | 5.0 | 5.1 | 5.3 | 5.5 | 5.9 | 1.5 |
|  | | | | | | | | | | |
| 0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 L | | | | | | | | | | |
| Vertical acceleration a_z in m/s^2 | | | | | | | | | | |
| 7.6 6.2 5.0 4.3 4.3 5.0 6.2 7.6 9.2 | | | | | | | | | | |

Table 2 - Basic acceleration data

Remarks:

The given transverse acceleration figures include components of gravity, pitch and heave parallel to the deck. The given vertical acceleration figures do not include the static weight component.

The basic acceleration data are to be considered as valid under the following operational conditions:

- .1 Operation in unrestricted area;
- .2 Operation during the whole year;
- .3 Duration of the voyage is 25 days;
- .4 Length of ship is 100 m;
- .5 Service speed is 15 knots;
- .6 $B/GM \geq 13$ (B: breadth of ship, GM: metacentric height).

For operation in a restricted area, reduction of these figures may be considered, taking into account the season of the year and the duration of the voyage.

For ships of a length other than 100 m and a service speed other than 15 knots, the acceleration figures should be corrected by a factor given in table 3.

| Length [m] Speed [kN] | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 120 | 140 | 160 | 180 | 200 | 250 | 300 |
|--------------------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 9 | 1,37 | 1,31 | 1,20 | 1,09 | 1,00 | 0,92 | 0,85 | 0,79 | 0,70 | 0,63 | 0,57 | 0,53 | 0,49 | 0,41 | 0,36 |
| 12 | 1,56 | 1,47 | 1,34 | 1,22 | 1,12 | 1,03 | 0,96 | 0,90 | 0,79 | 0,72 | 0,65 | 0,60 | 0,56 | 0,48 | 0,42 |
| 15 | 1,75 | 1,64 | 1,49 | 1,36 | 1,24 | 1,15 | 1,07 | 1,00 | 0,89 | 0,80 | 0,73 | 0,68 | 0,63 | 0,55 | 0,48 |
| 18 | 1,94 | 1,80 | 1,64 | 1,49 | 1,37 | 1,27 | 1,18 | 1,10 | 0,98 | 0,89 | 0,82 | 0,76 | 0,71 | 0,61 | 0,54 |
| 21 | 2,13 | 1,96 | 1,78 | 1,62 | 1,49 | 1,38 | 1,29 | 1,21 | 1,08 | 0,98 | 0,90 | 0,83 | 0,78 | 0,68 | 0,60 |
| 24 | 2,32 | 2,13 | 1,93 | 1,76 | 1,62 | 1,50 | 1,40 | 1,31 | 1,17 | 1,07 | 0,98 | 0,91 | 0,85 | 0,74 | 0,66 |

Table 3 – Correction factors for length and speed

For length/speed combinations not directly tabulated, the following formula may be used to obtain the correction factor with v = speed in knots and L = length between perpendiculars in metres:

$$\text{correction factor} = \left(0.345 \cdot \frac{v}{\sqrt{L}} \right) + \frac{(58.62 \cdot L - 1034.5)}{L^2}$$

This formula shall not be used for ship lengths less than 50 m or more than 300 m.

In addition, for ships with B/GM less than 13, only the transverse acceleration figures should be corrected by a factor given in Table 4.

| B / GM | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 → |
|---------------|------|------|------|------|------|------|------|------|------|------|
| on deck, high | 2,30 | 1,96 | 1,72 | 1,56 | 1,40 | 1,27 | 1,19 | 1,11 | 1,05 | 1,00 |
| on deck, low | 1,92 | 1,70 | 1,53 | 1,42 | 1,30 | 1,21 | 1,14 | 1,09 | 1,04 | 1,00 |
| Tween-deck | 1,54 | 1,42 | 1,33 | 1,26 | 1,19 | 1,14 | 1,09 | 1,06 | 1,03 | 1,00 |
| lower hold | 1,31 | 1,24 | 1,19 | 1,15 | 1,12 | 1,09 | 1,06 | 1,04 | 1,02 | 1,00 |

Table 4 - Correction factors for B/GM < 13

The following cautions should be observed:

In the case of marked roll resonance with amplitudes above + 30°, the given figures of transverse acceleration may be exceeded. Effective measures should be taken to avoid this condition.

In the case of heading into the seas at high speed with marked slamming shocks, the given figures of longitudinal and vertical acceleration may be exceeded. An appropriate reduction of speed should be considered.

In the case of running before large stern or quartering seas with a stability which does not amply exceed the accepted minimum requirements, large roll amplitudes must be expected with transverse accelerations greater than the figures given. An appropriate change of heading should be considered.

Forces by wind and sea to cargo units above the weather deck should be accounted for by simple approach:

force by wind pressure = 1 kN/m²

force by sea sloshing = 1 kN/m²

Sloshing by sea can induce forces much greater than the figure given above. This figure should be considered as remaining unavoidable after adequate measures to prevent overcoming seas.

Sea sloshing forces need only be applied to height of deck cargo up to 2m above the weather deck or hatch top.

For voyages in a restricted area, sea sloshing forces may be neglected.

Balance of forces – Advanced method

Friction contributes towards prevention of sliding the following friction coefficients (μ) should be applied.

| Materials in contact | Friction coefficient, (μ) |
|------------------------------|---------------------------------|
| timber-timber, wet or dry | 0,4 |
| steel-timber or steel-rubber | 0,3 |
| steel-steel, dry | 0,1 |
| steel-steel, wet | 0,0 |

Table 5 – Friction coefficients

The balance calculation should preferably be carried out for:

- transverse sliding in port and starboard directions;
- transverse tipping in port and starboard directions;
- longitudinal sliding under conditions of reduced friction in forward and aft directions

In the case of symmetrical securing arrangements, one appropriate calculation is sufficient.

1. Transverse sliding

The balance calculation should meet the following condition (see also figure 1):

$$F_y \leq \mu m g + CS_1 f_1 + CS_2 f_2 + \dots + CS_n f_n$$

where

n is the number of lashings being calculated

F_y is transverse force from load assumption (kN)

μ is friction coefficient

m is mass of the cargo unit (t)

g is gravity acceleration of earth = 9.81 m/s²

CS is calculated strength of transverse securing devices (kN)

$$CS = \frac{MSL}{1,5}$$

f is a function of μ and the vertical securing angle α (see table 6).

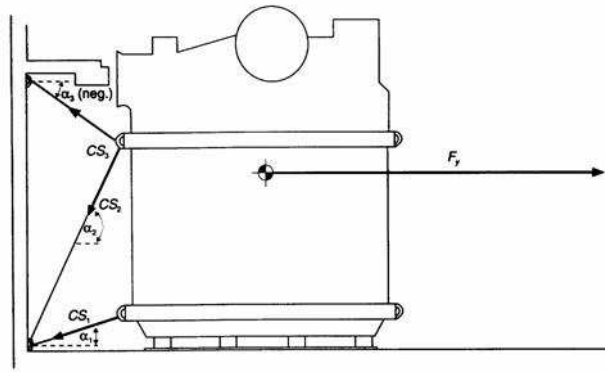


Figure 1 - Balance of transverse forces

A vertical securing angle α greater than 60° will reduce the effectiveness of this particular securing device in respect to sliding of the unit. Disregarding of such devices from the balance of forces should be considered, unless the necessary load is gained by the imminent tendency to tipping or by a reliable pre-tensioning of the securing device and maintaining the pre-tension throughout the voyage.

Any horizontal securing angle, i.e. deviation from the transverse direction, should not exceed 30° , otherwise an exclusion of this securing device from the transverse sliding balance should be considered.

| α μ | -30° | -20° | -10° | 0° | 10° | 20° | 30° | 40° | 50° | 60° | 70° | 80° | 90° |
|-------------------|-------------|-------------|-------------|-----------|------------|------------|------------|------------|------------|------------|------------|------------|------------|
| 0,3 | 0,72 | 0,84 | 0,93 | 1,00 | 1,04 | 1,04 | 1,02 | 0,96 | 0,87 | 0,76 | 0,62 | 0,47 | 0,30 |
| 0,1 | 0,82 | 0,91 | 0,97 | 1,00 | 1,00 | 0,97 | 0,92 | 0,83 | 0,72 | 0,59 | 0,44 | 0,27 | 0,10 |
| 0,0 | 0,87 | 0,94 | 0,98 | 1,00 | 0,98 | 0,94 | 0,87 | 0,77 | 0,64 | 0,50 | 0,34 | 0,17 | 0,00 |

Table 6 - f -Values as a function of α and μ

Remark: $f = \mu \sin \alpha + \cos \alpha$

2. Transverse tipping

This balance calculation should meet the following condition (see also figure 2):

$$F_y a \leq b m g + CS_1 c_1 + CS_2 c_2 + \dots + CS_n c_n$$

Where

F_y , m , g , CS , n are as explained under 1, Transverse sliding

a is lever-arm of tipping (m) (see figure 2)

b is lever-arm of stability (m) (see figure 2)

c is lever-arm of securing force (m) (see figure 2)

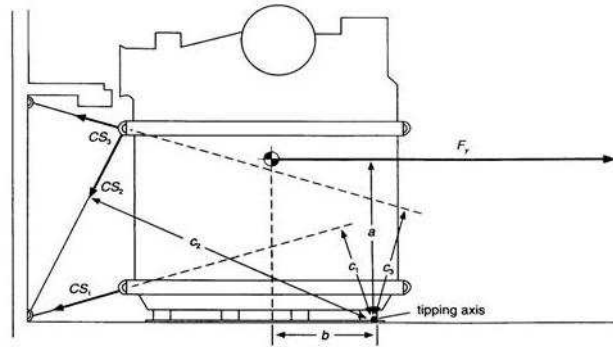


Figure 2 - Balance of transverse moments

3. Longitudinal sliding

Under normal conditions the transverse securing devices provide sufficient longitudinal components to prevent longitudinal sliding. If in doubt, a balance calculation should meet the following condition:

$$F_x \leq \mu (m g - F_z) + CS_1 f_1 + CS_2 f_2 + \dots + CS_n f_n$$

where

F_x is longitudinal force from load assumption (kN)

μ , m , g , f , n are as explained under 1, Transverse sliding

F_z is vertical force from load assumption (kN)

CS is calculated strength of longitudinal securing devices (kN)

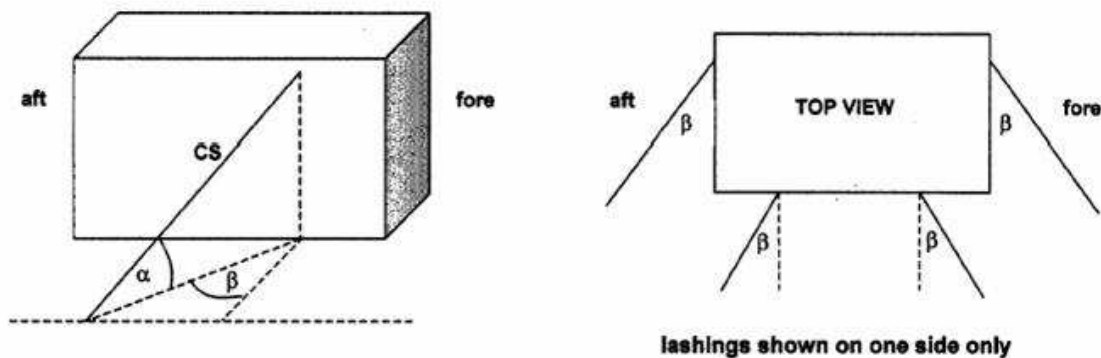
$$CS = \frac{MSL}{1,5}$$

Remark: Longitudinal components of transverse securing devices should not be assumed greater than 0.5 CS .

Balance of forces – Alternative Method

This alternative method allows a more precise consideration of horizontal securing angles.

Securing devices usually do not have a pure longitudinal or transverse direction in practice but have an angle β in the horizontal plane. This horizontal securing angle β is defined in this annex as the angle of deviation from the transverse direction. The angle β is to be scaled in the quadrant mode, i.e. between 0° and 90° .

Figure 3 – Definition of the vertical and horizontal securing angles α and β

A securing device with an angle β develops securing effects both in longitudinal and transverse direction, which can be expressed by multiplying the calculated strength CS with the appropriate values of f_x or f_y . The values of f_x and f_y can be obtained from Table 7.

Table 7 consists of five sets of figures, one each for the friction coefficients $\mu = 0.4, 0.3, 0.2, 0.1$ and 0. Each set of figures is obtained by using the vertical angle α and horizontal angle β . The value of f_x is obtained when entering the table with β from the right while f_y is obtained when entering with β from the left, using the nearest tabular value for α and β . Interpolation is not required but may be used.

The balance calculations are made in accordance with the following formulae:

$$\text{Transverse sliding} : Fy \leq \mu \cdot m \cdot g + fy_1 \cdot CS_1 + \dots + fy_n \cdot CS_n$$

$$\text{Longitudinal sliding} : Fx \leq \mu \cdot (m \cdot g - Fz) + fx_1 \cdot CS_1 + \dots + fx_n \cdot CS_n$$

$$\text{Transverse tipping} : Fy \cdot a \leq b \cdot m \cdot g + 0,9(CS_1 \cdot c_1 + CS_2 \cdot c_2 + \dots + CS_n \cdot c_n)$$

Caution:

Securing devices, which have a vertical angle α of less than 45° in combination with horizontal angle β greater than 45° , should not be used in the balance of transverse tipping in the above formula.

All symbols used in these formulae have the same meaning as defined under Balance of forces – Advanced method except f_x and f_y , obtained from Table 7, and CS is as follows:

$$CS = \frac{MSL}{1,35}$$

Table 7.1 for $\mu = 0.4$

| β for f_y | α | | | | | | | | | | | | | | β for f_x |
|----------------------|----------|-------|-------|------|------|------|------|------|------|------|------|------|------|------|----------------------|
| | -30 | -20 | -10 | 0 | 10 | 20 | 30 | 40 | 45 | 50 | 60 | 70 | 80 | 90 | |
| 0 | 0.67 | 0.80 | 0.92 | 1.00 | 1.05 | 1.08 | 1.07 | 1.02 | 0.99 | 0.95 | 0.85 | 0.72 | 0.57 | 0.40 | 90 |
| 10 | 0.65 | 0.79 | 0.90 | 0.98 | 1.04 | 1.06 | 1.05 | 1.01 | 0.98 | 0.94 | 0.84 | 0.71 | 0.56 | 0.40 | 80 |
| 20 | 0.61 | 0.75 | 0.86 | 0.94 | 0.99 | 1.02 | 1.01 | 0.98 | 0.95 | 0.91 | 0.82 | 0.70 | 0.56 | 0.40 | 70 |
| 30 | 0.55 | 0.68 | 0.78 | 0.87 | 0.92 | 0.95 | 0.95 | 0.92 | 0.90 | 0.86 | 0.78 | 0.67 | 0.54 | 0.40 | 60 |
| 40 | 0.46 | 0.58 | 0.68 | 0.77 | 0.82 | 0.86 | 0.86 | 0.84 | 0.82 | 0.80 | 0.73 | 0.64 | 0.53 | 0.40 | 50 |
| 50 | 0.36 | 0.47 | 0.56 | 0.64 | 0.70 | 0.74 | 0.76 | 0.75 | 0.74 | 0.72 | 0.67 | 0.60 | 0.51 | 0.40 | 40 |
| 60 | 0.23 | 0.33 | 0.42 | 0.50 | 0.56 | 0.61 | 0.63 | 0.64 | 0.64 | 0.63 | 0.60 | 0.55 | 0.48 | 0.40 | 30 |
| 70 | 0.10 | 0.18 | 0.27 | 0.34 | 0.41 | 0.46 | 0.50 | 0.52 | 0.52 | 0.53 | 0.52 | 0.49 | 0.45 | 0.40 | 20 |
| 80 | -0.05 | 0.03 | 0.10 | 0.17 | 0.24 | 0.30 | 0.35 | 0.39 | 0.41 | 0.42 | 0.43 | 0.44 | 0.42 | 0.40 | 10 |
| 90 | -0.20 | -0.14 | -0.07 | 0.00 | 0.07 | 0.14 | 0.20 | 0.26 | 0.28 | 0.31 | 0.35 | 0.38 | 0.39 | 0.40 | 0 |

Table 7.2 for $\mu = 0.3$

| β for f_y | α | | | | | | | | | | | | | | β for f_x |
|----------------------|----------|-------|-------|------|------|------|------|------|------|------|------|------|------|------|----------------------|
| | -30 | -20 | -10 | 0 | 10 | 20 | 30 | 40 | 45 | 50 | 60 | 70 | 80 | 90 | |
| 0 | 0.72 | 0.84 | 0.93 | 1.00 | 1.04 | 1.04 | 1.02 | 0.96 | 0.92 | 0.87 | 0.76 | 0.62 | 0.47 | 0.30 | 90 |
| 10 | 0.70 | 0.82 | 0.92 | 0.98 | 1.02 | 1.03 | 1.00 | 0.95 | 0.91 | 0.86 | 0.75 | 0.62 | 0.47 | 0.30 | 80 |
| 20 | 0.66 | 0.78 | 0.87 | 0.94 | 0.98 | 0.99 | 0.96 | 0.91 | 0.88 | 0.83 | 0.73 | 0.60 | 0.46 | 0.30 | 70 |
| 30 | 0.60 | 0.71 | 0.80 | 0.87 | 0.90 | 0.92 | 0.90 | 0.86 | 0.82 | 0.79 | 0.69 | 0.58 | 0.45 | 0.30 | 60 |
| 40 | 0.51 | 0.62 | 0.70 | 0.77 | 0.81 | 0.82 | 0.81 | 0.78 | 0.75 | 0.72 | 0.64 | 0.54 | 0.43 | 0.30 | 50 |
| 50 | 0.41 | 0.50 | 0.58 | 0.64 | 0.69 | 0.71 | 0.71 | 0.69 | 0.67 | 0.64 | 0.58 | 0.50 | 0.41 | 0.30 | 40 |
| 60 | 0.28 | 0.37 | 0.44 | 0.50 | 0.54 | 0.57 | 0.58 | 0.58 | 0.57 | 0.55 | 0.51 | 0.45 | 0.38 | 0.30 | 30 |
| 70 | 0.15 | 0.22 | 0.28 | 0.34 | 0.39 | 0.42 | 0.45 | 0.45 | 0.45 | 0.45 | 0.43 | 0.40 | 0.35 | 0.30 | 20 |
| 80 | 0.00 | 0.06 | 0.12 | 0.17 | 0.22 | 0.27 | 0.30 | 0.33 | 0.33 | 0.34 | 0.35 | 0.34 | 0.33 | 0.30 | 10 |
| 90 | -0.15 | -0.10 | -0.05 | 0.00 | 0.05 | 0.10 | 0.15 | 0.19 | 0.21 | 0.23 | 0.26 | 0.28 | 0.30 | 0.30 | 0 |

Table 7.3 for $\mu = 0.2$

| β for f_y | α | | | | | | | | | | | | | | β for f_x |
|----------------------|----------|-------|-------|------|------|------|------|------|------|------|------|------|------|------|----------------------|
| | -30 | -20 | -10 | 0 | 10 | 20 | 30 | 40 | 45 | 50 | 60 | 70 | 80 | 90 | |
| 0 | 0.77 | 0.87 | 0.95 | 1.00 | 1.02 | 1.01 | 0.97 | 0.89 | 0.85 | 0.80 | 0.67 | 0.53 | 0.37 | 0.20 | 90 |
| 10 | 0.75 | 0.86 | 0.94 | 0.98 | 1.00 | 0.99 | 0.95 | 0.88 | 0.84 | 0.79 | 0.67 | 0.52 | 0.37 | 0.20 | 80 |
| 20 | 0.71 | 0.81 | 0.89 | 0.94 | 0.96 | 0.95 | 0.91 | 0.85 | 0.81 | 0.76 | 0.64 | 0.51 | 0.36 | 0.20 | 70 |
| 30 | 0.65 | 0.75 | 0.82 | 0.87 | 0.89 | 0.88 | 0.85 | 0.79 | 0.75 | 0.71 | 0.61 | 0.48 | 0.35 | 0.20 | 60 |
| 40 | 0.56 | 0.65 | 0.72 | 0.77 | 0.79 | 0.79 | 0.76 | 0.72 | 0.68 | 0.65 | 0.56 | 0.45 | 0.33 | 0.20 | 50 |
| 50 | 0.46 | 0.54 | 0.60 | 0.64 | 0.67 | 0.67 | 0.66 | 0.62 | 0.60 | 0.57 | 0.49 | 0.41 | 0.31 | 0.20 | 40 |
| 60 | 0.33 | 0.40 | 0.46 | 0.50 | 0.53 | 0.54 | 0.53 | 0.51 | 0.49 | 0.47 | 0.42 | 0.36 | 0.28 | 0.20 | 30 |
| 70 | 0.20 | 0.25 | 0.30 | 0.34 | 0.37 | 0.39 | 0.40 | 0.39 | 0.38 | 0.37 | 0.34 | 0.30 | 0.26 | 0.20 | 20 |
| 80 | 0.05 | 0.09 | 0.14 | 0.17 | 0.21 | 0.23 | 0.25 | 0.26 | 0.26 | 0.26 | 0.26 | 0.25 | 0.23 | 0.20 | 10 |
| 90 | -0.10 | -0.07 | -0.03 | 0.00 | 0.03 | 0.07 | 0.10 | 0.13 | 0.14 | 0.15 | 0.17 | 0.19 | 0.20 | 0.20 | 0 |

Table 7.4 for $\mu = 0.1$

| β for f_y | α | | | | | | | | | | | | | | β for f_x |
|----------------------|----------|-------|-------|------|------|------|------|------|------|------|------|------|------|------|----------------------|
| | -30 | -20 | -10 | 0 | 10 | 20 | 30 | 40 | 45 | 50 | 60 | 70 | 80 | 90 | |
| 0 | 0.82 | 0.91 | 0.97 | 1.00 | 1.00 | 0.97 | 0.92 | 0.83 | 0.78 | 0.72 | 0.59 | 0.44 | 0.27 | 0.10 | 90 |
| 10 | 0.80 | 0.89 | 0.95 | 0.98 | 0.99 | 0.96 | 0.90 | 0.82 | 0.77 | 0.71 | 0.58 | 0.43 | 0.27 | 0.10 | 80 |
| 20 | 0.76 | 0.85 | 0.91 | 0.94 | 0.94 | 0.92 | 0.86 | 0.78 | 0.74 | 0.68 | 0.56 | 0.42 | 0.26 | 0.10 | 70 |
| 30 | 0.70 | 0.78 | 0.84 | 0.87 | 0.87 | 0.85 | 0.80 | 0.73 | 0.68 | 0.63 | 0.52 | 0.39 | 0.25 | 0.10 | 60 |
| 40 | 0.61 | 0.69 | 0.74 | 0.77 | 0.77 | 0.75 | 0.71 | 0.65 | 0.61 | 0.57 | 0.47 | 0.36 | 0.23 | 0.10 | 50 |
| 50 | 0.51 | 0.57 | 0.62 | 0.64 | 0.65 | 0.64 | 0.61 | 0.56 | 0.53 | 0.49 | 0.41 | 0.31 | 0.21 | 0.10 | 40 |
| 60 | 0.38 | 0.44 | 0.48 | 0.50 | 0.51 | 0.50 | 0.48 | 0.45 | 0.42 | 0.40 | 0.34 | 0.26 | 0.19 | 0.10 | 30 |
| 70 | 0.25 | 0.29 | 0.32 | 0.34 | 0.35 | 0.36 | 0.35 | 0.33 | 0.31 | 0.30 | 0.26 | 0.21 | 0.16 | 0.10 | 20 |
| 80 | 0.10 | 0.13 | 0.15 | 0.17 | 0.19 | 0.20 | 0.20 | 0.20 | 0.19 | 0.19 | 0.17 | 0.15 | 0.13 | 0.10 | 10 |
| 90 | -0.05 | -0.03 | -0.02 | 0.00 | 0.02 | 0.03 | 0.05 | 0.06 | 0.07 | 0.08 | 0.09 | 0.09 | 0.10 | 0.10 | 0 |

Table 7.5 for $\mu = 0.0$

| β for f_y | α | | | | | | | | | | | | | | β for f_x |
|----------------------|----------|------|------|------|------|------|------|------|------|------|------|------|------|------|----------------------|
| | -30 | -20 | -10 | 0 | 10 | 20 | 30 | 40 | 45 | 50 | 60 | 70 | 80 | 90 | |
| 0 | 0.87 | 0.94 | 0.98 | 1.00 | 0.98 | 0.94 | 0.87 | 0.77 | 0.71 | 0.64 | 0.50 | 0.34 | 0.17 | 0.00 | 90 |
| 10 | 0.85 | 0.93 | 0.97 | 0.98 | 0.97 | 0.93 | 0.85 | 0.75 | 0.70 | 0.63 | 0.49 | 0.34 | 0.17 | 0.00 | 80 |
| 20 | 0.81 | 0.88 | 0.93 | 0.94 | 0.93 | 0.88 | 0.81 | 0.72 | 0.66 | 0.60 | 0.47 | 0.32 | 0.16 | 0.00 | 70 |
| 30 | 0.75 | 0.81 | 0.85 | 0.87 | 0.85 | 0.81 | 0.75 | 0.66 | 0.61 | 0.56 | 0.43 | 0.30 | 0.15 | 0.00 | 60 |
| 40 | 0.66 | 0.72 | 0.75 | 0.77 | 0.75 | 0.72 | 0.66 | 0.59 | 0.54 | 0.49 | 0.38 | 0.26 | 0.13 | 0.00 | 50 |
| 50 | 0.56 | 0.60 | 0.63 | 0.64 | 0.63 | 0.60 | 0.56 | 0.49 | 0.45 | 0.41 | 0.32 | 0.22 | 0.11 | 0.00 | 40 |
| 60 | 0.43 | 0.47 | 0.49 | 0.50 | 0.49 | 0.47 | 0.43 | 0.38 | 0.35 | 0.32 | 0.25 | 0.17 | 0.09 | 0.00 | 30 |
| 70 | 0.30 | 0.32 | 0.34 | 0.34 | 0.34 | 0.32 | 0.30 | 0.26 | 0.24 | 0.22 | 0.17 | 0.12 | 0.06 | 0.00 | 20 |
| 80 | 0.15 | 0.16 | 0.17 | 0.17 | 0.17 | 0.16 | 0.15 | 0.13 | 0.12 | 0.11 | 0.09 | 0.06 | 0.03 | 0.00 | 10 |
| 90 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0 |

Remark: $f_x = \cos \alpha \cdot \sin \beta + \mu \cdot \sin \alpha$ $f_y = \cos \alpha \cdot \cos \beta + \mu \cdot \sin \alpha$

Calculated example 1 – Advanced method

Ship: $L = 120 \text{ m}$; $B = 20 \text{ m}$; $GM = 1,4 \text{ m}$; Speed = 15 knots

Cargo: $m = 62 \text{ t}$; dimensions = $6 \times 4 \times 4 \text{ m}$
Stowage at $0,7L$ on deck, low

Lever arm of tipping: $a = 1.8 \text{ m}$
Lever arm of stability: $b = 2.0 \text{ m}$
Lever arm of securing force: $c_1 = 1.0 \text{ m}$
 $c_2 = 2.8 \text{ m}$

Force by wind pressure:

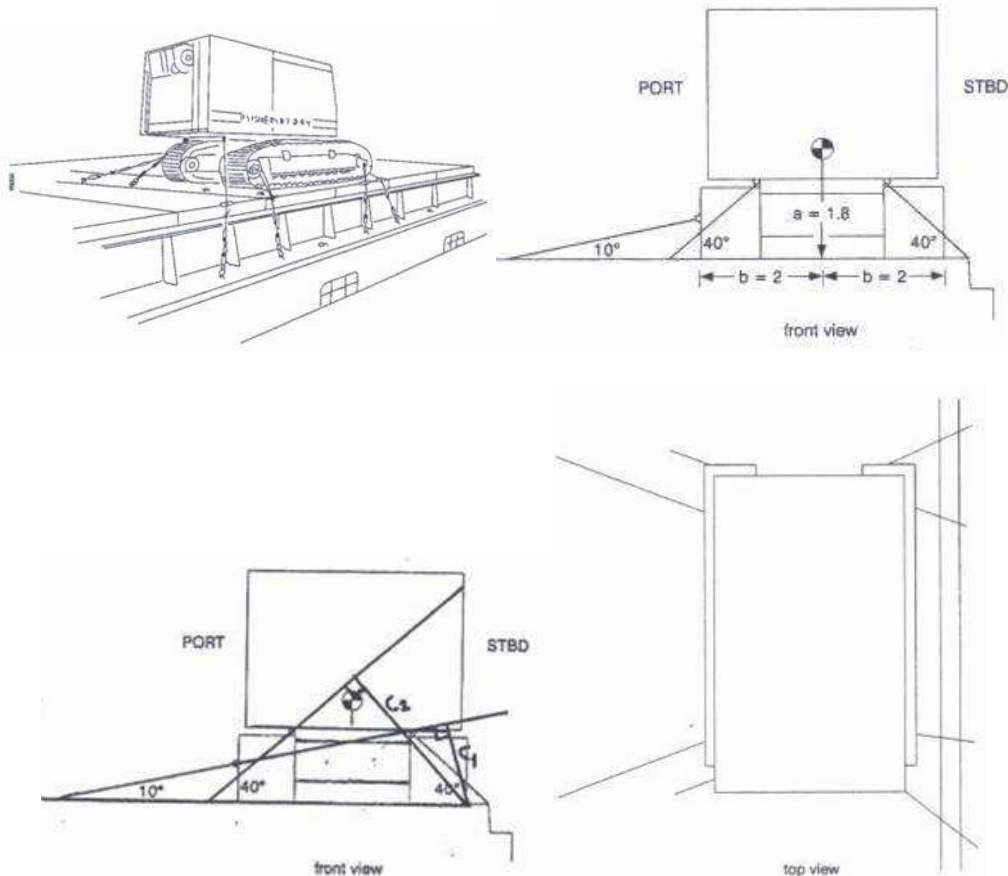
Longitudinal direction = $F_W = 4 \text{ m} \times 4 \text{ m} \times 1 \text{ kN/m}^2 = 16 \text{ kN}$

Transverse direction = $F_W = 6 \times 4 = 24 \text{ kN}$

Force by sea pressure:

Longitudinal direction = $F_S = 4 \times 2 = 8 \text{ kN}$

Transverse direction = $F_S = 6 \times 2 = 12 \text{ kN}$



Securing material:

| | |
|---|--|
| Wire rope: | breaking strength = 125 kN MSL = 100 kN |
| Shackles, turnbuckles, deck rings: | breaking strength = 180 kN MSL = 90 kN |
| Stowage on dunnage boards: | $\mu=0.3$ (Steel – timber) |
| Calculated strength (using lowest MSL): | CS = $90/1.5 = 60$ kN |

Securing Arrangement:

| SIDE | n | CS | α | f* | c |
|------|---|-------|----------|------|-----|
| STBD | 4 | 60 kN | 40° | 0.96 | 2.8 |
| PORT | 2 | 60 kN | 40° | 0.96 | 2.8 |
| PORT | 2 | 60 kN | 10° | 1.04 | 1.0 |

*) Where f is taken from Table 6

External forces:

$$F_x = \text{mass} \times \text{long. acc.} \times \text{correction factor from table 3} + \text{long. force by wind} + \text{long. force by sea}$$

$$= 62 \times 2.9 \times 0.89 + 16 + 8 = 184 \text{ kN}$$

$$F_y = \text{mass} \times \text{trans. acc.} \times \text{correction factor from table 3} + \text{trans. force by wind} + \text{trans. force by sea}$$

$$= 62 \times 6.3 \times 0.89 + 24 + 12 = 384 \text{ kN}$$

$$F_z = \text{mass} \times \text{vertical acc.} \times \text{correction factor from table 3}$$

$$= 62 \times 6.2 \times 0.89 = 342 \text{ kN}$$

Balance of forces (STBD arrangement):

$$F_y < \mu \times m \times g + n \times \text{CS} \times f = \text{Friction force} + \text{Lashing force}$$

$$384 < 0.3 \times 62 \times 9.81 + 4 \times 60 \times 0.96$$

$$384 < 412 \quad \text{This is OK!}$$

Balance of forces (PORT arrangement):

$$F_y < \mu \times m \times g + n \times \text{CS} \times f + n \times \text{CS} \times f = \text{Friction force} + \text{Lashing force}$$

$$384 < 0.3 \times 62 \times 9.81 + 2 \times 60 \times 0.96 + 2 \times 60 \times 1.04$$

$$384 < 422 \quad \text{This is OK!}$$

Transverse tipping (STBD arrangement):

$$F_y \times a < b \times m \times g + n \times \text{CS} \times c = \text{Tipping moment} + \text{Lashing force}$$

$$384 \times 1.8 < 2 \times 62 \times 9.81 + 4 \times 60 \times 2.8$$

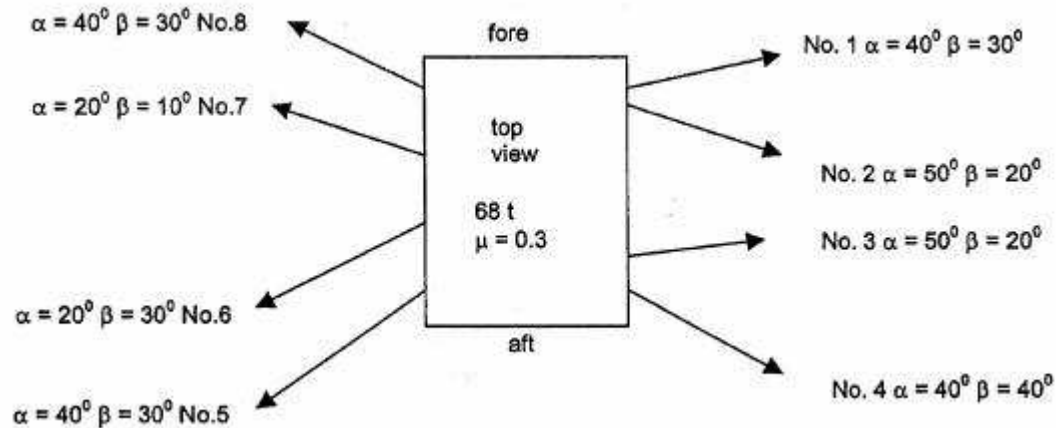
$$691 < 1888 \quad \text{No tipping, even without lashings!}$$

Calculated example 2

A cargo unit of 68 t mass is stowed on timber ($\mu = 0.3$) in the tween deck at 0.7 L of a vessel. L = 160 m, B = 24 m, v = 18 kn and GM = 1.5 m. Dimensions of the cargo unit are height = 2.4 m and width = 1.8 m.

The external forces are: $F_x = 112$ kN
 $F_y = 312$ kN
 $F_z = 346$ kN

The top view shows the overall securing arrangement with eight lashings.



Calculation of balance of forces:

| No. | MSL (kN) | CS (kN) | α | β | f_y | $Cs \times f_y$ | f_x | $Cs \times f_x$ |
|-----|----------|---------|----------|---------|-------|-----------------|-------|-----------------|
| 1 | 108 | 80 | 40° stbd | 30° fwd | 0.86 | 68.8 stbd | 0.58 | 46.4 fwd |
| 2 | 90 | 67 | 50° stbd | 20° aft | 0.83 | 55.6 stbd | 0.45 | 30.2 aft |
| 3 | 90 | 67 | 50° stbd | 20° fwd | 0.83 | 55.6 stbd | 0.45 | 30.2 fwd |
| 4 | 108 | 80 | 40° stbd | 40° aft | 0.78 | 62.4 stbd | 0.69 | 55.2 aft |
| 5 | 108 | 80 | 40° port | 30° aft | 0.86 | 68.8 port | 0.58 | 46.4 aft |
| 6 | 90 | 67 | 20° port | 30° aft | 0.92 | 61.6 port | 0.57 | 38.2 aft |
| 7 | 90 | 67 | 20° port | 10° fwd | 1.03 | 69.0 port | 0.27 | 18.1 fwd |
| 8 | 108 | 80 | 40° port | 30° fwd | 0.86 | 68.8 port | 0.58 | 46.4 fwd |

Transverse balance of forces (STBD arrangement) Nos. 1, 2, 3 and 4:

$$F_y < \mu \times m \times g + CS_1 \times f_{y1} + CS_2 \times f_{y2} + CS_3 \times f_{y3} + CS_4 \times f_{y4} = \text{Friction force} + \text{Lashing force}$$

$$312 < 0.3 \times 68 \times 9.81 + 68.8 + 55.6 + 55.6 + 62.4$$

$$312 < 443 \quad \text{this is OK!}$$

Transverse balance of forces (PORT arrangement) Nos. 5, 6, 7 and 8:

$$F_y < \mu \times m \times g + CS_5 \times f_{y5} + CS_6 \times f_{y6} + CS_7 \times f_{y7} + CS_8 \times f_{y8} = \text{Friction force} + \text{Lashing force}$$

$$312 < 0.3 \times 68 \times 9.81 + 68.8 + 61.6 + 69.0 + 68.8$$

$$312 < 468 \quad \text{this is OK!}$$

Longitudinal balance of forces (FWD arrangement) Nos. 1, 3, 7, 8:

$$F_x < \mu \times (m \times g - F_z) + CS_1 \times f_{x1} + CS_2 \times f_{x2} + CS_3 \times f_{x3} + CS_4 \times f_{x4} = \text{Frict. force} + \text{Lashing force}$$

$$112 < 0.3 (68 \times 9.81 - 346) + 46.4 + 30.2 + 18.1 + 46.4$$

$$112 < 237 \quad \text{this is OK!}$$

Longitudinal balance of forces (AFT arrangement) Nos. 2, 4, 5, 6:

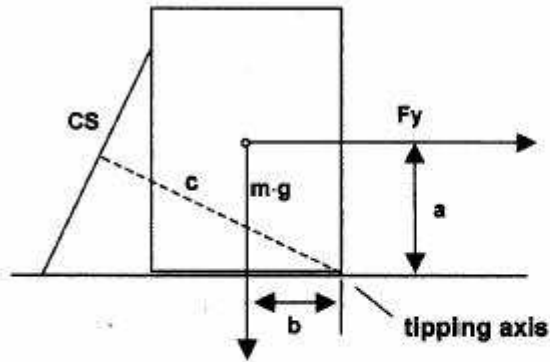
$$F_x < \mu \times (m \times g - F_z) + CS_5 \times f_{x5} + CS_6 \times f_{x6} + CS_7 \times f_{x7} + CS_8 \times f_{x8} = \text{Frict. force} + \text{Lashing force}$$

$$112 < 0.3 (68 \times 9.81 - 346) + 30.2 + 55.2 + 46.4 + 38.2$$

$$112 < 266 \quad \text{this is OK!}$$

Transverse Tipping

Unless specific information is provided, the vertical centre of gravity of the cargo unit can be assumed to be at one half the height and the transverse centre of gravity at one half the width. Also, if the lashing is connected as shown in the sketch, instead of measuring c , the length of the lever from the tipping axis to the lashing CS, it is conservative to assume that it is equal to the width of the cargo unit.



$$F_y \cdot a \leq b \cdot m \cdot g + 0.9 \cdot (CS_1 \cdot c_1 + CS_2 \cdot c_2 + CS_3 \cdot c_3 + CS_4 \cdot c_4)$$

$$312 \cdot 2.4/2 < 1.8/2 \cdot 68 \cdot 9.81 + 0.9 \cdot 1.8 \cdot (80 + 67 + 67 + 80)$$

$$374 < 600 + 476$$

$$374 < 1076 \quad \text{this is OK !}$$

Appendix III – Applicable Annexes from the CSS Code

ANNEX 6 Safe stowage and securing of coiled sheet steel

1 General

- 1.1 This annex deals only with coiled sheet steel stowed on the round. Vertical stowage is not dealt with because this type of stowage does not create any special securing problems.
- 1.2 Normally, coils of sheet steel have a gross mass in excess of 10 tonnes each.

2 Coils

- 2.1 Coils should be given bottom stow and, whenever possible, be stowed in regular tiers from side to side of the ship.
- 2.2 Coils should be stowed on dunnage laid athwartships. Coils should be stowed with their axes in the fore – and – aft direction. Each coil should be stowed against its neighbour. Wedges should be used as stoppers when necessary during loading and discharging to prevent shifting (figures 1 and 2).
- 2.3 The final coil in each row should normally rest on the two adjacent coils. The mass of this coil will lock the other coils in the row.
- 2.4 If it is necessary to load a second tier over the first, then the coils should be stowed in between the coils of the first tier (figure 2).
- 2.5 Any void space between coils in the topmost tier should be adequately secured (figure 3).

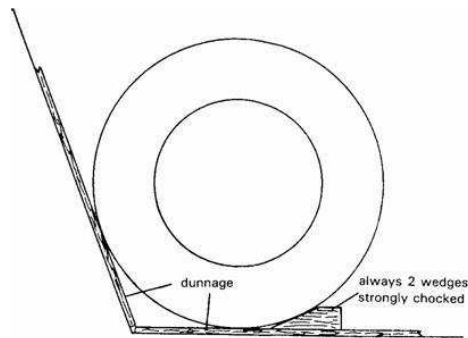


Figure 1 – Principle of dunnaging and wedging coils

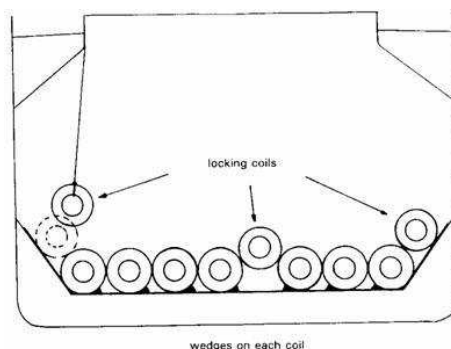


Figure 2 – Inserting of locking coils

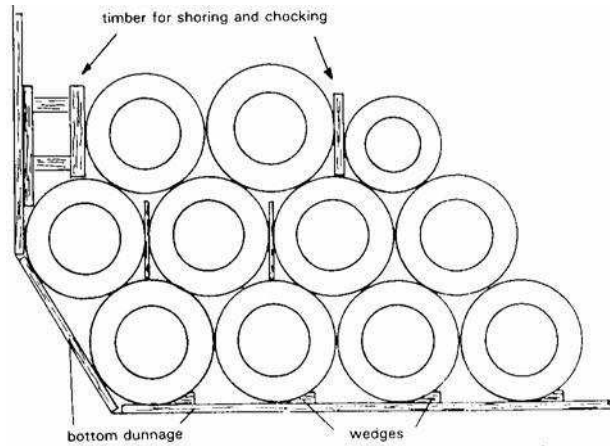


Figure 3 – Shoring and chocking in voids between coils

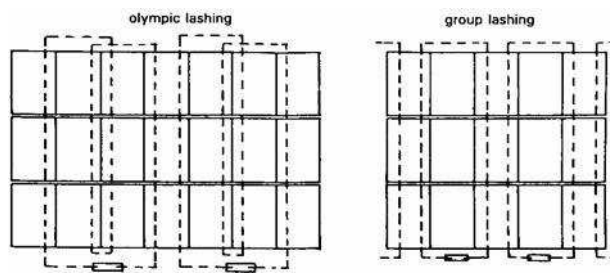


Figure 4 – Securing of top tier against fore-and-aft shifting (view from top)

3 Lashings

- 3.1 The objective is to form one large, immovable block of coils in the hold by lashing them together. In general, strip coils in three end rows in the top tier should be lashed. To prevent fore-and-aft shifting in the top tier of bare-wound coils group-lashing should not be applied due to their fragile nature; the end row of a top tier should be secured by dunnage and wires, which are to be tightened from side to side, and by additional wires to the bulkhead. When coils are fully loaded over the entire bottom space and are well shored, no lashings are required except for locking coils (figures 4, 5, and 6).

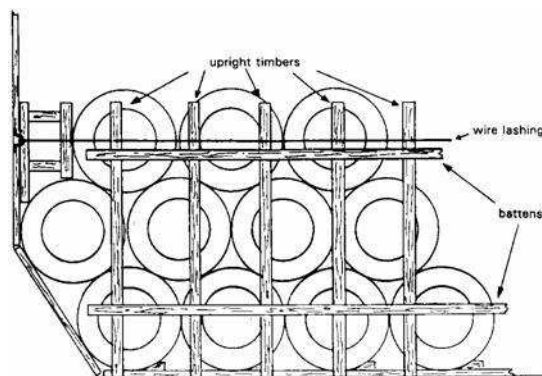


Figure 5 – Securing of end row in top tier against fore-and-aft shifting

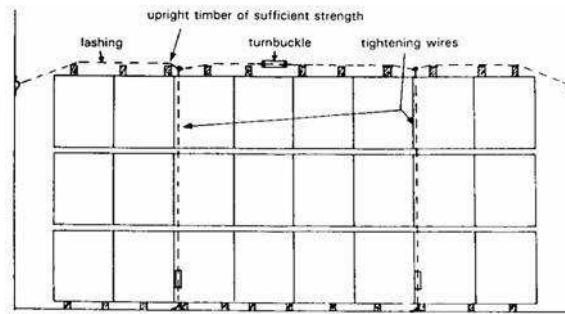


Figure 6 – Securing of end row in top tier against fore-and-aft shifting (view from top)

- 3.2 The lashings can be of a conventional type using wire steel band or any equivalent means.
- 3.3 Conventional lashings should consist of wires having sufficient tensile strength. The first tier should be chocked. It should be possible to re-tighten the lashings during the voyage (figures 5 and 6).
- 3.4 Wire lashings should be protected against damage from sharp edges.
- 3.5 If there are few coils, or a single coil only, they should be adequately secured to the ship, by placing them in cradles, by wedging, or by shoring and then lashing to prevent transverse and longitudinal movement.
- 3.6 Coils carried in containers, railway wagons and road vehicles should be stowed in cradles or specially made beds and should be prevented from moving by adequate securing.

ANNEX 7 Safe stowage and securing of heavy metal products

1 General

- 1.1 Heavy metal products in the context of this Code include any heavy item made of metal, such as bars, pipes, rods, plates, wire coils, etc.
- 1.2 The transport of heavy metal products by sea exposes the ship to the following principal hazards:
 - .1 overstressing of the ship's structure if the permissible hull stress or permissible deck loading is exceeded;
 - .2 overstressing of the ship's structure as a result of a short roll period caused by excessive metacentric height; and
 - .3 cargo shifting because of inadequate securing resulting in a loss of stability or damage to the hull or both.

2 Recommendations

- 2.1 The cargo spaces in which heavy metal products are to be stowed should be clean, dry and free from grease and oil.
- 2.2 The cargo should be so distributed as to avoid undue hull stress.
- 2.3 The permissible deck and tank top loading should not be exceeded.

- 2.4 The following measures should be taken when stowing and securing heavy metal products:
 - .1 cargo items should be stowed compactly from one side of the ship to the other leaving no voids between them and using timber blocks between items if necessary;
 - .2 cargo should be stowed level whenever possible and practicable;
 - .3 the surface of the cargo should be secured; and
 - .4 the shoring should be made of strong, non-splintering wood and adequately sized to withstand the acceleration forces. One shoring should be applied to every frame of the ship but at intervals of not less than 1 m.
- 2.5 In the case of thin plates and small parcels, alternate fore-and-aft and athwart ships stowage has proved satisfactory. The friction should be increased by using sufficient dry dunnage or other material between the different layers.
- 2.6 Pipes, rails, rolled sections, billets, etc., should be stowed in the fore and-aft direction to avoid damage to the sides of the ship if the cargo shifts.
- 2.7 The cargo, and especially the topmost layer, can be secured by:
 - .1 having other cargo stowed on top of it; or
 - .2 lashing by wire, chocking off or similar means.
- 2.8 Whenever heavy metal products are not stowed from side to side of the ship, special care should be taken to secure such stowage's adequately.
- 2.9 Whenever the surface of the cargo is to be secured, the lashings should be independent of each other, exert vertical pressure on the surface of the cargo, and be so positioned that no part of the cargo is unsecured.
- 3 Wire Coils
 - 3.1 Wire coils should be stowed flat so that each coil rests against an adjacent coil. The coils in successive tiers should be stowed so that each coil overlaps the coils below.
 - 3.2 Wire coils should be tightly stowed together and substantial securing arrangements should be used. Where voids between coils are unavoidable or where there are voids at the sides or ends of the cargo space, the stow should be adequately secured.
 - 3.3 When securing wire coils stowed on their sides in several layers like barrels, it is essential to remember that, unless the top layer is secured, the coils lying in the stow can be forced out of the stow by the coils below on account of the ship's motions.

ANNEX 8 Safe stowage and securing of anchor chains

- 1 General
 - 1.1 Anchor chains for ships and offshore structures are usually carried in bundles or in continuous lengths.
 - 1.2 Provided certain safety measures are followed prior to, during and after stowage, anchor chains may be lowered directly onto the place of stowage in bundles without further handling, or stowed longitudinally either along the ship's entire cargo space or part thereof.

- 1.3 If the cargo plans given in the ship's documentation contain no specific requirements, the cargo should be distributed over the lower hold and 'tween-decks in such a way that stability values thus obtained will guarantee adequate stability.

2 Recommendations

- 2.1 Cargo spaces in which chains are stowed should be clean and free from oil and grease.
- 2.2 Chains should only be stowed on surfaces which are permanently covered either by wooden ceiling or by sufficient layers of dunnage or other suitable friction-increasing materials. Chains should never be stowed directly on metal surfaces.

3 Stowage And Securing Of Chains In Bundles

- 3.1 Chains in bundles, which are lifted directly onto their place of stowage without further handling, should be left with their lifting wires attached and should preferably be provided with additional wires around the bundles for lashing purposes.
- 3.2 It is not necessary to separate layers of chain with friction-increasing material such as dunnage because chain bundles will grip each other. The top layer of chain bundles should be secured to both sides of the ship by suitable lashings. Bundles may be lashed independently or in a group, using the lifting wires.

4 Stowage and Securing of Chains which are Stowed Longitudinally

- 4.1 Stowage of each layer of chain should, whenever possible and practicable, commence and terminate close to the ship's side. Care should be taken to achieve a tight stow.
- 4.2 It is not necessary to separate layers of chain with friction-increasing material such as dunnage because chain layers will grip each other.
- 4.3 Bearing in mind the expected weather and sea conditions, the length and nature of the voyage and the nature of the cargo to be stowed on top of the chain, the top layer of each stow should be secured by lashings of adequate strength crossing the stow at suitable intervals and thus holding down the entire stow.

ANNEX 9 Safe stowage and securing of metal scrap in bulk

1 Introduction

- 1.1 This annex deals with the stowage of metal scrap which is difficult to stow compactly because of its size, shape and mass, but does not apply to metal scrap such as metal borings, shavings or turnings, the carriage of which is addressed by the Code of Safe Practice for Solid Bulk Cargoes.
- 1.2 The hazards involved in transporting metal scrap include:
 - .1 shifting of the stow which in turn can cause a list;
 - .2 shifting of individual heavy pieces which can rupture the side plating below the waterline and give rise to serious flooding;
 - .3 excessive loading on tank tops or 'tween-decks; and
 - .4 violent rolling caused by excessive metacentric height.

2 Recommendations

- 2.1 Before loading, the lower battens of the spar ceiling should be protected by substantial dunnage to reduce damage and to prevent heavy and sharp pieces of scrap coming in contact with the ship's side plating. Air and sounding pipes, and bilge and ballast lines protected only by wooden boards, should be similarly protected.
- 2.2 When loading, care should be taken to ensure that the first loads are not dropped from a height which could damage the tank tops.
- 2.3 If light and heavy scrap is to be stowed in the same cargo space, the heavy scrap should be loaded first. Scrap should never be stowed on top of metal turnings, or similar forms of waste metal.
- 2.4 Scrap should be compactly and evenly stowed with no voids or unsupported faces of loosely held scrap.
- 2.5 Heavy pieces of scrap, which could cause damage to the side plating or end bulkheads if they were to move, should be overstowed or secured by suitable lashings. The use of shoring is unlikely to be effective because of the nature of the scrap.
- 2.6 Care should be taken to avoid excessive loading on tank tops and decks,

ANNEX 11 General guidelines for the under-deck stowage of logs

1 Introduction

The purpose of this annex is to recommend safe practices for the under-deck stowage of logs and other operational safety measures designed to ensure the safe transport of such cargoes.

2 Prior to loading:

- .1 each cargo space configuration (length, breadth and depth), the cubic bale capacity of the respective cargo spaces, the various lengths of logs to be loaded, the cubic volume (log average), and the capacity of the gear to be used to load the logs should be determined;
- .2 using the above information, a pre-stow plan should be developed to allow the maximum utilisation of the available space; the better the under-deck stowage, the more cargo can safely be carried on deck;
- .3 the cargo spaces and related equipment should be examined to determine whether the condition of structural members, framework and equipment could affect the safe carriage of the log cargo. Any damage discovered during such an examination should be repaired in an appropriate manner;
- .4 the bilge suction screens should be examined to ensure they are clean, effective and properly maintained to prevent the admission of debris into the bilge piping system;
- .5 the bilge wells should be free of extraneous material such as wood bark and wood splinters;
- .6 the capacity of the bilge pumping system should be ascertained. A properly maintained and operating system is crucial for the safety of the ship. A portable dewatering pump of sufficient capacity and lift will provide additional insurance against a clogged bilge line;
- .7 side sparring, pipe guards, etc., designed to protect internal hull members should be in place; and
- .8 the master should ensure that the opening and closing of any high ballast dump valves are properly recorded in the ship's log. Given that such high ballast tanks are necessary to facilitate loading and bearing in mind regulation 22(1) of the International Convention on Load Lines, 1966, which requires a screw-down valve fitted in gravity overboard drain lines,

the master should ensure that the dump valves are properly monitored to preclude the accidental readmission of water into these tanks. Leaving these tanks open to the sea could lead to an apparent inexplicable list, a shift of deck cargo and potential capsize.

3 During loading operations:

- .1 each lift of logs should be hoisted aboard the ship in close proximity to the ship to minimise any potential swinging of the lift;
- .2 the possibility of damage to the ship and the safety of those who work in the cargo spaces should be considered. The logs should not be swinging when lowered into the space. The hatch coaming should be used, as necessary, to eliminate any swinging of the logs by gently resting the load against the inside of the coaming, or on it, prior to lowering;
- .3 the logs should be stowed compactly, thereby eliminating as many voids as is practicable. The amount and the vertical centre of gravity of the logs stowed under deck will govern the amount of cargo that can be safely stowed on deck. In considering this principle, the heaviest logs should be loaded first into the cargo spaces;
- .4 logs should generally be stowed compactly in a fore-and-aft direction, with the longer lengths towards the forward and aft areas of the space. If there is a void in the space between the fore and aft lengths it should be filled with logs stowed athwartships so as to fill in the void across the breadth of the spaces as completely as the length of the logs permits;
- .5 where the logs in the spaces can only be stowed fore-and-aft in one length, any remaining void forward or aft should be filled with logs stowed athwartships so as to fill in the void across the breadth of the space as completely as the length of the logs permits;
- .6 athwartship voids should be filled tier by tier as loading progresses;
- .7 butt ends of the logs should be alternately reversed to achieve a more level stowage, except where excess sheer on the inner bottom is encountered;
- .8 extreme pyramiding of logs should be avoided to the greatest extent possible. If the breadth of the space is greater than the breadth of the hatch opening, pyramiding may be avoided by sliding fore-and-aft loaded logs into the ends of the port and starboard sides of the space. This sliding of logs into the ends of the port and starboard sides of the space should commence early in the loading process (after reaching a height of approximately 2 m above the inner bottom) and should continue throughout the loading process;
- .9 it may be necessary to use loose tackle to manoeuvre heavy logs into the under-deck areas clear of the hatchways. Blocks, purchases and other loose tackle should be attached to suitably reinforced fixtures such as eyebolts or padeyes provided for this purpose. However, if this procedure is followed, care should be taken to avoid overloading the gear;
- .10 a careful watch by ship's personnel should be maintained throughout the loading to ensure no structural damage occurs. Any damage which affects the seaworthiness of the ship should be repaired;
- .11 when the logs are stowed to a height of about 1 m below the forward or aft athwartship hatch coaming, the size of the lift of logs should be reduced to facilitate stowing of the remaining area; and
- .12 logs in the hatch coaming area should be stowed as compactly as possible to maximum capacity.

4 After loading, the ship should be thoroughly examined to ascertain its structural condition, bilges should be sounded to verify the ship's watertight integrity

5 During the voyage:

- .1 the ship's heeling angle and rolling period should be checked, in a seaway, on a regular basis;
- .2 wedges, wastes, hammers and portable pump, if provided should be stored in an easily accessible place; and

- .3 the master or a responsible officer should ensure that it is safe to enter an enclosed cargo space by:
 - .3.1 ensuring that the space has been thoroughly ventilated by natural or mechanical means;
 - .3.2 testing the atmosphere of the space at different levels for oxygen deficiency and harmful vapour where suitable instruments are available; and
 - .3.3 requiring self-contained breathing apparatus to be worn by all persons entering the space where there is any doubt as to the adequacy of ventilation or testing before entry.

ANNEX 12 Safe stowing and securing of unit loads

1 Introduction

Unit load for the purposes of this annex means that a number of packages are either:

- .1 placed or stacked, and secured by strapping, shrink-wrapping or other suitable means, on a load board such as a pallet; or
- .2 placed in a protective outer packaging such as a pallet box; or
- .3 permanently secured together in a sling.

Note: A single large package such as a portable tank or receptacle, intermediate bulk container or freight container is excluded from the recommendations of this annex

2 Cargo Information

The master should be provided with at least the following information:

- .1 the total number of unit loads and commodity to be loaded;
- .2 the type of strapping or wrapping used;
- .3 the dimensions of a unit load in metres; and
- .4 the gross mass of a unit load in kilogrammes.

3 Recommendations

- 3.1 The cargo spaces of the ship in which unit loads will be stowed should be clean, dry and free from oil and grease.
- 3.2 The decks, including the tank top, should be flush all over.
- 3.3 The cargo spaces should preferably be of a rectangular shape, horizontally and vertically. Cargo spaces of another shape in forward holds or in 'tweendecks should be transformed into a rectangular shape both athwartships and longitudinally by the use of suitable timber (figure 1).

4 Stowage

- 4.1 The unit loads should be stowed in such a way that securing, if needed, can be performed on all sides of the stow.

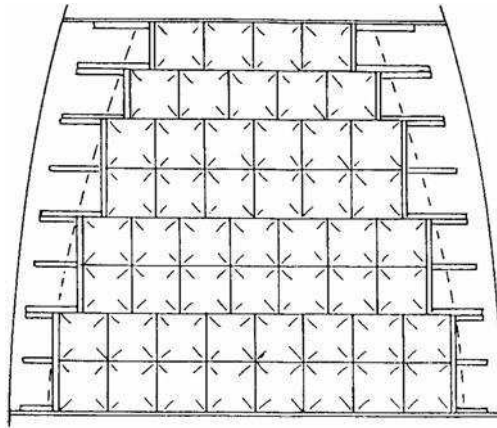


Figure 1 – Stowage and chocking of unit loads in a tapered stowage area (view from top)

- 4.2 The unit loads should be stowed without any void space between the loads and the ship's sides to prevent the unit loads from racking.
- 4.3 When unit loads have to be stowed on top of each other, attention should be paid to the strength of pallets and the shape and the condition of the unit loads.
- 4.4 Precautions should be taken when unit loads are mechanically handled to avoid damaging the unit loads.
- 5 Securing
 - 5.1 Block stowage should be ensured and no void space be left between the unit loads.
- 6 Securing when stowed athwart ships
 - 6.1 When unit loads are stowed in a lower hold or in a 'tween-deck against a bulkhead from side to side, gratings or plywood sheets should be positioned vertically against the stack of the unit loads. Wire lashings should be fitted from side to side keeping the gratings or plywood sheets tight against the stow.
 - 6.2 Additionally, lashing wires can be fitted at different spacing from the bulkhead over the stow to the horizontally placed wire lashings in order to further tighten the stow.
- 7 Stowage in a Wing of a Cargo Space and Free at Two Sides
 - 7.1 When unit loads are stowed in the forward or after end of a cargo space and the possibility of shifting in two directions exists, gratings or plywood sheets should be positioned vertically to the stack faces of the unit loads of the non-secured sides of the stow. Wire lashings should be taken around the stow from the wings to the bulkhead. Where the wires can damage the unit loads (particularly on the corners of the stow), gratings or plywood sheets should be positioned in such a way that no damage can occur on corners.
- 8 Stowage Free at Three Sides
 - 8.1 When unit loads are stowed against the ship's sides in such a way that shifting is possible from three sides, gratings or plywood sheets should be positioned vertically against the stack faces of the unit loads. Special attention should be paid to the corners of the stow to prevent damage to the unit loads by the wire lashings. Wire lashing at different heights should tighten the stow together with the gratings or plywood sheets at the sides (figure 2).

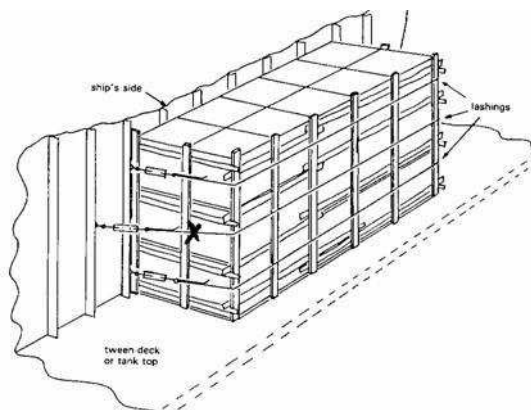


Figure 2 – Securing of units stowed at the ship's side

Note: Lashings must not place a sideways load on the frame/stiffener

9 General

- 9.1 Instead of gratings or plywood sheets, other possibilities are the use of aluminium stanchions or battens of sufficient strength.
- 9.2 During the voyage the wire lashings should be regularly inspected and slack wires should be re-tightened if necessary. In particular, after rough weather, wire lashings should be checked and re-tightened if necessary.

Appendix IV – LASHCON™ IMO USER GUIDE



LASHCON™ IMO USER GUIDE

BY

DET NORSKE VERITAS

Version: 9.0
Date: 2003-12-08

1 General

1.1 Introduction

LASHCON™ is a MS EXCEL based calculation tool for evaluation of semi- and non-standardised securing arrangements.

The program calculates accelerations and balance of forces in semi- and non-standardised lashing arrangements in accordance with annex 13 to the Code of Safe Practice for Cargo Stowage and Securing (the CSS code) from IMO.

1.2 System requirements

LASHCON™ requires Microsoft Windows version 3.1 or later, with Microsoft Excel 5.0 installed. Resources needed to run Microsoft Excel 5.0 are described in “Microsoft Excel User’s Guide”.

1.3 User requirements

The user should be familiar with Microsoft products such as Excel and Word. This includes the use of mouse pointer.


NOTE: The decimal separator may differ from the examples given in this booklet.

Normally either “.” or “,” is used.

2. User guide

2.1 Input sequence

- Once LASHCON™ has been started, the following screen picture will appear:

| | | | | | | |
|--|----------|--|--------|---|---------|---|
|  | | Code of Safe Practice for Cargo Stowage and Securing 2003 Edition, Annex 13 | | LASHCON IMO Version 9.0 December 2003 | | Sign: <input type="text"/> Time: 16:48 Date: 04.02.19 |
| <p>About LASHCON™: LASHCON is a MS EXCEL based calculation tool for control of lashing-arrangements for semi- and non-standardised cargo. The program is developed by Det Norske Veritas, and is based on the calculation procedures outlined in Annex 13 to the Code of Safe Practice for Cargo Stowage and Securing, 2003 Edition.</p> <p>Program assumptions: Reference is made to the User Manual.</p> | | | | | | |
| Input of main vessel data: | | | | | | Next page>> |
| Vessel Name: | Ship Id: | Lpp [m]: | B [m]: | V [kn]: | GM [m]: | Print |
| M/S Test Vessel | 123456 | 73,5 | 14,0 | 10,0 | 1,8 | |
| <p>NOTES:</p> <p>This version of Lashcon IMO contains the procedures for calculation of accelerations and lashing arrangement as given in the Code of Safe Practice for Cargo Stowage and Securing, 2003 Edition, Annex 13.</p> <p>Following enhancements have been incorporated:</p> <ol style="list-style-type: none"> 1. The range of validity for ship length has been extended down to L=30 m. 2. The B/GM range has been extended down to B/GM = 4 by power series extrapolation. | | | | | | |

- Input cells are marked white in LASHCON™. Not all input cells are necessary for successful computation. Ship name and identification is solely for user reference. Vessel main particulars are used for acceleration computation and must be filled in before proceeding. See 2.2 Input Data for details.

3. After successful completion of the input data, click on the button “**Next Page >>**” proceed to the “**Cargo and lashing data sheet**”. The following picture will then appear:

| NAUTICUS hull | | Code of Safe Practice for Cargo Stowage and Securing 2003 Edition, Annex 13 | | LASHCON IMO Version 9.0 December 2003 | | Sign: Time: 16:48 Date: 04.02.19 | | | | | | | |
|-------------------------------------|----------|---|----------|--|---------|--|---------|-------------|------------------|----------------------------|---|---|----|
| Input of cargo unit data | | | | Give cargo unit stowage position | | | | | | | | | |
| Cargo unit specification: | | | | Vertical: Deck, high ? | | | | | | | | | |
| Mass of cargo unit: | m | ton | | Longitudinal: AP | | | | | | | | | |
| Coefficient of friction: | μ | (-) | ? | | | | | | | | | | |
| Wind exposed area: | Aw | m ² | ? | Calculation method: | | | | | | | | | |
| Sea exposed area: | As | m ² | ? | <input checked="" type="radio"/> Alternative calculation ? Recommended. <input type="radio"/> Advanced calculation ? | | | | | | | | | |
| Lever arm of tipping: | a | m | ? | | | | | | | | | | |
| Lever arm of stabileness: | b | m | ? | | | | | | | | | | |
| Input of lashing data | | | | | | | | | | | | | |
| Max securing load [kN]: | MSL | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Transverse lashing direction | | | | | | | | | | | | | |
| Longitudinal lashing direction | | | | | | | | | | | | | |
| Vertical securing angle [degr]: | α | | | | | | | | | | | | |
| Vertical securing angle [degr]: | β | | | | | | | | | | | | |
| Horizontal securing point distance: | d [m] | | | | | | | | | | | | |
| RESULTS: | | | | | | | | | | | | | |
| Actual forces | | Securing capacity [kN / kNm] | | | | Accelerations | | | | Show Graph >> | | | |
| Transverse sliding force [kN]: | 0,0 | Transv. capacity: | PS [kN] | 0 | OK | Transverse: | $a_t =$ | 10,71 | m/s ² | | | | |
| | | | SB [kN] | 0 | OK | Vertical: | $a_v =$ | 9,28 | m/s ² | | | | |
| Longitudinal sliding force [kN]: | 0,0 | Long. capacity: | Fwd [kN] | 0 | OK | Longitudinal: | $a_l =$ | 3,83 | m/s ² | | | | |
| | | | Aft [kN] | 0 | OK | | | | | | | | |
| Cargo tipping moment [kNm] | 0,0 | Tipping capacity: | PS [kN] | 0 | OK | | | | | | | | |
| | | | SB [kN] | 0 | OK | | | | | | | | |
| <<< Main Data | | Print | | Save to stack | | Clear last | | Clear stack | | Show stack >> | | | |
| Main Vessel Data: | | | | | | | | | | | | | |
| Vessel Name: | Ship Id: | Lpp [m]: | B [m]: | V [kn]: | GM [m]: | | | | | | | | |
| M/S Test Vessel | 123456 | 73,50 | 14,00 | 10,00 | 1,80 | | | | | | | | |

For help on input data, press the “?” button to the right of the respective input. The input parameters are the same as explained in “Code of Safe Practice for Cargo Stowage and Securing Annex 13.

- Fill in the in the “**Input of cargo unit data**” field.
- Select the “**Cargo unit stowage position**” (vertical and longitudinal) by using the drop-down selection boxes in the upper right corner of the screen.
- Select the desired method of calculation.
 - Advanced calculation, see 2.3 Calculation Methods
 - Alternative calculation, see 2.3 Calculation Methods
- Give the applicable lashing particulars
 - MSL of lashing. [kN]
 - Lashing direction for drop down boxes.
 - Vertical securing angle [deg]
 - Horizontal securing angle [deg] (Alternative method only.)
 - Horizontal securing point distance [m]

8. Calculation results are shown in the yellow area. “**Actual forces**” is the forces acting on the cargo unit due to the “**Accelerations**” at the given lashing position. “**Securing capacity**” is the accumulated lashing forces from applied lashings. If sufficient number of lashings is applied, compliance will be shown by “**OK**” in red fonts to the right of each capacity.
9. Acceleration data for the whole ship can be extracted from the “**Tables and graphs**” sheet. This can be accessed by either pressing the “**Show graph >>**” button or by pressing the “**Tables and graphs**” tab.

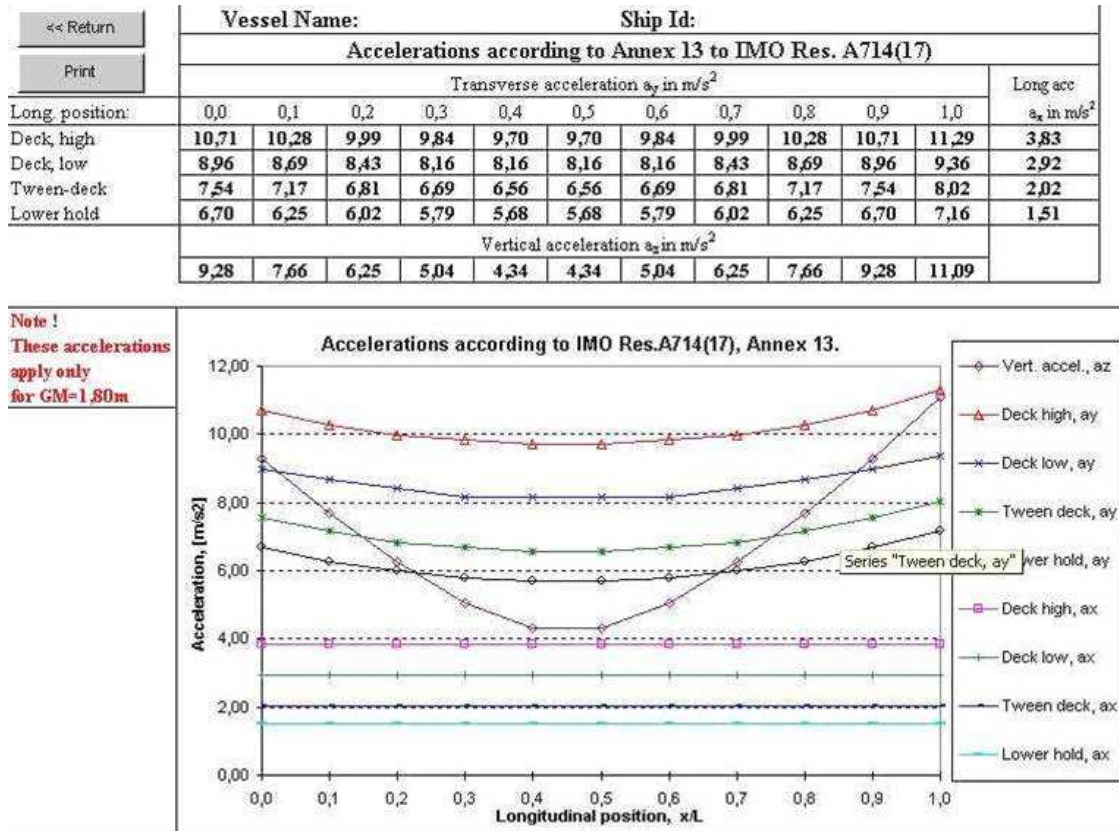


Chart and table showing the accelerations along the ship length, based on the annex 13 to the IMO CSS code.

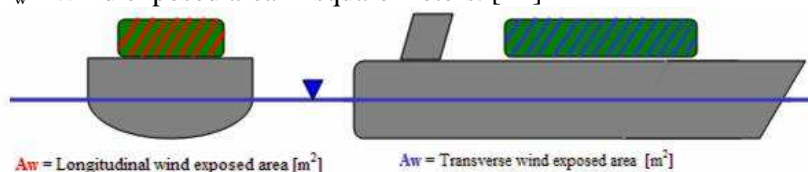
2.2 Input data

Main ship data:

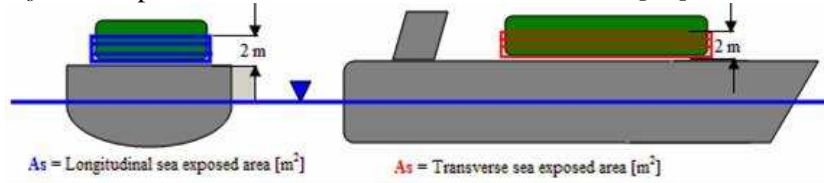
- Lpp - Length between perpendiculars in meters [m]
- B - Ship breadth in meters [m]
- V - Ship speed in knots [knots]
- GM - Ship GM value in meters [m]

Main cargo data:

- m - Mass of cargo unit in tonnes [ton]
- μ - Coefficient of friction [-]
- A_w - Wind exposed area in square meters. [m²]

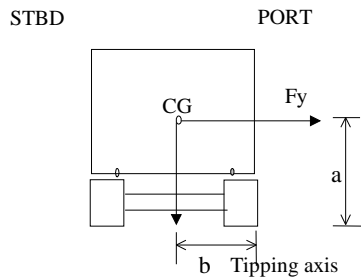


A_s - Sea exposed area, 2 meters above BL, in meters. [m^2]



a - Lever arm of tipping, i.e. height of cargo unit CG above deck, in meters. [m]

b - Lever arm of stability in meters. [m]

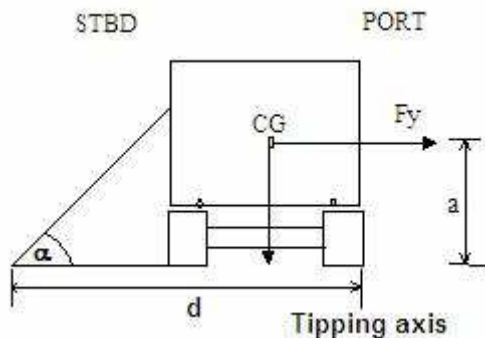


Advanced calculation, lashing parameters:

MSL - Max securing load [kN]

α - Vertical securing angle [degrees]

d - Lever arm of securing force [m]



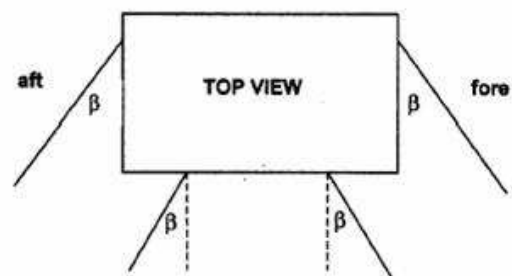
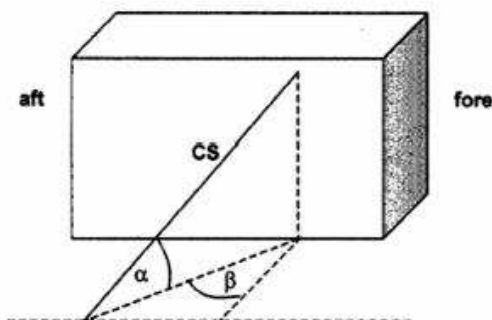
Alternative calculation, lashing parameters:

MSL - Max securing load [kN]

α - Vertical securing angle [degrees]

β - Horizontal securing angle [degrees]

d - Lever arm of securing force [m] (See Advanced Calculation, lashing parameters)



lashings shown on one side only

2.3 Calculation methods

Advanced calculation method

The advanced method is based on force equilibrium of internal inertia forces and external lashing forces. Additionally, the risk of tipping is evaluated on basis of moment equilibrium. Forces due to wind, sea and friction are accounted for. Elastic characteristics of lashings are not included.

In advanced calculations only the vertical angle of lashings, α , is included. Calculated strength of lashing, CS , is $MSL / 1.5$.

For detailed theory outline, please refer to CSS, Annex 13.

Alternative calculation method

The alternative calculation method is based on force equilibrium of internal inertia forces and external lashing forces. Additionally, the risk of tipping is evaluated on basis of moment equilibrium. Forces due to wind, sea and friction are accounted for. Elastic characteristics of lashings are not included.

The alternative method accounts for both the vertical of lashings, α , and horizontal angle of lashing β . The alternative method approach is regarded as more accurate than the advanced method. Hence the utilization of lashing strength is higher. Calculated strength of lashing, CS , is $MSL / 1.35$.

Which calculation method to choose?

The alternative calculation method is the most sophisticated with respect to force equilibrium. Hence, the allowable usage of the MSL is slightly higher. This method is therefore recommended. It should be noted that none of the calculation methods includes the elastic properties of the lashings. It is therefore important that the cargo unit is lashed with lashings of same type, with approximate equal elasticity. Lashing ropes and chains should not be combined. It is recommended to keep the lashings of approximately same lengths.

2.4 Special features of Lashcon IMO

Stack function:

LASHCONTM offers the possibility of saving your results in a stack. Lashing results, together with basic input is saved in a compact form in a table. In this way, the effect of different lashing arrangements or stowing positions can be compared in an easy manner.

Stack buttons:

“**Save to stack**”:
Current lashing data and results are saved to the stack.

“**Clear last**”:
Removes the last entry in the stack.

“**Clear stack**”:
Removes the contents of the entire stack.

“**Show stack**”:
Shows the stack.

2.5 Program assumptions

The calculation of accelerations and evaluation of lashing arrangements is based on the method described in annex 13 to the CSS code. For details on theory for evaluation of forces, please refer to CSS Annex 13. The following assumptions are directly quoted from the code:

A vertical securing angle α greater than 60° will reduce the effectiveness of this particular securing device in respect of sliding of the unit. Disregarding of such devices from the balance of forces should be considered, unless the necessary load is gained by the imminent tendency to tipping or by a reliable pre-tensioning of the securing device and maintaining the pre-tension throughout the voyage.

Any horizontal securing angle, i.e. deviation from the transverse direction should not exceed 30°, otherwise an exclusion of this securing device from the transverse sliding balance should be considered.

LASHCON™ applies to lashing arrangements with vertical securing angles in the range according to table 5 in annex 13, i.e. $-30^\circ \leq \alpha \leq 90^\circ$. Lashing angles outside this range may give corrupt results. In case such angle is given the program will give the following warning:

$\alpha < -30^\circ$ or $\alpha > 90^\circ$: **Warning! Securing angle outside range stated in annex 13.**

The acceleration figures shown in table 3 in annex 13 are basis for the calculation of accelerations in LASHCON™, and apply in principle to ships with $50 \text{ m} \leq L \leq 200 \text{ m}$, $9 \text{ kn} \leq V \leq 24 \text{ kn}$ and $B/GM \geq 7$.

In LASHCON™, however, the accelerations have been extrapolated by means of power series to apply for ships with $L > 30 \text{ m}$, and speed up to 25 knots. The B/GM has been extrapolated to apply down to $B/GM = 4$. LASHCON™ does not calculate transverse accelerations if $B/GM < 4$. If input parameters are outside the applicable range, the following warnings will appear:

$L > 200 \text{ m}$: **Warning! $L > 200$.**
Accelerations are extrapolated outside the range given in annex 13!

$B/GM < 7$: **Warning! $B/GM < 7$.**
Accelerations are extrapolated outside the range given in annex 13!

$B/GM < 4$: **Warning! $B/GM < 4$.**
Transverse accelerations are not calculated!

$V > 25 \text{ kn}$: **Warning! $V > 25 \text{ kn}$.**
Accelerations are not calculated!

Explanation of variables is given in the Help-function in LASHCON™. A complete explanation of variables involved and a full set of assumptions may be found in annex 13.

Appendix V – Certification for fixed cargo securing devices

Insert in this Appendix the (DNV) product certificates for fixed container securing devices and other fixed cargo securing devices.

Appendix VI – Certification for portable cargo securing devices

Insert in this Appendix the (DNV) product certificates for portable container securing devices, and the product certificates for other portable cargo securing devices.